Volume II

FOR THE SOUTHERN OREGON NORTHERN CALIFORNIA COAST EVOLUTIONARILY SIGNIFICANT UNIT OF

COHO SALMON

(*Oncorhynchus kisutch*)

Public Review DRAFT

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Southwest Regional Office
National Marine Fisheries Service
Arcata, CA

7. Elk River Population

- Northern Coastal Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 2,400 Spawners Required for ESU Viability
- 93 mi^2
- 63 IP km (39 mi) (23% High)
- Dominant Land Uses are Agriculture and Recreation
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Altered Hydrologic Function’
- Principal Threats are ‘Agricultural Practices’

7.1 History of Habitat and Land Use

Historically, the lower Elk River provided the most important habitat for coho salmon in the population area. Large wood jams spanning the lower Elk River channel would dislodge and relocate with winter high flows. The impacts to the Elk River basin included logging (and associated road-building) in the lower basin and extensive placer and hydraulic mining in the upper basin (Maguire 2001a). The legacy of mining in the Elk River basin may be substantial because hydraulic mining used water cannons to blast away alluvial deposits that caused potentially long lasting impacts on channel structure. Over time, settlement and associated agriculture encroached on the lower Elk River floodplain which confined the channel and reduced wetlands. These human settlements greatly reduced or eliminated wood jams and beaver that had previously helped form coho salmon rearing habitat. Basin-wide disturbances occurred from 1950 to 1990 and were associated with expansion of the road network and industrial logging on public and private lands (U.S. Forest Service (USFS) 1998a). Extensive road networks were developed to support logging, and these roads and timber harvesting practices greatly damaged the landscape surrounding the Elk River and impacted the water quality and habitat in the river and its tributaries. Between 1954 and 1989, over 300 million board feet of timber were removed from the Elk River population area and the cumulative effects

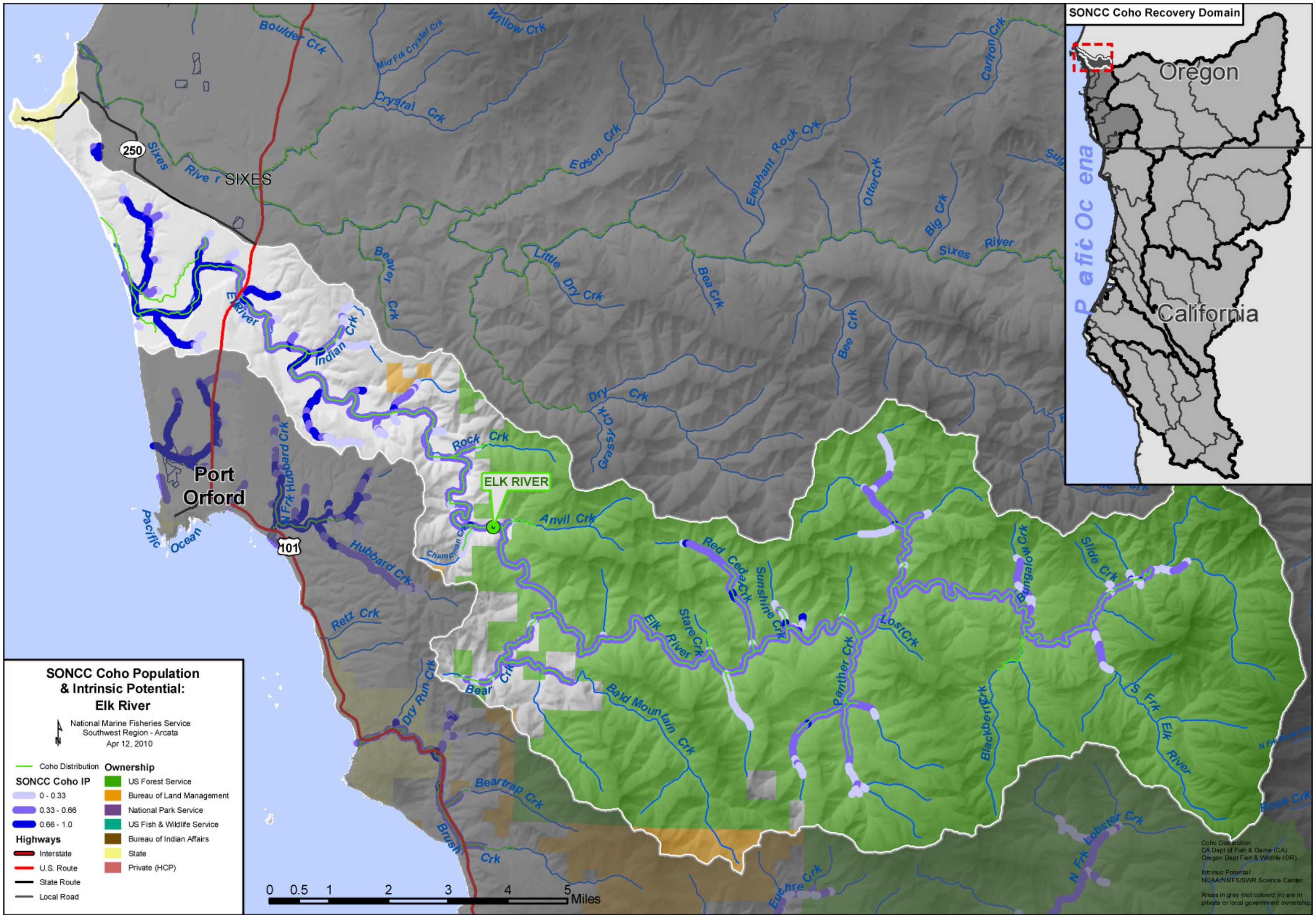

Figure 7-1. The geographic boundaries of the Elk River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

to streams were substantial, particularly following large storm events (USFS 1998a). Between 1952 and 1986, road and harvest-related landslides within the basin delivered 2.2 times more fine sediment volume than naturally-occurring landslides (USFS 1998a). Currently, the Elk River is recognized as a Key Watershed under the Northwest Forest Plan, (USDA and USDI 1994) and much of the USFS land is managed as Wilderness or Late Successional Reserve. Private timberlands are limited in the population area. In the last two decades, cranberry farming has expanded into lower tributary watersheds, where on and off-stream storage reservoirs have been built. Cranberry farming has contributed to the loss of function in three low gradient tributaries that were mostly high IP coho salmon habitat. Residential development has also increased in the lower basin.

7.2 Historic Fish Distribution and Abundance

The Elk River basin has 63 total Intrinsic Potential-kilometers (IP-km) of coho salmon habitat (Williams et al. 2008). Approximately 7.7 km of IP habitat is currently inaccessible due to a dam. The coho salmon habitat with highest IP is concentrated in the lower Elk River, including all tributaries of the alluvial coastal plain downstream of Rock Creek (Williams et al. 2008) (Figure 7-1). Short, low gradient stream reaches in upper tributaries, such as the North Fork Elk River, Red Cedar Creek, Panther Creek and Butler Creek also have optimal IP habitat.

Historically, coho salmon were more abundant in the Elk River basin than they are today. Contemporary distribution of coho salmon is much reduced from the period of early Anglo-American settlement beginning in the 1850s. This reduction may be due to habitat modification in the lower reaches, including diking and channelization of the mainstem, which eliminated summer and winter rearing habitat (Maguire 2001a). Smaller tributaries, such as one near the mouth of Elk River and upstream of Highway 101, are now disconnected or dammed for agricultural water supply. In 1927, the gillnet catch from the Elk River was dominated by 13,334 pounds of coho salmon (USFS 1998a). Tributaries with the highest IP are shown in Table 7-1.

Table 7-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Lower Elk River and Estuary	Panther Creek	Sunshine Creek
Indian Creek	Red Cedar Creek	Butler Creek
Bagley Creek		

7.3 Status of Elk River Coho Salmon

Spatial Structure and Diversity

Oregon Department of Fish and Wildlife (ODFW) has conducted adult coho salmon, carcass and redd counts (ODFW 2008a) and juvenile snorkel surveys (ODFW 2005a) in the mainstem Elk River and its tributaries. There are far more surveys with no sightings than those where coho salmon were found. Adult coho salmon were found in Anvil, Indian, Butler, and Red Cedar creeks as well as the mainstem Elk River between Sunshine Creek and Red Cedar Creek.

Juvenile coho salmon were found in Panther, Red Cedar, and Blackberry creeks as well as the middle mainstem Elk River. USFS (1998a) identified Red Cedar, the North Fork Elk, Panther Creek, and Anvil Creeks as those most important for coho salmon production as they appeared to account for most coho salmon production in the basin. The very low number of adult fish observed by ODFW and low density of juveniles in summer surveys indicates a very small population which would likely have restricted genetic diversity.

Population Size and Productivity

In 1997, adult coho salmon populations for the entire Elk River population area ranged between 100 and 200 (USFS 1998a). Estimated returns were zero in many years between 1998 and 2007, and at most 501 in 1998 (ODFW 2009a) (Table 7-2). Large differences in effort between years and incomplete survey coverage could account for observed differences in estimates. In addition, high flows may have occurred in some years, which could affect the ability to carry out sampling consistently or effectively.

Table 7-2. Estimates of annual spawning escapement of coho salmon for the Elk River. 1998 to 2008 (ODFW 2009a).

Year	Population Estimate	Year	Population Estimate	Year	Population Estimate
1998	501	2002	104	2006	0
1999	Not estimated	2003	187	2007	230
2000	0	2004	0	2008	Not estimated
2001	Not estimated	2005	0		

Extinction Risk

The Elk River coho salmon population is not viable and at high risk of extinction because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008). In addition, the areas where juvenile coho salmon currently rear are concentrated in the low gradient reaches of steeper upper basin tributaries, recognized by Frissell (1992) as alluviated canyons. These areas are prone to alteration by floods and populations dependent on them are vulnerable to periodic disturbance and habitat alterations. Therefore, even the low numbers of coho salmon observed in some years are at high risk of losing their habitat.

Role in SONCC Coho Salmon ESU Viability

As an independent population, the Elk River once served as a source of spawners for adjacent populations, such as Hubbard, Brush, Mussel and Euchre creeks to the south. As a core population, the Elk River will be required to achieve viability and once again serve as a source of spawners for adjacent populations.

7.4 Plans and Assessments

State of Oregon

Expert Panel on Limiting Factors for Oregon's SONCC coho salmon populations

ODFW (2008b) convened a panel of fisheries and watershed scientists as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on limiting factors and threats to recovery. Based on the input of panel members, concerns for the Elk River population are as follows:

> Key concerns were primarily loss of over-winter tributary and freshwater estuarine habitat complexity and floodplain connectivity for juveniles, especially in the lowlands which are naturally limited in this system and have been impacted by past and current agricultural practices. Secondary concerns were primarily related to high water temperatures in tributaries for summer parr (excluding the mainstem, where rearing is not expected) and loss of tributary habitat for juveniles and adults due to road crossings (especially in Bagley and Blackberry Creeks).

Oregon Plan for Salmon and Watersheds
http://www.oregon.gov/OPSW/about_us.shtml

The State of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is a comprehensive plan that includes voluntary actions for all of the threats currently facing coho salmon in these ESUs and involves all relevant state agencies. Reforms to fishery harvest and hatchery programs were implemented by ODFW in the late 1990s. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary.

Cumulative Effects of Southwest Oregon Coastal Land Use on Salmon Habitat

Oregon State University's Oak Creek Labs conducted a study funded by ODFW and the Oregon Department of Forestry to determine relationships between forest harvest and Pacific salmon productivity (Frissell 1992). The study assessed basins along the Oregon coast extending from the Sixes River to the southern border during the period from 1986 to 1992 with the most extensive research conducted in Euchre Creek to the south of the Elk River.

Oregon Clean Water Act 303(d) Impaired Water Body List

The mainstem Elk River and estuary, Bald Mountain Creek and Butler Creek are recognized as water quality impaired on the Oregon Clean Water Act 303d impaired water body list due to temperature problems and habitat modification. No TMDL has been approved.

U.S. Forest Service

Elk River Watershed Analysis (USFS 1998a)

The Elk River watershed analysis was developed to implement the Northwest Forest Plan and provides the watershed context for fishery protection, restoration, and enhancement efforts. The following is a summary of the most relevant findings:(1) Excessive sediment from natural and management activities has decreased pool depth; (2) Reduction of pool depth decreases available habitat and fish production and provides a competitive advantage to steelhead over other salmonids;(3) High road densities change hillslope hydrology, which contributes to elevated peak flows that damage streams; and(4) Over-winter survival for juvenile salmonids may be decreased due to low habitat complexity (i.e., no slow velocity marginal habitats behind large wood jams or old growth riparian trees).

Sufficiency Assessment: Forest Service and Bureau of Land Management Programs in Support of SONCC Coho Salmon Recovery (USFS and BLM 2011)

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, Upper Elk River was identified as a high priority 6th field subwatershed in the Rogue-Siskiyou National Forest (USFS and BLM 2011).

South Coast Watershed Council

Elk River Watershed Assessment (Maguire 2001a)

The Elk River watershed assessment includes a compilation, summary, and synthesis of existing data and information pertaining to watershed conditions in the Elk River basin. Some findings relevant to coho salmon recovery include issues with water temperature, highly altered wetlands, weak riparian cover (especially in the lower sections), sediment sources (present and potential), and noxious weed invasions. The assessment describes variation in run timing of coho salmon in the Elk River basin, with “early” coho salmon entering streams beginning in about mid-November and spawning soon after, while “late” coho salmon delay spawning until as late as March or April.

Elk River Action Plan (Massingill 2001a)

The Elk River action plan is a companion to Maguire (2001a) and defines specific action items for restoration of the Elk River basin.

7.5 Stresses

Table 7-3. Severity of stresses affecting each life stage of coho salmon in the Elk River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

Stresses (Limiting Factors)		Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	High	High	Very High[1]	Very High	Very High	Very High
2	Altered Hydrologic Function	High	High	High	Medium	Medium	High
3	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
4	Impaired Water Quality[1]	Low	High	Very High[1]	High	Low	Very High
5	Impaired Estuary/Mainstem Function	-	Low	Medium	High	Low	Medium
6	Altered Sediment Supply	Medium	Medium	Medium	Low	Medium	Medium
7	Barriers	-	Medium	Medium	Low	Medium	Medium
8	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
9	Increased Disease/Predation/Competition	Low	Low	Low	Low	Low	Low
10	Adverse Fishery-Related Effects	-	-	-	-	Low	Low

[1]Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited and quality winter rearing habitat, as well as summer rearing habitat, is lacking for the population. Juvenile summer rearing habitat is impaired by high temperatures resulting from degraded riparian conditions and water withdrawals. Winter rearing habitat has been reduced by channelization, diking, and filling of wetlands. Timber removal has decreased the source of large wood, and most historically available habitat in the estuary has been altered by development, channelization, sedimentation, and diking. Overall, these findings are consistent with those of the Oregon Expert Panel (ODFW 2008b) (Section 7.4), but the expert panel considered water temperature to be only a secondary, not primary, concern.

The IP habitat in the Elk River basin is concentrated in the low gradient reaches of the basin near the ocean. No thermal refugia have been noted. Off-channel juvenile rearing habitat with suitable temperature is vital to coho salmon recovery in this river. Habitat currently occupied by coho salmon is at a premium and should be prioritized for protection.

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure is the greatest constraint to coho salmon production in the Elk River. The lower Elk River channel is disconnected from its floodplain, wetlands, and tributaries (Figure 7-2). This has significantly reduced what was once optimal habitat for coho salmon spawning, egg incubation, and rearing. The ODFW (2008b) Expert Panel found that loss of floodplain connectivity and access to off-channel habitat was a major limiting factor in this population. This stress applies to both freshwater and tidally-influenced freshwater areas. Tributary channels are also altered by agricultural activities, as evidenced in aerial photos (Figure 7-2). One entire fork of Swamp Creek is no longer discernible on aerial photos and has been completely filled in. Large woody debris was historically important and available in the lower Elk River but today there is little large wood (ODFW 2008b).

Figure 7-2. Aerial image from Google Earth of the Lower Elk River above and below Highway 101 (Yellow line is highway.). Rectangular beige shapes are cranberry bogs. Filled river meanders, cutoff wetlands and streams, and an irrigation pond on a tributary (right) are highlighted with red arrows.

Altered Hydrologic Function

Diversion dams block water movement and restrict flows in a few lower river tributaries. Flow to the estuary from tributaries is completely disconnected. Wells for domestic and agricultural water supply in the lower Elk River and its tributaries have the potential to reduce surface water availability, which could substantially diminish coho salmon habitat in the smaller streams.

Water diversions or surface water supply reductions both can directly reduce the amount of habitat available to coho salmon by drying up smaller streams and can increase water temperatures, making habitat unsuitable for coho salmon. The Elk River Watershed Assessment (Maguire 2001a) found that the minimum Oregon Water Rights Division (OWRD) instream-flow right of 45 cubic feet per second in the mainstem Elk River is usually met. However, the only gauge is above the Elk River Fish Hatchery, and no measurements are taken further downstream or in tributaries with high IP. Therefore, compliance with the instream flow downstream of the hatchery has not been established. Increased peak flows in the watershed (USFS 1998acan negatively affect redd stability and over-winter survival of fry and juveniles.

Degraded Riparian Forest Conditions

ODFW (2008b) noted problems with high water temperatures due to riparian shade loss and competition from non-native shrubs. Elk River riparian zones were once dominated by large conifers, but today are dominated by hardwoods and invasive non-native species including gorse and Himalayan blackberry (USFS 1998a, Maguire 2001a). In steeper channels of headwater streams, riparian trees may be removed by rapidly moving landslides known as debris torrents that move down channels (USFS 1998a).

Impaired Water Quality

Water temperature in the mainstem Elk River, Bald Mountain, Panther and Butler creeks does not meet the ODEQ maximum average weekly temperature (temperature) standard of 64 ºF. Water temperatures are suitable during the time of adult returns and when eggs are in the gravel. Data from the South Coast Watershed Council’s monitoring program from 1991 to 2000 indicate that the warmest 7-day maximum recorded in the Elk River basin was 74.1 °F on the mainstem of the Elk River below Camp Creek. The water temperature at Bagley Creek is 3 to 4 °F warmer than that observed upstream at the National Forest boundary (Maguire 2001a). Butler, Bald Mountain, and Panther creeks were warm and ranged from 66 °F to 68 °F (USFS 1998a). Swamp Creek, a tributary to the estuary, also had impaired water temperature conditions of 69.7 °F (USFS 1998a). Fecal coliform levels exceeded standards in 8 out of 27 samples often during high flows, indicating moderately impaired conditions (Maguire 2001a). Phosphate levels exceeded the water quality standards 4 out of 28 samples (14.3 percent) during high flow events. All of these data (Maguire 2001a, USFS 1998a) are at least ten years old and so should not be considered a definitive description of current conditions. Effects of pesticides and herbicides on salmon are harmful (Ewing 1999), but there are no pesticide studies in the Elk River, nor any regional data available (Riley 2009).

Impaired Estuary/Mainstem Function

The main issues for coho salmon in the estuary are insufficient holding habitat for smolts and the barriers described below. Based on aerial photos, most of the land adjacent to the Elk River estuary has been converted to agricultural land, with associated channelization and diking that has disconnected small tributaries. A small amount of off-channel habitat remains near the mouth.

Altered Sediment Supply

Altered sediment supply poses an overall medium stress to coho salmon in the Elk River. Sediment contribution from landslides and erosion occurs naturally in the Elk River basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. High sediment yield is of particular concern in those areas of the basin with decomposing diorite-type soil, such as at Bald Mountain Creek and Purple Mountain Creek (Maguire 2001a). Excess fine sediment directly impacts coho salmon egg viability and can reduce food for fry, juveniles and smolts. Poor pool frequency and depth throughout the Elk River basin (Maguire 2001a) are likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and, in some reaches, diminished scour due to channel widening.

Barriers

The most important barriers in the Elk River are two agricultural dams that block migration of coho salmon and contribute to excessively high water temperature. One of the dams disrupts Swamp Creek, the tributary that was formerly connected to the estuary, and a second affects the small unnamed creek immediately upstream of Highway 101. In addition, diking and filling of river and estuarine tributaries constitute a great impediment to fish movement that is addressed as part of the channelization and diking stress. A few culverts are in need of modification to improve fish passage, as described in the “road-stream crossing barriers” threat description.

Adverse Hatchery Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. The Elk River Hatchery releases approximately 295,000 Chinook salmon juveniles into Elk River each September and an additional 10,000 yearling Chinook in April (ODFW 2008c). The risk of competition between wild coho salmon and hatchery-produced steelhead and Chinook salmon is minimized by rearing fish to a sufficient size that smoltification occurs quickly and the stocked fish quickly leave the river for the ocean (ODFW 2008c). Due to temperature impairment below the hatchery, juvenile coho salmon rear mostly upstream of the hatchery. Due to these factors, the potential for competition between hatchery-released Chinook salmon and wild coho salmon is expected to be reduced. Adverse hatchery-related effects pose a medium risk to all life stages of coho salmon in the Elk River, because of the ongoing in-basin stocking with Chinook salmon (Appendix B).

Disease/Predation/Competition

Water temperatures that are too high could elevate disease risk, although there are no recognized fish disease problems in the basin. Elk River Hatchery proactively manages disease risk and minimizes the risk of exposure of coho salmon to hatchery-related disease (ODFW 2008c).

Adverse Fishery-Related Effects

NMFS has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

7.6 Threats

Table 7-4. Severity of threats affecting each life stage of coho salmon in the Elk River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Agricultural Practices	High	High	High	High	High	High
2	Dams/Diversions	-	High	High	High	High	High
3	Channelization/Diking	High	High	High	Medium	Medium	High
4	Roads	Low	Medium	Medium	Medium	Medium	Medium
5	Timber Harvest	Medium	Medium	Medium	Low	Medium	Medium
6	Invasive/Non-Native Alien Species	-	Medium	Medium	Medium	Medium	Medium
7	Road/Stream Crossing Barriers	-	Low	Medium	Medium	Medium	Medium
8	Climate Change	-	-	Medium	Medium	Medium	Medium
9	High Intensity Fire	Low	Low	Low	Low	Low	Low
10	Hatcheries	Low	Low	Low	Low	Low	Low
11	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low
12	Urban/Residential/Industrial	Low	Low	Low	Low	Low	Low
13	Fishing and Collecting	-	-	-	-	Low	Low

Agricultural Practices

Agricultural practices are the top threat for coho salmon because their impacts are concentrated in the lower basin, where the highest IP habitat exists. Agricultural impacts include the loss and filling of wetlands, water diversion, riparian alteration, polluted stormwater runoff, and blocked access to formerly productive tributaries. Areas of bare soil on terraces adjacent to the lower river and estuary, and newly cleared riparian forests, which are apparent in recent aerial photo images, suggest that agricultural activities may be expanding. The ODFW (2008b) expert panel found agricultural activities to be the causal mechanism for a number of factors limiting Elk River coho salmon production. Removal of riparian trees, particularly conifers, associated with agricultural activities decreases shade and promotes increased water temperature. Cattle grazing can degrade bank structure, initiate erosion, and lead to increases in nutrients and pollutants. Non-point source pollution from cranberry cultivation has not been assessed, but the South Coast Watershed Council is working with growers to consider value-added organic options.

Dams/Diversions

There are two main effects of diversions on coho salmon: passage impairment and reduced water in the river. The most problematic diversions are those to cranberry bogs and the agricultural dams on Swamp Creek and the small unnamed creek just upstream of Highway 101. These and other diversions facilitate movement of water away from juvenile rearing habitat. The USGS stream flow gage is upstream of the Elk River hatchery and flow data for the lower river are not available. This reach may be at risk from over-diversion, but there are insufficient data to evaluate.

Channelization and Diking

The ODFW (2008b) expert panel found that habitat simplification, resulting from straightening, channelizing, revetting, filling, and/or stream channel dredging, was the most limiting stress upon coho salmon in the Elk River. One entire fork of Swamp Creek has been filled. Much of the lower Elk River channel has been diked since the major floods of 1955 and 1964 (USFS 1998a). Channel confinement causes bed load mobility that disrupts redds which results in high stress to eggs. Fry and juveniles have difficulty over-wintering in confined channels because of elevated water velocities and a lack of off-channel refugia. The Lower Elk River lacks large wood jams that formerly provided shelter from winter high flows and complex summer rearing habitat. Streamside roads in the basin may also confine the channel, creating higher velocities.

Roads

Some areas have road densities exceeding levels known to increase risk of fine sediment yield and altered hydrology. There are far more un-surfaced roads than paved roads in the Elk River basin, which can increase surface erosion. Road densities are highest in the lower Elk River, Panther Creek and Bald Mountain Creek watersheds. The number of road failures and landslides caused by roads is far greater on roads constructed before 1980 than more recently built roads (USFS 1998a).

Timber Harvest

Timber harvest poses a medium threat in the Elk River basin because of high rates of timber harvest on private lands. Private timberlands are located in the lower Elk River, in tributaries such as Indian and Bagley creeks, as well as in-holdings in the Bald Mountain and Panther Creek drainages. Harvest practices on private lands has been shown to increase movement of fine sediment to the Elk River, where the percentage of fine sediment from landslides delivered to streams was higher where trees had been harvested from riparian areas (USFS 1998a). High rates of timber harvest and high road densities in the lower Elk River is a concern because the tributary streams found there will be important for coho salmon recovery.

Invasive Non-Native Species

Gorse, Himalayan blackberry, and scotch broom pose serious problems for agricultural land in the lower river. These species have colonized riparian zones and are inhibiting regeneration of native hardwoods and conifers that provide shade and channel stability and allow for long-term large wood recruitment. Japanese knotweed (*Polygonum cuspidatum*) has spread into areas near

Port Orford and may be present in the Elk River (ODA 2010). Japanese knotweed is aggressive, fast growing, and out-competes native vegetation in riparian areas. Scotch broom and gorse are also locally common and similarly invasive. If these plants replace conifers or hardwoods in riparian zones, coho salmon habitat will be substantially impacted.

Road-Stream Crossings (Barriers)

Road crossings on Bagley and Blackberry Creeks are high priority barriers (ODFW 2008b). Additional barriers are listed in Table 7-5.

Table 7-5. List of prioritized road-stream crossing barriers in the range of Elk River coho salmon.

Priority	Stream Name	Road Name	Subarea	County	Miles of habitat*
High	Bagley Creek	NA	N/A	N/A	N/A
High	Blackberry Creek	NA	N/A	N/A	N/A
N/A	Chapman Creek	At intersection with Elk River	N/A	N/A	N/A

Climate Change

Air temperatures during July are expected to increase by0.0 – 0.5 °C at the coast and 1.5 to 2.0 °C in the eastern portion of the basin. January temperature rise is similar with an increase 0.5 to 1.0 °C at the coast and 1.0 to 1.5 °C in the interior portion of the basin. The latter trend could reduce snow pack in higher elevations, diminishing this source of cold water for coho salmon juvenile rearing. Sea level rise could expand the estuary and the footprint of tidal wetlands, which could potentially benefit coho salmon.

High Intensity Fire

The large amount of land owned by the USFS and managed as Wilderness and Late Successional Reserves means that the Elk River basin has more old growth coniferous forest and maturing stands than any other southwest Oregon coastal basin. Stands of this type have a low risk of stand-replacing fires.

Hatcheries

Hatcheries pose a medium threat to all life stages of coho salmon in the Elk River. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

Mining/Gravel Extraction

There are 534 historic mining claims in the Elk River basin (Bredensteiner et al. 2001), and eight are active. There is currently no industrial scale gravel extraction. Minor amounts of aggregate are extracted for local use. An application has been filed with the Army Corps of Engineers for extraction from the lower river (Wheeler 2009).

Urban/Residential/Industrial

There is some rural residential development in the lower Elk River. Residential development is concentrated in the lower basin, where the highest value coho salmon habitat occurs. Rural residential development can cause a variety of negative effects upon coho salmon and their habitats. These potential effects include, but are not limited to: increased road densities, increased densities of impervious surfaces, channel modification, reductions in riparian vegetation, reductions in riparian function, increased pollution and runoff, and reductions in in-stream water availability.

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook-directed fisheries. The exploitation rates associated with this freshwater fishery and all other fisheries managed by the State of Oregon were found to be low enough to avoid jeopardizing the existence of the ESU (NMFS 1999). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because recovery objectives to achieve species viability had not been established for SONCC coho salmon at that time (NMFS 1999). As of April 2011, NMFS has not authorized future collection of coho salmon for research purposes in Elk River.

7.7 Recovery Strategy

Deficiencies in the amount of suitable, juvenile rearing habitat are the most important factors limiting Elk River coho salmon recovery. The processes that create and maintain such habitat must be restored by increasing channel complexity and restoring flow. Channel complexity should be improved by constructing off-channel ponds or backwater habitat, restoring wetlands, and limiting development and fill. To increase instream structure, LWD should be added to stable channels to provide structure until natural sources of LWD (mature coniferous forests) are re-established next to the stream. Areas adjacent to the stream should be replanted and subsequently thinned to re-establish mature streamside forest as a source for LWD recruitment.

The most immediate need for habitat restoration and threat reduction in the Elk River are in those areas currently occupied by coho salmon, which are identified in this profile. Unoccupied areas must also be restored to provide enough habitats to allow for coho salmon recovery. Those areas with high IP habitat such as the Lower Elk River, Bagley Creek, Panther Creek, and Sunshine Creek are optimum candidates for restoration actions.

Table 7-6 on the following page lists the recovery actions for the Elk River population.

Table 7-6. Recovery action implementation schedule for the Elk River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkR.2.2.5	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Private timberlands that include: tributaries of the alluvial coastal plain downstream of North Fork Elk River, Rock, Indian, Bagley, Red Cedar, Panther, and Butler creeks	3
SONCC-ElkR.2.2.5.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-ElkR.2.2.5.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-ElkR.2.1.6	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	All tributaries of the alluvial coastal plain downstream of Rock Creek, as well as Indian Cree, Bagley, Sunshine creeks, North Fork Elk River, Red Cedar, Panther, and Butler creeks	3
SONCC-ElkR.2.1.6.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-ElkR.2.1.6.2	*Place instream structures, guided by assessment results*					
SONCC-ElkR.2.2.29	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Populatino wide	3
SONCC-ElkR.2.2.29.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-ElkR.2.2.29.2	*Implement beaver program (may include reintroduction)*					
SONCC-ElkR.10.2.14	Water Quality	Yes	Reduce pollutants	Educate stakeholders	Lower Elk River and tributaries downstream of confluence of Rock Creek	BR
SONCC-ElkR.10.2.14.1	*Develop an educational program that promotes Salmon Safe methods for agricultural operations and Integrated Pest Management for rural residents*					
SONCC-ElkR.10.2.15	Water Quality	Yes	Reduce pollutants	Set standard	Population wide	3
SONCC-ElkR.10.2.15.1	*Develop TMDLs for 303(d) listed water bodies*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkR.1.4.7	Estuary	No	Protect estuarine habitat	Improve regulatory mechanisms	Estuary	2
SONCC-ElkR.1.4.7.1	*Limit development and filling of estuarine habitat through the development of regulatory mechanisms such as county or city ordinances*					
SONCC-ElkR.1.4.7.2	*Maintain or strengthen current estuarine protection measures*					
SONCC-ElkR.1.2.8	Estuary	No	Improve estuarine habitat	Restore tidally influenced habitats	Estuary	3
SONCC-ElkR.1.2.8.1	*Assess coho use of different estuarine habitats and develop a plan to enhance those habitats (i.e. brackish wetlands, tidal sloughs, salt marshes, and tidally influenced freshwater)*					
SONCC-ElkR.1.2.8.2	*Restore tidally influenced habitats, guided by the plan*					
SONCC-ElkR.1.2.28	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-ElkR.1.2.28.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-ElkR.1.2.28.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-ElkR.16.1.16	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ElkR.16.1.16.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-ElkR.16.1.16.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-ElkR.16.1.17	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-ElkR.16.1.17.1	*Determine actual fishing impacts*					
SONCC-ElkR.16.1.17.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-ElkR.16.2.18	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ElkR.16.2.18.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-ElkR.16.2.18.2	*Identify scientific collection impacts expected to be consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkR.16.2.19	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ElkR.16.2.19.1	*Determine actual impacts of scientific collection*					
SONCC-ElkR.16.2.19.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-ElkR.3.1.12	Hydrology	No	Improve flow timing or volume	Increase instream flows	Lower Elk River and tributaries downstream of confluence of Rock Creek	3
SONCC-ElkR.3.1.12.1	*Determine instream flow needs for coho salmon, utilize existing USGS gauging station information*					
SONCC-ElkR.3.1.12.2	*Perform a groundwater study to determine the volume of aquifer storage and the role of aquifers in streamflow*					
SONCC-ElkR.3.1.13	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Lower Elk River and tributaries downstream of confluence of Rock Creek	3
SONCC-ElkR.3.1.13.1	*Provide incentives and education to landowners to reduce water consumption and reduce groundwater pumping and surface water diversion by utilizing conservation and storage.*					
SONCC-ElkR.27.1.20	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-ElkR.27.1.20.1	*Perform annual spawning surveys*					
SONCC-ElkR.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-ElkR.27.1.21.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-ElkR.27.1.22	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-ElkR.27.1.22.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkR.27.2.23	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-ElkR.27.2.23.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-ElkR.27.2.23.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-ElkR.27.2.24	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-ElkR.27.2.24.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-ElkR.27.2.25	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-ElkR.27.2.25.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-ElkR.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-ElkR.27.2.26.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-ElkR.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-ElkR.27.2.27.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-ElkR.27.1.31	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-ElkR.27.1.31.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-ElkR.27.2.32	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-ElkR.27.2.32.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-ElkR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkR.27.1.33.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-ElkR.27.1.33.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-ElkR.27.2.34	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-ElkR.27.2.34.1	*Determine best indicators of estuarine condition*					
SONCC-ElkR.5.1.11	Passage	No	Improve access	Remove barriers	Swamp Creek, unnamed tributary above Highway 101, and other streams downstream of confluence of Rock Creek and the mainstem Elk River.	3
SONCC-ElkR.5.1.11.1	*Evaluate and prioritize barriers for removal*					
SONCC-ElkR.5.1.11.2	*Remove barriers*					
SONCC-ElkR.7.1.1	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	USFS lands	2
SONCC-ElkR.7.1.1.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-ElkR.7.1.1.2	*Thin, or release conifers, guided by prescription*					
SONCC-ElkR.7.1.1.3	*Plant conifers, guided by prescription*					
SONCC-ElkR.7.1.2	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Private lands subject to development and Panther, Red Cedar, and Blackberry creeks, middle mainstem Elk River	3
SONCC-ElkR.7.1.2.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-ElkR.7.1.2.2	*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat*					
SONCC-ElkR.7.1.3	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Elk River, west of Indian Creek, between County Highway 207 and Elk River Road	3
SONCC-ElkR.7.1.3.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-ElkR.7.1.3.2	*Develop grazing management plan to meet objective*					
SONCC-ElkR.7.1.3.3	*Plant vegetation to stabilize stream bank*					
SONCC-ElkR.7.1.3.4	*Fence livestock out of riparian zones*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkR.7.1.3.5	*Remove instream livestock watering sources*					
SONCC-ElkR.7.1.4	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Private timberlands that include: tributaries of the alluvial coastal plain downstream of North Fork Elk River, Rock, Indian, Bagley, Red Cedar, Panther, and Butler creeks	2
SONCC-ElkR.7.1.4.1	*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*					
SONCC-ElkR.7.1.30	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	BLM lands	3
SONCC-ElkR.7.1.30.1	*Manage timber harvest (and associated activities) on Federal lands in accordance with the Aquatic Conservation Strategy of the NWFP to achieve riparian and stream channel improvements for coho salmon*					
SONCC-ElkR.8.1.9	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	All tributaries of the alluvial coastal plain downstream of Rock, Indian, and Bagley creeks. Priority is the Butler Creek watershed.	3
SONCC-ElkR.8.1.9.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-ElkR.8.1.9.2	*Decommission roads, guided by assessment*					
SONCC-ElkR.8.1.9.3	*Upgrade roads, guided by assessment*					
SONCC-ElkR.8.1.9.4	*Maintain roads, guided by assessment*					

8. Brush Creek Population

- Northern Coastal Stratum
- Dependent Population
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 12 mi^2
- 6 IP km (4 IP mi) (18% High)
- Dominant Land Uses are Recreation, Timber Harvest
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Degraded Riparian Forest Conditions’
- Principal Threats are ‘Roads’ and ‘Channelization and Diking’

8.1 History of Habitat and Land Use

Maguire (2001b) notes the Brush Creek watershed is poorly studied and the history of land use in the area is inconsistent. The creek bottom was the main trail north and south for Native Americans and then white settlers before a road was built through Brush Creek canyon just after 1920. The State of Oregon made its first purchase of land for Humbug Mountain State Park in 1926 and continued to expand the park to its current size (1800 acres) over the following 50 years. Maguire (2001b) could not substantiate whether there was a mill in middle Brush Creek reaches, but historic logging was widespread. Although Maguire (2001b) did not mention recent logging, it is evident in aerial photos as is the power line corridor, which can be easily seen because of the early seral conditions (Figure 8-2). The Highway 101 corridor confines the stream for long reaches and constitutes the most significant disturbance in the Brush Creek basin

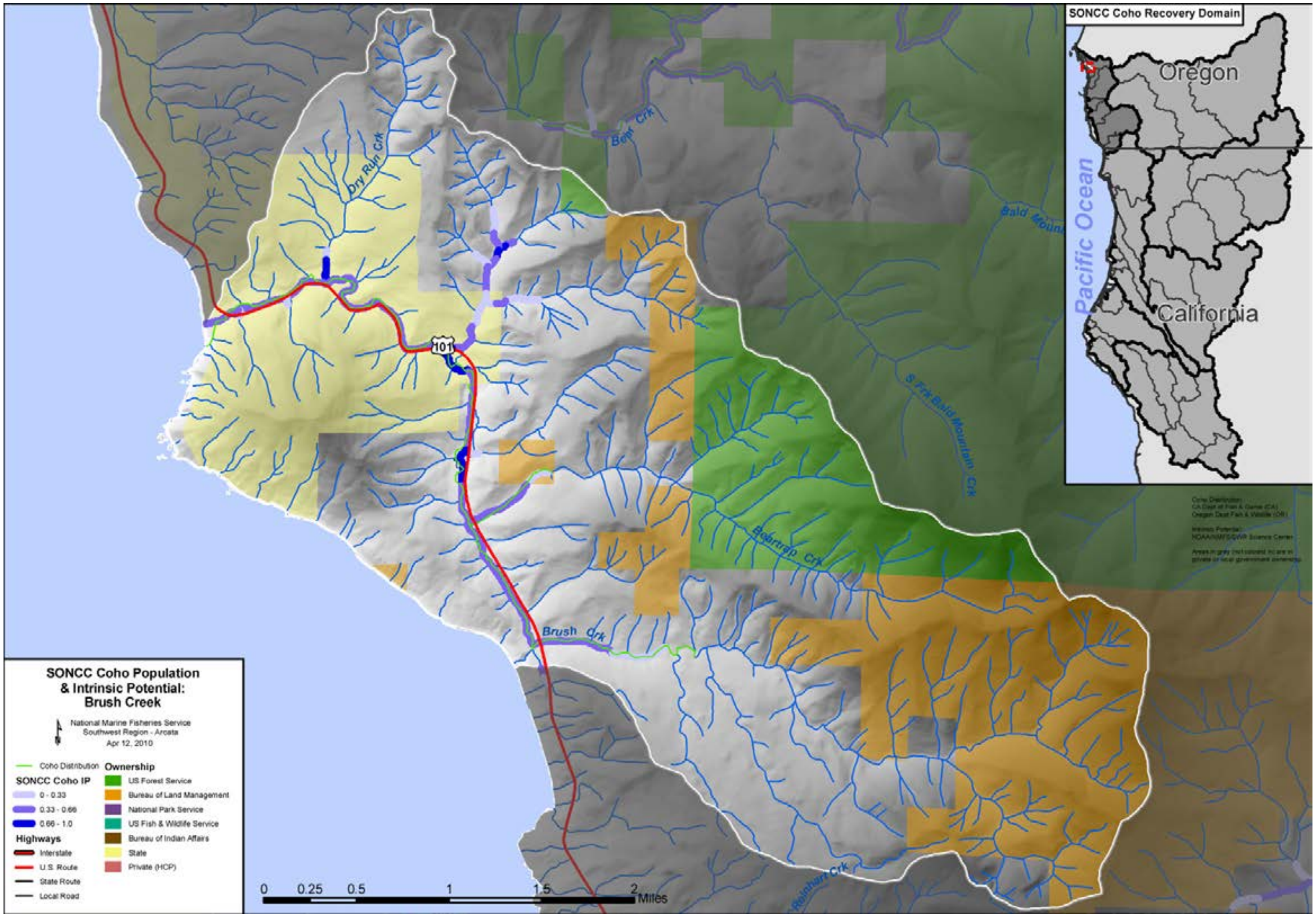

Figure 8-1. The geographic boundaries of the Brush Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

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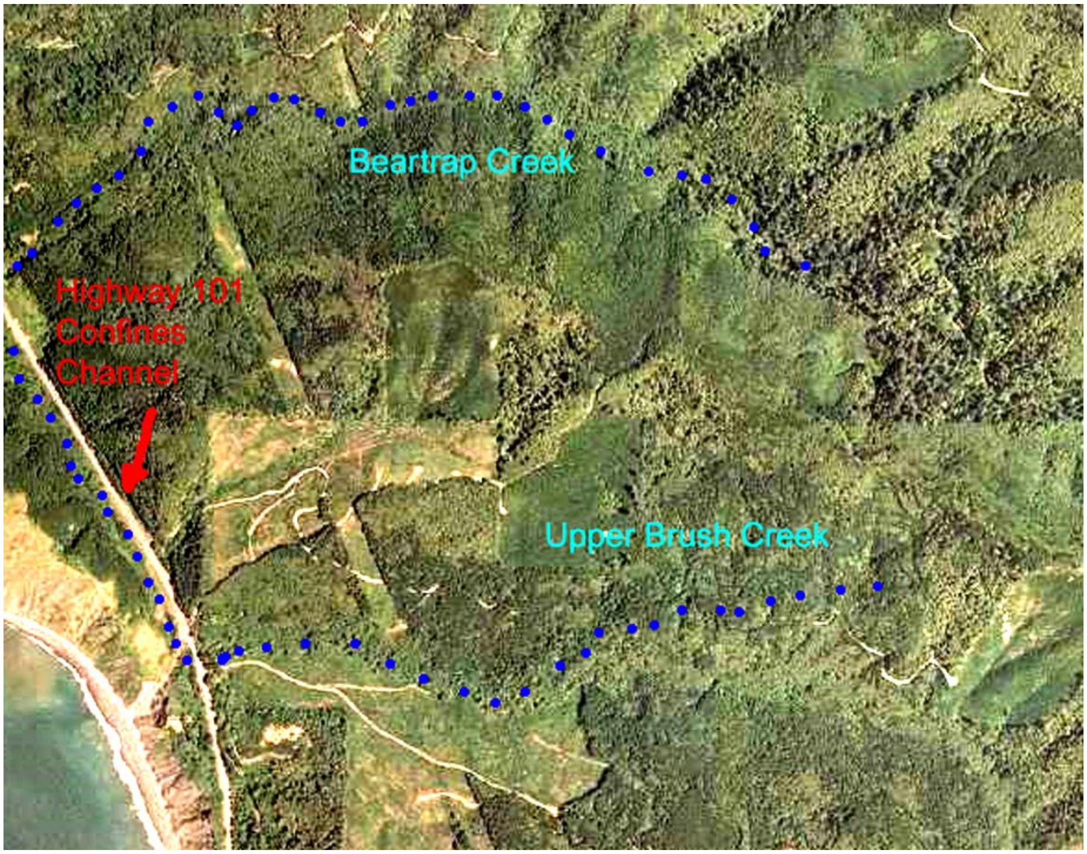

Figure 8-2. Upper Brush and tributary Beartrap Creek watersheds. Photo shows power line corridor, clearcut logging and Highway 101 running right along the stream. Blue dots approximate USGS (1984) streams.

8.2 Historic Fish Distribution and Abundance

There are 5.68 km of IP habitat in the Brush Creek basin, which is one of three coho salmon populations near Port Orford, Oregon (Maguire 2001b). Brush Creek has a higher gradient and greater natural valley confinement than its neighbor to the north, Hubbard Creek, with the bulk of high IP (>0.66) coho salmon habitat concentrated in the middle mainstem (Figure 8-1). Upper mainstem Brush Creek and the majority of Beartrap Creek are too steep for successful use by coho salmon. Table 8-1 lists the high intrinsic potential reaches and tributaries of Brush Creek.

Table 8-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Brush Creek Mainstem	Dry Run Creek	Unnamed Tributary (lower Brush)

8.3 Status of Brush Creek Coho Salmon

Spatial Structure and Diversity

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access have diverged from historical conditions, the greater the extinction risk. The confined mainstem channel conditions caused by Highway 101 restrict coho salmon use due to changes in stream velocity. ODFW (2005a) snorkeled two reaches, bracketing the area upstream and downstream of where Brush Creek first meets Highway 101, and found coho salmon in both reaches at very low densities (0.002 and 0.071 juveniles/m^2) in 2003 but did not find them in those same reaches in 2002. This suggests few adult spawners find suitable habitat in the Brush Creek basin, resulting in reduced diversity of the gene pool.

Population Size and Productivity

The very low density of coho salmon juveniles in Brush Creek found by ODFW in 2003 is likely associated with low adult population size caused by a reduction in the creek's carrying capacity due to channelization.

Extinction Risk

Not applicable because Brush Creek is not an independent population.

Role in SONCC Coho Salmon ESU Viability

The Brush Creek population is considered dependent because it does not have a high likelihood of sustaining itself over a 100-year time period in isolation and would likely receive sufficient immigration to alter its dynamics and extinction risk (Williams et al. 2006). Although such populations are not viable on their own, they do increase connectivity by allowing dispersal among independent populations and provide areas of refugia for other populations, acting as a source of colonists in some cases. The Brush Creek population likely interacts with other Northern Coastal dependent populations of coho salmon, such as Hubbard and Mussel creeks, as well as larger independent populations such as those in the Elk and Rogue rivers. Any restored habitat in Brush Creek provides potential connectivity that assists metapopulation function in the SONCC ESU.

8.4 Plans and Assessments

State of Oregon

Expert Panel Limiting Factors Report for Southwest Oregon

ODFW (2008b) convened a panel of fisheries and watershed science experts as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on limiting factors and threats to recovery. Based on the input of panel members, ODFW (2008b) summarized the concerns for the Brush Creek population as follows:

Key concerns in Brush Creek were primarily loss of over-winter tributary habitat complexity and floodplain connectivity for juveniles, especially in the lowlands which are naturally very limited in this system and have been impacted by past and current urban, rural residential, and forestry development and practices. A diversion that flows over a cliff and into the ocean is also a key concern. Secondary concerns were related to a loss of over-winter, lowland habitat complexity due to past and current agricultural practices. In addition, high water temperatures exist for summer parr due to a loss of riparian function and channel straightening.

South Coast Watersheds Council

Port Orford Watershed Assessment

The Port Orford Watershed Assessment (Maguire 2001b) is a summary of conditions, historic changes, and restoration needs for Mill, Hubbard, and Brush creeks.

Port Orford Action Plan

The Port Orford Action Plan (Massingill 2001b) is a companion document to the Watershed Assessment. It describes a restoration strategy with specific recommended actions.

8.5 Stresses

Table 8-2. Severity of stresses affecting each life stage of coho salmon in Brush Creek. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Very High	Very High	Very High[1]	Very High	Very High	Very High
2	Degraded Riparian Forest Conditions[1]	-	High	Very High[1]	High	High	Very High
3	Altered Sediment Supply	Low	Medium	High	Medium	Low	Medium
4	Impaired Estuary/Mainstem Function	-	Low	Low	Medium	Low	Low
5	Impaired Water Quality	Low	Low	Low	Low	Low	Low
6	Barriers	-	Low	Low	Low	Low	Low
7	Altered Hydrologic Function	Low	Low	Low	Low	-	Low
8	Adverse Fishery-Related Effects	-	-	-	-	Low	Low
9	Adverse Hatchery-related Effects	Low	Low	Low	Low	Low	Low

[1]Key limiting factor(s) and limited life stage(s).
[2]Increased Disease/Predation/Competition is not a considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited and quality winter rearing habitat is lacking. Degraded riparian conditions eliminated the source of large wood recruitment. Most historically available habitat in the estuary has been altered by development, channelization, and diking. These findings are consistent with those of the Oregon Expert Panel (ODFW 2008b) (Section 8.4). The diversion mentioned in ODFW (2008b) is discussed under the Altered Hydrologic Function stress, which rated as a low overall basin-wide stress.

Lack of Floodplain and Channel Structure

Highway 101 has caused major alterations of the Brush Creek channel, including relocation and confinement. This channel confinement resulted in increased velocity, which compromises adult coho salmon passage and decreases the quality of summer and winter rearing habitat. These high velocities could also increase bedload movement in confined reaches, leading to bed scour and loss of eggs and alevins. Large wood supply in Brush Creek is limited according to ODFW habitat data, and pool frequency is low. Where large wood has been restored to the channel, it has increased pool depth and created more complex habitats.

Degraded Riparian Forest Conditions

There are few large conifers in the riparian zone of Brush Creek above Humbug Mountain State Park, except for large trees in the headwaters of Brush Creek which are well above the range of coho salmon. The remainder of Brush Creek's riparian zone is comprised of hardwoods, including willow and alder. These species do not provide long lasting large wood for channel forming processes (Cederholm et al. 1997). Riparian development is impeded by the highway in some channelized sections. ODFW riparian surveys found the lower mainstem of Brush Creek to have poor riparian conditions (<75 conifers 36" diameter at breast height/1000 feet) due to development of campgrounds and recreational access.

Altered Sediment Supply

Altered sediment supply poses an overall medium stress to coho salmon in Brush Creek. Sediment contribution from landslides and erosion occurs naturally in the Brush Creek basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. Habitat surveys in the lower section of Brush Creek found poor (>17 percent fines) silt/sand surface conditions except in reaches confined by Highway 101, where scores rose to good levels (12 to 15 percent fines). Excess fine sediment directly impacts coho salmon egg viability and can reduce food for fry, juveniles and smolts. Poor pool frequency and depth throughout the Brush Creek basin is likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening.

Impaired Estuary/Mainstem Function

Estuary function is important to the population because of its unique role in the life history and survival of coho salmon (Miller and Sadro 2003, Koski 2009). Brush Creek meets the Pacific Ocean after passing through a narrow canyon opening spanned by Highway 101. The estuary is surrounded by very steep and unstable land at the base of Humbug Mountain and along the creek to the north. Although small in size, this estuary remains in good condition, with land being protected within Humbug Mountain State Park. The estuary/lagoon currently has little cover and complexity and has very little salmon rearing habitat. Because the estuary is naturally small, this lack of rearing habitat is not considered a threat for juveniles. However, lagoon breaching during the summer months may be affected by excess fine sediment and cause stress to outmigrating smolts.

Figure 8-3. Mouth of Brush Creek. Photo shows poorly developed estuary/lagoon, visible as a depression in the sandy beach that affords little opportunity for salmonid juvenile rearing.

Impaired Water Quality

Brush Creek's maximum floating weekly average water temperature (MWMT) value of less than 16° C is well under the ODEQ criteria of 18.4° C (64° F). Pesticide and herbicide use on both public and private lands contribute deleterious effects to water quality in Brush Creek. More significantly, Brush Creek's immediate adjacency to Highway 101 along most of its main stem makes it particularly vulnerable to herbicides from the Oregon Department of Transportations (ODOT) vegetation management program for invasive weed control.

Barriers

Maguire (2001b) reports only one potential barrier to juvenile salmonids in the Brush Creek basin, at the mouth of Dry Run Creek.

Altered Hydrologic Function

There are no dams or low-flow diversions in Brush Creek other than for use at Humbug Mountain State Park. However, timber harvest and associated roads may result in altered peak flows (Grant et al. 2008). In addition, extreme high flows are diverted into the ocean through an overflow channel about 3 miles upstream of the mouth (NMFS 2005b) (see Dams/Diversions section below).

Adverse Fishery-Related Effects

The National Marine Fisheries Service (NMFS) has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Brush Creek population area. Hatchery-origin coho salmon may stray into Brush Creek, but hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

8.6 Threats

Table 8-3. Severity of threats affecting each life stage of coho salmon in Brush Creek. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	Very High	Very High
2	Channelization/Diking	High	High	High	High	High	High
3	Timber Harvest	Medium	Medium	Medium	Medium	Medium	Medium
4	Climate Change	Low	Low	Medium	Medium	Medium	Medium
5	High Intensity Fire	Low	Low	Low	Low	Low	Low
6	Urban/Residential/Industrial	Low	Low	Low	Low	Low	Low
7	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
8	Dams/Diversions	-	Low	Low	Low	Low	Low
9	Fishing and Collecting	-	-	-	-	Low	Low
10	Hatcheries	Low	Low	Low	Low	Low	Low

[1] Agricultural Practices, Mining/Gravel Extraction, and Invasive and Non-Native/Alien Species are not considered threats to this population.

Roads

A greater problem than high overall road densities is the fact that Highway 101 follows and confines almost the entire mainstem of Brush Creek.

Channelization/Diking

Channelization and diking pose a high threat to Brush Creek coho salmon because of the effects of Highway 101, which runs adjacent to most of the mainstem of the creek. The highway causes confinement, accelerated currents and channel simplification, all of which affect coho salmon negatively. Development of campgrounds and day use recreation areas on the former flood terrace of the stream also confine the channel.

Timber Harvest

Timber harvesting in Brush Creek between 1972 and 1992 was less than 10 percent, except for patches of more intense activity where elevated road densities are also apparent (Bredensteiner et al. 2003). Maguire (2001b) produced a timber harvest map (Figure 8-4) that shows outlines of logged areas but does not provide information on when harvests took place or the harvest methods. Timber harvests in riparian zones and in headwater areas are likely to have played a role in decreased large wood supply. Forestry practices, past and present, in rain-dominated watersheds may combine to increase hydrologic risk as past practices may still be influencing the routing of water and causing channel modifications or increased fine sediment routing and turbidity (Maguire 2001b).

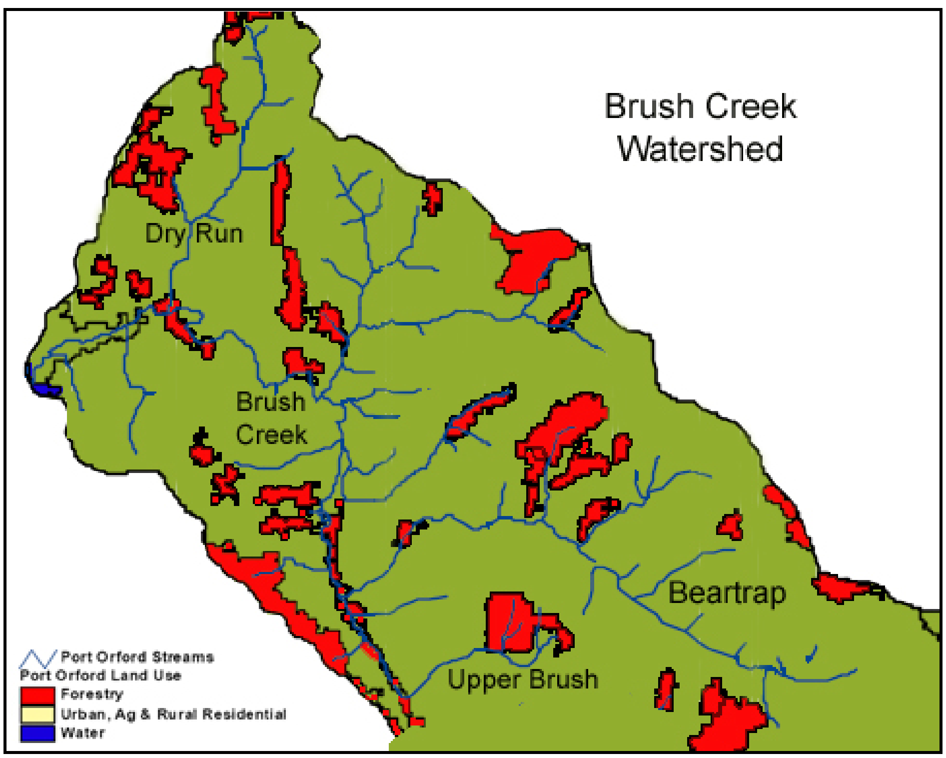

Figure 8-4. Map of timber harvest. This map was adapted from the Port Orford Watershed Assessment (Maguire 2001b) with polygons of timber harvests filled in with red. No metadata are available to understand harvest methods or dates.

Climate Change

There is low risk of change in average precipitation over the next 50 years (Appendix B). Modeled regional average temperature shows a moderate increase over the next 50 years (Appendix B). Average temperature could increase by up to 1° C in the summer and by a similar amount in the winter. The risk of sea level rise is high (Thieler and Hammer-Klose 2000), which may impact the quality and extent of wetland juvenile and smolt habitat. Adults may be negatively impacted by climate-related ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

High Intensity Fire

Brush Creek lies within the immediate coastal strip of southern Oregon and is subject to marine temperature mediation resulting in moist cool summers and high rainfall during fall, winter and spring. These attributes combine for a generally wet environment year-round and as a result a low threat score for fire.

Urbanization/Residential/Industrial Development

There is a relatively low level of urban and rural residential development in the Brush Creek basin.

Road-stream Crossing Barriers

A potential road-stream crossing barrier for juvenile coho salmon and other salmonids has been identified at the mouth of Dry Run Creek (Maguire 2001b).

Dams/Diversions

Near where Brush Creek first meets Highway 101, an overflow channel diverts peak flows from Brush Creek off a steep cliff into the ocean (NMFS 2005b). The overflow reduces roadway flooding downstream, but is unscreened and any coho entrained are killed. The overflow is now triggered during flows greater than 700 cfs, which are expected to occur on average once every 15 years

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook-directed fisheries that account for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the directed recreational fishery. The exploitation rates associated with this freshwater fishery and all other fisheries managed by the State of Oregon were found to be low enough to avoid jeopardizing the existence of the ESU (NMFS 1999). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because recovery objectives to achieve species viability had not been established for SONCC coho salmon at that time (NMFS 1999). As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in Brush Creek.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Brush Creek population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

8.7 Recovery Strategy

The most immediate need for habitat restoration and threat reduction in Brush Creek is in those areas currently occupied by coho salmon, which according to the limited available data is the mainstem of Brush Creek. Unoccupied areas must also be restored to provide enough habitat for coho salmon to complete their life cycle.

The Brush Creek population is considered dependent and therefore cannot be viable on its own; however, it is necessary to restore habitat within the basin so that it can support all life stages of coho salmon and provide connectivity between other populations in the ESU. The recovery criterion for this population is that 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival. Despite impaired habitat conditions, Brush Creek has maintained use by coho salmon, possibly through straying from larger independent populations like the Elk River and Rogue River nearby. Highway 101, which is not likely to be relocated, is the major impediment to achieving full coho salmon potential in Brush Creek.

The most important factor limiting recovery of coho salmon in Brush Creek is a deficiency in the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by increasing habitat complexity within the channel, re-establishing off-channel rearing areas, restoring riparian forests, and reducing threats to instream habitat.

Table 8-4 on the following page lists the recovery actions for the Brush Creek population.

Table 8-4. Recovery action implementation schedule for the Brush Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-BruC.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Mainstem within Humbug Mountain State Park	3
SONCC-BruC.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-BruC.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-BruC.2.1.2	Floodplain and Channel Structure	Yes	Increase channel complexity	Improve timber harvest practices	Population wide	BR
SONCC-BruC.2.1.2.1	*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*					
SONCC-BruC.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Lower mainstem	3
SONCC-BruC.2.2.3.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-BruC.2.2.3.2	*Implement beaver program (may include reintroduction)*					
SONCC-BruC.2.2.9	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide	3
SONCC-BruC.2.2.9.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-BruC.2.2.9.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-BruC.7.1.6	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Lower mainstem, estuary/lagoon	BR
SONCC-BruC.7.1.6.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-BruC.7.1.6.2	*Thin, or release conifers, guided by prescription*					
SONCC-BruC.7.1.6.3	*Plant conifers, guided by prescription*					
SONCC-BruC.27.2.8	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-BruC.27.2.8.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-BruC.27.2.8.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-BruC.27.1.12	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-BruC.27.1.12.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-BruC.27.2.13	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-BruC.27.2.13.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-BruC.27.2.14	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-BruC.27.2.14.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-BruC.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-BruC.27.1.15.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-BruC.27.1.15.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-BruC.27.2.16	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-BruC.27.2.16.1	*Determine best indicators of estuarine condition*					
SONCC-BruC.5.1.7	Passage	No	Improve access	Remove barriers	Population wide, particularly mouth of Dry Run Creek	BR
SONCC-BruC.5.1.7.1	*Assess and prioritize barriers using the ODFW fish passage barrier database*					
SONCC-BruC.5.1.7.2	*Remove barriers*					
SONCC-BruC.8.1.10	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	BR
SONCC-BruC.8.1.10.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-BruC.8.1.10.2	*Decommission roads, guided by assessment*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-BruC.8.1.10.3	*Upgrade roads, guided by assessment*					
SONCC-BruC.8.1.10.4	*Maintain roads, guided by assessment*					
SONCC-BruC.10.2.5	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-BruC.10.2.5.1	*Develop an educational program that teaches landowners and businesses about avoiding pollution from septic systems, backyard pesticides, fuels, and nutrients.*					
SONCC-BruC.10.2.11	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-BruC.10.2.11.1	*Develop stormwater management plan, consistent with ODEQ specifications, to minimize non-point source pollution from entering Brush Creek from HWY 101 and campgrounds*					

9. Mussel Creek Population

- Northern Coastal Stratum
- Dependent Population
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 14 mi^2
- 6 IP km (4 mi) (50% High)
- Dominant Land Uses are Timber Harvest and Recreation
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Degraded Riparian Forest Conditions’
- Principal Threats are ‘Timber Harvest’ and ‘Channelization/Diking’

9.1 History of Habitat and Land Use

Mussel Creek empties into the Pacific Ocean just south of Port Orford between Brush and Euchre Creeks. Historically, a trail likely passed through the lower basin, and became a road for automobiles in the 1920s prior to eventually becoming Highway 101 (Maguire 2001b). The roadway has caused the South Fork of Mussel Creek to be realigned, which resulted in a loss of habitat suitability for coho salmon. Tourist attractions such as the Prehistoric Gardens and the Arizona Beach campground are both located within the floodplain of lower Mussel Creek and Myrtle Creek.

Data for timber harvest on private lands are not available for the Mussel Creek basin, but aerial photos indicate timber has been harvested from most of the basin except for a small patch below Highway 101, adjacent to Prehistoric Gardens. Active timber harvest continues and road densities are high in this basin. In addition, Mussel Creek has very steep slopes, which likely facilitated sediment transport to the creeks during and after land disturbing activities. Myrtle Creek serves as an example of these channel changes; it loses surface flow in late summer and early fall possibly due to excessive fine sediment loads from steep, managed land near the headwaters. Additionally, the stream channel has been straightened and channelized to maximize space for camping and recreation. These impacts have made approximately 50 percent of the area with high intrinsic potential for coho salmon habitat currently uninhabitable and difficult to restore.

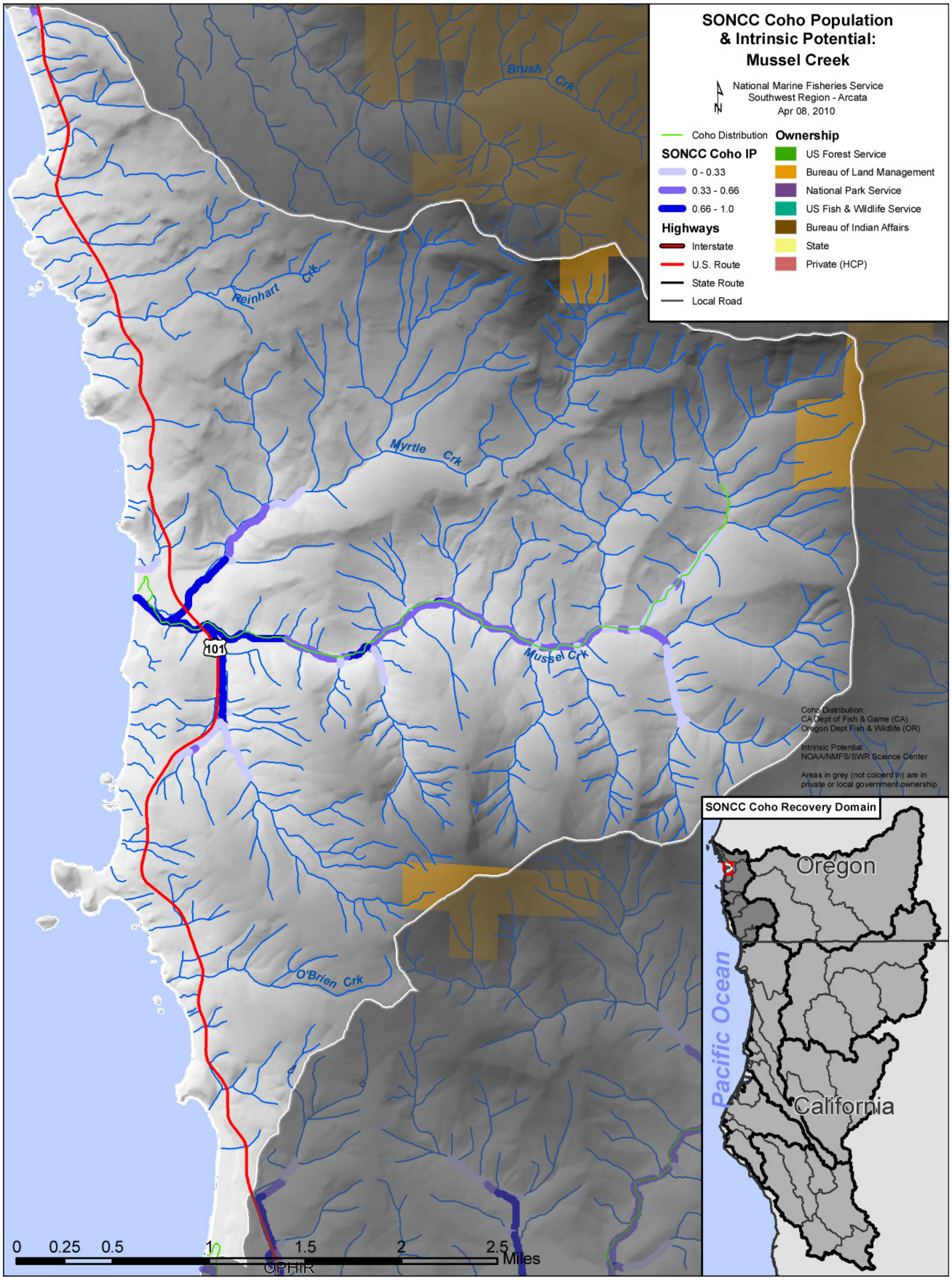

Figure 9-1. The geographic boundaries of the Mussel Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

9.2 Historic Fish Distribution and Abundance

No information is available about the historic distribution and abundance of coho salmon in Mussel Creek.

Table 9-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Lower Mussel Creek	Myrtle Creek	South Fork Mussel Creek

9.3 Status of Mussel Creek Coho Salmon

Spatial Structure and Diversity

Much of the high IP coho salmon habitat in Mussel Creek is no longer suitable because the South Fork is channelized and re-routed by Highway 101. The major tributary, Myrtle Creek, is also channelized and loses surface flows during the summer and fall. Approximately 50 percent of high IP coho salmon habitat has been lost due to channelization and straightening. Additionally, mainstem Mussel Creek lacks sufficient depth and other channel features necessary to be fully functional for coho salmon rearing. Available data show coho salmon are restricted to the mainstem Mussel Creek when present, and no coho salmon were observed during recent juvenile surveys in 2002 and 2003 (Oregon Department of Fish and Wildlife (ODFW 2005a). The small population size in Mussel Creek suggests restricted genetic diversity.

Population Size and Productivity

The Mussel Creek population is presumed to be nearly extirpated based on recent juvenile surveys, impaired habitat conditions, and the lack of any other information to indicate that coho salmon currently spawn or rear in the basin. The productivity and size of this population is driven by the dynamics of the Mussel Creek population as well as those of nearby populations, which contribute spawners as strays. However, the supply of strays to Mussel Creek is not expected to be substantial or consistent in the near term because most adjacent populations in the SONCC coho salmon ESU are at low levels.

Extinction Risk

Not applicable because Mussel Creek is not an independent population.

Role in SONCC Coho Salmon ESU Viability

The Mussel Creek population is considered dependent because it does not have a high likelihood of sustaining itself over a 100-year time period in isolation and would likely receive sufficient immigration to alter its dynamics and extinction risk (Williams et al. 2006). Although such populations are not viable on their own, they do increase connectivity by allowing dispersal among independent populations and provide areas of refugia for other populations, acting as a source of colonists in some cases. Historically the Mussel Creek population would have interacted with other Northern Coastal dependent populations of coho salmon such as those in

Brush and Euchre Creeks, as well as larger independent populations such as those in the Elk and Rogue Rivers. Any restored habitat in Mussel Creek provides potential connectivity that assists metapopulation function in the ESU.

9.4 Plans and Assessments

State of Oregon

Oregon Plan for Salmon and Watersheds
http://www.oregon.gov/OPSW/about_us.shtml

The State of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is a comprehensive plan that includes voluntary actions to address all of the threats currently facing coho salmon in these ESUs and involves all relevant state agencies. Reforms to fishery harvest and hatchery programs described in the Oregon Plan were implemented by ODFW in the late 1990s. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary.

Report of the Oregon Expert Panel on Limiting Factors

ODFW (2008b) convened a panel of fisheries and watershed science experts as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on limiting factors and threats to recovery. Based on the input of panel members, ODFW (2008b) summarized the concerns for the Mussel Creek population as follows:

> Key concerns in Mussel Creek were primarily loss of over-winter tributary habitat complexity and floodplain connectivity for juveniles, especially in the lowlands which are naturally very limited in these systems and have been impacted by past and current urban, rural residential, and forestry development and practices. Secondary concerns were related to a loss of over-winter, lowland habitat complexity due to past and current agricultural practices. In addition, high water temperatures exist for summer parr due to a loss of riparian function and channel straightening.

Cumulative Effects of Southwest Oregon Coastal Land Use on Salmon Habitat

Oregon State University (OSU) Oak Creek Labs conducted a study funded by ODFW and the Oregon Department of Forestry (ODF) to determine relationships between forest harvest and Pacific salmon productivity (Frissell 1992). The study assessed basins along the Oregon coast extending from the Sixes River to the southern border during the period from 1986 to 1992.

South Coast Watershed Council

9.5 Stresses

Table 9-2. Severity of stresses affecting each life stage of coho salmon in Mussel Creek. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Low	Very High	Very High[1]	Very High	Very High	Very High
2	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	Very High	Very High	Very High
3	Altered Sediment Supply	High	Medium	Medium	Medium	High	Medium
4	Impaired Estuary/Mainstem Function	-	Medium	High	Medium	Medium	Medium
5	Impaired Water Quality	Low	Medium	Medium	Low	Low	Low
6	Barriers	-	Low	Low	Low	Low	Low
7	Altered Hydrologic Function	Low	Low	Low	Low	-	Low
8	Adverse Fishery-Related Effects	-	-	-	-	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited and quality winter rearing habitat, as well as summer rearing habitat, is lacking as vital habitat for the population. Winter rearing habitat is often formed by instream large wood, but is also found in estuaries and floodplain wetlands. Timber removal has decreased the source of large wood, and much of the historically available habitat in the estuary and floodplain wetlands has been altered by development, channelization, and construction of a jetty. The IP habitat in the Mussel Creek basin is concentrated in the flattest parts of the basin, near the ocean. Off-channel juvenile rearing habitat with suitable temperature is vital to coho salmon recovery in this river. These findings are consistent with those of the Oregon Expert Panel (Section 9.4).

Lack of Floodplain and Channel Structure

In many areas, the creek and its tributaries disconnected from the floodplain. Channelization of Myrtle Creek and the South Fork Mussel Creek eliminated meanders and side channels that would have provided summer and winter coho salmon rearing habitat. Coho salmon juveniles prefer pools formed by large wood, but habitat surveys show less than one key piece per 100m in the middle reach of Mussel Creek upstream of the highest IP habitat, which rates as poor according to ODFW standards. The upper reach of Mussel Creek had 1 to 2 key pieces of large wood per 1000 feet, which rates as fair.

Figure 9-2. Photo of the Myrtle Creek channel. View is looking downstream just above its convergence with Mussel Creek. Surface flow has been lost, and the stream has been channelized. Photo taken on 9/18/2008.

Pool frequency in the upper reach of Mussel Creek was rated as (10 to 20 percent) according to ODFW standards. The good rating (20 to 35 percent) in the middle reach of Mussel Creek likely represents a substantial reduction in pool frequency from historic conditions, given the level of disturbance in the basin. Pool depth is poor (average less than 2 feet) in the entire sampled area.

Degraded Riparian Forest Conditions

Without proper riparian forests, Mussel Creek has no mechanism for recruitment of large wood, which would trap fine sediment and enhance habitat complexity (Chapter 3). Lack of riparian cover also decreases shade and thermal buffering, and reduces formation of undercut banks. Habitat surveys of riparian conditions in the middle reaches of Mussel Creek found the area to be devoid of large conifers (>36" diameter at breast height), which translates to a poor riparian condition score using the ODFW criteria (<75 large conifers per 1000' of stream). Lack of large conifers in the riparian zone of much of the lower creek is also apparent. One short reach of Mussel Creek downstream Highway 101 contains a patch of late seral forest with a mature riparian canopy (Figure 9-3).

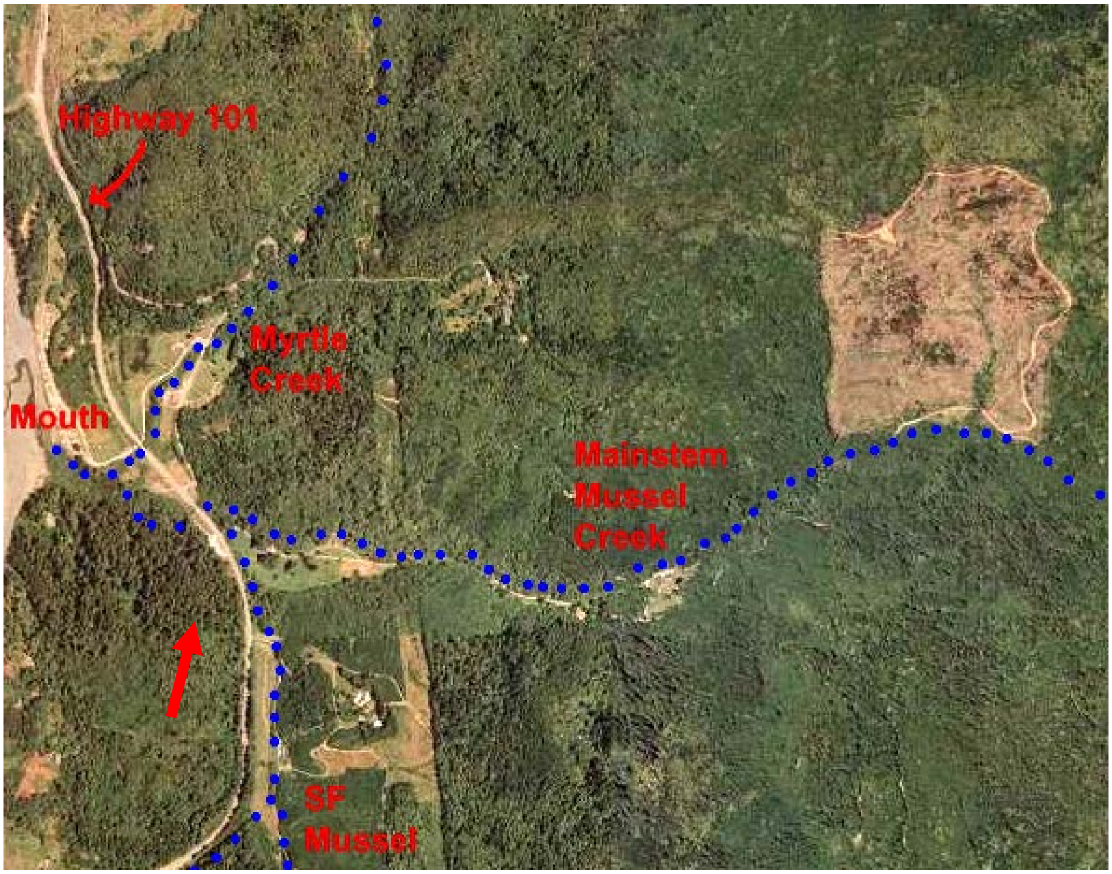

Figure 9-3. The lower reaches of Mussel, South Fork Mussel and Myrtle creeks in June 2005. Note the power line corridor in upper Myrtle riparian, Highway 101 confining South Fork, and a clearcut upper mainstem Mussel Creek. Arrow at lower-left points to patch of large trees, possibly old growth.

Altered Sediment Supply

Sediment contribution from landslides and erosion occurs naturally in the Mussel Creek basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. Habitat surveys in the middle reaches of Mussel Creek found poor (>17 percent surface fines) silt/sand surface conditions, while the steeper reach further upstream rated good (<12 percent). Excess fine sediment directly impacts coho salmon egg viability and can reduce food for fry, juveniles and smolts. Poor pool frequency and depth throughout the Mussel Creek basin is likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening.

Impaired Estuary/Mainstem Function

Little is known about the historic extent of estuarine area in Mussel Creek, but it is likely that development adjacent to the current estuary has reduced habitat. Currently the estuarine portion of Mussel Creek is confined to less than 10 acres of tidal sand and mudflat, and a few acres of tidal wetland habitat west of Highway 101(Figure 9-4). Based on the natural drainage pattern and elevations in the area, it is likely that much of the historical estuarine tidal area that once existed has been diked and filled to accommodate the highway, other small roads, and residential and agricultural development. Remaining habitat is largely degraded and provides little cover and foraging habitat.

Figure 9-4. Lagoon at the mouth of Mussel Creek. View is looking north. A sand bar blocks exchange of salt and fresh waters during periods of low flow. The lagoon is shallow, lacks cover, and likely provides limited habitat for juvenile salmonid rearing. (9/18/2008).

Impaired Water Quality

There are no water quality data available for Mussel Creek. Temperature problems are unlikely in Mussel Creek due to the proximity to the coast, topographic shading, short transit time, and likely contributions of groundwater from hollows throughout this steep basin. Turbidity is likely high during winter due to high road density and timber harvest in the basin. Potential sources of chemical water pollutants would be use of herbicides on industrial timberlands and leakage from septic systems at the campground, resorts, or the small number of rural residences in the basin.

Barriers

There are no known structural barriers to coho salmon passage in Mussel Creek. The dry reach of lower Myrtle Creek poses a potential seasonal impediment to passage.

Altered Hydrologic Function

The complex hydrology of Mussel Creek has been severely disrupted by Highway 101, debris torrents down Myrtle Creek, and development on the floodplain. Increased peak discharge is also likely in the Mussel Creek basin due to high road densities and widespread timber harvest.

Adverse Fishery-Related Effects

NMFS has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Mussel Creek population area. Hatchery-origin coho salmon may stray into Mussel Creek, but hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

9.6 Threats

Table 9-3. Severity of threats affecting each life stage of coho salmon in Mussel Creek. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Timber Harvest	High	Very High	Very High	Very High	Very High	Very High
2	Channelization/Diking	High	Very High	Very High	Very High	Very High	Very High
3	Roads	High	Very High	Very High	Very High	Very High	Very High
4	Urban/Residential/Industrial	High	High	High	High	High	High
5	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
6	Dams/Diversion	Low	Medium	Medium	Medium	Medium	Medium
7	Climate Change	Low	Low	Low	Low	Medium	Low
8	High Intensity Fire	Low	Low	Low	Low	Low	Low
9	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
10	Fishing and Collecting	-	-	-	-	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low

[1]Invasive Non Native/Alien Species and Mining/Gravel Extraction are not considered threats to this population.

Timber Harvest

Recent private timberland harvest data are not readily available. However, it is apparent from aerial photos that the basin has likely experienced extensive harvest in the last 50 years. As seen in Figure 9-3, active timber harvest on private lands within the Mussel Creek basin is occurring and is expected to continue.

Channelization/Diking

Highway 101 caused the relocation and straightening of most of the South Fork Mussel Creek channel, which altered more than 20 percent of the high IP habitat in the Mussel Creek basin. The highway is not likely to be relocated and is a major impediment to restoring habitat in South Fork Mussel Creek; however, there is a meadow east of creek that could potentially provide space for creation of a more complex channel. Myrtle Creek has also been channelized through the lower reach near the campground. A parking lot for beach access was constructed by rearranging deposited materials, which created a functional dike along the eastern lagoon border and reduced the lagoon area.

Roads

Road densities in the Mussel Creek basin are over thresholds recognized as contributing to increased fine sediment yield and elevated peak flows. Roads are expected to cause fine sediment delivery into Mussel Creek, because the basin is very steep and the geology is relatively unstable. The construction of Highway 101 has resulted in the channelization and realignment of the South Fork Mussel Creek, as well as parts of the mainstem Mussel Creek and Myrtle Creek. These impacts, along with excessive sedimentation from upslope activities, have altered the hydrology of these creeks and made them less suitable for coho salmon spawning and rearing. In addition, because of the small size of the Mussel Creek basin and the significant impacts of Highway 101 to high IP habitat in the basin, the highway continues to be a major threat to coho salmon in this basin.

Urban/Residential/Industrial Development

A resort (Prehistoric Gardens), a campground, and a day use recreation area (Arizona Beach) are operated in the floodplain of Mussel Creek. Additionally, an electrical power transmission line runs north-south across the South Fork and lower mainstem Mussel Creek and parallels the riparian zone of upper Myrtle Creek (Figure 9-3). Periodically, along this corridor all vegetation is removed. Other than the power lines, the existing developments are relatively small and are not expected to expand significantly. The recent acquisition and conversion of Arizona Beach from a privately operated campground facility to a state park should improve conditions in the basin.

Agricultural Practices

Cattle grazing occurs in the lower Mussel Creek floodplain adjacent to high IP habitat; however, it is not a significant activity in the basin.

Dams/Diversions

No dams are known to exist in the valley and few water diversions are presently active.

Climate Change

There is low risk of average temperature increase, or change in average precipitation, over the next 50 years (Appendix B). The risk of sea level rise is moderate (Appendix B, Thieler and

Hammer-Klose 2000). Adults may be negatively impacted by climate-related ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

High Intensity Fire

The proximity of the Mussel Creek basin to the coast is a strong moderating factor on fire risk.

Road-Stream Crossing Barriers

Road-stream crossing barriers are not a significant threat to coho salmon in Mussel Creek based on the lack of known barriers that exist in the basin. Given the amount of timber harvest that has occurred in the basin and the density of roads in the lower basin it is likely there are many partial or total barriers that have yet to be identified on private land. Based on the projected population growth in this area, an increase in road-stream crossings is not likely unless significant timber harvest resumes in un-roaded areas.

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook-directed fisheries that account for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the directed recreational fishery. The exploitation rates associated with this freshwater fishery and all other fisheries managed by the State of Oregon were found to be low enough to avoid jeopardizing the existence of the ESU (NMFS 1999). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because recovery objectives to achieve species viability had not been established for SONCC coho salmon at that time (NMFS 1999). As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in Mussel Creek.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Mussel Creek population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

9.7 Recovery Strategy

Restoration efforts should be focused on lower Mussel Creek, South Fork Mussel Creek, and Myrtle Creek, which all have high IP habitat (Figure 9-1).

The Mussel Creek population is considered dependent and therefore cannot be viable on its own; however, it is necessary to restore habitat within the basin so that it can support all life stages of coho salmon and provide connectivity between other populations in the ESU. The recovery criterion for this population is that 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival. The most important factor limiting recovery of coho salmon in Mussel Creek is a deficiency in the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by increasing habitat complexity within the channel, re-establishing off-channel rearing areas, restoring riparian forests, increasing summer flow, and reducing threats to instream habitat.

Table 9-4 on the following page lists the recovery actions for the Mussel Creek population.

Table 9-4. Recovery action implementation schedule for the Mussel Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MusC.2.2.4	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Lower mainstem and estuary	3
SONCC-MusC.2.2.4.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MusC.2.2.4.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-MusC.2.2.5	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Lower Mainstem	3
SONCC-MusC.2.2.5.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-MusC.2.2.5.2	*Implement beaver program (may include reintroduction)*					
SONCC-MusC.2.1.6	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	State park in lower mainstem	3
SONCC-MusC.2.1.6.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MusC.2.1.6.2	*Place instream structures, guided by assessment results*					
SONCC-MusC.7.1.1	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Lower mainstem and estuary	3
SONCC-MusC.7.1.1.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-MusC.7.1.1.2	*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat*					
SONCC-MusC.7.1.2	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	BR
SONCC-MusC.7.1.2.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-MusC.7.1.2.2	*Thin, or release conifers, guided by prescription*					
SONCC-MusC.7.1.2.3	*Plant conifers in the tributaries and alders and cottonwoods in the lower floodplain, guided by prescription*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MusC.7.1.3	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	BR
SONCC-MusC.7.1.3.2	*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*					
SONCC-MusC.27.2.10	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MusC.27.2.10.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-MusC.27.2.10.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-MusC.27.1.12	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MusC.27.1.12.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-MusC.27.2.13	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-MusC.27.2.13.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-MusC.27.2.14	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-MusC.27.2.14.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-MusC.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-MusC.27.1.15.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MusC.27.1.15.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-MusC.27.2.16	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-MusC.27.2.16.1	*Determine best indicators of estuarine condition*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MusC.5.1.8	Passage	No	Improve access	Remove barriers	Population wide	BR
SONCC-MusC.5.1.8.1	*Use ODFW and SCWC fish passage barrier database to 5.1 based on known coho use or data identifying suitable habitat conditions above barriers*					
SONCC-MusC.8.1.11	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	BR
SONCC-MusC.8.1.11.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MusC.8.1.11.2	*Decommission roads, guided by assessment*					
SONCC-MusC.8.1.11.3	*Upgrade roads, guided by assessment*					
SONCC-MusC.8.1.11.4	*Maintain roads, guided by assessment*					
SONCC-MusC.10.2.7	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-MusC.10.2.7.1	*Develop an educational program that teaches landowners and businesses about avoiding pollution from septic systems, backyard pesticides, fuels, and nutrients.*					

10. Lower Rogue River Population

- Northern Coastal Stratum
- Non-Core, Potentially Independent Population
- High Extinction Risk
- 320 Spawners Required for ESU Viability
- 198 mi^2
- 81 IP km (50 mi) (24% High)
- Dominant Land Uses are Timber Harvest and Agriculture
- Principal Stresses are 'Lack of Floodplain and Channel Structure' and 'Impaired Water Quality'
- Principal Threats are 'Roads' and 'Urban/Residential/Industrial Development'

10.1 History of Habitat and Land Use

Historically, beaver ponds created ideal habitat for coho salmon and likely existed in side channels of the valley floor and in the lowlands of tributaries all the way to the estuary [Oregon Department of Fish and Wildlife (ODFW) 2005b]. Timber near the coast was in stands separated by large meadows, which were regularly burned by Native Americans (Hicks 2005). Anglo-American settlement began with the gold rush in 1853. Canneries were established as early as 1861 (Hicks 2005) on the shores of the estuary and thrived until salmon stocks were depleted around 1930. Around the same time, larger wood jams which interfered with net fishing or shipping were removed (Hicks 2005). Grazing was once widespread in the Lower Rogue River watershed (Hicks 2005), with tens of thousands of sheep and cattle feeding in upland prairies. In the early to mid-1900s, agricultural use shifted to development of dairies, which led to the clearing of riparian vegetation from river terraces for conversion to pasture (Hicks 2005). Streams with mild gradient and broad valleys (ideal coho salmon habitat) were ideal pasture land, so forests were cleared to accommodate grazing which led to simplified channels.

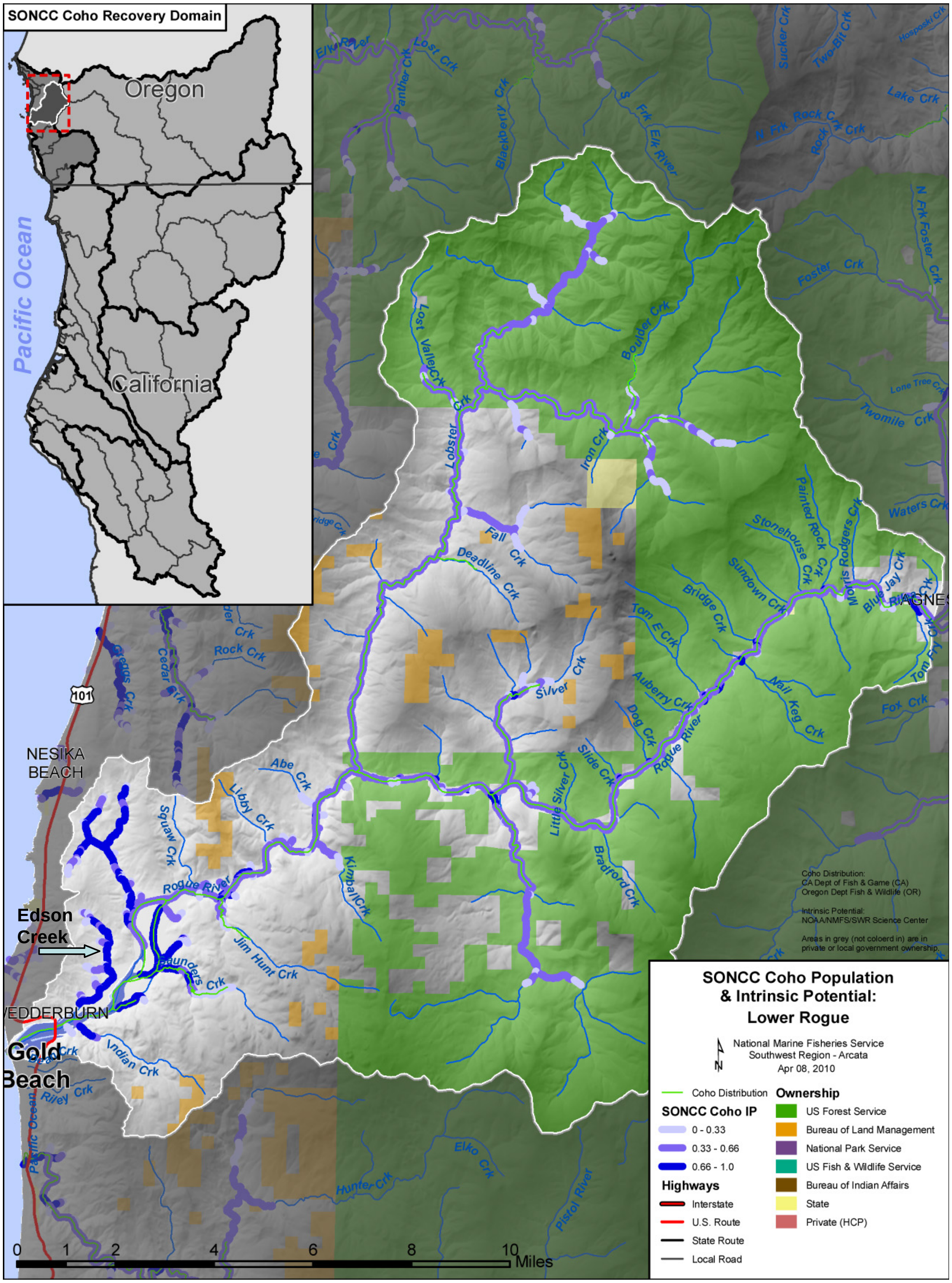

Figure 10-1. The boundaries of the Lower Rogue River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

The most profound change to the Lower Rogue River resulted from logging after World War II (U.S. Forest Service (USFS) 2000a). Most old growth timber in the Lower Rogue River subbasin has been logged (USFS 1996b, 2000a; Hicks 2005), with remnant patches scattered on federal lands in basins like Quosatana, Silver, and Lobster creeks as well as in inner gorge tributaries of the mainstem Rogue River below Agness. The flood of 1964 devastated Lower Rogue River tributary channels and a wave of sediment swept through the lower mainstem (USFS 2000a). Low gradient streams (formerly the best sites for coho salmon spawning and rearing) were the most impacted by sediment depositions. Logging on public lands resumed after 1970 and another wave of sediment was unleashed (USFS 1996b). The Lower Rogue continues to be impacted by the timber harvest that occurred on National Forest land during the 1970s and 1980s. During this period, harvests and expanding road networks were increasingly located on steep ground, and subsequent landslides during storm events contributed massive inputs of fine sediments into streams (USFS 2000a). Aquatic habitat remains compromised by elevated water temperatures and sediment levels decades after the initial impacts.

Mainstem Rogue River flow was diminished due to construction of Lost Creek Dam in the Upper Rogue in the 1970s (Figure 10-1), but flows from the dam were later increased to prevent the loss of spring-run Chinook salmon and are now thought to be adequate for mainstem ecosystem function of the Lower Rogue (Hicks 2005). Before disturbance, the estuary occasionally barred up and formed a lagoon (Hicks 2005). The Rogue River mouth now remains open due to the construction of jetties in 1960 to maintain navigability, which changed the estuary circulation and accelerated currents (Hicks 2005). Marina development eliminated the largest track of saltwater wetlands, and levees further upstream cut off access to tributaries and sloughs. The human population of Gold Beach is modest (1,847) and not believed to be increasing. Effects of urbanization and residential development in the Lower Rogue River subbasin are moderate (Hicks 2005), but domestic water use and wastewater treatment related to rural development are regional concerns (Southwest Oregon Resource Conservation and Development Council (SO RC&D) 2003).

10.2 Historic Fish Distribution and Abundance

While the Rogue River basin still produces many coho salmon, the indigenous stock adapted to the Lower Rogue River subbasin is diminished in range and abundance (USFS 2000a). Meengs and Lackey (2005) used the cannery data from near the mouth of the Rogue River in the late 1880s to estimate annual catches of 114,000 adult coho salmon; however, there is no way to know how many of these fish were returning specifically to the lower Rogue River area. Because this subbasin constitutes about 6 percent of the entire Rogue watershed area, an estimate of approximately 7,000 coho salmon could have spawned in the Lower Rogue River. Williams et al. (2006) used models to estimate that the Lower Rogue had 80.9 intrinsic-potential kilometers (IP km) of coho salmon habitat, with the highest IP habitats concentrated mostly in tributaries near the estuary (Figure 10-1). An estimated 37 coho salmon spawners would be needed to fully utilize each IP km, and would have produced an annual coho salmon population of 3,000 adults (Williams et al. 2008).

The highest IP (IP >0.66) habitat for coho salmon in the Lower Rogue River is in Indian, Saunders, God Wants You, Jerrys Draw and Edson creeks and an unnamed northern estuarine tributary (Figure 10-1). Jim Hunt Creek has a small patch of high IP at its confluence with the mainstem Rogue River. Steep tributaries upstream of Lobster Creek, such as Silver, Quosatana and Tom Fry creeks also have high IP reaches just above their confluence with the mainstem Rogue River. Table 10-1 lists all tributaries with the highest IP coho salmon habitat. Alluvial flats of the Lower Rogue mainstem also have segments of high IP habitat all the way up to Agnes, especially downstream of tributaries that add coarse sediment for spawning and flatten stream gradient locally.

Table 10-1. Tributaries with instances of high IP reaches (IP > 0.66) from Williams et al. (2006).

Stream Name	Stream Name
Edson Creek	Quosatana Creek
God Wants You Creek	Rogue River- Estuary
Indian Creek	Rogue River- Lower Mainstem
Jerrys Draw	Saunders Creek
Jim Hunt	Silver Creek
Kimball	Tom Fry Creek

10.3 Status of Lower Rogue River Coho Salmon

Spatial Structure and Diversity

Although they contain high IP (>0.66), the following areas are not known to currently support coho salmon: Edson Creek, Kimball Creek, Jim Hunt Creek, Indian Creek, Saunders Creek, and unnamed north-side tributaries to the estuary. Monitoring reports for the years 1998 through 2004 indicated that coho salmon are well distributed but at low levels in Lobster Creek, Quosatana Creek, Silver Creek, and Tom Fry Creek (ODFW 2005a). Many reaches in these streams are not prime coho salmon habitat due to the steep gradient (USFS 2000a). Genetic diversity has likely diminished as coho salmon have disappeared from productive tributaries and the population has declined. In addition, most spawners are of hatchery origin (Jacobs et al. 2002)

Population Size and Productivity

In 2001, Rogue River basin-wide monitoring indicated 32,962 adult coho salmon (Oregon State University (OSU) 2009, ODFW 2009b); however, ODFW (2009a) estimated a maximum of 235 spawners in the Lower Rogue River during the period 2000 to 2008 (Table 10-2). These escapement estimates suggest one year class may be weaker than the others – that observed in 2000, 2003, and 2006. The highest three year running average in the period 2000-2008 was 172 (from 2001 to 2003).

Table 10-2. Estimates of annual spawning escapement. Coho salmon escapement for the Lower Rogue River, 1998 to 2008.

Year	Population Estimate	Year	Population Estimate	Year	Population Estimate
1998	0	2002	205	2006	35
1999	0	2003	75	2007	193
2000	59	2004	127	2008	184
2001	235	2005	127		
Source: ODFW 2009a.					

Surveys completed from 1998 to 2003 (Hicks 2005) in the Lower Rogue River subbasin found coho salmon spawners in lower Lobster Creek (19 individuals), South Fork Lobster Creek (46 individuals), Silver Creek (18 individuals), and Quosatana Creek (5 individuals). During juvenile coho salmon surveys (ODFW 2005a) in the Lobster Creek watershed from 1998 to 2004, presence was zero of four years in Boulder Creek, one of two years in Deadline Creek, one of seven years in North Fork Lobster Creek, and four of six years in lower Lobster Creek. South Fork Lobster Creek, on National Forest land, is the only site with observed annual juvenile coho salmon presence, but juvenile density there is very low (0.000 to 0.110 coho salmon per m^2) (ODFW 2005a). The growth rate of the Lower Rogue River coho salmon population is unknown but likely negative, given that successful recruitment is consistent only in the South Fork Lobster Creek.

Huntley Park seine mark-recapture seine estimates occur in the Lower Rogue River (river mile 8) and are the most robust and precise estimates of adult coho salmon abundance in the Rogue River (ODFW 2011a). It is impossible to determine, with existing information, how many of the estimated coho salmon at Huntley Park were returning to the Lower Rogue River as opposed to other sub-basins in the Rogue River basin. The trend in abundance at Huntley Park can inform whether the population is at high risk of extinction according to the population decline criterion (Williams et al. 2008). The three year running average number of adults estimated at Huntley Park has declined at an annual rate of 12% over the last 12 years (1-2), greater than the 10% decline associated with a high risk of extinction (Williams et al. 2008). Therefore, the population is at high risk of extinction due to its sharply declining productivity.

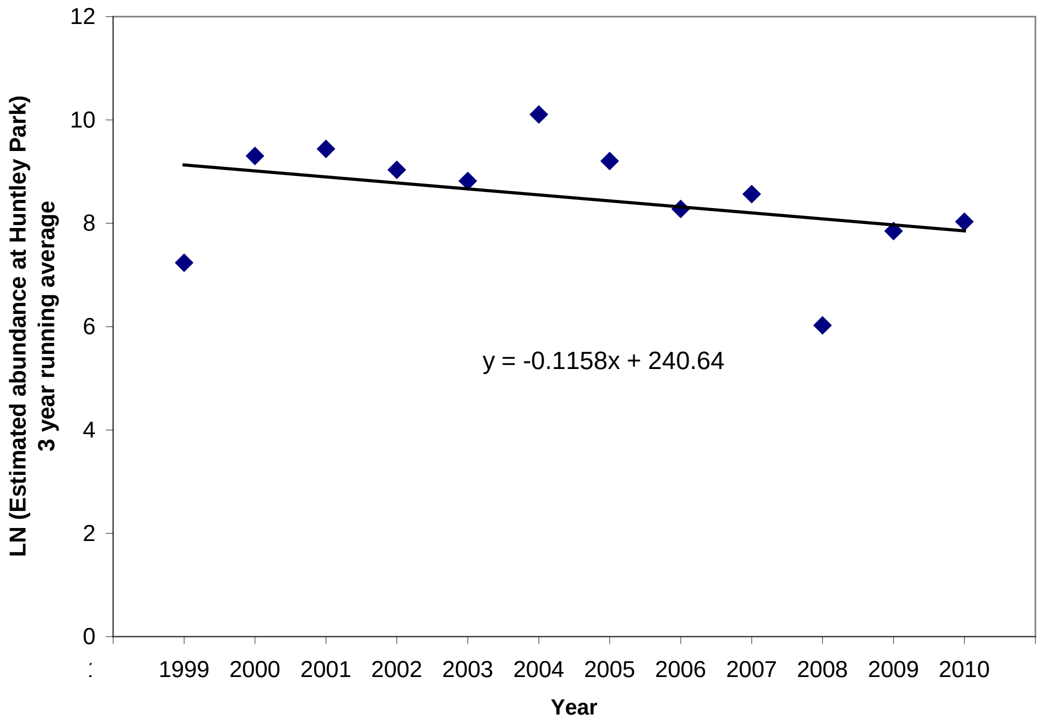

Figure 10-2. Rate of decline of estimated population abundance at Huntley Park, 1999-2010. (Data from ODFW 2011a).

Extinction Risk

The Lower Rogue River coho salmon population is not viable and at high risk of extinction. Although the three year running average of the estimated number of spawners from 2006 to 2008 exceeds the depensation threshold, the estimated number of spawners at Huntley Park has declined at a rate greater than 10% over the past four generations (Figure 1-2) and more than 5% of spawning adults are likely of hatchery origin (Figure 10-2.

Role in SONCC Coho Salmon ESU Viability

With an estimated 3,000 adult coho salmon produced annually before the 1800s (Williams et al. 2008), the Lower Rogue River was likely a source of strays for adjacent dependent populations of coho salmon such as Euchre and Hunter creeks. If restored, the Lower Rogue River population could serve as an occasional source of immigrants to larger nearby independent populations such as those in the Elk River and the interior Rogue River. Restored habitat in the Lower Rogue River and its tributaries would provide for connectivity between populations which assists metapopulation function in the SONCC coho salmon ESU.

10.4 Plans and Assessments

State of Oregon

Expert Panel on Limiting Factors for Oregon's SONCC coho salmon populations

ODFW (2008b) convened a panel of fisheries and watershed scientists as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on limiting factors and threats to recovery. Based on the input of panel members, concerns for the Lower Rogue River are as follows:

> Key concerns for the Lower Rogue River were primarily loss of over-winter tributary habitat for juveniles, especially in the lowlands which are naturally very limited in this system and have been impacted by past and current forestry practices and rural residential development. Another key concern is limited habitat complexity for pre-smolts due to a loss of large wood transport into the freshwater portions of the estuary. Secondary concerns were related to high water temperatures in tributaries for summer parr (excluding the mainstem, where rearing is not expected) due to land management and reduced estuarine habitat for pre-smolts and smolts due to past and current forestry practices and rural residential development.

Rogue River TMDL

The Rogue River TMDL (Oregon Department of Environmental Quality 2008) includes an extensive treatise on the water quality impairment of the Upper Rogue River and its tributaries and describes mechanisms that drive pollution of different types, including bacteria, temperature, sedimentation, pH, and dissolved oxygen.

Lobster Creek TMDL and Water Quality Management Plan

The Lobster Creek TMDL and Water Quality Management Plan (ODEQ 2002b) were developed to abate temperature problems in this major Lower Rogue River tributary. A shade model was used in the TMDL process to gauge needs for recovery of riparian zones. ODEQ (2002b) also acknowledged that sediment contributions play a role in channel changes and increased water temperature.

Cumulative Effects of Southwest Oregon Coastal Land Use on Salmon Habitat

OSU Oak Creek Labs conducted a study funded by ODFW and the Oregon Department of Forestry (ODF) to determine relationships between forest harvest and Pacific salmon productivity (Frissell 1992). The study evaluated watersheds along the Oregon coast extending from the Sixes River to the California-Oregon border from 1986 to 1992. The principal findings were as follows: (1) Compared to streams draining mature old growth forests, streams in heavily logged basins had one third less pool area, supported a reduced diversity of Pacific salmon species, and were more likely to have actively eroding banks; (2) Channel instability in heavily logged basins coincided with high failure rates for in-stream structures; (3) Erosion rates have increased basin wide, contributing to chronic habitat damage in downstream alluvial valleys leading to depression or elimination of mainstem spawning populations of Pacific salmon; and (4) With logging rotations of 30 to 50 years, large portions of drainage basins are deforested and made vulnerable to increased erosion before aquatic habitat and fish populations have recovered from the previous episode of disturbance.

Southwest Oregon Salmon Restoration Initiative

The Southwest Oregon Salmon Restoration Initiative provides the framework for coho salmon recovery in southwest Oregon (Prevost et al. 1997) and helped foster formation of watershed councils. This document was prepared as part of a Memorandum of Understanding between ODFW and the National Marine Fisheries Service (NMFS). Many of the recommended restoration measures have been carried out, but others are pending. Prevost et al. (1997) also identified 'core areas' for coho salmon recovery that overlap with areas of high coho salmon density and habitat quality. Streams with this designation include the upper South Fork of Lobster Creek, Quosatana Creek, and Silver Creek.

Lower Rogue Watershed Council

Lower Rogue Watershed Assessment

This extensive assessment on the Lower Rogue River subbasin (Hicks 2005) includes historical accounts, descriptions of land use and aquatic habitat, and a wealth of information on factors that might limit coho salmon and restoration opportunities.

10.5 Stresses

Table 10-3. Severity of stresses affecting each life stage of coho salmon in the Lower Rogue River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Medium	Very High	Very High[1]	Very High	Medium	Very High
2	Impaired Water Quality[1]	Medium	Very High	Very High[1]	Very High	Medium	Very High
3	Impaired Estuary/Mainstem Function	-	High	High[1]	Very High	High	Very High
4	Altered Sediment Supply	High	High	High	High	High	High
5	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
6	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
7	Altered Hydrologic Function	Medium	Medium	Medium	Low	Low	Medium
8	Increased Disease/Predation/Competition	Low	Low	Low	Low	Low	Low
9	Barriers	-	Low	Low	Low	Low	Low
10	Adverse Fishery-Related Effects	-	-	-	-	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The primary stresses to SONCC coho salmon in the Lower Rogue River are the lack of floodplain and channel structure, degraded water quality resulting from high water temperature, and impaired estuarine function. Juveniles are the most limited life stage, due to insufficient summer and winter rearing habitat. Recovery is extremely unlikely without additional summer and winter rearing habitat. Overall, these findings are consistent with those of the Oregon Expert Panel (ODFW 2008b) (Section 10.4), but the expert panel considered water temperature to be only a secondary, not primary, concern. The highest historic IP coho salmon habitat is in the western part of the watershed (Williams et al. 2008), where the land is privately owned and land management is likely to be more intensive. The greatest effects of this management are the loss of rearing habitat when land was reclaimed, and degradation of the remaining habitat by high water temperatures resulting from the lack of mature trees in the riparian zone and the reduction of the amount of water in the river by diversions.

Lack of Floodplain and Channel Structure

The floodplain and channel structure of the Lower Rogue River is highly impaired and constitutes a major limiting stress for coho salmon. Edson Creek has been channelized in many reaches and lacks large wood and pool-riffle structure necessary to support juvenile coho salmon. Libby Creek is one of the most altered Lower Rogue River tributaries due to the dam constructed above its confluence with the Lower Rogue River to create a recreational fishing pond. Channel structure and transport capacity has been completely disrupted in lower Jim Hall Creek and Kimball Creek.

ODFW habitat surveys show poor pool frequency for the upper South Fork Lobster Creek (<10 percent) and fair (10 to 20 percent) conditions in the upper-most reach of the North Fork and one of its tributaries. Pool frequencies increase to good (20 to 35 percent) in the lower reaches of the North Fork (NF) and South Fork (SF) Lobster Creek. The average maximum pool depths ranged from less than 2 feet deep to 3.3 feet deep, with the deepest pools located in lower Lobster and Quosatana creeks. Quosatana Creek has re-developed pool depths of up to 10 feet (USFS 1996b), but it still flows subsurface near its confluence with the Rogue River due to accumulations of fine sediment.

Impaired Water Quality

Water quality in the Lower Rogue River is very poor and constitutes a major limiting stress for coho salmon (USFS 1996b, 2000a; ODEQ 2002b, 2008; Hicks 2005). Coho salmon have a low tolerance for elevated water temperatures (McCullough 1999) and this factor consequently poses a very high level of stress for Lower Rogue coho salmon fry, juveniles and smolts. The ODEQ (2002b, 2008) limit for maximum weekly maximum water temperature (MWMT) is 64° Fahrenheit, which is compatible with coho salmon recovery. Only 36 percent of Lower Rogue locations surveyed met this standard (SO RC&D 2003), and cooler locations were in headwater areas that are too steep for coho salmon to access (USFS 2000a). Inner gorge tributaries of the mainstem Rogue River below Agness have recovered to optimal salmonid rearing temperatures (e.g., Bradford Creek at 59.5 to 61.7° F), providing critical summer refugia. Tom Fry Creek also has a half-mile reach above the mouth that is suitable for coho salmon rearing (USFS 2000a). The Quosatana Creek MWMT from 1991 to 1999 ranged from a low of 66.4° F to a high of 70.9° F (USFS 2000a). Recovery of pool depth in Quosatana Creek (USFS 1996b) may help re-establish cool water temperatures, due to seepage of groundwater from adjacent alluvial deposits, which have been shown to create a deep layer of cold water in healthy streams (U.S. Environmental Protection Agency (EPA) 2003a, ODEQ 2008).

The Lower Rogue River is recognized as having elevated nutrient levels (i.e., phosphorous; ODEQ 2010), but because the source of these nutrients is upstream, solutions to the problem are described in other Rogue River basin profiles. Libby Pond in the Lower Rogue subbasin appears highly enriched with nutrients and has substantial algae blooms. Conditions are conducive to the proliferation of toxic algae, a recognized problem in other Oregon lakes (Jones et al. 2008).

The Oregon Department of Agriculture (Riley 2009) currently has no pesticide data for the south coast Oregon, yet this may be a significant but little recognized region-wide problem for salmonids (Ewing 1999, Laetz et al. 2009).

Impaired Estuary/Mainstem Function

The Rogue River estuary is highly altered and retains little of its historic function downstream of Highway 101 (Figure 10-3; Hicks et al. 2008). Studies elsewhere in Oregon show estuarine tributaries and sloughs can be some of the most important habitat types for rearing coho salmon juveniles (Koehler and Miller 2003, Miller and Sadro 2003, Koski 2009). The lack of habitat in the Rogue River estuary that can be used for refugia likely results in high rates of predation from birds, fish, and pinnipeds. Numerous barriers in tributaries flowing into the estuary prevent use of these important rearing habitats and inhibit proper tidal exchange and greatly diminish opportunities for non-natal rearing in cooler coastal climates. The tributary on the north side of the estuary has been completely channelized and all of the wetlands near its mouth have been filled. Fine sediment from Saunders Creek has also partially filled Snag Patch Slough at its mouth (Hicks 2005).

Figure 10-3. Aerial photo of the Rogue River estuary. Photo shows the boat basin (right), jetties, levees and shoreline development. Photo from Hicks (2005).

Altered Sediment Supply

Altered sediment supply poses an overall high stress to coho salmon in the Lower Rogue River. Sediment contribution from landslides and erosion occurs naturally in the Lower Rogue River basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. Excess fine sediment reduces coho salmon egg viability and may reduce food for fry, juveniles and smolts. Accumulation of excess fine sediment has caused several creeks in the Lower Rogue River subbasin (Quosatana Creek, Jim Hunt Creek, and Kimball Creek) to flow subsurface. Low pool frequency and depth throughout the Lower Rogue River basin are likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening. The USFS (1996b, 2000a) and Hicks (2005) recognize elevated fine sediment transport as a major Lower Rogue River limiting stress for salmonids.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions are recognized as the major driving force of water temperature problems in the Rogue River basin (ODEQ 2002b, 2008). These conditions also contribute to the lack of large wood in stream channels in the Lower Rogue (USFS 1996b, 2000a; Hicks 2005). The lack of large woody debris and high water temperatures contribute to the limiting stresses for this population – lack of floodplain and channel structure and impaired water quality. Past land use has led to replacement of riparian conifers with hardwoods on both public and private forest lands in the Lower Rogue River subbasin (USFS 1996b, 2000a; Hicks 2005). Additionally, one of the more important riparian species (Port Orford Cedar) is experiencing a disease epidemic causing loss of this important riparian species in Quosatana Creek (USFS 1996b), and Frissell (1992) recognized the loss of this species as regionally significant.

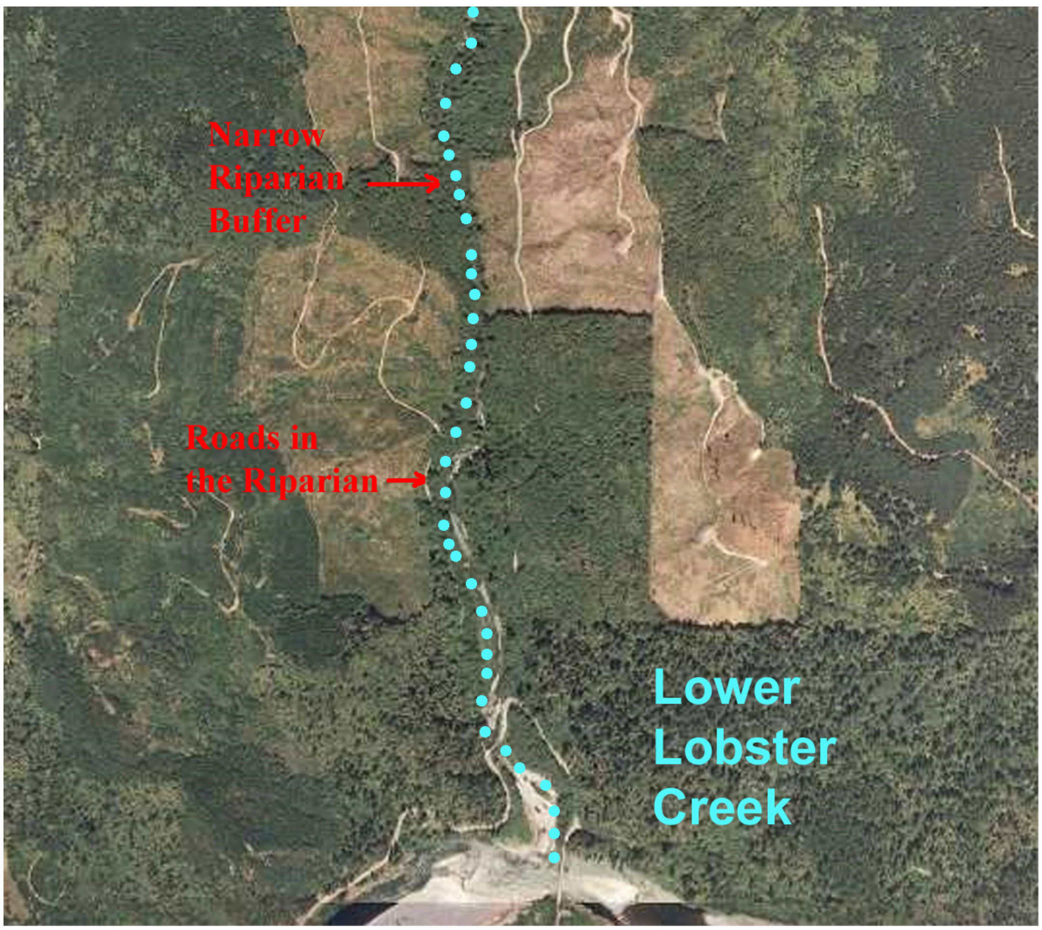

Figure 10-4. Aerial photo of Lower Lobster Creek at its convergence with the mainstem Rogue River. Convergence is at bottom of photo, which shows clear cuts, insufficient buffer widths, high road density and near stream roads. The stream course is shown in blue dots. (Terra Server, www.terraserver.com).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. No hatcheries or artificial propagation occur in the Lower Rogue population area, but there is an active hatchery in the Rogue River basin. Cole Rivers Hatchery is downstream of Lost Creek

Dam (RM 157) in the Upper Rogue River subbasin. Genetic stress due to introduction of out-of-basin genetic material is not a current concern, because broodstock are currently selected from those fish which return to the hatchery (ODFW 2008d). Hatchery fish are stocked under conditions designed to make them leave the system quickly (ODFW 2008d), but are nonetheless expected to influence wild smolts to some degree. Eighty-two percent of coho spawners observed in Lower Rogue River tributaries in 2001 were of hatchery origin (Jacobs et al. 2002). Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of Cole Rivers Hatchery in the Rogue River basin (Appendix B).

Altered Hydrologic Function

Water used for agriculture and residential developments in the Lower Rogue River subbasin is modest relative to mainstem flows. The USFS (2000a) rated hydrologic risk as moderate due to timber harvest and road construction, particularly in the transient snow zone. Extensive logging and road building have been hypothesized to diminish summer base flows (Montgomery and Buffington 1993) and likely contributed to increased peak flows. The loss of surface flow in creeks like Jim Hall and Kimball creeks may be due to aggradation, changes in net water yield, or a combination of the two. There is a side channel in the main river at the confluence with Edson Creek, which is the upper extent of the estuary, and cool flows from the tributary may create an important refugium that could be diminishing with increasing residential water use.

Increased Disease/Predation/Competition

Although above-optimal water temperatures can elevate disease risk for coho salmon (McCullough 1999), there are currently no documented problems in the Lower Rogue River. Hicks (2005) raised questions about predation in the simplified estuary, because the lack of cover reduces their ability to avoid predators.

Barriers

High road densities on private lands in the Lower Rogue River subbasin result in a high number of road-stream crossings that are potential juvenile and adult migration barriers. However, surveys have already identified most of the problems in potential coho salmon streams and many of these passage issues have been addressed or have plans in place to be addressed in the near future (Prevost et al. 1997, Hicks 2005). The USFS (2000a) addressed all fish passage problems related to culverts in the NF and SF Lobster Creek and will continue to improve fish passage at road-stream crossings as funds become available. Myers (2001) reported successful fish passage projects on private land in Lobster and Silver creeks.

Adverse Fishery-Related Effects

NMFS concluded that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

10.6 Threats

Table 10-4. Severity of threats affecting each life stage of coho salmon in the Lower Rogue River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Medium	Very High	Very High	Very High	Medium	Very High
2	Urban/Residential/Industrial	Medium	High	High	High	Medium	High
3	Channelization/Diking	Low	High	High	High	Low	High
4	Timber Harvest	Low	High	High	High	Low	High
5	Mining/Gravel Extraction	Low	Low	High	High	High	High
6	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
7	Agricultural Practices	Low	Medium	Medium	Medium	Low	Medium
8	Dams/Diversion	Low	Medium	Medium	Medium	Low	Medium
9	Climate Change	Low	Low	Medium	Medium	Medium	Medium
10	High Intensity Fire	Low	Low	Low	Low	Low	Low
11	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
12	Invasive Non-Native/Alien Species	-	Low	Medium	Medium	-	Medium
13	Fishing and Collecting	-	-	-	-	Low	Low

Roads

High road densities, numerous road-stream crossings, and roads on steep slopes combine to pose a critical threat to most coho salmon life history phases in the Lower Rogue River subbasin. The road density in the Lower Rogue River exceeds 2.5 miles of road per square mile (mi/mi^2) of watershed. NMFS (1995) set a limit for road density of 2 mi/mi^2 to protect anadromous salmonids in the interior Columbia River basin to limit sources of fine sediment mobilization. Roads have contributed substantially to increased landsliding and fine sediment yield, including failures at stream crossings (USFS 1996b, 2000a). The most severe erosion potential is when multiple road-stream crossings fail in a single tributary. This occurs when a crossing washes out and creates a slug of debris and fine sediments that wash out crossings further downstream. Miles of Lower Rogue channels have been scoured by these debris torrents, resulting in flattened stream profiles that may require decades to recover. The loss of riparian conifers will require even more time to replace. Private lands feature large numbers of near-stream roads and roads on slopes of greater than 50 percent (Hicks 2005). Most timber haul roads are not surfaced, and chronically contribute fine sediment to streams, although measures are being taken to remedy the problem in Lobster Creek (ODEQ 2002b).

Urban/Residential/Industrial Development

The city of Gold Beach encroaches on the estuary of the Rogue River. Impervious surfaces related to development contribute stormwater runoff and non-point source pollution, as observed elsewhere in the Rogue River basin (ODEQ 2008). Commercial development along the north bank confines the lower estuary. Residential development also occurs in the Lower Rogue River riparian zone upstream to Lobster Creek and may contribute pollutants from leaking septic systems. The high severity of this threat is due to concentrated impacts in areas of the highest IP coho salmon habitat, specifically in Edson Creek, Indian Creek, Saunders Creek, and in the estuary.

Channelization and Diking

Channelization and diking has greatly altered low gradient Lower Rogue River tributaries, the lower mainstem, and the estuary. Channel alteration of Edson Creek and the unnamed northern tributary of the estuary have had the greatest impact on coho salmon production in the Lower Rogue River subbasin because of the extent of high IP coho salmon habitat occurring there. Levees and dikes have been constructed to protect residential or commercial property in the lower seven miles of the Rogue River, decreasing summer and winter coho salmon juvenile rearing habitat and disconnecting the river from its floodplain. Some remaining side channels located in the lower portions of the population area maintain some rearing habitat capacity (Hicks 2005). Side channels cannot reform on the north side of the upper estuary, because of the levees that protect grazing land and a gravel mining operation.

Timber Harvest

Sixty percent of the Lower Rogue River watershed is in federal ownership, and this land currently has low levels of timber harvest. Reeves et al. (1993) found that the rate of timber harvest in Oregon coastal watersheds should not exceed 25 percent of a watershed to minimize risks and disturbances to aquatic resources. The study covered a period of 30 years (Reeves 2003) and watersheds exceeding that level of harvest did not maintain channel integrity or Pacific salmon species diversity. Therefore, the threat from timber harvest on private land will likely remain high. However, logging on public land is now largely restricted to selective harvests in previously logged areas in order to improve forest health. The greatest risk from timber harvest is on private industrial timberlands that are managed under the Oregon Forest Practices Act.

Mining/Gravel Extraction

Gravel mining is ongoing on the terrace of the Lower Rogue River estuary. There are gravel operations on both the north and south banks of the estuary in areas with some of the best restoration opportunities for creating mainstem rearing refugia for coho salmon.

Hatcheries

Hatcheries pose a medium threat to all life stages in the Lower Rogue River sub-basin. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Agricultural Practices

Livestock have been eliminated from prairies on public land (USFS 2000a), but on private land grazing may have significant effects on coho salmon. Pasture in the historic estuarine floodplain restricts side channel development that could provide refugia for rearing coho salmon. Across the subbasin, channel changes caused by conversion of forest to pasture in the highest IP coho salmon habitat are a major inhibitor of coho salmon recovery. Ongoing livestock grazing only contributes to the threat. The primary stream reaches impacted are the unnamed tributary on the north bank of the estuary and Edson Creek. The Oregon Department of Agriculture currently has no means of tracking pesticide use near the Lower Rogue River (Riley 2009), but agricultural use of these substances could be affecting coho salmon (see Water Quality).

Dams/Diversions

Libby Pond on Libby Creek is the only known impoundment within the Lower Rogue River subbasin that prevents access to historical coho salmon habitat. Concerns related to diversions, water use, and stream flows are restricted to Edson and Indian creeks. Problems with the base flow of Edson Creek are likely a combination of surface flow and groundwater extraction for agricultural and residential water use. The city of Gold Beach has a 0.77 cubic feet per second (cfs) water right on Indian Creek (USFS 2000a). Flow depletion is a factor known to contribute to stream warming (Poole and Berman 2001), resulting in loss of potential coho salmon habitat.

Climate Change

Climate change in this region will have the greatest impact on juveniles, smolts, and adults. Although the current climate is generally cool, modeled regional average temperature shows a moderate increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 1.5°C in the summer and by 1°C in the winter. Annual precipitation in this area is predicted to stay within the natural range of current variability however seasonal patterns in precipitation likely will occur (Mote and Salathe 2010). Overall, the range and degree of variability in temperature and precipitation are likely to increase in all populations. The vulnerability of the estuary and coast to sea level rise is moderate to high in this population. Juvenile and smolt rearing and migratory habitat are most at risk to climate change. Rising sea level may impact the quality and extent of wetland rearing habitat by inundating freshwater marshes or wetlands with saltwater.

High Intensity Fire

Proximity to the coast and high rainfall make fire risk less of an issue in the Lower Rogue River than in watersheds like the Applegate or Illinois in the interior of the Rogue River basin. Crowded stands of small-diameter trees have increased fire danger (SO RC&D 2003), and such stands are common on private timber lands.

Road-Stream Crossing Barriers

Coho salmon can access most of the Lower Rogue River watershed. Surveys of barriers have been conducted in all lower tributaries and in Lobster and Silver creeks (Hicks 2005) and most issues with fish passage at road-stream crossings have been resolved (Myers 2001). The Libby Pond is a current barrier although it is not a road-stream crossing.

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook salmon directed fisheries that account for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the directed fisheries. The exploitation rate associated with this and other freshwater fisheries in Oregon has been found to be low enough to not likely jeopardize the continued existence of the ESU (Good et al. 2005). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because no recovery objectives to achieve species viability had been established for SONCC coho salmon at that time (NMFS 1999). Regional-scale effects may be enough to impede recovery of the Interior Rogue River diversity stratum, even if they are not severe enough to jeopardize the continued existence of the ESU. Specifically, wild coho salmon in the Rogue River basin likely experience more exploitation effects than those in other areas, because they co-occur with the adult hatchery coho salmon that were produced in the Rogue's Cole Rivers Hatchery, return to the Rogue River to spawn, and are targeted there by recreational fishermen.

NMFS has authorized future collection of coho salmon for research purposes in the Lower Rogue River subbasin. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Invasive Non-Native/Alien Species

New Zealand mudsnails are known to be present in the Lower Rogue River population area. The mudsnail is a parthenogenic (i.e., asexual) livebearer with high reproductive potential, often reaching densities greater than 100,000/m² in suitable habitat (Portland State University (PSU) 2011). Due to the rapid population growth rates, New Zealand mudsnails may account for the majority of the invertebrate biomass in colonized areas. This species is known to out-compete native invertebrates and contributes little food value to salmonids.

10.7 Recovery Strategy

The most important factor limiting recovery of coho salmon in the Lower Rogue River is the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored. Channel complexity should be improved by constructing off-channel ponds or backwater habitat, reconnecting the wetlands and estuary to the river, restoring wetlands, and limiting development and fill. To increase instream structure, large wood should be added where the channel is stable, to provide structure until natural sources of large wood (mature coniferous and hardwood forests) are re-established next to the stream. Areas adjacent to the stream should be replanted and subsequently thinned to re-establish mature streamside forest as a source of large wood recruitment.

The most immediate need for habitat restoration and threat reduction in the Lower Rogue River is in those areas currently occupied by coho salmon, such as Snag Patch Slough in the estuary, the oxbow at the mouth of Edson Creek, and upper Lobster Creek. The least disturbed aquatic habitat would be a good place to start for restoring vital rearing habitat. Unoccupied areas must also be restored to provide habitat for coho salmon recovery, and the least disturbed areas with IP should be considered first for restoration: South Fork Lobster Creek, North Fork Lobster Creek, Indian Creek, and Saunders Creek (Reeves et al. 1995).

Table 10-5 on the following page lists the recovery actions for the Lower Rogue River population.

Table 10-5. Recovery action implementation schedule for the Lower Rogue River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LRR.1.1.6	Estuary	Yes	Improve connectivity of tidally-influenced habitat	Reconnect estuarine habitat	Estuary, Unnamed Tributary	3
SONCC-LRR.1.1.6.1	*Assess the tidal wetland habitat and develop a plan to reconnect the tributary*					
SONCC-LRR.1.1.6.2	*Reconnect tidal wetlands and tributary, guided by the plan*					
SONCC-LRR.1.2.7	Estuary	Yes	Improve estuarine habitat	Increase regulatory oversight that protects existing estuarine habitat	Undisturbed intertidal and shallow subtidal habitats in the lower estuary, such as the spit forming inside the jetties and the shore near the Coast Guard station.	2
SONCC-LRR.1.2.7.1	*Limit development near tidally influenced habitat, and maintain or strengthen current protection measures*					
SONCC-LRR.1.2.8	Estuary	Yes	Improve estuarine habitat	Restore estuarine habitat	Estuary	3
SONCC-LRR.1.2.8.1	*Assess coho use of different estuarine habitats and develop a plan to enhance those habitats (i.e. brackish wetlands, tidal sloughs, salt marshes, and tidally influenced freshwater)*					
SONCC-LRR.1.2.8.2	*Restore tidally influenced habitats, guided by the plan*					
SONCC-LRR.1.2.25	Estuary	Yes	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-LRR.1.2.25.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-LRR.1.2.25.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-LRR.2.1.9	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2
SONCC-LRR.2.1.9.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-LRR.2.1.9.2	*Place instream structures, guided by assessment results*					
SONCC-LRR.2.2.10	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	3
SONCC-LRR.2.2.10.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LRR.2.2.10.2	*Implement beaver program (may include reintroduction)*					
SONCC-LRR.10.2.26	Water Quality	Yes	Reduce pollutants	Reduce point- and non-point source pollution	Population wide	2
SONCC-LRR.10.2.26.1	*Identify pollution sources, and develop a strategy to meet objective*					
SONCC-LRR.10.2.26.2	*Implement strategy to prevent pollution*					
SONCC-LRR.16.1.12	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LRR.16.1.12.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-LRR.16.1.12.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-LRR.16.1.13	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-LRR.16.1.13.1	*Determine actual fishing impacts*					
SONCC-LRR.16.1.13.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-LRR.16.2.14	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LRR.16.2.14.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-LRR.16.2.14.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-LRR.16.2.15	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LRR.16.2.15.1	*Determine actual impacts of scientific collection*					
SONCC-LRR.16.2.15.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LRR.27.1.16	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-LRR.27.1.16.1	*Perform annual spawning surveys*					
SONCC-LRR.27.1.17	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-LRR.27.1.17.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-LRR.27.1.18	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-LRR.27.1.18.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-LRR.27.2.19	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-LRR.27.2.19.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-LRR.27.2.19.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-LRR.27.2.20	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-LRR.27.2.20.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-LRR.27.2.21	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-LRR.27.2.21.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-LRR.27.2.22	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-LRR.27.2.22.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LRR.27.2.23	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-LRR.27.2.23.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-LRR.27.2.24	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-LRR.27.2.24.1	*Identify habitat condition of the estuary*					
SONCC-LRR.27.1.28	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-LRR.27.1.28.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-LRR.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	Population wide	3
SONCC-LRR.27.2.29.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-LRR.27.1.30	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-LRR.27.1.30.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-LRR.27.1.30.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-LRR.27.2.31	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-LRR.27.2.31.1	*Determine best indicators of estuarine condition*					
SONCC-LRR.7.1.4	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-LRR.7.1.4.1	*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-LRR.7.1.5	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Lower Lobster Creek	3
SONCC-LRR.7.1.5.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-LRR.7.1.5.2		*Thin, or release conifers, guided by prescription*				
SONCC-LRR.7.1.5.3		*Plant conifers, guided by prescription*				
SONCC-LRR.7.1.27	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	BLM lands	3
SONCC-LRR.7.1.27.1		*Manage timber harvest (and associated activities) on Federal lands in accordance with the Aquatic Conservation Strategy of the NWFP to achieve riparian and stream channel improvements for coho salmon*				
SONCC-LRR.8.1.1	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	SF and NF Lobster, Silver, Saunders, and Indian creeks	3
SONCC-LRR.8.1.1.1		*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*				
SONCC-LRR.8.1.1.2		*Decommission roads, guided by assessment*				
SONCC-LRR.8.1.1.3		*Upgrade roads, guided by assessment*				
SONCC-LRR.8.1.1.4		*Maintain roads, guided by assessment*				
SONCC-LRR.8.1.2	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-LRR.8.1.2.1		*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*				

11. Hunter Creek Population

- Northern Coastal Stratum
- Dependent Population
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 44.5 mi^2
- 15 IP km (9 mi) (13% High)
- Dominant Land Uses are Timber Harvest and Grazing
- Principal Stresses are 'Lack of Floodplain and Channel Structure' and 'Degraded Riparian Forest Conditions'
- Principal Threats are 'Roads' and 'Channelization and Diking'

11.1 History of Habitat and Land Use

Hunter Creek enters the Pacific Ocean just south of the town of Gold Beach, which is located at the mouth of the Rogue River. Farming and ranching on the lower terraces began in the 1850s. Some coho salmon habitat was likely impacted, although basin-wide productivity remained high. Only about 20 people lived in lower Hunter Creek through the 1930s (Massingill 2001d), but today there are hundreds of residents as rural development has spread outwards from Gold Beach.

Forestry is the dominant land use in the Hunter Creek basin. Like most southwest Oregon river basins, Hunter Creek was extensively logged after World War II (EA Engineering, Science, and Technology 1998). In the 1950s, there were as many as 17 active mills in the Gold Beach/Hunter Creek area (Massingill 2001d). Private timber land was substantially logged by 1960, and reforestation was limited (Maguire 2001d). U.S. Forest Service (USFS) and Bureau of Land Management (BLM) lands in the headwaters of the upper mainstem and North Fork of Hunter Creek were logged from the 1950s to the 1980s (EA Engineering, Science, and Technology 1998). Damage in Hunter Creek from the floods of 1955 and 1964 was extensive.

In 1995, an area of lower Hunter Creek with a human population of about 414 people was annexed to the City of Gold Beach (Maguire 2001d). Residential development is concentrated in the lower basin. Commercial and industrial development in lower Hunter Creek and the estuary have also contributed to coho salmon habitat degradation.

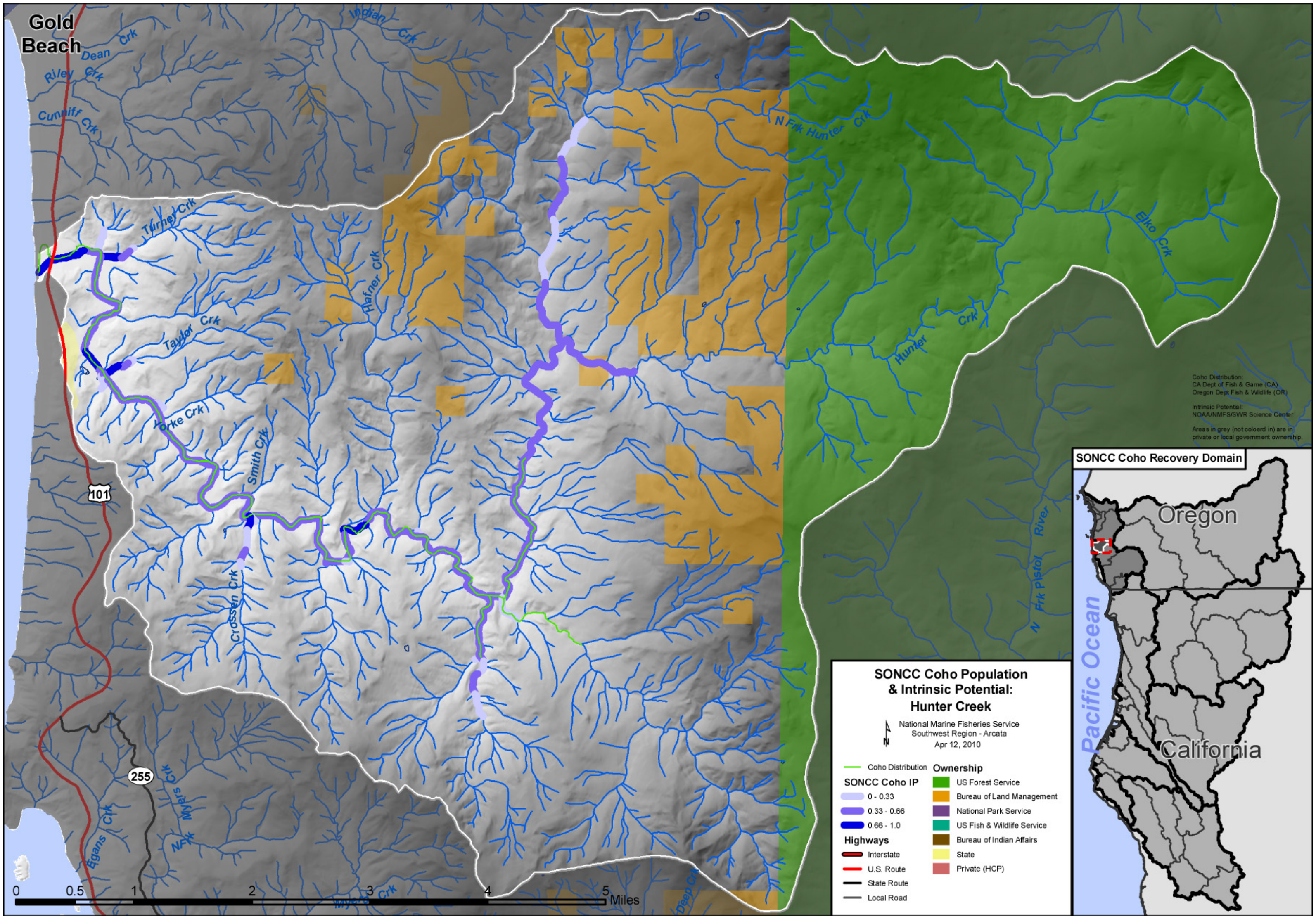

Figure 11-1. The geographic boundaries of the Hunter Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

11.2 Historic Fish Distribution and Abundance

Historic data on the distribution and abundance of coho salmon in Hunter Creek is limited. Annual estimates of coho salmon adults in Hunter Creek were 136 in 2001, 52 in 2002, 17 in 2004, 22 in 2005 and 35 in 2008. Williams et al. (2006) identified the estuary, lower mainstem, and tributaries below Conn Creek as having the highest coho salmon intrinsic potential habitat (IP > 0.66) in the basin. Hunter Creek has a total of 14.63 IP-km of coho salmon rearing habitat. Table 11-1 lists streams with high IP coho salmon habitat.

Table 11-1 Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Stream Name	Stream Name
Crossen Creek	Taylor Creek
Hunter Creek Estuary	Turner Creek
Lower Mainstem Hunter Creek	

11.3 Status of Hunter Creek Coho Salmon

Spatial Structure and Diversity

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Coho salmon still inhabit their historic range in Hunter Creek from the Big South Fork Hunter Creek downstream, including the lowest extent of the Big South Fork Hunter Creek and Little South Fork Hunter Creek (Maguire 2001d). In dive surveys of three reaches of Hunter Creek (upstream of Yorke Creek, downstream of Little South Fork Hunter Creek, and upstream of North Fork Hunter Creek) in 2002-2004, coho salmon were only found at the reach downstream of Little South Fork Hunter Creek and were at very low densities (0.038 and 0.063/sq. meter) (ODFW 2005a). This indicates patchy distribution and likely a small population, which would generally have less genetic diversity than larger ones. Thus, spatial structure and diversity is likely low.

Population Size and Productivity

The Oregon Department of Fish and Wildlife (ODFW 2009a) estimated coho salmon populations for the period 1998 to 2008 for south coast Oregon, including Hunter Creek. Coho salmon adults have been found in only 5 of 11 years, with annual estimates of 136 in 2001, 52 in 2002, 17 in 2004, 22 in 2005 and 35 in 2008. One year class appears to be completely missing and the lack of consistent returns in other brood years indicates very low productivity in the Hunter Creek. There is no information regarding how consistent ODFW survey effort was between years, so some qualification of these results is required. Also, in high flow years, surveys may be difficult or impossible. Consequently, the population may be somewhat larger than estimated and there may have been some coho salmon adults in years when the population estimate was zero.

Extinction Risk

Not applicable because Hunter Creek is not an independent population.

Role in SONCC Coho Salmon ESU Viability

The Hunter Creek population is considered dependent because it does not have a high likelihood of sustaining itself over a 100-year time period in isolation and likely received sufficient immigration to alter its dynamics and extinction risk (Williams et al. 2006, 2008). Although such populations may not be fully viable on their own, they do increase connectivity by allowing dispersal among independent populations, acting as a source of colonists in some cases. Historically, the Hunter Creek population would have interacted with other Northern Coastal potentially independent populations, such as the lower Rogue River to the north, or with other dependent populations like the Pistol River to the south. Any restored habitat in Hunter Creek provides potential connectivity that could assist with metapopulation function in the SONCC coho salmon ESU.

11.4 Plans and Assessments

State of Oregon

Expert Panel Limiting Factors Report for Southwest Oregon

ODFW (2008b) convened a panel of fisheries and watershed science experts as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on limiting factors and threats to recovery. Based on the input of panel members, ODFW (2008b) summarized the concerns for the Hunter Creek population as follows:

> Key concerns were a loss of over-winter tributary habitat complexity and floodplain connectivity for juveniles, especially in the lowlands which are naturally very limited in these systems and have been impacted by past and current urban, rural residential, and forestry development and practices. High water temperatures for summer parr due to a loss of riparian function and channel straightening is also a key concern in this stream. The secondary concern was related to a loss of over-winter, lowland habitat complexity due to past and current agricultural practices.

Oregon Plan for Salmon and Watersheds
http://www.oregon.gov/OPSW/about_us.shtml

The State of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is a comprehensive plan that includes voluntary actions for all of the threats currently facing coho salmon in these ESUs and involves all relevant state agencies. Reforms to fishery harvest and hatchery programs were implemented by ODFW in the late 1990’s. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary. The action plans, implementation success, and annual reports can be found at http://www.oregon.gov/OPSW/.

South Coast Watersheds Council

Hunter Creek Watershed Assessment

The Hunter Creek Watershed Assessment (Maguire 2001d) was prepared for the Hunter Creek Watershed Council (HCWC) by the SCWC. The purpose was to compile, summarize, and synthesize existing data and information pertaining to the Hunter Creek basin's condition. This information provides a foundation for the prioritization of projects outlined in the Hunter Creek Watershed Action Plan.

Hunter Creek Watershed Action Plan

The Hunter Creek Watershed Action Plan (Massingill 2001d) was crafted for the HCWC by the SCWC. It lays out a restoration strategy with specific recommended actions for Hunter Creek, including "increasing the size and complexity of the estuary, identifying and restoring wetlands, identifying current and potential sediment sources in the basin, protecting existing riparian vegetation and planting new riparian vegetation, converting alder-dominated stands to conifer, and assessing the risk of failure of road crossings in earthflow areas."

11.5 Stresses

Table 11-2. Severity of stresses affecting each life stage of coho salmon in Hunter Creek. Stress rank categories and assessment methods are described in Appendix C, and the data used to assess stresses for the initial threats assessment (described in Appendix C) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Medium	Very High	Very High[1]	Very High	High	Very High
2	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	High	Medium	Very High
3	Altered Sediment Supply	High	Medium	High	High	Medium	High
4	Impaired Water Quality[1]	Low	High	Very High[1]	High	Low	Very High
5	Impaired Estuary/Mainstem Function	-	Low	High	High	Low	Medium
6	Barriers	-	Low	Low	Low	Low	Low
7	Altered Hydrologic Function	Low	Low	Low	Low	-	Low
8	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
9	Adverse Fishery-Related Effects	-	-	-	-	Low	Low

[1]Key limiting factor(s) and limited life stage(s).
[2]Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited and quality winter rearing habitat is lacking as vital habitat for the population. Degraded riparian conditions eliminated the source of large wood recruitment. The complexity of the channel has been significantly reduced by the combined effect of excess fine sediment filling pools and the lack of structure to meter out sediment or provide scour mechanisms which create and maintain pools. These findings are consistent with those of the Oregon Expert Panel (Section 11.4).

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure is the most limiting stressor to coho salmon. Channelization of lower Hunter Creek has disconnected the stream from its riparian zone and wetlands and has likely disrupted surface water-groundwater interactions. Large fallen conifers and root masses that formerly forced the scour of pools are now scarce or absent, depriving coho salmon of necessary cover in their summer and winter habitats. ODFW and USFS conducted large wood surveys and found poor levels of large wood (<1 key piece per 100m). Wood removal from stream channels has occurred in the Hunter Creek basin (EA Engineering, Science, and Technology 1998).

ODFW and USFS habitat surveys of the Hunter Creek basin found that pool frequency varied from fair (10 to 20 percent) in lower Big South Fork and upper mainstem Hunter to good (20 to 35 percent) in the mainstem above the North Fork and the lower North Fork (Appendix B). Surveys of lower Hunter Creek found pool frequencies greater than 35 percent and pool depths greater than three feet, which ODFW rates as very good. However, pool frequencies and depths are probably substantially reduced from historic conditions. For example, nearby Quosatana Creek in the Lower Rogue River subbasin has a watershed with similar size to Hunter Creek but has mainstem pool depths of 10 feet (USFS 1996b). Hunter Creek pools historically may have approached or exceeded this depth before disturbance.

Degraded Riparian Forest Conditions

There are few large trees capable of providing large wood in the riparian zone of Hunter Creek. Specifically, ODFW found there were fewer than 75 conifers greater than 36” in diameter per 1000 ft. in all reaches of Hunter Creek. Large conifers stabilized bank structure, maintained shade, and improved both thermal and nutrient buffering. The riparian zone of Hunter Creek is significantly altered, and hardwood trees like alder and willow are now the most abundant species in alluvial valleys. These species do not provide long lasting large wood for channel forming processes (Cederholm et al. 1997). Serpentine soils naturally limit the presence of large-diameter conifer forests in much of the east side of the Hunter Creek basin. In serpentine areas, Port Orford cedar is an important riparian tree but unfortunately has suffered high mortality due to the spread of introduced Port-Orford cedar root rot (EA Engineering, Science, and Technology 1998). Sediment deposition and shifting bedload may be causing mortality of streamside hardwoods and conifers that inhibits riparian recovery and succession.

Altered Sediment Supply

Sediment contribution from landslides and erosion occurs naturally in the Hunter Creek basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. In lower Hunter Creek, where coho salmon are known to occur, sand and fine sediment increases to levels recognized as poor coho salmon habitat (>17 percent). Excess fine sediment directly impacts coho salmon egg viability and can reduce food for fry, juveniles and smolts. Poor pool frequency and depth throughout the Hunter Creek basin (Maguire 2001d) is likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening.

Impaired Water Quality

Hunter Creek is recognized as temperature impaired from its mouth to 18.4 miles upstream (Oregon Department of Environmental Quality (ODEQ) 2002a), which is the reach that contains some of the highest IP coho salmon habitat. North Fork Hunter Creek is also listed by ODEQ (2002a) as temperature impaired in its lower 4.8 miles. Upper mainstem temperatures are naturally warm (72 to 75 °F) because the headwaters have serpentine soils where vegetation is naturally sparse and stream shade low (Massingill 2001d). The Little South Fork is currently too warm during the summer, as is lower Hunter Creek which has temperatures as high as 74 to 75 °F. Only the lower Big South Fork is currently cool enough for rearing coho salmon. Aquatic insect samples on federal lands in the South Fork show that communities are diverse and very good in headwaters, but decline to fair or poor in lower reaches.

Lower Hunter Creek is pH impaired during the summer. Septic systems could be a source of pollution (Massingill 2001d) but this has not been investigated. Reduced flow levels combined with increased nutrients can contribute to nuisance algae blooms that can elevate pH during the day and depress dissolved oxygen levels at night.

Impaired Estuary/Mainstem Function

The lack of estuary function is a high stress to juveniles and smolts, but overall a medium stress for Hunter Creek coho salmon. The Hunter Creek estuary has occasional nuisance algae blooms (Figure 11-) and has lost both depth and complexity due to excess fine sediment deposition (Figure 11-). Almost all of the former estuarine habitat has been altered. Highway 101 completely bisects the estuary just upstream of the mouth and acts as a dike along most of its length. There are also dikes along the south side of the estuary in front of a large tourist-related commercial development. Further upstream, former estuarine habitat has been diked and filled for other commercial and agricultural use. There is one large side channel that remains, but this channel, along with most of the estuary shows signs of fine sediment accretion and lacks complex features such as large wood and deep pools. There appears to be no tidal wetlands remaining. Water quality is likely poor in the estuary during the low-flow season due to high water temperatures and the presence of algae blooms.

Figure 11-2. Algae bloom in the Hunter Creek estuary.

Figure 11-3. Large wedge of sediment (noted with red arrow) in the middle of the channel. There is commercial development in the riparian zone of the upper Hunter Creek estuary.

Barriers

Barriers to coho salmon migration exist, including several in the Lower Hunter Creek mainstem watershed (Maguire 2001d). A barrier on the Little South Fork Hunter Creek noted by Maguire (2001d) has now been removed and replaced with a bridge. Coho salmon still have access to most of the Hunter Creek basin; consequently, barriers represent a low stress.

Altered Hydrologic Function

Altered hydrologic function is believed to be a low stress for Hunter Creek coho salmon. Maguire (2001d) notes that residential development and increased water demand have the potential to compromise flows, although there have been no related studies. Timber harvest and roads have likely increased peak flows in the Hunter Creek basin (EA Engineering, Science, and Technology 1998), which are known to cause channel scour, loss of large wood and pool filling. Disconnection of the channel and floodplain also may disrupt surface and groundwater connections that can provide a cooling influence that benefits coho salmon and other salmonids.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Hunter Creek population area. Hatchery-origin coho salmon may stray into Hunter Creek, but hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

Adverse Fishery-Related Effects

NMFS has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

11.6 Threats

Table 11-3. Severity of threats affecting each life stage of coho salmon in Hunter Creek. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

Threats		Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Medium	Very High	Very High	Very High	Very High	Very High
2	Channelization/Diking	Low	Very High	Very High	Very High	Very High	Very High
3	Timber Harvest	Low	Very High	Very High	Very High	Very High	Very High
4	Agricultural Practices	Low	High	High	High	High	High
5	Urban/Residential/Industrial	Low	Medium	High	High	High	High
6	Dams/Diversion	Low	Medium	Medium	Medium	Medium	Medium
7	High Intensity Fire	Low	Medium	Medium	Medium	Medium	Medium
8	Road-Stream Crossing Barriers	-	Low	Medium	Medium	Medium	Medium
9	Climate Change	Low	Low	Medium	Medium	Medium	Medium
10	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low
12	Invasive and Non-Native/Alien Species	-	Low	Low	Low	Low	Low
13	Fishing and Collecting	-	-	-	-	Low	Low

Roads

Roads have been identified as a major source of sediment in the Hunter Creek watershed (EA Engineering, Science, and Technology 1998). Lower Hunter Creek, the Little Fork Hunter Creek, and Big South Fork Hunter Creek all have densities of over 3 miles of road per square mile of basin (mi./mi.^{2}). USFS and BLM lands in the headwaters of the North Fork and mainstem Hunter Creek have road densities of 1.6 to 2.5 mi./mi.^{2}. Unpaved roads often concentrate surface runoff and deliver sediment to stream channels. They also can initiate slope failures and landslides. Paved roads increase runoff and peak flows.

Channelization/Diking

Almost all high IP (>0.66) areas in Hunter Creek have been altered by channelization and diking. Constriction of the channel by dikes and levees increases current velocity, making it unsuitable for winter rearing, and increases bedload mobility that scours redds and causes mortality of eggs. Road berms that parallel streams confine the channel, cutting it off from its floodplain and adjacent wetlands (Figure 11-). Filling of the Hunter Creek estuary to enable commercial development isolates formerly productive wetlands and decreases coho salmon rearing habitat. Channel migration in the estuary is also constrained by the Highway 101 bridge.

Figure 11-4. Lower Hunter Creek flows adjacent to residential development. Creek is closely confined by a berm for Hunter Creek Road. Some houses encroach closely upon the creek and fully occupy the riparian floodplain.

Timber Harvest

Private industrial timber lands cover much of the middle and lower Hunter Creek basin, including tributaries that are occupied coho salmon habitat in their lowest reaches. Harvest cycles are on 30 to 50 year rotations, which do not allow sufficient time for basin recovery. Use of herbicides for site preparation after clear cutting to prevent growth of hardwoods or shrubs may also pose a risk to salmonids (Ewing 1999).

Agricultural Practices

Agricultural practices occur in much of the high IP area in the lower basin, and therefore pose a high threat to coho salmon. However, most of the upper Hunter Creek basin is unsuitable for agriculture. River terraces were cleared for farming and channels moved to accommodate greater agricultural production. Although agriculture may have been responsible for original changes to aquatic habitat, much of what was formerly farm land has now been converted to residential or industrial use.

Urbanization/Residential Development

Development in the Hunter Creek basin poses an overall high threat to coho salmon. Most development has occurred on the floodplain of the lower and middle reaches of Hunter Creek and the estuary, which is where suitable coho salmon habitat occurs. Rural residences use both surface water and groundwater, which can deplete streamflows. This diminishes habitat and contributes to stream warming. Rural residential septic systems may leach nutrients or pollutants into nearly streams, and pesticides and herbicides used in back yards can pollute nearby waterways. Commercial and industrial land use in lower Hunter Creek and the upper estuary may also contribute to non-point source pollution.

Dams and Diversions

Although dams and diversions are ranked a medium threat, there are no agricultural dams that are known to impede passage in Hunter Creek; however, diversions are a concern, particularly in lower Hunter Creek. Massingill (2001d) notes that Hunter Creek water rights are over-allocated from May through October, but approximately 25 percent of the water rights are junior to the in-stream rights held by ODFW which date from 1964.

High-Intensity Fire

The proximity of the Hunter Creek basin to the coast is a strong moderating factor on fire risk. However, serpentine terrain in the upper Hunter Creek basin has sparse vegetation and drier site conditions that make fires more frequent than in coastal rain forests. Early seral conditions with crowded trees elevate the risk of catastrophic fire regionally (Southwest Oregon Resource Conservation and Development Council 2003). If fire causes widespread loss of ground cover, substantial erosion may wash fine sediment into streams and degrade coho salmon habitat. Thus, fire poses an overall medium risk to coho salmon.

Road-stream Crossing Barriers

Road-stream crossings pose a low threat to coho salmon. The Big South Fork Hunter Creek has the highest density of stream crossings of any watershed in the basin, while the Lower and Middle Hunter Creek mainstem have moderate to high densities of road crossings (Maguire 2001d). These road crossing surveys were conducted to assess erosion potential; however, it is likely that some of these crossings impede fish migration.

Climate Change

There is low risk of change in average precipitation over the next 50 years (NCAR 2009). Modeled regional average temperature shows a moderate increase over the next 50 years (Appendix B). Average temperature could increase by up to 1^{o} C in the summer and by a similar amount in the winter. The risk of sea level rise is high (Thieler and Hammer-Klose 2000), which may impact the quality and extent of wetland juvenile and smolt habitat. Adults may be negatively impacted by climate-related ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Mining/Gravel Extraction

Sand and gravel has been extracted from gravel bars along the lower 10 km of Hunter Creek since at least the 1960s (Jones et al. 2011). Gravel mining can reduce instream habitat complexity, but it is unknown whether this has occurred in Hunter Creek. Air photo analysis indicates a decline in bar area from 1940-2009 but the reasons are unknown (Jones et al. 2011).

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Hunter Creek population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

Invasive and Non-Native/Alien Species

Given the extent of residential development in the lower floodplain of Hunter Creek, it is likely that invasive plant species will spread from residential landscaping into riparian areas, particularly if there are pre-existing gaps in the riparian vegetation. Some of these species could impede restoration of riparian forests and wetlands. The extent to which this has already occurred is unknown.

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook-directed fisheries that account for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the directed recreational fishery. The exploitation rates associated with this freshwater fishery and all other fisheries managed by the State of Oregon were found to be low enough to avoid jeopardizing the existence of the ESU (National Marine Fisheries Service (NMFS) 1999). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because recovery objectives to achieve species viability had not been established for SONCC coho salmon at that time (NMFS 1999). As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in Hunter Creek.

11.7 Recovery Strategy

The most immediate need for habitat restoration and threat reduction in Hunter Creek is in those areas currently occupied by coho salmon in mainstem Hunter Creek, Little South Fork Hunter Creek, and Big South Fork Hunter Creek. Unoccupied areas must also be restored to provide enough habitat for coho salmon recovery.

The Hunter Creek population is considered dependent and therefore cannot be viable on its own; however, it is necessary to restore habitat within the basin so that it can support all life stages of coho salmon and provide connectivity between other populations in the ESU. The recovery criterion for this population is that 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival. The most important factor limiting recovery of coho salmon in Hunter Creek is a deficiency in the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by increasing habitat complexity within the channel, re-establishing off-channel rearing areas, restoring riparian forests, and reducing threats to instream habitat.

Table 11-4 on the following page lists the recovery actions for the Hunter Creek population.

Table 11-4. Recovery action implementation schedule for the Hunter Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HunC.2.2.10	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide, particularly lower mainstem Hunter Creek and tributaries within floodplain	3
SONCC-HunC.2.2.10.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-HunC.2.2.10.2	*Implement beaver program (may include reintroduction)*					
SONCC-HunC.2.2.11	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Lower mainstem Hunter Creek, including estuary and tributaries within the floodplain	3
SONCC-HunC.2.2.11.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-HunC.2.2.11.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-HunC.2.1.13	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3
SONCC-HunC.2.1.13.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-HunC.2.1.13.2	*Place instream structures, guided by assessment results*					
SONCC-HunC.2.2.16	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Lower Hunter Creek	3
SONCC-HunC.2.2.16.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-HunC.2.2.16.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-HunC.7.1.1	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Private land	BR
SONCC-HunC.7.1.1.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-HunC.7.1.1.2	*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-HunC.7.1.2	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	USFS and BLM land	BR
SONCC-HunC.7.1.2.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-HunC.7.1.2.2		*Thin, or release conifers, guided by prescription*				
SONCC-HunC.7.1.2.3		*Plant conifers, guided by prescription*				
SONCC-HunC.7.1.3	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Remove invasive species	Lower mainstem	BR
SONCC-HunC.7.1.3.1		*Remove invasive species from lower river riparian zones and replace with conifers or native hardwood species, such as cottonwoods*				
SONCC-HunC.7.1.3.2		*Develop an educational program that teaches local landowners the methods and benefits of restoring riparian stand functions.*				
SONCC-HunC.7.1.4	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Lower Hunter Creek	BR
SONCC-HunC.7.1.4.1		*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*				
SONCC-HunC.1.1.15	Estuary	No	Improve connectivity of tidally-influenced habitat	Reconnect estuarine habitat	Highway 101 bridge	BR
SONCC-HunC.1.1.15.1		*Develop plan to replace Highway 101 bridge that will allow Hunter Creek to meander across estuarine floodplain*				
SONCC-HunC.1.1.15.2		*Install new bridge, guided by plan*				
SONCC-HunC.1.2.17	Estuary	No	Improve estuarine habitat	Restore estuarine habitat	Hunter Creek Estuary, immediately upstream of Highway 101	3
SONCC-HunC.1.2.17.1		*Assess tidally influenced habitat and develop a plan to restore tidal channels*				
SONCC-HunC.1.2.17.2		*Restore tidal wetlands and tidal channels in historic estuary, guided by the plan*				
SONCC-HunC.3.1.5	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Lower mainstem	BR
SONCC-HunC.3.1.5.1		*Develop an educational program that teaches landowners to implement water conservation measures*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HunC.3.1.6	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Lower mainstem and tributaries	BR
SONCC-HunC.3.1.6.1	*Install additional flow gages in the lower river and tributaries to study surface and groundwater use.*					
SONCC-HunC.27.2.9	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-HunC.27.2.9.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-HunC.27.2.9.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-HunC.27.1.18	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-HunC.27.1.18.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-HunC.27.2.19	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-HunC.27.2.19.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-HunC.27.2.20	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-HunC.27.2.20.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-HunC.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-HunC.27.1.21.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-HunC.27.1.21.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-HunC.27.2.22	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-HunC.27.2.22.1	*Determine best indicators of estuarine condition*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HunC.8.1.12	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide; prioritize middle and lower reaches of basin, as well as Big South Fork	BR
SONCC-HunC.8.1.12.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-HunC.8.1.12.2	*Decommission roads, guided by assessment*					
SONCC-HunC.8.1.12.3	*Upgrade roads, guided by assessment*					
SONCC-HunC.8.1.12.4	*Maintain roads, guided by assessment*					
SONCC-HunC.10.2.8	Water Quality	No	Reduce pollutants	Set standard	Population wide	3
SONCC-HunC.10.2.8.1	*Develop TMDLs for 303(d) listed water bodies*					
SONCC-HunC.10.2.14	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-HunC.10.2.14.1	*Develop an educational program that teaches landowners and businesses about avoiding pollution from septic systems, backyard pesticides, fuels, and nutrients.*					

12. Pistol River Population

- Northern Coastal Stratum
- Dependent
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 93 mi^2
- 30 IP km (19 IP mi) (23% High)
- Dominant Land Uses are 'Timber Harvest' and 'Agriculture'
- Principal Stresses are 'Altered Sediment Supply', 'Lack of Floodplain and Channel Structure' and 'Degraded Riparian Forest Conditions'
- Principal Threats are 'Roads', 'Channelization/Diking', and 'Timber Harvest'

12.1 History of Habitat and Land Use

The relevant history of the Pistol River is described in the Pistol River Watershed Analysis (U.S Forest Service (USFS) 1998b) and the Pistol River Watershed Assessment (Maguire 2001e), which are the basis of this summary. Early settlers likely diminished the habitat capacity of the two lower river tributaries, which no longer have recognizable channels. Two ranches in the grassy meadows near the lower river have been in continuous grazing since that time.

Long time residents remember a river too cold to swim in most of the summer, before intensive timber harvest began in the 1950s (Maguire 2001e). The 1955 flood carried sediment that filled the lower river, which had previously been the site of major salmon spawning. Where the lower Pistol River had been a sequence of riffles and deep corner pools, it became a series of long riffles with small, shallow pools. Tributaries like Deep Creek were changed by repeated debris torrents after timber harvest, but local residents report prior use by 300 to 400 spawning salmon (Maguire 2001e). These same observers note that the river's flood flows rise and fall much more quickly than before timber harvest and that base flow conditions appear greatly reduced. The mouth of the river now opens later in the fall than it used to. Local residents used to breach the sand berm at the mouth of the Pistol River, but that is no longer allowed (Maguire 2001e).

Private industrial timber land ownership covers 30 percent of the basin and lies between the federally managed land in the upper basin and the ranchland in the lower valley.

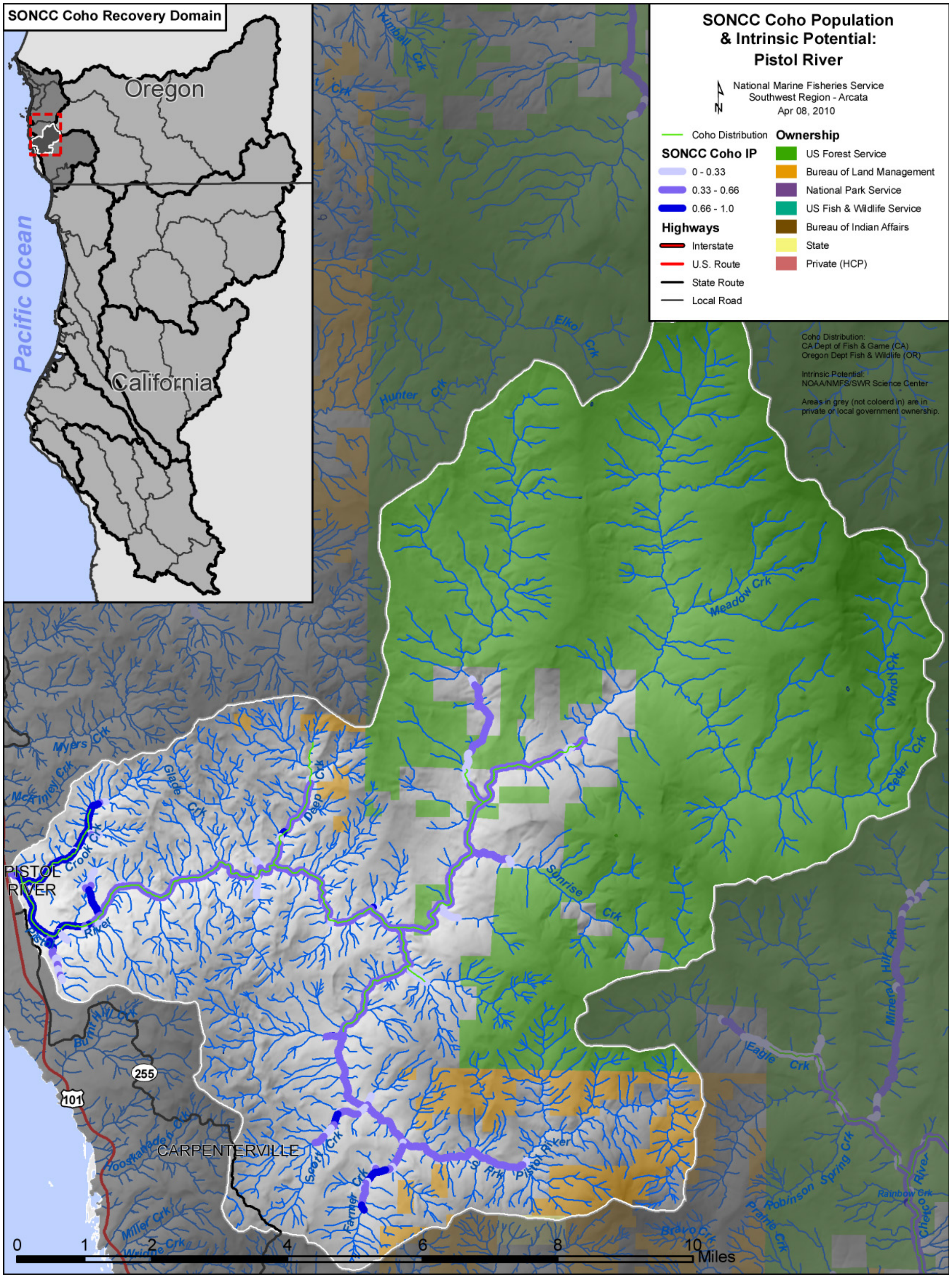

Figure 12-1. The geographic boundaries of the Pistol River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

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Since the Northwest Forest Plan (US Department of Agriculture (USDA) and US Department of the Interior (USDI) 1994) was adopted, there has been a very low level of timber harvest in the Pistol River basin on USFS and BLM lands. Streams in these upper tributaries have started to recover. Private industrial timber harvest is active in the western portion of the Pistol River basin, including much of the South Fork, where harvest rotations are 30 to 50 years.

The intensity of grazing in the lower Pistol River has undoubtedly decreased since a cheese factory located in the lower basin ceased operation in the 1960s, but fields still constrain the lower river channel and occupy its floodplain. Residential development has occurred in the lower Pistol River, but not to the same degree as other southwest Oregon streams like Hunter Creek and the lower Chetco River. Widespread restoration efforts over the last decade have met with mixed success (Swanson 2005).

12.2 Historic Fish Distribution and Abundance

The steep headwaters of the upper Pistol River prevent coho salmon access very far up major tributaries except in the South Fork (Maguire 2001e). Modeling by Williams et al.(2006) found high intrinsic potential (IP >0.66) habitat for coho salmon in the lower mainstem Pistol River, estuarine tributary Crook Creek and two unnamed tributaries of the lower river. Additionally, flat reaches in Deep Creek, and South Fork Pistol River tributaries, Farmer and Scott creeks, also have patches of high IP habitat (Table 12-1). The two unnamed tributaries of lower Pistol River are not found on U.S. Geological Survey (USGS) 1:24000 topographic map (USGS 1989) and no longer have recognizable stream channels when examined using aerial photos; therefore, they are not listed in Table 12-1. Pistol River had sufficient capacity before disturbance to provide possible refugia for smaller nearby populations and a modest source of colonists to adjacent smaller streams, such as Hunter Creek.

Table 12-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	**Stream Name**	**Stream Name**
Crook Creek	Farmer Creek	Pistol River Estuary
Deep Creek	Lower Pistol River	Scott Creek

12.3 Status of Pistol River Coho Salmon

Spatial Structure and Diversity

Much of the high IP coho salmon habitat in the lower mainstem Pistol River and its tributaries is presently unsuitable for coho salmon spawning or rearing. Some low gradient tributaries of the lower river are only partially degraded, but others have been completely lost. Although coho salmon population levels are low, spawning still occurs in the mainstem Pistol River up to the East Fork Pistol, in Crook Creek and Deep Creek, and in lower North Fork Pistol River, and in the lower South Fork Pistol River including its tributary Koontz and Davis Creek (Figure 12-1). The Oregon Department of Fish and Wildlife (ODFW) (2005a) conducted a total of 14 snorkel surveys at sites in the Pistol River basin from 2002 to 2004. They found juvenile coho salmon in 3 of 11 reaches (6 of 352 pools) sampled, all at very low levels of ≤0.001 coho/m2, including in the lower South Fork and two mainstem Pistol River reaches upstream of the North Fork Pistol River. Pistol River coho salmon are still well distributed but persisting at low levels, which is likely diminishing genetic diversity.

Population Size and Productivity

Although ODFW (2005a) found coho salmon juveniles in each year of their surveys between 2002 and 2004, they were found only at extremely low levels. Coho salmon are only intermittently present in Crook Creek (Swanson 2005), a formerly productive tributary. Population estimates for 1998 to 2008 for south coast Oregon coho salmon were provided by ODFW (2009a). They estimated escapement in the Pistol River as 78 coho salmon in 1999, 155 in 2000, 118 in 2002, and zero in all the other years. The lack of consistent spawner returns within year classes and the absence of some year classes indicate very low productivity in the Pistol River. Because there is no information on ODFW survey effort, some qualification of these results is required. If surveys are only in lower river tributaries, then coho salmon that spawned in upper basin tributaries would not be counted. Similarly, in high flow years counts may be difficult or impossible. Consequently, the population may be somewhat larger than estimated and there may have been some coho salmon adults in years when the population estimate was zero.

Extinction Risk

Not applicable because the Pistol River is not an independent population.

Role in SONCC Coho Salmon ESU Viability

Although dependent populations such as the Pistol River are not viable on their own, they do increase connectivity by allowing dispersal among independent populations and provide areas of refugia for other populations, acting as a source of colonists in some cases. The Pistol River may have been a source of colonists to nearby dependent populations, such as Hunter Creek. Any restored habitat in Pistol River provides potential connectivity that assists metapopulation function in the SONCC ESU.

12.4 Plans and Assessments

State of Oregon

Oregon Plan for Salmon and Watersheds
http://www.oregon.gov/OPSW/about_us.shtml

The State of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is a comprehensive plan that includes voluntary actions to address all of the threats currently facing coho salmon in these ESUs and involves all relevant state agencies. Reforms to fishery harvest and hatchery programs described in the Oregon Plan were implemented by ODFW in the late 1990s. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary.

Report of the Oregon Expert Panel on Limiting Factors

ODFW (2008b) convened a panel of fisheries and watershed science experts as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on limiting factors and threats to recovery. Based on the input of panel members, ODFW (2008b) summarized the concerns for the Pistol River population as follows:

> Key concerns in the Pistol River were a loss of over-winter tributary habitat complexity and floodplain connectivity for juveniles, especially in the lowlands which are naturally very limited in these systems and have been impacted by past and current urban, rural residential, and forestry development and practices. High water temperatures for summer parr due to a loss of riparian function and channel straightening is also a key concern in these streams. The secondary concern was related to a loss of over-winter, lowland habitat complexity due to past and current agricultural practices.

Cumulative Effects of Southwest Oregon Coastal Land Use on Salmon Habitat

Oregon State University (OSU) Oak Creek Labs conducted a study funded by ODFW and the Oregon Department of Forestry (ODF) to determine relationships between forest harvest and Pacific salmon productivity (Frissell 1992). The study assessed basins along the Oregon coast extending from the Sixes River to the southern border during the period from 1986 to 1992.

Curry County Soil and Water Conservation District

Pistol River Package OWEB Grant #98-025 Monitoring Report

The Pistol River Package Monitoring Report (Swanson 2005) describes conditions in the Pistol River after numerous basin enhancements were carried out, including large wood placement, fish passage improvements, riparian fencing and planting, rock weirs, and bio-engineered bank stabilization structures.

South Coast Watershed Council (Pistol River Watershed Council)

Pistol River Watershed Assessment

This assessment (Maguire 2001e) summarizes conditions, historic changes and restoration needs in the Pistol River basin. Community concerns, salmonid habitat, limiting factors, and prospects for recovery of fisheries and watershed health are included.

Pistol River Action Plan

The Pistol River Action Plan (Massingill 2001e) is a companion to Maguire (2001e), and proposes specific targets for restoration.

United States Forest Service

Pistol River Watershed Analysis

The Pistol River Watershed Analysis was written by the USFS (1998b) in accordance with the Northwest Forest Plan (USDA and USDI 1994) and sets a course of restoration for their ownership in the Pistol River. Planned activities include road decommissioning, hardwood thinning and conifer planting in riparian zones and combating the spread of Port Orford root disease in the watershed.

12.5 Stresses

Table 12-2. Severity of stresses affecting each life stage of coho salmon in the Pistol River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Sediment Supply[1]	Very High	Very High	Very High[1]	High	High	Very High
2	Lack of Floodplain and Channel Structure[1]	High	Very High	Very High[1]	Very High	High	Very High
3	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	High	High	Very High
4	Impaired Water Quality[1]	Medium	High	Very High[1]	High	Low	Very High
5	Altered Hydrologic Function	High	High	High	High	-	High
6	Impaired Estuary/Mainstem Function	-	Low	High	High	Low	Medium
7	Barriers	-	Low	Low	Low	Low	Low
8	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
9	Adverse Fishery-Related Effects	-	-	-	-	Low	Low

[1]Key limiting factor(s) and limited life stage(s).
[2]Increased Disease/Predation/Competition is not considered a stress to this population.

Limiting Stresses, Life Stages, and Habitat

The upper South Fork Pistol River above Farmer Creek may provide coho salmon refugia because it has suitable gradient, cool water temperatures, and pools greater than 1 meter deep; however, there are no data documenting coho presence in that reach. Otherwise there are currently no functioning coho salmon refugia in the Pistol River or its tributaries. Crook Creek is too warm at its convergence with the mainstem to support coho salmon (Maguire 2001e) and Deep Creek has too much fine sediment (Swanson 2005).

The juvenile life stage is most limited and quality winter rearing habitat, as well as summer rearing habitat, is lacking as vital habitat for the population. Juvenile summer rearing habitat is impaired by an excess of fine sediment, which has filled in the mainstem, tributary channels, and the estuary, and contributes to high water temperature. Lack of floodplain and channel structure due to channelization and filling of the floodplain has eliminated much of the coho salmon rearing habitat in the basin. Winter rearing habitat is often formed by instream large wood, but is also found in estuaries and floodplain wetlands. Degraded riparian conditions have eliminated the source of large wood recruitment and floodplain wetlands have been filled or disconnected from the river. Overall, these findings are consistent with those of the Oregon Expert Panel (Section 12.4) except that the expert panel did not consider excess sediment to be a concern.

Altered Sediment Supply

Sediment contribution from landslides and erosion occurs naturally in the Pistol River basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. For example, debris torrents in 2003 covered large wood restoration projects with approximately 100,000 to 200,000 cubic yards of sediment in lower Deep Creek (Swanson 2005). Debris flows significant enough to alter channel structure occurred in the South Fork Pistol River and upper mainstem Pistol River in 1996 (Maguire 2001e). Excess fine sediment directly impacts coho salmon egg viability and can reduce food for fry, juveniles and smolts. Poor pool frequency and depth throughout the Pistol River basin (Maguire 2001e) is likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening.

Figure 12-2. Photo of Pistol River estuary. View is looking downstream from the Pistol River Road bridge. The large gravel bars occupy a formerly deep channel here, suggesting excess fine sediment.

Lack of Floodplain and Channel Structure

Long-time lower Pistol River residents described the transformation of the channel from one with well developed deep pools joined by short riffles to one dominated by riffles with few pools of limited depth (Maguire 2001e). High fine sediment load and bedload movement retards channel recovery and also creates adverse conditions for eggs because redds are scoured out or deposits smother eggs and prevent fry emergence.

Before disturbance, the Pistol River riparian zone was comprised of large conifers that lived hundreds of years and then fell into streams, forming pools and complex habitats with which coho salmon co-evolved. Large wood was swept from many mainstem and tributary channels in the 1955 and 1964 floods, which lead to a loss of habitat complexity. Current large wood recruitment is also low. Large wood surveys by ODWF show that all Pistol River reaches have poor levels of large wood (<1 key piece per 100m). USFS large wood surveys found very good levels of large wood in the upper East Fork Pistol River, North Fork Pistol River, and Sunrise Creek on USFS lands, but these streams are largely inaccessible to coho salmon.

Disconnection of the lower Pistol River and estuary from its floodplain and confinement of its channel (Figure 12-3) are major impediments to lower river recovery. Lower Crook Creek has high IP coho salmon habitat, but its lower reaches are channelized also.

ODFW and USFS habitat data indicate that in the mainstem Pistol River, pool frequencies are greater than 35 percent, which they rate as good. An upper East Fork Pistol River reach, lower Meadow Creek, and the South Fork tributary Koontz and Davis Creek all had poor ratings (<10 percent pools). Pool frequency is only fair (10 to 25 percent) in the lower North Fork, lower Sunrise Creek, Deep Creek, and South Fork tributaries including Scott Creek.

Pool depth of greater than one meter (3.3 ft.) is rated as good by ODFW, and on that basis the South Fork and mainstem Pistol River below the East Fork have good pool depth. However, the Pistol River formerly had pools that were up to 20 feet deep (Maguire 2001e).

Figure 12-3. Aerial photo of Pistol River showing confinement by a levee. The levee separates the active channel from adjacent farm and industrial gravel operation to the west (left). The levees also cut off the river from oxbows and meanders on the east bank (right), which would have formerly created ideal coho salmon rearing areas. Yellow arrows highlight pockets of residential development.

Degraded Riparian Forest Conditions

ODFW surveys found fewer than 75 conifers greater than 36" in diameter per 1000 ft. on the South Fork Pistol River, mainstem Pistol River downstream of the East Fork, Sunrise Creek, and Deep Creek. This low density of large trees in the riparian zone has led to poor bank structure, reduced shade, and reduced thermal and nutrient buffering. The riparian zone of the mainstem Pistol River is predominantly hardwood trees (Figure 12-4), with very few large conifers. Willow and alder are the most abundant species in the alluvial valleys, although cottonwoods were once a significant part of the riparian community (Maguire 2001e). High bedload transport in the lower Pistol River is likely causing high mortality of both conifers and alders, because these species die if their root systems are buried.

Figure 12-4. Photo of the lower mainstem Pistol River. The river has a willow and alder riparian zone. Note also excess sediment and lack of channel structure.

Impaired Water Quality

The mainstem Pistol River is 303(d) listed for impaired temperature and dissolved oxygen from the mouth upstream to RM 19.8, and the lower half mile of the South Fork is also listed as temperature impaired. Maguire (2001e) reported that the ODEQ maximum floating weekly maximum temperature (MWMT) threshold for impairment of 64 °F was exceeded at all stations measured, indicating lack of suitability for coho salmon rearing; however, there are a few additional stations/years in the ODEQ LASAR database (see Appendix B) with temperatures below the 64 °F threshold: Glade Creek at mouth, upper Farmer Creek, South Fork Pistol River at upper crossing, Deep Creek at mouth (2 of 8 years), and North Fork Pistol River near mouth (1 of 6 years). Figure 12-5 shows water temperatures for the Pistol River from 1995 to 2000 as reported by Maguire (2001e). The lower East Fork Pistol River and Deep Creek are almost cool enough to provide suitable coho salmon habitat. Lower reaches of the North Fork and the upper mainstem Pistol River are showing improvement (65 °F to 69 °F), but the South Fork is much too warm to support coho salmon (71.4 °F to 72.8 °F). Lower mainstem Pistol River temperatures are also too warm (71.8 °F -75 °F). The Pistol River warms 2 to 4 °F between the East Fork Pistol and South Fork Pistol (Maguire 2001e).

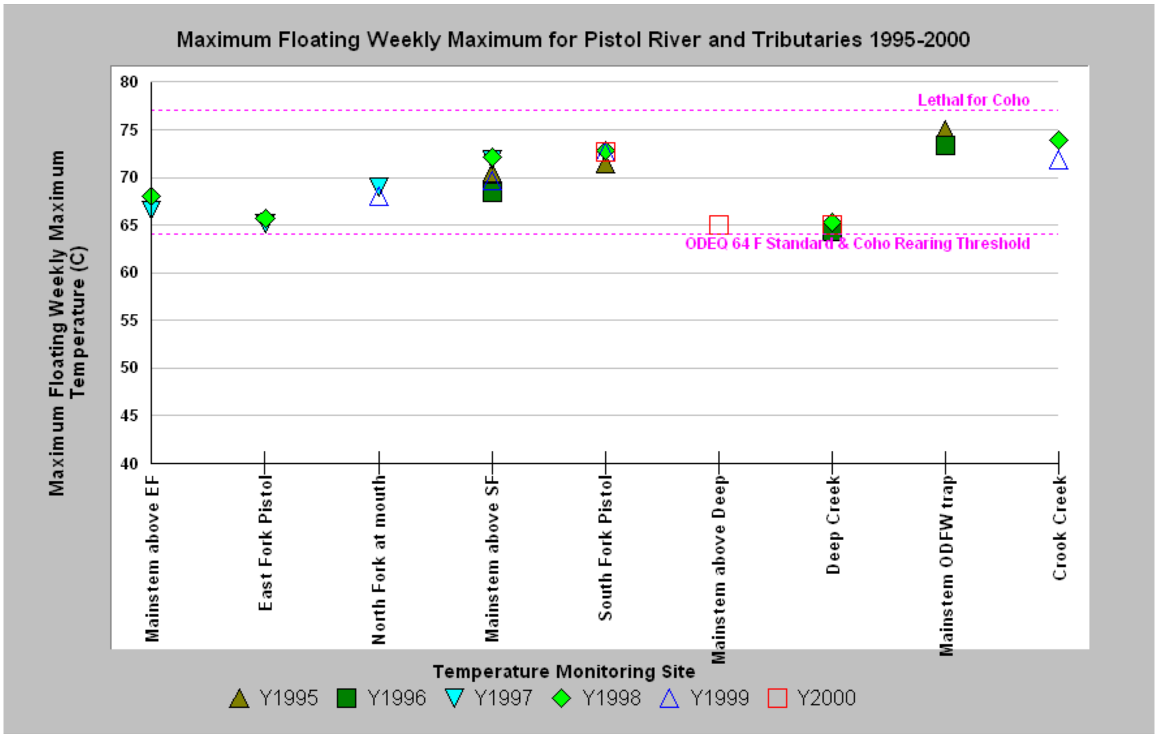

Figure 12-5. Maximum floating weekly maximum water temperatures for the Pistol River. Data includes tributaries and shows a pattern of exceeding coho salmon rearing requirements (McCullough 1999) and ODEQ standards (64 °F). The lethal temperature reference value of 77 °F is from Sullivan et al. (2000).

Water quality in the Pistol River is also compromised by low dissolved oxygen (DO) levels. The low DO levels are likely due to stagnation and to algal blooms, which are encouraged by excess nutrients and lack of shade. There are seasonal problems with elevated phosphorous, E. coli and biological oxygen demand (Maguire 2001e).

Altered Hydrologic Function

Changes in Pistol River basin hydrology have led to a substantial decrease in available habitat for coho salmon, resulting in a high level of stress across all life stages. The bedload build-up in the mainstem has buried the former stream channel, leaving wide gravel bars and a narrow ribbon of surface flow. Fine sediment over-supply also blocks surface and groundwater interactions by clogging interstitial spaces of stream gravels that are known to help maintain cool temperatures. This type of connection likely created cold water strata at depth in the deeper pools that were formerly common, even when surface waters were warm. Some Pistol River Watershed Council members believe that the summer base flows have also diminished (Maguire 2001e). Studies elsewhere in the Pacific Northwest indicate that converting forest stands of fewer large trees to ones with many small trees can decrease base flows for several decades (Murphy 1995).

The hydrology of the lower basin has been substantially altered through disconnection of the floodplain and channelization. High road densities in some Pistol River watersheds may also cause increased peak flows. These peak flows can scour eggs and flush fry, juveniles, and smolts from the river system.

Impaired Estuary/Mainstem Function

The Pistol River estuary retains little of its historic form or function and provides little opportunity for estuarine rearing. Studies elsewhere in Oregon found that estuarine tributaries and sloughs can be important habitat types for rearing coho salmon juveniles (Koehler and Miller 2003, Miller and Sadro 2003). The remnants of past estuarine habitat indicate the Pistol River estuary was formerly large with numerous tributaries, tidal channels, and likely tidal wetlands. The diking and filling for conversion to agricultural uses has completely eliminated these habitats. Lack of riparian vegetation in the estuary and the accretion of fine sediment have led to highly degraded water quality and habitat conditions. Long-time residents remember pools up to 20 feet deep, while ODFW 1991 habitat data indicated a mean pool depth of only 3.3 feet in the lowermost Pistol River reach (Maguire 2001e). Long time residents noted a decrease in estuarine use by smelt, which is likely due to a change in seasonality of the opening of the mouth. Crook Creek, the largest estuary tributary, loses surface flow during the summer for its last 500 feet (Swanson 2005), seasonally preventing fish use of this important rearing stream. Highway 101 bisects the estuary near the mouth of the river, constraining the estuary and preventing full tidal inundation upstream. The estuary to the west of Highway 101 encompasses a fair amount of sand and mudflat habitat that could be used for rearing, but it lacks complex habitat features such as large wood or deep pools. Reduced estuarine function poses a medium overall stress to Pistol River coho salmon.

Barriers

Although road densities in the Pistol River basin are high, which increases risk of passage problems, coho salmon still have access to most of the basin (Maguire 2001e). The dry reach at the mouth of Crook Creek (Swanson 2005) is a seasonal barrier to juveniles. A major passage problem into Deep Creek has been resolved by replacing a culvert with a bridge (Swanson 2005). Consequently, barriers represent a low stress.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Pistol River population area. Hatchery-origin coho salmon may stray into Pistol River, but hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

Adverse Fishery-Related Effects

NMFS has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

12.6 Threats

Table 12-3. Severity of threats affecting each life stage of coho salmon in the Pistol River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

Threats[1]		Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	High	Very High	Very High	Very High	Very High	Very High
2	Channelization/Diking	Medium	Very High	Very High	Very High	Very High	Very High
3	Timber Harvest	Medium	Very High	Very High	Very High	Very High	Very High
4	Agricultural Practices	Low	Medium	High	High	High	High
5	Dams/Diversion	Low	Medium	Medium	Medium	Medium	Medium
6	Urban/Residential/Industrial	Low	Medium	Medium	Medium	Medium	Medium
7	High Intensity Fire	Low	Medium	Medium	Medium	Medium	Medium
8	Climate Change	Low	Low	Medium	Medium	Medium	Medium
9	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low
10	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low
12	Fishing and Collecting	-	-	-	-	Low	Low

[1]Invasive and Non-Native/Alien Species is not considered a threat to this population.

Roads

There are high road densities (2.5 to 3.0 mi./mi.^{2}) in the South Fork Pistol River and very high densities (>3.0 mi./mi.^{2}) in the Upper and Lower Pistol River. Road densities are medium (1.6-2.5 mi./mi.^{2}) in the East Fork Pistol River, North Fork Pistol River, and in mainstem watersheds between the East Fork and South Fork Pistol River. Additionally there is a high number of road stream crossings, streamside roads, and many road segments that cross steep unstable slopes or erodible soils. These conditions all pose a risk of elevated fine sediment yield. Road density estimates are conservative because they do not include skid roads, landings, or temporary roads. The main timber harvest haul road along the Pistol River has initiated large landslides (Maguire 2001e). A main haul road also follows the South Fork Pistol River.

Channelization/Diking

Channelization and diking have occurred in high IP coho salmon habitat in the lower tributaries, along the lower mainstem, and in the estuary. Crook Creek had ideal gradient and valley width for coho salmon, but the channel has been straightened and greatly reduced in complexity (Figure 12-6). The lower mainstem and estuary have been similarly channelized and disconnected from the flood plain and adjacent wetlands. Roads that follow the river or tributaries may cut them off from their floodplains as well.

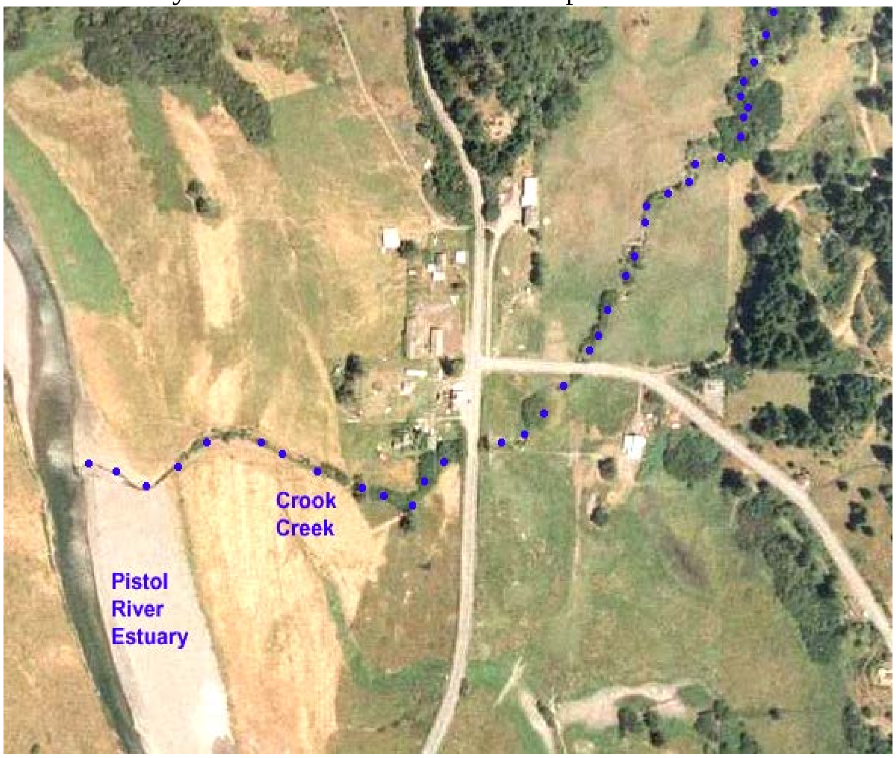

Figure 12-6. Photo of Crook Creek joining the Pistol River estuary. Convergence is at center left. The creek's channel is straightened and confined. It also lacks a functional riparian zone.

Timber Harvest

Private industrial timber lands occupy 30 percent of the landscape and coincide with watersheds that have low gradient streams, which were the best coho salmon habitat. Deep Creek is an example of where short timber harvest rotations are likely inhibiting channel and coho salmon recovery.

Studies of adjacent southwest Oregon basins found that "downstream, cumulative impacts of human activity are pervasive in southwest Oregon, wherever logging has occurred over an extensive portion of a drainage basin or has involved operations on steep, unstable slopes. The downstream effects of channel sedimentation and aggradation can severely damage streams even where buffer zones of riparian vegetation have been retained, and such effects persist more than 20-30 years after logging activities have ceased" (Frissell 1992).

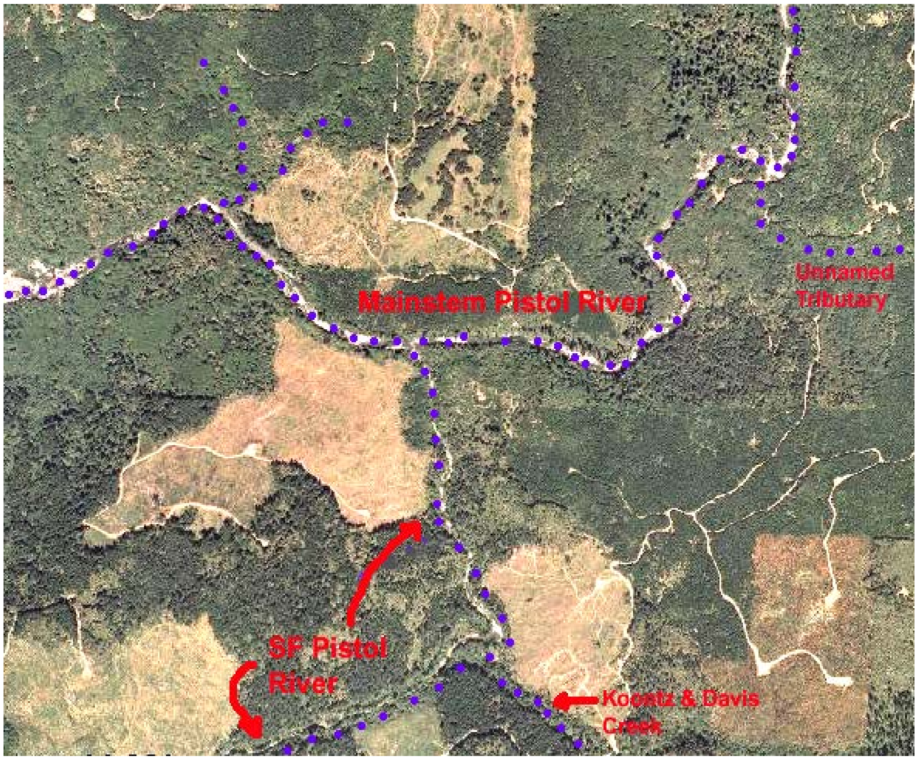

Figure 12-7. Photo of the mainstem Pistol River and the South Fork. Also shown is lower tributary Koontz and Davis Creek. Note extensive clear cuts and high road density.

Agricultural Practices

The same farms and ranches have operated in the lower river for well over 100 years and levels of grazing are likely not as high as they were in the past. Nonetheless, long term activities have led to the disconnection of the lower Pistol River and estuary from floodplains (Figure 12-3). Lower Pistol River tributaries have also been profoundly altered; two unnamed tributaries with high IP coho salmon habitat now have unrecognizable channels. Crook Creek has also been straightened and disconnected from its floodplain (Figure 12-6), but landowners have been trying to restore it (Swanson 2005). The negative effects of pesticides and herbicides on Pacific salmon species and aquatic ecosystem function are becoming more well documented regionally (National Marine Fisheries Service (NMFS) 2008, Laetz et al. 2009), but the extent of use of these chemicals by Pistol River farms and ranches is unknown.

Dams and Diversions

There are no known dams on the Pistol River. The Oregon Water Resources Department has a Pistol River instream water right of 15 cubic feet per second (cfs) (Maguire 2001e). The sum of the diversion water rights in the Pistol River basin is 1.5 cfs, primarily for agricultural use, but only 0.1 cfs of this is senior to the instream right (Maguire 2001e). The effects of water diversions on coho salmon in the Pistol River basin are not well understood. Crook Creek, an important coho tributary, loses surface flow at the downstream end of an agricultural area, but it is unknown if diversions contribute to that condition. A potentially significant contributor to the diminished apparent flow in the Pistol River is the aggradation of the stream bed, with more flow now sub-surface.

Urbanization/Residential/Industrial

Both commercial and residential development is occurring in the sensitive lower river and estuary. This area once held some of the most productive coho salmon habitats.

High Intensity Fire

The Pistol River is very near the coast and has moderate air temperatures and high rainfall. Consequently, it should have naturally low fire risk; however, hot (100 °F) 35 mph east winds occur seasonally, which can cause extreme seasonal fire risk (Maguire 2001e). Large areas of the Pistol River basin are presently covered by even-aged plantations and hardwoods that elevate fire risk. Sudden oak death syndrome is known to occur in the adjacent North Fork Chetco basin (Oregon Department of Agriculture (ODA) 2008) and could become a significant contributor to increased fire risk if it causes mortality of tanoaks in the Pistol River basin.

Climate Change

There is low risk of average temperature increase over the next 50 years (Appendix B). Modeled regional average temperature shows a moderate increase over the next 50 years (Appendix B). Average temperature could increase by up to 1o C in the summer and by a similar amount in the winter. The risk of sea level rise is also low (Appendix B, Thieler and Hammer-Klose 2000). Adults may be negatively impacted by climate-related ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Mining/Gravel Extraction

Pistol River does not have geologic formations that bear gold and so was spared mining impacts that were experienced by interior basins of the Rogue River. Gravel mining can inhibit channel recovery by flattening the streams profile upstream and downstream from the point of extraction. The Sixes River company gravel permit for operation in the Pistol River has expired and there is no prospect of gravel mining activity in the near future (Wheeler 2009).

Road-Stream Crossing Barriers

Although there are many road-stream crossings on private industrial timber lands in the western Pistol River basin, many are well above the range of coho salmon. Maguire (2001e) and the ODFW (2008e) fish passage database do not indicate that road-stream crossing barriers are a significant problem for coho salmon distribution in the Pistol River basin.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Pistol River population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook-directed fisheries that account for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the directed recreational fishery. The exploitation rates associated with this freshwater fishery and all other fisheries managed by the State of Oregon were found to be low enough to avoid jeopardizing the existence of the ESU (NMFS 1999). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because recovery objectives to achieve species viability had not been established for SONCC coho salmon at that time (NMFS 1999). As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in the Pistol River.

12.7 Recovery Strategy

The most immediate need for habitat restoration and threat reduction in the Pistol River is in those areas currently occupied by coho salmon in mainstem Pistol River, Crook Creek, Deep Creek, North Fork Pistol River, South Fork Pistol River, and Koontz and Davis Creek. Unoccupied areas must also be restored to provide enough habitat for coho salmon recovery, and the places with the greatest chance of success are those with high IP habitat such as the lower mainstem Pistol River, the estuary, Crook Creek, Deep Creek, Scott Creek, and Farmer Creek.

The Pistol River population is considered dependent and therefore cannot be viable on its own; however, it is necessary to restore habitat within the basin so that it can support all life stages of coho salmon and provide connectivity between other populations in the ESU. The recovery criterion for this population is that 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival.

The most important factor limiting recovery of coho salmon in the Pistol River is a deficiency in the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by increasing habitat complexity within the channel, re-establishing off-channel rearing areas, restoring riparian forests, and reducing threats to instream habitat.

Table 12-4 on the following page lists the recovery actions for the Pistol River population.

Table 12-4. Recovery action implementation schedule for the Pistol Riverpopulation.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-PisR.2.2.6	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Lower mainstem, estuary, and Crooks Creek	3
SONCC-PisR.2.2.6.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-PisR.2.2.6.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-PisR.2.2.7	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	3
SONCC-PisR.2.2.7.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-PisR.2.2.7.2	*Implement beaver program (may include reintroduction)*					
SONCC-PisR.7.1.1	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Estuary, lower mainstem, upper South Fork, and Crook, Deep, Farmer and Scott creeks	3
SONCC-PisR.7.1.1.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-PisR.7.1.1.2	*Thin, or release conifers, guided by prescription*					
SONCC-PisR.7.1.1.3	*Plant conifers, guided by prescription*					
SONCC-PisR.7.1.2	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Private land	BR
SONCC-PisR.7.1.2.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-PisR.7.1.2.2	*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat*					
SONCC-PisR.7.1.3	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Private timberland	BR
SONCC-PisR.7.1.3.1	*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-PisR.8.1.4	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide; prioritize upper South Fork Pistol River and Crook, Deep, Farmer, and Scott creeks	3
SONCC-PisR.8.1.4.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-PisR.8.1.4.2	*Decommission roads, guided by assessment*					
SONCC-PisR.8.1.4.3	*Upgrade roads, guided by assessment*					
SONCC-PisR.8.1.4.4	*Maintain roads, guided by assessment*					
SONCC-PisR.3.1.11	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	BR
SONCC-PisR.3.1.11.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-PisR.3.1.12	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-PisR.3.1.12.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-PisR.27.2.13	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-PisR.27.2.13.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-PisR.27.2.13.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-PisR.27.1.14	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-PisR.27.1.14.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-PisR.27.2.15	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-PisR.27.2.15.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-PisR.27.2.16	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-PisR.27.2.16.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-PisR.27.1.17	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-PisR.27.1.17.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-PisR.27.1.17.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-PisR.27.2.18	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-PisR.27.2.18.1	*Determine best indicators of estuarine condition*					
SONCC-PisR.5.1.10	Passage	No	Improve access	Remove barriers	Population wide	BR
SONCC-PisR.5.1.10.1	*Use ODFW and SCWC fish passage barrier database to 5.1 based on known coho use or data identifying suitable habitat conditions above barriers*					
SONCC-PisR.10.2.8	Water Quality	No	Reduce pollutants	Educate stakeholders	Lower mainstem, estuary, and Crooks Creek	BR
SONCC-PisR.10.2.8.1	*Develop an educational program that teaches landowners and businesses about avoiding pollution from septic systems, backyard pesticides, fuels, and nutrients.*					
SONCC-PisR.10.2.9	Water Quality	No	Reduce pollutants	Set standard	Population wide	3
SONCC-PisR.10.2.9.1	*Develop TMDLs for 303(d) listed water bodies*					

13. Chetco River Population

- Northern Coastal Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 4,500 Spawners Required for ESU Viability
- 356 mi^2
- 135 IP km (84 mi) (8% High)
- Dominant Land Uses are ‘Recreation’ and ‘Agriculture’
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Degraded Riparian Forest Conditions’
- Principal Threats are ‘Channelization/Diking’ and ‘Urban/Residential/Industrial Development’

13.1 History of Habitat and Land Use

Historically, the mouth of the Chetco River and the surrounding low lying bottom lands were dominated by salt water and fresh water marshes. The population area was forested with a diversity of habitat types which supported abundant life (U.S. Forest Service (USFS) 1996a). The lower Chetco River was the center of coho salmon productivity in this population (Maguire 2001f), coinciding with areas that have the highest intrinsic potential (IP >0.66) coho salmon habitat. Large floating wood jams changed location on lower Chetco River gravel bars, scouring holes as they moved. Beaver were also abundant in the lower portions of the river and estuary and likely contributed to habitat complexity (Maguire 2001f).

The discovery of gold in the interior Chetco River basin in the 1850s precipitated the first major alteration to fish habitat. Miners excavated river terraces, leaving a lasting footprint on some stream channels. Although some of this activity occurred upstream of the range of coho salmon, it released fine sediment that affected downstream reaches. Near the coast, logging intensity increased. In the early 1900s, a railroad was constructed and timber was exported from the lower tributary, Jacks Creek.

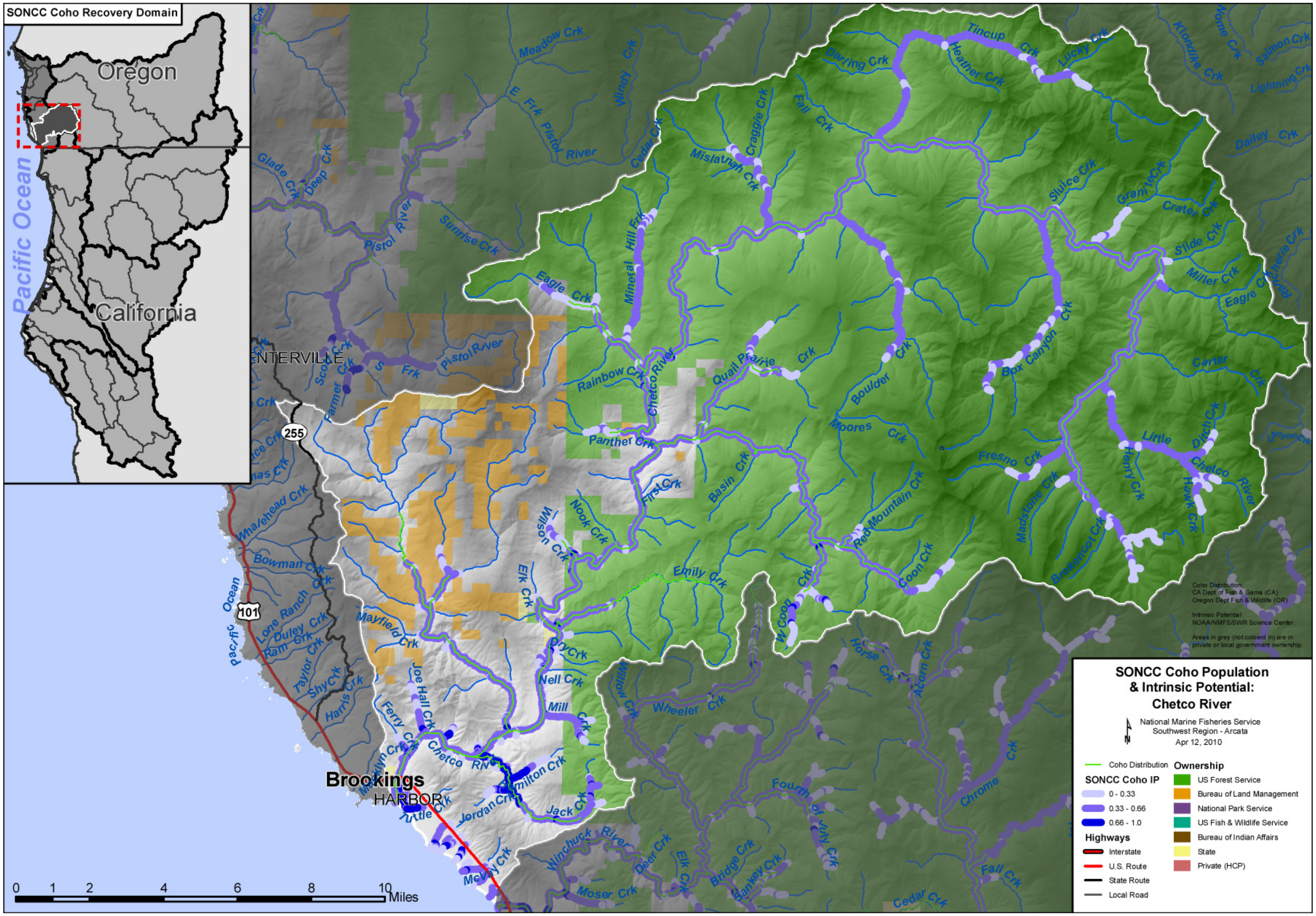

Figure 13-1. The geographic boundaries of the Chetco River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

After World War II, logging and road building on public and private lands increased and resulted in widespread disturbance. The 1964 flood delivered massive amounts of fine sediment that filled in deep pools, changed channel configuration, and eliminated much of the coho salmon habitat (Maguire 2001f). This loss was likely greatest in the mainstem, South Fork, Eagle Creek, and Panther Creek. Long-time fishermen of the Chetco River recounted that formerly deep pools were filled and the river bar was so aggraded that you could drive on it after the flood (Maguire 2001f). Logging on U.S. Forest Service lands and private land continued through the 1970s and 1980s. Land management practices have resulted in the replacement of large streamside conifers with hardwoods in most of the population area (USFS 1996a; Maguire 2001f).

The estuary was altered by the construction of levees at the mouth in 1962 to improve navigation to the ocean (Figure 13-1). Long-time residents remember that before the levees were constructed, a sand bar formed in late summer which created a lagoon with connections to tributaries and wetlands (Maguire 2001f). Levee construction disconnected wetlands and streams that were vital coho salmon habitat, and also changed the salinity and other water quality parameters by altering the tidal exchange. The harbor continues to be dredged periodically to keep the entrance open to navigation.

13.2 Historic Fish Distribution and Abundance

The Chetco River coho salmon population is not well studied and there is little trend data, but local residents described coho salmon in the Chetco River as formerly abundant and the target of a “net fishery” (Maguire 2001f). The lower tributaries were subject to extensive fishing pressure, with Tuttle Creek noted as having particularly large runs of coho salmon (Maguire 2001f).

The Oregon Department of Fish and Wildlife (ODFW) believe that the “abundance of coho salmon has been reduced due to modification of low gradient streams” (Maguire 2001f). The lower mainstem Chetco, North Fork Chetco, and Jacks Creek are identified as the most suitable reaches for juvenile rearing (IP > 0.66) in the entire basin (Williams et al. 2006). Small patches of high IP habitat also occur at the mouths of lower and middle Chetco River tributaries and in upstream areas of the South Fork and its tributary, Coon Creek. Moderate IP reaches occur in many upper tributaries. Table 13-1 lists tributaries with high IP (>0.66) reaches.

Table 13-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Chetco Estuary	Jack Creek	North Fork Chetco
Emily Creek	Joe Hill Creek	SF Chetco/Coon Creek
Hamilton Creek (tributary of Jack Creek)	Lower Chetco River	Tuttle Creek
Jordan Creek (tributary of Jack Creek)	Mill Creek	Wilson Creek

13.3 Status of Chetco River Coho Salmon

Spatial Structure and Diversity

Coho salmon occur in many parts of the Chetco River population area and juvenile coho salmon have been found in the upper mainstem reaches in the Kalmiopsis Wilderness (ODFW 2005a). Coho salmon are present in several tributaries throughout the population area including tributaries in the upper-most portions of the watershed (USFS 1996a). Coho salmon are present in the majority of the IP habitat identified by Williams et al 2006.

Although the genetic structure of the population has not been studied, it is likely that diversity has been diminished as the population has declined, consistent with the known dynamics of small populations (Chapter 2). The ODFW Expert Panel expressed concern that out-of-basin hatchery-produced coho salmon may stray into the Chetco River and affect the genetic integrity of the wild population (ODFW 2008b). However, hatchery effects were not considered a stress or threat to this population given the small number of strays thought to affect the Chetco River.

Population Size and Productivity

The USFS (1996a) characterized Chetco River coho salmon as relatively scarce, which indicates their population has diminished greatly from the historic levels described in Maguire (2001f). The Expert Panel stated that the Chetco River coho population has a very low abundance and is verging on extirpation (ODFW 2008b). Population estimates for 1998 to 2008 for the Chetco River are shown in Figure 13-2. The range of estimates is from zero to 665 adults. Years with no observed returns are 1998, 1999, 2002, 2003, and 2005 (ODFW 2009a). It is problematic to draw definitive conclusions from these data because the locations of sampling and water conditions at time of sampling are unknown. If survey coverage was incomplete, coho salmon may have been overlooked in many years. High flows may have occurred in some years, making accurate counts difficult or impossible.

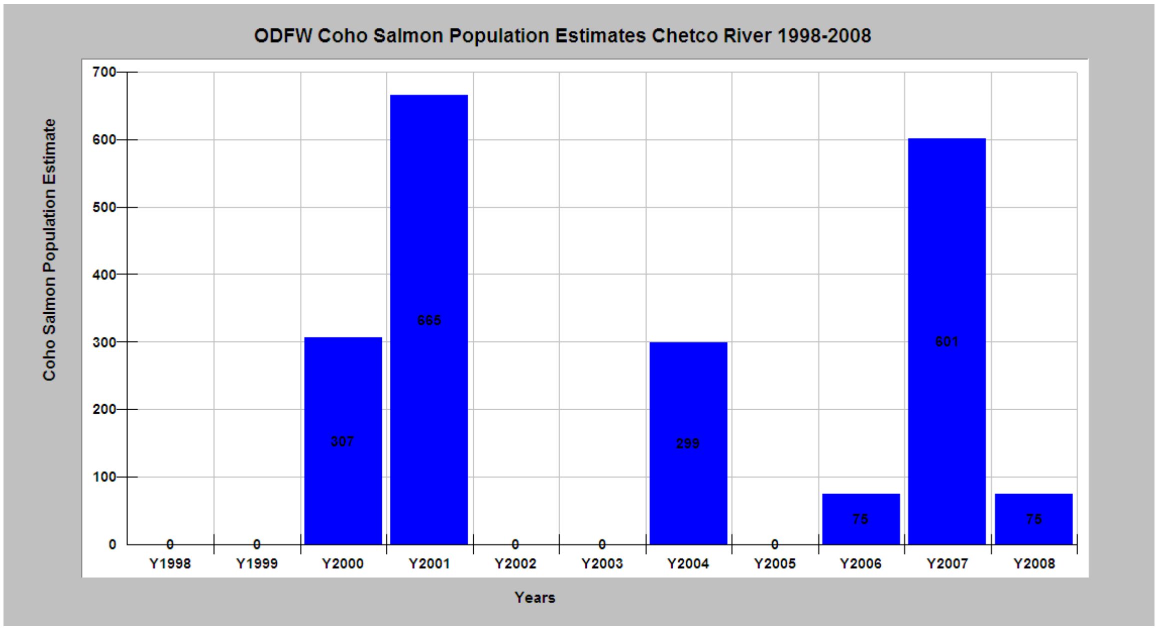

Figure 13-2. Chetco River basin-wide adult coho salmon return estimates. The data are for the years 1998 to 2008 (ODFW 2009a).

The more robust returns in 2001, 2004 and 2007 suggest that one year class is stronger than the other two. The lack of returns in 2003, after 307 coho spawned in the Chetco River in 2000, suggests that successful recruitment of juveniles to the adult life stage was problematic. With the exception of one year class, the overall population productivity for Chetco River coho salmon appears to be very low.

Extinction Risk

The Chetco River coho salmon population is not viable and at high risk of extinction, because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

As a functionally independent population, the Chetco River would have once served as a source of spawners for adjacent basins, such as the Winchuck River to the south and Pistol River to the north. As a core population, the Chetco River will be an important source of colonists to other recovering basins in the ESU.

13.4 Plans and Assessments

State of Oregon

http://www.Oregon.gov

Expert Panel on Limiting Factors for Oregon's SONCC coho salmon populations

ODFW (2008b) convened a panel of fisheries and watershed scientists as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on limiting factors and threats to recovery. Based on the input of panel members, ODFW (2008b) summarized the concerns for the Chetco River population as follows:

> Key concerns in the Chetco River were primarily loss of over-winter tributary and freshwater estuarine habitat complexity and floodplain connectivity for juveniles, especially in the lowlands which are naturally very limited in this system and have been impacted by past and current urban, rural residential, and forestry development and practices. Secondary concerns were related to a loss of large wood and habitat complexity, high water temperatures in tributaries for summer parr (excluding the mainstem, where rearing is not expected), reduced estuarine habitat for smolts, and a very low spawner abundance susceptible to genetic impacts by out-of-basin hatchery fish.

Oregon Plan for Salmon and Watersheds

The State of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is a comprehensive plan that includes voluntary actions for all of the threats currently facing coho in these ESUs and involves all relevant state agencies. Reforms to fishery harvest and hatchery programs were implemented by ODFW in the late 1990's. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary. The action plans, implementation, and annual reports can be found at http://www.oregon.gov/OPSW/.

Southwest Oregon Salmon Restoration Initiative

The Southwest Oregon Salmon Restoration Initiative (Prevost et al. 1997) was created to help fulfill a memorandum of understanding between ODFW and the National Marine Fisheries Service (NMFS) to recover coho salmon. The initiative provides the framework for recovery in southwest Oregon and helped foster formation of watershed councils. Although the Chetco River has 72.8 miles of "high value" coho salmon habitat, there are no reaches or tributaries designated as "core areas" that are the highest priority for restoration in the SONCC.

Oregon Coastal Management Program (OCMP)

The OCMP has identified several areas of the Chetco River (mainstem Chetco River from Box Canyon Creek to estuary, North Fork Chetco River, and Bravo Creek) as 303(d) impaired water bodies under the Clean Water Act as a result of excessively high river temperatures. Due to this listing, a total maximum daily load (TMDL) must be prepared for these areas, in accordance with

40 CFR 130.6. The Oregon Department of Water Quality has initiated a TMDL for the Chetco River basin. The TMDL is in the initial scoping and data collection phase.

Cumulative Effects of Southwest Oregon Coastal Land Use on Salmon Habitat

Oregon State University (OSU) Oak Creek Labs conducted a study funded by ODFW and the Oregon Department of Forestry (ODF) to determine relationships between forest harvest and Pacific salmon productivity (Frissell 1992). The study assessed basins along the Oregon coast extending from the Sixes River to the southern border during the period from 1986 to 1992 with the most extensive research conducted in Euchre Creek to the south of the Elk River.

South Coast Watersheds Council

http://oregonwatersheds.org/

Chetco River Watershed Assessment

The Chetco River Watershed Assessment (Maguire 2001f) identified reduced juvenile summer and over-wintering habitat as the greatest limiting factor for coho salmon, and linked degraded habitat conditions to sedimentation of channels, reduction of large wood jams, diking and draining of wetlands, and riparian removal on the lower mainstem Chetco River and its tributaries. The report offered solutions such as the potential for increased peak flows, reducing estuary eutrophication, and increasing water supply.

Chetco River Action Plan

The Chetco River Action Plan was written to address issues raised in the CRWA. Its intent is to define specific priority actions for restoration. Recommendations include educating residents regarding the need for riparian and water quality protection and water conservation. Recommended actions include increasing conifers in riparian zones, reconnecting wetlands in the lower Chetco River and estuary, and decreasing erosion potential related to roads. The document concludes Jack Creek and the North Fork Chetco have the greatest coho salmon restoration potential.

13.5 Stresses

Table 13-2. Severity of stresses affecting each life stage of coho salmon in the Chetco River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	Very High	Very High	Very High
2	Lack of Floodplain and Channel Structure[1]	High	High	Very High[1]	Very High	High	Very High
3	Altered Hydrologic Function[1]	High	High	Very High[1]	Medium	Medium	Very High
4	Impaired Water Quality[1]	Low	High	Very High[1]	High	Medium	Very High
5	Impaired Estuary/Mainstem Function[1]	-	Low	Very High[1]	High	High	Very High
6	Altered Sediment Supply	Low	Medium	Medium	Medium	Low	Medium
7	Barriers	-	Low	Low	Low	Low	Low
8	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
9	Adverse Fishery-Related Effects	-	-	-	-	Low	Low

[1]Key limiting factor(s) and limited life stage(s).
[2]Increased Disease/Predation/Competition is not considered a threat to this population.

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited and quality winter rearing habitat, as well as summer rearing habitat, is lacking for the population. Juvenile summer rearing habitat is impaired by high water temperatures resulting from degraded riparian conditions and water withdrawals. Winter rearing habitat is severely lacking because of channel simplification, disconnection from the floodplain, degraded riparian conditions, poor large wood availability, and an estuary which has been altered and reduced in size due to development, channelization, and diking. Large wood has been removed and is not naturally replacing at the rates required to maintain key components of habitat complexity. Overall, these findings are consistent with those of the Oregon Expert Panel (ODFW 2008b) (Section 13.4), but the expert panel considered altered hydrologic function and impaired water quality to be only secondary, not primary, concerns.

Degraded Riparian Forest Conditions

Degraded riparian forest condition is the most significant stress affecting coho viability in the Chetco River basin. Old growth conifers historically lined the banks of the lower mainstem Chetco River and tributaries in most of the population area. These trees helped create high quality coho salmon rearing habitat by maintaining stable banks, creating undercuts beneath roots, contributing large wood to the channel, and providing shade to maintain cool stream temperature. Canopy within the North Fork watershed is currently dominated by hardwood species. ODFW riparian surveys indicate poor riparian conditions on the North Fork Chetco with fewer than 75 conifers larger than 36 inches in diameter per thousand feet of stream length. The CRWA (USFS 1996a) used remote sensing to gauge the size of trees within 200 feet of streams and found few large conifers along reaches on USFS lands. The Oregon Department of Agriculture (2008) documented sudden oak death syndrome in the riparian zones of the North Fork Chetco River and Joe Hall Creek.

Lack of Floodplain and Channel Structure

The lower Chetco River channel has been disconnected from its estuary, floodplain, wetlands, and smaller tributaries. Tributary channels and floodplains have been simplified. Higher peak flows have increased bank erosion, caused loss of large woody structure, and scoured channels in many upper tributaries in the Chetco population area (USFS 1996a). Large wood surveys from ODFW and the USFS confirm very low levels in the North Fork, upper South Fork, Boulder Creek, and Mislatnah Creek.

Stream channels in the Chetco River tend to be wide and shallow, and pools lack both depth and complexity (Massingill 2001f). Good quality spawning gravel is present, but quantity is limited. Only large mainstem reaches have pools deeper than 3 feet. An insufficient abundance of deep pools in most lower and middle Chetco River channels limits juvenile rearing potential. For example, the South Fork Chetco River, including Coons Creek, have coho salmon present and are showing a cooling trend, but lack deep pools and large wood.

Altered Hydrologic Function

In late summer and early fall, water withdrawals that reduce flow in the lower Chetco River and tributaries are of concern. The lower Chetco River, North Fork Chetco, middle mainstem Chetco, and Jack Creek are over-allocated during low flow months (Massingill 2001f). In 1964, the State of Oregon Water Rights Division established a minimum flow requirement of 80 cubic feet per second (cfs) for the Chetco River. Total allocated water rights for out of stream use are 59 cfs (Maguire 2001f). Minimum flow levels were not met in 11 of the 25 years from 1970 to 1994, and the number of days per year below this level ranged from two to 77 days (USFS 1996a). . These reduced flows disrupt juvenile rearing habitat as well as migration of smolts. Base flows may also decrease following clear cutting because of the increase in water use by young trees growing in dense stands (Murphy 1995). Disconnection of the floodplain and channel, disrupts exchange of surface water and groundwater that helps maintain cool water temperatures needed for juvenile rearing of coho salmon (Chapter 3).

Two areas have been identified by ODFW as Streamflow Restoration Priority Areas: Jack(s) Creek and the Chetco River mainstem above the North Fork. These areas were determined to have both “need” (fisheries) and “optimism” (water resources) (Maguire 2001f).

Impaired Water Quality

Temperature is the most widespread water quality impairment in Chetco River. The river is warm coming out of the Kalmiopsis Wilderness because of sparse vegetation and riparian conditions resulting from granitic soil (Maguire 2001f). Historically, it was cooled by tributaries flowing from forested watersheds in the middle and lower basin. Most tributaries and the lower mainstem Chetco River have warmed considerably in modern times and do not meet the ODEQ (2002a) temperature criterion of MWMT 64 °F. Tributaries no longer provide a significant buffer to mainstem temperatures and their function as cold water refugia for downstream migrating coho salmon juveniles and other salmonids is now impaired. Although tributaries still provide cool water refugia, the quantity and quality of the cold water refugia has decreased over time while temperatures gradually warm. Temperature data confirm that reaches of the mainstem are acutely stressful or lethal to salmonids (Figure 13-3), indicating that cooler water inputs from tributaries has become even more important over time. The water temperature in stream channels on U.S. Forest Service (USFS) lands has been improving. Emily Creek and the South Fork Chetco River have been gradually approaching suitable water temperatures for coho salmon (USFS 1996a). The middle North Fork Chetco River and its tributary Bosley Creek, on BLM lands, are currently suitable for coho salmon, but Bravo Creek and the lower North Fork reaches on private timberlands are too warm. There are also problems with high total phosphates, and occasional high pH, in the lower Chetco River (Maguire 2001f). Water quality in the estuary is poor due to low dissolved oxygen in the summer (Maguire 2001f).

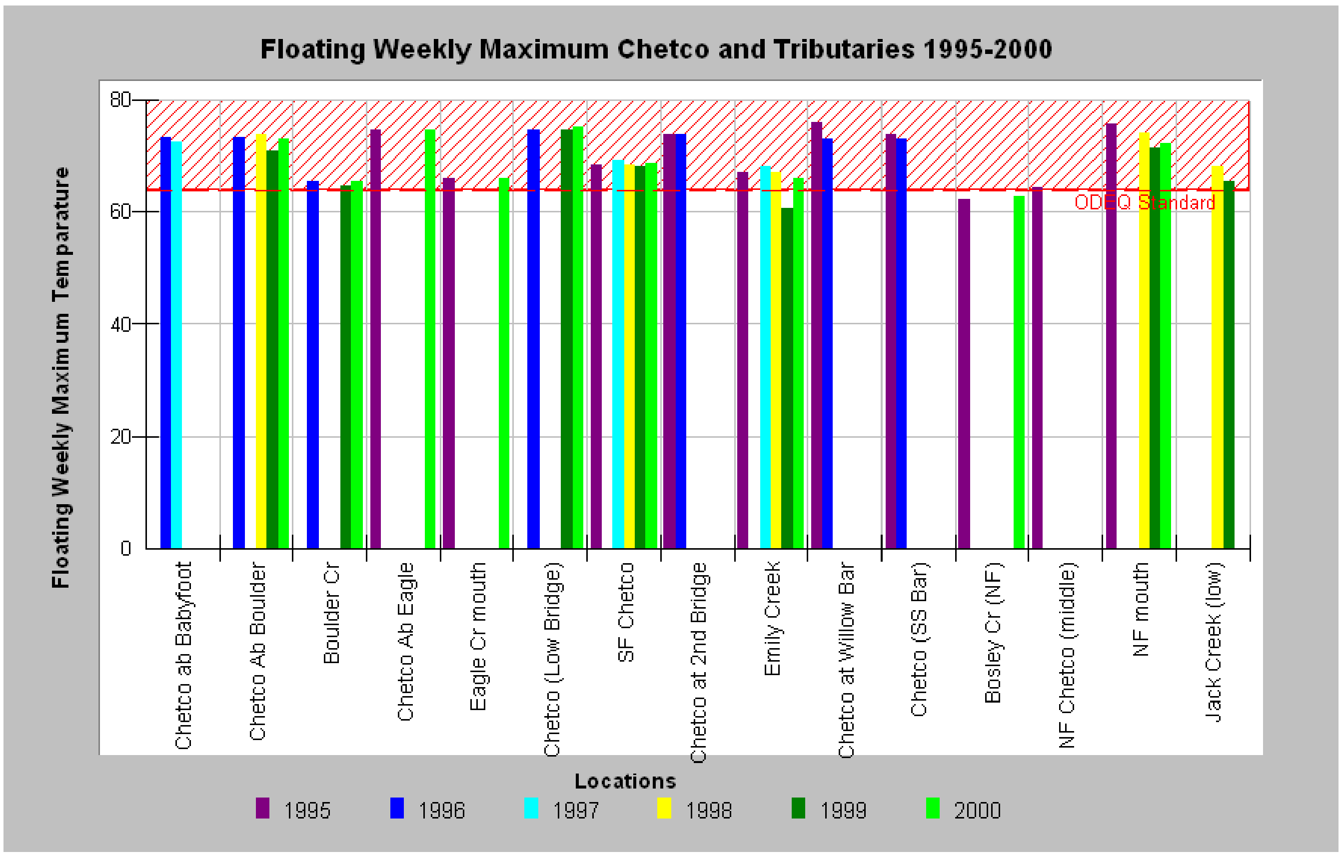

Figure 13-3. Maximum floating weekly maximum temperatures (MWMT). These data show that from 1995 to 2000, water temperature exceeded the 64 °F standard at most locations (Maguire 2001f).

Impaired Estuary/Mainstem Function

The Chetco River estuary was historically small, and much of what once was estuarine rearing habitat no longer serves this function for coho salmon (Massingill 2001f). There is little to no remaining estuarine rearing habitat or refugia for smolts or adults. Upstream of the mouth, steep terrain adjacent to the mainstem limits the availability of tidal estuarine habitat. Formerly productive Tuttle Creek is disconnected as it now flows through several hundred feet of culverts underneath an RV Park. Reduced freshwater flows into the estuary contribute to and exacerbate stagnation and water quality problems. Lack of juvenile rearing habitat and impaired water quality in the estuary constitute an overall high stress for coho salmon.

Altered Sediment Supply

Altered sediment supply poses an overall medium stress to coho salmon in the Chetco River. Sediment contribution from landslides and erosion occurs naturally in the Chetco River basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. Excess fine sediment directly impacts coho salmon egg viability and can reduce food for fry, juveniles and smolts. Poor pool frequency and depth throughout the Chetco River basin (Massingill 2001f) are likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening. Overall, coarse sediment supply in the Chetco River basin has declined since the 1970's (Wallick et al. 2009) due to improved management practices on public lands in the upper basin.

Barriers

One major tributary, Ferry Creek, is culverted for several hundred feet just upstream of its confluence which is likely a complete barrier. Road-stream crossings in the Lower, Middle and North Fork watersheds and their tributaries that could be barriers to coho salmon or other adult and juvenile salmonids have been inventoried and necessary restoration actions are planned (Maguire 2001f), although progress is unknown. The barrier at the confluence of Left Redwood Creek and the mainstem Chetco River, as well as those on the small tributaries to the south of Jacks Creek that empty directly to the ocean, are of greatest concern. The first barrier blocks access to most of the river, and the others occur upstream where high IP habitat is scarce.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Chetco River population area. The ODFW Expert Panel expressed concern that out-of-basin hatchery-produced coho salmon may stray into the Chetco River and affect the genetic integrity of the wild population (ODFW 2008b). Hatchery-origin coho salmon may stray into the Chetco River, but hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

Adverse Fishery-Related Effects

NMFS has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

13.6 Threats

Table 13-3. Severity of threats affecting each life stage of coho salmon in the Chetco River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

Threats		Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Channelization/Diking	Medium	High	High	High	High	High
2	Roads	Medium	High	High	High	High	High
3	Urban/Residential/Industrial	Low	High	High	High	High	High
4	Timber Harvest	Low	High	High	High	High	High
5	Mining/Gravel Extraction	Medium	High	High	Medium	Medium	Medium
6	Agricultural Practices	Low	Medium	Medium	Medium	Medium	Medium
7	Dams/Diversion	Low	Medium	Medium	Medium	Medium	Medium
8	High Intensity Fire	Low	Medium	Medium	Medium	Medium	Medium
9	Climate Change	Low	Low	Medium	Medium	Medium	Medium
10	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low
12	Invasive Non-Native/Alien Species	Low	Low	Low	Low	-	Low
13	Fishing and Collecting	-	-	-	-	Low	Low

Channelization/Diking

Nearly all of the tidal wetlands in the Chetco River have been channelized or diked and are no longer available to coho salmon. Development along the south side of the river likely eliminated limited tidal wetlands that provided off-channel habitat for coho salmon rearing and holding. Two marinas and a large jetty have been built in the estuary and most of the floodplain is developed. Many reaches of the lower Chetco River mainstem, its tributaries, and the estuary have high intrinsic potential coho salmon habitat (Williams et al. 2006); however, this portion of the river has been disconnected from the floodplain. The estuary was partially filled when levees were constructed to improve navigability into the ocean. The mouth of the river and the mainstem upstream are now channelized and diked. Tuttle Creek, which was formerly productive for coho salmon (Maguire 2001f), has been straightened and confined. The Chetco River channel above the North Fork has been confined in order to expand pastures for grazing. Streams are also forced into narrow channels due to confinement by roads throughout the population area (USFS 1996a). This leads to reduced floodplain connectivity and function, increased current velocity, and makes reaches less suitable for coho rearing.

Roads

The highest road densities in the middle, lower, and North Fork Chetco River are on private lands. Maguire (2001f) used road crossing density to evaluate the risk of sediment impacts and found the highest density of road crossings in the Chetco coastal area and middle Chetco mainstem. There was a moderately high risk due to density of road crossings in Jack Creek, and the lower and upper Chetco mainstem. The North Fork and Eagle Creek both received moderate risk ratings. On USFS land, streams with the highest road densities are Mill, Emily, Eagle, Panther, West Coon and Quail Prairie creeks, South Fork Chetco River, and the south side of the Chetco River below Long Ridge (USFS 1996a). Another effect of roads is the potential for elevated peak flows. The lower Chetco River near the coast and middle mainstem is at the highest risk of damaging peak flows due to roads (Massingill 2001f). There is a moderate risk for elevated peak flows in Jacks Creek, the lower mainstem Chetco, and the North Fork Chetco.

Urban/Residential/Industrial Development

The number of rural landowners in the Chetco River basin has increased considerably since 1950. For example, in 1950 there were less than ten adjoining property owners near the mouth of the North Fork, and in 2001 there were 92 (Massingill 2001f). The highest intrinsic potential coho habitat is centered in the lower basin where most land is privately owned and land management is often intensive. Human population growth is concentrated around Brookings Harbor at the mouth of the Chetco River and upstream to USFS ownership at the mouth of the South Fork Chetco River. As rural populations grow, so does the demand for water, the risks of increases in peak flow, increases in sediment inputs, riparian vegetation removal and water contamination. Currently, municipal uses account for most of the water withdrawals from the Chetco River and its tributaries (Massingill 2001f).

Development continues to occur adjacent to the estuary, and fill material has reduced the size and function of the estuary. Marina development and other commercial activities in and near the estuary combine with urbanization to create a high amount of impervious area that can contribute to non-point source pollution. Paved roads, parking lots, rooftops, or other surfaces that do not absorb rainfall tend to send much more water to streams, elevating peak flows and contributing pollution to streams (Booth and Jackson 1997). Leakage or percolation from rural residential septic systems is a potential source of nutrient pollution.

Timber Harvest

Timber harvest in the Chetco River basin poses a threat to coho salmon due to short rotation clear cutting cycles in areas that overlap with high IP coho salmon habitat, or contribute water to IP habitat downstream. Landscape-scale imagery available from Google Earth shows widespread timber harvest and extensive road networks on private timber land in the western portion of the population area. More than 50 percent of the area in many small drainages along the Chetco River from Eagle Creek to the mouth has been harvested (USFS 1996a). Other parts of the population area have also experienced intense timber harvest, such as Basin creek which has had 60 percent of its area harvested recently. . These levels of timber harvest have been found to disrupt channels and diminish Pacific salmon species diversity in other Oregon coastal basins (Reeves et al. 1993).

Mining/Gravel Extraction

Gold mining claims remain in the upper Chetco River basin (Zaitz 2010), which cover several miles of stream. Mining activity could potentially increase, including use of larger dredges and heavy equipment (Zaitz 2010). The largest active gravel mining site is in the lower Chetco River on the terrace just upstream of Jacks Creek, where the river is low gradient and the valley is unconfined.

Agricultural Practices

Grazing is the principal agricultural activity in the Chetco River basin. However, the largest agricultural impact to coho salmon is the confinement of the lower river channel and the resulting disconnection from its historic floodplain. The levees, dikes, and general encroachment of pasture and agricultural lands onto the floodplain have greatly reduced off channel rearing habitat availability.

Dams/Diversions

One major tributary to the estuary, Ferry Creek, is dammed just upstream of its confluence. There are no known diversions that block fish passage. Effects of water diversions other than passage issues are described under the ‘Urban/Residential/Industrial Development’ threat.

High Intensity Fire

Extensive portions of the Chetco River population area burned in the 23,500 acre Silver Fire of 1987. The Biscuit Fire of 2002 burned most of the upper Chetco River, including most of the Kalmiopsis Wilderness area (Azuma et al. 2004). However, 63 percent of the area burned in the Biscuit Fire was at low to very low intensity. In the North Fork Chetco, sudden oak death syndrome is killing tan oak and bay laurel trees (ODA 2008), which can elevate fire risk because dead trees are more flammable.

Climate Change

Climate change in this region will have the greatest impact on juveniles, smolts, and adults. Although the current climate is generally cool, modeled regional average temperature predicts a moderate increase over the next 50 years. Average temperature could increase by up to 1.5^{o}C in the summer and by 1^{o}C in the winter. Annual precipitation in this area is predicted to stay within the natural range of current variability; however seasonal patterns in precipitation will likely occur (Mote and Salathe 2010). Overall, the range and degree of variability in temperature and precipitation are likely to increase. The vulnerability of the estuary and coast to sea level rise is moderate to high in this coastal population. Rising sea level may impact the quality and extent of wetland rearing habitat.

Road-Stream Crossing Barriers

Coho salmon have access to most of the population area, although there are ten remaining barriers which have been identified as problematic for fish passage. One of the most significant barriers is the barrier at the confluence of the mainstem Chetco River and Redwood Creek, which blocks access to the majority of Redwood Creek. Five tide gates on small streams emptying directly to the ocean are problematic because they affect some of the little available IP habitat in this basin.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Chetco River population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Invasive Non-Native/Alien Species

Sudden oak death (SOD) is a non-native pathogen which affects almost all native plants, trees, and shrubs. SOD infections often result in mortalities to some species of oaks and bay laurels. There are known outbreaks of SOD in Curry County and the Chetco River. SOD infections, especially SOD control efforts to limit outbreaks, result in affects to riparian function by removing trees from riparian areas.

Japanese knotweed (*Polygonum cuspidatum*) has spread into the Chetco River (ODA 2010) and efforts are underway to control its spread and distribution. This is a concern because Japanese knotweed is aggressive, fast growing, and out-competes native vegetation in riparian areas. Scotch broom and gorse are also locally common and similarly invasive. If these plants replace conifers or hardwoods in riparian zones, it substantially impacts coho salmon habitat.

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook-directed fisheries that account for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the directed recreational fishery. The exploitation rates associated with this freshwater fishery and all other fisheries managed by the State of Oregon were found to be low enough to avoid jeopardizing the existence of the ESU (NMFS 1999). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because recovery objectives to achieve species viability had not been established for SONCC coho salmon at that time (NMFS 1999). NMFS has authorized future collection of coho salmon for research purposes in the Chetco River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

13.7 Recovery Strategy

The most important factor limiting recovery of coho salmon in the Chetco River is a deficiency in the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by increasing channel complexity, restoring flow, and reducing stream temperatures. Channel complexity should be improved by restoring large wood in streams, restoring those processes that provide large wood to streams, constructing off-channel ponds or backwater habitat, restoring wetlands, moving levees, or limiting development and fill. Areas adjacent to the stream should be replanted with conifers to re-establish mature streamside forest as a source for large wood recruitment. Restoration of sufficient water may require changes in water use and allocation.

Habitat restoration and threat reduction in the Chetco River should be focused on those areas currently occupied by coho salmon, which would allow for immediate benefits to the population. Unoccupied areas must also be restored to provide enough habitat to achieve population viability and provide for conditions suitable to allow for re-colonization.

Table 13-4 on the following page lists the recovery actions for the Chetco River population.

Table 13-4. Recovery action implementation schedule for the Chetco River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.2.2.5	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Lower mainstem, South Fork, and Estuary (in particular areas south of Highway 101)	3
SONCC-WinR.2.2.5.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-WinR.2.2.5.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-WinR.2.2.6	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	3
SONCC-WinR.2.2.6.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-WinR.2.2.6.2	*Implement beaver program (may include reintroduction)*					
SONCC-WinR.2.1.7	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Lower mainstem, South Fork, and Estuary	3
SONCC-WinR.2.1.7.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-WinR.2.1.7.2	*Place instream structures, guided by assessment results*					
SONCC-WinR.2.1.31	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2
SONCC-WinR.2.1.31.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-WinR.2.1.31.2	*Place instream structures, guided by assessment results*					
SONCC-WinR.10.2.15	Water Quality	Yes	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-WinR.10.2.15.1	*Develop an educational program that teaches to reduce channel encroachment, reduce usage of toxic chemicals, maintaining septic systems, water conservation, and landscaping with native species.*					
SONCC-WinR.10.2.16	Water Quality	Yes	Reduce pollutants	Set standard	Population wide	2
SONCC-WinR.10.2.16.1	*Develop TMDLs for 303(d) listed water bodies*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.1.2.30	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-WinR.1.2.30.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-WinR.1.2.30.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-WinR.16.1.17	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-WinR.16.1.17.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-WinR.16.1.17.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-WinR.16.1.18	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-WinR.16.1.18.1	*Determine actual fishing impacts*					
SONCC-WinR.16.1.18.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-WinR.16.2.19	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-WinR.16.2.19.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-WinR.16.2.19.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-WinR.16.2.20	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-WinR.16.2.20.1	*Determine actual impacts of scientific collection*					
SONCC-WinR.16.2.20.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-WinR.3.1.8	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	3
SONCC-WinR.3.1.8.1	*Determine instream flow needs for coho salmon*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.3.1.8.2	*Measure streamflow hourly by establishing a USGS gaging station.*					
SONCC-WinR.3.1.8.3	*Maintain USGS gaging station*					
SONCC-WinR.3.1.8.4	*Perform a groundwater study to determine the volume of aquifer storage and the role of aquifers in streamflow*					
SONCC-WinR.3.1.9	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-WinR.3.1.9.1	*Provide incentives and education to landowners to reduce water consumption and reduce groundwater pumping and surface water diversion by utilizing conservation and storage.*					
SONCC-WinR.3.1.10	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Lower basin	BR
SONCC-WinR.3.1.10.1	*Develop regulatory mechanisms to ensure a flow of 20 CFS is maintained in summer months*					
SONCC-WinR.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-WinR.27.1.21.1	*Perform annual spawning surveys*					
SONCC-WinR.27.1.22	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-WinR.27.1.22.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-WinR.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-WinR.27.1.23.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-WinR.27.2.24	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-WinR.27.2.24.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-WinR.27.2.24.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-WinR.27.2.25	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.27.2.25.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-WinR.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-WinR.27.2.26.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-WinR.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-WinR.27.2.27.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-WinR.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-WinR.27.2.28.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-WinR.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	Estuary	2
SONCC-WinR.27.2.29.1	*Identify habitat condition of the estuary*					
SONCC-WinR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-WinR.27.1.33.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-WinR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-WinR.27.2.34.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-WinR.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-WinR.27.1.35.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-WinR.27.1.35.2	*If appropriate, modify population types and targets using revised methodology*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-WinR.27.1.36	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Evaluate the potential to restore extirpated independent populations	Population wide	3
SONCC-WinR.27.1.36.1		*Evaluate the potential to restore extirpated independent populations*				
SONCC-WinR.5.1.11	Passage	No	Improve access	Provide artificial passage	Confluence of mainstem and South Fork	2
SONCC-WinR.5.1.11.1		*Determine whether the water storage reservoir is a full or partial barrier to coho salmon and develop a plan to provide passage*				
SONCC-WinR.5.1.11.2		*Restore passage, guided by the plan*				
SONCC-WinR.5.1.12	Passage	No	Improve access	Remove barriers	Estuarine tributary crossings at Winchuck River Road	BR
SONCC-WinR.5.1.12.1		*Assess and prioritize barriers. Develop a plan for removal*				
SONCC-WinR.5.1.12.2		*Remove barriers, guided by the plan*				
SONCC-WinR.7.1.1	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	South Fork, East Fork, Fourth of July, and Bear creeks, Upper mainstem Winchuck River just below the East Fork, Estuary	2
SONCC-WinR.7.1.1.1		*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*				
SONCC-WinR.7.1.1.2		*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat and wetlands*				
SONCC-WinR.7.1.2	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Privately held timber lands	2
SONCC-WinR.7.1.2.1		*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*				
SONCC-WinR.7.1.3	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Upper Bear Creek and South Fork	3
SONCC-WinR.7.1.3.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-WinR.7.1.3.2		*Thin, or release conifers, guided by prescription*				
SONCC-WinR.7.1.3.3		*Plant conifers, guided by prescription*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.7.1.4	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Rangeland	BR
SONCC-WinR.7.1.4.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-WinR.7.1.4.2	*Develop grazing management plan to meet objective*					
SONCC-WinR.7.1.4.3	*Plant vegetation to stabilize stream bank*					
SONCC-WinR.7.1.4.4	*Fence livestock out of riparian zones*					
SONCC-WinR.7.1.4.5	*Remove instream livestock watering sources*					
SONCC-WinR.7.1.32	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	BLM lands	3
SONCC-WinR.7.1.32.1	*Manage timber harvest (and associated activities) on Federal lands in accordance with the Aquatic Conservation Strategy of the NWFP to achieve riparian and stream channel improvements for coho salmon*					
SONCC-WinR.8.1.13	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	USFS land	BR
SONCC-WinR.8.1.13.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-WinR.8.1.13.2	*Decommission roads, guided by assessment*					
SONCC-WinR.8.1.13.3	*Upgrade roads, guided by assessment*					
SONCC-WinR.8.1.13.4	*Maintain roads, guided by assessment*					

14. Winchuck River Population

- Northern Coastal Stratum
- Non-Core, Potentially Independent Population
- High Extinction Risk
- 220 Spawners Required for ESU Viability
- 77 mi^2
- 56 IP km (35 mi) (16% High)
- Dominant Land Uses are Forestry and Urban/Residential/Industrial Development
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Impaired Water Quality’
- Principal Threats are ‘Channelization/Diking’ and ‘Urban/Residential/Industrial Development’

14.1 History of Habitat and Land Use

The lower reaches of the Winchuck River were inhabited by Anglo-American settlers after 1856. Several dairies were operated there for over a century. Dairy operations in stream side areas diminished coho salmon habitat by confining the channel to expand grazing areas. Stream side dairies also contributed excess nutrients and pollutants as effluents were washed into waterways. Mining occurred in the upper Winchuck River watershed in Wheeler Creek as early as the mid-1850s.

The post-WWII logging era impacted river habitat. The U.S. Forest Service manages 66 percent of the Winchuck River watershed, and USFS timber harvesting activities in the 1970s and 1980s contributed to further habitat degradation. Most of the South Fork Winchuck River watershed is private industrial timberland that continues to be actively harvested today. One resident recalls that once the logging started the river changed; it was dirtier, warmer, and had more sediment (Maguire 2001g). Others observed that mainstem and tributary pools have filled in, banks have eroded, peak flows have increased, and base flows have reduced.

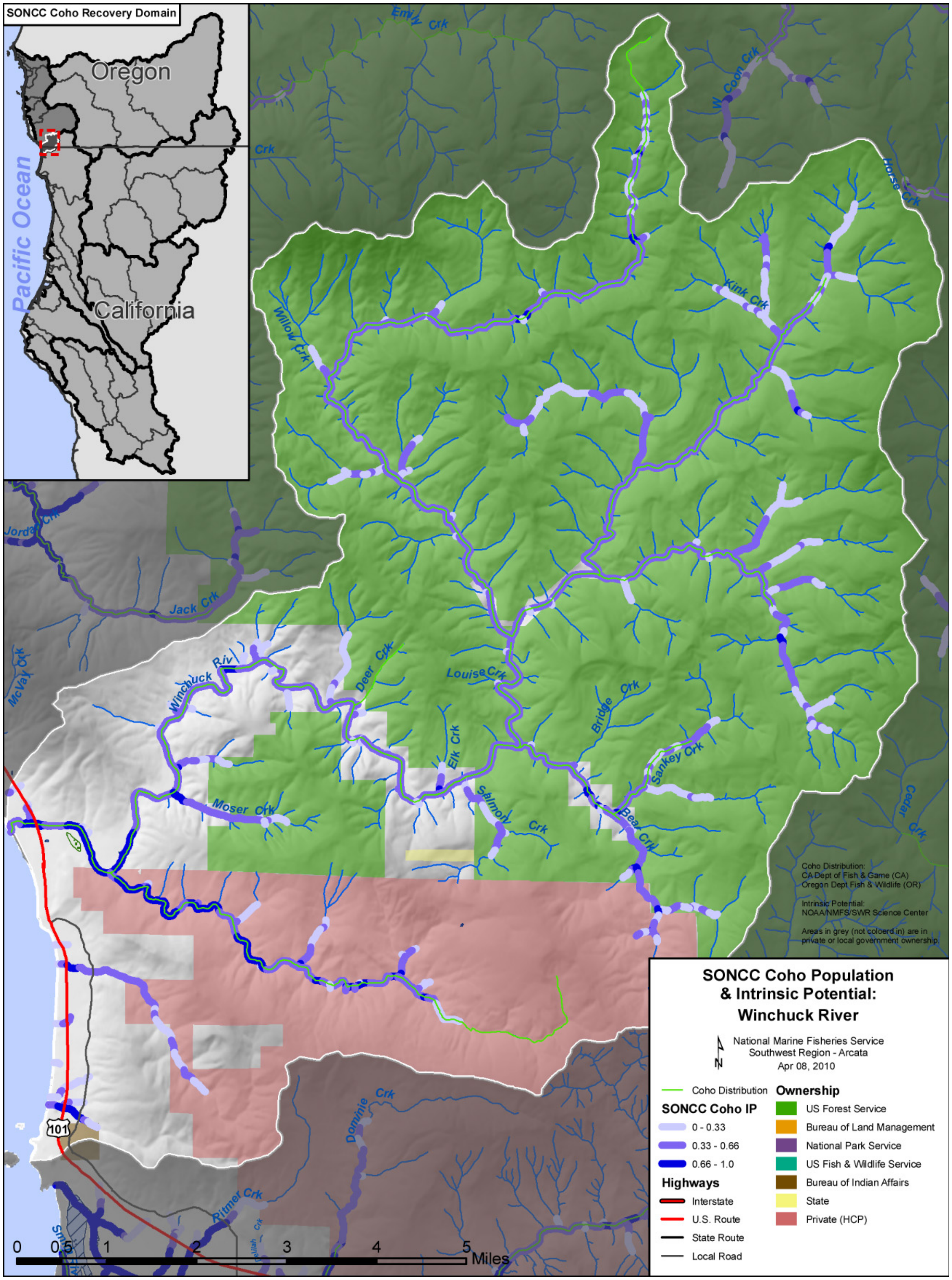

Figure 14-1. The geographic boundaries of the Winchuck River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Until the 1970s, residential development in the watershed remained sparse. Long-time Winchuck River residents recalled that before 1975, the river valley was inhabited by 10 families who owned large tracts of land. Then a road through the river valley was paved, development increased, and today there are more than 150 homes. Agricultural activities now include lily bulb production and cattle grazing to a lesser extent. Residential and agricultural uses are centered in the lower and middle portions of the river.

14.2 Historic Fish Distribution and Abundance

The Winchuck River coho salmon population is not well studied and there are no historic data sets with which to evaluate trends. High intrinsic potential (IP >0.66) habitat for coho salmon exists in the South Fork Winchuck River and lower mainstem Winchuck River as well as in patches in the upper East Fork Winchuck, Moser, Bear, Fourth of July, and Wheeler creeks. Coho salmon likely inhabited these reaches historically (Figure 14-1). Table 14-1 lists Winchuck River reaches and tributaries with the highest coho salmon habitat IP (>0.66).

The Oregon Department of Fish and Wildlife (ODFW) believes that the coho salmon population in the Winchuck River was naturally smaller than the Chinook population due to the large quantity of mainstem habitat with high energy flows and large substrate but acknowledges that "abundance of coho salmon has probably been reduced due to modification of low gradient streams" (Maguire 2001g).

Table 14-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	**Stream Name**	**Stream Name**
Winchuck River Estuary	Middle Winchuck (SF to EF)	East Fork Winchuck
Lower Winchuck River	Moser Creek	Fourth of July Creek
South Fork Winchuck River	Bear Creek	Wheeler Creek

14.3 Status of Winchuck River Coho Salmon

Spatial Structure and Diversity

Juvenile coho salmon surveys for 2002, 2003 and 2004 document presence of coho salmon in the South Fork, East Fork, Fourth of July, and Bear creeks and the upper mainstem Winchuck River just below the East Fork (ODFW 2005a). No juveniles were found in the lower Winchuck River or Wheeler Creek (ODFW 2005a) although subsequent survey efforts in 2007 revealed coho salmon present in Wheeler Creek. It is likely that genetic diversity has been diminished as the population has declined and likely suffers from the effects of low population size.

Population Size and Productivity

ODFW (2008b) described the Winchuck River coho salmon population as having very low abundance verging on extirpation. ODFW (2009a) estimated basin-wide returns from 1998 to 2008. The estimate was zero for all years except in 2000 and 2007, when 37 and 163 adults were found, respectively. The lack of any detected spawner returns in many years indicates very low productivity in the Winchuck River. It is problematic to draw definitive conclusions from these data because no effort data is included, and the locations of sampling and water conditions at time of sampling are unknown. Large differences in effort between years could account for observed differences in estimates.

Young-of-the-year coho salmon have been found in many years in the South Fork Winchuck River (Figure 14-2) during the 1995 to 2009 monitored period (Green Diamond Resource Company (GDRC) 2009).

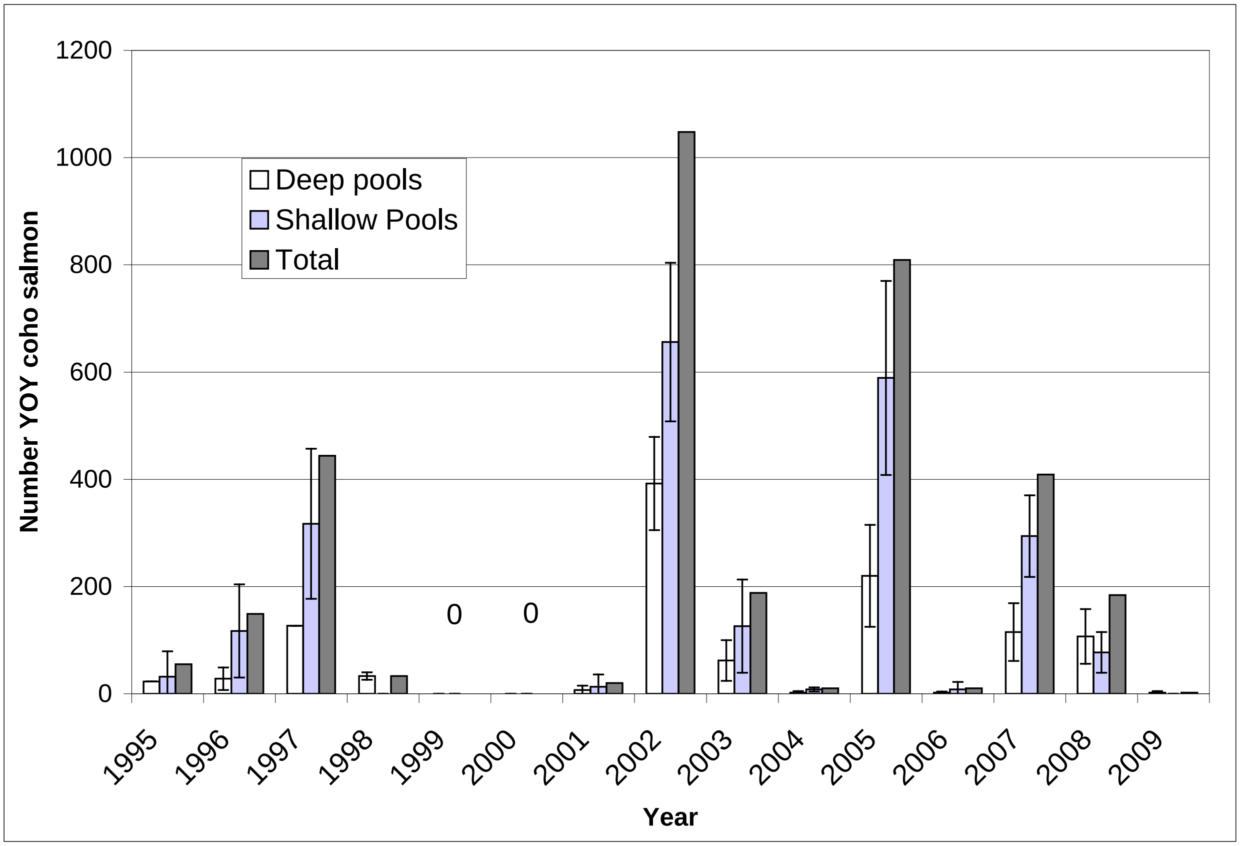

Figure 14-2: Number young of the year coho salmon found in deep and shallow pools. Deep pools (>=3.4 feet) and shallow pools (< 3.4 feet) are in the South Fork Winchuck River (95-percent confidence intervals) (House 2010).

Extinction Risk

The Winchuck River coho salmon population is not viable and at high risk of extinction because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Winchuck River population is considered potentially independent because it likely receives sufficient immigration from the adjacent Chetco and Smith rivers to influence its dynamics and extinction risk (Williams et al. 2006). As an independent population, the Winchuck River was also a source of colonists for adjacent large river systems and smaller coastal tributaries further to the north and south. Any restored habitat in the Winchuck River and its tributaries provides potential connectivity that assists metapopulation function in the SONCC coho salmon ESU. As a non-core population, the Winchuck River population is expected to play a supporting role in recovery by supporting immigration from core populations. The recovery objective for the Winchuck River is to achieve a moderate risk of extinction (244 spawning adults).

14.4 Plans and Assessments

State of Oregon

Expert Panel on Limiting Factors for Oregon's SONCC coho salmon populations

ODFW (2008b) convened a panel of fisheries and watershed scientists as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on limiting factors and threats to recovery. Based on the input of panel members, ODFW (2008b) summarized the key concerns for the Winchuck River population as follows:

> Key concerns were primarily loss of over-winter tributary and freshwater estuarine habitat complexity and floodplain connectivity for juveniles, especially in the lowlands which are naturally limited in this system and have been impacted by past and current agricultural practices. Secondary concerns were reduced habitat complexity for summer and winter parr due to non-native vegetation, especially Japanese knotweed, limiting riparian species and their recruitment to the stream. Very low spawner abundance susceptible to genetic impacts by out-of-basin hatchery fish was another secondary concern.

Cumulative Effects Assessment of Timber Harvest on Salmon Habitat Southwest Oregon Coastal Streams

Oregon State University (OSU) Oak Creek Labs conducted a study funded by ODFW and the Oregon Department of Forestry (ODF) to determine relationships between forest harvest and Pacific salmon productivity (Frissell 1992). The study assessed watersheds along the Oregon coast extending from the Sixes River to the southern border during the period from 1986 to 1992.

Oregon Plan for Salmon and Watersheds
http://www.oregon.gov/OPSW/about_us.shtml

The State of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is a comprehensive plan that includes voluntary actions for all of the threats currently facing coho salmon in these ESUs and involves all relevant state agencies. Reforms to fishery harvest and hatchery programs were implemented by ODFW in the late 1990s. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary.

Southwest Oregon Salmon Restoration Initiative

The Southwest Oregon Salmon Restoration Initiative (Prevost et al. 1997) is a regional document that was created to help fulfill a memorandum of understanding between ODFW and the

National Marine Fisheries Service (NMFS) to recover coho salmon. The initiative provides the framework for recovery in southwest Oregon and helped foster formation of watershed councils. The Winchuck River is recognized as having 16.9 miles of "high value" coho salmon habitat.

United States Forest Service, Rogue River-Siskiyou National Forest

Watershed Analysis (WA) (USFS 1995a)

This document was prepared in accordance with the Northwest Forest Plan. The watershed analysis identifies an approach for restoration on land managed by the USFS in the Winchuck River, which comprises 66 percent of the basin. The WA characterizes most USFS tributaries in the upper Winchuck River basin as being "in recovery" and gives the highest priority to projects designed to reduce or prevent sediment delivery to streams. Planned activities include road decommissioning and relocation; hardwood thinning and conifer planting in riparian zones; and combating the spread of Port Orford root disease in the watershed.

South Coast Watershed Council

Winchuck River Watershed Assessment

The Winchuck River Watershed Assessment (Maguire 2001g) summarizes conditions, historic changes, and restoration needs in the Winchuck River basin. Community concerns, salmonid habitat, limiting factors, and prospects for recovery of fisheries and watershed health are included.

Winchuck River Action Plan

The Winchuck River Action Plan is a companion to Maguire (2001g), and proposes specific targets for restoration.

Green Diamond Resource Company (GDRC)

Green Diamond Habitat Conservation Plan

The Green Diamond HCP (GDRC 2006) outlines a plan for the conservation of aquatic species in select watersheds in the Winchuck River basin. Approximately half of the private land in the Winchuck River basin is owned by Green Diamond and therefore managed according to the provisions of the HCP. The plan was developed in accordance with ESA section 10 regulations which require Green Diamond to develop a conservation strategy to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to Green Diamond's activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and to contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species. The plan has a number of provisions designed to protect coho salmon and salmon habitat throughout the company's land in the watershed. As part of their HCP (NMFS 2007a), Green Diamond monitors the abundance of coho salmon juveniles, as well as habitat, in the South Fork Winchuck River (GDRC 2009).

14.5 Stresses

Table 14-2. Severity of stresses affecting each life stage of coho salmon in the Winchuck River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Medium	Very High	Very High[1]	Very High	High	Very High
2	Impaired Water Quality[1]	Low	Very High	Very High[1]	Very High	Low	Very High
3	Altered Hydrologic Function	Medium	Very High	Very High	Medium	High	Very High
4	Degraded Riparian Forest Conditions	Medium	High	High	High	Medium	High
6	Altered Sediment Supply	Medium	High	High	High	Medium	High
5	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	Medium
7	Barriers	-	Low	Medium	Low	Medium	Low
8	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
9	Adverse Fishery-related Effects	-	-	-	-	Low	Low

[1]Key limiting factor(s) and limited life stage(s).
[2]Increased Disease/Predation/Competition is not considered a stress to this population.

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited, and quality summer and winter rearing habitat are lacking for the population. Juvenile summer rearing habitat is impaired by high temperatures resulting from degraded riparian conditions and water withdrawals. Winter rearing habitat has been degraded by channelization, diking, loss of complexity, and disconnection from the floodplain. Degraded riparian conditions eliminated the source of LWD recruitment. Most historically available habitat in the estuary has been altered by development, channelization, and diking.

Lack of Floodplain and Channel Structure

Channel structure is generally considered good on lands managed by the USFS, which do not contain most of the high IP habitat. Large wood levels were rated as very good in the East Fork Winchuck, upper Wheeler Creek, and most of the mainstem of Bear Creek. Scores are good for lower Wheeler and Fourth of July creeks, which are also located upon public land. Only Upper Bear Creek located immediately downstream of private timber lands had a poor LWD score. The Bear Creek tributary, Sankey Creek, has LWD levels that range from fair to good. Comparable data were not available for privately owned lands with high IP in the lower watershed. Another indicator of the degree of channel structure is the mean pool frequency. Disturbed basins were found to have a mean pool frequency of 34 percent (Wood-Smith and

Buffington 1996). Streams with pool frequency lower than 35 percent are therefore considered to have unacceptably low pool frequency. These streams are Brush (<10 percent), Salmon (<10 percent), Bear (10 to 20 percent), upper Wheeler (20 to 35 percent), and upper Fourth of July (20 to 35 percent) creeks, as well as the upper East Fork Winchuck River (20 to 35 percent). Lower reaches of the East Fork Winchuck, Wheeler, and Fourth of July creeks had scores of greater than 35 percent pool frequency by area. Such data were not available for the areas of most importance for coho salmon rearing – the lower mainstem and South Fork Winchuck River.

Most concern over the lack of floodplain and channel structure is focused on the South Fork and lower mainstem of the Winchuck River, where critically important juvenile rearing once occurred. However, aerial photos indicate the Winchuck River and South Fork floodplains have been modified, thus confining the channel and cutting it off from its flood terraces. This modification has eliminated side channels that were formerly the best coho summer and over-wintering rearing habitat.

Impaired Water Quality

Elevated water temperatures are the primary concern with impaired water quality in the Winchuck River. The lower mainstem, which has the highest coho salmon IP habitat, is too warm. Weekly maximum temperatures downstream of the East Fork range from 67.1 ^{o}F to 70.7 ^{o}F. Tributaries flowing from National Forest lands, including the upper East Fork Winchuck, Wheeler, Bear, and Fourth of July creeks, all provide suitable water temperatures for coho salmon. The Winchuck River, from the mouth to the confluence with the East Fork Winchuck River, has been 303(d) listed for temperature.

In the mainstem Winchuck, fecal coliform bacteria and phosphates are moderately high; dissolved oxygen levels are sometimes low; biological oxygen demand is high; and chlorophyll measurements are the highest of all Curry County streams (Massingill 2001g).

Altered Hydrologic Function

The Winchuck River basin suffers from flow depletion and changes in peak flow related to watershed disturbance patterns. There have been no formal evaluations on the current flows in the Winchuck River, so the degree of any deficit in water amount is unknown. However, evidence suggests that such a deficit exists. The Winchuck River Watershed Council identified two issues relevant to this stress (Maguire 2001g). The Council recognized that "low summer flow results in elevated stream temperatures," and that "the cool water that used to go into the river from the tributaries is now being withdrawn." The relationship between the amount of water and the temperature of the water is well established, as are the problems with water temperature in many areas of the Winchuck.

Aerial photos and USGS topographic maps of the South Fork Winchuck River suggest a hydrologic disruption represented by a water storage reservoir near the mouth. The topographic map shows an intermittent stream above the confluence with the mainstem Winchuck River. The South Fork Winchuck River has the majority of high IP coho salmon habitat in the population area. If this reservoir is a barrier, it blocks juvenile and adult access to nearly all of the South Fork.

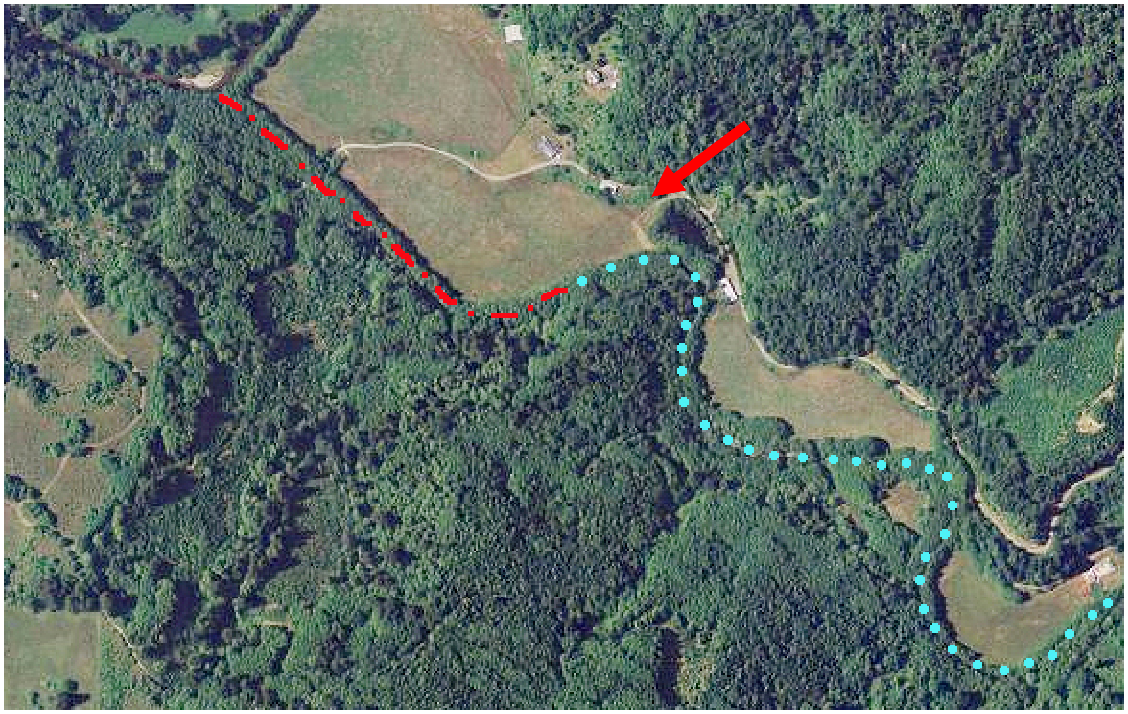

Figure 14-3. Aerial photograph from 2005. Photo shows the lower South Fork at its convergence with the Winchuck River. Blue dots indicate USGS (1966) topographic map stream lines (1:24000) with added red dashes and dots indicating presumed intermittent flow. Red arrow highlights the pond.

Degraded Riparian Forest Conditions

Little data upon which to quantitatively evaluate the riparian forest conditions in the Winchuck River basin exist. In 1996, the last year for which data were available, the percentage of the lower river basin which had large trees (>30 inches DBH) was very low, but the percentage with medium-sized trees (>20 inches DBH) was more favorable. Current conditions are highly altered compared to conditions prior to Anglo-American settlement. Ground and aerial photos indicate that the much of the lower mainstem and lower South Fork Winchuck riparian canopy has been simplified, decreased, and converted to hardwoods. Trees have been removed from riparian zones, creating narrow buffer widths and decreasing potential for large wood recruitment. The middle mainstem Winchuck River at its confluence with Elk and Salmon creeks has degraded riparian conditions (Figure 14-4). The mainstem and lower Elk Creek have narrow strips of riparian hardwoods with fields encroaching very close to the stream, while tributaries have narrow or no riparian buffers.

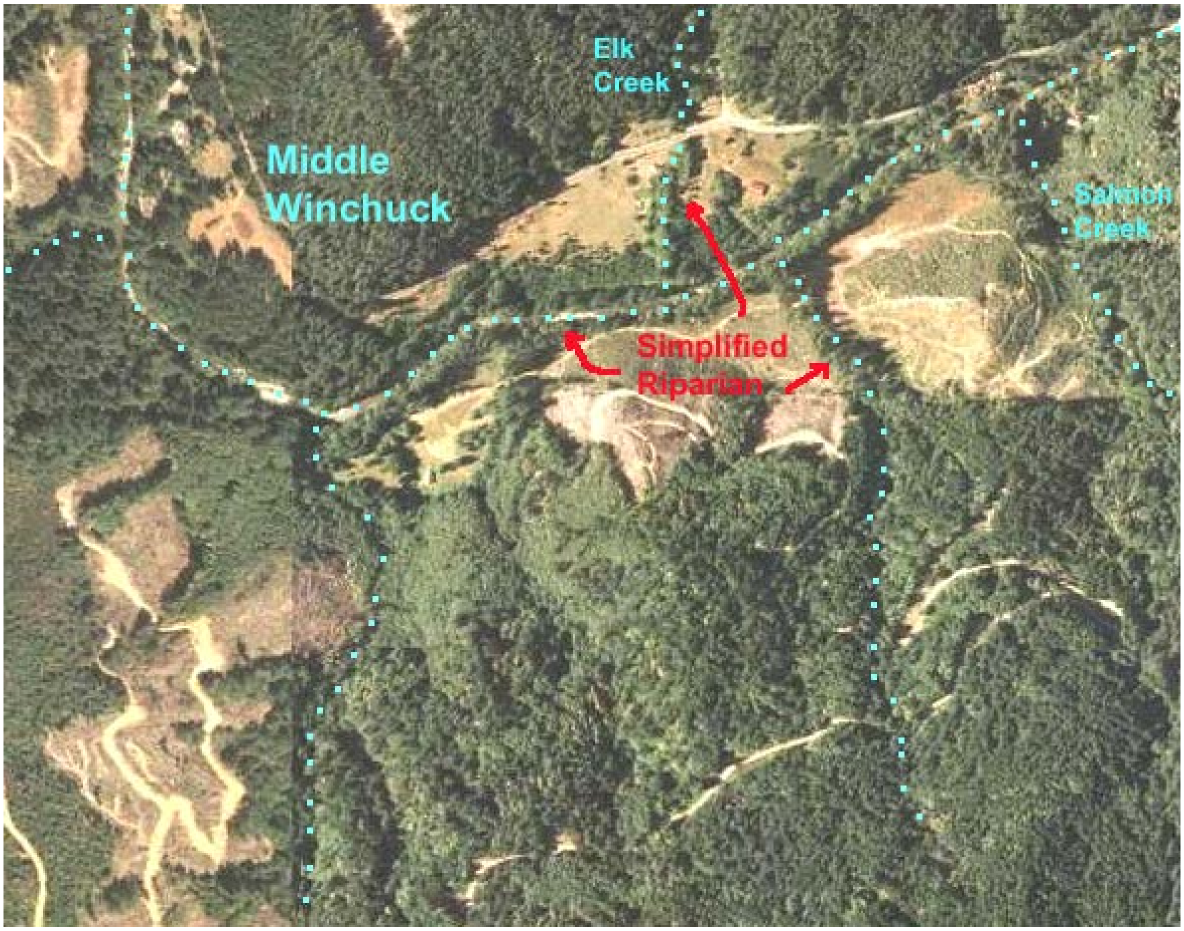

Figure 14-4. Middle mainstem Winchuck River. The confluence with Elk and Salmon creeks has a narrow riparian zone dominated mostly by hardwoods. Logging has left a very narrow buffer along tributaries and appears to come very near the stream at center left. Photo from 2005.

Altered Sediment Supply

Altered sediment supply poses an overall high stress to coho salmon in the Winchuck River. Sediment contribution from landslides and erosion occurs naturally in the Winchuck River basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. Excess fine sediment directly impacts coho salmon egg viability and can reduce food for fry, juveniles and smolts. Poor pool frequency and depth throughout the Winchuck River basin (Maguire 2001g) are likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and diminished scour due to channel widening in some reaches.

Figure 14-5. Aerial photo of the Winchuck River estuary from 2005. Photo shows that residential development has led to channelization and diminished riparian zone width.

Impaired Estuary/Mainstem Function

Impaired estuarine function poses a high stress to coho salmon. The Winchuck estuary was historically small, and much of the estuarine habitat that did exist has been diked and filled Figure 14-5). Numerous roads have been built on the floodplain, and the Winchuck River Road blocks access to estuarine tributaries. Historic channels have been blocked, and the mainstem is now confined, with little off-channel habitat. The lower part of the estuary does have some seasonal rearing potential downstream of Highway 101.

Maguire (2001g) identified wetland areas in the Winchuck River basin. All but one occurred in the same areas associated with high IP coho salmon habitat. Eighty eight percent of the identified wetland area was described as moderately to highly altered. Sixty nine percent of the wetland area has some degree of connection to a stream, although the degree of connectivity that historically occurred was likely much greater than currently observed.

Barriers

Ten barriers to migration have been identified in the lower Winchuck River (Massingill 2001g), but most block access to small, steep tributaries that are mostly unsuitable for coho salmon. However, access to even short reaches of these tributaries is desirable because they are cool and can provide refuge for coho salmon juveniles when mainstem temperatures are warm. As noted in the Hydrologic Function section, intermittent flows appear to exist in the lower reach of the South Fork Winchuck, which is likely a migration barrier for juveniles in summer. The overall stress score for Winchuck River barriers basin-wide is medium.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Winchuck River population area. Hatchery-origin coho salmon may stray into the Winchuck River, but hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

Adverse Fishery-Related Effects

NMFS has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

14.6 Threats

Table 14-3. Severity of threats affecting each life stage of coho salmon in the Winchuck River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Channelization/Diking	Medium	High	High	High	Medium	High
2	Urban/Residential/Industrial	Low	High	High	High	Medium	High
3	Dams/Diversion	Low	High	High	High	Medium	High
4	Agricultural Practices	Low	High	High	Medium	Low	Medium
5	Timber Harvest	Low	High	High	Medium	Low	Medium
6	Roads	Low	High	High	Medium	Low	Medium
7	Invasive Non-Native/Alien Species	Low	High	High	Medium	Low	Medium
8	High Intensity Fire	Low	Medium	Medium	Medium	Low	Medium
9	Mining/Gravel Extraction	Low	Medium	Medium	Medium	Low	Medium
10	Climate Change	Low	Low	Low	Low	Low	Low
11	Road-Stream Crossing Barriers	-	Low	Medium	Low	Medium	Medium
12	Hatcheries	Low	Low	Low	Low	Low	Low
13	Fishing and Collecting	-	-	-	-	Low	Low

Channelization/Diking

Channelization and confinement of a river occur when a stream is controlled and re-directed so that nearby fertile lands can be used for agriculture or residential development, or a road can be built. As described under the floodplain and channel structure stress, there is evidence of extensive modification of the Winchuck River, especially in areas which once provided critically important juvenile rearing habitat for coho salmon.

Urbanization/Residential/Industrial

Although only four percent of the basin is utilized for activities other than forestry (Maguire 2001g), development in that small area occurs in the areas which are critical for juvenile rearing of coho salmon. Residential development has already occurred in the floodplain and estuary, which will inhibit efforts to restore natural channel processes. Domestic water consumption is the pre-dominant use for most of the water rights in the basin, which will only increase if there are increases in residential development (Maguire 2001g).

Dams and Diversions

Diversions for agriculture and residential purposes are creating a deficit in the amount of water available in the river, which in turn presents a threat to coho salmon and their recovery. There is one particular diversion which is of great concern because it restricts coho salmon movement. In the lower South Fork Winchuck River, an agricultural diversion is thought to cause intermittent flow that seasonally blocks access.

Agricultural Practices

Agricultural activity occurs in the lower mainstem area, one of the few segments with high IP coho salmon habitat in the basin. Use of the land for agriculture has perpetuated the impaired riverine conditions that began with logging in the 1800s. The river has been channelized and disconnected from its floodplain, and growth of riparian vegetation has been prevented. Maguire (2001g) identified the land use occurring within 500 feet of the wetlands in the Winchuck River, and determined 27 percent of these wetlands were bounded by agriculture. In addition, the great majority of water diverted from the Winchuck River under out-of-stream water rights is allocated for irrigation.

Timber Harvest

Timber harvest on public land has greatly diminished, but harvest remains active on private land in the South Fork Winchuck, middle mainstem Winchuck River, and upper Bear Creek, including areas with high IP coho salmon habitat. The South Fork Winchuck River watershed is intensively harvested with some areas in their third rotation (Maguire 2001g). Recent aerial photos confirm that harvest rates remain high (Figure 14-6). Although active timber harvest is not occurring in most of the basin, active harvest in the South Fork Winchuck River, which contains more than half of the high IP coho salmon in the basin, makes this threat of great concern to coho salmon recovery. Active harvest in this watershed may also contribute to the deficit of water in the stream.

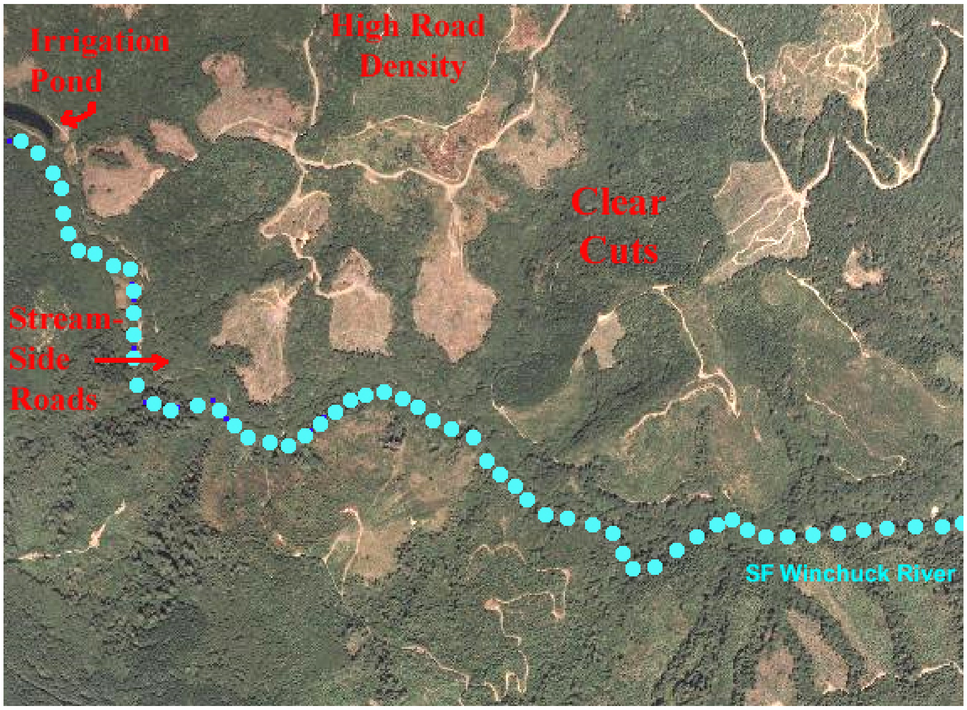

Figure 14-6. South Fork Winchuck aerial photo. This 2005 image shows widespread clear cuts, dense road networks, including stream side roads, and an irrigation impoundment. Photo from Terra Server.

Roads

Road densities are relatively low in most basins, with only the Wheeler Creek basin exceeding thresholds recognized as impaired.

Invasive Species

Japanese knotweed (*Polygonum cuspidatum*) has spread into the lower Winchuck River (ODFW 2008b). Japanese knotweed is aggressive, fast growing, and out-competes native vegetation in riparian areas. Scotch broom and gorse are also locally common and similarly invasive. If these plants replace conifers or hardwoods in riparian zones, coho salmon habitat will be substantially impacted.

High-Intensity Fire

The Winchuck River is very near the coast and has moderate air temperatures and high rainfall. However, Maguire (2001g) points out that autumnal winds may elevate fire risk because they are associated with extreme high temperatures (>100° F) and high wind speeds (>35 mph) that can create extreme fire hazard conditions. Presence of hardwood stands and even aged plantations following logging may also be more at risk of catastrophic fire than the older, uneven aged forest stands they replaced.

Mining

There are two remaining mining claims in the Winchuck River basin: North Fork Wheeler Creek Mine and Mt. Emily Mine (Maguire 2001g). There is currently no known significant threat posed by these mining operations.

Climate Change

Because of the proximity of the Winchuck River basin to the coast, only a minimal increase in air temperature is projected for the years 2030 to 2050. The temperature is predicted to rise by less than 0.5 C in July, and between 0.5 and 1.5 C in January. . The latter trend could reduce snow pack in higher elevations, diminishing this source of cold water for coho salmon juvenile rearing. Sea level rise could expand the estuary and the footprint of tidal wetlands, which could potentially benefit coho salmon.

Road-Stream Crossing Barriers

Road-stream crossing barriers are not a significant threat to coho salmon in the Winchuck River based upon the lack of known barriers that exist in the watershed. Given the amount of logging that has occurred in the watershed and the density of roads in the lower watershed, many partial or total barriers have yet to be identified on private land. Based on the projected population growth in this area, an increase in road-stream crossings is not likely unless timber harvest rates increase and logging resumes in roadless areas.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Winchuck River population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook-directed fisheries. The exploitation rates associated with this freshwater fishery and all other fisheries managed by the State of Oregon were found to be low enough to avoid jeopardizing the existence of the ESU (NMFS 1999). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because recovery objectives to achieve species viability had not been established for SONCC coho salmon at that time (NMFS 1999). As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in the Winchuck River.

14.7 Recovery Strategy

The most important factor limiting recovery of coho salmon in the Winchuck River is a deficiency in the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by increasing channel complexity and restoring flow. Channel complexity would be improved by constructing off-channel ponds or backwater habitat; restoring wetlands; moving levees; or limiting development and fill. To increase instream structure, LWD should be added where the channel is stable to provide structure until natural sources of LWD (mature coniferous forests) are re-established next to the stream. Restoration of sufficient water may require changes in water use and allocation.

The most immediate need for habitat restoration and threat reduction in the Winchuck River is in those areas currently occupied by coho salmon, which are identified in this profile. Unoccupied areas must also be restored to provide enough habitats to allow for coho salmon recovery. Efforts should be focused upon those areas with the most potential to support coho salmon (IP habitats) in the lower mainstem Winchuck River, South Fork Winchuck River, and Moser Creek

Table 14-4 on the following page lists the recovery actions for the Winchuck River population.

Table 14-4. Recovery action implementation schedule for the Winchuck River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.2.2.5	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Lower mainstem, South Fork, and Estuary (in particular areas south of Highway 101)	3
SONCC-WinR.2.2.5.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-WinR.2.2.5.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-WinR.2.2.6	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	3
SONCC-WinR.2.2.6.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-WinR.2.2.6.2	*Implement beaver program (may include reintroduction)*					
SONCC-WinR.2.1.7	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Lower mainstem, South Fork, and Estuary	3
SONCC-WinR.2.1.7.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-WinR.2.1.7.2	*Place instream structures, guided by assessment results*					
SONCC-WinR.2.1.31	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2
SONCC-WinR.2.1.31.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-WinR.2.1.31.2	*Place instream structures, guided by assessment results*					
SONCC-WinR.10.2.15	Water Quality	Yes	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-WinR.10.2.15.1	*Develop an educational program that teaches to reduce channel encroachment, reduce usage of toxic chemicals, maintaining septic systems, water conservation, and landscaping with native species.*					
SONCC-WinR.10.2.16	Water Quality	Yes	Reduce pollutants	Set standard	Population wide	2
SONCC-WinR.10.2.16.1	*Develop TMDLs for 303(d) listed water bodies*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.1.2.30	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-WinR.1.2.30.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-WinR.1.2.30.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-WinR.16.1.17	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-WinR.16.1.17.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-WinR.16.1.17.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-WinR.16.1.18	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-WinR.16.1.18.1	*Determine actual fishing impacts*					
SONCC-WinR.16.1.18.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-WinR.16.2.19	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-WinR.16.2.19.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-WinR.16.2.19.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-WinR.16.2.20	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-WinR.16.2.20.1	*Determine actual impacts of scientific collection*					
SONCC-WinR.16.2.20.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-WinR.3.1.8	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	3
SONCC-WinR.3.1.8.1	*Determine instream flow needs for coho salmon*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.3.1.8.2	*Measure streamflow hourly by establishing a USGS gaging station.*					
SONCC-WinR.3.1.8.3	*Maintain USGS gaging station*					
SONCC-WinR.3.1.8.4	*Perform a groundwater study to determine the volume of aquifer storage and the role of aquifers in streamflow*					
SONCC-WinR.3.1.9	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-WinR.3.1.9.1	*Provide incentives and education to landowners to reduce water consumption and reduce groundwater pumping and surface water diversion by utilizing conservation and storage.*					
SONCC-WinR.3.1.10	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Lower basin	BR
SONCC-WinR.3.1.10.1	*Develop regulatory mechanisms to ensure a flow of 20 CFS is maintained in summer months*					
SONCC-WinR.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-WinR.27.1.21.1	*Perform annual spawning surveys*					
SONCC-WinR.27.1.22	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-WinR.27.1.22.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-WinR.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-WinR.27.1.23.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-WinR.27.2.24	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-WinR.27.2.24.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-WinR.27.2.24.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-WinR.27.2.25	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.27.2.25.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-WinR.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-WinR.27.2.26.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-WinR.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-WinR.27.2.27.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-WinR.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-WinR.27.2.28.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-WinR.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	Estuary	2
SONCC-WinR.27.2.29.1	*Identify habitat condition of the estuary*					
SONCC-WinR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-WinR.27.1.33.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-WinR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-WinR.27.2.34.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-WinR.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-WinR.27.1.35.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-WinR.27.1.35.2	*If appropriate, modify population types and targets using revised methodology*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-WinR.27.1.36	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Evaluate the potential to restore extirpated independent populations	Population wide	3
SONCC-WinR.27.1.36.1		*Evaluate the potential to restore extirpated independent populations*				
SONCC-WinR.5.1.11	Passage	No	Improve access	Provide artificial passage	Confluence of mainstem and South Fork	2
SONCC-WinR.5.1.11.1		*Determine whether the water storage reservoir is a full or partial barrier to coho salmon and develop a plan to provide passage*				
SONCC-WinR.5.1.11.2		*Restore passage, guided by the plan*				
SONCC-WinR.5.1.12	Passage	No	Improve access	Remove barriers	Estuarine tributary crossings at Winchuck River Road	BR
SONCC-WinR.5.1.12.1		*Assess and prioritize barriers. Develop a plan for removal*				
SONCC-WinR.5.1.12.2		*Remove barriers, guided by the plan*				
SONCC-WinR.7.1.1	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	South Fork, East Fork, Fourth of July, and Bear creeks, Upper mainstem Winchuck River just below the East Fork, Estuary	2
SONCC-WinR.7.1.1.1		*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*				
SONCC-WinR.7.1.1.2		*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat and wetlands*				
SONCC-WinR.7.1.2	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Privately held timber lands	2
SONCC-WinR.7.1.2.1		*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*				
SONCC-WinR.7.1.3	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Upper Bear Creek and South Fork	3
SONCC-WinR.7.1.3.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-WinR.7.1.3.2		*Thin, or release conifers, guided by prescription*				
SONCC-WinR.7.1.3.3		*Plant conifers, guided by prescription*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WinR.7.1.4	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Rangeland	BR
SONCC-WinR.7.1.4.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-WinR.7.1.4.2	*Develop grazing management plan to meet objective*					
SONCC-WinR.7.1.4.3	*Plant vegetation to stabilize stream bank*					
SONCC-WinR.7.1.4.4	*Fence livestock out of riparian zones*					
SONCC-WinR.7.1.4.5	*Remove instream livestock watering sources*					
SONCC-WinR.7.1.32	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	BLM lands	3
SONCC-WinR.7.1.32.1	*Manage timber harvest (and associated activities) on Federal lands in accordance with the Aquatic Conservation Strategy of the NWFP to achieve riparian and stream channel improvements for coho salmon*					
SONCC-WinR.8.1.13	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	USFS land	BR
SONCC-WinR.8.1.13.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-WinR.8.1.13.2	*Decommission roads, guided by assessment*					
SONCC-WinR.8.1.13.3	*Upgrade roads, guided by assessment*					
SONCC-WinR.8.1.13.4	*Maintain roads, guided by assessment*					

15. Smith River Population

- Central Coastal Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 6,800 Spawners Required for ESU Viability
- 762 mi^2
- 325 IP km (202 mi) (23% High)
- Dominant Land Uses are Agriculture and Timber Harvest
- Principal Stresses are ‘Impaired Estuary/Mainstem Function’ and ‘Lack of Floodplain and Channel Structure’
- Principal Threats are ‘Roads’ and ‘Channelization/Diking’

15.1 History of Habitat and Land Use

Over the past 120 years, land use has changed less in the Smith River than in many other California watersheds, but changes have still occurred and have affected instream habitat and anadromous fish throughout the area. While most of the upper watershed remains fairly pristine and unaffected by human activities, the areas that have been impacted are in the lower Smith River, where the greatest potential to support coho salmon exists. Human activities that have affected habitat in the Smith River include logging; road building; urbanization; placer, hard rock, and gravel mining; flood control (e.g., levees and tide gates); ranching; and pesticide use. Agriculture in the lower watershed and around the estuary has been, and continues to be the greatest contributor to loss and degradation of coho salmon habitat.

The Lake Earl Watershed may have at one time been connected to the Smith River. However, it is unlikely that there has been any connection in recent history. The Lake Earl Watershed was considered part of the Smith river population in Williams *et al*. (2008). Therefore, the Lake Earl Watershed was removed as part of the Smith river population.

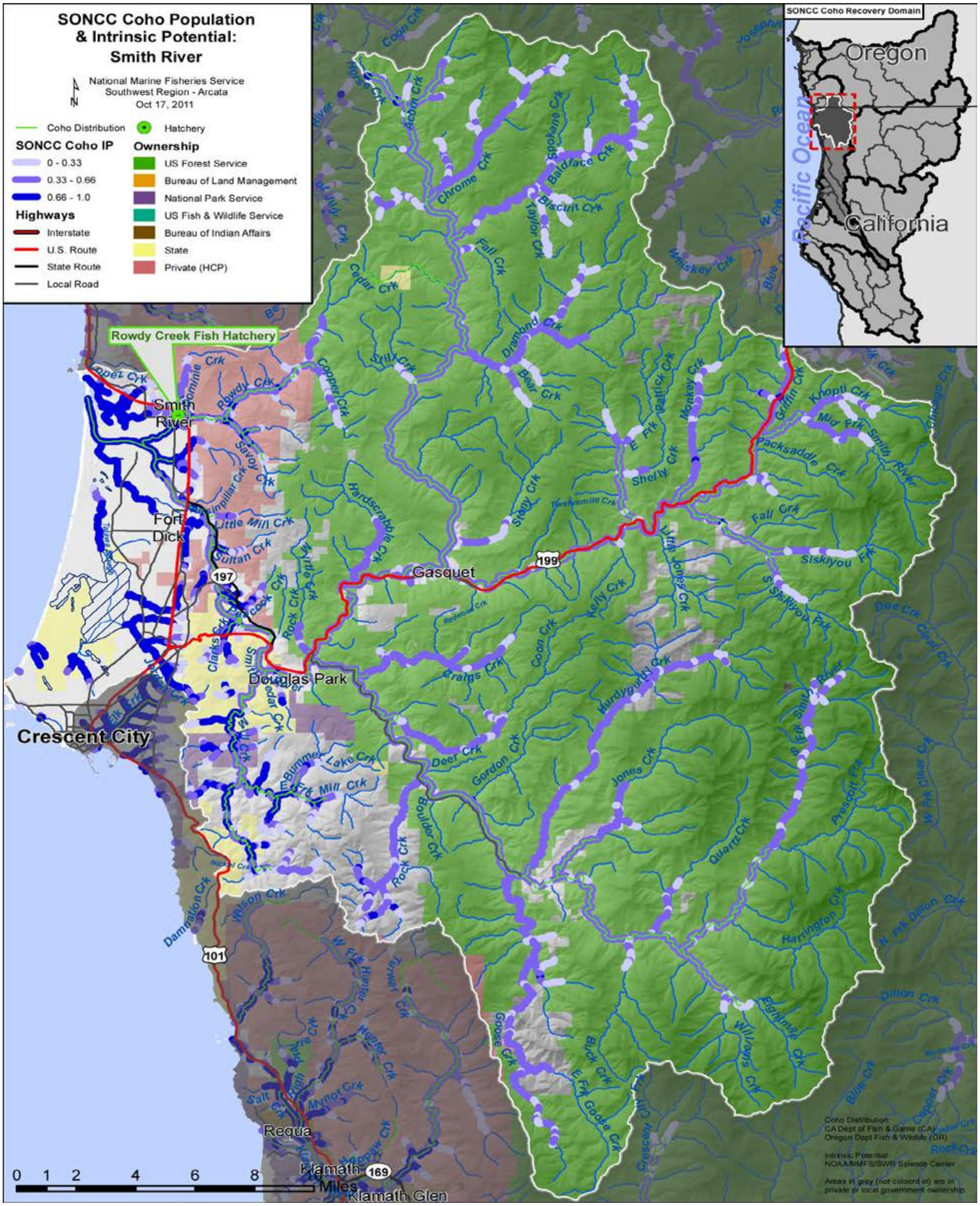

Figure 15-1. The geographic boundaries of the Smith River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Land ownership consists of large holdings of private land in the coastal plain, while a majority of the middle to upper watershed is public lands. Much of the private land has been under intensive land uses for the past 100 years and efforts have begun to purchase available property to protect salmonid populations. Rowdy Creek occurs in the lower watershed and is mostly in private ownership, while Mill Creek, another tributary with high IP, is now almost entirely under public ownership since the State Park acquired 25,000 acres of the watershed in 2002. With the exception of small-developed areas near the communities of Fort Dick, land uses in the floodplain are primarily agricultural.

The estuary and lower river have been modified to expedite navigation, transportation, logging, and agriculture. These modifications include diking, channelizing, removing woody debris, removing riparian vegetation, and dredging. Over 40 percent of the estuary has been converted for agricultural uses (Quinones and Mulligan 2005). Large scale, channel-altering floods in 1955 and 1964 added to the loss of habitat in the Smith River by decreasing pool depths, altering channel morphology, and increasing sediment deposition. Overall, these changes greatly reduced habitat diversity and instream cover complexity in the lower river and estuary (McCain et al. 1995).

In the 1940s, most agriculture in the watershed was dairy farming. In the 1950s and 1960s, flower bulb production and other industrial agricultural uses began. By 1970, irrigated pastures and lily bulb farms covered about 4,000 acres on the coastal plain. Today, this area produces 90 percent of the lily bulbs in the United States. The production of lily flowers and bulbs requires pesticide use to control nematodes and diseases, which can impact salmonids.

While agricultural use and rural development have increased to some extent, logging in this watershed has decreased. Like most areas along the coast, timber harvest peaked in the mid-1900s and has decreased over the past 50 years. The effects of past timber harvest in the Smith River watershed continue to impact habitat through increased sedimentation from roads or road-related erosion and reduced recruitment of large wood into the river. Satellite images from 1994 to 1998 show that large sections of forested land in the mid to upper Smith River watershed have undergone significant decreases in forest canopy-cover. Decreases in canopy cover are likely from timber harvesting and forest fire. In the last ten years, this region has experienced a dramatic increase in forest fires that have been exacerbated by higher seasonal temperatures, drought, increased forest fuels (e.g., brush and other understory), and camping-related accidents.

Logging-related erosion, along with debris from hydraulic mining, which began in the area in the 1860s, are thought to be major contributors of continued sediment loading in the Smith River. High gradients throughout the watershed along with high road densities have led to frequent mass-wasting events, which have further added to sediment loads. According to aerial photography analysis, there have been over a thousand landslides in the Smith River watershed, including hundreds over 200 feet wide (McCain et al. 1995; California Department of Fish and Game (CDFG) 1980). These episodic mass-wasting events deliver large amounts of sediment into streams, and high volumes of water washes the sediment downstream.

Although many of the destructive land use practices that once occurred in the area have ceased, their legacy in the Smith River results in an altered sediment supply, impaired water quality, a lack of floodplain and channel structure, and altered estuarine function. The presence of numerous fish passage barriers also impedes spawning and rearing potential in many streams. The majority of poor habitat conditions exists in the Smith River Plain and overlap with areas of high IP value.

15.2 Historic Fish Distribution and Abundance

The Smith River is the largest watershed in the Central Coastal Stratum includes five large tributaries: Rowdy Creek, Mill Creek, and the North Fork, South Fork, and Middle Fork of the Smith River. Although the watershed extends 32 miles inland, the tributaries with the highest intrinsic potential (>0.66) are located completely within the lower 6 miles of the watershed (Figure 15-1).

The distribution of coho salmon is generally limited by the steep channel reaches caused by the Siskiyou Mountains that lie approximately 6 miles from the coast. Forty percent of this watershed is known to be sloped at over 50 percent gradient (Bartson 1997), and does not support coho salmon. Coho salmon are believed to extend throughout the majority of lower tributaries and use middle and upper tributaries to a lesser extent because of the species' preference for inclines less than 3 percent (Bjornn and Reiser 1991). Middle and upper reaches have a significant amount of moderate IP habitat (0.33 to 0.66) and can support coho salmon rearing. Studies conducted in the Smith River from 1979 to 2002 show that nearly all of the tributaries in the lower river were occupied by coho salmon (Jong et al. 2008). The South Fork Smith River has a low gradient, is fully accessible, and is used by spawning coho salmon. Coho salmon have also been observed in a number of tributaries in the North Fork Smith River.

Data from the Smith River indicates that run sizes in this area were large and could have been on the order of more than 7,000 returning adult coho salmon (National Marine Fisheries Service (NMFS) 2006). By 1965, CDFG estimated an escapement of 5,000 and by 1991 escapement was down to just over 800 (NMFS 2005a).

Available information suggests a decline in anadromous salmonid populations of the Smith River; however due to the anecdotal nature of early information, there is little basis for determining the extent of the decline. Observations of the Smith River and its fisheries prior to 1935 were not recorded and subsequent observations were infrequent. A cannery that operated on the Smith River in the late 1800s provides records that indicate the harvest of all salmon species combined between 1893 and 1897 was typically over 50 tons annually (Bartson 1997). There is no way to discern what proportion of this catch was coho salmon, but presumably there was once a thriving run in the accessible tributaries of the Smith River. Rowdy Creek, a tributary of the lower river, supported large runs of anadromous fish (California Assembly 1961) prior to extensive human influences especially logging. Mill Creek, a tributary of the lower river located several miles upstream from Rowdy Creek, has also been a highly productive tributary.

Table 15-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Subarea	Stream Name	Subarea	Stream Name
Smith River Plain	Tolowa Slough	**Mill Creek[1]**	W. Branch Mill Creek[1]
	Ritmer Creek		Bummer Lake Creek[1]
	Morrison Creek[1]		East Fork Mill Creek[1]
	Little Mill Creek[1]	**North Fork[2]**	Horse Creek
	Peacock Creek[1]	**South Fork[1]**	Rock Creek
	Clarks Creek[1]		Goose Creek
	Tryon Creek	**Middle Fork[1]**	Siskiyou Fork[2]
	Tillas Slough		Griffin Creek[1]
	Sultan Creek[1]	**Rowdy Creek[1]**	S. Fork Rowdy Creek[1]
			Dominie Creek[1]
			Savoy Creek[1]

Current estimates of the abundance and distribution of the Smith River coho salmon population are unknown for the watershed as a whole. However, there is a long-term data set beginning in 1994 that documents salmon abundance in the West Branch and East Fork Mill Creek (McLeod and Howard 2010) In addition Scriven (2001) conducted a juvenile coho salmon distribution study throughout the Smith River watershed. Within West Branch of Mill Creek, adult coho salmon spawner counts have ranged from a high of 175 to a low of three between 1994 and 2009 with decreases in numbers seen in more current years (McLeod and Howard 2010). Estimates of total coho salmon spawners from these watersheds are unknown.

Downstream migrant traps operated on the East Fork and West Branches of Mill Creek from 1994 to 2000 showed numbers of outmigrating smolts ranged from zero to 1,500 with one brood lineage having slightly higher numbers than the other (Albro and Gray 2002). Work by Scriven in 1994 showed that juvenile densities range from 3,905 juveniles/km in West Branch of Mill Creek to 245 per kilometer in Rowdy Creek and 63 per kilometer in Patrick Creek (Scriven 2001). Although all studies indicate that Mill Creek has favorable spawning and rearing conditions for coho salmon and that productivity in this watershed is fairly high, it is far below carrying capacity as indicated by the fact that Hallock et al. (1952) was able to seine 60,602 juveniles from Mill Creek in 1951. Other tributaries where juvenile coho salmon have been found include lower tributaries such as Morrison Creek, Little Mill Creek, Sultan Creek, Peacock Creek, and Clarks Creek as well and upper tributaries including Shelley Creek, Rock Creek, and Jones Creek (Scriven 2001).

15.3 Current Status of Coho Salmon in the Smith River

Spatial Structure and Diversity

Juvenile and adult spawning surveys indicate that coho salmon in the Smith River population occur in many tributaries. Historically, coho salmon occurred in high densities in streams along the Smith River Plain including Mill Creek. Juveniles have been observed most often in Mill Creek, but have also been found further upstream in the watershed. Within the middle and upper watershed of the Smith River, coho salmon occurred at moderate to high densities in many tributaries in the North, South, and Middle Fork drainages. The majority of production appears to occur in Mill Creek where spawning coho salmon have been observed (Rellim Redwood Company 1994; Scriven 2001).

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 21 coho salmon per IP-km of habitat are needed (6,800 spawners total) to approximate the historical distribution of Smith River coho salmon and habitat. However, juvenile coho salmon do maintain a relatively large distribution in the Smith River (Scriven 2001; Jong et al. 2008).

Population Size and Productivity

If a spawning population is too small, the survival and production of eggs or offspring will suffer because it may be difficult for spawners to find mates or predation pressure is likely to be significant. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 325 coho salmon must spawn in the Smith River each year to avoid such effects of extremely low population sizes.

Assuming Mill Creek provides the best spawning habitat in the Smith River basin, recent surveys in Mill Creek (McLeod and Howard 2010) suggest that the total population size for the Smith River basin may be less than the moderate-risk threshold for this population and at a level that puts it at high risk of extinction. Total spawner counts in the Mill Creek watershed ranged from a low of 18 in 2007 to a high of 237 in 2005 based on surveys since 1994 (McLeod and Howard 2010). Assuming Mill Creek data is representative of the entire Smith River population, the coho salmon population is experiencing a decreasing population trend since 2005. Survey of coho salmon escapement estimates in West Branch Mill Creek, East Fork Mill Creek, and Mainstem Mill Creek are shown below (McLeod and Howard 2010).

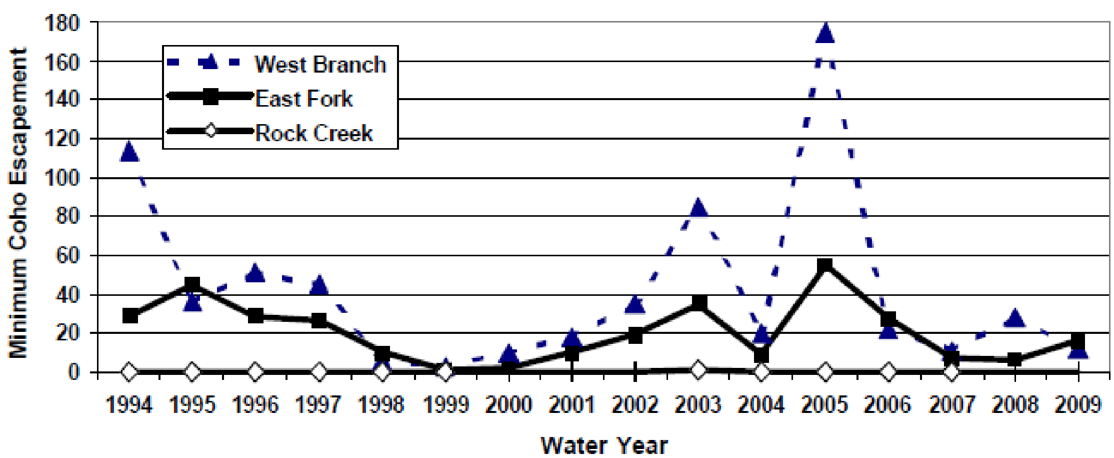

Figure 15-2. Coho escapement estimates. Data are for West Branch Mill Creek, East Fork Mill Creek and Rock Creek for 1994 to 2009 (McLeod and Howard 2010).

The Rowdy Creek Hatchery provides the longest running adult data collected by annual trapping on Rowdy Creek from October 1 through May 1 of every year. The following graph shows total adult coho salmon migrating upstream to Rowdy Creek Hatchery during spawning season from 1977 until 2010, with inconsistent survey efforts between years.

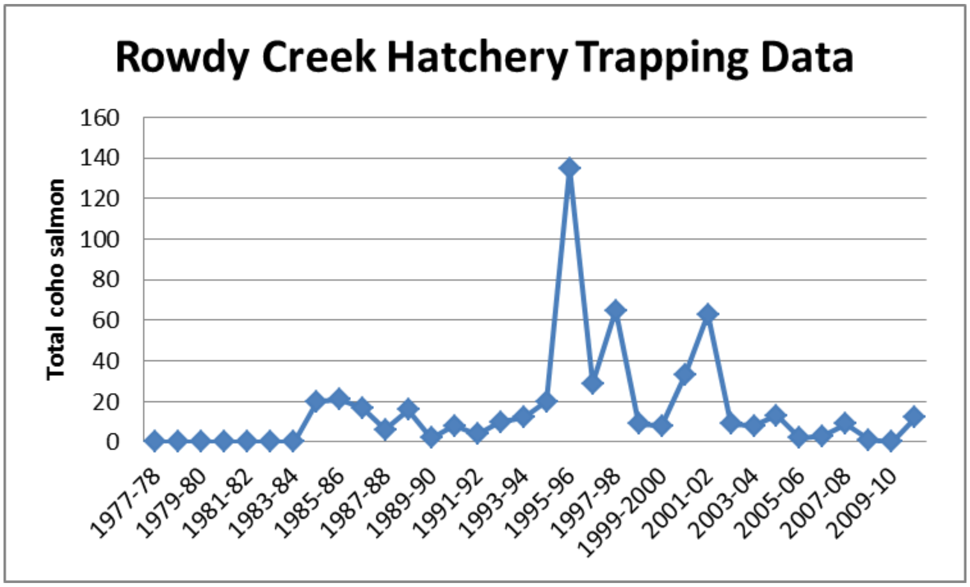

Figure 15-3. Rowdy Creek Hatchery Trapping Data for 1977 to 2010 (Van Scoyk 2011).

Based on the IP-km modeled for the Smith River, the basin is far below its carrying capacity. Because of the low population abundance and productivity, the Smith River population is considered at high risk of extinction.

Extinction Risk

Recent spawning surveys in the Smith River watershed indicate that this population is likely below the depensation threshold (325 spawners). Therefore, it is at high risk of extinction based on the criteria established by Williams et al. (2008). Currently, the population is restricted to 37 tributaries within the Smith River watershed with the largest known spawning population in Mill Creek.

Role in SONCC Coho Salmon ESU Viability

The Smith River population is a “Functionally Independent” population within the Central Coastal diversity stratum, meaning that it was sufficiently large to be historically viable-in-isolation and has demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005; Williams et al. 2006). Any straying that does occur into the Smith River population likely occurs because of the number of large populations in close proximity along the coast. As a core population, the recovery target for the Smith River population is to be at low risk of extinction and have more than 6,800 spawners annually.

15.4 Plans and Assessments

U.S. Forest Service, Six Rivers National Forest Assessments

The Six River National Forest has prepared a number of assessments for lands within the Smith River drainage, including:

- The South Fork Smith River Sediment Source Assessment (2003) to evaluate sediment production trends and identify sites for mitigation such as tree planting or toe treatments.
- Smith River ecosystem analysis: Basin and subbasin analyses and late successional reserve assessment (McCain et al. 1995) with recommendations for improving salmon populations, with a focus on upgrading and storm proofing roads and upgrading culverts.
- Roads Analysis and Off-Highway Vehicle Strategy (USFS 2005a) to develop road and OHV management recommendations.

Green Diamond Resource Company (GDRC)

Green Diamond Habitat Conservation Plan (HCP)

The Green Diamond HCP (GDRC 2006) outlines a plan for the conservation of aquatic species in select watersheds in the Smith River. Approximately 25 percent of private land in the Smith River watershed is owned by Green Diamond and managed according to the provisions of the HCP. The plan was developed in accordance with the ESA section 10 regulations, which require Green Diamond to develop a conservation strategy to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to Green Diamond's activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species. The plan has a number of provisions designed to protect coho salmon and salmon habitat throughout the company's land in the watershed.

Redwood National and State Parks

General Plan Amendment and Environmental Impact Report for Del Norte Coast Redwood State Park-Mill Creek Addition

Redwood National and State Parks (RNSP) manages a significant amount of land in the Smith River Watershed, including some of the most important coho habitat in Mill Creek. The RNSP has completed a number of restoration projects on their lands including the installation of LWD structures, road decommissioning, and second growth timber management to release conifers.

California Department of Fish and Game

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004. Priority actions in the Recovery Strategy for the Smith River HU include barrier removal, floodplain and channel restoration, estuarine slough and wetland restoration, and study of the impacts of the Rowdy Creek hatchery steelhead on coho salmon.

Smith River Advisory Council (SRAC)

Smith River Anadromous Fish Action Plan (SRAFAP)

In 2002, the Smith River Advisory Council was funded by the Fisheries Restoration Grant Program to publish the SRAFAP, which identified specific actions and funding sources to improve anadromous fish habitat throughout the Smith River basin. The recommendations included decommissioning roads, replacing culverts, planting riparian vegetation, and monitoring. The Plan encourages collaborative involvement and monitoring.

Smith River Project
http://www.bardicmedia.com/smith/index.shtml

Smith River Flood Plain Pesticide Aquatic Ecological Exposure Assessment

Prepared for The Smith River Project by the Center for Ethics and Toxics, the assessment identified high pesticide use in the approximately 11-square-mile area of the Smith River floodplain. The second part of this study found that levels of use exceeded the federal government's established level of concern for endangered aquatic organisms for four of five pesticides studied.

Smith River Fisheries and Ecosystem Report (1997)

Prepared by the Institute for River Ecosystems at Humboldt State University, the Smith River Fisheries and Ecosystem Report summarizes a detailed history and overview of the Smith River along with trends in fisheries and habitat, and a proposed restoration strategy.

Natural Resources of Lake Earl and the Smith River Delta

This report, written by Monroe et al. (1975), identifies specific resources and land uses in the Lake Earl and Smith River Plain; issues in these areas, and recommends courses of action needed to insure resource protection.

Mill Creek Fisheries Monitoring Program

Monitoring for anadromous fishes have been conducted in Mill Creek.

Snorkel surveys for juvenile coho salmon in tributaries to the Smith River, California

A graduate student from Humboldt State University assessed the distribution of juvenile coho salmon in the Smith River for his M.S. thesis (Scriven 2001).

North Coast Salmonid Conservation Assessment

The North coast Salmonid Conservation Assessment provides specific recommendations for improving riparian habitat in the lower Smith River and estuary, encouraging collaborative efforts to remove existing and potential fish barriers, and developing monitoring studies.

Smith River Alliance (SRA)

Save-the-Redwoods League

Siskiyou Land Conservancy

Rural Human Services

Western Rivers Conservancy

15.5 Stresses

Table 15-2. Severity of stresses affecting each life stage of coho salmon in the Smith River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Impaired Estuary/Mainstem Function[1]	-	Low	Very High[1]	Very High	Medium	High
2	Lack of Floodplain and Channel Structure[1]	Medium	High	High[1]	High	Medium	High
3	Impaired Water Quality[1]	Low	High	High[1]	High	High	High
4	Barriers	-	Medium	High	High	Medium	High
5	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
6	Altered Sediment Supply	Medium	Medium	Low	Low	Medium	Medium
7	Degraded Riparian Forest Conditions	-	Medium	Medium	Medium	Low	Medium
8	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
9	Increased Disease/Predation/Competition	Low	Medium	Medium	Low	Low	Low
10	Altered Hydrologic Function	Low	Low	Low	Low	-	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Although habitat quality in the middle and upper parts of the basin have not been heavily impacted by land use, many areas in the lower parts of the Smith River and the Smith River estuary are creating limitations on the survival and viability of the Smith River coho salmon population. Degraded estuarine habitat conditions, lack of floodplain and channel structure are the limiting stressors for the population overall, and are most affecting the juvenile life stage. Overall, lack of access to, and decrease in the quantity of high quality winter (Stillwater Sciences 2006) and summer rearing habitat is limiting juvenile survival, and the estuarine rearing life history trait historically found in the population is limited by the degraded conditions in the Smith River estuary. Additionally, the high pesticide use associated with agriculture in the Smith River Plain adjacent to streams and drainages that enter the Smith River Estuary may be affecting the survival of coho salmon.

The majority of refugia habitat in the Smith River occurs in the lower and middle reaches of the watershed, which currently is being affected by agricultural practices and degraded habitat quality. There are also several tributaries in the middle and upper watershed that are known to support coho salmon and likely provide good rearing habitat and refugia from poor water quality in the lower river, both of which are considered vital habitat for the Smith River coho salmon population.

Of particular importance are the five tributaries to the Smith River that flow into the estuary: Rowdy Creek, Ritmer Creek, Delilah Creek, Yontocket Slough, and an unnamed creek. Tributaries and sloughs near the estuary provide vital habitat for juveniles and fry that are swept downstream during high flow events. This habitat increases survival of juveniles, which increases overall productivity and life history diversity of this population. The juveniles in these streams may express an estuarine life history pattern for rearing. Given the high flows and steep conditions found in the middle and upper Smith River watershed, low gradient tributaries near the estuary likely contributes to the success and continued survival of coho salmon in the Smith River. The lower Smith River and its tributaries are critical to the recovery of coho salmon in the Smith River (Frissell 1992). Therefore, the continued degradation of these habitats has a large impact on the entire population. Further upstream, refugia areas with good water quality are likely to be available in most cases, but are not always accessible or usable due to high gradients and barriers. These most likely occur where cold, clean water comes in from tributaries and where groundwater emerges into the stream.

Impaired Estuarine Functions

This stress refers to just the estuary conditions in the Smith River, since this is a single population basin (see Chapter 3 for further description of this stressor).

The estuary is important to the growth and survival of coho and any change or loss of access to estuarine habitat can severely affect the productivity of the population. Overall, the ability of the estuary to provide foraging and refuge opportunities is diminished and estuarine function is limited by existing modifications of the floodplain and channel. Impaired estuarine function is a high threat to juveniles and smolts in the population. A combination of factors has led to a severely degraded estuarine function in the Smith River.

There are several estuary sloughs which contribute valuable rearing habitat for coho salmon, but much of the historic tidal wetland habitat (>70 percent) and nearly all the historic tidal channels have been lost to agricultural and rural development through diking, dredging, the presence of tide gates, and filling. Approximately 40 percent of Smith River estuarine surface area was reduced between 1856 and 1966 (Quinones and Mulligan 2005). Dikes and levees along the channel prevent natural flow and change sediment and wood delivery in and out of the estuary. Behind the levees, filling of the estuary reduces functional rearing and refugia habitat and prey production. Sediment accumulation in accessible estuary areas restricts and simplifies channel habitat by decreasing pool and wetland depths and influencing the distribution and abundance of prey populations such as macro-invertebrate and benthic plankton. Overall, the Smith River estuary has limited cover, especially in the lower reach of the estuary (Quinones and Mulligan 2005). Cover, especially coarse woody debris contributes to estuarine function and habitat value (Koski 2009).

Lack of Floodplain and Channel Structure

The Smith River is degraded from a lack of large woody debris, an accumulation of sediment, levees, and a simplified floodplain and channel structure, which is considered a high threat to the Smith River population. This lack of floodplain and channel structure decreases, pool quality and depth, and off channel habitat, which causes a lack of suitable summer and winter rearing habitat for juveniles. Fry, juveniles, and smolts are impacted by lack of floodplain and channel structure because these life stages depend heavily on complex instream habitat and off-channels rearing habitat. Habitat surveys in Rowdy Creek found an average of only 3.5 large wood pieces per 100 feet of recruitment zone (GDRC 2006) and in some upper reaches of Chrome and Spokane Creeks, large woody debris frequency was rated as poor (<1.5 USFS rating). In a related dataset, pool frequency in some of these upper reaches was also rated as fair (10 to 20 percent by area) and pool depths were found to be less than 3 feet, which is thought to be a suitable depth for use by both juveniles and adults.

Other reaches lower in the watershed were rated as having very good (>35 percent) pool frequency and pool depth in some reaches of Rowdy Creek, had average depths ranging from poor (<2 ft) to very good (>3.3 ft). The lack of floodplain and channel structure affects egg and adult life stages because it reduces the quality and quantity of spawning gravel, changes the channel morphology and flow regime, and creates a lack of instream cover for juveniles. The lack of large woody structures and associated winter rearing habitat has been identified as a key limiting factor for juvenile coho salmon in the Smith River (GDRC 2006; Stillwater Sciences 2006). Tributaries in the lower Smith River and the estuary are particularly affected by a lack of floodplain and channel structure, and the lack of woody structures and floodplain connectivity in the estuary likely severely limits estuarine rearing.

Impaired Water Quality

Water quality in the Smith River is thought to be good in the middle and upper river, but compromised in the estuary and lower river where agricultural and rural road runoff is greatest and a restricted tidal prism prevents sufficient flows to flush sediment and pollutants. The contaminants of concern originate from point and non-point source pollution from farms, dairies, and septic systems that flow directly into the river. Of particular concern is the lily farming that occurs on the floodplain. One study showed that intense use of pesticides between 1996 and 2000 by lily farmers led to high levels of chemicals including carbofuran, chlorothalonil, diurin, disulfoton, and pentachloronitrobenzene. Recent testing in the lower Smith River has revealed copper concentrations that may have acute toxic effects and impair olfaction and reproduction of coho salmon (North Coast Regional Water Quality Control Board (NCRWQCB) 2011). The current level of chemical contamination is a high risk for juvenile salmonids (Bailey and Lappe 2002).

Water quality data including temperature and aquatic insect EPT and IBI provide an indication of water quality in the Smith River. These data show that temperature is generally good (<15 °C) with only isolated reaches in Mill Creek and the South Fork with fair or poor temperature (>17°C). Aquatic insect B-IBI NorCal, which is an indicator of stream health, was rated as good (60 to 80) in sampled locations along the mainstem Smith River from the mouth of Peacock Creek up into the North, Middle, and South Forks. Aquatic Invertebrate EPT on the other hand, indicated that there may be extensive pollutants in some tributaries. Samples from Jones Creek in the South Fork Smith River had a low (<12) number of taxa that may indicate the presence of pollutants in that stream. Other measurements in the upper watershed were either good (≥23; Middle Fork) or fair to poor (<18; Eightmile Creek).

Barriers

Barriers to fish passage in the Smith River are primarily due to road-stream crossings and aggradation or degradation of the channel and are thought to be a high stress for many life stages in the population. According to the California Fish Passage Assessment Database (CalFish 2009) there are approximately 175 diversions, and 150 road-stream crossing barriers within the Smith River Hydrologic Unit (HU). Forty-eight of the road-related barriers, ranging from partial to complete barriers, occur in the lower watershed where stream reaches are characterized as high IP for coho salmon. Known complete barriers identified in the database are in the Tenmile Creek, West Fork Patrick Creek, Yontocket Slough, Shelley Creek and Buck Creek. The majority of these barriers is associated with farm and small county access roads, and creates passage problems through changes in hydrology and creating alluvial sills that block tributary mouths. In addition to tide gates, these crossings prevent access to the already limited amount of overwintering habitat in the coastal plain (Stillwater Sciences 2006). The California Department of Fish and Game (CDFG) has funded several fish passage restoration projects since 2005, including barrier removals on Cedar, Clarks, Peacock, and Rowdy creeks (CDFG 2010a). Nevertheless, there are at least several dozen remaining fish barriers in the lower basin, which are considered a high stress for the juvenile and smolt life stages and a medium stress for the rest of the life stages. Because a large number of barriers remain in the lower basin blocking a large amount of spawning, winter refugia, and summer rearing habitat, the overall impact from barriers is considered high.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. Rowdy Creek Hatchery produced coho salmon from the 1930s but the species is no longer produced there. The genetic effect of this hatchery on coho salmon produced in the Smith River is unknown. The hatchery still produces 100,000 steelhead and 150,000 Chinook salmon, which are stocked into the Smith River. Hatchery coho salmon from other watersheds, such as the Rogue River, are found in the Smith River. Adverse hatchery-related effects pose a medium risk to all life stages of coho salmon in the Mad River, because of the ongoing in-basin stocking with steelhead and Chinook salmon from Rowdy Creek Hatchery (Appendix B).

Altered Sediment Supply

Altered sediment supply presents a low to medium stressor to coho salmon in the Smith River. Large introductions of sediment originating from historic logging practices, mining in the Gasquet Mountains, and an estimated 2,000 landslides are thought to contribute to increased sediment delivery to the Smith River. Excluding the coastal plain, 90 percent of the basin has high or extreme erosion potential (CDFG 1980), as evidenced by the high number of landslides and debris torrents found throughout the watershed. Although erosion can be high and sediment tends to accumulate in the Smith River Plain, river flows are generally high enough and persistent enough to prevent sediment accumulation and turbidity in the lower parts of the basin. Data on sedimentation indicates that some areas have accumulated fine sediment and suffer from filling of pools and increases in the amount of fine sediment. Measurements of sediment accumulation in pools (V*) in West Branch Mill Creek and Clarks Creek had fair ratings (>0.25), displaying effects from both anthropogenic and natural causes. Other data from a tributary of the North Fork (Cedar Creek) and the East Fork of Mill Creek showed a very good V* rating (<0.15) and did not show that pool depth and quality in this area were altered.

Mean particle size was rated between fair and poor (<50 mm) in Clarks Creek, West Branch Mill Creek, and the North Fork (Cedar Creek), indicating unnatural proportions of fine sediment as compared to background levels. Only the East Fork of Mill Creek was given a good rating (50 to 60 mm). In areas where sediment does tend to accumulate (especially in the estuary), pools are filled, gravels cemented, and stream habitat simplified, creating stress for both adults and juveniles through decreases in available spawning and rearing habitat. Salmon eggs and fry are particularly susceptible to any introduction of fine sediment because it can smother redds and kill eggs by depriving them of oxygen.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions pose a medium stress for most life stages of coho salmon in the Smith River. Riparian vegetation in the lower reaches of the Smith River is inadequate due to the conversion of this area for agriculture, residential development and timber harvest. Inadequate riparian vegetation simplifies instream habitat, elevates water temperatures from increased insolation, increases erosion and sedimentation, and decreases the amount of large woody debris recruitment that is essential to the survival of juvenile salmonids in the lower watershed. In the middle and upper Smith River watershed, most areas have riparian forest dominated by thick hardwood and conifer species and conditions are considered adequate for shading and contributing large woody debris. The USFS rated the middle and upper Smith River as having very good (fully functional) stream corridor vegetation in their habitat surveys of the area.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Increased Disease/Predation/Competition

Currently, juvenile hatchery Chinook and steelhead released from the Rowdy Creek Hatchery are likely exerting predatory and competitive pressure on native coho salmon.

Altered Hydrologic Function

The Smith River experiences a relatively natural hydrologic regime due to the absence of large dams and other significant alterations to channel morphology or hydrology. The USFS rated the upper watershed as having very good (fully functional) water quantity and flow regime, and although areas lower in the watershed exhibit impacts from changes in land use, localized water withdrawal and diversion of flows, altered hydrologic function is considered a low stress to the Smith River coho salmon population. In the lower watershed and estuary, there are numerous diversions for agriculture, but the cumulative effect does not currently result in a shortage of flow in the mainstem needed for salmon, but it is unknown how diversions may affect tributary streams.

Crescent City, including Pelican Bay State Prison, diverts surface water from the mainstem (Katelman 2005) and the Smith River Community Services District (SRCSD) operates three wells to supply water to the Town of Smith River and surrounding developments. The total amount of water extracted for Crescent City and the Smith River Community Services District ranges from two to three million gallons per day, but this amount has had no detectable effect on surface flows of the river (Voight and Waldvogel 2002). Agricultural use is the second largest source of water extraction, but the total amount is minimal and also does not affect surface flows (Voight and Waldvogel 2002). Generally, the hydrologic function in the watershed is good, primarily because of abundant rainfall in the region, which supplies sufficient water for agriculture, municipalities, and salmon.

15.6 Threats

Table 15-3. Severity of threats affecting each life stage of coho salmon in the Smith River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	High	High	High	High	High	High
2	Channelization/Diking	Low	High	High	High	High	High
3	Road-Stream Crossing Barriers	Medium	Medium	Medium	Medium	Medium	High
4	Agricultural Practices	Low	High	High	High	Medium	High
5	Urban/Residential/Industrial	Medium	Medium	Medium	Medium	Medium	Medium
6	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
7	Timber Harvest	Medium	Medium	Medium	Medium	Medium	Medium
8	High Intensity Fire	Medium	Medium	Low	Low	Medium	Medium
9	Climate Change	Low	Low	Medium	Medium	Medium	Medium
10	Invasive Non-Native/Alien Species	Low	Medium	Medium	Medium	Low	Medium
11	Fishing and Collecting	-	-	-	-	Medium	Medium
12	Dams/Diversion	Low	Low	Low	Low	Low	Low
13	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low

Roads

Roads are considered a high threat to coho salmon in the Smith River. Erosion on many abandoned or unmaintained roads is a chronic source of fine sediment input to many streams and is exacerbated in the middle and upper parts of the basin by steep hillsides and an unstable geology. With a history of both agricultural and logging uses, the Smith River Plain is characterized by high road density. Road surveys indicate that a majority of the watershed contains more than 3 miles of road per square mile, and the areas with the highest densities of roads (>3 mi/sq mi) include the Smith River Plain, Rowdy Creek, Mill Creek, the South Fork, the lower North Fork and scattered watersheds in the Upper Middle Fork. The proximity of Highway 199 to stream channels beyond the urban center has also resulted in substantial sediment deposits, which are attributed to causing some of the reaches to go dry in the summer and potential passage problems in other times of the year. Erosion and the associated sediment delivery to streams affect multiple life stages, including the egg life stage, because fine sediment can smother eggs. Fry, juveniles and adults are adversely affected by road-related sedimentation due to the decreases in pool quality and quantity and the simplification of spawning and rearing habitat. When sediment builds up, the channel widens and becomes shallower, pools fill, and gravel is buried, making streams less favorable for spawning and rearing. Overall, logging and mining roads in the mid and upper reaches and farm roads in the coastal plain pose a high threat to all life stages of coho salmon in the Smith River population. This threat will likely reduce in the future as measures are undertaken by public land managers to decommission and upgrade roads throughout the upper Smith River watershed.

Channelization/Diking

The overall threat to coho salmon from channelization and diking is high and will continue as long as dikes and levees remain in place, and large portions of the coastal plain remain as agricultural farms and pastures. The extent of channelization and diking in the historic floodplain and estuary of the Smith River watershed is extensive and interferes directly with ecological function in this area, decreasing rearing quality in the lower reaches of the basin. Although the historic extent of tidal wetlands is not known, it is likely that close to 7,000 acres of tidal wetlands have been converted to agricultural land. Remaining tidal channels are severely truncated and channelized, providing only a fraction of their potential as rearing habitat. The lower reaches of streams, such as Rowdy Creek, are also channelized and important rearing habitat has been reduced and degraded. Low gradient stream channels directly connected to the estuary allow for estuarine life history traits that are unique to this population, and the degradation and inaccessibility of these habitats may have a significant effect on the Smith River coho salmon population. Without restoration of historic tidal wetlands and tidal channels, estuarine function will continue to be limited. The early life stages of coho salmon that rely on the estuary for growth and survival are most affected.

Road-stream Crossing Barriers

Road-stream crossing barriers are a high threat to the population, and although some work has gone into removing barriers throughout the watershed, the current number and extent of barriers mean that it will likely remain at this elevated status in the future, or until all barriers have been removed or remediated. According to the California Fish Passage Assessment Database (CalFish 2009) there are potentially 150 road-stream crossing barriers in the Smith River HU. Of these, roughly half have been assessed, a third have been prioritized and nineteen have been given a high priority for removal. Most road-stream crossing barriers are in tributaries in the middle and upper Smith River, but a few are lower down in tributaries in the Smith River Plain and cause passage problems for the Smith River coho salmon population. Until recently, notable barriers existed in Rowdy Creek and Mill Creek blocking much of the high IP habitat for spawning and rearing coho salmon. Barriers on Jordan Creek were especially restricting until 2001 when a state fish passage restoration project was implemented. Since 2005, the California Department of Fish and Game has sponsored several fish passage restoration projects, including barrier removals on Cedar, Clarks, Peacock, and Rowdy, creeks (CDFG 2010a). Given the high density of agricultural roads in the lower basin; however, road barriers remain one of the most important impediments to recovery efforts. A list of highly ranked road-stream crossing barriers identified in 2002 is given in Table 15-4.

Table 15-4. List of high priority barriers on roads in the Smith River and Lake Earl watersheds. Length of anadromous habitat, when given, was estimated in Taylor (2001) and the Smith River Anadromous Fish Action Plan (Voight and Waldvogel 2002). Prioritization is from the CalFish (2009) and Taylor (2001).

Priority	Stream Name	Road Name	Subarea	County	Miles of habitat
High	Sultan Creek	Culvert Hwy 197	Smith River Plain	Del Norte	1
High	Shelly Creek	Patrick's Creek Road	Middle Fork Smith River	Del Norte	
High	Rock Creek	Culvert Hwy 197	Smith River Plain	Del Norte	0.13
High	Little Mill Creek	Culvert Hwy 197	Smith River Plain	Del Norte	1
Very high	Clarks Creek	Culvert Hwy 199	Smith River Plain	Del Norte	1.3
High	Morrison Creek	Culvert Hwy 101	Smith River Plain	Del Norte	1
High	Ritmer Creek	Oceanview Drive	Smith River Plain	Del Norte	
High	Griffin Creek	Hwy 199	Middle Fork Smith River	Del Norte	0.13
High	Dominie Creek	Culvert Hwy 101	Smith River Plain	Del Norte	1.7
High	Unnamed Tributary to Smith River	Hwy 199	Middle Fork Smith River	Del Norte	0.13
High	Griffin Creek	Hwy 199	Middle Fork Smith River	Del Norte	0.15
High	Griffin Creek	Oregon Mountain Road	Middle Fork Smith River	Del Norte	
High	Unnamed Tributary to Smith River	Hwy 199	Middle Fork Smith River	Del Norte	0.06
High	Unnamed Trib to Smith River	Hwy 197	Smith River Plain	Del Norte	0.04
High	Unnamed Trib to Smith River	Hwy 197	Smith River Plain	Del Norte	
High	Unnamed trib to Morrison Ck	Hwy 101	Smith River Plain	Del Norte	0.3
High	Tryon Creek	Hwy 101	Smith River Plain	Del Norte	0.3
High	Brush Creek	Hwy 101	Smith River Plain	Del Norte	0.4
High	Unnamed trib to Smith River	Hwy 101	Smith River Plain	Del Norte	0.3
High	Peacock Creek	Tan Oak Drive	Smith River Plain	Del Norte	1.2
High	Ritmer Creek	Oceanview Drive	Smith River Plain	Del Norte	0.5
High	Clarks Creek	Walker Road	Smith River Plain	Del Norte	1.5
High	Tryon Creek	At Estuary	Smith River Plain	Del Norte	<.25
High	Huntspilar Creek	Highway 197	Smith River Plain	Del Norte	0.75
High	Morrison Creek	County Road D4	Smith River Plain	Del Norte	1.5
High	Coldwater Creek	Highway 199	Smith River Plain	Del Norte	0.75

Agricultural Practices

Agriculture practices are not common in the middle and upper reaches of the Smith River (0 to 2 percent of land use), but are very prevalent (>10 percent) in the Smith River Plain. Therefore, agricultural practices are considered an overall high threat to coho salmon in the Smith River. The coastal plain is dominated by agricultural activities focused on flower production, produce, and dairy farming. These farms contribute pesticides, herbicides, erosion, and animal waste into the watershed, are commonly associated with levees to protect fields. Poor water quality in the lower basin is primarily the result of pollutants and changes in habitat from alterations in land use have decreased the survival and viability of the Smith River coho salmon population. Because of the land clearings, agricultural practices are responsible for the significant decrease in large woody recruitment in the lower basin. The life stages most affected by agricultural practices are juveniles and smolts because they spend weeks to months rearing in the affected floodplain and estuarine areas and are particularly susceptible to poor water and habitat quality.

Urban/Residential/Industrial Development

Urban, residential, and industrial development is considered a medium threat to coho salmon in the Smith River because it occurs in the Smith River Plain where the highest quality-rearing habitat is located. Communities within the Smith River watershed and Smith River Plain are generally small and rural. The largest community in the Smith River watershed, the Town of Smith River, is surrounded by areas used for agriculture and includes several small communities in the coastal plain near Rock Creek and Peacock Creek. Most communities have fewer than 1,000 residents and do not appear to be undergoing significant growth. Crescent City, the largest city in the county, is located south of the Smith River watershed and supports nearly all of the county's population of nearly 29,000 people. Agricultural areas may be subdivided for rural residential use and future impacts may include the loss of wetlands, degraded water quality, channelization and diking, and altered hydrology. Recent public lands acquisitions, including 9,500 acres of Goose Creek watershed from Green Diamond Resources Company in 2006 and a pending 5,400 acre acquisition from ALCO Holdings, Inc., makes the Smith River Recreation Area approximately 315,000 acres. California State Parks has also expanded by gaining 25,000 acres of the Mill Creek Watershed in 2002. Private lands not managed by a HCP, compose 15.7 percent of the Smith River watershed.

Hatcheries

Hatcheries pose a medium threat to all life stages of coho salmon in the Smith River. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Timber Harvest

Timber harvest is considered a medium threat to coho salmon in the Smith River. Currently logging in the Smith River watershed is conducted in small units on land owned by the California Redwood Company (subsidiary to Green Diamond Resource Company) and the U.S. Forest Service's Six Rivers Ranger District. The area with the greatest extent of timber harvest (>35 percent of land use) is in the upper reaches of Rowdy Creek, Dominie Creek, and Ritmer Creek on industrial timberland. Most of the private land used for timber harvest is managed under the Green Diamond Resource Company's 50 year Habitat Conservation Plan and

Candidate Conservation Agreement with Assurances (HCP) (GDRC 2006) that includes minimization and mitigation measures consisting of road and riparian management, slope stability, and harvesting restrictions. The impacts of timber harvesting, even if carried out under the HCP, would result in the loss of pool habitat, loss of large wood and stream complexity, altered hydrology and nutrient cycling, and increased sediment loads. Changes in habitat conditions will have a negative effect on all life stages of coho salmon utilizing those areas. Timber harvest on public land is minimal and primarily associated with fuels reduction. As part of the aquatic conservation strategy of the Northwest Forest Plan (USDA and USDI 1994), the Smith River was designated as a key watershed, which has restrictions on timber harvest in the watershed.

High Intensity Fire

Fire is considered a medium threat to the Smith River coho salmon population. The inland reaches of the Smith River are thirty-two miles from the coast, forest dominated, and have an inherent risk of wildfire. Unnatural fuel loads due to past timber harvest and fire suppression could make this a greater threat if not fully addressed through fuels reduction and ecological fire management. The effects of high intensity fire could be severely detrimental, creating excessive amounts of erosion, loss of riparian vegetation, and degraded water quality. Overall, the threat from fire is low to medium because of the ongoing efforts in the watershed to reduce fuel loads.

Climate Change

Climate change poses a medium threat to this population. Ongoing and anticipated climate change in this region is likely to add further risk of forest fires, which would contribute to a decrease in canopy closure, increase sedimentation, degrade water quality, and have overall negative impacts to ecosystem processes. Additionally, decreased canopy closure increases the potential for erosion and ground instability, which leads to more sediment in the river system. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. Modeled regional temperature shows a moderate increase over the next 50 years. Average temperature could increase by up to 2^{o}C in the summer and by up to 1^{o}C in the winter and annual precipitation in this area is predicted to trend downward over the next century. Snowpack in upper elevations of the basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009).

The vulnerability of the estuary and coast to sea level rise is moderate to high in this population. Juvenile and smolt rearing and migratory habitat is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation will also likely impact water quality and hydrologic function in the summer. Rising sea level will also impact the quality and extent of estuarine rearing habitat. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, as with all populations in the ESU, adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007; Feely et al. 2008; Portner and Knust 2007).

Invasive Non-Native/Alien Species

Of notable concern is the expansion of exotic reed canary grass, *Phalaris arundinacea*, a cool-season perennial grass that grows successfully in northern latitudes. Reed canary grass is considered a serious threat to riparian and streamside corridors, wetlands, marshes, floodplains, and wet prairies by forming large dense stands. These stands exclude and displace desirable native plants, constrict waterways and promote silt deposition and are widely tolerant to degraded conditions (Lyons 1998). Colonies established outside of the water channel are known to promote channel incision through erosion of soil beneath the dense mats of rhizomes, causing cutaways where water flows rapidly between stands (Lyons 1998). This species is widely found in the Smith River watershed and is suspected of inhibiting coho salmon access to the use of tributaries like Yontocket Slough and Tryon Creek.

Also of concern is the establishment of the New Zealand mud snail (NZMS), *Potamopyrgus antipodarum*, which is native to New Zealand, but in the late 1980s was discovered to have spread to North America. This small invasive mollusk is now found in many waters across the West and the spread of this invasive species is believed to occur by migrant fish and waterfowl, and people's waders, fishing gear, and bait. In September 2008, a sparse number of New Zealand mud snails were found in Tillas Slough of the Smith River watershed. Adverse impacts of this introduction include reduction in the insect species diversity and abundance and diminished availability of critical food resources to fish (Global Invasive Species Database 2010).

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Smith River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Dams/Diversions

Diversions and dams are considered a low threat to the population. There are no known dams that limit coho salmon access in the Smith River. Water diversions predominantly support agriculture, urban areas, rural residences, timber operations and road maintenance in the lower watershed and coastal plain. A hydrologic assessment of the diversions in the Smith River watershed has not been completed, but at this time withdrawals are not thought to significantly alter streamflow and no major diversions are planned for the future in this basin. However, the California State Park operates a diversion on East Branch Mill Creek, one of the most important tributaries for coho salmon in the Smith River and this diversion is considered a threat to coho salmon during some portions of the year.

Mining/Gravel Extraction

Although mining activities have ceased for the most part in the population area, there continues to be numerous metal mining activities along reaches of middle and upper tributaries on Forest

Service lands (McCain et al. 1995) and a gravel mine in the coastal plain. According to Bartson (1997), mining remains a source of sediment to the Smith River, although the extent of the problem remains unknown. Many areas historically disturbed by mining are actively eroding (McCain et al. 1995), and are exacerbated by the steep, unstable geology characteristic of the Smith River watershed. Although mining companies have expressed interest in mining for heavy metals in this watershed, Smith River NRA Act prohibits the formation of any new mining claims. In 1996, the Forest Service formulated administrative rules concerning mining in the NRA. Because of current regulatory standards and mining levels, the overall threat to coho salmon associated with mining in this watershed is considered low (Bartson 1997).

15.7 Recovery Strategy

Coho salmon in the Smith River experience some advantages over other rivers in the region due to the geology of the basin that enables the river to move sediment and to sustain cooler temperatures. The relatively low urban development in the area and the high ratio of public lands to private lands also helps to preserve the river ecosystem. Nevertheless, the coho salmon in the Smith River have declined substantially and are dependent on rearing areas in the lower watershed where development and agriculture have the greatest adverse effects. Although restoration and public land acquisition has resulted in improved habitat and ecosystem functions in the Smith River, the loss of estuary, slough, and floodplain habitats continue to negatively affect the viability of coho salmon.

Recovery of the population will require enhancing existing juvenile coho salmon habitat and expanding the spatial structure of the population. Tributaries in the Smith River Plain have the highest IP habitat, and should therefore be the first place to look for opportunities. Throughout the lower watershed, a focus should be on improving fish passage and floodplain and channel structure, especially where overwintering, low-velocity habitat can be created, improved, or accessed. Therefore, restoration of the Smith River estuary, which lacks extensive wetland and tidal channel rearing habitat, is imperative. In addition, agricultural run-off needs to be addressed to reduce the concentration levels of pesticides reaching the Smith River and its tributaries. On a larger scale, sediment from roads and the paucity of LWD needs to be addressed watershed-wide.

Table 15-5 on the following page lists the recovery actions for the Smith River population.

Table 15-5. Recovery action implementation schedule for the Smith River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SmiR.1.3.12	Estuary	Yes	Increase tidal exchange of water	Improve hydrologic function to restore tidal prism and dilute pollutants	Estuary	3
SONCC-SmiR.1.3.12.1	*Complete a hydrologic study to assess estuary function and identify restoration actions to restore the tidal prism and dilute pollutants*					
SONCC-SmiR.1.3.12.2	*Complete restoration actions identified in the plan*					
SONCC-SmiR.1.2.13	Estuary	Yes	Improve estuarine habitat	Reduce pollutants	Lake Earl, Smith River Plain, Smith River Estuary	BR
SONCC-SmiR.1.2.13.1	*Identify agricultural lands that contribute unacceptable levels of pollutants to the estuary. Develop a plan to hydrologically disconnect the runoff*					
SONCC-SmiR.1.2.13.2	*Hydrologically disconnect agricultural lands guided by the plan*					
SONCC-SmiR.1.2.32	Estuary	Yes	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-SmiR.1.2.32.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-SmiR.1.2.32.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-SmiR.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Smith River Plain, Estuary, tributaries, Rowdy, Chrome, and Spokane creeks	3
SONCC-SmiR.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-SmiR.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-SmiR.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Restore natural channel form and function	Smith River Plain, Rowdy and Domnie creeks	2
SONCC-SmiR.2.2.2.1	*Assess channelized reaches and develop a plan for reconstructing a natural meandering channel*					
SONCC-SmiR.2.2.2.2	*Reconstruct channelized reaches guided by the plan*					
SONCC-SmiR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Lake Earl, Smith River Plain	2
SONCC-SmiR.2.2.3.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-SmiR.2.2.3.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SmiR.2.2.4	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Smith River Plain, tributaries, Rowdy, Chrome, Spokane, and Mill creeks	3
SONCC-SmiR.2.2.4.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-SmiR.2.2.4.2	*Implement beaver program (may include reintroduction)*					
SONCC-SmiR.2.2.5	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Lower Mainstem, Smith River Plain, Lake Earl watershed	3
SONCC-SmiR.2.2.5.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-SmiR.2.2.5.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-SmiR.10.2.9	Water Quality	Yes	Reduce pollutants	Reduce point- and non-point source pollution	Smith River watershed, Lake Earl watershed, Smith River Plain	3
SONCC-SmiR.10.2.9.1	*Identify pollution sources, and develop a strategy to meet objective*					
SONCC-SmiR.10.2.9.2	*Implement strategy to prevent pollution*					
SONCC-SmiR.10.2.10	Water Quality	Yes	Reduce pollutants	Educate stakeholders	Smith River watershed, Lake Earl watershed, Smith River Plain	3
SONCC-SmiR.10.2.10.1	*Promote pollution reduction*					
SONCC-SmiR.10.2.11	Water Quality	Yes	Reduce pollutants	Remove pollutants	Lake Earl, Smith River Plain, South Fork, North Fork, Middle Fork, Mill and Rowdy creeks	BR
SONCC-SmiR.10.2.11.1	*Locate and prioritize mine tailings and mill sites. Develop a plan for remediation*					
SONCC-SmiR.10.2.11.2	*Take necessary actions to ensure responsible parties remediate mine tailing piles, guided by the plan*					
SONCC-SmiR.16.1.21	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SmiR.16.1.21.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-SmiR.16.1.21.2	*Identify fishing impacts expected to be consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SmiR.16.1.22	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-SmiR.16.1.22.1	*Determine actual fishing impacts*					
SONCC-SmiR.16.1.22.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-SmiR.16.2.23	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SmiR.16.2.23.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-SmiR.16.2.23.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-SmiR.16.2.24	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SmiR.16.2.24.1	*Determine actual impacts of scientific collection*					
SONCC-SmiR.16.2.24.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-SmiR.17.2.20	Hatcheries	No	Reduce adverse hatchery impacts	Identify and reduce impacts of hatchery on SONCC coho salmon	Rowdy Creek Hatchery	BR
SONCC-SmiR.17.2.20.1	*Develop Hatchery and Genetic Management Plan*					
SONCC-SmiR.17.2.20.2	*Implement Hatchery and Genetic Management Plan*					
SONCC-SmiR.3.1.17	Hydrology	No	Improve flow timing or volume	Increase instream flows	East Fork of Mill Creek, Smith River watershed, Lake Earl watershed, Smith River Plain	BR
SONCC-SmiR.3.1.17.1	*Evaluate diversions and water use. Develop a plan to reduce diversions*					
SONCC-SmiR.3.1.17.2	*Reduce diversions, guided by the plan*					
SONCC-SmiR.3.1.18	Hydrology	No	Improve flow timing or volume	Remove dams	Craigs, Rowdy, and Patrick creeks, Middle and Upper Smith River	BR

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SmiR.3.1.18.1	*Evaluate and prioritize dams for removal. Develop a plan to remove dams*					
SONCC-SmiR.3.1.18.2	*Remove dams, guided by the plan*					
SONCC-SmiR.3.1.19	Hydrology	No	Improve flow timing or volume	Manage flow	Lake Earl	3
SONCC-SmiR.3.1.19.1	*Identify issues preventing natural breaching of the Lake Tolowa/Lake Earl sand bar. Develop a plan to increase breaching events*					
SONCC-SmiR.3.1.19.2	*Implement plan to increase frequency of breaching events*					
SONCC-SmiR.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-SmiR.27.1.25.1	*Perform annual spawning surveys*					
SONCC-SmiR.27.1.26	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-SmiR.27.1.26.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-SmiR.27.1.27	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-SmiR.27.1.27.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-SmiR.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-SmiR.27.2.28.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-SmiR.27.2.28.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-SmiR.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-SmiR.27.2.29.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-SmiR.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-SmiR.27.2.30.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SmiR.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-SmiR.27.2.31.1	*Identify habitat condition of the estuary*					
SONCC-SmiR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-SmiR.27.1.33.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-SmiR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-SmiR.27.2.34.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-SmiR.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-SmiR.27.1.35.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-SmiR.27.1.35.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-SmiR.27.2.36	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-SmiR.27.2.36.1	*Determine best indicators of estuarine condition*					
SONCC-SmiR.5.1.14	Passage	No	Improve access	Remove barriers	Cedar, Clarks, Rowdy, Patrick, Morrison, Peacock, Sultan, Dominie, Ritmer, Jordon, and Yonkers creeks	3
SONCC-SmiR.5.1.14.1	*Evaluate and prioritize barriers for removal*					
SONCC-SmiR.5.1.14.2	*Remove barriers*					
SONCC-SmiR.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Smith River Plain, Estuary, Mainstem Smith River, tributaries, Rowdy, Chrome, and Spokane creeks	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SmiR.7.1.6.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-SmiR.7.1.6.2	*Thin, or release conifers, guided by prescription*					
SONCC-SmiR.7.1.6.3	*Plant conifers, guided by prescription*					
SONCC-SmiR.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Lower tributaries, Lake Earl watershed, Smith River Plain	3
SONCC-SmiR.7.1.7.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-SmiR.7.1.7.2	*Develop grazing management plan to meet objective*					
SONCC-SmiR.7.1.7.3	*Plant vegetation to stabilize stream bank*					
SONCC-SmiR.7.1.7.4	*Fence livestock out of riparian zones*					
SONCC-SmiR.7.1.7.5	*Remove instream livestock watering sources*					
SONCC-SmiR.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Remove invasive species	Lake Earl, Smith River Plain	3
SONCC-SmiR.7.1.8.1	*Implement an invasive species prevention and removal plan for reed canary grass*					
SONCC-SmiR.8.1.15	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Lake Earl, Smith River Plain, South Fork, North Fork, Middle Fork, Mill and Rowdy creeks	3
SONCC-SmiR.8.1.15.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-SmiR.8.1.15.2	*Decommission roads, guided by assessment*					
SONCC-SmiR.8.1.15.3	*Upgrade roads, guided by assessment*					
SONCC-SmiR.8.1.15.4	*Maintain roads, guided by assessment*					
SONCC-SmiR.8.1.16	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	BR
SONCC-SmiR.8.1.16.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-SmiR.8.1.16.2	*Stabilize landslides with appropriate treatments, guided by the plan*					

16. Elk Creek Population

- Central Coastal Diversity Stratum
- Dependent Population
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 8.26 mi^2
- 16 IP km (10 mi) (88% High)
- Dominant Land Use is Urban and Residential Development
- Principal Stresses are 'Degraded Riparian Forest Conditions'
- Principal Threats are 'Channelization and Diking' and 'Urban/Residential/Industrial Development'

16.1 History of Habitat and Land Use

Over the past century, alterations from timber harvest, grazing, and urban, residential, and industrial development have diminished Elk Creek's original stream functions, and reduced the quality of habitat for coho salmon. Intensive logging began in the early 1900s and continued into the 1950s. Although much of the valley was harvested during this time, intact stands of old-growth redwood remain in the hills of the upper basin. These stands are now within Jedediah Smith Redwoods State Park. Logging in the basin likely affected salmonids by destabilizing stream banks, increasing sediment inputs to stream habitat, and increasing water temperatures. These adverse impacts have decreased over time as vegetation has become reestablished in riparian areas. Remnant millponds in the lower basin may also impact aquatic habitat by contaminating water quality; however, their connectivity to Elk Creek, and their contaminant load, is unknown (Burgess 2008). Soil at a mill superfund site in the Crescent City area has been contaminated by numerous chemicals (US Environmental Protection Agency (USEPA) 2008). Although no information on water quality is available for Elk Creek at this time, Elk Creek may be similarly affected.

Historically, most of the land within the population area was used for agriculture and dairy farming, but this has transitioned over time to livestock ranching and hay production within a few large tracts of private land. Remnant stream diversions and dams exist in several locations, but the current connectivity of these structures to Elk Creek is unknown.

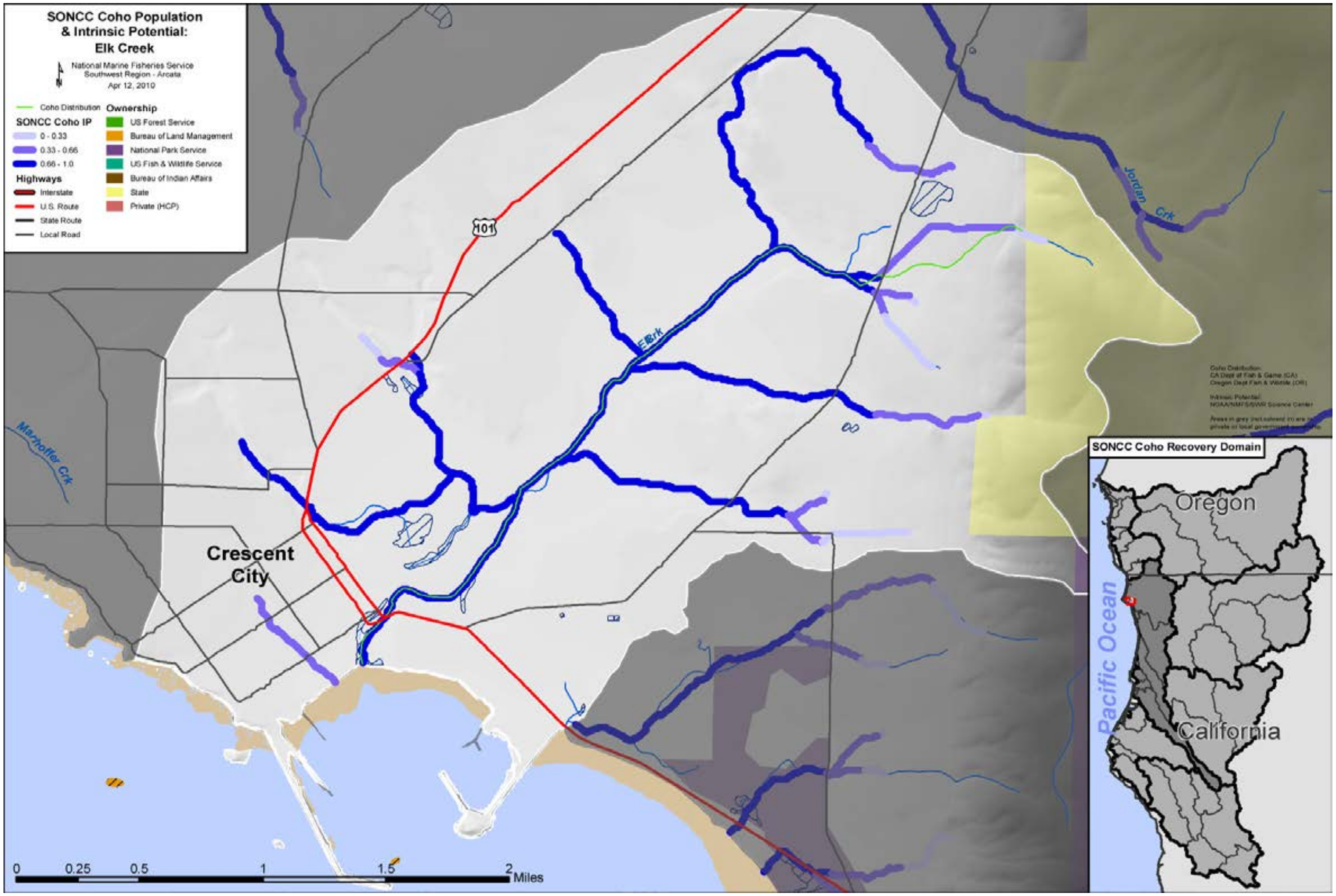

Figure 16-1. The geographic boundaries of the Elk Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

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Stock watering is accomplished by the pumping of ground water or by diverting water from creeks (Burgess 2008). Land designated for grass and hay cropland is cultivated and mowed seasonally to provide forage for livestock.

Urban, residential, and industrial development within the Elk Valley has had a major impact on aquatic habitat. The growth of Crescent City since the early twentieth century has resulted in approximately 40 percent of the basin being developed (Mintier & Associates et al. 2001). Land use development is confined primarily to Crescent City and to a portion of Del Norte County lands. The greatest degree of habitat alteration from development has occurred in the lower valley. Most of the coastal wetlands and estuarine rearing habitat that might have existed in the lower basin at one time has been dredged, channelized, and/or filled, and the stream in this area is channelized underground through a 500 ft long box culvert under Highway 101.

The types of activities associated with development that affect salmon and salmon habitat include construction of impervious surfaces, removal of riparian vegetation, the building of roads and road-stream crossings, and diking, dredging, and filling of wetland and floodplain areas. Potential threats to water quality have also arisen from urban runoff and roadway pollutants. The North Coast Regional Water Quality Control Board (NCRWQCB) has identified residential sewage systems as a potential water quality concern in the Elk Creek basin (Mintier & Associates et al. 2001).

A small portion of the basin has been protected for natural resource value through various measures. These measures include a zoned Habitat Conservation Area by Del Norte County throughout the Elk Valley, the Jedediah Smith Redwoods State Park in the uppermost part of the basin, and the CDFG's Elk Creek Wetlands Wildlife Area just south-east of Crescent City. Management and regulations in place within these areas provide benefits to aquatic habitat although the degrees of protection vary by ownership.

16.2 Historic Fish Distribution and Abundance

Although little is known about coho salmon use of Elk Creek, the IP model indicates that much of the area has the potential to support juveniles (Figure 16-1). Areas of high IP value (IP>0.66) are spread throughout the entire basin and into all major tributaries entering Elk Creek. In general, the Elk Valley appears to have very good potential for rearing habitat.

The abundance and distribution of coho salmon in the Elk Creek basin is not well studied or documented; however, longtime residents of the basin have commented that both the size and the number of salmonids observed have declined in recent decades (Redwood National and State Parks (RNSP) 2005). There are no historical records of adult coho salmon runs in the basin and only a few small-scale surveys for juvenile coho salmon have been conducted over the past two decades. The oldest known survey data, taken in the late 1980s by CDFG, confirm the presence of juvenile, young-of-the-year (YOY) coho salmon in Elk Creek (Jong et al. 2008). California Department of Fish and Game (CDFG 2004a) juvenile surveys between 2000 and 2003 indicate that coho salmon primarily utilize the eastern portion of the basin and may be concentrated in the Nune's Creek drainage area east of Elk Valley Road (Jong et al. 2008). These surveys demonstrated the presence of young of the year (YOY) every year in the lower part of Nune's Creek near the Elk Valley Road crossing (average of 32 juveniles per year). Age-1+ juveniles were observed only one year (2001) during this sampling effort. One age-1+ fish was also found lower in the system in the mainstem Elk Creek in 2000 (Jong et al. 2008).

Coho salmon have been found up to about 4 miles from the mouth of Elk Creek. Urban and industrial development in the western and southern portion of the basin may have affected the distribution of coho salmon in these areas. Little information is available about many of the creeks in the basin, but many have been highly degraded and may be accessible only at certain times of the year.

Table 16-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Subarea	Stream Name
Smith River Plain	Elk Creek[1] (all tributaries)
[1]Denotes a "Key Stream" as identified in the State of California's Coho Salmon Recovery Strategy	

16.3 Status of Elk Creek Coho Salmon

Spatial Structure and Diversity

In assessing the viability of the Elk Creek population, the spatial structure criterion arises as a key concern. The geographic size of the Elk Creek population, occupying a single small coastal basin approximately 21.4 square km, makes it naturally vulnerable to extinction risk. Although historically coho salmon may have used tributaries throughout the basin at various times throughout the year, survey data indicates they may currently occupy only a few smaller tributaries. Much of the historic habitat available to coho salmon in Elk Creek has been lost to development and degradation. The available habitat for both spawning and rearing has been severely restricted and overall opportunity and capacity within the system is low under current conditions.

There is no information on specific population traits, life history characteristics, or genetic diversity of the Elk Creek population and therefore no information to assess the diversity of the population. Because of the small number of individuals, this population is expected to have a low genetic and life history diversity.

Population Size and Productivity

Based on the limited available data on the size and productivity of the Elk Creek population, this population appears to be depressed in abundance and may consist of only a handful of spawning adults each year. A spawner survey in 1999 found just one coho salmon carcass (CDFG 1999), and 16 coho salmon carcasses were found in Nune's Creek in 2005 (Burgess 2008). Considering the information available for this basin, and comparing with other coastal basins in northern California, there are probably fewer than 50 adults that comprise the Elk Creek SONCC coho salmon population (Brown et al. 1994; Weitkamp et al. 1995).

The presence of juveniles in the basin suggests suitable incubating conditions in reaches where coho salmon successfully spawn. Previous data from CDFG juvenile surveys (CDFG 2004a) indicate low number of juveniles (average 32 juveniles per year) distributed throughout a small portion of the basin (CDFG 2004a). Only a few age-1+ smolt size coho salmon have ever been found. These data indicate rearing capacity for the system may be low, or that juveniles are leaving the system earlier than expected.

With the low number of spawning adults observed in the Elk Creek population, and the relatively few smolt-size juveniles found, it is likely this basin supports a small but potentially consistent population with presumably low overall productivity. As a dependent population, abundance and productivity is highly influenced by nearby populations, which contribute spawners as strays. The Smith River population to the north and the Klamath River population to the south are both likely sources of strays to the Elk Creek population. Both these populations have been severely restricted, have low numbers of returning adults compared to historic runs, and are at moderate to high risk of extinction. The lack of productivity in these neighboring systems and the associated reduction in strays entering Elk Creek further increases this population's risk of extinction.

Extinction Risk

Not applicable because Elk Creek is not an independent population.

Role in SONCC Coho Salmon ESU Viability

The Elk Creek population is considered dependent because it does not have a high likelihood of sustaining itself over a 100-year time period in isolation and receives sufficient immigration to alter its dynamics and extinction risk (Williams et al. 2006; Williams et al. 2008). Although dependent populations are not viable on their own, they do increase connectivity through dispersal among independent populations and provide individuals for other populations, acting as a source of colonists in some cases. By exchanging spawners, the Elk Creek population interacts with other Central Coastal populations and plays an important role in the health and status of the ESU.

16.4 Plans and Assessments

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The relevant recommendations in the CDFG Recovery Strategy for the Elk Creek population were general for the entire Smith River Plain HSA and did not include any specific analysis for this basin. Any relevant recommendations for the HSA have been considered and incorporated into the recovery strategy and list of recovery actions for this population.

Rural Human Services

16.5 Stresses

Table 16-2. Severity of stresses affecting each life stage of coho salmon in Elk Creek. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Degraded Riparian Forest Conditions[1]	-	High	High[1]	High	High	High
2	Altered Sediment Supply	Medium	Medium	Medium	Medium	Medium	Medium
3	Lack of Floodplain and Channel Structure	Medium	Medium	Medium	Medium	Medium	Medium
4	Impaired Water Quality	Low	Medium	Medium	Medium	Low	Medium
5	Altered Hydrologic Function	Low	Medium	Medium	Medium	-	Medium
6	Impaired Estuary/Mainstem Function	-	Low	Medium	Medium	Low	Medium
7	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
8	Barriers	-	Low	Medium	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1]Key limiting factor(s) and limited life stage(s).
[2]Increased Disease/Predation/Competition is not considered a stress for this population

Limiting Stresses, Life Stages, and Habitat

The key limiting stressor for this population appears to be from degraded riparian forests. Not enough information is available to identify the limiting life stages at this point, but juveniles are believed to be the most limited. There is no current habitat information to indicate the presence of refugial areas or vital habitat areas in the Elk Creek basin.

Degraded Riparian Forest Conditions

Degraded riparian forest condition is the most significant stress affecting coho salmon recovery in Elk Creek. This factor is a high stress across all life stages, except for the egg stage, because of its impact on water temperature, sedimentation, bank stability, and stream complexity. Riparian conditions are most degraded in areas affected by development and agricultural use. Degraded conditions occur throughout the basin, but occur primarily near Crescent City and in agricultural lands in the northwestern portion of the basin. In areas where these impacts are greatest, riparian vegetation has been either completely removed or degraded to the point where it is no longer benefitting stream conditions. Stressors influencing spawning and rearing coho salmon result from loss of canopy cover and shading as well as the loss of large wood.

Altered Sediment Supply

Because Elk Creek is a low gradient coastal system, it naturally stores fine sediment in the meandering mainstem channels and wetlands. Past agriculture and current grazing in the valley along with urban and industrial development have led to increased sediment loads and unnatural storage of sediment in Elk Creek and its tributary streams. The effects have been a simplification of stream habitat, widening and filling of channels and backwater habitats, and reduction in stream flows. The added sediment also reduces or eliminates macro-invertebrate habitat, thereby decreasing foraging opportunities for juveniles.

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure is considered a medium stress to the Elk Creek population and presents a moderate stress to all life stages, especially in areas that have been highly altered through urbanization and channelization. In the lower part of the basin, development in and around Crescent City has resulted in simplification of tributary streams and the mainstem Elk Creek. Much of the mainstem was channelized and numerous unnatural channels exist within Elk Valley. In many areas, the creek and its tributaries are completely disconnected from the floodplain. This is the case at the mouth where the stream passes under Highway 101 and Crescent City through a 500-foot box culvert. These lower reaches would naturally exhibit complex floodplain and channel characteristics.

Impaired Water Quality

Stresses on coho salmon in Elk Creek from impaired water quality are considered moderate. Impairments likely arise from temperature and chemical contamination. Point source pollution from developed areas and non-point source runoff pollution from roads occurs throughout the valley. Remnant mill sites in the lower basin may also contaminate water quality. Channelization throughout the lower basin and grazing practices in the northern basin likely leads to elevated water temperature in Elk Creek during the summer months. The fry, juvenile, and smolt life stages are most susceptible to the impacts of impaired water quality because juveniles inhabit the basin for extended periods of time. The extent of impaired water quality in Elk Creek is unknown at this time due to a lack of information.

Altered Hydrologic Function

Altered hydrologic function presents a moderate stress to fry and juvenile coho salmon in Elk Creek. The hydrologic regime of the creek has been altered primarily as a result of the development that has occurred in and around Crescent City. Impervious surfaces have led to decreased water storage capacity in the basin, increased frequency of flooding and peak flow volumes, and decreased base flow. Many road-stream crossings are undersized to accommodate natural flows and prevent proper flushing in the system. There are no known water withdrawals within the basin; however, it is likely there are groundwater pumps and diversions associated with the agricultural and rural development north of Crescent City. Overall, the amount of available habitat for juvenile rearing in the basin has decreased and natural biological and physical processes on which these fish depend have been altered due to hydrologic alterations in the basin.

Impaired Estuary/Mainstem Function

Little is known about the historic extent of estuarine area in Elk Creek. Currently this area is confined to six acres of tidal sand flat south of the Hwy 101 culvert. Based on the natural drainage pattern and elevations in the area, much of the historical estuarine tidal area likely has been dredged and filled to accommodate the highway and commercial/industrial development. The reduction in the amount of estuarine habitat and the loss of natural estuarine functions have likely resulted in a loss of foraging and growth opportunities for juveniles as well as the loss of transitional migratory habitat for smolts.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Barriers

Overall, barriers present a low stress to the coho salmon in Elk Creek. However, road-related barriers have been found in Nune’s Creek and in two other tributaries that pass under Elk Valley Road on the eastern side of the basin (CalFish 2009). These barriers block fish access during certain flows and create unnatural sediment and debris storage.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Elk Creek population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

16.6 Threats

Table 16-3. Severity of threats affecting each life stage of coho salmon in Elk Creek. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Channelization/Diking	Medium	High	High	High	High	High
2	Urban/Residential/Industrial	Medium	High	High	High	High	High
3	Agricultural Practices	Low	Medium	Medium	Medium	Medium	Medium
4	Roads	Low	Medium	Medium	Medium	Medium	Medium
5	Timber Harvest	Low	Medium	Medium	Medium	Medium	Medium
6	Fishing and Collecting	-	-	-	-	Medium	Medium
7	Dams/Diversion	Low	Low	Low	Low	Low	Low
8	High Intensity Fire	Low	Low	Low	Low	Low	Low
9	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
10	Climate Change	Low	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low

[1]Invasive Non-Native/Alien Species, and Mining/Gravel Extraction are not considered threats to this population

Channelization/Diking

Development in the Elk Creek basin has resulted in channelization and diking of the mainstem, tributaries, and floodplain of Elk Creek. Most of the channel modification and diking has been confined to central Elk Valley and Crescent City. Remnant channelization and ponding associated with milling near the lower end of Elk Creek have altered the hydrology of the creek in the lower basin. Complex channel networks throughout the valley are likely remnants of past milling activities and agricultural practices. Given the wide floodplain in the lower basin, Highway 101 likely impinges flow and tidal inundation. Currently the creek is channelized at its mouth through a long box culvert that passes under the highway and Crescent City. The result of these alterations has been a simplification of the system and alteration of natural hydrology to the point where relatively few intact reaches remain. Development in the Crescent City area is likely to continue in the future, so channelization/diking is considered a medium stress for eggs and a high stress for all other life stages.

Urban/Residential/Industrial Development

Roughly 40 percent of the Elk Creek basin has been developed for urban, residential, and industrial use and development is likely to continue into the future. Projected annual population growth is approximately 2 percent for Crescent City, which will likely result in more urban and rural development in and around Elk Creek. Although some county zoning restrictions in the central basin limit the type and extent of development, the headwaters of many tributaries are likely to be affected by new residential and urban development. Impacts related to development include increased impervious surface area, loss of riparian vegetation, road construction, and the diking, dredging, and filling of wetland and floodplain areas. Potential threats to water quality also arise from urban runoff, roadway pollutants, and onsite sewage systems. This threat is considered medium for the egg stage and high for all other life stages due to the continuing urban, residential, and industrial use, and ongoing impacts related to development.

Agricultural Practices

Agriculture in the Elk Creek basin primarily includes cattle ranching and associated hay operations. Because agriculture is restricted to only a portion of the basin, it is only a medium threat to coho salmon in Elk Creek. The greatest threat arises from cattle that have unrestricted access to some reaches of Elk Creek. Stream banks in these reaches are mostly denuded of vegetation and bank and streambed (head-cut) erosion have been observed in these areas (Burgess 2008). Impacts to aquatic ecosystems include decreased bank stability, increased sediment inputs, loss of shade- and cover-providing riparian vegetation, and elevated coliform levels in water. Cattle in a live stream channel can also be a physical barrier to migrating salmonids.

Roads

Although roads occur at very high density (>3 mi./sq. mi.) within the basin, they are considered only a moderate threat because the majority are paved. The building of more unpaved roads is unlikely. Existing unpaved roads within the Elk Valley are likely the main source of sediment to Elk Creek.

Timber Harvest

Historically, much of the basin was used for timber harvest; however, harvest is currently limited to small-scale harvest on private lands. Most harvestable tracts are less than 100 acres. More land throughout the valley could be used for timber harvest and therefore considered to be a medium threat.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. As of April 2011, NMFS has not authorized future collection of coho salmon for research purposes in Elk Creek.

Dams/Diversions

Although diversions and dams are known to exist in the basin, these structures are isolated, no longer used, and do not limit fish passage.

High Intensity Fire

The threat of high intensity fire is low because much of the basin is un-forested, fuel loading is low, and climatic conditions do not favor frequent or high-intensity fires.

Road-stream Crossing Barriers

Road-stream crossing barriers are not a significant threat to coho salmon in Elk Creek, based on the few known barriers that exist in the basin. The Five Counties Fish Passage Assessment listed several sites in Elk Creek where fish passage has been compromised by a crossing (Taylor 2001). At least one of these, on Nune's Creek, has been identified as a barrier to juvenile and adult fish passage at certain flows. Other culverts in this drainage likely store fine sediment and create unnatural pooling (NMFS 2005). Several other partial barriers and undersized culverts have been found in tributaries to Elk Creek (See Table 16-4). Given the amount of development and the density of roads in the basin, there are likely many more barriers yet to be identified.

Table 16-4. List of known road barriers in the Elk Creek basin. Length of anadromous habitat was estimated based on IP maps and prioritization (Taylor 2001).

IP priority	Stream Name	Road Name	Miles of habitat
1	Nune's Creek #1	Elk Valley Rd.	0.5 miles
2	Elk Creek Tributary	Elk Valley Rd.	0.5 miles
3	Nune's Creek #2	Elk Valley Rd.	0.5 miles
4	Elk Creek Tributary	Elk View Rd	1.5 miles

Climate Change

Climate change poses a low threat to this population due to its cooler climate, and low risk of temperature increase and precipitation change over the next 50 years (see Appendix B for modeling methods). Overall, the range and degree of variability in temperature and precipitation are likely to increase in all populations. Adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Elk Creek population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

16.7 Recovery Strategy

The Elk Creek basin has a large amount of high IP habitat for its small size. The recovery criterion for this population is that 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival. Although much of the basin has been developed, numerous opportunities exist to help restore coho salmon in the basin. Coho salmon are known to use much of the available habitat in the basin, but in some areas this habitat has been severely degraded. In order to help increase the size, health, and distribution of the population, actions should focus on increasing the quality and quantity of habitat available. By addressing the major threat to the population - urban, residential, and industrial development in and around Crescent City - many of the major stresses affecting coho salmon will be abated. Improving the condition of riparian areas is the most important step in the recovery of the population, but other important actions include reducing sediment loading, increasing floodplain and channel complexity, improving water quality, restoring hydrologic function, and improving fish passage. Additionally, measures to restrict or control development and to protect habitat and habitat functions are necessary to prevent further degradation.

Table 16-5 on the following page lists the recovery actions for the Elk Creek population.

Table 16-5. Recovery action implementation schedule for the Elk Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkC.7.1.14	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Upper Elk Valley	BR
SONCC-ElkC.7.1.14.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-ElkC.7.1.14.2	*Develop grazing management plan to meet objective*					
SONCC-ElkC.7.1.14.3	*Plant vegetation to stabilize stream bank*					
SONCC-ElkC.7.1.14.4	*Fence livestock out of riparian zones*					
SONCC-ElkC.7.1.14.5	*Remove instream livestock watering sources*					
SONCC-ElkC.7.1.15	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Remove invasive species	Crescent City, Upper Elk Valley, Eastern Tributaries	BR
SONCC-ElkC.7.1.15.1	*Remove invasive species which are inhibiting establishment of native riparian vegetation*					
SONCC-ElkC.7.1.16	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Revegetate riparian areas	Crescent City, Upper Elk Valley, eastern tributaries	BR
SONCC-ElkC.7.1.16.1	*Develop a riparian management plan with landowners that establishes riparian buffers on their property through planting, invasive species removal, or protection measures*					
SONCC-ElkC.7.1.16.2	*Implement the riparian management plan*					
SONCC-ElkC.7.1.17	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Crescent City, Upper Elk Valley, eastern tributaries	BR
SONCC-ElkC.7.1.17.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-ElkC.7.1.17.2	*Develop watershed-specific guidance for managing riparian vegetation*					
SONCC-ElkC.1.2.10	Estuary	No	Improve estuarine habitat	Restore estuarine habitat	Estuary, downstream of Highway 101	BR
SONCC-ElkC.1.2.10.1	*Develop a plan to restore historic tidal channels and wetlands*					
SONCC-ElkC.1.2.10.2	*Restore tidal wetlands and tidal channels in historic estuary, guided by the plan*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkC.2.1.1	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	BR
SONCC-ElkC.2.1.1.1	*Develop a watershed assessment of Elk Creek*					
SONCC-ElkC.2.1.1.2	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-ElkC.2.1.1.3	*Place instream structures, guided by assessment results*					
SONCC-ElkC.2.2.2	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Increase beaver abundance	Elk Valley	3
SONCC-ElkC.2.2.2.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-ElkC.2.2.2.2	*Implement beaver program (may include reintroduction)*					
SONCC-ElkC.2.2.3	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels	Central Elk Valley and tributaries in Crescent City	BR
SONCC-ElkC.2.2.3.1	*Develop plan to reconnect priority channelized stream reaches to historic side channels and wetlands*					
SONCC-ElkC.2.2.3.2	*Reconnect historic side channels and wetlands, guided by the plan*					
SONCC-ElkC.3.1.4	Hydrology	No	Improve flow timing or volume	Restore hydrograph	Central Elk Valley and Crescent City	BR
SONCC-ElkC.3.1.4.1	*Complete comprehensive flow study to determine the natural flow regime through Elk Valley*					
SONCC-ElkC.3.1.4.2	*Disconnect unnatural channels and ditches that can not support spawning or rearing.*					
SONCC-ElkC.3.1.5	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-ElkC.3.1.5.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-ElkC.3.1.6	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	BR
SONCC-ElkC.3.1.6.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-ElkC.3.1.7	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-ElkC.3.1.7.1	*Establish a categorical exemption under CEQA for water leasing*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-ElkC.3.1.8	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	BR
SONCC-ElkC.3.1.8.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-ElkC.3.2.9	Hydrology	No	Increase water storage	Improve water retention	Central Elk Valley and Crescent City	BR
SONCC-ElkC.3.2.9.1	*Maintain open space lands (e.g., agriculture, forestland) for water retention and limit addition of impervious surfaces in the watershed.*					
SONCC-ElkC.3.2.9.2	*Manage runoff from impervious surfaces in such a way that it does not negatively impact hydrologic function*					
SONCC-ElkC.27.2.22	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-ElkC.27.2.22.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-ElkC.27.2.22.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-ElkC.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-ElkC.27.1.23.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-ElkC.27.2.24	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-ElkC.27.2.24.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-ElkC.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-ElkC.27.1.25.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-ElkC.27.1.25.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-ElkC.27.2.26	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-ElkC.27.2.26.1	*Determine best indicators of estuarine condition*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ElkC.5.1.20	Passage	No	Improve access	Reduce flow barrier	Population wide, especially Elk Valley Road, Nune's Creek	BR
SONCC-ElkC.5.1.20.1	*Inventory, describe, and map migration and flow barriers and develop a plan to restore passage*					
SONCC-ElkC.5.1.20.2	*Restore passage, guided by plan*					
SONCC-ElkC.5.1.21	Passage	No	Improve access	Remove structural barrier	Population wide, especially Elk Valley Road, Nune's Creek	BR
SONCC-ElkC.5.1.21.1	*Upgrade culverts to accommodate fish passage at all life stages*					
SONCC-ElkC.8.1.11	Sediment	No	Reduce delivery of sediment to streams	Improve land management practices	Central and Upper Elk Valley	BR
SONCC-ElkC.8.1.11.1	*Develop an educational program that shares BMPs for major land practices (e.g. timber harvest agriculture, water treatment, grazing, private roads)*					
SONCC-ElkC.8.1.12	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	BR
SONCC-ElkC.8.1.12.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-ElkC.8.1.12.2	*Decommission roads, guided by assessment*					
SONCC-ElkC.8.1.12.3	*Upgrade roads, guided by assessment*					
SONCC-ElkC.8.1.12.4	*Maintain roads, guided by assessment*					
SONCC-ElkC.10.2.18	Water Quality	No	Reduce pollutants	Reduce point- and non-point source pollution	Central Elk Valley and Crescent City	BR
SONCC-ElkC.10.2.18.1	*Identify point and nonpoint pollution sources throughout the watershed, especially those sites known to have been associated with past milling operations (e.g. Lower Elk Valley ponds)*					
SONCC-ElkC.10.2.18.2	*Implement strategy to prevent pollution such as hydrologically disconnect contaminated sites from Elk Creek (esp. contaminated mill sites)*					
SONCC-ElkC.10.2.19	Water Quality	No	Reduce pollutants	Educate stakeholders	Central Elk Valley and Crescent City	BR
SONCC-ElkC.10.2.19.1	*Reduce or minimize both domestic and municipal sources of nutrient input (i.e., sewage treatment plant discharge and storm drain runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.*					

17. Wilson Creek Population

- Central Coastal Diversity Stratum
- Dependent Population
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 26.5 mi^2
- 19 IP km (12 mi) (54% High)
- Dominant Land Uses are Timber Harvest and Recreation
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Degraded Riparian Forest Conditions’
- Principal Threat is ‘Roads’

17.1 History of Habitat and Land Use

Historically, timber harvest dominated the land use in the population area, and continues in many areas today. Lasting impacts to instream habitat from historic logging operations include increased sedimentation and erosion from unpaved logging roads and road crossings, decreased large wood recruitment, and decreased channel complexity. Currently 75 percent of land in the watershed is used for timber production while the remaining 25 percent is the Del Norte Coast Redwoods State Park and Redwood National Park (Pacific Watershed Associates (PWA) 2004). In the early 1900s, California established Del Norte Coast Redwoods State Park, which has numerous intact old-growth stands, while the federal government has managed Redwood National Park, which includes some previously harvested lands, for conservation goals since 1968. In 1994, the State of California and the National Park Service agreed to manage the parks jointly. Highway 101, built in 1926, continues to impair estuarine function of some streams and is a barrier to fish passage on at least one stream. While in a relatively rural area, there has been residential and industrial development in and around the Wilson Creek population area. In the streams immediately south of Crescent City, rural development and roads impact coho salmon habitat through alterations to fish passage and stream function. More recently, the housing developments in the northern part of the population area have encroached on these small coastal creeks.

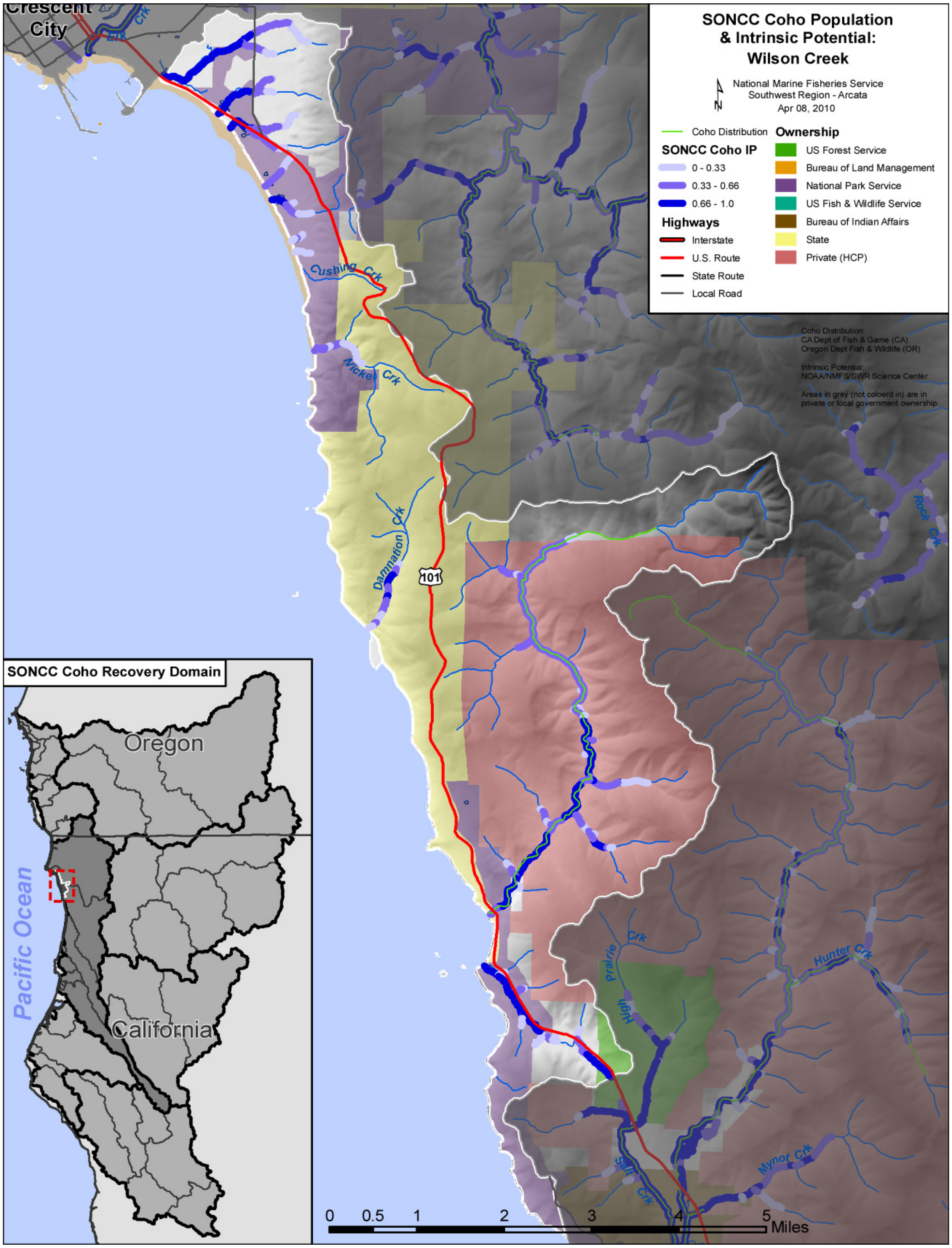

Figure 17-1 The geographic boundaries of the Wilson Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006) Grey areas indicate private ownership.

17.2 Historic Fish Distribution and Abundance

The Wilson Creek population area is comprised of Wilson Creek as well as several smaller creeks along the coast north and south of Wilson Creek. The population area includes seven small creeks just south of Crescent City, which are currently unnamed, as well as Cushing Creek, Nickel Creek, Damnation Creek, Wilson Creek, and Lagoon Creek. Each of these creeks contributes to the persistence and continued survival of the Wilson Creek population of coho salmon. Aside from a small subset of historical data on juvenile abundance in Wilson Creek, no long-term data exist on coho salmon characteristics in the Wilson Creek population area. Fish rescue data taken between 1939 and 1952 ranged from 41,507 juveniles in 1940 to 1,957 juveniles in 1952 (Brown and Moyle 1991) and suggest highly variable, but at times substantial, numbers of juvenile coho salmon occupying the Wilson Creek drainage.

The lower four miles of the creek has high intrinsic potential (IP > 0.66). Other creeks in the area also exhibit high IP values for coho salmon including Nickel Creek, Cushing Creek, Lagoon Creek and several unnamed, small coastal streams south of Crescent City. The highest potential is primarily restricted to the coastal bottomlands of these streams. Many of these streams may have supported coho salmon in the past and likely provided habitat for occasional strays and juveniles in years with abundant returns. Wilson Creek is probably the only creek in the population area to have independently supported large coho salmon runs in the past.

Table 17-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Subarea	**Stream Name**
Wilson Creek	Cushing Creek
	Damnation Creek
	Lagoon Creek
	Wilson Creek[1]
	Unnamed coastal creeks approximately 2 miles south of Crescent City

[1]Denotes a “Key Stream” as identified in the State of California’s Coho Salmon Recovery Strategy

17.3 Status of Wilson Creek Coho Salmon

Spatial Structure and Diversity

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access have diverged from historical conditions, the greater the extinction risk. The geographic extent of this population, which occupies an area less than 30 square miles, and encompasses only a few small coastal watersheds, make it naturally isolated. Although the availability of suitable, high IP habitat suggests that historically coho may have occupied streams throughout the population area, recent surveys suggest their current distribution is limited to the Wilson Creek drainage.

Many of the creeks within the population area have never been surveyed for fish presence or habitat condition, and only Wilson Creek has been thoroughly surveyed for coho salmon. Survey data is lacking for determining the presence and distribution of juveniles in the additional drainages in the basin, but the presence of high IP habitat suggests these areas could potentially support coho salmon. The unnamed creeks just south of Crescent City have the highest potential for having had historic runs and supporting current runs, but current presence/absence data does not exist. A very limited amount of habitat and/or fisheries data is available for Lagoon Creek, Nickel Creek, and Cushing Creek, and none confirm the presence of coho salmon in these small watersheds. The presence of steelhead in Nickel Creek, however, suggests current habitat conditions may be suitable for coho salmon.

Within Wilson Creek, natural fish passage barriers and stream conditions restrict the availability of summer rearing habitat. Known rearing habitat is found in most of the area upstream of the Redwood National and State Parks boundary (below which the stream is intermittent in summer) and downstream of the Green Diamond Resource Company (GDRC) property line (above which a natural waterfall exists). This reach is approximately 5 miles long with four major tributaries. High IP values in this reach exist in the first 2.5 miles upstream of the park boundary. Survey data indicates the presence of coho salmon juveniles although no documented spawning by coho salmon occurs in the area. While other high IP areas exist in the Wilson Creek basin, it is likely that these areas are degraded by historic and current land use activities such as logging, road building, and development. Salmon spawn in only 2.5 km of the historic 18.8 kilometers of habitat (13 percent), indicating a severe restriction in distribution and spatial structure.

Population Size and Productivity

Data suggest the size of the Wilson Creek population is highly variable and the population is dependent on production from other populations. Williams et al. (2008) characterized the population as dependent because of its low productive potential and high degree of outside influence. NMFS is aware of only one coho spawning survey for the population, conducted in Wilson Creek, which documented only one redd. However, the presence of juvenile coho salmon (GDRC 2009) and use of Wilson Creek by other salmonid species for spawning confirms the presence of suitable spawning conditions (GDRC 2006). In small spawning populations, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may become too great. This situation accelerates a decline toward extinction.

It is likely that much of the production that occurs in this population is in Wilson Creek, where coho salmon juveniles consistently occur. The number of juveniles has varied widely as indicated by Green Diamond summer surveys between 1995 and 2010. The estimated population was almost 1,400 in 1995, fell to fewer than 50 by 1999 and 2000, fluctuated between about 500 to 11,000 juveniles from 2001 to 2008, was 0 in 2009, and then rose to 1843 in 2010 (GDRC 2011a). Prior to this sampling effort, CDFG observed only two outmigrating coho smolts leaving the system in 1987, and concluded the low recruitment was due to low young-of-the-year (YOY) survival and an overall lack of suitable rearing habitat. Coho salmon presence was detected for 13 of 16 brood years sampled in the years 1983 to 2002 (Jong et al. 2008). Despite the fairly consistent presence of coho salmon in the Wilson Creek population, the low abundance of spawners and the highly variable population numbers indicate low population size and poor productivity.

Extinction Risk

Not applicable because Wilson Creek is not an independent population.

Role in SONCC Coho Salmon ESU Viability

The Wilson Creek population is dependent because it does not have a high likelihood of sustaining itself over a 100-year time period in isolation and likely received sufficient immigration to alter its dynamics and extinction risk (Williams et al. 2006). Although such populations may not be fully viable on their own, they do increase connectivity by allowing dispersal among independent populations, acting as a source of colonists in some cases. Historically, the Wilson Creek population would have interacted with other potentially independent populations, such as the Smith River to the north or the Lower Klamath River to the south, as well as the dependent Elk Creek population to the north. Any restored habitat in Wilson Creek provides potential connectivity and increased resiliency in the SONCC coho salmon ESU.

17.4 Plans and Assessments

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The California Fish and Game Commission adopted the Recovery Strategy for California Coho Salmon in February 2004. The CDFG Recovery Strategy for the Wilson Creek population includes recommendations for the Wilson Creek hydrologic sub-area (HSA) but not for the other watersheds in the population area. The recommendations developed by CDFG for all SONCC coho salmon populations have been considered and incorporated into the recovery strategy and list of recovery actions where appropriate.

Wilson Creek Watershed Assessment and Erosion Prevention Planning Project

This CDFG-funded project (PWA 2004) identified current and future sources of sediment from roads within the Wilson Creek watershed. This work included a) an analysis of historic photos to determine road construction history; b) an inventory of current and future road-related sediment sources for 109 miles of logging road; and c) a prioritized plan for cost-effective erosion control and erosion prevention treatments for the Wilson Creek basin. The analysis identified 520 sites with the potential to deliver sediment to streams and prioritized the areas for treatment before they deliver sediment to Wilson Creek and its tributaries.

Redwood National and State Parks

Fish Distribution and Status Survey

In 2006, the RNSP surveyed seven watersheds within the park to determine the distribution and status of threatened and non-listed salmonid species. Included in this survey was an assessment of the lower 135 meters of Nickel Creek.

California Conservation Corps

Green Diamond Resource Company

Habitat Conservation Plan

Green Diamond Resource Company (GDRC) owns forestland in the Wilson Creek basin. The GDRC developed an Habitat Conservation Plan, which was finalized in 2006 and is valid through 2056, in accordance with ESA section 10 to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to Green Diamond's activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species (GDRC 2006). The plan contains a number of provisions designed to protect coho salmon and salmon habitat throughout the population area.

17.5 Stresses

Table 17-2. Severity of stresses affecting each life stage of coho salmon in the Wilson Creek population. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	High	High	Very High[1]	High	High	High
2	Degraded Riparian Forest Conditions[1]	-	High	High[1]	High	High	High
3	Altered Sediment Supply	High	High	High	Medium	Medium	High
4	Altered Hydrologic Function	Medium	Medium	Medium	Medium	-	Medium
5	Impaired Estuary/Mainstem Function	-	Low	Medium	Medium	Medium	Medium
6	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
7	Impaired Water Quality	Low	Low	Low	Low	Low	Low
8	Barriers	-	Low	Low	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
10	Adverse Fishery-Related Effects	Low	Low	Low	Low	Low	Low

[1]Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Lack of floodplain and channel structure and degraded riparian conditions are the limiting stressors for the Wilson Creek coho salmon population. These stressors are likely limiting juveniles by causing decreases in rearing habitat, large wood, simplifying instream habitat, and causing the disconnection of refugia for winter and summer rearing habitat. Additionally, these stresses affect adult coho salmon by decreasing available spawning habitat in high IP streams and tributaries.

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure and associated decreases in rearing habitat pose a high or very high stress to coho salmon across all life history stages. Alterations to instream habitat have led to a significant decrease in the quality and quantity of rearing habitat, which is the limiting factor for juvenile coho survival and viability in the Wilson Creek population area. Sedimentation from current and historic logging, road building, and development has led to the filling, widening and simplification of stream channels, disconnection of floodplains and other off channel areas, and the loss of pool habitat. These changes have also affected flow regime, the availability and quality of spawning habitat, and bedload movement throughout the basin.

The amount of in-channel large wood is likely substantially lower than historical conditions. There have been two habitat surveys in the Wilson Creek watershed, one in 1994 (GDRC 2006) and another in 2005 (GDRC 2011b). The total number of pieces of large wood in the active channel increased from 2.1 per 100 feet to 2.9 per 100 feet, with most of the change due to an increase in the number of pieces in the smallest size category (6-20 feet long and 1-1.9 feet diameter). This increase is likely due to the placement of large wood structures in Wilson Creek over the past 10 years. The amount of large wood in Wilson Creek is lower than in most other inventoried streams on Green Diamond land (GDRC 2006), well below levels required for healthy stream function, and the small size of this wood (less than 2 foot diameter) reflects the alder-dominant riparian zones prevalent in the watershed. The lack of large diameter wood results in decreased amounts of in channel shelter and decreases the formation of pools and other refugia vital to juvenile survival (CH2MHILL 2006). Percent pools by length remained static between the 1994 and 2005 surveys at 28-29 percent, while the proportion of pools greater than 3ft deep by occurrence decreased from 55 percent to 48 percent.

Channels predicted to be moderate IP habitat in some small unnamed streams in the lowlands of the northern portion of the population area appear to have been filled in to accommodate agriculture and residential development, because they currently lack defined stream channels but there is riparian vegetation present upstream (Figure 17-2).

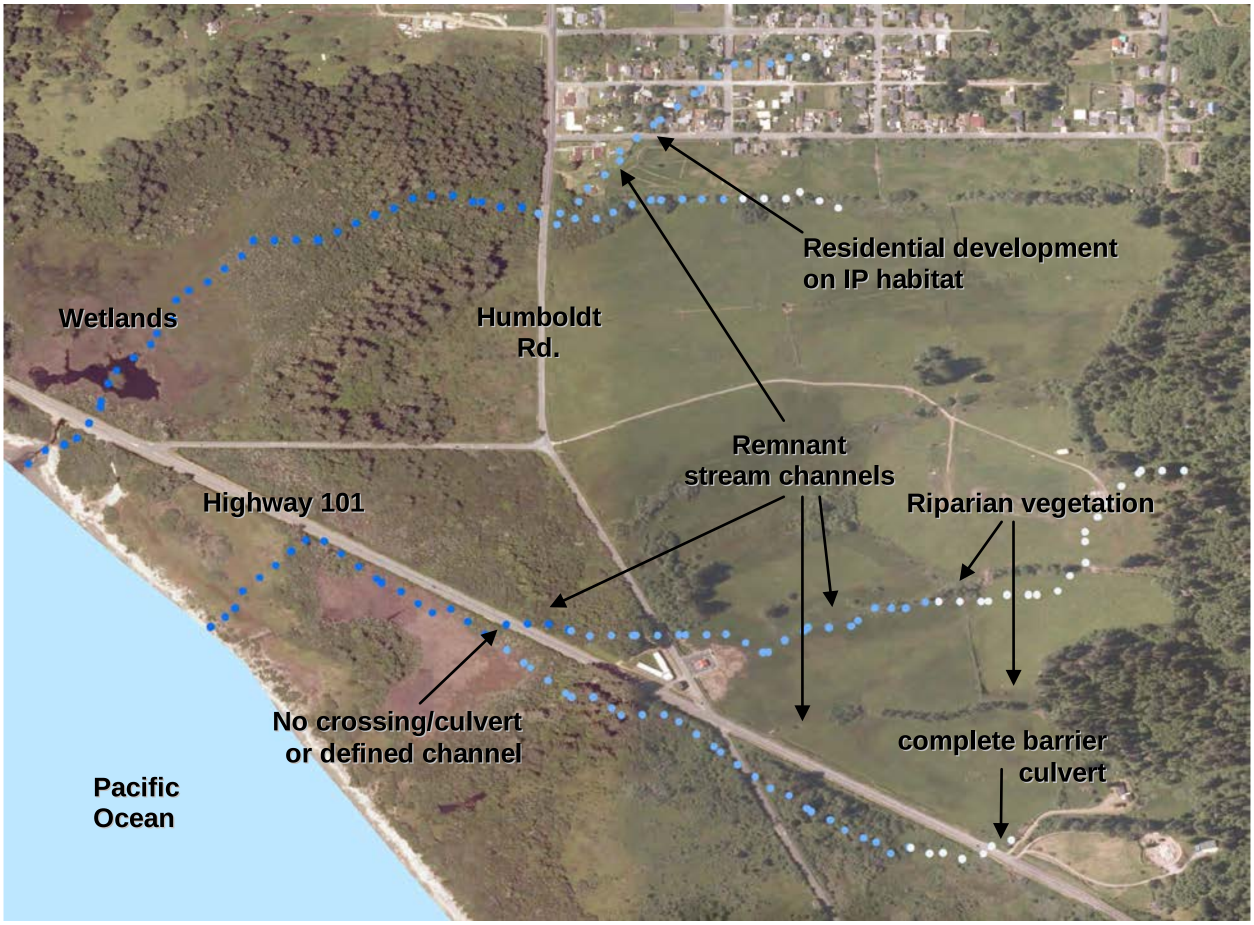

Figure 17-2. Aerial photo of the floodplain of un-named creeks in the northern portion of the population area, just south of Crescent City. Dotted lines represent IP habitat (Williams et al. 2006). Photo from the U.S. Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) taken in 2010.

Degraded Riparian Forest Conditions

The impacts of degraded riparian conditions on juvenile and adult coho salmon include increased sedimentation and bank instability, and lack of stream complexity due to poor wood recruitment. These impacts are the result of historic and current logging practices and residential development throughout the watershed. Mean percent canopy in Wilson Creek decreased from 79 percent in 1994 to 58 percent in 2005 and is provided almost entirely by hardwoods (GDRC 2006, 2011b).

Altered Sediment Supply

Altered sediment supply is a high stress to the early life stages of coho salmon in the Wilson Creek population. Alterations to the sediment supply have resulted from historic and current logging in the basin, road building in unstable areas, and removal of vegetation from riparian areas and upslope sites for urban development. Sediment loading has led to the filling in and widening of stream channels, increase in fine sediment, decreases in pool depth and complexity, mortality of eggs and smothering of redds, and changes in channel form that may result in passage problems. In lower Wilson Creek, sediment deposits have eliminated surface flows during certain times of the year, limiting connectivity for migrating juveniles. Assessments of erosion and sedimentation in the watershed (PWA 2004) confirm the high level of this stress. The percent of pool tailouts with 0-25% embeddedness decreased from 37 percent in 1994 to 28 percent in 2005 (GDRC 2006, 2011b), suggesting the fine sediment levels may be decreasing in Wilson Creek.

Altered Hydrologic Function

Sediment from logging and road construction negative affects the hydrologic function of streams in the population area. Sediment has eliminated surface flows in up to 3 miles of the lower part of Wilson Creek during low flow conditions, which has limited connectivity and decreased rearing habitat availability for juveniles. Summer fish surveys by Green Diamond in 2010 and 2011 found that the creek remained wet for approximately another 0.5 miles downstream than it did between 1995 and 2009 (GDRC 2011b), to the most upstream high IP habitat shown in Figure 17-1. A review of aerial photos indicates annual variability of which portions of the lower creek are dry. Natural hydrologic function is important for maintaining summer rearing habitat for juvenile coho, and can be improved by improving timber harvest practices, treating road systems, decommissioning roads, and managing development for increased ecosystem function.

Impaired Estuary/Mainstem Function

The major coho-producing stream, Wilson Creek, lacks an estuary (GDRC 2006). It is unclear if this is a natural condition or is caused by channel confinement and fill associated with Highway 101. Other small streams in the population area are experiencing loss of estuarine habitat and degradation of estuarine conditions due to diking, development of wetlands (Figure 17-2), and changes to the hydrograph. Highway 101 creates a permanent dike near the mouths of some of the unnamed streams immediately south of Crescent City, diminishing tidal exchange, creating passage barriers, and disconnecting vital estuarine and off channel wetland habitat. Estuarine and brackish habitats can increase the size and survival of out migrating juvenile salmon. Eliminating impediments to natural estuarine function would increase the value of this habitat and increase growth and survival of juveniles.

Impaired Water Quality

Water temperatures at monitored locations are highly suitable for coho salmon in Wilson Creek (GDRC 2006, 2011b), suggesting that the coastal climate maintains cool water despite the poor riparian shade. Groundwater seeps could also potentially contribute to cool water temperatures. Instream measurements are lacking, but turbidity during winter storm events is likely high. Highway 101 runs through the lower portions of the streams in the population area and is a potential source of chemical/petroleum spills from accidents. Also, the lower end of Lagoon Creek in the southern part of the population area was historically a millpond and is known to contain chemical contaminants (Anderson 2010).

Barriers

Overall, barriers present a low level of stress to the Wilson Creek population. The PWA (2004) Wilson Creek assessment identified 91 road-stream crossings in the watershed, including three sites identified as potential fish barriers located on tributaries with moderate IP habitat. Green

Diamond has since remedied all three sites (Bourque 2011). Surveys have identified at least two impassible culverts on creeks with high IP values in unnamed creeks south of Crescent City (CalFish 2009), one of which is located on Highway 101 and has little or no IP habitat upstream (Figure 17-2). In addition, there is no culvert across Highway 101 at one stream with predicted moderate IP, because either the stream channel never existed or it was filled in (Figure 17-2). Road-stream crossings may prevent juvenile movement and migration during certain times of the year and identified impassable culverts prevent coho salmon from using habitat in those smaller watersheds. Additionally, a number of barriers may exist in key streams, which cause decreased habitat availability and limit the potential spatial structure in the population area.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Wilson Creek population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

Adverse Fishery-Related Effects

NMFS has determined that federally managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). NMFS has not formally evaluated the effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU (Appendix B).

17.6 Threats

Table 17-3. Severity of threats affecting each life stage of coho salmon in the Wilson Creek population. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	High	Very High	Very High	High	High	High
2	Timber Harvest	Medium	Medium	Medium	Medium	Medium	Medium
3	Fishing and Collecting	-	-	-	-	Medium	Medium
4	Climate Change	Low	Low	Low	Low	Medium	Low
5	Urban/Residential/Industrial	Low	Low	Medium	Low	Low	Low
6	Agricultural Practices	Low	Low	Low	Low	Low	Low
7	Channelization/Diking	Low	Low	Low	Low	Low	Low
8	Dams/Diversion	Low	Low	Low	Low	Low	Low
9	High Intensity Fire	Low	Low	Low	Low	Low	Low
10	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low

[1]Mining and Gravel Extraction and Invasive Non-Native/Alien Species are not considered threats to this population.

Roads

Road density within the Wilson Creek population area is over 3 miles of road per square mile of watershed area. Roads are not maintained in many areas, creating landslides, increased sedimentation and alteration of hydrologic function throughout the population area. Watersheds with high road density are thought to be “not properly functioning” (NMFS 1996). Over 109 miles of road in the Wilson Creek watershed exist, of which only a portion are needed for timber operations in the area. Although timber harvest in Redwood National and State Parks ceased in 1968, the remaining roads (many of which are now trails) continue to degrade stream conditions on public lands. Roads contribute the majority of the sediment to the creeks in the Wilson Creek population area and cause loss of habitat complexity within streams (PWA 2004). Much of the excess sediment sources in the Wilson Creek basin originate from poorly built road-stream crossings, areas of landslide erosion, and road surface and ditch erosion. Increased sediment delivery in Wilson Creek has filled pools, widened channels, and simplified stream habitat, decreasing spawning and rearing habitat quantity and quality throughout the area. The Enderts Beach Road/Del Norte Redwoods Coastal Trail, which was originally the historic Highway 101, runs along the entire coast within the Del Norte Coast Redwoods State Park, potentially blocking fish passage in some areas and contributing to sedimentation and erosion in small coastal watersheds (Burgess 2008, Sanders 2008).

Timber Harvest

Although timber harvest was once considered a major threat to coho salmon in the Wilson Creek population, it currently presents a medium threat due to the more limited extent of timber harvest today. Nevertheless, a distinct contrast in tree size is evident between private lands in Wilson Creek (with mainly small trees 10 to 19.9" in diameter) and public lands in western Wilson Creek and in Damnation Creek (with mainly large trees >30" in diameter). The threats posed by timber harvest are confined to the Wilson Creek watershed where logging continues within the roughly 5,000 acres owned by Green Diamond. Within Green Diamond property, harvest occurs at a moderate level and under the direction of the company's HCP, which addresses ways to minimize and mitigate effects from timber harvest through measures related to road and riparian management, slope stability, and harvesting activities. Poor riparian conditions in Wilson Creek and throughout the population area are attributed to past and present timber harvest and continue to be a threat to the Wilson Creek population in many areas. Although some watersheds outside of Wilson Creek may have partly recovered some riparian structure and function, the cessation of timber harvest in riparian areas has been too recent to allow many areas to progress to the necessary late seral stage that provides benefits for salmonids. While working under an HCP provides direction for less intensive and harmful timber harvest activities, the continuation of any amount of timber harvesting will continue to be a threat to the Wilson Creek coho salmon population.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. NMFS has not formally evaluated the effects of these fisheries on the continued existence of the SONCC coho salmon ESU.

Climate Change

There is moderate risk of a change in average precipitation over the next 50 years (Appendix B). Modeled regional average temperature shows a moderate increase over the next 50 years (Appendix B). Average temperature could increase by up to 1^{o}C in the summer and by a similar amount in the winter. The risk of sea level rise is low (Thieler and Hammer-Klose 2000). Adults may be negatively impacted by climate-related ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Urban/Residential/Industrial Development

Due to the current land ownership, threats from urban, residential, and industrial development are minimal in most of the population area; however there is potential for additional development in the floodplain and watersheds of the small unnamed creeks south of Crescent City.

Agricultural Practices

Most of the Wilson Creek population area (80 percent) is comprised of state, federal, and timberlands covered by an HCP. Given that only a fraction of the land base is used for agricultural production, agriculture poses a low threat to all life stages of coho salmon in the population area. There is some cattle grazing on private non-HCP land the Wilson Creek watershed (Bourque 2011), but potential effect on aquatic habitat is unknown. Legacy effects of past agriculture appear to include the filling of channels in some unnamed streams south of Crescent City to facilitate increased agricultural production (Figure 17-2).

Channelization/Diking

Channelization and diking is a low threat to coho salmon in the area, although Highway 101 acts as a dike near the mouth of several unnamed streams south of Crescent City and interferes with hydrologic connectivity. The highway may also act as a dike on Lagoon Creek, which has been highly altered and lacks much of its historic hydrologic function.

Dams/Diversions

Dams and diversions present a low threat to the Wilson Creek coho salmon population. A logjam located near the mouth of Lagoon Creek is probably related to a dam or structure that was built to form the mill pond at the old mill site. It is unknown if this jam is creating a passage problem for fish or causing other hydrologic issues. A natural lagoon may have once been present at this site but was also likely modified to help form the millpond. The likelihood that illegal withdrawal is occurring is minimal since most of the land is in Redwood National and State Parks, or owned by Green Diamond.

High Intensity Fire

The Wilson Creek population area is located in a cool, Mediterranean climate, with no history of episodic or seasonal fire. The area is characterized by cool, wet winters and surrounding redwood forests keep forest conditions moist and fire potential low.

Road-Stream Crossing Barriers

Road-stream crossing barriers pose a low threat to the Wilson Creek coho salmon population. However, a number of barriers exist in key streams and limit or prevent access to high IP stream reaches and reduce connectivity within high IP streams. Road-stream crossings preventing fish passage barriers have been identified in the Wilson Creek watershed, and at least two impassable culverts have been identified in the creeks south of Crescent City.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Wilson Creek population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

17.7 Recovery Strategy

The most immediate need for habitat restoration and threat reduction in the Wilson Creek population area is the mainstem of Wilson Creek, which is the only creek currently occupied by coho salmon. Unoccupied areas must also be restored to provide enough habitat for coho salmon recovery.

The inherent capacity to support coho salmon in the Wilson Creek population area is evident, yet the Wilson Creek population is severely depressed and likely occupies only one small coastal watershed with less than 5 miles of stream habitat. The Wilson Creek population is dependent and therefore cannot be viable on its own; however, it is necessary to restore habitat within the basin so that it can support all life stages of coho salmon and provide connectivity between other populations in the ESU. The recovery criterion for this population is that coho salmon must occupy 20% of IP habitat in years following spawning of brood years with high marine survival. The most important factor limiting recovery of coho salmon in Wilson Creek is a lack of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by increasing habitat complexity within the channel, re-establishing off-channel rearing areas, restoring riparian forests, and reducing threats to instream habitat.

Little is known about creeks in the population area other than Wilson Creek, but occupancy of these creeks would provide greater spatial diversity and capacity to the population. Before time or money is invested in these creeks, however, it must be determined whether coho salmon are present, and the quality and quantity of the habitat there should be evaluated.

Table 17-4 on the following page lists the recovery actions for the Wilson Creek population.

Table 17-4. Recovery action implementation schedule for the Wilson Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WilC.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Unnamed creeks south of Crescent City and Wilson Creek	3
SONCC-WilC.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-WilC.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-WilC.2.2.10	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Unnamed creeks south of Crescent City and Lower Wilson Creek	3
SONCC-WilC.2.2.10.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-WilC.2.2.10.2	*Implement beaver program (may include reintroduction)*					
SONCC-WilC.2.2.11	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Unnamed creeks south of Crescent City and Lower Wilson Creek	3
SONCC-WilC.2.2.11.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-WilC.2.2.11.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-WilC.7.1.2	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	BR
SONCC-WilC.7.1.2.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-WilC.7.1.2.2	*Thin, or release conifers, guided by prescription*					
SONCC-WilC.7.1.2.3	*Plant conifers, guided by prescription*					
SONCC-WilC.7.1.3	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	BR
SONCC-WilC.7.1.3.1	*Apply best management practices for timber harvest*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WilC.27.2.8	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-WilC.27.2.8.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-WilC.27.2.8.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-WilC.27.1.9	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Assess coho habitat use	Unnamed creeks south of Crescent City	BR
SONCC-WilC.27.1.9.1	*Assess coho population use of tributaries and other small streams on RNSP lands*					
SONCC-WilC.27.1.9.2	*Assess coho population use of tributaries and other small streams on private lands*					
SONCC-WilC.27.1.12	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-WilC.27.1.12.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-WilC.27.1.13	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-WilC.27.1.13.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-WilC.27.1.13.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-WilC.27.2.14	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-WilC.27.2.14.1	*Determine best indicators of estuarine condition*					
SONCC-WilC.5.1.4	Passage	No	Improve access	Remove barriers	Lagoon Creek and unnamed coastal creeks, Highway 101	BR
SONCC-WilC.5.1.4.1	*Evaluate and prioritize barriers for removal*					
SONCC-WilC.5.1.4.2	*Remove barriers*					
SONCC-WilC.5.1.5	Passage	No	Improve access	Remove structural barriers	Population wide	BR
SONCC-WilC.5.1.5.1	*Size culverts to 100 year occurrence flows with a minimum diameter of 24 inches.*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-WilC.8.1.6	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	BR
SONCC-WilC.8.1.6.1	*Limit road construction on steep streamside slopes, headwall swales, and shallow-deep seated landslide areas*					
SONCC-WilC.8.1.6.2	*Limit loading and hauling of logs during high risk periods (high rainfall periods)*					
SONCC-WilC.8.1.7	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	RNSP lands in lower Wilson Creek, Nickel Creek, and unnamed tributaries	3
SONCC-WilC.8.1.7.1	*Decommission roads, guided by Wilson Creek Watershed Assessment and Erosion Prevention Planning Project*					

18. Lower Klamath River Population

- Central Coastal Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 5,900 Spawners Required for ESU Viability
- 492.3 mi^2
- 205 IP-km (127 mi) (28 % High)
- Dominant Land Use is Timber Harvest
- Principal Stresses are ‘Altered Sediment Supply’ and Lack of Floodplain and Channel Structure'
- Principal Threats are ‘Roads’ and ‘Timber Harvest’

18.1 History of Habitat and Land Use

For over a century, timber harvest has been the dominant land use within the Lower Klamath River (LKR) subbasin. Small-scale commercial harvest began in the mid- to late-1890s, while intensive logging began in the 1950s with a peak harvest in the late 1960s. By 1969, approximately 50 percent of the subbasin was logged, and by 1994 almost all of the remaining old-growth was logged, including riparian zones (Gale and Randolph 2000). Analysis of aerial photographic data indicated that 90 percent of the subbasin was logged between 1948 and 1997, and the watersheds most impacted by timber harvest included South Fork Ah Pah, Surpur, Morek, Tully, and Johnsons creeks (Gale and Randolph 2000). As timber harvest increased, so did road construction and by 1994 the road density in the subbasin was 5.3 miles of road per square mile of land, with an associated 7,249 road-stream crossings. Stemming from this period of timber harvest and road building was an increased frequency in landslides and debris torrents. Between 1948 and 1997 there were: (1) about 1,729 landslides, 760 of which could be linked to anthropogenic activities, and (2) approximately 255 debris torrents, with 131 linked to anthropogenic activities (Gale and Randolph 2000). Today, Green Diamond Resource Company (GDRC, formerly Simpson Timber Company) conducts the majority of timber harvest in the subbasin and operates under a Habitat Conservation Plan (GDRC 2006).

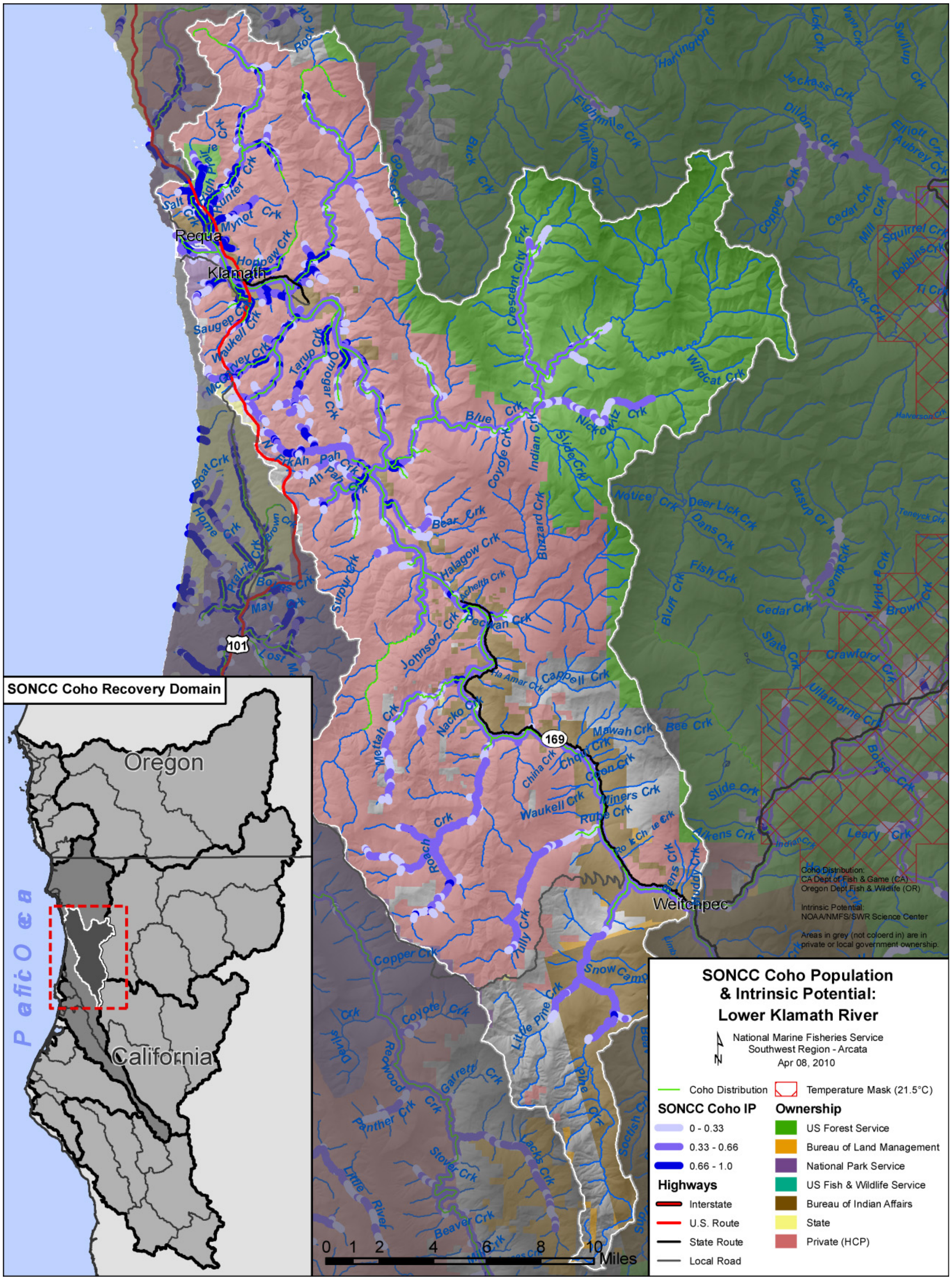

Figure 18-1. The geographic boundaries of the LKR coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Other activities have also played a role in the subbasin history with rural residential development occurring concurrently with the timber harvest. The principal human population centers, near fish-bearing tributaries, include Requa, Klamath and Klamath Glen in the lower portion of the subbasin, and Wautek (Johnsons) and Pecwan in the upper portion of the subbasin. Although only a small portion of the subbasin is suitable terrain for agriculture, conversion of land for farming and ranching resulted in a loss of floodplain habitat in the LKR, including the estuary, which reduces available rearing habitat for juvenile coho salmon. Flood protection for residential communities along the Lower Klamath, and construction of the Highway 101 bypass further reduced floodplain habitat. Small-scale gravel mining and water diversions have also have had localized impacts on the habitat in the LKR (Gale and Randolph 2000) by causing sediment disturbance and potentially increasing sediment deposition onto coho salmon redds in the tributaries or reducing the tributary instream flows.

In addition to anthropogenic activities, floods over the last 150 years have also greatly affected stream channels and riparian ecosystems on the LKR mainstem (Harden et al. 1978, Kelsey 1980, Lisle 1981, 1989). These floods mobilized large amounts of sediment, led to substantial channel aggradation and widening, removed critical riparian forests, and subsequent loss of LWD (Payne and Associates 1989, Gale and Randolph 2000).

18.2 Historic Fish Distribution and Abundance

There is little information on the historic size of the LKR coho salmon population. The commercial gill-net fishery in the LKR caught 11,162 coho salmon (83,836 pounds) between late September and late October 1919 (Snyder 1931). The estimated annual sport fishery catch in the LKR was 1,187 coho salmon in 1951 (Gibbs and Kimsey 1955) and 4,000 coho salmon in 1954 (McCormick 1958). The proportion of coho salmon caught in the aforementioned fisheries that originated from the LKR coho salmon population is unknown. The California Department of Fish and Game (CDFG 2004b) reported that in the 1960s, approximately 8,000 coho salmon returned to the mainstem Klamath River and tributaries (excluding the Shasta, Scott, Salmon and Trinity rivers). The percentage of these fish that originated from the LKR coho salmon population is also unknown.

Historical CDFG and U.S. Fish and Wildlife Service (USFWS) records (1945 to 1993) note the presence of coho salmon in Hunter, Hoppaw, Saugep, Terwer, McGarvey, Tarup, Blue, Bear, Tectah, and Roach creeks (Voight and Gale 1998). Presence and abundance in these streams varied among years and was largely dependent on plantings of coho salmon fingerlings by CDFG. Although most of these plantings were of fish originating from within the subbasin, 20,000 out-of-basin coho salmon from Alsea River, Oregon, were planted in McGarvey Creek between 1962 to 1963. About 150,000 coho salmon fingerlings were planted in Tarup, McGarvey, Hunter, Surpur, and Tectah creeks between 1962 and 1990 (Table 18-1). Planting of coho salmon peaked in the late 1960s and some stocked subbasins were more successful than others (Voight and Gale 1998). The current population of LKR coho salmon may be partial descendants of these planted fish.

Table 18-1. Number of coho salmon fingerlings planted in LKR subbasin tributaries. (Data from Voight and Gale 1998).

Creek	# Coho Salmon Fingerlings Planted	Years	Origin	Program
Tarup	50,000	1968-1990	Unknown	DFG & BIA
McGarvey	20,000	1962-1963	Alsea River, OR	CDFG
Hunter	2,000	1989	Unknown	CDFG & BIA
Surpur	10,000	1969	Unknown	CDFG
Tectah	60,000	1966-1968	Unknown	CDFG

Data concerning historic fish rescue in LKR tributaries provide some information about the abundance of coho salmon in the population area. For example, from 1939 to 1945 there were between 152 and 25,226 juvenile coho salmon rescued in Hunter Creek, from 1950 to 1952 there were between 380 and 3,537 coho salmon juveniles rescued in High Prairie Creek, and in 1940 there were 10,000 juvenile coho salmon rescued in Mynot Creek (Shapovalov 1941). The number of juvenile coho salmon rescued from Terwer Creek ranged from 318 to 13,685 from the 1940s through the early 1950s (Brown and Moyle 1991). In 1989, juvenile coho salmon were observed during fish surveys in McGarvey, Tarup, Tectah, Roach and Ah Pah creeks, but there were less than 10 individuals per creek (Brown and Moyle 1991).

Williams et al. (2008) concluded, based on the model results to predict the IP coho salmon habitat, that the amount of coho salmon habitat included most LKR tributaries (Figure 18-1;Table 18-2). Further, most of the high IP reaches are in the lower (downstream) tributaries.

Table 18-2. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Hunter Creek	Richardson Creek	Salt Creek
Mynot Creek	Omagaar Creek	High Prairie Creek
Spruce Creek	Ah Pah Creek	Bear Creek
Panther Creek	N. Fork Ah Pah Creek	Blue Creek
McGarvey Creek	Tarup Creek	Mettah Creek
W. Fork McGarvey Creek	Waukell Creek	Johnson Creek
Terwer Creek	Saugep Creek	Hog Ranch Creek
Hoppaw Creek	Junior Creek	Roach Creek
Pine Creek		

In addition to providing connectivity to tributary watersheds for spawning and rearing, the mainstem LKR provides migratory and rearing habitat for adult and juvenile coho salmon for all Klamath River coho salmon populations. No reliable records appear to exist on the production of coho salmon in this population, but it is probably high (Brown and Moyle 1991, Soto et al. 2008, Hillemeier et al. 2009, Silloway 2010).

18.3 Status of Lower Klamath River Coho Salmon

Spatial Structure and Diversity

The Yurok Tribe, CDFG, and GDRC conducted multiple fish surveys over the past several decades and from these data we can assess, to some degree, the spatial structure of the LKR coho salmon population. Surveys conducted between 1996 and 2004 found coho salmon in nearly all surveyed streams including Salt Creek, High Prairie, Hunter, Hoppaw, Saugep, Waukell, Terwer, McGarvey, Tarup, Omagaar, Blue, Ah Pah, Bear, Surpur, Little Surpur, , Pularvasar, One Mile, Tectah, Johnsons, Pecwan, Mettah, Roach, Cappell, and Tully creeks (Table 18-3). Coho salmon were generally not well distributed in tributaries upstream of Blue Creek, although many of these creeks contain moderate to high IP habitat (e.g., Mettah, Roach, Tully, and Pine creeks; Gale et al. 1998). In general, coho salmon were only observed in the lower reaches of most tributaries, and in some cases the Yurok Tribe noted that their presence appeared to be attributable to non-natal rearing [Voight and Gale 1998, Yurok Tribal Fisheries Program (YTFP) 2009b].

When present, coho salmon were generally scarce and confined to the lower reaches of tributaries. However, surveys in 1996 indicated well-distributed coho salmon in McGarvey and Blue creeks, with observed patterns similar to historical reports. The distribution of juveniles appeared diminished compared to historical accounts in Hunter, Hoppaw and Tarup creeks (Voight and Gale 1998). Blue Creek was the only tributary where moderate numbers of juvenile and young-of-year (YOY) coho salmon were consistently observed. Three Blue Creek tributaries are important to anadromous salmonid spawning and rearing, including West Fork Blue Creek, Nickowitz Creek, and Crescent City Fork Blue Creek, which is the largest and lowest gradient tributary accessible to anadromous fish in the Blue Creek watershed (Figure 18-1). Large numbers of YOY coho salmon were also observed in Ah Pah Creek in 1997, but abundance was less notable during subsequent years.

Because of the high incidence of non-natal rearing, juvenile survey data cannot be used to determine the distribution of the LKR population. Spawner distribution data may provide more accurate information regarding natal population distribution. Spawning data from a few of the major tributaries in the LKR shows moderate spawner densities throughout surveyed reaches of these watersheds. Spawning coho salmon have been found in Blue Creek (mainstem), Crescent City Fork of Blue Creek, Hunter, Waukell, McGarvey, Terwer, Ah Pah, Tectah, and Pine (Gale 2009a, 2009b; Beesley 2010). Blue Creek is the largest and most resilient LKR watershed and correspondingly supports the largest anadromous fish populations in the subbasin. Habitat surveys in other creeks have shown only marginal habitat suitability for coho salmon spawning, primarily due to the high embeddedness of spawning gravels (Voight and Gale 1998), and lack of channel structure (e.g., fluvial stored wood) required to facilitate necessary gravel sorting and retention dynamics (Beesley and Fiori 2007a, 2008a).

Table 18-3. Tributaries in the LKR population with recent coho salmon presence. Based on surveys by CDFG and YTFP 1990 to 2008.

Stream Name	
Salt Creek	Blue Creek
Hunter Creek	Bear Creek
Mynot Creek	Surpur Creek
Hoppaw Creek	Mettah Creek
Terwer Creek	Tully Creek
Tarup Creek	McGarvey Creek
Saugep Creek	Omagaar Creek
Waukell Creek	High Prairie Creek
Tectah Creek	Little Surpur Creek
Ah Pah Creek	One Mile Creek
Pularvasar Creek	Cappell Creek
Junior Creek	Pecwan Creek
Johnsons Creek	Roach Creek

For the LKR coho salmon population to be at low risk for the spatial structure and diversity threshold, Williams et al. (2008) estimated that a minimum of 29 coho salmon per-IP km of habitat are needed (5,900 spawners total). The current distribution of spawners is well below this threshold. Coho salmon are well distributed throughout the Lower Klamath tributaries, but occur at very low densities. This restricted spatial structure indicates that the population is at increased risk of extinction.

Very little is known about the life history and genetic diversity of the LKR population, but based on survey data the population has been affected by out-of-basin stock planting and hatchery influences. The reduced population abundance has likely led to depensation effects some years (e.g. inbreeding) and reduced genetic diversity. Compared with other Klamath populations, however, tributaries in the LKR subbasin may support some of the healthiest wild coho salmon in the basin. We also know that the population has a relatively high capacity for life history plasticity based on the diversity of unique habitat features and that historically, the population could have had a wide array of life history strategies that utilized diverse tributary and estuary habitats during various times of the year. Because genetic and life history diversity is important in building and maintaining resilience within a population, and is likely reduced from historical levels, the population is at increased risk of extinction based on its reduced capacity for resilience.

Population Size and Productivity

Coho salmon have a wide distribution throughout the Lower Klamath, but almost always low abundances; based on the results of juvenile surveys, spawner surveys, and outmigrant trapping (Voight and Gale 1998, Gale and Randolph 2000, GDRC 2006, YTFP 2009a). Moderate densities of coho salmon are found in Blue, McGarvey and Ah Pah creeks. Age 1+ coho salmon have also been captured or observed in the Lower Klamath River and overwintering survival has been estimated at between 27 and 76 percent with an average of 47 percent (Ackerman et al. 2006, Voight and McCanne 2006).

Surveys have been conducted on many LKR tributaries and the results indicate a low, but relatively constant abundance of juveniles (Voight and McCanne 2002, Mohr and Hankin 2005, GDRC 2009). Juvenile coho salmon abundance in Hunter Creek and East Fork Hunter Creek has fluctuated widely (from 0 to 6,000 individuals) from year to year throughout the last decade. Average estimated abundance is approximately 2,000 individuals per year in Hunter Creek (GDRC 2009). Ah Pah Creek had an estimated average of 3,500 juveniles between 2007 and 2008 (GDRC 2009). Juvenile coho salmon abundance was estimated by Ackerman et al. (2006) to be between 15 and 46,000 individuals from 2002 to 2006.

Consistent spawner survey data are only available from Blue Creek but these data provide a relatively long period of productivity and abundance information for the population (Gale et al. 1998, Gale 2009c). Between 1995 and 2008, 2,562 adult coho salmon were observed (Figure 18-2). Observed numbers of spawners ranged from 4 in 1995 to 1,040 in 2002. Approximately two percent of observed returns were jacks during this period. Although these surveys did not sample the full run of coho salmon, they can provide some indication of coho salmon production from Blue Creek.

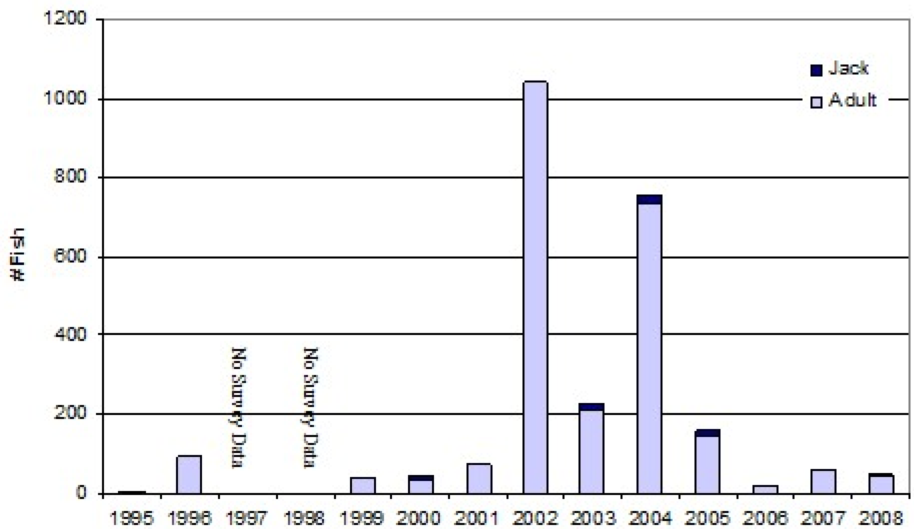

Figure 18-2. Coho salmon observed spawning in the Blue Creek watershed of the Lower Klamath River subbasin between 1995 and 2008. Data are from YTFP snorkel surveys (Gale et al. 1998, Gale 2009c).

Adult coho salmon population abundance, estimated by Ackerman et al. (2006), ranged from 15 to 1,500 spawners between 2001 and 2006, based on juvenile coho salmon abundance in the Lower Klamath River (Table 18-4) and an assumed 10.2 percent marine survival. There does not appear to be a significantly strong or weak year class based on these estimates, a conclusion that is supported by the Blue Creek spawner data.

Table 18-4. Estimates of sub-yearling coho salmon abundance (Voight and McCanne 2002, 2006) and estimated adult abundance in LKR tributaries (Ackerman et al. 2006). Juvenile abundance estimates are for two years prior to the adult return year.

Adult Return Year	Mean Juvenile Abundance	95% CI Juvenile Abundance	Mean Adult Abundance	95% CI Adult Abundance
2001	--	--	512[1]	--
2002	322	15 – 628	14	1 – 28
2003	13,089	8,062 – 18,115	574	354 – 795
2004	33,812	21,433 – 46,191	1,483	940 – 2,026
2005	21,188	10,529 – 31,847	929	462 – 1,397
2006	7,188	499 – 13,877	315	22 – 609

1. Estimate assumed based 2.89 recruits per spawner in Trinity for 2001 brood.

Williams et al. (2008) determined at least 205 coho salmon must spawn in the LKR subbasin each year to avoid effects of extremely low population sizes. Based on criteria established by Williams et al. 2008, the Lower Klamath River population is at high risk of extinction because the spawner abundance has likely been below the depensation threshold of 205 (Table 18-4).

The productivity of the population, based on the juvenile and adult abundance estimates, appears to be declining. Historic data indicate that populations were more abundant as recently as 50 years ago and results of recent data suggests that many populations have experienced low, highly variable abundances of coho salmon over the past decade. It is likely that the population has experienced negative population abundance over the past 50 years and even recent strong returns in some tributaries have not sustained any positive population growth in the population. Because the productivity of the population is negative, the population is at increased risk of extinction.

Extinction Risk

The LKR coho salmon population is not viable and at high risk of extinction. The estimated average spawner abundance from the three lowest consecutive years within the past twelve years is likely less than the depensation threshold of 205 spawners, assuming marine survival of less than 1 percent (NMFS 2011).

Role of Population in SONCC Coho Salmon ESU Viability

The LKR population is considered a “Functionally Independent” population within the Central Coastal diversity stratum meaning that it was sufficiently large to be historically viable-in-isolation and has demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005, Williams et al. 2006). Though strays have minimal influence on the LKR population, this subbasin facilitates straying because of its downstream location in the Klamath River and the number of independent populations in close proximity along the coast. In addition to spawning and rearing habitat, the LKR is important for populations throughout the Klamath and Trinity subbasins. Coho salmon juveniles and smolts from upstream populations use the LKR subbasin during the summer and winter for rearing and acclimation, and adults use thermal refugia for holding prior to migrating upstream (Voight and Gale 1998, YTFP 1999, Soto et al. 2008, YTFP 2009a, Hillemeier et al. 2009, Silloway 2010, Belchik and Turo 2002). In addition, the LKR population is considered a core population. For the stratum and ESU to be viable, the Lower Klamath population must be above its low risk threshold of 5,900 spawners.

18.4 Plans and Assessments

U.S. Forest Service- Orleans District

Watershed Condition Framework
http://www.fs.fed.us/publications/watershed/Watershed_Condition_Framework.pdf

The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands, including the Lower Klamath River. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004 and is a guide for recovering coho salmon on the north and central coasts of California, including the Lower Klamath River. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts.

Yurok Tribe

Yurok Tribal Fisheries Program – Lower Klamath Division - Restoration Plans

Lower Klamath River Sub-basin Watershed Restoration Plan.

This plan (Gale and Randolph 2000) prioritizes upslope restoration and identified tributary specific restoration objectives for a majority of Lower Klamath tributaries. Since 2000, YTFP and the Yurok Tribe Watershed Restoration Program (YTWRP) have been working cooperatively with restoration partners to revise and implement the sub-basin restoration plan and meet program objectives.

Restoration Planning in Lower Blue Creek, Lower Klamath River: Phase 1.

This report (Beesley and Fiori 2008a) describes factors currently limiting salmonid production in lower Blue Creek and presents site-specific restoration strategies that address identified limiting factors.

Geomorphic and Hydrologic Assessment and Restoration Planning in the Salt Creek Watershed, Lower Klamath River Sub-basin, California.

This report (Beesley and Fiori 2007a) describes factors currently limiting salmonid production in the Salt Creek watershed and presents several potential restoration options for improving watershed function and salmonid productivity.

Cooperative Restoration of Tribal Trust Fish and Wildlife Habitat in Lower Klamath River Tributaries.

This report (Beesley and Fiori 2008b) describes factors currently limiting salmonid production in several priority Lower Klamath tributaries and presents site-specific restoration strategies that address identified limiting factors.

Yurok Tribe Environmental Program - Restoration Plans

Klamath River Estuary Wetlands Restoration Prioritization Plan.

This plan (Patterson 2009) applies the California Rapid Assessment Method (CRAM) to assess the ambient condition of wetland complexes in the Klamath River Estuary. The method provides a standardized numerical scoring system for wetland attributes that was used to prioritize sites for wetland mitigation and restoration projects.

Green Diamond Resource Company

Habitat Conservation Plan

About 65 percent of the LKR subbasin is private land; the majority of which is owned by Green Diamond. The Aquatic Habitat Conservation Plan, finalized in 2006 and valid through 2056, was developed in accordance with the ESA section 10 regulations which require Green Diamond to develop a conservation strategy to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to Green Diamond's activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species. The plan has a number of provisions designed to protect coho salmon and salmon habitat throughout the Lower Klamath.

18.5 Stresses

Table 18-5. Severity of stresses affecting each life stage of coho salmon in the Lower Klamath River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult[1]	Overall Stress Rank
1	Altered Sediment Supply[1]	High	Very High	Very High[1]	Very High	High[1]	Very High
2	Lack of Floodplain and Channel Structure[1]	High	Very High	Very High[1]	Very High	High	Very High
3	Degraded Riparian Forest Conditions	High	High	High	High	High	High
4	Impaired Estuary/Mainstem Function	-	Low	High	High	High	High
5	Altered Hydrologic Function	Medium	Medium	High	High	High	High
6	Impaired Water Quality	Low	Medium	High	Medium	Medium	Medium
7	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
8	Increased Disease/Predation/Competition	Low	Low	Medium	Medium	Medium	Medium
9	Barriers	-	Low	Medium	Medium	Medium	Medium
10	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium

[1]Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Several key stresses limit the productivity of this population due to their impact on ecosystem function and on the growth and survival of certain life stages. Altered sediment supply and the lack of complex floodplain and channel structure (LWD) are primary stressors and the most likely limiting stresses due to their impacts on habitat necessary for coho salmon reproduction, growth, and survival in the Lower Klamath River (YTFP 1999, 2009b). Impaired estuary and mainstem conditions may also contribute to losses in the population due to the impact on survival. The overall population-level impact from the impaired estuary is unknown, but assumed to be large given the current state of the Klamath River estuary and its importance to growth and survival of juveniles and smolts. An altered sediment supply in many tributaries has hindered fish passage, resulted in poor summer survival, poor spawning and incubation habitat suitability, and the loss and degradation of stream and off-channel habitat. Most potential spawning reaches have excessively embedded and armored substrate, making redd construction more challenging for adults and reducing permeability in constructed redds. The combination of high rates of sedimentation, lack of channel structure (LWD), and impaired hydrologic function in the mainstem have led to subsurface flows from tributaries during periods of low to no precipitation, resulting in high stranding and mortality rates and reduced growth. Channel sedimentation and lack of channel structure (LWD) resulted in significant loss to overwintering and summer rearing habitat as well. In some streams, the dewatering of tributary reaches substantially reduces summer rearing habitat and can occur so quickly that juveniles are unable to relocate. YTFP has documented substantial juvenile and some adult steelhead mortality associated with seasonal tributary drying events (Beesley 2010).

In terms of floodplain and channel structure, the cumulative cascading effects from high rates of sedimentation, lack of fluvial recruited/deposited wood, and changes in run-off processes (as a result of road building and timber harvest activities) have altered floodplain formation processes. Repeated channel avulsion and valley mobilizing events and subsequent long-term channel incision has resulted in coarsening of floodplain and instream sediments, decreased floodplain hydrologic connectivity, and chronic riparian forest dysfunction. Long-term channel incision in the lower reaches of many tributaries has resulted in a coarsening of bed materials and likely reduced the amount of suitable salmonid spawning gravels. Off-channel habitat (e.g., backwaters, alcoves, or inundated floodplains) used as refugia also become increasingly limited and hydrologically disconnected during periods of long-term channel incision.

Channel simplification (primarily lack of channel structure (LWD), and the lack of floodplain and off-channel habitat availability results in most tributary stream reaches having minimal refuge habitat from elevated winter flows and/or turbidity. This in turn causes fish to be either flushed downstream and out into the mainstem river, to have greatly reduced growth rates due to excessive energy expenditure in the increased velocities, or to perish. This also puts increased demand on river and estuary off-channel habitat as fish pushed into the mainstem search for suitable low-velocity rearing habitat. Additionally, increased turbidity in many tributaries during increased flow events likely hinders winter/spring feeding potential and in turn may be responsible for the reduced growth rates that have been observed in tributary streams versus fish in off-channel habitat (Gale 2010, YTFP 1999, Pagliuco et al. 2011).

In many tributaries repeated aggradation and degradation has also led to floodplain conditions that preclude the establishment of viable and resilient riparian forests. Resulting poor LWD recruitment acts to perpetuate these conditions. LWD serves many different and critically important functions in a watershed. Channel stored wood can alter sediment storage and delivery dynamics, dampen peak flows, facilitate the formation and maintenance of critical salmonid habitats (e.g., spawning beds and pools), and provide cover for fish and other aquatic dependent species. Accumulations of large wood have been observed to be a significant component in floodplain and terrace deposits and help maintain complex instream and floodplain habitat. Fluvial deposited wood has also been attributed to the development of viable and resilient riparian forests.

Looking at the overall productivity of the population, the three most limited life stages are eggs, fry, and juveniles. Spawning and incubation are limited by the lack of suitable spawning gravels due to bed coarsening and embeddedness. Summer rearing is inhibited by the lack of complex instream habitat (e.g., deep pools and LWD) and the loss of summer habitat due to low and subsurface flow conditions in tributaries. Overwinter rearing is inhibited by the lack of complex instream habitat (e.g., deep pools and LWD) and lack of off-channel habitat. The loss of suitable rearing habitat is a key limiting factor for this population and contributes to low productivity.

The primary limiting habitat types for the LKR population are high quality spawning and rearing habitat. It is important to note, the areas that provide valuable rearing habitat can be different from those areas that may provide spawning habitat, however a few key tributaries in the Lower Klamath provide the majority of these habitats to the population. These important tributaries include Tectah, Terwer, Hunter, McGarvey, and Blue creeks (YTFP 2009a). Small pockets of high quality spawning and rearing habitat also exist in Ah Pah, Mettah, Johnsons, High Prairie, Hoppaw, and Tarup creeks. For non-natal populations and for some natal fish, the mainstem, estuary, and lower reaches of several Lower Klamath tributaries offer refugia areas that also provide vital habitat for growth and survival. Vital habitat is listed in Table 18-6 below.

As the largest and most intact tributary in the Lower Klamath, Blue Creek is an area where extensive vital habitat exists and therefore an essential area for recovery.

Although the lower reaches of Blue Creek have been heavily impacted, the majority of the upper watershed and Crescent City Fork is protected on National Forest lands as wilderness or Late Successional Reserve. The upper Blue Creek drainage contains the highest quality habitat and riparian conditions of all the Lower Klamath tributaries. The Blue Creek wild coho salmon stock represents an important genetic stronghold for the LKR coho salmon population (Gale et al. 1998).

Because of seasonally elevated water temperatures in most of the mainstem Klamath River, many LKR tributaries and off-channel areas can serve as thermal refugia during the summer. These refugia areas can be important for juveniles that have been displaced from other habitat and are forced to rear in the mainstem or estuary or migrate through these habitats to reach the ocean during critical summer months (May-September). Summer rearing habitat in these areas is also important for coho salmon (Silloway 2010, Hillemeier et al. 2009). Refugial areas are also used by adult fish that enter the Klamath early in the spawning season. Because many tributaries go subsurface, the majority of available thermal refugia are at tributary mouths. Thermal and low velocity refugia are important for non-natal populations and for the Lower Klamath population juveniles that get flushed out of, or actively leave their natal creeks (Pagliuco et al. 2011, Fiori et al. 2011a, Fiori et al. 2011b). During summer, Pine, Tully, Pecwan, Tectah, and Mettah juveniles have a long journey to reach the ocean.

Table 18-6. Potential vital habitat within the geographic boundaries of the LKR subbasin.

Stream Name	Stream Name	Stream Name
Hunter Creek[1,2]	Morek Creek[2]	Waukell Creek[1,2,3]
Mynot Creek[1]	Ah Pah Creek[1,2]	Saugep Creek[1,2,3]
Spruce Creek[1,2,3]	N. Fork Ah Pah Creek[1]	Junior Creek[1,2,3]
Panther Creek[1,2,3]	Tarup Creek[1,2]	Salt Creek[1,2,3]
McGarvey Creek[1,2,3]	Tectah Creek[1,2]	High Prairie Creek[1]
W. Fork McGarvey Creek[1]	Blue Creek[1,2]	Bear Creek[1]
Terwer Creek[1,2,3]	Crescent City Fork[1,2]	Roaches Creek[2]
Hoppaw Creek[1]	EF Blue[1,2]	Mettah Creek[1]
Richardson Creek[1,2,3]	WF Blue[1,2]	Johnsons Creek[1]
Pine Creek[1,2]	Estuary Sloughs[1,2,3]	Cappell Creek[2]
[1]High Quality Spawning and/or Rearing Habitat [2]Thermal refugia [3]Flow refugia		

Altered Sediment Supply

Altered (increased) sediment supply represents one of the greatest stresses to the population due to the high degree of sediment loading and aggradation that occurs in LKR tributaries. Past and ongoing increased sediment supply in the LKR subbasin reduced quantity and quality of coho salmon habitat for all life stages; therefore, NMFS considers altered sediment supply to have an overall stress ranking of very high. Timber harvest, removal of riparian and instream LWD, and road building (when combined with the naturally erodible geology of the area and large floods), have resulted in substantial streambed sedimentation, excessive channel widening, loss of riparian forests, and an overall reduction in the quality and quantity of instream fish habitat. Mass wasting is common in the region and causes more downslope movement of material than any other geologic process—including stream action (Harris and Tuttle 1984). Such a high degree of sedimentation combined with the loss of fluvial stored LWD and resilient riparian forests, hinders successful spawning of adult coho salmon and emergence of fry, limits access to rearing habitats, increases competition and predation, and reduces macroinvertebrate densities (Gale and Randolph 2000, Beesley and Fiori 2007b). In over one-half of stream pool tailouts surveyed, embeddedness (as a percent occurrence) exceeded 50 percent and often reached 100 percent (Gale and Randolph 2000, GDRC 2006, 2009). Of the streams surveyed (in the 1990s) in the LKR subbasin, the highest embeddedness (>50 percent) were Roaches, Pecwan, Cappel, WF McGarvey, SF Mettah, Johnsons, and Mynot creeks (GDRC 2006). In 2007 to 2008 the frequency of highly-embedded reaches seemed to decrease and Mynot, Hoppaw, and Ah Pah creeks had the highest incidence of embeddedness. It is evident that some reaches within these creeks experience high sedimentation and may have unsuitable gravel for egg incubation and fry emergence.

In addition to reduced quality and quantity of spawning gravels; excessive sedimentation also results in the loss of coho salmon habitat and the loss of connectivity within tributaries due to intermittent periods of subsurface flow during the summer (Beesley and Fiori 2007b). Subsurface flows in the lower reaches and at the mouths of tributaries are due to the interplay of several physical and hydrologic processes, including the timing of sediment transport in tributaries relative to the surface water elevation of the mainstem Klamath River. Deposition of suspended sediment and bedload originating from tributaries occurs when the water surface elevation of the Klamath River is higher than the elevation of the tributary channel. The majority of LKR tributaries flow subsurface during some part of the year (primarily from March to November). During spring and summer there is a loss of rearing habitat and access to and from the upper watersheds. During the fall, spawning may be delayed in some tributaries due to a lack of access. Sediment from upstream watersheds is not only deposited in tributaries, but also downstream in the mainstem and estuary, forming point bars (where sloughs historically were present) and filling pools where coho salmon were once able to hold in the lower river (Beesley and Fiori 2007b).

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure in the LKR population area is a high to very high stress for all life history stages, and is especially stressful to juvenile coho salmon. Most stream reaches are unstable, have simplified instream structure and habitat diversity, excessive erosion and aggradation, and lack suitable spawning gravels, resulting in reduced quality and complexity of instream habitat (Gale and Randolph 2000; Beesley and Fiori 2004, 2007a, 2007b, 2008a, 2008b, 2009). The index of D50 (a measure of median substrate size) can be used to evaluate floodplain and channel structure. Measurements of D50 from Blue, Terwer, and Hunter creeks show variable sediment characteristics between creeks. Although Terwer Creek had very good sediment characteristics, Blue and Hunter creeks had fair to poor spawning gravels (Beesley and Fiori 2008a). Seventy to ninety percent of the particles measured at riffle crests in lower Blue Creek were larger than the preferred size range (14.5 – 35 mm) for salmonid spawning (Beesley and Fiori 2008a; Kondolf and Wolman 1993).

Recruitment of high quality LWD to fluvial habitats is critical to channel formation, floodplain connectivity, spawning gravel sorting, retention dynamics, and instream structure. Active removal of fluvial deposited wood and decades of no or low LWD recruitment has simplified stream and riparian forest complexity, reduced floodplain connectivity and productivity, and reduced the amount of off-channel habitat. The distribution and abundance of LWD in LKR tributaries has been surveyed by the YTFP and GDRC. YTFP (Gale and Randolph 2000) found that LWD in the LKR tributaries ranged from 34 to 537 pieces/mile (average = 230). LWD is the primary cover type in only about 25 percent of LKR tributaries and the lowest densities of LWD (<100 pieces/mile) occurred in Morek, Cappell, and Slide Creek (Gale and Randolph 2000). Conifers comprise between 1 and 19 percent of the riparian canopy in Lower Klamath tributaries and the riparian forest is dominated almost exclusively by deciduous tree species, such as red alder (*Alnus rubra*). Alders are substantially inferior to conifers for maintaining channel stability and floodplain connectivity, and for creating and maintaining productive fluvial habitats for fish and wildlife.

Pool depth and frequency is another important characteristic of streams that provides information about instream habitat quality. Pools were infrequent in most surveyed tributaries (average = 20 percent of total stream length while very good conditions would have >50 percent). Pools were most infrequent in Mynot, Omagaar, Tarup, Bear, and Johnsons (GDRC 2006). Pools throughout LKR tributaries were generally shallow with only about 20 percent of pools >3 ft maximum depth (Gale and Randolph 2000). The tributaries with the lowest number of deep pools (>3 ft) include Mettah, Bear, Ah Pah, Omagaar, Saugep, Hoppaw, Mynot, and High Prairie creeks. Shallow pool depths likely limit the rearing capacity in many streams. Looking at pool habitat complexity, the percentage of LWD as structural shelter in pools reflects the quantity and quality of potential salmonid habitat and possibly the effects of past management practices (GDRC 2006). Looking at these data, we see that most pools lack LWD; West Fork Blue Creek, Johnsons, Roaches, and Tully creeks have a notable lack of LWD in pools. In general, the lack of functional instream and floodplain habitat hinders successful spawning and emergence, limits rearing capacity for juveniles, increases competition and predation, alters food webs, and leads to an overall decrease in growth and survival of coho salmon in the population (Gale and Randolph 2000; Beesley and Fiori 2007b, 2008a, 2008b).

Riparian Forest Conditions

Degraded riparian forest conditions are a high stress for all life stages of coho salmon in this population. Past logging practices have resulted in the removal of nearly all mature conifers from tributary riparian areas (Gale and Randolph 2000). Riparian forests of LKR tributaries have not recovered from these activities, and in many cases, succession from deciduous (e.g., red alder) dominated riparian stands to conifer dominated forests is not occurring. Riparian forests comprised of mature native conifers, especially coastal redwoods, are critically important for creating and maintaining the complex, productive stream and floodplain habitats necessary to Lower Klamath coho salmon populations. Redwood dominated riparian forests facilitate increased channel stability and stream bank protection, provide a continual supply of high quality LWD to fluvial habitats, filter and sort sediment and capture nutrients, provide substantial shade and instream cover, and support complex, self-maintaining stream and riparian food webs. The lack of mature, conifer dominated riparian forests and fluvial LWD recruitment in Lower Klamath tributaries and the mainstem has resulted in increased water temperatures, poor sediment sorting, storage, and delivery dynamics, simplified stream reaches and floodplain areas with low habitat quality (see above). The poorest channel and riparian conditions have been noted in Waukell, Saugep, Surpur, and Little Surpur creeks (Gale and Randolph 2000); however, these conditions persist in virtually every Lower Klamath tributary, including Blue Creek (Beesley and Fiori 2008a).

Currently, conifers comprise less than one third of the riparian canopy along the mainstem Lower Klamath River, and in a majority of the tributaries conifers make up less than 15 percent of the riparian canopy. Live conifers comprise less than 25 percent of the potentially recruitable LWD. Examples of a relatively healthy riparian forest include portions of upper Blue Creek where live conifers comprise between 27 and 77 percent of the total canopy and represent between 40 to70 percent of the potentially recruitable LWD (Gale and Randolph 2000). The lower reaches of Blue Creek, in contrast, exhibit poorly functional riparian areas due to channel incision and concurrent loss of floodplain connectivity, bank instability, and impacts resulting from feral cattle and past logging practices in the watershed (Beesley and Fiori 2008a). The lack of riparian cover and forest regeneration in this area has impacted water quality during the summer (see below) and significantly reduced salmonid rearing capacity, especially during winter-spring (Beesley and Fiori 2008a).

Impaired Estuary/Mainstem Function

The Lower Klamath River mainstem and estuary provide migratory and rearing habitat for all populations of salmon in the Klamath Basin. Although the Klamath River estuary is largely intact and unaffected by urban development, several factors limit its ability to support properly functioning habitat for coho salmon (Hiner and Brown 2004, NFMS 2007b, Beesley and Fiori 2004 and 2008b). This stress is regarded as high for this population of coho salmon in the Klamath Basin. The available rearing habitat has been reduced because of levee construction and channel realignment occurring in the Klamath River estuary and in the lower reaches of a majority of the off-estuary tributaries (e.g., Hunter-Salt Creek slough, Mynot Creek, Hoppaw Creek, and Waukell Creek slough). Large coastal wetlands in the Lower Klamath have been converted into grass pastures for cattle or farming, and the ability of streams to breach their banks and access floodplain habitats during flood events has been severely minimized, especially on the north side of the estuary (Gale and Randolph 2000, Beesley and Fiori 2004, 2008b). A large levee was also constructed around the Klamath Glen community after the 1964 flood and extends along the lower 0.5 miles of Terwer Creek. This levee and others in the lower river have eliminated juvenile access to floodplains, wetlands, and estuarine and tidally influenced sloughs that provide refugia and abundant food resources for rapid growth and increased survival. Patterson (2009) concluded that wetlands in the Klamath River estuary were degraded by various factors ranging from invasive species to cattle grazing and altered hydrology. Sedimentation in the estuary has also reduced quality of estuary habitat through the filling of pools and simplification of instream habitat. Little deep water or off-channel habitat exists in the estuary to provide refugia for coho salmon from high water temperatures in the summer/fall or high flows in the winter.

Mainstem function is a high stress for the LKR population and for other upstream populations due to the conditions encountered when migrating to and from the ocean and while staging and rearing prior to ocean entry. Water quality in the mainstem Klamath River is generally poor (e.g., high turbidity and stream velocities during winter and high water temperatures in summer/fall), and sedimentation from past and ongoing land use have led to substantial reductions in fluvial habitat complexity and loss of refugia. Water temperatures during summer and fall in the lower mainstem Klamath River often exceed upper tolerable thresholds for salmonids (see below). In addition to water quality, water withdrawals from the Klamath River and its major tributaries (e.g., Trinity, Shasta and Scott rivers) have altered the hydrologic regime and resulted in a lowered water table during summer and fall months. Connectivity with most tributaries in the Lower Klamath is impaired during the late summer and fall, and a substantial precipitation event is usually necessary before access is reestablished in the LKR tributaries for migrating adult salmonids (Beesley and Fiori 2007b). As juvenile coho salmon migrate downstream, the lack of adequate rearing habitat and refugia decreases opportunities for growth prior to ocean entry, which can ultimately influence ocean survival. Although this population has the shortest stretch of mainstem to pass through and has relatively good mainstem water quality compared to upstream reaches, the degradation of mainstem conditions and loss of estuarine habitat together constitute a high stress for this population.

Altered Hydrologic Function

Altered hydrologic function is a high stress for the population with the greatest impacts to juveniles, smolts, and adults which are impacted by altered flows in LKR tributaries and an altered hydrograph in the mainstem Klamath River. The timing, magnitude and extent of flows in the Lower Klamath River from the confluence of the Trinity River to the estuary are altered compared to historic conditions. Generally, spring and summer flows are lower than historical flows, while fall and winter flows in the Lower Klamath River are generally similar to historical flows. The hydrologic function of tributaries in the Lower Klamath has also been altered, evidenced by lower portions of tributaries going dry from late spring to fall. The removal of mature conifers from throughout the Lower Klamath has likely resulted in a change in the "wet season" stream hydrograph. In particular, this change in vegetative canopy and slope cover has likely resulted in peak discharge levels of an increased intensity and shorter duration following storm events (Beesley and Fiori 2007b).

Seasonal intermittent drying is the most common pattern observed in Lower Klamath tributaries (Gale and Randolph 2000, Beesley and Fiori 2007b). Most creeks begin drying up at the mouth in late spring/early summer and subsurface conditions progressively migrate upstream during summer/fall. Subsurface conditions are largely driven by the timing, duration, and magnitude of rainfall and river/tributary flows, excessive sedimentation emanating from tributaries, and the combination of sediment transport and backwater interactions between tributaries and mainstem Klamath. Lower Klamath tributaries such as Terwer and Hunter creeks, begin drying upstream of the mouth and subsurface conditions progress both upstream and downstream of this location as the dry season progresses. Based on YTFP investigations, watersheds that appear most impacted by subsurface flow conditions and that are critically important to Lower Klamath coho salmon include Hunter, Terwer, Ah Pah, Tectah, and Johnsons. Lower Klamath tributaries such as Hunter, Mynot, Hoppaw, Tarup, Omagaar, Bear, and Johnsons creeks were usually the first to begin drying in the spring, and typically experienced periods of subsurface flow during winter and early spring months in the absence of continued, frequent rain events. All of these creeks experienced a disruption or complete cessation of flow during critical juvenile emigration periods for most if not all of the years monitored (Gale and Randolph 2000, Beesley and Fiori 2007b). Because of alterations in the hydrology of tributaries, the timing and magnitude of rains in autumn is crucial for salmonid spawners attempting to gain access to spawning grounds (Voight and Gale 1998), and for juvenile fish seeking refuge in tributary habitats to overwinter (Soto et al. 2008, Hillemeier et al. 2009).

Impaired Water Quality

Impaired water quality is a moderate stress for this population and is especially detrimental to juveniles, smolts, and adults. Seasonally high water temperatures in the Lower Klamath River, the estuary, and in lower reaches of some LKR tributaries are a primary limitation for this and other Klamath Basin coho salmon populations. Generally, temperatures near the headwaters of LKR tributaries are mostly very good or good, but water quality decreases in the lower reaches (Bjornn and Reiser 1991). Tributaries such as Roaches, Blue, Pine, and Terwer creeks have localized areas of seasonally high water temperature in their lower reaches. YTFP and GDRC have conducted a water temperature monitoring program in Lower Klamath tributaries since 1995 (YTFP 2009b). These efforts have revealed that tributary water temperatures in the Lower

Klamath consistently remain within acceptable tolerances for coho salmon (Gale and Randolph 2000, Bell 1991). From 1995 to 2000, the annual variation in average daily water temperature was less than 10 ºC in most Lower Klamath tributaries, with the summer maximum temperature never exceeding 16 ºC in most of these watersheds. Lower Blue Creek had the highest recorded summer water temperatures of all monitored tributaries; however, water temperatures still fell within acceptable tolerances for salmonids throughout the year.

In the Lower Klamath mainstem, maximum water temperatures at three Lower Klamath gauging stations exceeded 24 ºC at times and regularly report temperatures above the critical 22 ºC threshold for most of July and August (Hiner 2006, Beesley and Fiori 2004, 2008b). Temperatures in the estuary have also been recorded as being above lethal thresholds; however, thermal refugia in tidal areas may exist (Wallace 1998, Bartholow 2005). In general, water temperatures in the Lower Klamath mainstem are below 17 ºC in the fall when adults typically migrate upstream, and temperatures do not increase in the spring until most juveniles have outmigrated. However, early adult migrations and late spring and summer juvenile migrations have likely been eliminated as fish are likely forced to leave the mainstem and estuary early, thereby reducing the life history diversity of the population.

Data gathered from future and ongoing turbidity monitoring efforts by GDRC and the YTEP will be analyzed to determine if turbidity is an issue for tributaries in the Lower Klamath River. Based on current stream and river sedimentation conditions, it is likely that seasonally high turbidity levels in the Lower Klamath River, and in a majority of its tributaries, is a moderate stressor to most life stages of coho salmon. Dissolved oxygen (DO) concentrations and pH within the mainstem, estuary, and in some of the off-estuary tributaries are generally adequate but can reach levels which are stressful to coho salmon during late summer. DO concentrations below 7 mg/L have been noted during summer months but are generally above threshold levels during the spring and fall when coho salmon are most abundant in these areas (Hiner and Brown 2004, Hiner 2006, NMFS 2007a, Beesley and Fiori 2004, 2008b). Estuary and mainstem reaches can experience wide diel fluctuations in pH during the summer and have been found to exceed upper thresholds of 8.5 during late summer months. Ammonia toxicity can also be a concern when pH levels are high; however, this is more of a concern in upstream reaches where pH levels are higher (NMFS 2007b).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. No hatcheries or artificial propagation occur in the Lower Klamath population area, but there are two hatcheries in the Klamath River basin. Iron Gate Hatchery is upstream on the Klamath River, and Trinity River Hatchery is on the Trinity River, which breaks from the Klamath upstream of the Lower Klamath River population area. Hatchery coho salmon were observed during spawning surveys on Blue Creek, a tributary to the Lower Klamath River (Beesley 2010). The proportion of spawning adults in the Lower Klamath River that are of hatchery origin is unknown. Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of Iron Gate Hatchery and Trinity River Hatchery in the Klamath basin (Appendix B)

Increased Disease/Predation/Competition

Increased disease, predation, and competition constitute a moderate stressor for most life stages and can have a localized or seasonal impact on both juvenile and adult life stages. Rearing habitat is generally limited in LKR tributaries and competition within these habitats likely results from high seasonal concentrations of juveniles (both natal and non-natal). Off-channel winter pond habitat and instream summer habitat in upper reaches of tributaries both likely experience density-dependent competition among natal juveniles and between natal and non-natal juveniles. Competition for thermal refugia in mainstem reaches may also be an issue in this population. Some juveniles may rear in the mainstem and estuary and be limited in their distribution due to scarcity of rearing habitat with adequate water quality. Also, adults may need to hold in the mainstem in refugial areas prior to upstream migration due to hydrologic conditions that inhibit access to tributary spawning groups in the Lower Klamath.

Disease is a significant stressor to coho salmon in the Lower Klamath River. Diseases that affect adults in the Klamath Basin are primarily from the common pathogens Ichthyopthirius multifilis (Ich) and Flavobacterium columnare [columnaris; National Research Council (NRC) 2004]. These pathogens were responsible for the 2002 fish kill on the Klamath River (Guillen 2003, CDFG 2003a, Belchik et al. 2004) although adult mortality from Ich and columnaris are not as common as juvenile mortality from Ceratomyxa Shasta or Parvicapsula minibicornis. Nichols et al. (2003) identified Ceratomyxosis, which is caused by C. shasta, as the most significant disease for juvenile salmon in the Klamath Basin. Generally, disease exposure is much lower below the Trinity River confluence, but is exacerbated by poor mainstem water quality and stressful conditions in the Lower Klamath River (Bartholomew 2008). Disease effects become most evident as water temperatures rise above 14º C. As with the impacts of poor water quality in the mainstem, some life history strategies may be eliminated due to disease impacts, thereby reducing the viability of the population.

Predation can also have localized impacts, but is generally a natural process unless facilitated by anthropogenic alterations to habitat or predator populations. In the Lower Klamath River, pinniped predation is often speculated to be significant; however, Williamson and Hillemeier (2001) found that pinniped predation rates on coho salmon in 1998 and 1999 were only 0.2 percent and 1.2 percent, respectively. Pinniped predation rates offshore and in the open ocean may add to this predation. Also important may be increased seasonal predation rates on juveniles in streams due to the lack of cover and high densities of juveniles in some habitats. It is likely that predation rates are not unnaturally high but do contribute to a reduction in the number of adults returning to the Klamath Basin and the number of juveniles that survive.

Barriers

Barriers are a moderate stress due to the prevalence of flow barriers in most tributaries and the occurrence of road-related barriers. Most tributaries have formed large, persistent gravel deltas at their mouths and these seasonal barriers interrupt successful juvenile emigration in the spring, block adult immigration in the fall, inhibit immigration of non-natal juvenile salmonids, limit the quality and quantity of rearing habitat, increase competition and predation, and alter composition of available food organisms (Payne and Associates 1989, Beesley and Fiori 2007b). There appears to be extensive mortality of juveniles that occurs each year due to subsurface flows, and oversummer survival of natal coho salmon is often reduced by the occurrence of these barriers (Beesley 2010). The dewatering of tributary reaches is primarily the result of excessive aggradation, and loss of fluvial deposited and recruited LWD, as well as deposition of sediment from the mainstem Klamath River and the altered hydrologic function. Large gravel bars and deltas at the tributary mouths form barriers which require either high tributary or mainstem flows to allow fish passage.

Important road-related fish passage and water conveyance issues have been identified on McGarvey, Waukell, Blue, Terwer, and Richardson creeks. A grade control structure on W. Fork McGarvey Creek blocks access to high IP reaches. Three undersized culverts (1 Saugep, 1 Waukell, and 1 Junior) and a grade control structure on Waukell Creek (Klamath Beach Road and Hwy 101), and an impassible culvert (except at higher Klamath River flows of around 20,000 cfs or higher when backwatering occurs) on Richardson Creek (Klamath Beach Road) block access to important tributary habitat and inhibit geomorphic function and floodplain connectivity and thereby reduce the quality and quantity of rearing habitat (Taylor 2007). The Hwy 169 bridge over Terwer Creek and the GDRC bridge over Blue Creek also inhibit geomorphic function and limit floodplain connectivity in these creeks. Due to the importance of blocked tributary and estuary habitat to the LKR population and other Klamath River populations, the impact of these barriers is significant.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

18.6 Threats

Table 18-7. Severity of threats affecting each life stage of coho salmon in the Lower Klamath River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Agricultural Practices	High	High	Very High	Very High	High	High
2	Roads	High	High	High	High	High	High
3	Timber Harvest	High	High	Medium	Medium	High	High
4	Dams/Diversions	Medium	Medium	High	High	High	High
5	Channelization/Diking	Medium	Medium	Very High	Very High	Medium	Medium
6	Climate Change	Medium	Medium	High	High	Medium	Medium
7	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
8	Urban/Residential/Industrial	Low	Low	Medium	Medium	Medium	Medium
9	Fishing and Collecting	-	-	-	-	Medium	Medium
10	Road-Stream Crossing Barriers	-	Medium	Medium	Low	Low	Low
11	Invasive Non-Native/Alien Species	Low	Low	Medium	Medium	Low	Low
12	Mining/Gravel Extraction	Low	Low	Medium	Medium	Low	Low
13	High Intensity Fire	Low	Low	Low	Low	Low	Low

Agricultural Practices

Agricultural practices in the LKR area pose a high to very high threat to coho salmon due to the overlap between agricultural lands and important tributary, mainstem, and estuary habitat. Agriculture in the LKR subbasin has resulted in the loss of habitat due to draining, diking, or filling of wetland, estuary, and floodplain habitat, the loss of riparian forest and LWD recruitment, impacts to bank stability and sedimentation, as well as water quantity and fish passage issues related to diversion of water. Only a small portion of the Lower Klamath subbasin is suitable for agriculture but the impacts from agriculture affect some of the most important tributaries and off-estuary habitats for coho salmon. These include Salt, Hunter, Mynot, Spruce, Hoppaw, Terwer, Tarup, Panther, and Blue creeks. Portions of the estuary have also been diked and filled for agriculture, especially near the Salt Creek and Hunter Creek confluences and near Rekwoi. The loss of estuarine and tributary habitat is on the order of hundreds of acres of floodplain and wetland habitat.

Cattle are actively grazed on private land in Salt, lower Hunter/Mynot/Spruce, Hoppaw, Panther, and lower Terwer creeks. Most of these pastures (except in lower Terwer Creek) are located within the floodplain of the Klamath River. The Hunter, Mynot, Spruce, and Salt Creek pastures were established through diking and conversion of the Hunter Creek slough. The Terwer Creek pastures were established on a large floodplain terrace near the confluence with the Klamath River. Cattle are also grazed on the Klamath River bar at the confluence of Tarup, Pecwan, and Johnsons Creeks. In addition to these established grazing operations, feral cattle exist in Terwer, Blue, and Bear creeks. The cattle have slowly extended its range over the past 10 years and now extends upstream to the mouth of Slide Creek (Blue Creek tributary), near the lower boundary of the Siskiyou Wilderness Area. Grazing by these feral cattle has degraded riparian function and has created highly unstable banks and high rates of sedimentation and aggradation. Although cattle on Salt, lower Hunter and Mynot creeks have been excluded from the stream channel, cattle operations in these areas remain a significant limitation and threat to coho salmon. In some areas such as Terwer Creek, the YTFP has been working with landowners to provide benefits to both fish habitat and agricultural uses including the construction of two off-channel wetlands and by conversion of hay fields to riparian forests (Fiori et al. 2011a, 2011b, Pagliuco et al. 2011).

Roads

The density of unpaved roads (>3 mi. per sq. mi) in the Lower Klamath creates a high threat to the coho salmon population. The highest densities of roads (>9.6 mi. per sq. mi) exist in Ah Pah, Surpur, Waukell creeks (Gale and Randolph 2000). Many streams have over 12 road crossings per square mile and the South Fork Ah Pah watershed has over 25 road crossings per square mile. The cumulative sedimentation that has occurred over the past 50 years of road-building and intensive logging has caused significant impacts to stream habitat. GDRC owns and manages approximately 169,600 square miles of lands below the Trinity River confluence for timber production and a majority of roads in the subbasin exist on these lands. As part of the GDRC HCP (2006), the company has prioritized road upgrades and decommissioning for 30 subbasins across its Lower Klamath River holdings. Implementation of these measures will contribute to an overall improvement of ecosystem function, habitat quality and quantity through the watersheds with prioritized sites. Although the impacts from some existing roads may decrease through implementation of the HCP, the dominant land use within the Lower Klamath subbasin is still timber harvest so a majority of these roads will continue to be used and will continue to deliver sediment to streams.

Another major impact from roads is the impact that Highway 101 and rural roads have on estuary and tributary habitat in the Lower Klamath. Highway 101 passes through or borders approximately 3 miles of estuary wetland habitat. In addition to the direct loss caused by the road footprint, the hydrologic connectivity of off-estuary wetlands located in the vicinity of the highway has been altered by the road and associated infrastructure, dikes, and levees along this route (Beesley and Fiori 2008b). This altered hydrology affects estuarine function, especially during storms. Much of the estuary’s ability to convey or store high flows without damage to mainstem and tributary channels has been lost. Altered hydrology has also led to downcutting, further separating the streambed from the floodplain. Smaller highways and roads in the subbasin have a similar effect. For example the Hwy 169 bridge over Terwer Creek and the

GDRC bridge over lower Blue Creek are undersized and limit geomorphic function (Beesley and Fiori 2008a, 2008b).

Timber Harvest

Timber harvest is a high threat for a majority of the coho salmon life stages because of the extent of harvest in the Lower Klamath tributaries and the existing poor habitat conditions. The majority of private timber land in the LKR population area is owned by GDRC, and will continue to be harvested for timber. Within GDRC property, harvest occurs at a moderate to high level and under the direction of the company's HCP (GDRC 2006). This plan lays out goals and objectives to minimize and mitigate effects from timber harvest through measures related to road and riparian management, slope stability, and harvesting activities. Timber harvest is still the dominant land use within the Lower Klamath subbasin and the impacts of these activities, even when carried out under the HCP guidelines, include the loss of pool habitat, loss of LWD and stream complexity, altered hydrology and nutrient cycling, and increased sediment loads.

Dams/Diversions

Dams and diversions pose a high threat to the population and have the greatest impact on juveniles, smolts, and adults. Although there are no large dams or major diversions in the Lower Klamath, the large upstream diversion of water and the existence of numerous large dams perpetuate impacts on the mainstem Klamath River. Iron Gate, Copco 2 and 1, JC Boyle and Keno dams create significant stresses in the mainstem river (NMFS 2007c). Low dissolved oxygen, elevated summer/fall water temperatures, and high nutrients are some of the water quality issues exacerbated by the four mainstem dams. Poor water quality and changes in hydrology in the mainstem has been shown to affect disease incidence and mortality as well.

There are only a few diversions in the LKR subbasin, and these are negligible compared to the Klamath, Trinity, Scott and Shasta diversions. The total amount of water diverted within the LKR area is not known, but is assumed minor relative to available water supply. Diversions to the Klamath Project in the Upper Klamath subbasin, the Trinity River Diversion, and diversions from the Scott and Shasta Rivers, decrease the total volume of water that otherwise would have naturally flowed down the Lower Klamath River reach (NMFS 2010, NMFS 2009a). The Klamath Project diverts between approximately 245,000 to 350,000 acre-feet (depending on water year type) each year. The Trinity River Division diverts an average of 53 percent (670,393 AF) of the subbasin runoff at Lewiston. Together, these major diversions cumulatively decrease the natural mainstem flows of the Lower Klamath River by an average of 915,000 to 1,020,000 acre-feet per year. Reductions in flow and changes in the shape of the hydrograph can exacerbate water quality issues in the mainstem and increase the occurrence and severity of sediment barriers at many tributary mouths in the Lower Klamath. These diversions decrease the quantity of mainstem flows on the Klamath River mostly during the spring and summer months, when juvenile access to cooler tributaries and cooler mainstem water temperatures is essential.

Generally, spring and summer flows are lower than historical flows, while fall and winter flows in the Lower Klamath are generally similar to historical flows. The hydrologic function of tributaries to the Lower Klamath has also been altered, as evidenced by downstream portions of tributaries going dry during late spring and summer (e.g., Terwer Creek).

Channelization/Diking

Channelization and diking pose a moderate to very high threat to the population due to the associated loss of habitat in the estuary and along many important tributaries. Salt, High Prairie, Hunter, Mynot, Hoppaw, Waukell, Terwer, Saugep, Spruce, and Johnsons creeks have all been impacted by these activities (Gale and Randolph 2000, Beesley and Fiori 2004, 2008b). The lower two miles of Hoppaw Creek have been subjected to levee construction, channel realignment, and channelization for purposes of flood protection and Waukell Creek was realigned and channelized during the relocation of Highway 101 after the 1964 flood. A levee was constructed around the Klamath Glen housing community following the 1964 flood and this levee extends along the lower 0.5 miles of Terwer Creek, between its confluence with the Klamath and the Highway 169 bridge crossing.

Similarly, levee construction has eliminated estuarine slough habitat near the confluence of Salt and Hunter creeks and both these creeks have been channelized through present day pastureland. Hunter Creek levees extend from its mouth to the Hunter Creek subdivision (2.5 miles), while the Salt Creek levees extend upstream of the Requa Road bridge crossing (0.5 miles). High Prairie Creek has been channelized between the Redwood Community subdivision and the Highway 101 bridge crossing (the lower 3,500 feet). Similarly, levees were built along lower Mynot Creek from its confluence with Hunter Creek to upstream of the Margaret Keeting School (Gale and Randolph 2000).

These levees continue to reduce or eliminate hydrologic connectivity of floodplains, wetlands, and estuarine sloughs that provide essential ecosystem functions and productive juvenile rearing areas. Some natural dikes and channels have also formed as a result of excessive sedimentation and flow alterations. Numerous historic off-channel areas and tributaries are inaccessible permanently or seasonally due to inadequate flows and sediment accretion.

Climate Change

Climate change poses a medium to high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. Although the current climate is generally cool, modeled regional average temperature show a moderate increase over the next 50 years. Average temperatures could increase by up to 1.8 °C in the summer and by 1 °C in the winter. Recent studies have already shown that water temperatures in the Lower Klamath mainstem have already been increasing at a rate of 0.4 °C/decade since the early 1960s. The season of high temperatures that are potentially stressful to salmon has lengthened by about 1 month (Bartholow 2005). Snowpack in the Klamath Basin will likely decrease with changes in temperature and precipitation and these changes will likely impact mainstem and tributary hydrology [California Natural Resources Agency (CNRA) 2009].

The vulnerability of the estuary and coast to changes in sea level is moderate in this region due to projected sea level rise and local rates of subsidence. Juvenile and smolt rearing and migratory habitat are most at risk to climate change as is adult access to tributary spawning habitat. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function and could impact the duration of barriers at the mouths of tributaries. Factors such as the timing, intensity, and extent of rainfall could either improve accessibility to tributaries or make it more difficult for fish to immigrate and emigrate from tributaries. Rising sea level may also impact the quality and extent of wetland rearing habitat in the estuary. Wetlands would naturally migrate inland with rising sea level but there are few places that are unarmored and would allow for this migration. Overall, the range and degree of variability in temperature and precipitation are likely to increase in all populations. Adults will also be negatively impacted by changes in ocean conditions such as ocean acidification, and prey availability (Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Hatcheries

Hatcheries pose a medium threat to all life stages in the Lower Klamath River sub-basin. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Urban/Residential/Industrial Development

Currently, urbanization is an overall medium threat. The effects of population growth and related development are localized within the LKR population area. The principal population areas near fish-bearing tributaries are Requa, Klamath, and Klamath Glen in the lower portion of the subbasin, and Wautek (Johnsons) and Pecwan in the upper portion. Activities in the Lower Klamath associated with development include levee construction, water withdrawal, bank armoring, and vegetation removal. The tributaries most impacted include Salt, High Prairie, Hunter, Mynot, Hoppaw, Waukell, and Terwer creeks. Land development in the Lower Klamath often results in the loss and degradation of critical floodplain and wetland habitat, especially in the vicinity of the estuary. The existing towns of Klamath, Klamath Glen, and Requa will continue to grow, though slowly. As these towns continue to expand, more infrastructure will likely be needed to protect private property and floodplains will likely be developed to accommodate more growth. This usually results in more levee construction, more roads, and resultant loss of fisheries habitats. In addition, sewage, pollution, water diversions, and removal of riparian vegetation could increase.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath Basin and Trinity subbasin. The effects of the fisheries managed by the State of California and the Yurok and Hoopa Tribes, on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Lower Klamath River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Road-Stream Crossing Barriers

Road-stream crossing barriers are a low to moderate threat due to the occurrence of several fish passage barriers (Taylor 2007, CalFish 2009). Possible affected streams include McGarvey, Richardson, Saugep, Waukell, Junior Creek, Blue, and Terwer creeks and a Highway 101 grade control structure barrier on W. Fork McGarvey Creek blocks access to high IP reaches. Another impassable highway grade control structure exists on Waukell Creek, and an undersized culvert exists on Richardson Creek that is impassable most of the time except for when backwatering occurs from the mainstem Klamath at higher flows. Several road crossings in the vicinity of the estuary (e.g., Saugep, Junior, and Spruce creeks) have limited passage for coho salmon (Taylor 2007). Several other total barriers exist in the subbasin, but are on streams where coho salmon have not been documented and no IP habitat exists (e.g., Burrill, Rube, Mareep, Knulthkarn). The passable culvert on Waukell, which is a barrier to stream function, will soon be addressed.

Table 18-8. List of road-stream crossing barriers in the LKR population area.

Priority	**Stream Name**	**Barrier Type**	**Road Name**	**Miles of habitat above barrier**
Low	Waukell Creek	Grade Control Structure	Hwy 101	<1.0
Low	Waukell Creek	Culvert	Hwy 101	<1.0
High	Richardson Creek	Culvert	Klamath Beach Rd	1.0
Low	McGarvey Creek	Grade Control Structure	Hwy 101	<1.0
High	Terwer	Bridge	Hwy 169	>1.0
High	Blue	Bridge	GDRC road	>1.0
High	Junior	Culvert	Unnamed	>1.0
Medium	Saugep	Culvert	Klamath Beach Rd	>1.0
Medium	Spruce	Culvert	Hwy 101	>1.0

Invasive Non-Native/Alien Species

A few non-native invasive species may be affecting this population. Bullfrog and Brown trout predation potentially have an effect on juvenile populations of coho salmon in certain areas of the LKR population area. In addition to predation, some tributaries in the vicinity of the estuary (e.g., Junior, Waukell, Salt, and Spruce creeks) are currently overgrown with non-native invasive plant species which impact water quality, inhibit the establishment of native riparian species, and dramatically reduce rearing capacity (Taylor 2007). The most prevalent invasive species are Reed Canary Grass (*Phalaris arundinacea*), Himalayan Blackberry (*Rubus procerns, Rubus discolor*), Common Reed (*Phragmites australis*), and the Yellow Pond lily (*Nuphar lutea*) (Patterson 2009; YTFP 2009b).

Mining/Gravel Extraction

Gravel extraction poses a medium threat to juvenile and smolt coho salmon and a low threat to the other life stages. In the LKR tributaries, there has been only one commercial gravel mining operation, which has extracted 5,000 to 15,000 cubic yards of gravel each year from different locations in lower Hunter Creek during late summer and early fall. Gravel extraction on the

LKR mainstem has been limited overall, but mining on mainstem gravel bars and on lower Terwer Creek has been proposed (McBride 1990). Gravel extraction has also been proposed to address the delta barriers at the mouths of Lower Klamath tributaries, but no such activities have been undertaken to date. This would not be a long-term solution to the issue, but the gravel operations on the lower Van Duzen River is a good example of how gravel mining can improve fish passage if done correctly. If not managed or designed properly, gravel extractions could disturb juveniles and degrade instream and riparian habitats.

High Intensity Fire

The threat of high intensity fire in the Lower Klamath is minimal because climatic conditions do not favor frequent or high-intensity fires in this area. What fire risks do exist in this area are the result of past timber harvest activities, fire suppression, and climate change.

18.7 Recovery Strategy

Although the Lower Klamath River population is currently depressed in abundance and habitat is degraded in most areas, the potential for coho salmon recovery is very high. Based on what is known about habitat availability and quality it appears that spawning habitat and summer and winter rearing habitat may be limited by sediment loading and a lack of floodplain and channel structure. Currently, a few key tributaries support the majority of production and provide refugia for the population. These and other important tributaries would benefit from strategic restoration actions targeted at reducing upslope sources of sediment, improving riparian function, and enhancing stream habitat complexity and floodplain connectivity.

Restoring or enhancing floodplain and channel structure is of particular importance and can be accomplished by placing complex wood jams (CWJs) and/or engineered log jams (ELJs) throughout Lower Klamath tributaries, and critical mainstem and estuary habitats. Constructing these complex and/or engineered log jams, along with other wood loading activities, will facilitate future LWD recruitment, and is a top priority. In addition, constructing off-channel ponds, wetlands, and side-channels, removing or setting back levees, decreasing sediment input, and stabilizing uplands are also recovery actions of high priority.

The removal of the four mainstem hydroelectric dams in the Upper Klamath is also important to the improvement of hydrologic function, water quality, and disease conditions in the mainstem Klamath and estuary. The immediate restoration and maintenance of LKR tributary riparian forests, hydrologic function, and floodplain and channel structure for spawning and rearing will help increase productivity, abundance, and distribution of the population.

Recovery actions aimed at improving mainstem water quality, tributary access, and estuary habitat will benefit not only the LKR population, but also upstream Klamath River populations that use the LKR subbasin for non-natal rearing and as migratory habitat. In addition to restoration, recovery actions in the LKR should focus on protecting those tributaries that have been identified as being strongholds for the population.

To improve the viability of this population it will be imperative to address these limiting stressors and to improve habitat conditions for these life stages throughout the subbasin. Addressing other stresses and threats and improving habitat for all life stages and life history strategies will also be an important component of recovery for this population. For fish from the population that have a life history that depends on the estuary and mainstem river (and for non-natal populations), creating and enhancing complex off-channel slough and wetland habitat and restoring connectivity to this habitat is imperative. Mainstem habitats should also be enhanced to improve overwinter rearing conditions for all life stages and species.

Table 18-9 on the following page lists the recovery actions for the Lower Klamath River population.

Table 18-9. Recovery action implementation schedule for the Lower Klamath River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LKR.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Mainstem Klamath River, Estuary, and lower Klamath River tributaries	2
SONCC-LKR.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-LKR.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-LKR.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Mainstem Klamath River, Estuary, and lower Klamath River tributaries	2
SONCC-LKR.2.2.2.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-LKR.2.2.2.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-LKR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Mainstem Klamath River, Estuary, and lower Klamath River tributaries	3
SONCC-LKR.2.2.3.1	*Revise the Yurok Tribe's Lower Klamath Sub-basin Restoration Plan to include updated prioritized, site specific restoration treatments for 1) Lower Klamath tributaries; 2) mainstem river habitats; and 3) the Klamath River estuary and off-estuary slough and wetland habitats.*					
SONCC-LKR.2.2.4	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Re-connect existing off-channel ponds, wetlands, and side channels	Mainstem Klamath River, Estuary, and lower Klamath River tributaries	2
SONCC-LKR.2.2.4.1	*Assess instream flow conditions and side channel connectivity and develop a plan to obtain adequate flows for channel connectivity*					
SONCC-LKR.2.2.4.2	*Mechanically alter or install CWJs or ELJs in side channels, off channel ponds, and wetlands to achieve and maintain connectivity*					
SONCC-LKR.2.2.4.3	*Install flow gage to ensure appropriate flows*					
SONCC-LKR.2.2.6	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Mainstem Klamath River, Estuary, and lower Klamath River tributaries	3
SONCC-LKR.2.2.6.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-LKR.2.2.6.2	*Implement beaver program (may include reintroduction)*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LKR.2.2.7	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Improve regulatory mechanisms	Population wide	BR
SONCC-LKR.2.2.7.1	*Limit hunting or removal of beaver*					
SONCC-LKR.2.2.8	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Mainstem Klamath River, Klamath River Estuary, Terwer, Klamath Glen, Salt, High Prarie, Hunter, Mynot, Hoppaw, Waukell	3
SONCC-LKR.2.2.8.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-LKR.2.2.8.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-LKR.8.1.9	Sediment	Yes	Reduce delivery of sediment to streams	Quantify dominant sediment sources and sinks	Population wide	3
SONCC-LKR.8.1.9.1	*Complete sediment budget*					
SONCC-LKR.8.1.10	Sediment	Yes	Reduce delivery of sediment to streams	Reduce erosion	Lower Klamath River sub-basin	2
SONCC-LKR.8.1.10.1	*Identify and prioritize upslope sources with excessive sediment loads, and design treatments*					
SONCC-LKR.8.1.10.2	*Implement sediment treatments, guided by assessment results*					
SONCC-LKR.8.1.11	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	All Lower Klamath River Tributaries (especially Waukell, Ah Pah, Surpur, Blue, McGarvey, Hoppaw, Mynot, Hunter, Terwer, Tarup)	2
SONCC-LKR.8.1.11.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-LKR.8.1.11.2	*Decommission roads, guided by assessment*					
SONCC-LKR.8.1.11.3	*Upgrade roads, guided by assessment*					
SONCC-LKR.8.1.11.4	*Maintain roads, guided by assessment*					
SONCC-LKR.8.1.12	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-LKR.8.1.12.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LKR.8.1.13	Sediment	Yes	Reduce delivery of sediment to streams	Reduce stream bank erosion	All Lower Klamath Tributaries (especially Blue, Waukell, Ah Pah, Salt, Hunter, Hoppaw, Tarup, Omagaar)	3
SONCC-LKR.8.1.13.1	*Inventory sediment sources, and prioritize for treatment*					
SONCC-LKR.8.1.13.2	*Treat priority sediment source sites, guided by assessment*					
SONCC-LKR.1.2.39	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-LKR.1.2.39.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-LKR.1.2.39.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-LKR.16.1.25	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LKR.16.1.25.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-LKR.16.1.25.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-LKR.16.1.26	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-LKR.16.1.26.1	*Determine actual fishing impacts*					
SONCC-LKR.16.1.26.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-LKR.16.2.27	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LKR.16.2.27.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-LKR.16.2.27.2	*Identify scientific collection impacts expected to be consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LKR.16.2.28	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LKR.16.2.28.1	*Determine actual impacts of scientific collection*					
SONCC-LKR.16.2.28.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-LKR.3.1.19	Hydrology	No	Improve flow timing or volume	Increase instream flows	Lower Klamath Tributaries (e.g.Hoppaw, Tarup, Omagaar, Bear, Hunter, Mynot, Johnsons)	3
SONCC-LKR.3.1.19.1	*Identify diversions in tributaries that have subsurface or low flow barrier conditions during the summer*					
SONCC-LKR.3.1.19.2	*Reduce diversions*					
SONCC-LKR.3.1.20	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-LKR.3.1.20.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-LKR.3.1.21	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-LKR.3.1.21.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-LKR.3.1.22	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-LKR.3.1.22.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-LKR.3.1.23	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-LKR.3.1.23.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-LKR.27.1.29	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-LKR.27.1.29.1	*Perform annual spawning surveys*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LKR.27.1.30	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Develop survival estimates	Site to be determined	3
SONCC-LKR.27.1.30.1	*Install and annually operate a life cycle monitoring (LCM) station*					
SONCC-LKR.27.1.31	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-LKR.27.1.31.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-LKR.27.1.32	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-LKR.27.1.32.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-LKR.27.1.32.2	*Annually estimate the in-river tribal harvest of wild/natural SONCC coho salmon*					
SONCC-LKR.27.2.33	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-LKR.27.2.33.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-LKR.27.2.33.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-LKR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-LKR.27.2.34.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-LKR.27.2.35	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-LKR.27.2.35.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-LKR.27.2.36	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-LKR.27.2.36.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LKR.27.2.37	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-LKR.27.2.37.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-LKR.27.2.38	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-LKR.27.2.38.1	*Identify habitat condition of the estuary*					
SONCC-LKR.27.2.41	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-LKR.27.2.41.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-LKR.27.1.42	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Disease'	All IP habitat	3
SONCC-LKR.27.1.42.1	*Annually estimate the infection and mortality rate of juvenile coho salmon from pathogens, such as Ceratomyxa shasta and Parvicapusla minibicornis*					
SONCC-LKR.27.1.43	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-LKR.27.1.43.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-LKR.27.1.43.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-LKR.27.2.44	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-LKR.27.2.44.1	*Determine best indicators of estuarine condition*					
SONCC-LKR.5.1.40	Passage	No	Improve access	Remove barriers	Population wide	3
SONCC-LKR.5.1.40.1	*Evaluate and prioritize barriers for removal*					
SONCC-LKR.5.1.40.2	*Remove barriers, guided by the assessment*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LKR.7.1.14	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Blue, Hunter, Hoppaw, Terwer, McGarvey, Tarup, Omagaar, Ah Pah, Bear, Surpur, Little Surpur, Tully, Waukell, Saugep, Tectah	3
SONCC-LKR.7.1.14.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-LKR.7.1.14.2	*Thin, or release conifers, guided by prescription*					
SONCC-LKR.7.1.14.3	*Plant conifers, guided by prescription*					
SONCC-LKR.7.1.15	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Mainstem Klamath River, Klamath River Estuary, Lower Klamath River tributaries (especially Salt, Hunter, Blue, Terwer Creeks)	3
SONCC-LKR.7.1.15.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-LKR.7.1.15.2	*Develop grazing management plan to meet objective*					
SONCC-LKR.7.1.15.3	*Plant vegetation to stabilize stream bank*					
SONCC-LKR.7.1.15.4	*Fence livestock out of riparian zones*					
SONCC-LKR.7.1.15.5	*Remove instream livestock watering sources*					
SONCC-LKR.7.1.16	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Revegetate riparian areas	Mainstem Klamath River and Blue Creek	3
SONCC-LKR.7.1.16.1	*Control feral cattle to rehabilitate riparian forests*					
SONCC-LKR.7.1.17	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce the risk of catastrophic fires on riparian forests by allowing for natural fire regime by creating fire-safe private lands	All Lower Klamath River Tributaries (e.g. Blue, Ah Pah, Terwer, Hunter, Tectah, Surpur, Mettah, Pecwan, Bear)	BR
SONCC-LKR.7.1.17.1	*Develop educational materials for landowners in the urban/rural interface areas and for USFS distribution*					
SONCC-LKR.7.1.17.2	*Develop a plan for fire break stewardship and defensible space*					
SONCC-LKR.7.1.17.3	*Implement fire-safe community action plans in identified areas*					
SONCC-LKR.7.1.18	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-LKR.7.1.18.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					

19. Redwood Creek Population

- Central Coastal Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 4,900 Spawners Required for ESU Viability
- 293 mi^2
- 151 IP km (94 mi) (38 % High)
- Dominant Land Uses are Timber Harvest and Agriculture
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’, ‘Degraded Estuarine Conditions’, and ‘Impaired Water Quality’
- Principal Threats are ‘Roads’ ‘Channelization/Diking’ and ‘Timber Harvest’

19.1 Habitat and Land Use Changes in Redwood Creek

Logging, road building, and the construction of flood control levees are the land uses that have had the most pronounced effect on coho salmon habitat in the Redwood Creek basin. Much of the upper and middle portions of the basin are owned by private timber companies and are used for timber production. In addition, livestock grazing occurs on some private lands, both in the middle and upper portions of the basin and in the valley bottom near Orick, where flood control levees protect the grazing lands. Much of the lower basin is public parkland, managed for protection and restoration of the old-growth redwood forest ecosystem. However, much of the parkland was heavily logged and roaded prior to National Park Service ownership. The largest community in the basin, Orick, is located near the mouth of Redwood Creek. In this valley bottom, 3.4 miles of flood control levees were constructed in 1968 to protect the Orick community and surrounding farm/ranch lands from a 200-year flood event. While providing flood protection for the community, the levees reduced coho salmon habitat by confining Redwood Creek to a 250-foot wide channel and bisecting the estuary.

These past land uses have resulted in impacts that have interacted to reduce available habitat throughout the basin. Increased sediment production from logged hillslopes and roads, especially during the 1955 and 1964 flood events, have choked Redwood Creek with sediment. The loss of riparian vegetation has reduced shading and created a lack of instream large wood.

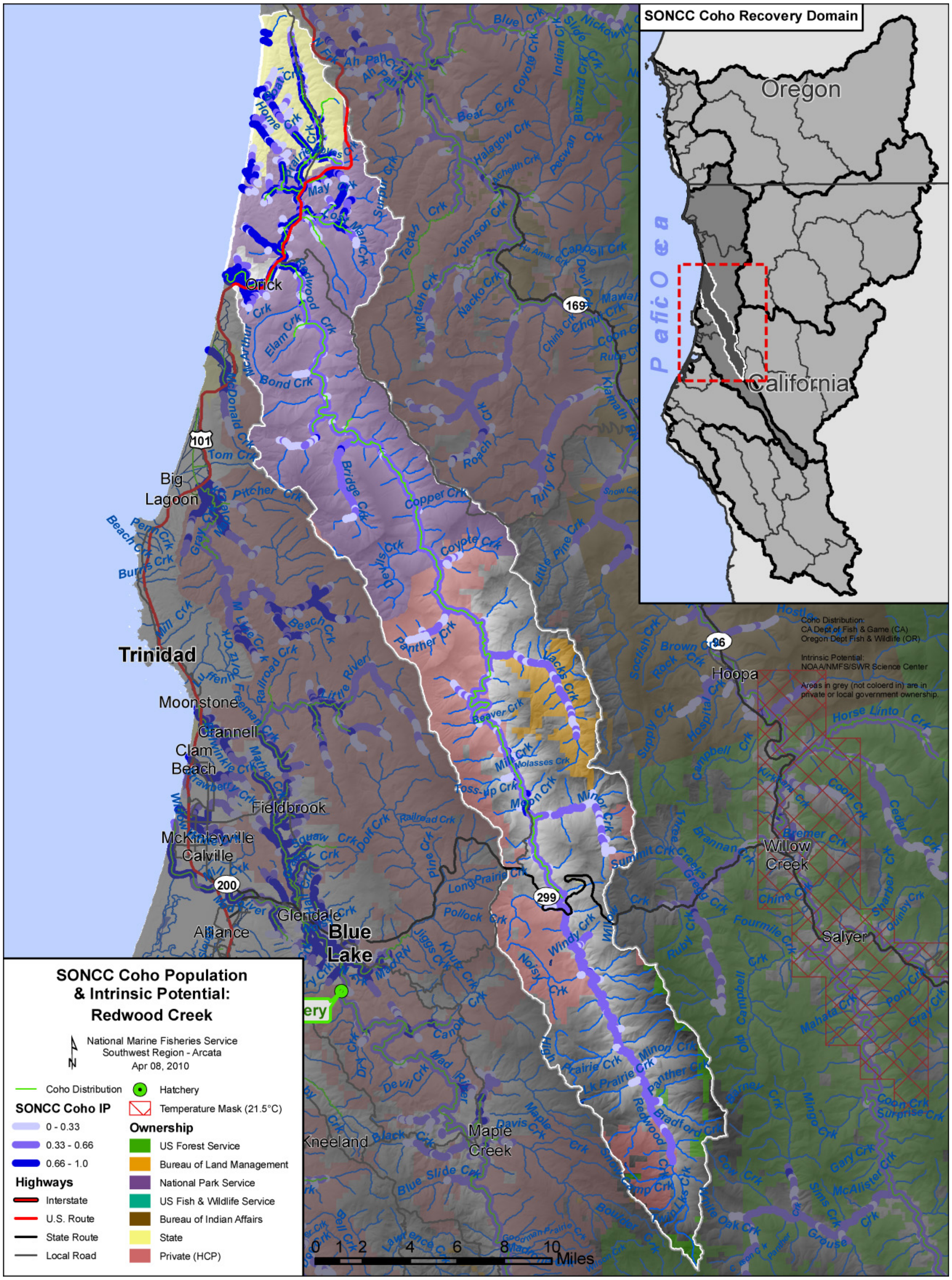

Figure 19-1. The geographic boundaries of the Redwood Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 1006), land ownership, coho salmon distribution (CDFG 1009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 1006). Grey areas indicate private ownership.

These land uses have resulted in warm, shallow and wide instream habitat conditions that have severely impacted coho salmon and their habitat (Cannata et al. 2006). Most of the basin is now comprised of forest stands of smaller diameter trees, with a greater percentage of hardwoods that provide different ecological functions than those found historically. Fortunately, some remaining late seral conifer stands are found within RNSP, particularly within the lower mainstem corridor of Redwood Creek and the Prairie Creek watershed.

The construction of flood control levees along the most downstream 3.4 miles of Redwood Creek has resulted in loss of estuarine area and habitat value (Cannata et al. 2006). In addition, gravel and riparian vegetation continue to be removed to maintain flood conveyance capacity.

Figure 19-2. Aerial photograph of the Redwood Creek estuary, before levees. This photo, taken in September 1948, prior to the construction of the levees, shows the size of the estuary and amount of riparian vegetation. Note that this photo is not prior to other land use impacts, such as logging. Photo from Klamath River Information System (KRIS).

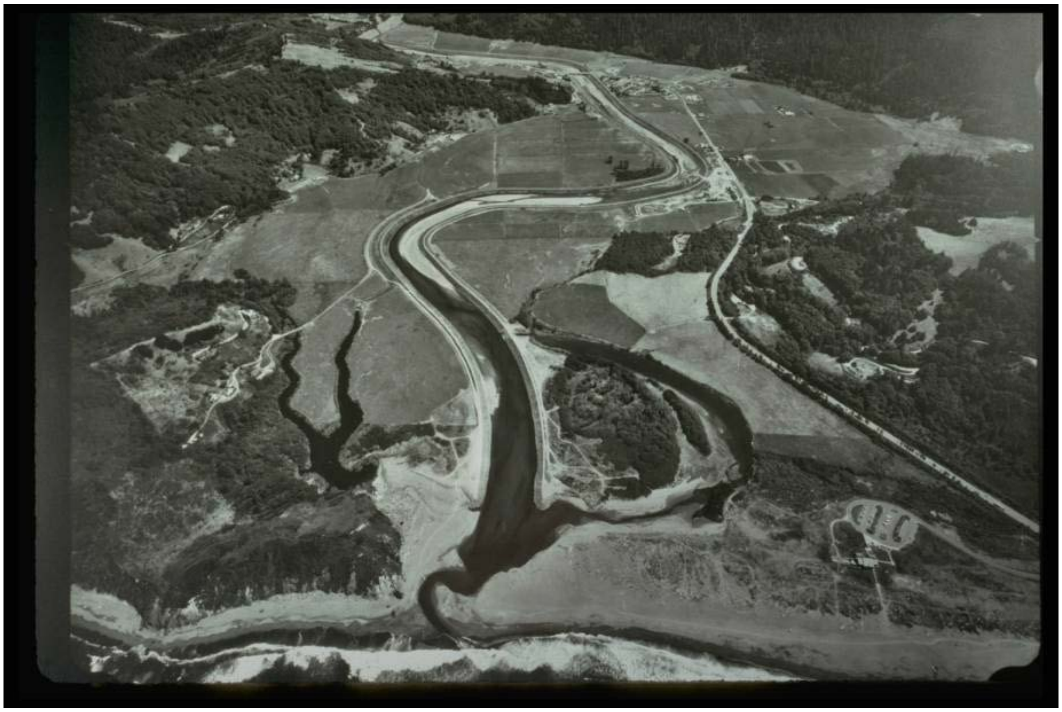

Figure 19-3. Aerial photograph of the Redwood Creek estuary, with levees. Photo shows the levees and continued gravel and vegetation removal for channel maintenance; note the much-reduced estuary size and reduction in habitat complexity. Redwood Creek estuary in 1988 from KRIS.

19.2 Historic Fish Distribution and Abundance

Aside from the data described in the assessment of population viaility detailed further in this section and the IP data shown in Table 19-1, there is limited data that describe the historical coho salmon population in Redwood Creek. Potential coho salmon habitat is distributed throughout the basin. The IP data show the highest values (IP > 0.66) in Prairie Creek and its tributaries, including Lost Man Creek, and in the most downstream 4 miles of mainstem Redwood Creek, including Strawberry Creek and Sand Cache Creek. The Prairie Creek watershed is almost all park lands managed by RNSP. The downstream 4 miles of Redwood Creek is mostly private land. Table 19-1 shows the areas with high IP. In addition, it is notable that almost the entire length of mainstem Redwood Creek is modeled as having moderate IP (IP between 0.33 and 0.66).

Table 19-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	**Stream Name**	**Stream Name**
Prairie Creek	Lower Mainstem Redwood Creek.	Strawberry Creek
Lost Man Creek	Skunk Cabbage Creek	Sand Cache Creek
Little Lost Man Creek	Tom McDonald Creek	May Creek
Streelow Creek	Bridge Creek	All of the unnamed tributaries to Prairie Creek
Middle Mainstem Redwood Creek, near Toss-up Creek	McArthur Creek	

Coho salmon have been detected in lower mainstem Redwood Creek, as well as Prairie, Lost Man, Little Lost Man, Streelow, Strawberry, Lacks, Elam, Tom McDonald, Emerald (a.k.a. Harry Weir), McArthur, and Bridge creeks. The historic range includes Coyote, Panther, Minor, Karen and Pilchuck creeks in the Beaver Creek HSA, as well as Sand Cache Creek, tributary to the estuary. Various investigators have found that coho salmon may also use some of the tributaries in the Lake Prairie HSA [Anderson 1988, Brown 1988, Neillands 1990; Pacific Coast Fish, Wildlife and Wetlands Restoration Association (PCFWWRA) 1995, California Department of Fish and Game (CDFG) 2001 surveys, and RNSP unpublished data]. RNSP (2001) described historic presence of coho salmon juveniles and spawning adults in middle and upper mainstem Redwood Creek, including upstream of Highway 299.

Historic estimates of coho salmon abundance in Redwood Creek are scarce. In 1965, CDFG estimated an average run size of 5,000 Chinook salmon, 2,000 coho salmon and 10,000 winter steelhead (CDFG 1965 *in* Good et al. 2005) for the entire Redwood Creek basin. The CDFG report (1965) did not include a time period for the estimates of run size. Hallock et al. (1952) seined 9,610 juvenile coho salmon from Prairie Creek and its tributaries in 1951; however, this information does not include seining information from mainstem Redwood Creek and its other tributaries.

19.3 Status of Redwood Creek Coho Salmon

Spatial Structure and Diversity

Currently, except for Prairie Creek, coho salmon have limited distribution in the Redwood Creek basin, most likely due to habitat degradation and high water temperatures in mainstem Redwood Creek (Madej et al. 2006). Although much of the basin is accessible to adult and juvenile coho salmon, high summer water temperatures in the middle portion of mainstem Redwood Creek are believed to limit most of the current juvenile distribution to lower Redwood Creek and its tributaries, and to the Prairie Creek sub-watershed, where summer water temperatures are cooler than in the middle and upper portions of mainstem Redwood Creek (Madej et al. 2006). High summer water temperatures are likely to continue until streamside conifers mature and provide shade that help to regulate summer water temperatures, and until the mainstem channel condition improves and channel complexity increases so that deep pools could be used as thermal refugia for coho salmon.

During the summer of 2003, RNSP conducted a juvenile coho salmon presence-absence snorkel survey of the lower half of mainstem Redwood Creek. During this survey, no coho salmon were observed in the main channel above river mile 13. A small number of juvenile coho salmon were observed in 9 locations in the section of Redwood Creek between river mile 4.8 and river mile 13 (Ozaki and Anderson 2005).

Additional distribution information is available from Sparkman (2008a, 2008b) who trapped 6 age 0+ coho salmon in mainstem Redwood Creek at river mile 33 in 2007. In addition, Sparkman (2010) trapped 32 age 0+ coho salmon and 7 age 1+ coho salmon at river mile 33 in 2008; the first year in 9 consecutive years of outmigrant trapping in which age 1+ coho salmon were caught in the middle portion of mainstem Redwood Creek. Research is currently ongoing in the Redwood Creek basin to investigate adult abundance and distribution of salmonids, using redds as the population metric. Based on preliminary investigations and professional judgment, coho salmon juveniles and adults are currently present in McArthur, Elam and Bridge creeks, all tributaries to lower to middle mainstem Redwood Creek (Ricker 2011). Bridge Creek in particular likely contains high quality coho salmon spawning habitat, although the quantity and quality of winter rearing habitat appears limited. Available information suggests limited distribution, particularly in the middle to upper portions of mainstem Redwood, indicating that that the current spatial structure is impaired compared to historic conditions.

Williams et al. (2008) determined that at least 32 coho salmon per-IP km of habitat are needed (4,900 spawners total) to approximate the historical distribution of Redwood Creek coho salmon and habitat. Although the estimate of historical adult abundance from Williams et al. (2008) includes Redwood Creek and Prairie Creek, the current distribution of spawning adults appears mostly limited to the Prairie Creek sub-watershed. In addition, recent juvenile outmigrant data from Sparkman (2008a, 2008b) suggests that few adult coho salmon are returning to mainstem Redwood Creek each year to spawn.

Regarding life history diversity traits, Redwood Creek is one of the few places in California with documented variation in the period of freshwater juvenile coho salmon rearing. Coho salmon have been generally thought to rear for one year in northern California streams; a two-year rearing period had only been observed farther north (Bell and Duffy 2007). However, Bell and Duffy (2007) observed that 28 percent of outmigrants from Prairie Creek reared in freshwater for two years. This variation in the length of the freshwater rearing period could be critical to coho salmon persistence in Redwood Creek, because it bolsters the population's resilience to environmental disturbance. The more diverse life history traits are expressed (or the more these traits are not restricted), the more diverse a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany et al. 2000). Bell and Duffy (2007) also found that the size of age 2 smolts from Prairie Creek was not as large as age 1 smolts from other healthy systems (Shapovalov and Taft 1954 *in* Bell and Duffy 2007), indicating that age 2 smolts from Prairie Creek would not mature precociously and return as jacks at any higher rate than age 1 smolts from Prairie Creek.

Population Size and Productivity

Williams et al. (2008) determined at least 151 coho salmon must spawn in the Redwood Creek basin each year to avoid effects of extremely low population size.

The CDFG has trapped outmigrants in mainstem Redwood Creek to provide information on the current viability of salmonid populations in the basin. Sparkman (2011a) has conducted outmigrant trapping in middle Redwood Creek since 2000, with the trap located at river mile 33 (known as the "upper trap"). Since 2004, Sparkman (2011b) has also conducted outmigrant trapping at river mile 4 (known as the "lower trap"), just upstream of where Prairie Creek enters mainstem Redwood Creek. From 2000 to 2006, Sparkman (2007) did not capture any out-migrating coho salmon at the upper trap, suggesting that coho salmon spawning in mainstem Redwood Creek and tributaries upstream of Prairie Creek may have had limited success for about 7 years. However, 6 age 0+ juveniles were captured at the upper trap in 2007 (Sparkman 2008a, 2008b), and 32 age 0+ and 7 age 1+ juveniles were caught at the upper trap in 2008 (Sparkman 2011b).

Low numbers of juvenile coho salmon have been captured at the lower trap during all of the study years. For example, in 2003, 110 age 0+ and 12 age-1+ were captured at the lower trap, in 2004, 202 age 0+ and 69 age-1+ juvenile coho salmon were captured at the lower trap (Sparkman 2004), and in 2010, 6 age 0+ coho salmon and 13 age 1+ coho salmon were captured at the lower trap (Sparkman 2011b). During 2011, Sparkman captured 226 age 0+ coho salmon and 24 age 1+ coho salmon at the lower trap and no coho salmon at the upper trap. Sparkman estimated juvenile population abundances for mainstem Redwood Creek (not including Prairie Creek) of 884 age 0+ coho salmon and 113 age 1+ coho salmon (Sparkman 2011c).

Sparkman (2011c) also began trapping out-migrants from Prairie Creek during 2011 and captured 198 age 0+ coho salmon and 2,449 age 1+ coho salmon at the Prairie Creek trap located at the mouth of Prairie Creek, just upstream from its confluence with Redwood Creek. For 2011, Sparkman estimated juvenile population abundances for Prairie Creek of 726 age 0+ coho salmon and 8,446 age 1+ coho salmon.

Additionally, Duffy (2011) has monitored juvenile and adult coho salmon populations and estimated juvenile and adult abundance in the Prairie Creek sub-watershed since 1998. Duffy (2011) estimated juvenile abundance using a modified Hankin and Reeves (1988) approach as summarized in Table 19-2.

Using walking surveys to enumerate live fish, redd surveys and carcass mark-recapture studies, Duffy (2011) has also estimated escapement of adult coho salmon to Prairie Creek from 1999 to 2010. These estimates indicate mostly low to occasionally moderate numbers of returning adult coho salmon (Duffy 2011). Numbers of live fish ranged from 680 in 2001-2002 to 28 in 2009-2010 (Table 19-3; Duffy 2011) for the Prairie Creek sub-watershed. Other tributaries to mainstem Redwood Creek contain adult coho salmon (Ricker 2011) but at unknown abundance levels. Williams et al. (2008) estimated that the historic annual spawner abundance for the entire Redwood Creek population unit was about 4,900. All of the available information suggests that the overall number of coho salmon in the Redwood Creek basin is low compared to modeled historic abundance.

Table 19-2. Estimated abundance of juvenile coho salmon in the Prairie Creek sub-watershed of Redwood Creek during 1998-2010 (Duffy 2011).

	Pools	Runs	Riffles	Total

Year	Month	Avg	95% CI	Avg	95% CI	Avg	95% CI	Avg	95% CI
1998	Oct	5080	75	1047	11	0	0	6127	67
1999	Aug	4256	63	1645	23	1229	240	7130	303
1999	Oct	5123	949	1703	27	537	95	7363	850
2000	Aug	2741	138	1733	17	20	0	4494	109
2000	Oct	2622	432	1443	21	22	0	4086	324
2001	Aug	1875	56	728	4	14	0	2617	40
2001	Oct	1588	83	805	8	0	0	2393	62
2002	Aug	4243	886	2919	17	1025	50	8187	657
2002	Oct	4500	2519	2764	32	465	63	7729	1826
2003	Aug	4481	435	2484	24	1699	801	8664	1126
2003	Oct	3709	81	2722	24	686	70	7117	144
2004	Aug	3134	260	1972	24	261	12	5367	231
2005	Aug	1460	93	1391	39	303	30	3154	122
2006	Aug	3870	84	2176	675	701	27	6747	578
2007	Aug	2950	77	1627	72	64	2	4641	107
2008	Aug	3276	217	1698	117	61	1	5035	242
2009	Aug	2465	80	1011	15	565	79	4041	148
2010	Aug	3102	112	1466	17	549	60	5117	153

Table 19-3. Escapement of adult coho salmon to the Prairie Creek sub-watershed during 1999-2011. Estimates are derived from AUC analysis of live fish observations. Year listed is the latter portion of the spawning season (e.g. 1999 = 1998/1999) (Duffy 2011).

	Coho Salmon Estimated Adult Abundance	
Year	n	95% CI
1999	56	3.4
2000	84	6.7
2001	212	6.0
2002	680	19.4
2003	542	46.1
2004	268	12.4
2005	643	40.6
2006	349	27.6
2007	165	8.5
2008	466	44.5
2009	127	25.8
2010	28	4.1
2011	218	22.0

Monitoring data and population estimates from Sparkman (2008a, 2008b, 2011a, 2011b, 2011c) and Duffy (2010, 2011) show a negative population trend, as do the apparent long-term declines of coho salmon observed in Redwood Creek. Therefore, the Redwood Creek coho salmon population is at high risk of extinction given its small population size and likely negative trends in numbers of juveniles and adults.

Extinction Risk

The Redwood Creek coho salmon population is not viable and at high risk of extinction because the estimated average number of spawners has been below the depensation threshold (151 spawners) for the past three years (Table ES-1 in Williams et al. 2008).

3.4 Role in SONCC Coho Salmon ESU Viability

The Redwood Creek population is considered a functionally independent population within the Central Coastal diversity stratum, meaning that it was sufficiently large to be historically viable-in-isolation and has demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005, Williams et al. 2006). In addition, the Redwood Creek coho salmon population is considered a core population. As a core population, the recovery target is for this population to be viable and to have a low risk of extinction according to population viability criteria (Chapter 4).

19.4 Plans and Assessments

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004.

Redwood Creek Total Maximum Daily Load (TMDL)
http://www.swrcb.ca.gov/northcoast/

NCRWQCB identified Redwood Creek as water quality limited due to its high sediment loads, and designated the basin as a high priority for Total Maximum Daily Load (TMDL) development in accordance with Section 303(d) of the Clean Water Act. The Environmental Protection Agency and the NCRWQCB worked together to complete the sediment TMDL in 1998.

The North Coast Watershed Assessment Program (NCWAP)
http://coastalwatersheds.ca.gov

The NCWAPs Redwood Creek Basin Assessment (Cannata et al. 2006) identified limiting factors for anadromous salmonids including:

- Large reduction in area and habitat quality of the estuary/lagoon;
- Excessive sediment in stream channels, and excessive sediment delivery;
- Lack of large conifer contributions and lack of LWD in stream channels;
- High summer water temperatures
- General lack of structural components to create habitat diversity

Redwood Creek Watershed Group

The Redwood Creek Integrated Watershed Strategy
http://co.humboldt.ca.us/planning/Prop 50/01_RWC_IWS%20Final.pdf

The watershed strategy integrates natural resource considerations with infrastructure needs at the basin scale. The strategy identified restoration of Strawberry Creek, wastewater treatment planning for the community of Orick and sediment source reductions as priority projects.

Redwood National and State Parks

Watershed Rehabilitation Plan (1981)

Management Alternatives of the Redwood Creek Estuary (1983)

Redwood National and State Parks, Humboldt and Del Norte Counties: Final General Management Plan/General Plan, environmental impact statement/environmental impact report - USDI National Park Service and California Department of Parks and Recreation (1999)

Road Strategy: Access and Treatment Priorities for Parkland in the Redwood Creek Watershed (2005)

Planning and strategy documents from RNSP focus on ecosystem restoration, especially road removal and forest restoration efforts. Between 1978 and 2010 RNSP removed 266 miles of roads from Park lands, with 114 miles of road remaining to be treated.

Bureau of Land Management, Arcata Field Office

Lacks Creek Management Area Management Plan

The plan identifies road upgrading and decommissioning opportunities within the Lacks Creek sub-watershed.

Green Diamond Resource Company (GDRC)

Green Diamond Habitat Conservation Plan

Approximately 25 percent of private land in the middle to upper portions of Redwood Creek basin is owned by the Green Diamond Resource Company, and managed according to the provisions of their HCP. The plan contains a number of provisions, such as upgrading roads with a high to moderate risk of sediment delivery to stream channels, to reduce impacts on coho salmon and salmon habitat in the Redwood Creek basin.

19.5 Stresses

Table 19-4. Severity of stresses affecting each life stage of coho salmon in Redwood Creek. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Very High	Very High	Very High[1]	Very High[1]	Very High	Very High
2	Impaired Water Quality[1]	High	Very High	Very High[1]	Very High[1]	High	Very High
3	Impaired Estuary/Mainstem Function[1]	-	Medium	Very High[1]	Very High[1]	High	Very High
4	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
5	Altered Sediment Supply	Very High	High	Medium	Medium	Medium	High
6	Altered Hydrologic Function	Medium	Medium	Medium	Low	-	Medium
7	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
8	Barriers	-	Low	Low	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Lack of floodplain and channel structure, impaired estuarine function and impaired water quality are all stressors that limit juvenile rearing success of the Redwood Creek coho salmon population. Except for the valuable habitat that the relatively undisturbed Prairie Creek sub-watershed provides, the majority of summer and winter rearing habitat within the basin is in a currently degraded state. Many of the important, high IP tributaries have legacy logging effects, such as large quantities of sediment deposited within stream channels, lack of channel structure and lack of well-distributed large wood, which adversely affect both summer and winter rearing conditions. In mainstem Redwood Creek, high summer water temperatures, increased sediment supply, lack of channel structure, and a lower river and estuary that is disconnected from off-channel floodplain habitat also combine to adversely affect summer and winter rearing habitat. Based on the type and extent of stressors and threats affecting the population as well as the limiting factors influencing productivity, the juvenile and smolt life stages are likely most limited and quality summer and winter rearing habitat is likely lacking for the population. Cannata et al. (2006) identified Prairie Creek and its tributaries as refugia based on current habitat conditions.

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure is a very high stress across all life stages. In general, the Prairie Creek sub-watershed contains the best habitat conditions, while the mainstem Redwood Creek and its other tributaries contain the poorest habitat conditions. The mainstem channel is aggraded, and pool frequency and depth are ranked as poor throughout the mainstem (Cannata et al. 2006). Data on instream wood is limited; however given the poor riparian canopy conditions that exist throughout the mainstem, and based on discussions with RNSP, a lack of instream wood structure is limiting the development of complex habitat throughout much of the basin. The most downstream 3.4 miles of Redwood Creek is disconnected from its floodplain and confined to a channel width of 250 feet by flood control levees, resulting in a lower river channel and estuary that is disconnected from sloughs, wetlands and other low gradient tributaries that once provided important over-wintering rearing habitat. In addition, the lower river channel contains few pools and riffles and generally lacks complexity and structure that is important for rearing juvenile coho salmon.

Impaired Water Quality

Impaired water quality is a very high stress for the fry, juvenile and smolt life stages and a high stress for adults. High water temperature in the summer and early fall months stress rearing coho salmon. Redwood Creek is listed as temperature impaired under section 303d of the Clean Water Act. High water temperature in mainstem Redwood Creek, including the estuary, is one of the factors limiting coho salmon production in the basin (Sparkman 2006; Cannata et al. 2006). Madej et al. (2006) demonstrated that high summer water temperatures in mainstem Redwood Creek currently limits juvenile coho salmon distribution in the basin and hypothesized that this restriction did not exist historically. Sparkman (2006) has shown that in some years summer water temperatures are in the lethal range for juvenile coho salmon in the middle section of mainstem Redwood Creek.

Madej et al. (2006) reports that the greatest thermal complexity occurs in lower Redwood Creek upstream of the leveed reach. In this reach, Madej et al. (2006) measured with thermal infrared imaging many cool springs, seeps, side channels and tributaries, and where the water temperatures are influenced by the cooler coastal climate. During the 2003 presence-absence juvenile coho salmon survey (Ozaki and Anderson 2005), 7 of the 9 locations where coho salmon were observed were side pool locations (no coho salmon juveniles were observed upstream of river mile 13). Side pools were separated from the main channel by a gravel bar, but open to Redwood Creek on the downstream end. Many of the pools were influenced by cool seeps and springs, intragravel water flow, groundwater or small tributaries. These pool features were generally cooler than the mainstem of Redwood Creek (Madej et al. 2006).

Impaired Estuarine Functions

Prior to the construction of 3.4 miles of flood control levees in 1968, the Redwood Creek estuary was characterized by its size, depth, and complexity, with a connected north slough channel and estuarine tributaries. The flood control levees cut-off the last meander of Redwood Creek, now known as the south slough, and its tributary, Strawberry Creek. Currently, the estuary covers approximately half of its historic area (Janda et al. 1975). The levees bisect and terminate in the estuary and the estuary is disconnected from much of its historic off-channel rearing habitat. Water quality, water circulation, riparian vegetation, and pool and riffle habitat have all been greatly reduced (Anderson 1995; Cannata et al. 2006). Since the levees created a smaller estuary than what was historically present with less area for coastal processes such as waves and tides to sustain an open estuary the timing of the closing of the mouth has also changed resulting in a closed lagoon for a longer period of time, which aggravates poor water quality conditions, and can affect juvenile fish passage in the summer and adult fish passage in the fall. The reduction in function of the estuarine system and lower river habitat, which once provided connected sloughs and tributaries for off-channel non-natal rearing, is a limiting factor to salmonid production in the basin. Reconfiguration of the levees (i.e., combination of levee setback and/or removal) to restore estuarine and lower river function is critical to recovery of the Redwood Creek coho salmon population (CDFG 2004b).

Degraded Riparian Forest Conditions

Degraded riparian forest conditions exist across the basin, and present a high stress to the fry, juvenile, and smolt life stages. Data from RNSP (2006) and the Green Diamond Aquatic Habitat Conservation Plan (GDRC 2006) show that streamside canopy cover conditions vary, with some good to very good conditions (70 percent to 100 percent shade) in tributaries, and poor cover and shade conditions in the mainstem channel of Redwood Creek. However, even where streamside canopy cover is in good condition, many of the riparian areas currently consist of open hardwood, and second-growth dominated forests. Hardwood and small conifer dominated riparian forests provide smaller or short-term large wood recruitment into Redwood Creek compared to historic conditions of large wood supply to the channel from once prevalent old-growth redwood forests. However, while hardwood dominated riparian forests may not contribute as valuable large wood recruitment to stream channels, hardwood riparian forests provide allochthonous contributions, a valuable source of food for salmonids. Hardwood and second growth conifers also provide shade to the stream channel.

Altered Sediment Supply

Altered sediment supply constitutes a medium to very high stress across all life stages. Increased sediment delivery has aggraded and widened channels, filled pools and has simplified stream habitat throughout the basin, particularly within mainstem Redwood Creek and its low gradient tributaries. Many tributary mouths have accumulations of sediment that limit access for juveniles and adults (Anderson and Brown 1982). Data from the Prairie Creek watershed suggests that sediment supply may be less of an issue there; for example, measurements suggest that some pools have less fine sediment accumulation than pools in other parts of the basin. However, most data collected on the sediment regime (e.g., high embeddedness) indicate that both stored sediment within the channels, and continued sediment delivery, are critical stresses affecting the population.

High turbidity levels in Redwood Creek are believed to occur more frequently and persist longer than historically (Cannata et al. 2006). RNSP has been measuring turbidity levels in Lost Man Creek at numerous locations since 2002, and has found elevated turbidity from legacy road and stream crossing sediment sources and from first and second year adjustments of recently implemented road removal projects (Klein et al. 2006). Effects to coho salmon from elevated turbidity include an impaired ability to find food, gill abrasion, food assemblage changes, smothering of eggs and filling of pools with fine sediment.

Altered Hydrologic Function

Altered hydrologic function is a low stress for smolts, and a medium stress for egg, fry and juvenile life stages. Low summer stream flows are problematic where increased stored sediment has aggraded the channel, contributed to subsurface flows, and reduced the amount of available rearing habitat. Reduced hydrologic function (i.e., poor water circulation, changes in the timing of the mouth closing off, low dissolved oxygen) due to the flood control levees also contributes to a significant reduction in available rearing habitat in the lower most 3.4 miles of Redwood Creek. Low fall stream flows can impede adult migrations and low summer stream flows may be aggravated by unauthorized water diversions, affecting the availability of summer rearing habitat. Another factor in hydrologic function may be the conversion of extensive areas from conifer-dominated to dense hardwood forests (e.g., tan oak). This vegetation change may have influences on summer low flows; however, we are unaware of any studies examining this in Redwood Creek.

Adverse Fishery-Related Effects

NMFS has determined that federally managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Barriers

Physical road and stream crossing barriers are a low stressor for all life stages except eggs, which do not require access to other portions of the stream network. Barriers created by excess sediment accumulations at tributary mouths are discussed under the sediment stress above. RNSP has documented road-related barriers or partial barriers within the park, and is in the process of upgrading or removing these culverts and replacing them with bridges, such as the recently completed opening of access in Streelow Creek and the North Fork of Lost Man Creek. The levees also act as barriers, the south levee allows only partial access to Strawberry Creek and the north levee aggravates sand accumulation at the mouth of the north slough, impeding passage into the slough and Sand Cache Creek (Anderson 1995). Invasive reed canary grass also hampers access in Strawberry and Sand Cache Creeks by choking the stream channel with non-native vegetation. Reed canary grass is currently being removed from Strawberry Creek and native riparian vegetation is being planted that will eventually provide shaded conditions that hamper reed canary grass re-growth. In addition, unnaturally large log jams caused by historic logging practices in tributaries such as Bridge and Little Lost Man creeks impede coho salmon passage (RNSP 2006; Ricker 2011).

Adverse Hatchery Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. The Prairie Creek Fish Hatchery produced coho salmon that were stocked into Redwood Creek until 1992. The genetic effect of this hatchery on coho salmon produced in Redwood Creek is unknown. No hatchery fish are currently stocked into Redwood Creek. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

19.6 Threats

Table 19-5. Severity of threats affecting each life stage of coho salmon in the Redwood Creek. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	Very High	Very High
2	Channelization/Diking	High	Very High	Very High	Very High	High	Very High
3	Timber Harvest	High	High	High	High	High	High
4	Mining/Gravel Extraction	-	High	High	High	Medium	High
5	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
6	Dams/Diversion	Medium	Medium	Medium	Medium	Medium	Medium
7	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
8	Invasive Non-Native/Alien species	Medium	Medium	Medium	Medium	-	Medium
9	Urban/Residential/Industrial	Medium	Medium	Medium	Medium	Medium	Medium
10	Climate Change	Low	Low	Medium	Medium	Medium	Medium
11	Fishing and Collecting	-	-	-	-	Medium	Medium
12	Hatcheries	Low	Low	Low	Low	Low	Low
13	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low

Roads

Roads are a very high threat across all life stages. Information found in Cederholm et al. (1981) suggests that fine sediment availability increases in basins with more than three miles of road per square mile of area. As of 2006, Cannata et al. found that the Redwood Creek basin has an average of approximately 4.8 miles of road per square mile of area. Cannata et al. (2006) also found that the road density drops to 2.15 miles of road per square mile of area within the Prairie Creek and lower river sub-basins, and that private lands in the middle and upper portions of the Redwood Creek basin average over 8 miles of road per square mile of area. Although many of the roads in the middle and upper portion of the basin were built prior to current road construction standards, there is an active road improvement program in this area with the goal of reducing fine sediment delivery to stream channels. Even with active road removal and upgrade efforts, roads are a significant source of both chronic and catastrophic fine sediment input to streams, affecting the quality and quantity of available coho salmon habitat in Redwood Creek and its tributaries. The high road density in Redwood Creek has likely also resulted in an increase in the frequency of road-related landslides in the basin. Roads can also affect fish passage where road-stream intersections have not been adequately designed to allow fish passage.

Channelization/Diking

Channelization and diking is a very high threat overall and a very high threat to fry, juvenile and smolt life stages. As previously discussed, the flood control levees and associated channel maintenance activities significantly reduce available habitat in the estuary and lower portion of Redwood Creek. Ecosystem function within the flood control reach will continue to be impaired by the levees and channel maintenance activities until the levees are reconfigured.

Timber Harvest

Timber harvest is a high threat to the coho salmon population in Redwood Creek. Many of the changes in instream and riparian conditions in Redwood Creek are a result of intensive timber harvest in previous decades. Although current timber harvest practices are more protective of coho salmon habitat than previous practices, timber harvest continues to threaten coho salmon in Redwood Creek by increasing sediment yield and by reducing streamside shading and potential large wood recruitment. Approximately half of the basin is in private ownership as industrial timber land, and timber harvest continues in the middle and upper portions of Redwood Creek.

Mining/Gravel Extraction

Instream gravel extraction is a high threat to fry, juvenile and smolt life stages, and a medium threat to adult coho salmon. Gravel extraction is not a threat to eggs because gravel extraction does not occur in coho salmon spawning habitat in Redwood Creek. Gravel extraction occurred sporadically between 1968 and 2000, and annually between 2004 and 2010 within the flood control reach of the most downstream 3.4 miles of Redwood Creek. Most gravel extraction occurred as part of Humboldt County's channel conveyance maintenance program required by the Army Corps of Engineers' (Corps) Operations and Maintenance Manual for the flood control levees. Some commercial gravel extraction also occurred prior to 2000 within this reach.

The gravel extraction that occurs as channel maintenance is permitted by the Corps and the permit contains numerous measures to reduce the effects on fish habitat, such as a head-of-bar buffer to provide for channel steering around skimmed gravel bars, and a 2-foot vertical offset from summer low flow water surface elevations to provide low to moderate channel confinement. However, even with minimization measures, gravel extraction reduces overall habitat complexity and reduces the quality and quantity of available pool and velocity refuge habitat. Given the sensitivity of the channel to disturbance (i.e., current lack of floodplain and channel structure), and the potential use of the gravel extraction reach by coho salmon juveniles for summer rearing (e.g., if habitat is restored in this reach) due to relatively cooler summer water temperatures than upstream, gravel extraction is a significant threat to rearing juveniles and a moderate threat to adults who require resting habitat in pools during upstream migration.

Agricultural Practices

Grazing occurs in the lowest reaches of Redwood Creek as well as in the middle and upper portions of the basin and may contribute to increased sediment generation and delivery and decreased riparian vegetation. However, specific information on the magnitude of the threat is limited. Water withdrawals for agricultural uses are discussed in the "Dam/Diversions" section, and the effects of the channelization and dikes, which were installed in the lower reaches of Redwood Creek partly to control flooding on agricultural land, are considered in the "Channelization/diking" section of this profile.

Dams/Diversions

Dams and diversions are of medium threat to the Redwood Creek coho salmon population. Water withdrawals (authorized and unauthorized) for domestic and agriculture use occur in the Orick area, in Redwood Valley and in the upper basin. The water withdrawals affect stream flow quantity in the summer, affecting the availability of summer rearing habitat. From the 1950s through 2002 summer dams were constructed in the Redwood Valley area, but these dams have been denied permits by CDFG since 2003 and summer dams are not a current threat to passage. However, there may be legacy effects from summer dam construction in the form of fine sediment deposition in stream gravels and reduced invertebrate production at the previous dam sites.

High Intensity Fire

The vegetation characteristics throughout the basin present a moderate threat for high intensity fires that could alter the sediment delivery regime as well as riparian vegetation characteristics. Most of the basin contains forests of small diameter trees that are close together. These types of previously logged forests burn with greater intensity than late seral forest stands, and high intensity forest fires create an erosion hazard. The increased sediment yield from high intensity fires would likely deliver sediment to coho salmon habitat in the basin, filling pools and reducing habitat complexity. Conversion of extensive conifer-dominated forests to dense hardwood stands has also likely increased fire risk. However, the Prairie Creek sub-watershed that offers the best habitat available for coho salmon within the basin contains predominately old growth redwood trees that burn with a lower intensity than the second growth found throughout much of the rest of the basin.

Invasive Non-Native/Alien Species

New Zealand mud snails (NZMS) were discovered within lower Redwood Creek in late 2009. This invasive non-native species has very high secondary production (Hall et al. 2006) may out-compete native invertebrates, and provides little food value for juvenile salmonids (Vinson et al. 2007). In addition, Strawberry and Sand Cache creeks, low gradient tributaries to the estuary, contain reed canary grass that is choking the channel, outcompeting native riparian vegetation and adversely affecting water quality, passage and access for coho salmon (Love 2008).

Urban/Residential/Industrial Development

Rural population growth will continue to present a medium threat to coho salmon in Redwood Creek. Such growth can result in removal of vegetation, increased sediment generation and delivery, introduction of exotic species, water withdrawals from stream channels and inadequate septic facilities and pesticide use that affect water quality. Some of the rural growth is in the middle to upper basin, and much of the rural growth is in the Orick area, with some of the growth planned for the floodplain in the flood control levee reach of lower Redwood Creek.

Climate Change

Climate change poses a medium threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles and adults. The current climate is generally cool near the coast and moderately hot inland. Modeled regional average temperature shows a moderate increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 1.6^{o} C in the summer and by up to 1^{o} C in the winter. Annual precipitation in this area is predicted to change little over the next century. The vulnerability of the estuary and coast to sea level rise is moderate in this population. Juvenile and smolt rearing and migratory habitat is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation will affect water quality and hydrologic function in the summer and winter. Rising sea level will affect the quality and extent of estuarine rearing habitat for juveniles and smolts. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, as with all populations in the ESU, adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and near shore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Redwood Creek population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress

Road-Stream Crossing Barriers

Road-stream crossing barriers are a low threat to the population. Most of the existing road-stream crossing barriers occur in high gradient tributaries upstream of coho salmon habitat.

19.7 Recovery Strategy

Coho salmon in the Redwood Creek basin are severely depressed in abundance, and restricted in spatial distribution. Recovery activities in the basin should promote increased spatial distribution, particularly in the mainstem of Redwood Creek and tributaries such as Bridge Creek, as well as increased productivity and abundance. Efforts to increase distribution will also likely yield increases in diversity, abundance and productivity. Secondly, preservation of observed life history diversity (i.e., two years of freshwater rearing) should be encouraged.

Activities should occur basin-wide, with a focus on Prairie Creek and its tributaries, and lower mainstem Redwood Creek and its tributaries. Top priorities in the basin include restoring estuarine function and lower river connectivity to sloughs, wetlands, tributaries and floodplain habitat through levee reconfiguration, reducing summer stream temperatures in mainstem Redwood Creek by the addition of channel complexity features that will promote pool development and thermal refuge (such as large wood), and reducing sediment sources that have a high risk of delivering sediment to stream channels.

Other important actions include restoring wetlands, low gradient channels, off-channel habitat, sloughs and tributaries in lower Redwood Creek, including Strawberry Creek, and the north slough channel (Sand Cache Creek), reducing gravel and vegetation removal associated with levee maintenance and minimizing timber harvest impacts on riparian corridors to promote large wood delivery to stream channels.

Table 19-6 on the following page lists the recovery actions for the Redwood Creek population.

Table 19-6. Recovery action implementation schedule for the Redwood Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-RedC.1.2.5	Estuary	Yes	Improve estuarine habitat	Remove, set back, or reconfigure levees or dikes	2.8 miles total levee length (1.4 mile each side of Redwood Creek from mouth upstream)	2
SONCC-RedC.1.2.5.1	*Purchase land or conservation easements to facilitate levee reconfiguration.*					
SONCC-RedC.1.2.5.2	*Develop a plan to reconfigure the levees and restore the natural stream channel.*					
SONCC-RedC.1.2.5.3	*Reconfigure the downstream most section of the levees to restore the historic form and function of the estuary*					
SONCC-RedC.1.2.32	Estuary	Yes	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-RedC.1.2.32.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-RedC.1.2.32.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-RedC.2.2.1	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees or dikes	4 miles total levee length (2 mile each side Redwood Creek from Hwy 101 Bridge upstream)	2
SONCC-RedC.2.2.1.1	*Develop a plan to reconfigure the levees and restore the natural stream channel. Assess habitat and develop a plan to increase complexity with LWD and enhance riparian vegetation in conjunction with levee reconfiguration*					
SONCC-RedC.2.2.1.2	*Reconfigure the upstream portions of the levees.*					
SONCC-RedC.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Enhance non natal rearing sites	3.6 miles of lower Redwood Creek	3
SONCC-RedC.2.2.2.1	*After or during levee reconfiguration, add LWD, boulders, or other instream structure to increase habitat complexity and improve pool frequency and depth*					
SONCC-RedC.2.2.2.2	*Plant native riparian vegetation*					
SONCC-RedC.2.1.3	Floodplain and Channel Structure	Yes	Increase channel complexity	Improve regulatory mechanisms	3.6 miles of lower Redwood Creek	3
SONCC-RedC.2.1.3.1	*Modify Army Corps of Engineers' Operations and Maintenance Manual to reduce the frequency and magnitude of gravel and vegetation removal, while still providing flood protection for the town of Orick*					
SONCC-RedC.2.1.4	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-RedC.2.1.4.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-RedC.2.1.4.2	*Place instream structures, guided by assessment results*					
SONCC-RedC.16.1.19	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-RedC.16.1.19.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-RedC.16.1.19.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-RedC.16.1.20	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-RedC.16.1.20.1	*Determine actual fishing impacts*					
SONCC-RedC.16.1.20.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-RedC.16.2.21	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-RedC.16.2.21.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-RedC.16.2.21.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-RedC.16.2.22	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-RedC.16.2.22.1	*Determine actual impacts of scientific collection*					
SONCC-RedC.16.2.22.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-RedC.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-RedC.27.1.23.1	*Perform annual spawning surveys*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-RedC.27.1.24	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-RedC.27.1.24.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-RedC.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-RedC.27.1.25.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-RedC.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-RedC.27.2.26.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-RedC.27.2.26.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-RedC.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-RedC.27.2.27.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-RedC.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-RedC.27.2.28.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-RedC.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-RedC.27.2.29.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-RedC.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-RedC.27.2.30.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-RedC.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-RedC.27.2.31.1	*Identify habitat condition of the estuary*					
SONCC-RedC.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-RedC.27.1.33.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-RedC.27.1.34	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-RedC.27.1.34.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-RedC.27.1.34.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-RedC.27.2.35	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-RedC.27.2.35.1	*Determine best indicators of estuarine condition*					
SONCC-RedC.5.1.10	Passage	No	Improve access	Remove structural barrier	Strawberry Creek. 2 sites on RNSP land and 3 sites on private land	3
SONCC-RedC.5.1.10.1	*Assess culverts and develop a plan to provide passage at all life stages through the upgrade of the culverts.*					
SONCC-RedC.5.1.10.2	*Upgrade culverts, guided by the plan*					
SONCC-RedC.5.1.11	Passage	No	Improve access	Reduce invasive species	3 miles of the tributaries and sloughs Strawberry, Dorance and Sand Cache Creeks.	2
SONCC-RedC.5.1.11.1	*Eradicate Reed Canary Grass*					
SONCC-RedC.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	3
SONCC-RedC.7.1.6.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-RedC.7.1.6.2	*Thin, or release conifers, guided by prescription*					
SONCC-RedC.7.1.6.3	*Plant conifers, guided by prescription*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-RedC.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	3
SONCC-RedC.7.1.7.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-RedC.7.1.7.2	*Develop watershed-specific guidance for managing riparian vegetation*					
SONCC-RedC.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Population wide	3
SONCC-RedC.7.1.8.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-RedC.7.1.8.2	*Develop grazing management plan to meet objective*					
SONCC-RedC.7.1.8.3	*Plant vegetation to stabilize stream bank*					
SONCC-RedC.7.1.8.4	*Fence livestock out of riparian zones*					
SONCC-RedC.7.1.8.5	*Remove instream livestock watering sources*					
SONCC-RedC.7.1.9	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-RedC.7.1.9.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					
SONCC-RedC.8.1.12	Sediment	No	Reduce delivery of sediment to streams	Reduce risk of catastrophic fire	Population wide	3
SONCC-RedC.8.1.12.1	*Identify forested stands for fire hazard reduction*					
SONCC-RedC.8.1.12.2	*Apply appropriate management techniques (e.g. thinning, burning) to reduce risks of high intensity fire*					
SONCC-RedC.8.1.13	Sediment	No	Reduce delivery of sediment to streams	Reduce erosion	Population wide	3
SONCC-RedC.8.1.13.1	*Inventory sediment sources, and prioritize for treatment*					
SONCC-RedC.8.1.14	Sediment	No	Reduce delivery of sediment to streams	Improve timber harvest practices	Population wide	3
SONCC-RedC.8.1.14.1	*Apply best management practices for timber harvest*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-RedC.8.1.15	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-RedC.8.1.15.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-RedC.8.1.15.2	*Decommission roads, guided by assessment*					
SONCC-RedC.8.1.15.3	*Upgrade roads, guided by assessment*					
SONCC-RedC.8.1.15.4	*Maintain roads, guided by assessment*					
SONCC-RedC.8.1.16	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-RedC.8.1.16.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					

20. Maple Creek/Big Lagoon Population

- Central Coastal Stratum
- Non-Core 2, Potentially Independent Population
- High Extinction Risk
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 46.9 mi^2
- 41 IP-km (25 mi) (59% High)
- Dominant Land Use is Timber Production
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Altered Sediment Supply’
- Principal Threats are ‘Timber Harvest’ and ‘Roads’

20.1 History of Habitat and Land Use

Timber harvest has been the single most disturbing activity in the Maple Creek basin. Intensive logging took place between the 1940s and 1960s and effects of the removal of riparian canopy can still be seen in several stream reaches where the alders dominate. Historic logging practices often made use of mill ponds. Gray Creek still has a remnant dam in place and an associated remnant mill pond.

Currently, timber harvest remains as the dominant land use with over 98 percent of the basin owned by Green Diamond Resource Company (GDRC). Current timber harvest regulations and a Habitat Conservation Plan (HCP) help protect the river from many of the destructive practices that originally took place. Many roads have been constructed throughout the basin for upstream of highway and residential development on the south end of Big Lagoon access to timberland. Logging roads, which are often built alongside streams and have many stream crossings, have contributed to erosion, runoff, and excess sediment in streams. Increases in sediment supply have left streams wider and shallower, creating more simplified habitat. In addition, sediment accumulating in Big Lagoon contributes to wetland accretion. Marshland increase is documented including the appearance of alluvial islands downstream of the highway where deeper waters previously existed (Parker 1988).

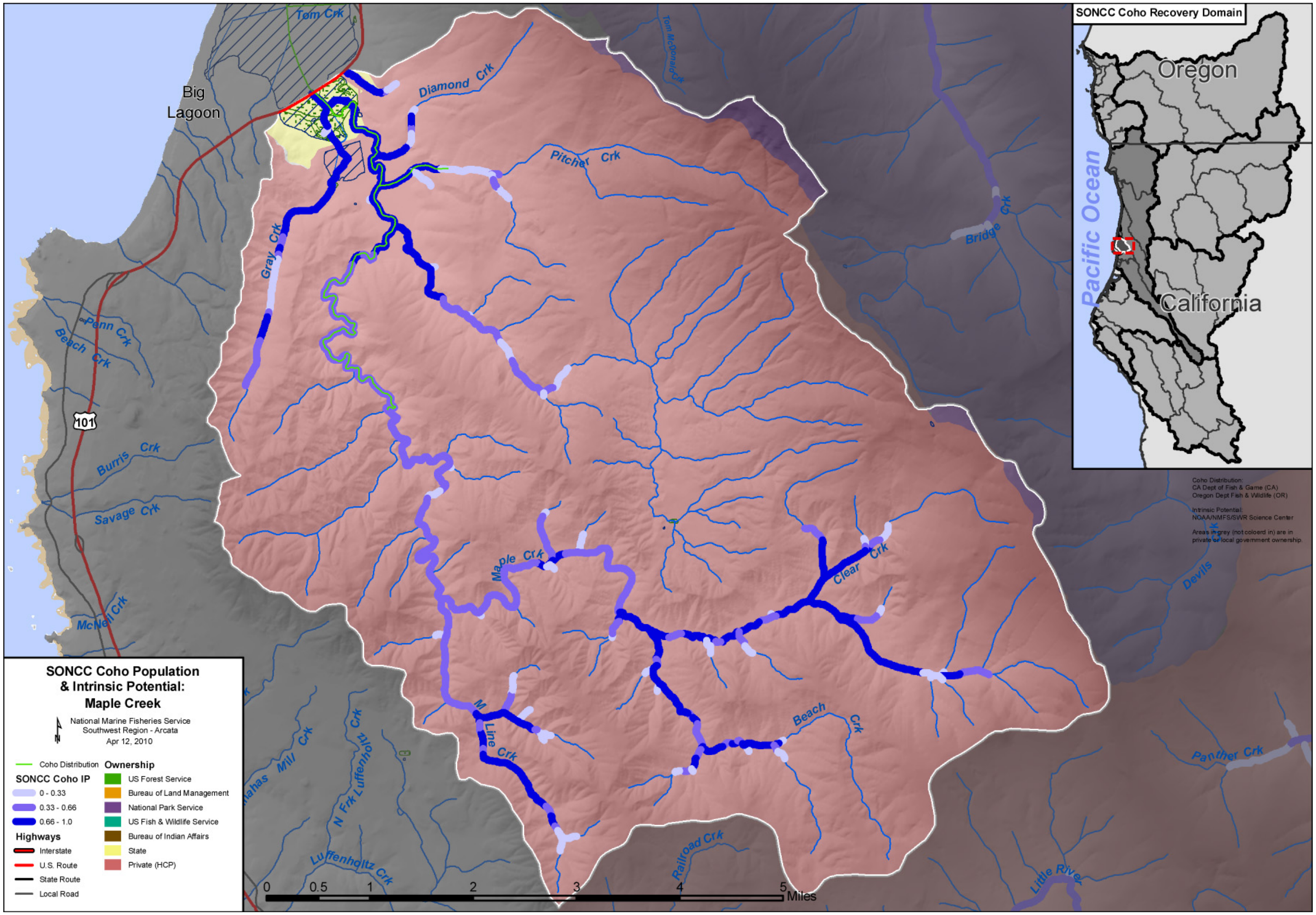

Figure 20-1. The geographic boundaries of the Maple Creek/Big Lagoon coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership

Other large changes affecting sedimentation rates in the estuary and overall estuarine function include the building of Highway 101 and the construction of a dam on Gray Creek. Built in the 1920s, Highway 101 is on dredge spoils across most of the mile-long estuarine floodplain of Maple Creek. On either side of the highway, remnant dredge ditches can still be seen. Numerous historic tidal channels are truncated by the highway dike and most (approximately 90 percent) of the historic tidal wetland area has been lost (Figure 20-1). Flow from Maple Creek is impeded by Highway 101 during flood events, and backs up on the south side of the highway. The building of the Gray Creek dam has also altered the hydrology of the estuary. In what was historically the upper extent of tidal exchange, the creek now builds up behind the dam in a large lake. Although a channelized stream flows from the mill pond providing connectivity, tidal exchange has been truncated and a large section of tidally influenced, important rearing habitat has been lost (Figure 20-2).

Big Lagoon is almost completely encompassed by state lands. Harry A. Merlo State Recreation Area and Humboldt Lagoons State Park almost completely surround the lagoon, while the Department of Fish and Game manages Big Lagoon as a wildlife area. In the early 1900s, farmers wanted to drain the lagoons along the north coast for agriculture. The parks were established along Big Lagoon to protect the lagoons from being converted to agricultural uses. The park includes a campground, day use area, and a boat launch on the south end of the lagoon that is operated by Humboldt County. Recreational use includes camping, kayaking, fishing, and wildlife viewing in the creek and the lagoon.

Just off the shoreline of the lagoon and abutting the park, there is some residential development with associated paved or graveled roads. Near this development, a 20 acre parcel of land bordering the south end of Big Lagoon belongs to the Big Lagoon Rancheria Tribe. The tribal land has undergone a small amount of residential development. The community consists of eight homes, a community water facility and an improved road system.

Figure 20-2. Photo shows Gray Creek mill pond and channelization of Maple Creek. Note the reduction of tidal exchange as a result of Highway 101.

20.2 Historic Fish Distribution and Abundance

The Maple Creek/Big Lagoon basin has a high potential to support unique life history diversity for coho salmon. Maple Creek flows into Big Lagoon, a brackish water body separated from the ocean by a narrow sand spit. Throughout the majority of the year, Big Lagoon is an enclosed lake. Most years, high water levels in the fall and winter cause the lagoon to breach, creating an opening for salmon to migrate upstream and juvenile salmon to out-migrate to the sea. However, in low water years, the lagoon may not breach at all, and blocks adult coho salmon from entering the basin and forcing juveniles to overwinter in the lagoon. Very little historic data exists that describes the number of coho salmon in Maple Creek basin or the distribution of fish throughout the basin. However, the U.S. Fish and Wildlife Service (USFWS) did report as many as 1,200 coho salmon that were estimated to occur in Maple Creek as late as the 1960's (GDRC 2006).

GDRC, the largest private landowner in the basin, has performed several spawning and juvenile surveys for coho salmon. In the 1998 to 1999 and 1999 to 2000 season, the surveys only reported a few redds, all of which were assumed to be created by anadromous or "lagoon run" cutthroat or possibly steelhead. Adult coho salmon were not observed in the lagoon or Maple

Creek, and only one 1+ coho salmon was seen in the summer of 1999 (GDRC 2006). A thorough search of past survey records by CDFG shows that coho salmon have been documented throughout the basin since 1995 (Jong et al. 2008).

Table 20-1. Documented presence of coho salmon by brood year. Data are for the Maple Creek basin (Jong et al. 2008).

Stream	**BY1995**	**BY1996**	**BY1997**	**BY1998**	**BY1999**	**BY2000**	**BY2001**	**BY2002**
Tom Creek	Y	Y						
Maple Creek			Y	U	Y	U	Y	Y
Pitcher Creek			Y	U	U	U	U	
North Fork Maple Creek				U	U	U		Y
Y = coho salmon confirmed, U = coho salmon not confirmed, null = not surveyed								

More recently, spawning and juvenile snorkel surveys have taken place, and adult coho salmon have been found lower in the basin (Perry 2009). Adequate adult escapement is questionable in these streams due to the timing of when the lagoon breaches. The absence of 0+ coho salmon during the summer of 1999 by GDRC and the lack of documented presence for that brood year suggests that Big Lagoon did not breach during the winter of 1998 to 1999, while the presence of 1+ coho salmon indicates that adults were able to enter during the 1997 to 1998 spawning season. Coho salmon use of Maple Creek for spawning is variable and dependent on breaching of the lagoon. Changes in the timing and/or frequency of breaching due to human activities in the basin are unknown.

Potential coho salmon habitat is distributed throughout the majority of the basin, with the highest IP values (IP >0.66) in the lower reaches of Maple Creek and its tributaries as well as tributaries to Big Lagoon. High potential habitat also exists in a few of the upper reaches of Maple Creek and the tributaries located higher in the basin, however natural barriers block access to all of these locations.

Table 20-2. Tributaries with instances of high IP reaches (IP value > 0.66). (Williams et al 2006).

Stream Name	Stream Name	Stream Name
Pitcher Creek	Diamond Creek	Gray Creek
North Fork Maple Creek	Tom Creek	

20.3 Status of Maple Creek/Big Lagoon Coho Salmon

Spatial Structure and Diversity

Coho salmon have access to the lower reaches of the basin, but are restricted from the upper reaches by natural barriers. Spawning, snorkel, and electroshocking surveys have identified coho salmon primarily in the lowest parts of the Maple Creek basin. No juvenile coho salmon were found in Tom Creek, Diamond Creek or Gray Creek in the early 1990s by GDRC. Several natural barriers throughout Maple Creek limit the spatial distribution of coho salmon to the lower reaches of the basin. In addition to the map above that shows the current distribution, GDRC has also found coho salmon in the North Fork Maple Creek (GDRC 2006).

The unique lagoon ecosystem within the Maple Creek basin creates potential for a diversity of life history traits. Because the sand bar does not always breach on an annual basis, emigrating smolt may rear an additional year in the lagoon and adult coho salmon either do not spawn or are forced to stray to nearby basins. The diverse life history and gene flow with nearby basins increases the overall resiliency of the population and the ESU. Although some of the diverse genetic and life history traits are likely still present, the reduced population abundance diminishes the diversity of this population.

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 39 coho salmon per-IP km of habitat are needed (1600 spawners total) to approximate the historical distribution of Maple Creek/Big Lagoon coho salmon and habitat. The currently restricted distribution of coho salmon in Maple Creek/Big Lagoon due to natural barriers, combined with the threat of altered bar breach events, further threaten this population.

Population Size and Productivity

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 41 coho salmon must spawn in Maple Creek each year to avoid such depensatory effects.

Spawning surveys completed by GDRC have not found any adult coho salmon and entire age classes of juveniles are absent. The Maple Creek/Big Lagoon coho salmon population is depressed. Surveys in late September 2009 of lower Maple Creek for large mouth bass resulted in the capture of six coho salmon smolts around the GDRC Bridge approximately 2.5 miles upstream of Hwy 101 (USFWS 2009). Productivity of coho salmon within the basin is unknown but assumed to be very low. Because there is no indication that the population is growing based on recent surveys, it is assumed that population growth is neutral or negative.

Extinction Risk

The Maple Creek/Big Lagoon coho salmon population is not viable and at high risk of extinction, because the estimated average spawner abundance over the past three years is likely less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Maple Creek/Big Lagoon population is a non-core, potentially independent population within the Central Coastal diversity stratum. This population has a high likelihood of persisting in isolation over a 100-year time scale, but is too strongly influenced by immigration from other populations to exhibit independent dynamics. The recovery target for the Maple Creek/Big Lagoon population is juvenile occupancy to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU.

There are several populations which may interact with the Maple Creek/Big Lagoon population. Stone Lagoon, which is located just to the north of Big Lagoon, has a similar ecology, where sand spit breaches occur on an annual basis. Adult salmon in some years will not have access to their natal streams when the sand spit remains intact. Those fish must return as strays to other nearby basins. If a breach event were not to occur in Stone Lagoon, but did occur in Big Lagoon, coho salmon may access the Maple Creek basin. Conversely, straying can also occur where returning adults use spawning habitat in adjacent basins when Big Lagoon does not breach. The adjacent basins may also act as potential refugia for this population when Big Lagoon doesn’t breach, thus preventing total loss of that year-class. Because of high straying potential, there is likely a good genetic flow between adjacent basins.

20.4 Plans and Assessments

Green Diamond Resource Company

Green Diamond Habitat Conservation Plan

The GDRC habitat conservation plan (HCP) (GDRC 2006) outlines a plan for the conservation of aquatic species in the Maple Creek/Big Lagoon. Almost all of the 98 percent of private land in the Maple Creek/Big Lagoon basin is owned by GDRC and therefore managed according to the provisions of the HCP. The plan was developed in accordance with the ESA section 10 regulations, which require GDRC to develop a conservation strategy to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to GDRC’s activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species. The plan has a number of provisions designed to protect coho salmon and salmon habitat throughout the Maple Creek/Big Lagoon basin.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004. The recommendations developed by CDFG for the Big Lagoon HSA in the Trinidad HU address the impacts of logging and restoration of the riparian zone. The strategy identifies recovery actions for the state listed coho salmon.

Maple Creek/Big Lagoon Watershed Inventory and Restoration Planning Project Report

The Maple Creek/Big Lagoon watershed inventory and restoration planning report (Pacific Watershed Associates 2005) identified locations with future road-related sediment delivery, potential projects that could improve in-stream channel conditions for anadromous fish, and a prioritized plan of action for erosion prevention and restoration.

20.5 Stresses

Table 20-3. Severity of stresses affecting each life stage of coho salmon in the Maple Creek/Big Lagoon. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Very High	Very High	Very High[1]	Very High	Very High	Very High
2	Altered Sediment Supply[1]	High	High	Very High[1]	Very High	High	High
3	Impaired Estuary/Mainstem Function	-	Low	High	Very High	Very High	High
4	Altered Hydrologic Function	Low	Medium	High	High	Medium	Medium
5	Degraded Riparian Forest Conditions	-	Medium	Medium	Medium	Low	Medium
6	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
7	Impaired Water Quality	Low	Low	Low	Low	Low	Low
8	Barriers	-	Low	Low	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
10	Increased Disease/Predation/Competition	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

An altered sediment supply and lack of floodplain and channel structure are the stresses most limiting rearing opportunities. The combined effect of excess sediment filling pools with the lack of structure to meter out sediment or provide scour mechanisms, which create and maintain pools, significantly reduces the complexity of the channel. Furthermore, the population likely depended on the rich tidally influenced habitat for rearing. The increased amounts of sediment reaching the lagoon and settling around the highway dike have converted a significant amount of estuary habitat to upland marsh habitat, further reducing rearing habitat. Therefore, the juvenile life stage is most limited and quality summer and winter rearing habitat are lacking as vital habitat for the Maple Creek/Big Lagoon population.

A combination of logging practices and the construction of Highway 101 have significantly reduced the amount and quality of rearing habitat. A reduction in large wood simplifies the channel leading to less available refuge during high winter flows and low summer flows. The lagoon provides prolonged rearing habitat for juveniles, which increases life history diversity for the ESU since the lagoon does not usually breach during the late spring and summer when most other smolts outmigrate to the ocean. A large amount of tidal marshland, backwater channels, and wetlands have been converted to dryer uplands due to the highway acting as a dike across the lagoon and an excess of sediment settling in that area.

The lowest portions of the Maple Creek basin within and just upstream of the estuary contain the highest quality and most connected habitat. There are several small streams that enter the lagoon near the mouth of Maple Creek and tributaries that enter Maple Creek just upstream of the mouth. These tributaries provide the best refuge for coho salmon (Table 20-4), although they are blocked by natural barriers within a half mile. The lower reaches of these small tributaries may still provide refuge from the mainstem Maple Creek or Big Lagoon. Though connectivity has been reduced, the remaining connected habitat between the tidal wetlands and the freshwater tributaries provide a diversity of habitat types and refugia sites. Several of these tributaries have no documented use by coho salmon, but the streams could still potentially provide refugia for juveniles rearing in the lower basin.

Table 20-4. Potential refugia areas within the Maple Creek/Big Lagoon basin.

Stream Name	Stream Name	Stream Name
Big Lagoon	Tom Creek	North Fork Maple Creek
Maple Creek	Pitcher Creek	Diamond Creek

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure is defined as a very high stress across all life stages of coho salmon. Simplified channel and floodplain structure are primarily the result of a lack of large wood in the Maple Creek basin, and an overabundance of fine sediment. Although no surveys of large wood structures are available, the history of intensive logging in the area suggests the basin likely experiences low wood recruitment. Large wood is required to sort sediment, scour pools, and facilitate floodplain connectivity. Surveys in the upper basin indicate pool habitat has been filling with sediment. The oversimplified stream channel and floodplain can no longer provide refugia and rearing habitat for juveniles and lacks habitat features, such as deep pools and side channels.

Altered Sediment Supply

Altered sediment supply presents a high to very high stress for all life stages of coho salmon in the Maple Creek/Big Lagoon basin. Surveys indicate that excess sediment has filled pools, widened channels, and simplified stream habitat throughout the basin, including the lagoon. The input of fines also increases embeddedness of the spawning gravel and can suffocate eggs during development. In addition to negative stream impacts in the basin, the increased sediment supply accumulates upstream of the bridge and downstream into the mouth of the lagoon (Figure 20-3), reducing the size of the lagoon and rearing habitat.

Impaired Estuary/Mainstem Function

The impaired estuary/mainstem function stress refers to only the estuary conditions in Maple Creek/Big Lagoon since this is a single population basin. Mainstem conditions are addressed through other stressors, such as floodplain and channel structure, riparian condition, and hydrologic function. Estuary function is important to the population because of its unique role in the life history and survival of coho salmon

Big Lagoon is one of the few coastal lagoons that is managed by California Department of Fish and Game. Big Lagoon is a brackish lake that is enclosed by a sand spit the majority of the year. Most years, the lagoon breaches, providing adult coho salmon access to the basin from the ocean. For the most part, the lagoon habitat provides opportunities for rearing in wetland areas. However, the overall estuarine function has been degraded by sediment accretion and Highway 101. Elevated sediment accretion in the lagoon and in lower Maple Creek has led to a shallowing of tidal channels and conversion of open water to marsh and uplands. An increase of marshland at the rate of 0.23 ha/year was observed between 1931 and 1978 (Parker 1988). Figure 20-3 shows the conversion of lagoon habitat to upland marsh habitat between 1931 and 1978.

The dike supporting Highway 101 effectively blocks hydrologic connectivity between Big Lagoon and Maple Creek. Numerous large historic tidal channels and tidal wetland have been blocked by the dike. Without tidal exchange, accretion upstream of the highway is converting formally brackish wetland habitat to freshwater wetland, mudflats, and uplands. The conversion from brackish to freshwater wetland has decreased the productivity and rearing potential of wetland areas. Big Lagoon also likely experiences changes due to a loss of exchange with Maple Creek. Riverine flushing is dampened by the dike, potentially impacting salinities, sediment accretion in the lagoon, and breach events at the spit. Based on his work in the small coastal lagoons in Humboldt County, Kraus et al. (2002) found that both riverine and ocean processes can affect breach events in these basins. For the barrier spits, small streams and runoff during the rainy season gradually raise the water level and cause breaching from lagoon to ocean by seepage and failure. The pooling of water upstream of the highway can clearly interfere with this process.

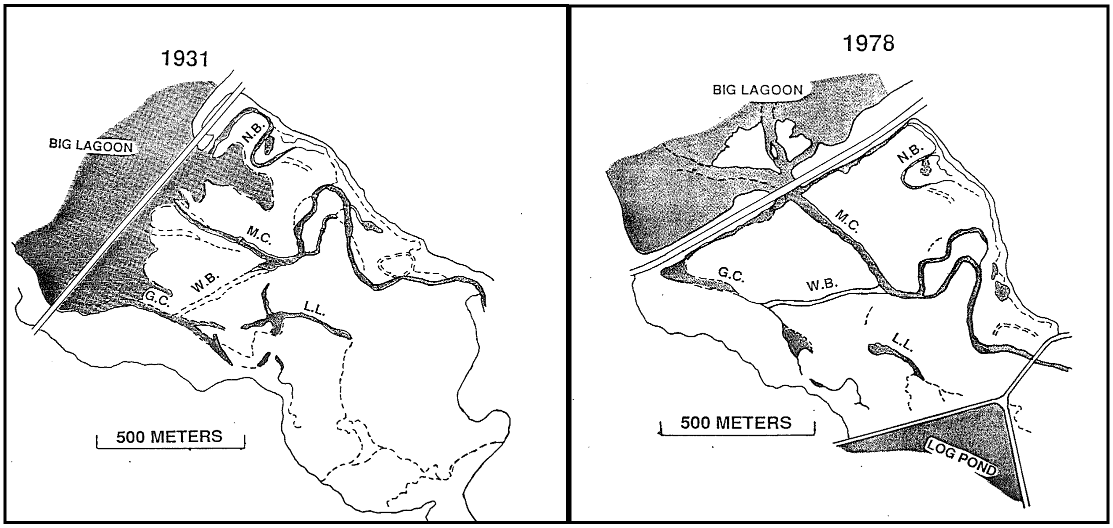

Figure 20-3. Line drawing showing the changes in Big Lagoon between 1931 and 1978. Stippled pattern represents permanent water; dashed lines indicate indefinite banks, dry paleochannels or subaqueous channel banks (Parker 1988). Note the increase in upland marsh habitat and creation of Gray Creek mill pond.

Altered Hydrologic Function

Altered hydrologic function within the Maple Creek basin poses a high risk to juvenile and smolt life stages, a medium risk to fry and adults, and a low risk to the egg life stage. Flows remain intact with few diversions. However, the estuary has been significantly modified by Highway 101 impeding hydrologic exchange between the lagoon and Maple and Gray Creeks. Satellite images show historic tidal channels that have been truncated by the highway. Additionally, flows from the upper basin pool behind the highway, accumulating sediment there. The accumulation effectively converts tidal wetland to freshwater marshes, which reduces the diversity of habitat and quality of rearing habitat for juveniles.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions represent a low to medium stress on sub-adult life stages of coho salmon in Maple Creek and Big Lagoon. Early logging resulted in the harvest of large trees from the riparian zone and the construction of roads alongside streams, so there is a lack of old growth conifers in these areas and many reaches are now dominated by alders. Riparian vegetation should have a diversity of age classes and species that provide a continuous source of large wood input to the stream.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the State of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS.

Impaired Water Quality

Impaired water quality is a low to medium stress for all the life stages of coho salmon in Maple Creek/Big Lagoon. The 7 day maximum average water temperature ranged from 14 to 15 °C (GDRC 2006) and there are no apparent sources of excessive nutrient or pollutant runoff.

Barriers

Barriers represent a low stress for coho salmon in the Big Lagoon and Maple Creek basin. A dam on Gray Creek has been assessed by the California Department of Water Resources and determined as not a barrier to fish passage (CalFish 2009). The sand spit at the outlet of Big Lagoon is the only potential barrier in years when the lagoon doesn't breach. Numerous natural barriers existing in the basin (Perry 2009)

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Maple Creek/Big Lagoon population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

Increased Disease/Predation/Competition

There is no documented increase in disease, predation, or competition within the Maple Creek/Big Lagoon basin. Disease, predation, or competition is considered a low stress to the population. Predation from bass and rainbow trout in the old mill pond at Gray Creek may be a concern. Bass and trout prey upon juvenile salmonids and could prevent coho salmon from utilizing the high IP habitat in this creek.

20.6 Threats

Table 20-5. Severity of threats affecting each life stage of coho salmon in the Maple Creek/Big Lagoon. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	Very High	Very High
2	Timber Harvest	Very High	Very High	Very High	Very High	Very High	Very High
3	Channelization/Diking	Medium	Medium	Medium	Medium	Medium	Medium
4	Dams/Diversion	Medium	Medium	Medium	Medium	Medium	Medium
5	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
6	Fishing and Collecting	-	-	-	-	Medium	Medium
7	Climate Change	Low	Low	Low	Low	Medium	Low
8	Urban/Residential/Industrial	Low	Low	Low	Low	Low	Low
9	Agricultural Practices	Low	Low	Low	Low	Low	Low
10	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low
12	Invasive Non-Native/Alien Species	Low	Low	Low	Low	-	Low

[1]Mining/Gravel Extraction is not considered a threat to this population.

Roads

Roads are a significant threat across all life stages of coho salmon in the Maple Creek basin. Road density is very high with an average of 9.6 miles per square mile of basin and road networks consist primarily of un-paved logging roads built on unstable Franciscan soils (GDRC 2006). The high density of roads is the most significant source of increased sediment in the creeks and the lagoon. As described previously, increased amounts of sediment are contributing to the loss of lagoon habitat. Additionally, roads interfere with tidal exchange, increasing channelization and limiting tidal rearing habitat. Roads often parallel the stream channel and have multiple crossings, increasing runoff and sediment input. Therefore, roads are one of the most serious threats for this population. The GDRC HCP describes a road maintenance plan to help abate this threat, but more road decommissioning is needed in the most geologically sensitive locations. Roads in the tidally influenced region and along stream corridors should be prioritized for decommissioning.

Timber Harvest

Timber harvest has been the predominant threat since the 1940s when the Maple Creek basin was first logged intensively. Today, the threat from timber harvest is considered very high across all life stages despite ongoing conservation measures by GDRC. Poor riparian conditions in Maple Creek and throughout the basin have been attributed to past and present timber harvest. The lack of older legacy trees along streams and large wood in streams reflects the outcome of early harvest practices that left no riparian buffers. Although some areas of the basin have likely recovered some of their riparian structure and function, the cessation of logging in riparian areas is too recent for many areas to reach late seral stage. Late seral stage riparian trees provide a source for large wood recruitment into the stream.

Today, GDRC manages the basin for timber harvest under an AHCP (GDRC 2006) that includes minimization and mitigation measures consisting of road and riparian management, slope stability, and harvesting restrictions. The impacts of timber harvesting, even if carried out under the AHCP, would result in the loss of pool habitat, loss of large wood and stream complexity, altered hydrology and nutrient cycling, and increased sediment loads. Changes in habitat conditions will have a negative effect on all life stages of coho salmon utilizing those areas. GDRC’s recent wood additions to streams and their assessments of erosion and sedimentation sources will help mitigate the impacts from future timber harvest in Maple Creek.

Channelization/Diking

Channelization and diking, a medium threat across all life stages, is not widespread throughout the basin but has localized impacts. In the upper basin, there are some reaches where roads parallel the stream, confining the channel and reducing floodplain connectivity and function. Channelization and diking is primarily a problem associated with Highway 101. The highway dike prevents hydrologic connectivity between Maple Creek, Gray Creek, and Big Lagoon, channelizing flows into a single thread channel that must pass under a single bridge constriction. Future impacts upstream of the dike include increased accretion in channel and floodplain habitat, the conversion of open water to mudflats, and wetlands to uplands. Without proper connectivity to Maple Creek and Gray Creek, Big Lagoon will also undergo changes in accretion and estuarine habitat.

Dams/Diversions

Dams and diversions present a medium threat across all life history stages of coho salmon. There is only one dam and associated diversion within the basin. The dam is located near the mouth of Gray Creek and forms a 70 acre pond once used as a mill pond. California Department of Water Resources determined there were no fish passage issues at this site (CalFish 2009). The unnatural lake is providing habitat for non-native predatory fishes, has converted tidally influenced land to freshwater, and is potentially harboring contaminants from its historic use as a log pond. Coho salmon have not been found in Gray Creek likely because of one or both of these issues associated with the pond.

High Intensity Fire

Fire is listed as a medium threat for coho salmon in the Maple Creek basin. The management of the timberlands by GDRC can alter the natural fire regime. Densely wooded and even-aged stands can have increased potential for fire, whereas thinning and prescribed burning can reduce the potential for high intensity fire. The GDRC AHCP prioritizes units for low intensity, controlled burns to reduce the buildup of excess fuels and reduce the risk of high intensity fire. When fires occur in the basin, the effects could be detrimental, potentially creating excessive amounts of erosion, loss of riparian vegetation, and degraded water quality.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and near shore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in Maple Creek. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Climate Change

Climate change poses a low threat to this population due to its cooler climate, low risk of temperature increase and precipitation change over the next 50 years (see Appendix B for modeling methods). Also, as with all populations in the ESU, adult coho salmon will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Urban/Residential/Industrial Development

Development presents a low threat for coho salmon in the Maple Creek/Big Lagoon basin. The Maple Creek basin is almost entirely owned by GDRC and if it remains as such, should have a minimal threat of development. The lagoon is primarily surrounded by public land and also has no threat of development. The Big Lagoon Rancheria Tribe owns 20 acres on the south side of the lagoon and contains a small amount of residential development.

Agricultural Practices

Because 98 percent of the basin is managed for timber harvest by GDRC, there is only a low threat from agricultural practice within the Maple Creek/Big Lagoon basin. The lagoon is protected from agriculture by the state parks that surround the sensitive environment. There are 20 acres of tribal land on the south side of the lagoon that may have the potential for small scale agriculture, but currently are dominated by eight households, roads, and a community water facility.

Road-Stream Crossing Barriers

Road-stream crossing barriers in the Maple Creek basin pose a low to medium threat for coho salmon. Road-stream crossings that have been evaluated as potential barriers are not accessible to coho salmon or they are on tributaries too small to provide coho salmon habitat (Perry 2009). However, road crossings present a major threat through their contribution to high sedimentation rates. Altered sediment supply is ranked as the most significant stress in the basin. Crossings should be regularly evaluated and either maintained, improved or decommissioned to prevent chronic erosion or wash-outs.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Maple Creek/Big Lagoon population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Invasive/Non-Native Species

Invasive, non-native species is considered a low stress in the Maple Creek basin. Predation from bass in the old mill pond at Gray Creek may be a concern. Bass prey upon juvenile salmonids and could prevent coho salmon from utilizing the high IP habitat in this creek.

20.7 Recovery Strategy

Coho salmon in the Maple Creek/Big Lagoon basin are severely depressed in abundance and have a restricted distribution because of degraded habitat quality. The recovery criterion for the population is that coho salmon must occupy 20% of IP habitat in years following spawning of brood years with high marine survival. Recovery actions should focus on habitat restoration to enhance survival and growth of juveniles as well as increase spatial distribution by connecting high quality habitat. Activities that reduce sediment delivery and increase the large wood component of streams would increase habitat complexity and quality of water and substrate. Activities that reduce sediment will also be beneficial to the lagoon/estuary.

Table 20-6 on the following page lists the recovery actions for the Maple Creek/Big Lagoon population.

Table 20-6. Recovery action implementation schedule for the Maple Creek/Big Lagoonpopulation.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MapC.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Big Lagoon, estuary, mainstem Maple Creek, Maple Creek tributaries	3
SONCC-MapC.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MapC.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-MapC.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels	Mill/Pitcher Creek	2
SONCC-MapC.2.2.2.1	*Assess habitat and develop a plan to restore the historic floodplain through reconnection of sidechannels and off channel habitat*					
SONCC-MapC.2.2.2.2	*Restore the historic floodplain, guided by the plan*					
SONCC-MapC.8.1.4	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-MapC.8.1.4.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MapC.8.1.4.2	*Decommission roads, guided by assessment*					
SONCC-MapC.8.1.4.3	*Upgrade roads, guided by assessment*					
SONCC-MapC.8.1.4.4	*Maintain roads, guided by assessment*					
SONCC-MapC.8.1.5	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-MapC.8.1.5.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-MapC.14.2.8	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of warm-water, non-native fish species	Gray Creek Mill Pond	3
SONCC-MapC.14.2.8.1	*Assess the different exotic species and the abundance of each species in the mill pond behind Gray Creek dam. Develop a plan to eradicate exotic species in conjunction with dam removal*					
SONCC-MapC.14.2.8.2	*Eradicate exotic species, guided by assessment results*					
SONCC-MapC.14.3.9	Disease/Predation/ Competition	No	Reduce competition	Reduce abundance of New Zealand mud snail	Big Lagoon, Lower Maple Creek	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MapC.14.3.9.1	*Investigate New Zealand Mud Snail presence in Big Lagoon and Maple Creek. Assess the risk to coho salmonids and determine a strategy for control if necessary*					
SONCC-MapC.14.3.9.2	*Control New Zealand Mud Snails guided by assessment results*					
SONCC-MapC.1.3.6	Estuary	No	Increase tidal exchange of water	Install bridges	Highway 101 dyke at Big Lagoon	3
SONCC-MapC.1.3.6.1	*Develop a plan to install bridges on Highway 101 that will increase tidal and riverine exchange, reduced channelization, reduce upland conversion, and increase flushing flows to Big Lagoon*					
SONCC-MapC.1.3.6.2	*Install bridges, guided by the plan*					
SONCC-MapC.1.3.7	Estuary	No	Increase tidal exchange of water	Remove dam	Gray Creek Mill Pond	3
SONCC-MapC.1.3.7.1	*Develop a plan to remove Gray Creek dam that will restore tidal wetland habitat and improve hydrologic connectivity*					
SONCC-MapC.1.3.7.2	*Remove Gray Creek dam, guided by the plan*					
SONCC-MapC.1.2.21	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-MapC.1.2.21.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-MapC.1.2.21.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-MapC.16.1.10	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MapC.16.1.10.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MapC.16.1.10.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-MapC.16.1.11	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MapC.16.1.11.1	*Determine actual fishing impacts*					
SONCC-MapC.16.1.11.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-MapC.16.2.12	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MapC.16.2.12.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-MapC.16.2.12.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-MapC.16.2.13	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MapC.16.2.13.1	*Determine actual impacts of scientific collection*					
SONCC-MapC.16.2.13.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-MapC.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MapC.27.1.15.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-MapC.27.1.16	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-MapC.27.1.16.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-MapC.27.2.17	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MapC.27.2.17.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-MapC.27.2.17.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-MapC.27.2.18	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-MapC.27.2.18.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-MapC.27.2.19	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MapC.27.2.19.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MapC.27.2.20	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-MapC.27.2.20.1	*Identify habitat condition of the estuary*					
SONCC-MapC.27.1.22	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-MapC.27.1.22.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MapC.27.1.22.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-MapC.27.2.23	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-MapC.27.2.23.1	*Determine best indicators of estuarine condition*					
SONCC-MapC.7.1.3	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Big Lagoon, estuary, mainstem Maple Creek, Maple Creek tributaries	3
SONCC-MapC.7.1.3.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-MapC.7.1.3.2	*Thin, or release conifers, guided by prescription*					
SONCC-MapC.7.1.3.3	*Plant conifers, guided by prescription*					

21. Little River Population

- Central Coastal Stratum
- Non-Core, Potentially Independent Population
- Moderate Extinction Risk
- 140 Spawners Required for ESU Viability
- 45.9 mi^2
- 34 IP-km (21 mi) (46% High)
- Dominant Land Uses are ‘Agriculture’ and ‘Timber Harvest’
- Principal Stresses are ‘Altered Sediment Supply’ and ‘Lack of Floodplain and Channel Structure’
- Principal Threats are ‘Timber Harvest’ and ‘Agriculture’

21.1 History of Habitat and Land Use

The most prominent land use in the Little River basin, and the most damaging, has been timber harvest. The first sawmill opened on the Little River in 1909, and the logging town of Crannell was built soon after on the coastal plain near the mouth of the Little River. The basin was intensely harvested throughout the early 1900s. The river was modified for sawmill use and logging operations. Historic photographs from the Humboldt State University Library’s Boyle Collection show a millpond at the mouth of Bullwinkle Creek and the main channel of Little River flowed through the mill (Figure 21-2). Historic pictures also show a fish ladder, but how well it functioned is unknown. Crannell was a booming town and even had its own railroad with 18 miles of railway, which was used for hauling timber to and from the mill. Historic logging practices severely degraded habitat throughout the basin (Figure 21-3).

Large-scale clear cuts, road construction, skid trails, and landings occurred on the highly erodible Franciscan soils that are dominant throughout the basin. These practices led to many slope failures, delivering sediment into the stream and severely aggrading the system. During the years of intense harvest, the river likely flowed with high amounts of turbidity, severely affecting development and behavior of all fish species. Additionally, trees were cut in the sensitive riparian zone, removing potential for instream wood recruitment and exposing the stream to increased solar radiation. Over a short period of time the combination of increased sediment and removal of large wood led to a highly disturbed basin with highly degraded fish habitat conditions.

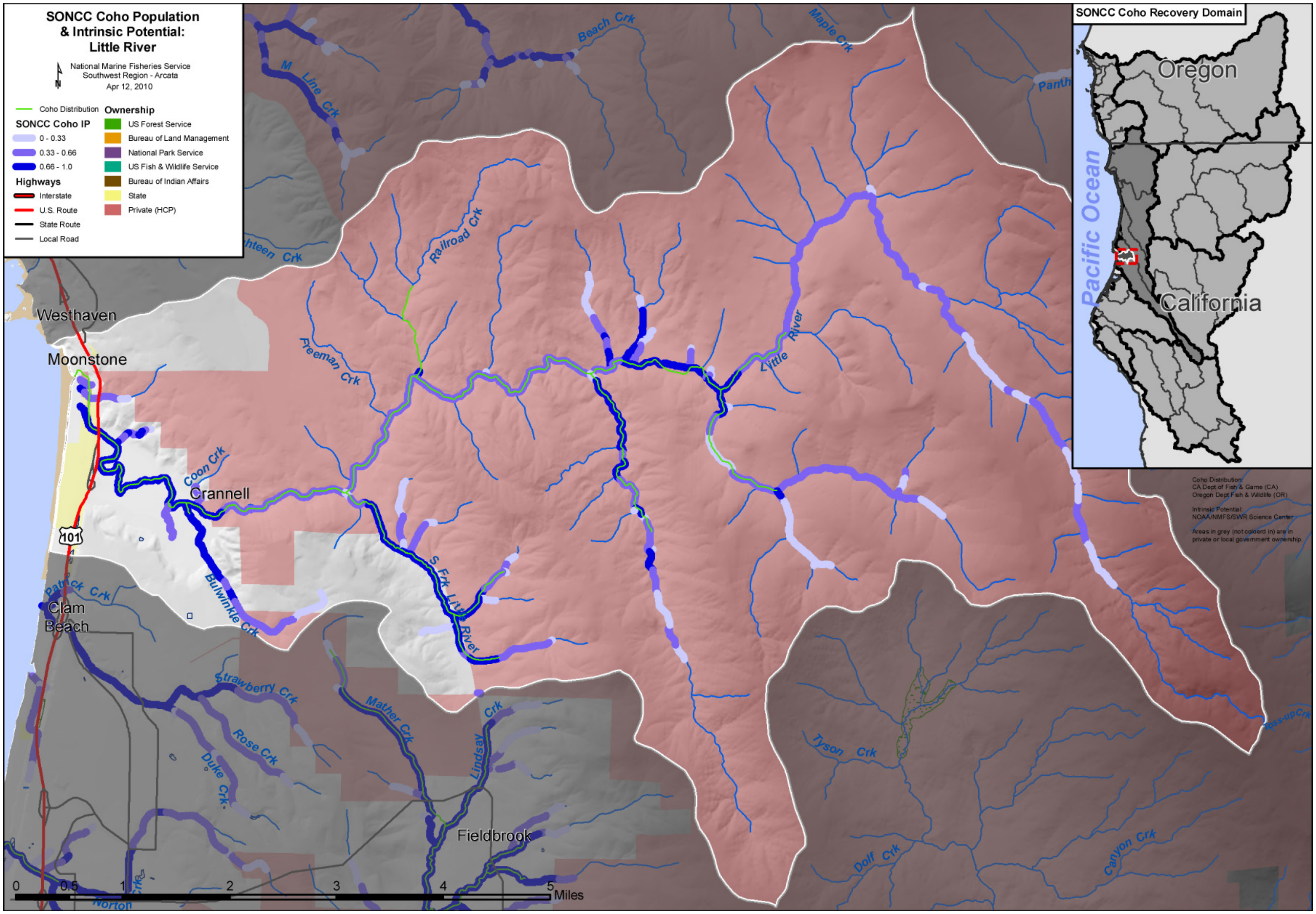

Figure 21-1. The geographic boundaries of the Little River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Figure 21-2. Historic Little River Redwood Company saw mill. Courtesy of Humboldt State University Library.

Figure 21-3. Logs on landing. Courtesy of Humboldt State University Library

Today, the historic town of Crannell has all but faded away. The flat coastal plain near the mouth of the Little River is now occupied by a few farm houses and large agricultural fields with virtually no remnants of the mill or town that once dominated the valley. Agriculture is now the primary land use in the valley. The land is used for grazing livestock and cranberry farming.

While the effects of grazing are less disturbing to salmonids and their habitat than the previous logging practices, adverse effects are still present. Livestock that are not properly fenced out of riparian zones are degrading the sensitive vegetation in these areas and contributing to bank instability and erosion. This further exacerbates the issue of excess sediment in the lower basin. Other agricultural practices, such as construction of cranberry bogs, have destroyed riparian and seasonal wetlands next to Little River. High IP reaches occur where agricultural lands dominate, which decreases rearing habitat quality and limits coho salmon production potential.

The majority of the basin in the uplands is still managed for timber production, which is mostly under the guidelines of current state timber harvest regulations and an aquatic habitat conservation plan (HCP). Management under the HCP helps protect the river from many of the destructive practices that originally took place. An extensive road system, with road density >3 mi./sq. mi., winds through the basin, contributing to runoff of surface material and increasing sediment delivery to streams. Gibbons and Salo (1973) concluded that sediment input per unit area from roads is usually greater than input from all other timber harvesting activities. Highly erosive geology in combination with extensive timber harvest and road building over the years has led to mass wasting events, deep-seated landslides, and chronic sediment delivery into Little River.

21.2 Historic Fish Distribution and Abundance

Historic coho salmon abundance data in the Little River prior to development in the basin is unavailable to infer trends, however recent data suggest the system can support, and likely has supported in the past, substantial numbers of coho salmon for its size. The IP model suggests that the areas with the highest potential for coho salmon production occur in the lower reaches of the Little River and its tributaries. Also, the Lower South Fork and mainstem Little River near its confluences with the Lower South Fork and Upper South Fork provide high production potential.

Currently, coho salmon appear to be distributed throughout the mainstem and in lower portions of the major tributaries. Coho salmon consistently spawn and rear in these areas, and occur in generally moderate abundance. This conclusion is supported by limited spawner survey and juvenile monitoring data. Since 1998, Green Diamond Resource Company (Green Diamond, GDRC) has monitored juvenile out-migration in four tributaries (Lower South Fork, Upper South Fork, Carson Creek, and Railroad Creek). Combining results from all tributaries between 1999 and 2009, out-migrant population estimates for Little River are highly variable and fluctuate between 200 and 5,800 smolts (Figure 21-4). The average annual out-migrant production over this time was 3,156, with the highest production in Carson Creek (1,596) and the lowest in Railroad Creek (71).

A combination of presence/absence data from CDFG, NMFS, and Green Diamond is available for additional tributaries that are not regularly monitored. Coon Creek, Water Gulch, C-Line Creek, and Pattie’s Creek have no records of coho salmon presence. Bullwinkle Creek, Freeman Creek, Railroad Creek, Danielle Creek, and Heightman Creek show coho salmon presence from Green Diamond records only (GDRC 2006 and 2009, Perry 2009). Production varies by tributary and by year, but the basin is able to consistently produce coho salmon smolts.

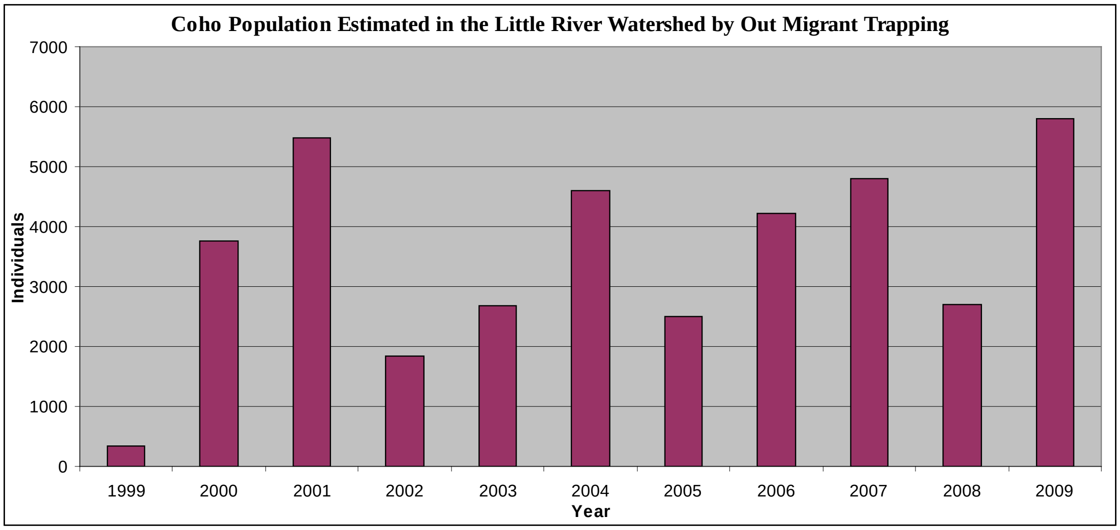

Figure 21-4. Out-migrant population estimates. Estimates are from Little River tributaries 1999 to 2009 (Carson Creek trap was added as a trapping location in 2000).

Young-of-the-year snorkel surveys in three major tributaries (Lower South Fork, Railroad Creek, and Upper South Fork) were conducted to estimate the summer juvenile coho salmon population over this same time period (1999 to 2009). Outmigrant trapping data was then used in combination with fry population estimates from the previous year to estimate overwintering survival in each of the tributaries. The calculated overwinter survival rates varied greatly, but provide good estimates of rearing potential in the system. Outmigrant trapping only documents fish that are moving through the system in the spring. It is assumed that many fish may move out of the tributaries earlier to rear in the mainstem or estuary. Because early outmigrants are not captured, the overwinter survival rate is probably underestimated. Additionally, in some years, Railroad Creek had an outmigrant population estimate that was greater than the fry population estimate. This may simply be observer error, but could also be an indication of a life history strategy where fry from other tributaries are moving into Railroad Creek to seek refugia. Based on available data, Railroad Creek and Upper South Fork show the highest overwintering survival rates between 1999 and 2009 (average 27.6 and 26.2 percent, respectively); while Lower South Fork had substantially lower survival rates (average of 17.0 percent). Studies in other basins have shown survival rates between 1.2 and 1.7 percent between the fry and smolt life stage (Godfrey 1965) so this basin appears to have very good rearing conditions in these creeks (GDRC 2006).

Spawning surveys were conducted in 6 streams within the Little River HPA from 1998 through 2000. Unfortunately, because of high flows and turbid waters, few adult coho salmon were observed. A total of 18 adult coho salmon were seen in Railroad Creek during that time. Because of the lack of adult spawning data, juvenile surveys provide the best indication of distribution in the Little River.

Table 21-1. Tributaries with instances of high IP reaches (IP value > 0.66). (Williams et al 2006).

Stream Name	Stream Name	Stream Name
Bullwinkle Creek	Railroad Creek	Lower South Fork Little River
Carson Creek	South Fork Little River	Upper South Fork Little River

21.3 Status of Little River Coho Salmon

Spatial Structure and Diversity

Although coho salmon maintain some spatial diversity by using select tributaries, many tributaries appear to be underutilized. Only a few known unnatural barriers exist within the basin, which allows coho salmon to access different watersheds and improves the overall connectivity and diversity of the population. The major tributaries of the Lower South Fork, Upper South Fork, Carson Creek, and Railroad Creek are all proven coho salmon producing tributaries within the Little River basin. Underutilized areas include Coon Creek, Water Gulch, C-Line Creek, and Pattie's Creek, which have no records of coho salmon presence. These creeks have moderate and high IP values, suggesting coho salmon likely occupied habitat in these areas. The low numbers of coho salmon and minimally known unique life history traits suggest an overall low diversity within the population.

Quality of instream habitat may be the main limiting factor to coho salmon distribution. Some creeks, such as Bullwinkle Creek, have been modeled as having high intrinsic potential; however no coho salmon have been observed. Perhaps because of the history of the millpond and the alterations made to streams like this in the past, coho salmon have not been able to recolonize the habitat. Other creeks located in the lower basin probably have similar levels of degraded habitat due to the history of intense modification during the early 1900s.

Carson Creek contains high IP habitat and surveys have shown this tributary to be the greatest producer of juvenile coho salmon. Lower South Fork Little River and Carson Creek have much higher production than any other tributaries in the Little River. Lower South Fork also had the highest average overwintering survival rate for coho salmon. High production and overwintering data suggest that these creeks contain high quality habitat.

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historic conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 41 coho salmon per-IP km of habitat are needed (1,400 spawners total) to approximate the historical distribution of Little Creek coho salmon and habitat. Currently, coho salmon appear to have access to most historically occupied habitats in the basin but are limited by habitat quality in some areas.

Population Size and Productivity

The population of coho salmon in Little River is depressed from historic levels modeled by Williams et al. (2006); however, the last decade of monitoring suggests the juvenile coho salmon population may be somewhat stable with no recognizable downward trends (GDRC 2009). Current data suggest that the population produces approximately 2,000 to 6,000 smolts per year from various tributaries throughout the basin. Although spawning estimates are unknown, considering that the basin produces over 16,000 fry a year then there are likely at least 66 spawning pairs on average in any given year. Currently, the population likely contains less than 200 adults. This is based on an average of 2,000 eggs per female and an egg mortality rate of 88 percent (Neave 1949; Crone and Bond 1976). Based on the biological data collected in the last decade, it appears the Lower South Fork Little River and Carson Creek have much higher production than any other tributaries in the Little River. The Lower South Fork also had the highest average overwintering survival rate for coho salmon.

At least 34 coho salmon must spawn in the Little River each year to avoid effects of extremely low population sizes, and 140 spawners are needed to be at the moderate risk threshold and be 90% confident that the population will not fall below the depensation threshold (Chapter 4). Currently, the number of spawning adults in the population is greater than moderate risk threshold of 140, but less than the low risk spawner threshold for the population (1,400; Williams et al. 2008.

Because the basin is still in a state of recovery from historic logging practices and stress and threats from timber harvest and agriculture remain, the population hasn't had a chance to fully recover. Even though population numbers seem to be stable, the overall abundance is much lower than historic condition and below the low-risk threshold.

Extinction Risk

The Little River coho salmon population is not viable and at moderate risk of extinction. The estimated number of spawners likely exceeds the depensation threshold, but does not meet the low-risk threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Little River population is a potentially independent population (Williams et al. 2008), with a high likelihood of persisting in isolation over 100-year time scales, but is strongly influenced by immigration from other populations and does not exhibit dynamics independent of other nearby populations. Several nearby populations may interact with the Little River population. The Maple Creek population to the north is a potentially independent population (Williams et al. 2008), and may produce coho salmon strays that spawn in the Little River. Maple Creek has a lagoon that breaches its sandbar annually, allowing adult fish to reach their spawning grounds. Occasionally, the lagoon may not breach during the winter, and adult coho salmon are forced to find other basins to spawn. Little River is the first major stream south of Maple Creek. In years when Maple Creek is inaccessible, coho salmon from the Maple Creek population likely enter the Little River.

Because these nearby populations also have low abundance, the adjacent populations are not likely contributing large numbers of spawners to the Little River. The Little River population, in fact, may be contributing strays to adjacent populations, and may influence their dynamics. Ultimately, recovery of the Little River population depends on concurrent improvements to the status of all coastal populations.

21.4 Plans and Assessments

California Department of Fish and Game

Recovery Strategy for California Coho Salmon

Coho salmon north of San Francisco are listed as threatened under the California Endangered Species Act, and this document describes a recovery strategy for the species in California. The Little River HSA is included in the Trinidad HU, and the strategy contains specific recommendations for the restoration of Little River and its major tributaries. Most recommendations address the impacts of logging and agriculture in the lower river basin. Restoration actions focus on the rehabilitation of the riparian zone and estuary.

Green Diamond Resource Company

Green Diamond HCP

The Green Diamond HCP (GDRC 2006) outlines a plan for the conservation of aquatic species in select watersheds in the Little River. The majority of the roughly 99.4 percent of private land in the Little River is owned by Green Diamond and therefore managed according to the provisions of the HCP. The plan was developed in accordance with the ESA section 10 regulations which require Green Diamond to develop a conservation strategy to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to Green Diamond's activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species. The plan has a number of provisions designed to protect coho salmon and salmon habitat throughout the Little River.

Under the provisions of the Green Diamond HCP, the company conducted initial assessment of salmon populations and habitat and conduct ongoing monitoring of certain physical and biological metrics. Initial channel and habitat typing assessments as well as LWD surveys, and juvenile presence/absence and spawning surveys were conducted on tributaries on Green Diamond land between 1994 and 1998 (GDRC 2006). Green Diamond also conducts long-term monitoring of instream habitat, water quality, mass wasting and slope stability, LWD, summer juvenile salmon population estimates, and out-migrant salmon abundance. Juvenile fish surveys and outmigrant trapping is conducted on the Little River. A report summarizing the results of these monitoring efforts is submitted to NMFS every other year.

Pacific Coast Fish Wildlife and Wetlands Restoration Association

21.5 Stresses

Table 21-2. Severity of stresses affecting each life stage of coho salmon in the Little River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Sediment Supply[1]	Very High	Very High	Very High[1]	Very High	High	Very High
2	Lack of Floodplain and Channel Structure[1]	High	High	High[1]	High	High	High
3	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
4	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	Medium
5	Impaired Water Quality	Medium	Medium	Medium	Medium	Medium	Medium
6	Barriers	-	Medium	Medium	Low	Low	Medium
7	Altered Hydrologic Function	Low	Medium	Medium	Low	-	Medium
8	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Land use in the Little River basin has led to an increase in sediment and a lack of instream wood, which are the greatest stressors for this population. Filling of pools by excess sediment combined with lack of wood to sort and meter out sediment or provide complex habitat has degraded rearing habitat. Over wintering and summering juvenile coho salmon is the most limited life stage due to the degraded quality of rearing habitat that should provide deep pools and complex channels for juveniles to escape high velocity flows during the winter season and provide cover during the summer season.

Increased channel complexity in the Little River basin would provide vital habitat for juvenile rearing opportunities. Historically, greater habitat complexity existed within the basin, but has been degraded by the long history of intense timber harvest. Currently, the lack of LWD due to past logging practices and the increase in sediment supply reduce complexity by filling in pools and reducing habitat structure. Additionally, a historic network of tidal and backwater channels once existed in the estuary. Highway 101 acts as a dike, channelizing and filling the historic channels that once provided high quality rearing habitat for coho salmon. Carson Creek contains high IP habitat and surveys have shown the tributary to be the greatest producer of juvenile coho salmon. Winter survival rates have been calculated highest in the Lower South Fork Little River. These tributaries should be noted as vital habitat for the population.

Altered Sediment Supply

Altered sediment supply is the highest stress affecting all life history phases of coho salmon, imposing a very high stress on all sub-adult life stages and a high stress on adults. Increased sediment delivery is a result of high road density, timber harvest, and agriculture in the lower Little River. An increase in fine sediment contributes to multiple problems including the simplification of stream habitat, increased turbidity, and increased embeddedness, which reduces survival rates of eggs. Additionally, fine sediment can interfere with gill function, feeding, and other normal behaviors of juvenile coho. The high stress ranking was based on measurements of D50 (particle size) and V* (a measure of pool filling), which were derived from surveys conducted in upper portions of the basin. The D50 of particle sizes was rated as fair, (38 to 50 and 110 to 128) indicating the mean size of substrate is smaller than desired. The V* was rated as poor (>0.35), indicating pools were filled with excess fines.

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure is a high stress across all life stages of coho salmon. Simplified channel and floodplain structure are primarily the result of a lack of large wood in the Little River system, an overabundance of fine sediment, and levees in the lower Little River. Green Diamond completed large wood surveys for the Little River Basin in 2009. Table 21-3 shows the results of the survey. The results of the survey show that South Fork Little River and Railroad Creek have the highest volume of large wood, while the mainstem Little River has the lowest volume (GDRC 2009). It can be assumed that with the history of logging in the area, the basin likely experiences low wood recruitment. Large wood is required to sort sediment, scour pools, and facilitate channel complexity. The V* surveys in the upper basin indicate pool habitat is filling with sediment. The oversimplified stream channel and floodplain provide fewer refugia and less rearing habitat for juveniles, and attributes such as deep pools and side channels are reduced in number.

Table 21-3. Large woody debris survey for Little River and its tributaries. Surveys were done in 1994 and 1995. Volume calculation comes from separate spreadsheet (GDRC 2006).

Stream	Surveyed Length (feet)	Metric (per 100' stream)	Size Classes of In-channel Large Wood; Max Diameter (ft)					
			1-1.9	2-2.9	3-3.9	≥4	Total Pieces	Total Volume (ft³)
Carson Creek (SF Little River)	12356	Pieces	6	1	0	0	8	1603
Carson Tributary	3021	Pieces	4	2	1	0	8	1767
Little River	14497	Pieces	2	0	0	0	3	1000
Lower South Fork Little River	9847	Pieces	4	2	0	0	8	2203
Railroad Creek	6877	Pieces	4	2	1	1	8	22669
Upper South Fork Little River	9673	Pieces	3	1	0	0	5	1858

Riparian Forest Conditions

The degraded riparian forest conditions across the Little River basin are rated as a medium to high stress for coho salmon with the greatest impacts to fry and juvenile life stages. As described above, a healthy riparian forest is essential to the continued input of wood into streams, to riparian shading and hydrologic function, and to the creation of complex fish habitat and stream morphology. Currently, riparian areas lack old growth conifer trees and are now dominated by second growth hardwood species, primarily red alder (GDRC 2006). A diverse age class of conifers is needed to supply a source for future wood recruitment. This stress is especially significant in the lower floodplain, which is dominated by agricultural land and experiences chronic destruction of the riparian vegetation through grazing. The riparian zone in these lowlands is dominated by dense shrubs such as willow and blackberry and provides reduced potential for future large wood recruitment

Impaired Estuary/Mainstem Function

This stress refers to just the estuary conditions in the Little River, since this is a single population basin. Mainstem conditions are addressed through other stressors such as floodplain and channel structure, riparian condition, hydrologic function, etc. Estuary function is important to the population because of its unique role in the life history and survival of coho salmon.

The Little River has a large tidally influenced area for its size. The outlet of the Little River is surrounded by Moonstone Beach County Park and Little River State Park. Approximately 0.75 river miles of mud flat, wetland, and sandbar habitat exist downstream of Highway 101. Upstream, the estuary and many associated tidal channels have been diked, filled, and channelized for agricultural purposes and the riparian vegetation has been cleared or degraded by grazing. Estuarine function is severely hampered by the lack of channel structure and the loss of tidal wetland and tidal channels. Currently only a few off-channel and backwater habitats occur within the estuary. Although the past extent of the estuary is unknown, based on similar coastal systems, the current extent of the estuary is far less than what it was historically. Estuarine habitats are important for juvenile rearing during the summer and historically provided numerous opportunities for growth and refuge for juveniles and smolts. The reductions in estuarine function is considered a high stress for juvenile and smolt life stages because of the lack of quality rearing habitat and the lack of refugia and holding habitat. Impaired estuarine function is considered a medium stress for adults in the population.

Impaired Water Quality

Water quality in the Little River has been rated as a medium stress across all life stages of coho salmon. Water temperature monitoring has occurred since 1994 at 14 different sites in 11 permanent, fish bearing channels. Temperature has been rated as good (14 to 15 °C) throughout the basin, although a few locations in the lower floodplain zone had temperatures readings up to 17 °C. Warmest temperatures (17 to 19 ºC) occurred in the lower mainstem Little River and in the Lower South Fork Little River. The coolest of the maximum recorded temperatures (11 to 12 ºC) occurred in the upper portions of the mainstem Little River, the upper portions of the Lower South Fork Little River and in Railroad Creek (Hurt 1969, GDRC 2009). Despite inadequate riparian cover, water temperature stays relatively cool due to the basin's location within the summer fog zone. Air temperature remains mild in this region year round.

Barriers

Barriers provide a low to medium stress for coho salmon in the Little River basin. There are no documented artificial barriers in the basin although there are several natural barriers in the form of falls and plunge pools in the upper reaches. There is potential for undocumented barriers on the private land in the upper basin, particularly with the high densities of road (e.g., >3 mi. /sq. mi. of basin) that are present there. Barriers primarily affect fry and juvenile coho, limiting access to summer and winter rearing areas.

Hydrologic Function

Altered hydrologic function is described as a low to medium threat for coho salmon. There are three water diversions present in the basin. The quantity of water that is withdrawn from these diversions and their overall impact on stream flows in the basin is unknown. In addition to diversion withdrawals, the dense road network in the basin (e.g., >3 mi. /sq. mi. of basin) contributes to altered hydrologic function by disconnecting many small streams from their natural courses. Inboard ditches can divert water out of its natural drainage, spilling it overland outside of a natural channel.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Little River population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

21.6 Threats

Table 21-4. Severity of threats affecting each life stage of coho salmon in the Little River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	High	Very High
2	Timber Harvest	Very High	Very High	Very High	Very High	High	Very High
3	Agricultural Practices	High	High	High	High	Medium	High
4	Channelization/Diking	Medium	Medium	Medium	Medium	Low	Medium
5	Dams/Diversion	Medium	Medium	Medium	Medium	Low	Medium
6	High Intensity Fire	Medium	Medium	Medium	Medium	Low	Medium
7	Urban/Residential/Industrial	Medium	Medium	Medium	Medium	Low	Medium
8	Fishing and Collecting	-	-	-	-	Medium	Medium
9	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
10	Climate Change	Low	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low

[1]Mining/Gravel Extraction, and Invasive Non-Native/Alien Species are not considered threats to this population.

Roads

Roads represent the most significant threat across all life stages of coho salmon in the Little River population. Road density is very high (>3 mi. /sq. mi. of basin) throughout the basin and most roads are unpaved logging and private roads. The high density of roads is the most significant contributor of sediment delivery within the basin. Sediment from roads results from road-related landslides, chronic erosion of native road surface and cut and fill slopes, and road-stream crossing failures. Roads can lead to landslides and mass wasting events where the entire roadbed can become saturated and fail, creating major sediment and diversion issues. Road maintenance can also contribute gravel spoils to the stream during grading or re-surfacing. Chronic sediment from surface runoff delivers silt to the stream, increasing water turbidity.

Roads interfere with the stream network by increasing sediment delivery at crossings and often diverting water away from natural drainages via inboard ditches. Basin-wide, an average of 30 percent of the road network in the Little River basin is estimated to be hydrologically connected to the stream network (GDRC 2006). On private property in the upper basin, inventory data described in the Green Diamond HCP stated 74 percent of the road network on Green Diamond land, or approximately 218 miles, are hydrologically connected (GDRC 2006). Overall, the degree of connectivity varies greatly across the basin, but is potentially high in many areas (NMFS 2007a). Hydrologic connectivity to roads increases the amount of sediments delivered to streams and the channelization and diversion that occurs as a result of road surface. Without proper upgrading and decommissioning of roads in the basin, impacts are likely to continue in the future and increase in magnitude as more roads become degraded and more roads are built.

Timber Harvest

Timber harvest has been a major threat in the basin since the early 1900s and continues to threaten aquatic habitat and coho salmon today. Within Green Diamond Resource Company property, harvest occurs under the direction of the company's HCP. This plan lays out goals and procedures to minimize and mitigate effects from timber harvest through measures related to road and riparian management, slope stability, and harvesting activities. At any given time, a portion of the Little River basin is being used for timber harvest and the impacts of such land use, even if carried out under the HCP guidelines, include the reduction of pool habitat, LWD and stream complexity; altered hydrology and nutrient cycling; and increased sediment loads.

Agricultural Practices

Next to timber harvest, agriculture is the predominant land use in the lower Little River basin and represents a high threat, especially for sub-adult life stages. The land is used for grazing livestock, hay operations, and also a minor amount of cranberry bogs. There is little to no livestock exclusion from the river and animals often trample streambanks and overgraze the riparian vegetation. The grazing of livestock adjacent to the stream leads to eroded banks and an excess of sediment and nutrients entering the water. In addition, diversions and ditches associated with agriculture in the area contribute to degraded habitat conditions and poor hydrologic connectivity. The reduction of estuarine function in the Little River is primarily the result of conversion of lowland estuarine habitat to agricultural land and the agricultural practices that occur in the estuarine floodplain.

Channelization/Diking

Most channelization and diking occurs in the lower Little River and is associated with flood protection and agriculture. Ditches and dikes occur in the lower two miles of the Little River, constraining flow and off-channel access for juvenile rearing. Channelization limits habitat complexity and diversity as well as altering the stream hydraulically. A channelized stream has a greater velocity and can erode banks as the stream tries to attain sinuosity. Juvenile fish depend on off channel areas and sinuous channels for rearing. The lower part of the basin where most of the channelization has occurred, in its natural state would form the most complex channels, providing the greatest value to rearing coho salmon. The loss of such complex habitat is a great detriment to the system.

Dams/Diversions

There are no dams in the basin; however, a few water diversions occur on Little River and Bullwinkle Creek that withdraw unknown amounts of water. As described above in the roads section, diversions also occur as roadside ditches. Diversions affect hydrologic connectivity and function through the loss and alteration of flow. Diversions pose a moderate threat to coho salmon in this population. Juveniles are especially vulnerable to the impacts from unscreened diversions as they are often entrained in such features.

High Intensity Fire

Vegetation and climate conditions in the basin make it naturally prone to low intensity, infrequent fire. However, unnatural fuel loads and changing climate could make this a greater threat if not fully addressed. The management of the timberlands by Green Diamond and other private timberland owners can alter the natural fire regime. Densely wooded and even-aged stands can have increased potential for fire, whereas thinning and prescribed burning can reduce the potential for large-scale fire. Green Diamond’s HCP prioritizes units for low intensity, controlled burns to reduce the buildup of excess fuels and reduce the risk of high intensity fire. The effects of high intensity fire could be severely detrimental, creating excessive amounts of erosion, loss of riparian vegetation, and degraded water quality.

Urban/Residential/Industrial Development

Historically, the logging town of Crannell presented a very high threat to all coho salmon life stages due to industrial and residential development, railroad construction, and extensive road systems. Currently, urban, residential, and industrial development is listed as a medium threat due to the low levels of development in the area. Development is limited to the few homes and ranches in the lower basin. Residential development could pose a greater threat in the future due to the close proximity of the basin to the large urban centers of McKinleyville and Arcata, California. As these communities grow, it is possible that the area could be rezoned and developed.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Little River, and has determined that these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Road-stream Crossing Barriers

Road-stream crossing barriers are defined as a low threat. There are currently no documented barriers created by road stream crossing within the basin. GDRC and local restoration groups continue to decommission roads and upgrade crossings in the upper basin, which in turn lessens this threat. Working with landowners in the lower basin will be important in the future to prevent any barriers from being created in this important rearing area.

Climate Change

Climate change poses a low threat to this population due to its cooler climate and low risk of average temperature increase and precipitation change over the next 50 years (see Appendix B for modeling methods). Also, with all populations in the ESU adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Little River population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress

21.7 Recovery Strategy

Coho salmon abundance in the Little River basin is depressed, but appears to be fairly stable. Juvenile outmigrant trapping and juvenile snorkeling surveys have shown good rearing productivity within the Little River basin. Most encouraging is the documented generally high juvenile survival. Recovery activities should focus on habitat restoration aimed at increasing the quality of habitat over a wider range within the basin, encouraging greater spatial diversity and increased production potential. Restoration should particularly focus on the high IP tributaries such as Carson Creek, Bullwinkle Creek and the South Fork Little River, as well as restoring habitat to benefit summer rearing. Activities that reduce sediment delivery and increase large wood will help increase habitat complexity, water quality, and channel and floodplain structure. Excluding livestock from the riparian corridor and re-establishing riparian vegetation adjacent to the river are important recovery actions for all coho life stages in the lower basin.

Table 21-5 on the following page lists the recovery actions for the Little River population.

Table 21-5. Recovery action implementation schedule for the Little River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LitR.2.1.2	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Estuary and Bullwinkle, Lower & Upper South Forks, Railroad, and Carson Creeks	2
SONCC-LitR.2.1.2.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-LitR.2.1.2.2	*Place instream structures, guided by assessment results*					
SONCC-LitR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Estuary	3
SONCC-LitR.2.2.3.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-LitR.2.2.3.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-LitR.8.1.1	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-LitR.8.1.1.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-LitR.8.1.1.2	*Decommission roads, guided by assessment*					
SONCC-LitR.8.1.1.3	*Upgrade roads, guided by assessment*					
SONCC-LitR.8.1.1.4	*Maintain roads, guided by assessment*					
SONCC-LitR.1.2.4	Estuary	No	Improve estuarine habitat	Restore estuarine habitat	Estuary	3
SONCC-LitR.1.2.4.1	*Assess tidally influenced habitat and develop a plan to restore tidal channels*					
SONCC-LitR.1.2.4.2	*Restore natural tidal channel form and function, guided by the plan*					
SONCC-LitR.1.4.5	Estuary	No	Protect estuarine habitat	Protect tidal wetland habitat	Estuary, downstream of highway 101	BR
SONCC-LitR.1.4.5.1	*Increase regulatory oversight to provide protection of existing tidal wetland habitat*					
SONCC-LitR.1.2.20	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-LitR.1.2.20.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LitR.1.2.20.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-LitR.16.1.9	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LitR.16.1.9.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-LitR.16.1.9.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-LitR.16.1.10	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-LitR.16.1.10.1	*Determine actual fishing impacts*					
SONCC-LitR.16.1.10.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-LitR.16.2.11	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LitR.16.2.11.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-LitR.16.2.11.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-LitR.16.2.12	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LitR.16.2.12.1	*Determine actual impacts of scientific collection*					
SONCC-LitR.16.2.12.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-LitR.27.1.13	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-LitR.27.1.13.1	*Perform annual spawning surveys*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LitR.27.1.14	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-LitR.27.1.14.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-LitR.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	3
SONCC-LitR.27.1.15.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-LitR.27.2.16	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-LitR.27.2.16.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-LitR.27.2.16.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-LitR.27.2.17	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-LitR.27.2.17.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-LitR.27.2.18	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-LitR.27.2.18.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-LitR.27.2.19	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-LitR.27.2.19.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-LitR.27.2.22	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	Estuary	3
SONCC-LitR.27.2.22.1	*Identify habitat condition of the estuary*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LitR.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-LitR.27.1.23.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-LitR.27.1.23.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-LitR.27.2.24	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-LitR.27.2.24.1	*Determine best indicators of estuarine condition*					
SONCC-LitR.5.1.8	Passage	No	Improve access	Remove barriers	Lower mainstem, estuary, private lands	BR
SONCC-LitR.5.1.8.1	*Assess road crossing barriers*					
SONCC-LitR.5.1.8.2	*Remove road crossing barriers, guided by the assessment*					
SONCC-LitR.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Lower mainstem	BR
SONCC-LitR.7.1.6.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-LitR.7.1.6.2	*Thin, or release conifers, guided by prescription*					
SONCC-LitR.7.1.6.3	*Plant conifers, guided by prescription*					
SONCC-LitR.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Lower mainstem	3
SONCC-LitR.7.1.7.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-LitR.7.1.7.2	*Develop grazing management plan to meet objective*					
SONCC-LitR.7.1.7.3	*Plant vegetation to stabilize stream bank*					
SONCC-LitR.7.1.7.4	*Fence livestock out of riparian zones*					
SONCC-LitR.7.1.7.5	*Remove instream livestock watering sources*					

22. Strawberry Creek Population

- Central Coastal Stratum
- Dependent Population
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 4 mi^2
- 7 IP km (4 mi) (60% High)
- Dominant Land Uses are ‘Residential Development’ and ‘Agriculture’
- Principal Stresses are ‘Barriers’ and ‘Impaired Estuary/Mainstem Function’
- Principal Threats are ‘Road-Stream Crossing Barriers’ and ‘Roads’

22.1 History of Habitat and Land Use

The community of McKinleyville encompasses most of the Strawberry Creek basin, with nearly 100 percent of the land privately owned. About 13.8 percent of the basin is owned by Green Diamond Resource Company (GDRC) as industrial timberlands covered under a Habitat Conservation Plan (HCP). Historically, much of the basin was cleared for rural development, agriculture and timber harvest purposes. Although historically timber harvest and agricultural practices took place within the basin, low-density rural residential and low intensity agricultural land uses now dominate. The foothills, which contain the headwaters, have a more recent history of timber harvest with secondary growth currently dominating the basin.

Highway 101, which crosses Strawberry Creek low in the basin, was established in the 1920s and is responsible for some of the earliest and more significant habitat changes in Strawberry Creek. The highway culvert and the concrete channel immediately upstream are significant impediments to coho salmon passage. Additional partial barriers are present at road crossings upstream on Strawberry Creek. On Patrick Creek, the most downstream tributary to Strawberry Creek, the Highway 101 crossing completely blocks fish passage.

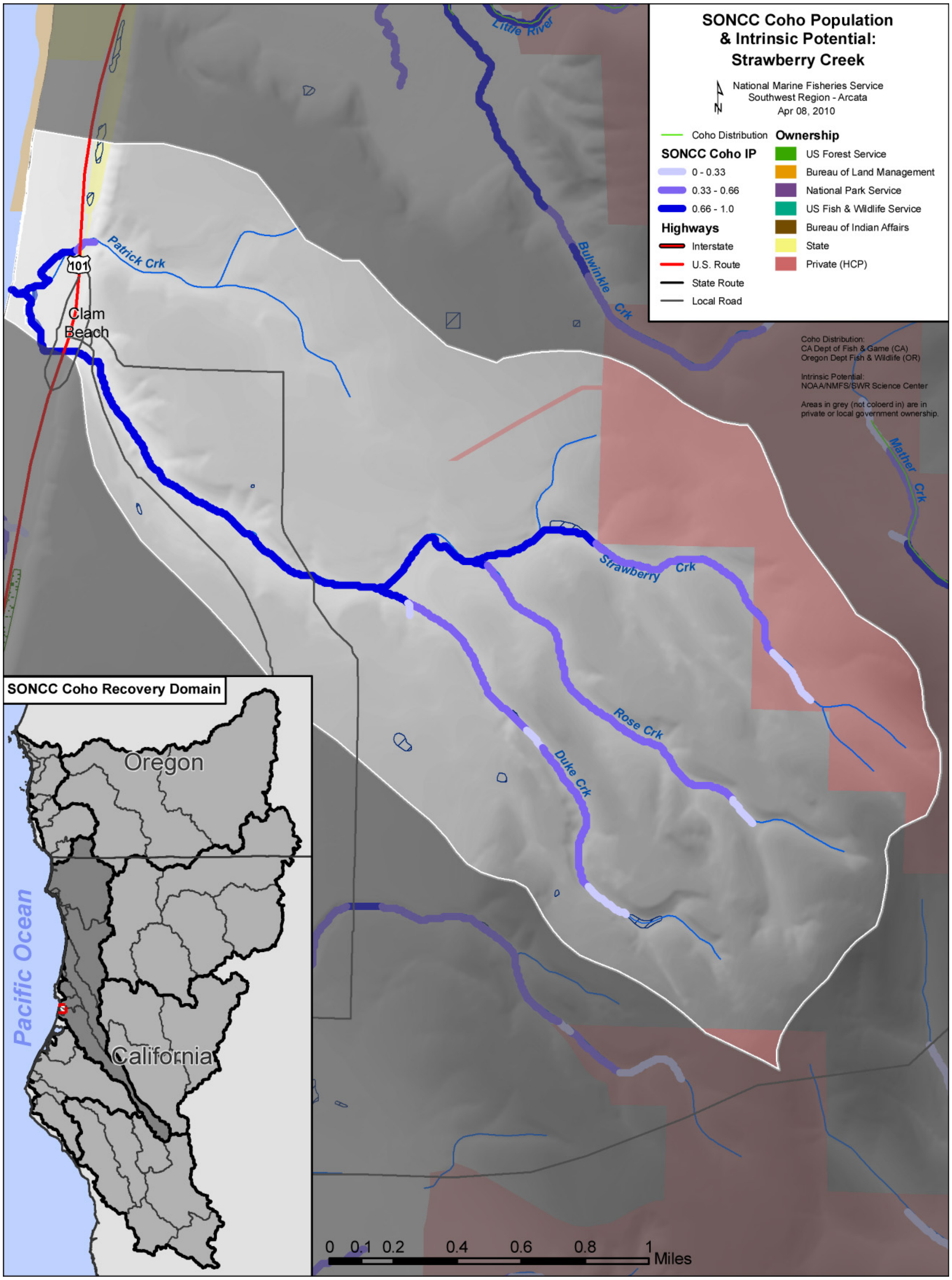

Figure 22-1. The geographic boundaries of the Strawberry Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Natural instream structures such as wood were likely removed during road construction to facilitate unimpeded flow through culverts and narrow channels. The original riparian vegetation containing old growth trees was removed during past timber practices. A majority of the basin contains second growth mixed conifer, redwood, Sitka spruce, and other riparian vegetation maintaining relatively complex channel conditions. Large trees are found embedded in the banks throughout much of the basin and cool water with good stream flow exists throughout most of the area.

Strawberry Creek is subject to increased storm water runoff in areas adjacent to the impervious surfaces of the Arcata/Eureka Airport in the lowest part of the basin. Low-density rural residential development in the Strawberry Creek basin, and associated impervious surfaces such as roads, has also increased storm water runoff and associated pollutants.

22.2 Historic Fish Distribution and Abundance

Potential coho salmon habitat is distributed throughout the Strawberry Creek basin, which comprises about 3.5 square miles. The IP modeled results suggest that high value (IP > 0.66) coho salmon habitat occurs in about 50 percent of the basin; particularly in the section of Strawberry Creek from the ocean to the confluence of the tributary Duke Creek. Medium potential coho salmon habitat (IP 0.33 – 0.66) occurs in the upper basin areas of Strawberry Creek and in the Duke Creek and Rose Creek tributaries. The small tributary Patrick Creek contains a small amount of high value coho salmon habitat while the remaining portion contained medium potential habitat.

Although coho salmon have been found historically in Strawberry Creek, no historic data exist to describe run characteristics, fish distribution or population abundance for coho salmon in Strawberry Creek or in its tributaries, Duke Creek, Rose Creek, and Patrick Creek. Surveys did not detect presence of coho salmon for brood years 2000-2002 in Strawberry Creek, although there is a historical record of coho presence for brood year 1967 (Jong et al. 2008).

Table 22-1. Tributaries with instances of high IP reaches (IP value > 0.66) (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Strawberry Creek	Patrick Creek	Duke Creek

22.3 Status of Strawberry Creek Coho Salmon

Spatial Structure and Diversity

About 50 percent of the Strawberry Creek basin has a high IP value, indicating there is potential for good spatial distribution of coho salmon in the basin. However, in the recent past, fish have been restricted during most years to just the lowest reaches of the basin by partial barriers in Strawberry Creek and many tributaries and a complete barrier on the Patrick Creek tributary near the Pacific Ocean. No stream crossings have been improved in the Strawberry Creek basin and the existing barriers likely inhibit coho salmon recovery in the majority of the basin.

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Although the amount of habitat currently utilized by coho salmon is unknown, it is presumed to be very limited due to the presence of passage barriers and habitat degradation associated with low density rural development.

Population Size and Productivity

There are no data available on the current or historic coho salmon abundance in Strawberry Creek; however, it is designated as a dependent population and likely is dominated by strays from nearby basins. Due to migration barriers and habitat degradation within the Strawberry Creek basin, it is likely that coho salmon numbers are very low, and may even be extirpated from the basin. Sampling efforts have been limited, but coho salmon have not been detected in Strawberry Creek during the past 40 years. Nearby coho salmon populations include the dependent Norton/Widow White Creek population and the functionally independent Mad River and Little River populations. The Mad River and Norton/Widow White Creek populations are severely depressed, and therefore are not likely contributing strays into Strawberry Creek. The Little River population is low but stable, and therefore could be a source of colonists to Strawberry Creek.

Extinction Risk

Not applicable because Strawberry Creek is not an independent population.

Role of Population in SONCC Coho Salmon ESU Viability

The Strawberry Creek population is considered dependent because it does not have a high likelihood of sustaining itself over a 100-year time period in isolation and likely received sufficient immigration to alter its dynamics and extinction risk (Williams et al. 2006). Although such populations may not be fully viable on their own, they do increase connectivity by allowing dispersal among independent populations, acting as a source of colonists in some cases. Historically, the Strawberry Creek population would have interacted with other Central Coastal populations such the potentially independent as Little River population to the north, the functionally independent Mad River population to the south, or the dependent Norton/Widow White Creek population to the south. Any restored habitat in Strawberry Creek provides potential connectivity and increased resiliency in the SONCC coho salmon ESU.

22.4 Plans and Assessments

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004.

Green Diamond Resource Company

Habitat Conservation Plan

GDRC owns 14 percent of the Strawberry Creek basin. The Habitat Conservation Plan, finalized in 2006 and valid through 2056, was developed in accordance with the ESA section 10 regulations which require GDRC to develop a conservation strategy to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to GDRC's activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species (GDRC 2006). The plan has a number of provisions designed to protect coho salmon and salmon habitat throughout the population area.

22.5 Stresses

Table 22-2. Severity of stresses affecting each life stage of coho salmon in Strawberry Creek. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile	Smolt	Adult[1]	Overall Stress Rank
1	Barriers[1]	-	Medium	High	High	Very High[1]	High
2	Impaired Estuary/Mainstem Function	-	Medium	High	High	Medium	High
3	Altered Sediment Supply	Medium	Medium	Medium	Medium	Medium	Medium
4	Lack of Floodplain and Channel Structure	Medium	Medium	Medium	Medium	Medium	Medium
5	Degraded Riparian Forest Conditions	-	Medium	Medium	Medium	Medium	Medium
6	Altered Hydrologic Function	Medium	Medium	Medium	Medium	-	Medium
7	Impaired Water Quality	Medium	Medium	Medium	Medium	Low	Medium
8	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition are not considered a stress for this population.

Limiting Stressors, Life Stages, and Habitat

The major limiting stressors for the Strawberry Creek population are road-crossing barriers in the lower basin. These barriers limit, if not completely block, all migration into the upper parts of the basin where spawning and rearing habitat occur. If adults are able to migrate through these barriers, smolt outmigration may be hindered. Tidal freshwater habitat is important for the growth and survival of juvenile coho salmon. Significant amounts of high IP habitat exist in the lower Strawberry Creek, including the tidally influenced areas of Strawberry and Patrick Creek. These high IP habitats may be valuable for winter and summer rearing and should be prioritized for recovery.

Barriers

Barriers pose a very high stress to juveniles, smolts, and adults. At least four barriers have been assessed in the Strawberry Creek basin, which are located at major road-stream crossings. As discussed in more detail in the section below regarding road-stream crossing threats, the crossing on Patrick Creek is a complete barrier to both juvenile and adult coho salmon and there are three other known partial barriers on the mainstem of Strawberry Creek. Additional road-stream crossings also likely occur on private roads and driveways, which have not been surveyed, and the extent of fish passage at these stream crossings is unknown.

Impaired Estuary/Mainstem Function

This stress refers to just the estuary conditions in Strawberry Creek, since this is a single population basin. Mainstem conditions are addressed through other stressors such as floodplain and channel structure, riparian condition, and hydrologic function. Estuary function is important to the population because of its unique role in the life history and survival of coho salmon

The Strawberry Creek basin has a small and narrow estuary that is heavily impacted by Highway 101 and a parking area off Clam Beach Drive. The development of this four-lane stretch of Highway 101 in the estuary has reduced the current extent of habitat to just a few acres downstream of the highway. Patrick Creek, a tributary to the estuary is completely blocked to fish at Highway 101 (CalFish 2009). The Highway 101 culvert on Strawberry Creek is partially filled with sediment, which restricts tidal exchange and estuarine wetland habitat. Currently, the estuary area adjacent to the ocean has large pieces of embedded, old growth wood that probably provide limited function as refugia. Vehicular access to riparian areas on Clam Beach might negatively affect migrating or rearing coho salmon by increasing turbidity at stream crossings or damaging riparian vegetation. There is no evidence that the mouth of Strawberry Creek closes to the Pacific Ocean during even the lowest water years, meaning bar breaching is not an issue. Given the small size of the basin, estuarine habitat could be very important to juvenile coho salmon rearing and therefore the loss of estuarine function is considered a high stress for the population. Juveniles and smolts are most affected since they rely on rearing and holding habitat in the estuary.

Altered Sediment Supply

Altered sediment supply is a medium stress to all life stages. The sediment supply in Strawberry Creek is being altered by the surrounding residential and urban land uses, as well as logging and road building further up in the basin, and sediment supply to the creeks has increased due to these land use practices. This increase in material contributes to the filling in of pools and widening of channels and the input of fines can create high levels of embeddedness, decreasing the quality of spawning gravel. Considering the continued increases in the human population in the areas surrounding Strawberry Creek, this stress is likely to continue into the future, and may become more detrimental over time.

Lack of Floodplain and Channel Structure

Floodplain and channel structure presents a medium stress across most life history stages. No habitat surveys have been conducted in the Strawberry Creek basin but the removal of large wood from stream channels and the removal/depletion of riparian habitat, which is the source of future large wood input, have likely reduced the structural complexity of stream channels. Fine sediment input from land use practices in the upper basin areas has likely filled pools and simplified habitat, limiting rearing and spawning habitat in accessible areas. In addition, just upstream of the Highway 101 culvert, Strawberry Creek is channelized, creating simplified stream habitat with lack of cover or refuge for about 800 feet, and adding to existing passage problems throughout the basin.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions present a medium stress across most life stages. Forests are present the majority of riparian areas in the basin; however, the size and age of trees is likely much lower than it was historically. The riparian forest conditions have been most altered through timber harvest in the upper Strawberry Creek basin, which is an area that has medium IP potential habitat. Some of the canopy cover has been depleted from road building and timber harvest in riparian areas and streamside corridors. Many of the legacy trees have been removed, leaving low potential for large wood recruitment and adding to existing sediment issues.

Altered Hydrologic Function

Altered hydrologic function represents a medium stress across most life history stages. The McKinleyville Community Services District provides water from the Mad River to residents of the lower Strawberry Creek basin (MCSD 2010) where the majority of the human population is located. No stream diversions were found in the Strawberry Creek basin, although many of the rural residents in the basin may utilize wells, which could contribute to a lowered water table. On the other hand, no sand berm forms during the summer at Strawberry Creek's confluence with the Pacific Ocean, so the basin still has excellent flow volume and cool water temperatures throughout the year. Thus, hydrologic function is not a significant stressor in the basin.

Impaired Water Quality

Water quality poses a medium to low stress to coho salmon in the basin. This stress is most likely in the form of temperature and some rural residential pollutants, but it is unknown what, if any, effect this has on the Strawberry Creek coho salmon population. No water temperature data have been collected in Strawberry Creek or its tributaries, but temperature is not likely a limiting factor because the entire basin falls within coastal influences, where cool and moist conditions dominate.

Adverse Fishery-Related Effects

NMFS has determined that federally managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Strawberry Creek population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

22.6 Threats

Table 22-3. Severity of threats affecting each life stage of coho salmon in Strawberry Creek. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Road-Stream Crossing Barriers	Very High	Very High	Very High	Very High	Very High	Very High
2	Roads	Medium	Medium	Medium	Medium	Medium	Medium
3	Urban/Residential/Industrial	Medium	Medium	Medium	Medium	Medium	Medium
4	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
5	Channelization/Diking	Low	Medium	Medium	Medium	Medium	Medium
6	Fishing and Collecting	-	-	-	-	Medium	Medium
7	Climate Change	Low	Low	Low	Low	Medium	Low
8	Dams/Diversion	Low	Low	Low	Low	Low	Low
9	Timber Harvest	Low	Low	Low	Low	Low	Low
10	Hatcheries	Low	Low	Low	Low	Low	Low

[1]Invasive Non-Native/Alien Species, High Intensity Fire, and Mining/Gravel Extraction are not considered threats to this population.

Road-stream Crossing Barriers

Road-stream crossing barriers constitute a very high threat to coho salmon population in Strawberry Creek. At least four barriers have been assessed in the Strawberry Creek basin, and all are located at major road-stream crossings (Taylor 2000, Lang 2005). The state Highway 101 culvert is located adjacent to Strawberry Creek's outlet to the ocean and is the lower most barrier to passage, and excludes upstream movement of juvenile coho salmon into the majority of the basin during nearly all flows. Adult coho salmon passage occurs during only about 48 percent of flows (Lang 2005). Just upstream of the Highway 101 culvert is a steep trapezoidal concrete channel paralleling Central Avenue in McKinleyville, presenting the next partial barrier to fish passage in the Strawberry Creek basin. Eight-hundred feet upstream is the Humboldt County road crossing at Central Avenue (Lang 2005). This crossing represents a complete barrier to juvenile coho salmon and a partial barrier to adult coho salmon. Further upstream at the Dows Prairie Road crossing, another culvert is a partial barrier to adult and juvenile coho salmon. The small tributary Patrick Creek meets Strawberry Creek below the 101 Highway culvert at Strawberry Creek near Clam Beach. A complete barrier to fish passage on Patrick Creek occurs upstream of this confluence at Highway 101 (Lang 2005); however there are only are only a few hundred feet of medium-IP habitat upstream of this barrier.

No efforts have been made to improve these crossings. The culverts under Highway 101 at both Strawberry Creek and the tributary Patrick Creek pose especially significant problems due to their locations low in the Strawberry Creek basin.

Table 22-4. List of prioritized road-stream crossing barriers in the Strawberry Creek population.

IP priority	Stream Name	Road Name	Watershed	County	Miles of habitat
high	Strawberry Creek	Highway 101	Strawberry	Humboldt	>5.2
high	Strawberry Creek	Central Avenue	Strawberry	Humboldt	5.1
high	Strawberry Creek	Dows Prairie Rd.	Strawberry	Humboldt	4.1
high	Strawberry Creek	Highway 101	Patrick Creek	Humboldt	<1

Roads

Roads pose a medium threat to coho salmon in Strawberry Creek. Many of the roads in the more rural portions of the basin are unpaved and these roads create a significant source of sediment input to the stream. Because these roads are in a rural setting and often in the form of driveways and private roads, they can be difficult to treat, as decommissioning is not an option. In accordance with their aquatic Habitat Conservation Plan, the GDRC intends to maintain or decommission their roads to minimize adverse effects to salmon.

Urban/Residential/Industrial Development

Low-density rural residential development of the area occupied by the Strawberry Creek population of coho salmon contributes to all the stresses affecting this population, and poses a medium threat to all life stages of the Strawberry Creek coho salmon population. This threat is considered medium instead of high because no areas are designated for future medium or high-density residential development, industrial, or mixed use. Further urban development has not occurred in the basin and is not planned. The only industrial-type development is the Arcata/Eureka Airport, which could contribute to runoff of pollutants into the basin due to its impervious surfaces.

Agricultural Practices

Although agriculture may have historically played a larger role in the Strawberry Creek basin, now it presents a medium threat with 5 to 10 percent of the basin affected by agricultural practices. Some of the landowners have a small number of horses or cattle grazing near the stream, and this activity likely contributes to the altered sediment supply seen in many areas of lower Strawberry Creek. Grazing can result in multiple stresses including increased sediment supply, degraded riparian zones, and poor water quality.

Channelization/Diking

Channelization and diking is a medium threat to almost all life stages of the Strawberry Creek coho salmon population, but may be a more significant threat in certain areas. In particular, just upstream of the Highway 101 culvert on Strawberry Creek is a steep trapezoidal concrete channel paralleling Central Avenue in McKinleyville. Channelization of the stream, in conjunction with a lack of instream structure, creates a simplified stream habitat with no cover or refuge for about 800 feet. Habitat within the channelized area is unsuitable for coho salmon rearing and presents a barrier to juvenile fish passage and adult passage during some flows.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in Strawberry Creek.

Climate Change

There is moderate risk of a change in average precipitation over the next 50 years (Appendix B). Modeled regional average temperature shows a moderate increase over the next 50 years (Appendix B). Average temperature could increase by up to 1^{o}C in the summer and by a similar amount in the winter. The risk of sea level rise is low to moderate (Thieler and Hammer-Klose 2000), which may impact the quality and extent of wetland juvenile and smolt habitat. Adults may be negatively impacted by climate-related ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Dams/Diversions

Aerial photos show the presence of two small ponds on Duke Creek, both likely formed by impoundments. One is about 0.6 miles upstream of the mouth of Duke Creek in an area of medium IP habitat value and other is located an additional 0.8 upstream in an area of low IP habitat value.

Timber Harvest

Extensive timber harvest likely occurred in the early history of McKinleyville's development, and set the stage for land to be cleared for later agriculture or low-density human settlement. Logging of the basin may have contributed to early degradation of the riparian zone and lack of instream structure. However, threats from timber operations are no longer major stressors within the system, especially since 13.8 percent of the GDRC's timberlands are now operated under a NMFS-approved Aquatic Habitat Conservation Plan to minimize and mitigate impacts to coho salmon. Currently, timber harvest constitutes a low threat to the population.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Strawberry Creek population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

22.7 Recovery Strategy

Coho salmon have not been detected in Strawberry Creek during the past 40 years, although survey efforts have been quite limited. The Strawberry Creek population is dependent and therefore cannot be viable on its own; however, it is necessary to restore access and habitat within the basin so that it can provide connectivity between other populations in the ESU. The recovery criterion for the population is that 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival

The most immediate need for coho salmon recovery in the Strawberry Creek basin is to provide adult passage at road-stream crossings barriers in the lower basin. The spatial distribution and diversity of coho salmon is below its potential due to these barriers and the population will not recover without passage improvements. With increased passage, coho salmon would have the opportunity to recolonize most of the basin.

There are no survey data to assess habitat quality quantitatively; however, it is likely that habitats are lacking instream complexity and mature riparian forests. Restoration efforts should focus on the mainstem of Strawberry Creek and the lower portions of Patrick Creek, Rose Creek, and Duke Creek, which all have high IP habitat (Figure 22-1). In addition, eliminating impediments to natural estuarine function would increase the value of this habitat and potentially increase growth and survival of juveniles.

Table 22-5 on the following page lists the recovery actions for the Strawberry Creek population.

Table 22-5. Recovery action implementation schedule for the Strawberry Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-StrC.5.1.1	Passage	Yes	Improve access	Remove structural barrier	Mainstem Strawberry, Patrick, Duke, and Rose creeks, Highway 101 culvert	3
SONCC-StrC.5.1.1.1	*Assess road-stream crossing barriers*					
SONCC-StrC.5.1.1.2	*Upgrade County culverts to accommodate fish passage at all life stages*					
SONCC-StrC.5.1.1.3	*Prioritize and resolve passage issues at Highway 101*					
SONCC-StrC.1.4.7	Estuary	No	Protect estuarine habitat	Prevent damage from vehicular traffic	Lower Strawberry Creek	BR
SONCC-StrC.1.4.7.1	*Stop all vehicular traffic on Clam beach and Strawberry Creek estuary*					
SONCC-StrC.1.2.8	Estuary	No	Improve estuarine habitat	Construct additional wetland habitat in tidally-inundated stream reaches	Lower Strawberry Creek, downstream of highway 101	3
SONCC-StrC.1.2.8.1	*Assess tidally influenced habitat and wetlands and develop a plan to restore wetland and off channel habitat*					
SONCC-StrC.1.2.8.2	*Construct additional wetland habitat (wetland and off-channel habitat) downstream of the highway on tidally-inundated stream reaches*					
SONCC-StrC.1.2.9	Estuary	No	Improve estuarine habitat	Relocate parking area	Lower Strawberry Creek	BR
SONCC-StrC.1.2.9.1	*Relocate the parking area on Clam Beach Drive and expand and connect the adjacent wetland area*					
SONCC-StrC.2.2.2	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Restore natural channel form and function	Lower Strawberry Creek	3
SONCC-StrC.2.2.2.1	*Assess concrete channel and develop a plan to restore natural channel form and function*					
SONCC-StrC.2.2.2.2	*Remove concrete channel and restore natural channel, guided by the plan*					
SONCC-StrC.2.1.13	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3
SONCC-StrC.2.1.13.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-StrC.2.1.13.2	*Place instream structures, guided by assessment results*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-StrC.2.2.14	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Increase beaver abundance		BR
SONCC-StrC.2.2.14.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-StrC.2.2.14.2	*Implement beaver program (may include reintroduction)*					
SONCC-StrC.2.2.14.3	*Limit hunting or removal of beaver*					
SONCC-StrC.27.2.11	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-StrC.27.2.11.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-StrC.27.2.11.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-StrC.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-StrC.27.1.15.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-StrC.27.1.16	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-StrC.27.1.16.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-StrC.27.1.16.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-StrC.27.2.17	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-StrC.27.2.17.1	*Determine best indicators of estuarine condition*					
SONCC-StrC.7.1.5	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Middle Strawberry Creek and tributaries	BR
SONCC-StrC.7.1.5.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-StrC.7.1.5.2	*Develop grazing management plan to meet objective*					
SONCC-StrC.7.1.5.3	*Plant vegetation to stabilize stream bank*					
SONCC-StrC.7.1.5.4	*Fence livestock out of riparian zones*					
SONCC-StrC.7.1.5.5	*Remove instream livestock watering sources*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-StrC.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Middle and Upper Strawberry Creek	BR
SONCC-StrC.7.1.6.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-StrC.7.1.6.2	*Develop watershed-specific guidance for managing riparian vegetation*					
SONCC-StrC.8.1.10	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-StrC.8.1.10.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-StrC.10.2.3	Water Quality	No	Reduce pollutants	Improve regulatory mechanisms	Population wide	BR
SONCC-StrC.10.2.3.1	*Complete system upgrades to achieve CWA compliance*					
SONCC-StrC.10.2.3.2	*Provide incentives for septic repair and upgrades*					
SONCC-StrC.10.2.4	Water Quality	No	Reduce pollutants	Reduce point- and non-point source pollution	Population wide	BR
SONCC-StrC.10.2.4.1	*Limit impervious surfaces*					
SONCC-StrC.10.2.12	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-StrC.10.2.12.1	*Develop an educational program that teaches landowners and businesses about avoiding pollution from septic systems, backyard pesticides, fuels, and nutrients.*					

23. Norton/Widow White Creek Population

- Central Coastal Stratum
- Dependent Population
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 6.14 mi²
- 10 IP km (6 mi) (62% High)
- Dominant Land Uses are Urbanization and Agriculture
- Principal Stresses are 'Degraded Riparian Forest Conditions' and 'Lack of Floodplain and Channel Structure'
- Principal Threats are 'Channelization/Diking' and 'Roads'

23.1 History of Habitat and Land Use

The community of McKinleyville encompasses most of the Norton/Widow White basin, with nearly 100 percent of the land privately owned. Historically, much of the basin was cleared for farming, agriculture and timber harvest purposes. The majority of the channel meanders through a low-lying coastal plain, and is currently occupied by urban and rural development, and some small-scale agricultural areas. The foothills, which contain the headwaters, have a more recent history of timber harvest with second growth currently dominating the landscape.

Significant habitat changes began in Norton/Widow White Creeks around the 1920s, when Highway 101 was built and created a fish barrier low in the basin. Currently, the long culvert at this location is still a partial barrier, inhibiting movement of juvenile salmonids. Just to the east of the highway, extensive urban development has also contributed to habitat degradation and there are many road/stream crossings, channelized reaches, water diversions, housing and urban developments all within the riparian corridor. Many of the road crossings have created partial or complete barriers to fish and much of the riparian vegetation has been depleted or altered. Additionally, asphalt and other impervious surfaces replace upland vegetation in many cases, contributing to an altered and flashier hydrograph and decreased water quality throughout the lower basin.

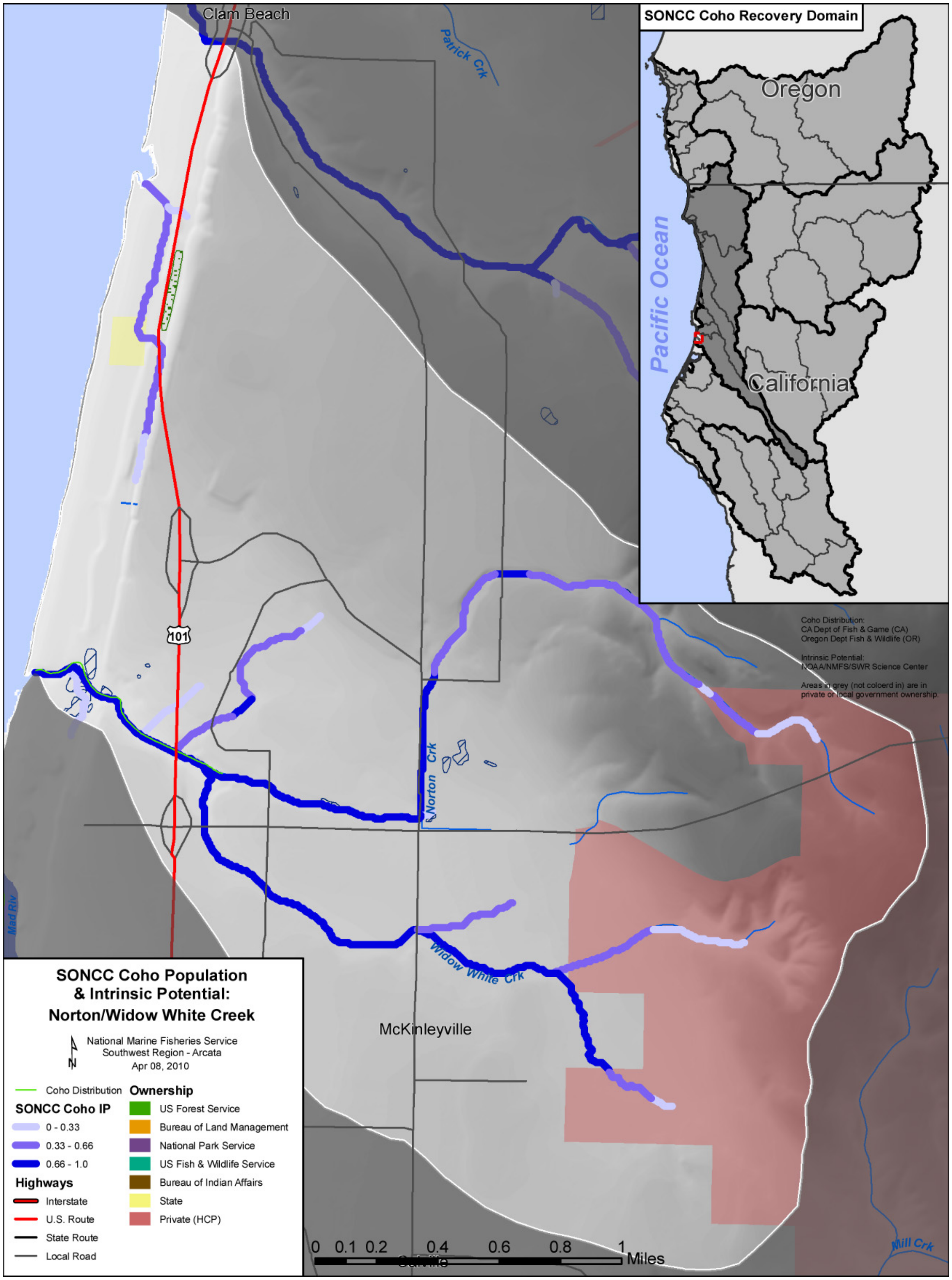

Figure 23-1. The geographic boundaries of the Norton/Widow White coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Natural structures such as wood were likely removed during development to facilitate unimpeded flow through culverts and narrow channels, which has contributed to the simplification of the stream habitat. Additionally, the lack of riparian vegetation decreases future recruitment of large wood structures in the channel, further simplifying habitat. The original riparian vegetation containing old growth trees has been removed in many areas and has been replaced with nonnative species that do not provide the same benefits as natives. Many reaches are simplified through landscaping and other urban and residential alterations that do not provide the shade, bank stability, and floodplain structure necessary for functional coho salmon habitat.

Development in McKinleyville is composed primarily of residential neighborhoods, small retail businesses, and a small number of light industrial facilities. The high level of impervious surfaces from these developed areas contributes to increased storm water runoff, increased point and non-point source pollution, and alterations to the hydrology. Pollutants entering the storm water conveyance facilities are expected to consist of sediments and topsoil, oils and greases (petroleum hydrocarbons), organics (mainly from pesticides), nutrients (mainly from fertilizers), heavy metals, and bacterial/viral constituents (Humboldt County 2005), and are likely also entering Norton/Widow White Creek and negatively affect coho salmon of all life stages.

Today, there are community efforts to restore this basin, particularly along the popular Hammond Trail, which provides a positive interpretive opportunity for the public. The schools that lie along the creeks also provide potential for educational activities related to stream habitat and fish use.

23.2 Historic Fish Distribution and Abundance

No data exist on run characteristics or population abundance for coho salmon in Norton Creek or the major tributary, Widow White Creek. Surveys detected presence of coho salmon brood year 2001 in Norton Creek and 2000 in Widow White Creek, but not 2001 in Widow White Creek (Jong et al. 2008). Additionally, two historical surveys did not detect presence of brood years 1983 in Widow White Creek (Jong et al. 2008). Potential coho salmon habitat is distributed throughout the 15.9 km² basin. The IP model shows 8.54 km of IP habitat, with high values (IP > 0.66) for most (5.94 km) of the basin, and lower values near the upper parts of Norton Creek and some smaller tributaries to Widow White Creek.

23.3 Status of Norton/Widow Coho Salmon

Spatial Structure and Diversity

The majority of both Norton and Widow White creeks have high IP value, indicating there is potential for good spatial distribution of coho salmon in the basin. The current distribution of coho salmon spans from the estuary upstream to just past the confluence of Norton and Widow White creeks (Figure 23-1). In the recent past, barriers limited coho salmon to the lowest reaches of the basin, but recent restoration activities have improved access allowing for the potential recolonization of the upper basin by coho salmon. Although several road/stream crossing barriers have been improved since 2001, the culvert at Highway 101 remains a partial barrier (Lang 2005) and continues to inhibit recovery in the majority of the basin.

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. The amount of habitat currently used by coho salmon is unknown but presumed to be very limited due to habitat degradation associated with urbanization and the presence of barriers.

Population Size and Productivity

There are no data available on the current or historic coho salmon population size or productivity in Norton/Widow White Creek; however, this population is designated as a dependent population and likely is dominated by strays from nearby stream systems. Due to extensive habitat degradation and migration barriers within the basin, population size and productivity are presumably low. Currently, Norton/Widow White Creek shares a mouth with the Mad River, which has a coho salmon population that is identified as functionally independent but is also currently severely depressed, and therefore not providing an abundance of individuals for straying into adjacent populations.

Extinction Risk

Not applicable because Norton/Widow White Creek is not an independent population.

Role in SONCC Coho Salmon ESU Viability

The Norton/Widow White Creek population is considered dependent because it does not have a high likelihood of sustaining itself over a 100-year time period in isolation and likely received sufficient immigration to alter its dynamics and extinction risk (Williams et al. 2006). Although such populations may not be fully viable on their own, they do increase connectivity by allowing dispersal among independent populations, acting as a source of colonists in some cases. Historically, the Norton/Widow White Creek population would have interacted with other Northern Coastal potentially independent populations, such as the Mad River to the south, or with other dependent populations like the Strawberry Creek to the north. Any restored habitat in Norton/Widow White Creek provides potential connectivity and increased resiliency in the SONCC coho salmon ESU.

23.4 Plans and Assessments

Green Diamond Resource Company

Habitat Conservation Plan

Green Diamond Resource Company owns 18 percent of the Norton/Widow White Creek basin. In 2006 Green Diamond finalized a Habitat Conservation Plan (HCP), which is valid through 2056. Developed in accordance with the ESA section 10, the HCP contains a conservation strategy to minimize and mitigate the potential adverse effects of any authorized taking of aquatic species that may occur incidental to Green Diamond's activities; to ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery in the wild of aquatic species; and to contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species (GDRC 2006). The plan has a number of provisions designed to protect coho salmon and salmon habitat throughout the population area.

23.5 Stresses

Table 23-1. Severity of stresses affecting each life stage of coho salmon in Norton/Widow White Creek. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	Very High	Very High	Very High
2	Lack of Floodplain and Channel Structure[1]	Low	High	High[1]	High	High	High
3	Altered Hydrologic Function	Medium	Medium	Medium	Medium	-	Medium
4	Impaired Water Quality	Medium	Medium	Medium	Low	Low	Medium
5	Altered Sediment Supply	Low	Medium	Medium	Low	Medium	Medium
6	Barriers	-	Medium	Medium	Low	Low	Medium
7	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
8	Impaired Estuary/Mainstem Function	-	Low	Medium	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Based on the type and extent of stresses and threats affecting the Norton/Widow White Creek population as well as the limiting factors influencing productivity, it is likely that the juvenile life stage is most limited and that quality summer and winter rearing habitat is lacking as vital habitat for the population. Degraded riparian forest conditions and the lack of floodplain and channel structure are the stresses most limiting rearing opportunities. Lack of riparian forests and channel structure significantly contribute to the simplification of the channel. Development within the lower basin coupled with timber harvest in the upper, have degraded the riparian forests and limited the availability for LWD recruitment. Simplification of the channel disconnects the floodplain and reduces rearing habitat for juvenile salmon in the summer and winter when fish are seeking either cover in cool, deep pools or off-channel velocity refugia.

The best refuge areas for coho salmon are located within the high IP reaches and outside of highly developed area. The upper reaches of Widow White Creek appear to be upstream of most development, and contain lower road densities and less coverage by impervious surfaces as compared to lower reaches in the watershed. This upper reach is upstream of any diversions and has potential for more complex habitat and riparian diversity. Unfortunately, there are many road crossings and highly channelized areas between the lower basin and the upper basin. The accumulation of partial barriers and low flow areas may limit access to these upper reaches.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions present a very high stress across all life history stages except the egg stage. The high amount of urban/residential development in the lower part of the basin has altered the riparian and upslope landscape, and replaced native vegetation with impervious surfaces and exotic plants. Many of the legacy trees in the upper basin were harvested, resulting in little potential for large wood recruitment, increased sedimentation in spawning areas, decreased food availability, and widespread decreases in bank stability.

Lack of Floodplain and Channel Structure

Floodplain and channel structure presents a high stress across most life history stages of coho salmon. Urbanization has highly altered the floodplain of Norton/Widow White Creek. Changes in land uses affecting the floodplain and channel structure include urban/residential development, timber harvest and a shift from natural vegetation to impervious surfaces. No habitat surveys have been conducted in the Norton/Widow White Creek basin but the removal of large wood from stream channels and the removal/depletion of riparian habitat, which is the source of future large wood input, have likely reduced the structural complexity of stream channels. Fine sediment input from land use practices in the upper basin areas has likely filled pools and simplified habitat, limiting rearing and spawning habitat in accessible areas. .

Altered Hydrologic Function

Altered hydrologic function represents a medium stress across most life history stages. Hydrologic function has been altered through high amounts of impervious surfaces and several diversions. The McKinleyville Community Services District provides water from the Mad River to residents of the lower and middle portions of the basin (MCSD 2010) where the majority of the human population is located; however, there are several water diversions in the upper reaches of Widow White and Norton creeks. The diversions are relatively high in the basin, and it is unknown how much water the users are withdrawing. Additionally, many of the rural residents in the basin use wells that may contribute to a lowered water table.

Impaired Water Quality

Water quality poses a medium to low stress to coho salmon in the basin. This stress is most likely in the form of urban pollutants and surface runoff from impervious surfaces. Norton Creek runs through Humboldt Sanitation and Recycling, which is also the location of a historic auto-wrecking yard. The contribution of pollutants from this site is unknown. No water temperature data have been collected in the Norton/Widow White basin, but temperature is likely not a limiting factor for the Norton/Widow White basin because the entire basin falls within coastal influences, where cool and moist climate conditions dominate.

Altered Sediment Supply

Altered sediment supply is a medium stress to some life stages. Because of the high road density and decreased amount of riparian vegetation in the basin, sediment supply to the creeks has been altered and is likely affecting both rearing and spawning habitat. Many rural residents in the upper basin have gravel or dirt roads and driveways, which can contribute fine sediment to the streams. Additionally, many of the residents have horses or cattle that graze adjacent to the stream and contribute to bank instability and the introduction of fine sediment into adjacent stream reaches. The combination of unpaved roads and erosion associated with livestock increases fine sediment input and contributes to the filling of pools and widening of channels. These fine sediments can also create high levels of embeddedness, decreasing the quality of spawning gravel.

Barriers

Barriers are a medium stress for the Norton/Widow White Creek coho salmon population. Although work has begun to address issues throughout the basin, barriers continue to be an issue. The California Fish Passage Assessment Database lists eight barriers in the Norton/Widow White Creek basin (CalFish 2009). Several partial or complete barriers related to culverts have recently been reconstructed to allow unimpeded fish passage (Lang 2005). Rather than replacing the culverts, jump heights have been reduced through the construction of multiple rock weirs that create a series of pools with one-foot jump heights at the culvert outlet. This method of grade control still poses passage problems for juvenile fish, reducing their ability to seek out refuge habitat. The culvert at Highway 101 is a partial barrier and is a high priority for replacement due to its location low in the basin. One natural barrier exists on Norton Creek at river mile 1.5, and appears to be related to low flows. This barrier is listed as the natural limit to anadromy in the creek (CalFish 2009). It appears restoration efforts to improve fish passage have lowered the severity of this stress. Currently, complete barriers have been removed, allowing adults access to the upper basin, while juvenile fish passage remains to be a problem.

Adverse Fishery-Related Effects

NMFS has determined that federally managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). NMFS has not formally evaluated the effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU by (Appendix B).

Impaired Estuary/Mainstem Function

Dune dynamics and the migration of the Mad River mouth influence the mouth of Norton/Widow White Creek and its estuary. The Mad River mouth has migrated north over the last several decades, reaching all the way to Clam Beach and consuming the outlet of Norton/Widow White Creek. Currently, the Mad River mouth is moving south and Norton/Widow White Creek continues to flow parallel to the beach until reaching the mouth of the Mad River where it enters the sea. The continued southerly migration of the Mad River will probably isolate the mouth of Norton/Widow White Creek again in the future. There is some functional wetland habitat that is likely used by juveniles and smolts from this population as well as the Mad River coho salmon population. One potential issue may be stranding of juveniles in pools on the beach if the hydrology is such that fish can access these pools at high tide and then are stranded during low tide. These so-called "death traps" can heat up during the day and likely lead to mortality events. The lower part of the creek runs along the beach both north and south of where it meets the beach and there are numerous areas where it pools up and could result in such stranding events. Eliminating such features, which could be the result of anthropogenic changes in the basin, would prevent this from happening. Overall, the availability of access to and from the basin and the availability of habitat make this a low stress for the population.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Norton/Widow White Creek population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

23.6 Threats

Table 23-2. Severity of threats affecting each life stage of coho salmon in Norton/Widow White Creek. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Channelization/Diking	Medium	Very High	Very High	Very High	Very High	Very High
2	Roads	Medium	Very High	Very High	Very High	Very High	Very High
3	Urban/Residential/Industrial	Medium	Very High	Very High	Very High	Very High	Very High
4	Road-Stream Crossing Barriers	-	High	High	High	Medium	High
5	Agricultural Practices	Low	Medium	Medium	Medium	Medium	Medium
6	Dams/Diversion	Low	Medium	Medium	Medium	Medium	Medium
7	High Intensity Fire	Low	Medium	Medium	Medium	Medium	Medium
8	Timber Harvest	Low	Medium	Medium	Medium	Medium	Medium
9	Fishing and Collecting	-	-	-	-	Medium	Medium
10	Climate Change	Low	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low
12	Invasive Non-Native/Alien Species	Low	Low	Low	Low	Low	Low

[1] Mining/Gravel Extraction is not considered a threat to this population.

Channelization/Diking

Channelization and diking are a very high threat to almost all life history stages of the Norton/Widow White Creek coho salmon population. This threat is tied to the urbanization of the basin, and contributes significantly to all stresses. The channel is restricted by the close proximity to roads and other urban structures, limiting its access to much of the floodplain. Further, habitat within the channelized area is simplified and therefore less suitable for coho salmon. One of the most acutely channelized reaches is Norton Creek along Central Avenue, where the high-IP habitat is confined to a narrow ditch for approximately 2000 feet,

Roads

Roads pose a very high threat to Norton/Widow White Creek coho salmon. Many of the roads in the more rural portions of the basin are unpaved with gravel or dirt surfaces, are not maintained, and contribute to increased sediment loading throughout the basin. Because these roads are in a rural setting and often in the form of driveways and private roads, they can be difficult to treat, as decommissioning or proper maintenance is often not an option. Additionally, the existence of these roads adjacent to the stream channel can contribute to altered hydrologic function, decreased bank stability, disconnected floodplain, and simplification of the channel.

Urban/Residential/Industrial Development

Urban and residential development in the Norton/Widow White Creek basin contributes to all of the stresses affecting this population, and poses a very high threat to almost all life history stages of coho salmon. The basin is almost entirely privately owned with a multitude of land uses including, timber harvest, residential development, light industrial and commercial services. Development has led to more paved roads, which facilitate runoff of pollutants into creeks, degrading water quality. Development is also resulted in other threats to this population, including road-stream crossing barriers and channelization.

Road-Stream Crossing Barriers

Road-stream crossing barriers constitute a low threat to the coho salmon population in Norton/Widow White Creek. There are six major road-stream crossings within the Norton/Widow White basin. Currently, none of these are known to be complete barriers to fish, however the partial barrier from the Highway 101 culvert may decrease distribution into the basin. Surveys by Humboldt State University (Lang 2005) and Ross Taylor and Associates (Taylor 2000) listed five barriers as either temporal and/or partial barriers. The Widow White Creek crossings at McKinleyville Road and Murray Road were modified to lower jump heights but still pose passage problems for juvenile salmon (Lang 2005). Road-stream crossings also occur on private roads and driveways, and the extent of fish passage problems at these stream crossings is unknown.

Agricultural Practices

Agriculture may have once played a more significant role in the Norton/Widow White Creek basin, but now only presents a medium threat. Most of the basin is dominated by urban and rural development; however there are some small-scale agriculture lands further upstream at the base of the foothills. Many of these landowners have a small number of horses or cattle grazing adjacent to the stream. Grazing can contribute to multiple stresses including increased sediment supply, degraded riparian zones, and poor water quality.

Dams/Diversions

Dams and diversions present a medium threat across all life stages. There are no known dams within the Norton/Widow White Creek basin; however, there are at least three diversions. These diversions can contribute to decreased flows, limiting the habitat availability and increasing stream temperatures in the summer. However, given the location of this population on the coast in a cool, wet climate, it is unlikely that the small numbers of withdrawals are having a significant effect on the water quantity and quality in Norton/Widow White Creek.

High Intensity Fire

High intensity fire poses a medium threat to the coho salmon population in Norton/Widow White Creek. Due to the largely urban and pastoral setting, timber stands do not occupy much of the area and therefore fire is not an imminent threat to the population. If those timber stands that remain, primarily those in the upper basin, were to burn, the resultant sediment delivery to streams would be harmful to the coho salmon habitat found there as well as to individuals living downstream. However, the likelihood of a large catastrophic fire is small given the cool, damp climate and the lack of fuels found throughout the area.

Timber Harvest

Extensive timber harvest likely occurred in the early history of McKinleyville's development and resulted in clearing the land for later agriculture and human settlement. Logging of the basin may have contributed to early degradation of the riparian zone and lack of instream structure, which now are major stressors within the system. Currently, timber harvest constitutes a medium threat to the population, with at least 18 percent of the land is managed for timber extraction. This extraction follows NMFS-approved practices outlined in the Green Diamond Resource Company's Habitat Conservation Plan (GDRC 2006) that minimizes harm to threatened species and their habitats. However, even with improved harvest practices, timber harvest and the associated road building contribute to stresses in the basin.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. NMFS has not evaluated the effects of these fisheries on the continued existence of the SONCC coho salmon ESU. As of April 2011, NMFS has not authorized the collection of coho salmon for research purposes in Norton/Widow White Creek.

Climate Change

There is moderate risk of a change in average precipitation over the next 50 years (Appendix B). Modeled regional average temperature shows a low increase over the next 50 years (Appendix B). Average temperature could increase by up to 1^{o}C in the summer and by a similar amount in the winter. The risk of sea level rise is low to moderate (Thieler and Hammer-Klose 2000), which may impact the quality and extent of wetland juvenile and smolt habitat. Adults may be negatively impacted by climate-related ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Norton/Widow White Creek population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress

Invasive and Non-Native/Alien Species

Given the extent of residential development along streams in the Norton/Widow White Creek basin, it is likely that invasive plant species will spread from residential landscaping into riparian areas, particularly if there are pre-existing gaps in the riparian vegetation. Some of these species could impede restoration of riparian forests and wetlands. The extent to which this has already occurred is unknown.

23.7 Recovery Strategy

The greatest need for habitat restoration and threat reduction is in those areas currently occupied by coho salmon in the lower reaches of Widow White and Norton creeks. Unoccupied areas must also be restored to provide enough habitat for coho salmon recovery.

The Norton/Widow White Creek population is considered dependent and therefore cannot be viable on its own; however, it is necessary to restore access and habitat within the basin so that it can provide connectivity between other populations in the ESU. The recovery criterion for the population is that coho salmon must occupy 20% of IP habitat in years following spawning of brood years with high marine survival. The coho salmon population in Norton/Widow White Creek is severely depressed, with adult salmon only recently regaining access to habitat throughout the basin. The most important factor limiting recovery of coho salmon in the Norton/Widow White Creek basin is a lack of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by increasing habitat complexity within the channel, re-establishing off-channel rearing areas, restoring riparian forests, and reducing threats to instream habitat. Other necessary actions include additional fish passage improvements, particularly at Highway 101, which is a partial barrier to adults, but also several juvenile barriers at county road crossings. Urban development remains the single largest threat, contributing to most stresses, but remains the most difficult to change.

Table 23-3 on the following page lists the recovery actions for the Norton/Widow White Creek population.

Table 23-3. Recovery action implementation schedule for the Norton/Widow White Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-NWWC.2.1.7	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3
SONCC-NWWC.2.1.7.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-NWWC.2.1.7.2	*Place instream structures, guided by assessment results*					
SONCC-NWWC.2.2.8	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Lower Widow White Creek	3
SONCC-NWWC.2.2.8.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-NWWC.2.2.8.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-NWWC.2.2.9	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Lower Widow White Creek	BR
SONCC-NWWC.2.2.9.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-NWWC.2.2.9.2	*Implement beaver program (may include reintroduction)*					
SONCC-NWWC.2.2.9.3	*Limit hunting or removal of beaver*					
SONCC-NWWC.7.1.1	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	BR
SONCC-NWWC.7.1.1.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-NWWC.7.1.1.2	*Develop watershed-specific guidance for managing riparian vegetation*					
SONCC-NWWC.7.1.2	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	BR
SONCC-NWWC.7.1.2.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-NWWC.7.1.2.2	*Thin, or release conifers, guided by prescription*					
SONCC-NWWC.7.1.2.3	*Plant conifers, guided by prescription*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-NWWC.27.2.6	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-NWWC.27.2.6.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-NWWC.27.2.6.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-NWWC.27.1.10	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-NWWC.27.1.10.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-NWWC.27.2.11	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-NWWC.27.2.11.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-NWWC.27.2.12	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-NWWC.27.2.12.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-NWWC.27.1.13	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-NWWC.27.1.13.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-NWWC.27.1.13.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-NWWC.27.2.14	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-NWWC.27.2.14.1	*Determine best indicators of estuarine condition*					
SONCC-NWWC.5.1.3	Passage	No	Improve access	Remove barriers	Population wide, especially highway 101 culvert	3
SONCC-NWWC.5.1.3.1	*Evaluate and prioritize barriers for removal*					
SONCC-NWWC.5.1.3.2	*Prioritize and resolve passage issues at Highway 101*					
SONCC-NWWC.5.1.3.3	*Upgrade County culverts to accommodate fish passage at all life stages*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-NWWC.10.2.4	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-NWWC.10.2.4.1	*Develop a watershed assessment that identifies and prioritizes recovery actions and provides a framework for educational programs*					
SONCC-NWWC.10.2.5	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-NWWC.10.2.5.1	*Develop an educational program that teaches landowners and businesses about avoiding pollution from septic systems, backyard pesticides, fuels, and nutrients.*					

24. Mad River Population

- Central Coastal Stratum
- Non-Core, Functionally Independent Population
- High Extinction Risk
- 540 Spawners Required for ESU Viability
- 494 mi^2
- 136 IP-km (85 mi) (52 % High)
- Dominant Land Uses are Timber Harvest, Gravel Mining
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’, ‘Altered Sediment Supply’
- Principal Threats are ‘Roads’ and ‘Timber Harvest’

24.1 History of Habitat and Land Use

Logging, road building, gravel mining, grazing and water diversion/impoundment are the land and water uses that have had the most pronounced effect on coho salmon habitat in the Mad River basin. Much of the North Fork watershed and the lower and middle portions of the Mad River basin are owned by Green Diamond Resource Company (GDRC) and are used for timber production. Grazing occurs on large ranches throughout the Mad River basin, as well as more concentrated grazing along the reaches of the lower river and its tributaries. Most of the upper basin is part of the Six Rivers National Forest (SRNF) and is managed using an ecosystem-based approach that provides for resource protection under the Northwest Forest Plan (Forest Ecosystem Management Assessment Team 1993). The Humboldt Bay Municipal Water District (HBMWD) constructed Matthews Dam in 1961 at river mile (RM) 84 in the upper basin, well upstream of historic coho salmon habitat. The HBMWD also pumps groundwater and diverts surface water for municipal and industrial use at its Essex facility in the lower Mad River.

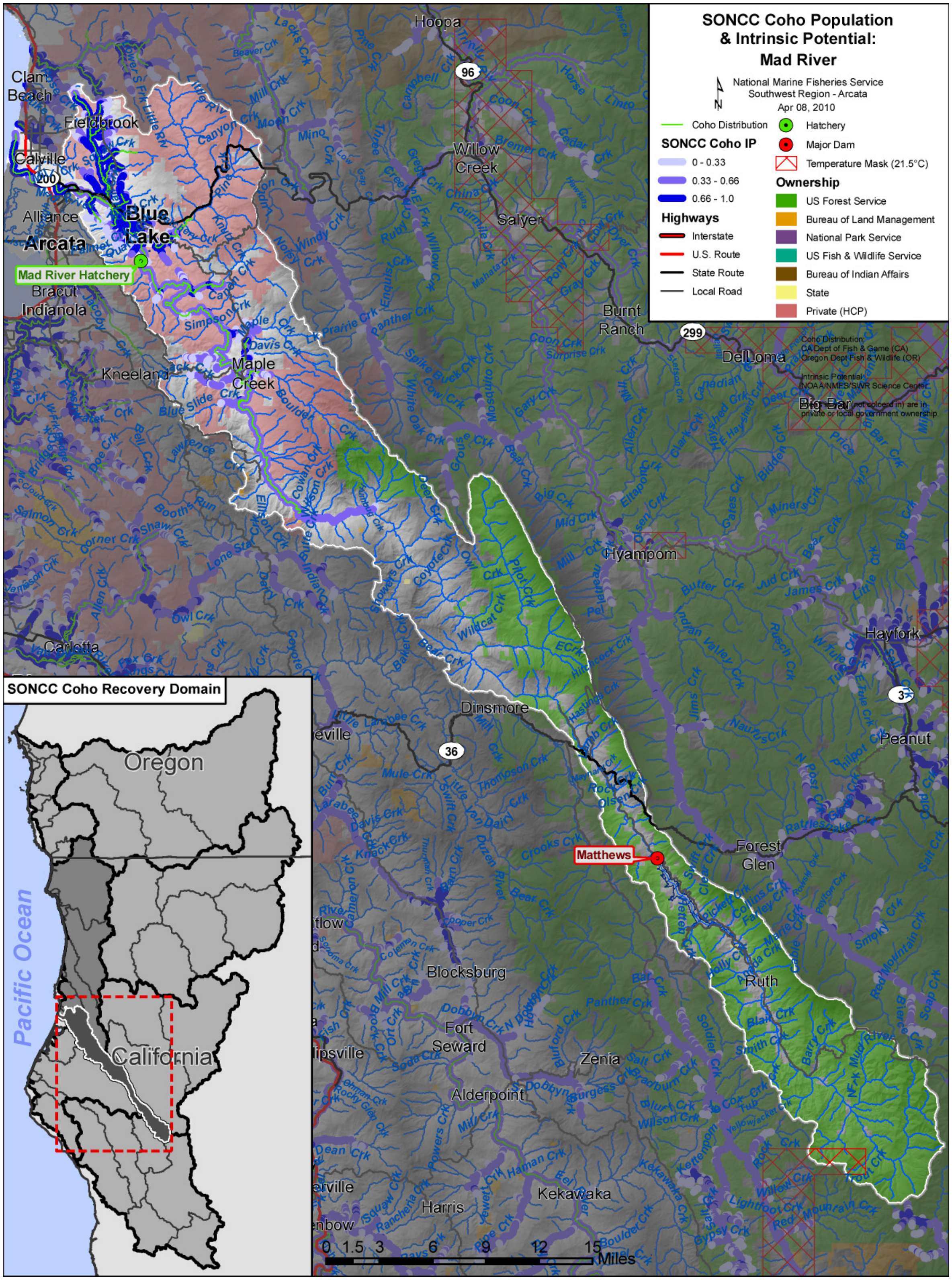

Figure 24-1. The geographic boundaries of the Mad River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU
5 and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Extensive instream gravel mining occurs throughout the lower Mad River, although mining practices have greatly improved since the 1970s. The majority of large gravel bars on the lower mainstem Mad River, between Blue Lake and Highway 299, are mined each year, and annual mining typically removes the estimated mean annual recruitment of gravel coming into the mining reach. Although the Army Corps of Engineers permits gravel mining with numerous mitigation measures, such as a head-of-bar buffer to maintain river flow around the gravel bar and a skim floor elevation that maintains low to moderate channel confinement, gravel mining reduces the availability of complex rearing habitat in the lower Mad River (NMFS 2004). The largest communities, Arcata, Blue Lake and McKinleyville, are situated along the lowermost reach, near the mouth of the Mad River; many of the impacts of urbanization are in the form of development and associated road construction and land clearing, resulting in increased run-off and sedimentation.

These land uses have reduced available habitat throughout the basin. Increased sediment production from logged hillslopes and roads, especially during the 1955 and 1964 flood events, have filled the Mad River with sediment and have created chronically high turbidity levels. Although the Mad River basin has naturally high rates of sediment delivery due to unstable hillslopes prone to landslides and high rates of surface erosion, the U.S. Environmental Protection Agency (EPA) estimated that 64 percent of total sediment delivered to streams was attributed to human and land management related activities, with roads being the dominant sediment source (EPA 2007a). In the lower Mad River and North Fork areas, total sediment loading is currently five times greater than natural sediment loading (EPA 2007a).

Compounding the increase in sediment delivery, loss of riparian vegetation has reduced shading and created a lack of instream large wood. These land uses have resulted in warm, shallow and wide instream habitat conditions that have severely impacted coho salmon and their habitat. Most of the basin is now comprised of forest stands of smaller diameter trees, with a greater percentage of hardwoods that provide different ecological functions than those found historically (GDRC 2006). Improved access to lower river tributaries, such as Lindsay Creek, is occurring through culvert upgrades and removal, but some of the lower river tributaries still have habitat blocked by road-stream crossings. Water impoundment has resulted in greater than naturally occurring summer flows in the middle and lower sections of the river, potentially increasing habitat availability during summer and early fall months. Screened water diversions at Essex in the lower river create fluctuations in summer and early fall flows and decrease flow downstream of the diversions.

24.2 Historic Fish Distribution and Abundance

There is limited data about the historical coho salmon population in the Mad River. Potential coho salmon habitat is typically distributed in the downstream 40 percent of the basin. Since 1961, access to the upper basin has been blocked at Matthews Dam. IP data show the highest values (IP > 0.66) in the lower mainstem Mad River and its tributaries, such as Lindsay, Noisy, Hall and Mill Creeks, and in the North Fork Mad River watershed, all on private lands. Table 24-1 shows the areas with high IP values.

Table 24-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Mad River (lower)	Squaw Creek	Warren Creek
Lindsay Creek	Leggit Creek	Powers Creek
Mill Creek	Hatchery Creek	Dry Creek
Hall Creek	Sullivan Gulch	Leggett Creek
Noisy Creek	Grassy Creek	North Fork Mad River
Quarry Creek	Mather Creek	Maple Creek
Palmer Creek	Essex Gulch	Canon Creek
Boulder Creek		

From 1938 to 1964, the California Department of Fish and Game (CDFG) counted coho salmon migrating above Sweasey Dam at RM 22 in the middle portion of the basin (Sweasey Dam was built in 1938 and demolished in 1970). On average, 474 adult coho salmon passed the dam each year with a high of 3,580 adults in 1962 and a low of 3 adults in 1958 (CDFG 1968). In 1958, the California Department of Water Resources (DWR) assumed that the number of fish migrating above Sweasey Dam represented approximately 16 percent of the total Mad River population. DWR also assumed that most coho salmon used the lower basin and its tributaries (e.g., Lindsay Creek). From the early 1970s to 1999 (the last year of artificial coho salmon propagation in the Mad River), the number of coho salmon adults returning to the Mad River hatchery declined. It should be noted, however, that in the early 1990s, the weir that directed fish into the hatchery ceased to operate, allowing adults to pass the facility. From 1985 to 2000, adult coho salmon counted in spawner survey index reaches in Canon Creek averaged five and in the North Fork Mad River averaged 10, with the highest counts for both streams occurring in the first five years of this period (CDFG 2000).

24.3 Status of Mad River Coho Salmon

Spatial Structure and Diversity

Coho salmon have access to the most downstream 43 miles of the basin; approximately 60 percent of the basin may be naturally inaccessible to coho salmon because a collection of large boulders in the channel may prohibit upstream migration at RM 43 to 53 (Halligan 2008). Most of the population is limited to the lower Mad River and its tributaries, such as Lindsay Creek, and the most downstream 5 miles of the North Fork Mad River (CDFG 2000). Distribution has been reduced by road-stream crossing barriers in the lower portion of the basin, and access had been limited in much of the lower river tributary habitat until an intensive program of barrier removal began approximately 5 years ago, improving access to important low gradient tributary habitat.

Non-natal rearing of coho salmon in the estuary and lower Mad River results in increased survival and productivity of the Mad River population that primarily spawns and rears in tributaries (Halligan 2003, 2007). In general, non-natal rearing found in the lower Mad River bolsters rearing success and increases the population's resiliency to disturbance and habitat degradation in the tributaries.

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) estimated that a minimum of 32 coho salmon per-IP km of habitat are needed (4,900 spawners total) for the Mad River coho salmon population to approximate the historical abundance and distribution. The current distribution of spawning adults is mostly limited to the lower river tributaries and the Mad River coho salmon population is at high risk of extinction due to its limited spatial structure and diversity.

Population Size and Productivity

There is little information on the current population size of coho salmon in the Mad River; however, data from GDRC (2006) counts from 1981 to 2008 indicate low abundance with an average of three adult coho salmon counted in index reaches in Canon Creek. Information from the Mad River Hatchery shows that between 1991 and 1999, adult coho salmon returns declined to an average of 38, 16 of which were females. However, only a fraction of all fish ascending the Mad River entered the fish ladder at the hatchery. All available information indicates low numbers of returning adult coho salmon in the Mad River basin and suggests that the overall number of coho salmon in the basin is extremely low compared to historic conditions.

The population growth rate in the Mad River has not been quantified, although information from CDFG (2000) and GDRC (2006) suggests negative trends in population growth rate, as does the apparent long-term declines of coho salmon observed in the Mad River. Therefore, the Mad River coho salmon population is at high risk of extinction given its very low population size and negative population growth rate.

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 153 coho salmon must spawn in the Mad River basin each year to avoid such effects of extremely low population sizes.

Extinction Risk

The Mad River coho salmon population is not viable and at high risk of extinction, because the estimated average spawner abundance over the past three years is likely less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role of Population in SONCC Coho Salmon ESU Viability

The Mad River population is a functionally independent population within the Central Coastal diversity stratum, meaning that it was sufficiently large to be historically viable-in-isolation and has demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005, Williams et al. 2006). The Mad River is well positioned to contribute spawners to adjacent populations within this and the Southern Coastal diversity stratum.

24.4 Plans and Assessments

State of California

Total Maximum Daily Load
http://www.swrcb.ca.gov/northcoast/

The North Coast Regional Water Quality Control Board (RWQCB) identified the Mad River as water quality limited due to excessive sediment loads, high levels of turbidity, and high water temperatures. The Total Maximum Daily Load (TMDL) was developed for sediment and turbidity in accordance with Section 303(d) of the Clean Water Act (CWA) in 2007.

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004. Priority actions in the Recovery Strategy for the Mad River HU include minimizing sediment delivery to the river; protecting riparian vegetation; restoring floodplain and channel, estuarine slough and wetlands; and assessing impacts of Mad River Hatchery steelhead production on coho salmon (CDFG 2004b).

Green Diamond Resource Company (GDRC)

Green Diamond Habitat Conservation Plan (HCP)

The Green Diamond HCP (GDRC 2006) outlines a plan for the conservation of aquatic species in select watersheds in the Mad River. The majority of the roughly 65 percent of private land in the Mad River basin is owned by Green Diamond, and therefore managed according to the provisions of the HCP. The plan was developed in accordance with ESA section 10 regulations which require Green Diamond to develop a conservation strategy to minimize and mitigate the potential adverse effects of any take of aquatic species that may occur incidental to Green Diamond's activities, ensure that any authorized take and its probable impacts will not appreciably reduce the likelihood of survival and recovery of aquatic species, and contribute to efforts to reduce the need to list currently unlisted species under the ESA in the future by providing early conservation benefits to those species. The plan contains provisions designed to protect coho salmon and salmon habitat throughout the company's land in the basin.

Redwood Community Action Agency

Mad River Watershed Assessment and Management Plan
http://www.naturalresourcesservices.org/mad-river-watershed-management-plan.html

RCAA, funded by a grant from the SWRCB, in conjunction with landowners and agency representatives, developed an assessment for the Mad River basin. The assessment focuses on identification of sediment sources within the basin and will be used to help develop an implementation plan that will assist public and private landowners in addressing water quality impairments and identifying basin-wide sediment source reduction opportunities for beneficial uses such as recovery of anadromous salmonids. The assessment was completed in July 2010 and work began on the implementation plan during summer 2010. A description of the process, the complete assessment and, eventually the implementation plan are available at the web address:

Lindsay Creek Community and Watershed-Based Land Use Assessment
http://www.naturalresourcesservices.org/lindsay-creek-community-and-watershed-based-land-use-assessment.html

RCAA led an innovative strategy to base land use decision-making on a new method of watershed assessment, including a strong component of community participation and Geographic Information System (GIS) Analysis. The assessment process culminated in the Strategy for the Lindsay Creek Watershed and Community, which includes GIS analyses that integrate information on riparian vegetation characteristics, salmonid habitat quality, sediment sources, landslide hazard, and land ownership. The strategy will help guide decision making and inform the Lindsay Creek Watershed Group of opportunities for sediment source reduction, riparian habitat improvement, and other salmonid habitat improvement efforts.

Sufficiency Assessment: Forest Service and Bureau of Land Management Programs in Support of SONCC Coho Salmon Recovery (USFS and BLM 2011)

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, the Mad River was identified as a high priority 6th field subwatershed in the Six Rivers National Forest (USFS and BLM 2011).

Mad River Stakeholders Group

Lindsay Creek Watershed Group

U.S. Forest Service-Six Rivers National Forest

Although most of the USFS land is located upstream of the major coho salmon production areas, the management of these lands to minimize sediment and maintain and promote healthy riparian vegetation is important to downstream reaches where coho salmon

24.5 Stresses

Table 24-2 . Severity of stresses affecting each life stage of coho salmon in the Mad River population. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Impaired Water Quality[1]	Low	Very High	Very High[1]	Very High	Medium	High
2	Impaired Estuary/Mainstem Function	-	High	Very High	Very High	Medium	High
3	Altered Sediment Supply	High	High	High	High	Medium	High
4	Degraded Riparian Forest Conditions	-	High	High	High	High	High
5	Lack of Floodplain and Channel Structure[1]	Low	High	High[1]	High	Medium	High
6	Altered Hydrologic Function	Medium	Medium	Medium	Medium	-	Medium
7	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
8	Increased Disease/Predation/Competition	Medium	Medium	Medium	Low	Low	Medium
9	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
10	Barriers	-	Medium	Medium	Low	Low	Low

[1]Key limiting factor(s) and limited life stage(s).

Limiting Stresses and Life Stages

Lack of floodplain and channel structure, impaired estuary function, impaired water quality and altered sediment supply are all stresses that limit juvenile rearing success for the Mad River coho salmon population. While many of the barriers to migration have been removed from the tributaries to the lower Mad River, many of these high IP tributaries have high sediment input, lack of channel structure, and lack of large woody debris, which adversely affects both summer and winter tributary rearing conditions. In the middle and lower portions of the mainstem Mad River, high summer water temperatures, increased sediment supply, and lack of channel structure also combine to adversely affect summer and winter rearing habitat. Off-channel rearing habitat, especially in the lower river and estuary also likely limits the success of winter rearing.

Based on the type and extent of stresses and threats affecting the population as well as the limiting factors influencing productivity, the juvenile life stage is most likely limited and quality summer and winter rearing habitat is lacking as vital habitat for the population.

The Recovery Strategy for California Coho Salmon (CDFG 2004b) identified tributaries that provide refugia value based on current habitat conditions (Table 24-3).

Table 24-3. Potential refugia areas in the geographic boundary of the Mad River population area.

Watershed	Stream Name	Watershed	Stream Name
Blue Lake	Warren Creek Lindsay Creek Grassy Creek Squaw Creek Mather Creek	Blue Lake	Hall Creek Noisy Creek Leggit Creek Hatchery Creek (Camp Bauer Creek) Powers Creek
North Fork	North Fork Mad River Sullivan Gulch	Butler Valley	Dry Creek Canon Creek Maple Creek Boulder Creek

Water Quality

Impaired water quality is a very high stress to fry, juvenile and smolt life stages and a medium stress for adult coho salmon and eggs. These levels of stress coincide with high water temperature in the summer and early fall when the most affected life stages are present. Temperature data indicates that most of the lower to middle mainstem river, and the lower portions of the North Fork Mad River have very high temperatures (greater than 17 °C.), compared to tributaries. These data are consistent with the CWA 303(d) listing for temperature for the Mad River. High stream temperatures may limit coho salmon distribution and production in the basin. Water temperatures are cooler in lower reaches of the Mad River (Jensen 2000); however, temperature values still fall within the stressful to potentially lethal range for juvenile coho salmon. Halligan (2007) found hundreds of coho salmon rearing in the lower mainstem Mad River during summer months, but presence of juveniles was strongly correlated with undercut banks, overhanging vegetation, large wood recruitment and thermal refugia provided by cool seeps and springs, intragravel water flow, groundwater or confluence with small tributaries.

Impaired Estuary/Mainstem Function

The loss and degradation of estuarine habitat in the Mad River is a high to very high stress for coho salmon due to the loss of rearing habitat and refugia. Levees have been constructed in most of the historic estuary for agriculture or floodplain development. Limited estuary rearing habitat remains. Historically, the potential for estuarine rearing and the amount of refugia habitat was likely significant given the size of the floodplain in the estuary. The estuary was also once connected to sloughs and other off-channel rearing habitat, such as overflow channels and cut-off meanders. The mouth of the Mad River was previously located further south than its current location, and entered the ocean closer to Arcata. The Mad River now turns north and enters the ocean near McKinleyville (Figure 24-1. The relocation of the mouth has increased the size of the estuary, but available estuarine rearing habitat is simplified, with little instream structure or diversity, very little off-channel habitat, and a highly altered estuarine function.

Riparian Forest Conditions

Degraded riparian forest conditions exist across the basin, and are a high stress to fry, juvenile, smolt and adult coho salmon life stages. Streamside canopy data are lacking; however, based on the extensive timber harvest that has occurred in the lower to middle portion of the basin, including the North Fork, poor cover and shade conditions likely exist through much of the lower to middle basin. In addition, open and hardwood-dominated riparian forest conditions have likely replaced riparian forests that once contained large confers for large wood recruitment. Hardwood and small conifer dominated riparian forests provide limited wood recruitment into the Mad River.

Floodplain and Channel Structure

A lack of floodplain and channel structure is a high stress for fry, juvenile and smolt life stages, and a medium stress for adults. In general, the lower to middle mainstem Mad River and the lower North Fork contain the poorest habitat conditions, and the tributaries that enter the lower Mad River, such as Lindsay Creek, provide relatively better habitat conditions. The mainstem channel is severely aggraded, and pool frequency and depth are likely poor throughout the mainstem. Halligan (2007) found few pools and riffles in the lower mainstem Mad River and the lower North Fork channel. Data on instream large wood structures is limited; however given the poor riparian canopy conditions that likely exist in the lower to middle portions of the basin, a lack of instream wood is likely limiting the development of complex habitat. Some short sections of the lower North Fork and the lower Mad River are confined by flood control levees. These levees disconnect the channel from its floodplain and limit the formation of off-channel habitat, which is critical for juvenile winter rearing.

Sediment Supply

Altered sediment supply is a high stress for egg, fry, juvenile and smolt life stages and a medium stress for adult coho salmon in the Mad River. Increased sediment delivery has aggraded and widened channels, filled pools, and simplified stream habitat throughout the basin, especially within the mainstem Mad River and its lower tributaries, particularly the North Fork. Data from the Six Rivers National Forest suggest that sediment supply may be less of an issue in the upper basin. For example, some pools between RM 43 and RM 53 have low fine sediment accumulation; however, coho salmon are rarely able to access this portion of the basin due to boulder and bedrock falls. Data collected on the sediment budget during TMDL development (EPA 2007a) indicate that both stored sediment within the channels and continued sediment delivery are critical stresses affecting the population. The EPA (2007a) found that the middle Mad River area produces the greatest sediment relative to other areas of the basin, due to active landslides and active land management (e.g., timber harvesting). The lower Mad/North Fork areas produce the greatest proportion of land management-related sediment. Sediment accumulation at the mouths of tributaries, such as the North Fork Mad River, may inhibit access.

Very high turbidity levels in the Mad River occur more frequently, with greater magnitude, and persist longer than turbidity levels in nearby basins that were used for comparisons (EPA 2007a). EPA measured turbidity values at numerous locations during development of the TMDL, and found elevated turbidity from many sediment sources, such as legacy roads, naturally occurring and human-influenced landslides, past timber harvest, and from first and second year adjustments of recently implemented road and barrier removal projects. Elevated turbidity levels result in a reduced ability of coho salmon to find food, gill abrasion, smothering of eggs, fine sediment accumulation in pools, and food assemblage changes which result in decreased growth rate.

Hydrologic Function

Altered hydrologic function is a medium stressor for the egg, fry, juvenile and smolt life stages of coho salmon. Low summer stream flows are problematic where increased stored sediment has reduced the amount of available rearing habitat through aggraded channels, contributing to subsurface flows. Water district operations, managed under an HCP, include an upstream impoundment at RM 84 and groundwater pumping and surface water diversions at the Essex facility on RM 9 to 10. The water district operations affect the quantity and timing of water availability in the Mad River. The construction of Matthews Dam increased summer and early fall stream flows throughout the middle and lower mainstem Mad River downstream to the Essex facility, likely increasing availability of summer rearing habitat. However, groundwater pumping and surface water diversions at Essex reduce downstream flow. Reduced flow downstream of Essex reduces available rearing habitat from RM 10 to the estuary. Smaller agricultural diversions exist in various locations throughout the lower mainstem Mad River and the North Fork, also reducing summer base flows in the lowest section of the mainstem.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. The Mad River Hatchery produced coho salmon from 1971 to 1999. The original broodstock was from the Noyo River, and at other times coho salmon from other watersheds within and outside the ESU were released into the Mad River. Coho salmon production ceased after the 1999 brood year, but it is unclear if this has reduced genetic effects of hatchery-reared fish on wild fish within the Mad River basin, and if the reproductive ability of naturally spawned Mad River coho salmon is reduced due to past intermingling of hatchery-raised and wild fish. The Mad River Hatchery still produces steelhead, which are stocked into the Mad River. Adverse hatchery-related effects pose a medium risk to all life stages of coho salmon in the Mad River, because the Mad River is stocked with steelhead from the Mad River Hatchery (Appendix B).

Increased Disease/Predation/Competition

Disease, predation, and competition are a medium threat to eggs, fry, and juveniles, and a low threat to smolts and adult coho salmon. The primary source of this stressor is the Mad River Hatchery, located in the lower Mad River near the town of Blue Lake at RM 12, which currently produces 150,000-1+ steelhead smolts annually, and releases them into the lower mainstem Mad River during the spring when coho salmon juveniles are hatching and rearing in the same section of the river. While the Mad River Hatchery attempts to reduce predation effects by releasing steelhead during high turbidity, and by releasing fewer steelhead than historically, coho salmon fry and juveniles are likely eaten by and compete with the hatchery-reared steelhead. Juvenile coho salmon abundance and overall population size is negatively affected as a result.

Adverse Fishery-Related Effects

NMFS has determined that federally managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Barriers

Barriers are a medium stress for the fry and juvenile life stages, and a low stress for smolts and adult coho salmon. Humboldt County and Caltrans have documented road related barriers or partial barriers within the basin, mostly within the lower river tributaries. Many of these road-stream crossing barriers have been removed (e.g., Lindsay, Mill, Anker, Grassy, Mather and Hall creeks and Sullivan Gulch) or are planned for removal. Barriers on Powers Creek, Essex Creek, and Quarry Creek in the lower Mad River also require improvements to allow for unimpeded juvenile and adult coho salmon passage.

24.6 Threats

Table 24-4. Severity of threats affecting each life stage of coho salmon in the Mad River population. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

Threats		Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	High	Very High	Very High	Very High	High	Very High
2	Timber Harvest	Medium	High	High	High	Medium	High
3	Mining/Gravel Extraction	Low	High	High	High	Medium	High
4	Channelization/Diking	Low	High	High	High	Low	High
5	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
6	Dams/Diversion	Medium	Medium	Medium	Medium	Low	Medium
7	Agricultural Practices	Low	Medium	Medium	Medium	Low	Medium
8	High Intensity Fire	Low	Medium	Medium	Medium	Low	Medium
9	Climate Change	Low	Low	Medium	Medium	Medium	Medium
10	Urban/Residential/Industrial	Low	Medium	Medium	Medium	Low	Medium
11	Fishing and Collecting	-	-	-	-	Medium	Medium
12	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low

[1] Invasive Non-Native/Alien Species is not considered a threat to this population,

Roads

Roads are a very high threat to the fry, juvenile and smolt life stages, and a high threat to eggs and adult coho salmon. Road density is very high throughout the basin, ranging from 4.4 to 6.3 miles of road per square mile in the lower Mad River and North Fork areas (EPA 2007a). Roads are a significant source of both chronic and catastrophic sediment input to streams in the basin, affecting the quality and quantity of available coho salmon habitat in the Mad River and its tributaries. In 2007, the EPA developed the TMDL for sediment and turbidity for the Mad River (EPA 2007a). An estimated 64 percent of the total sediment delivered to streams was attributed to human and land management-related activities, and road-related sediment contributes approximately 62 to 73 percent of the anthropogenic sediment in the basin (EPA 2007a).

Timber Harvest

Timber harvest is a high threat to the coho salmon population in the Mad River. Many of the changes that have occurred to instream and riparian conditions in the basin reflect legacy effects of more intensive harvest from previous decades. Such legacy effects are addressed under the appropriate stresses earlier in this profile. Although current timber harvest practices are more protective of coho salmon habitat than before, timber harvest likely threats the persistence of the coho salmon population by increasing sediment yield and by reducing streamside shading and potential large wood recruitment. The majority of the private timberland in the Mad River basin is owned by Green Diamond and will continue to be harvested for timber. Within Green Diamond property, harvest occurs at a moderate level and under the direction of the company’s HCP (GDRC 2006). This plan lays out goals and objectives to minimize and mitigate effects from timber harvest through measures related to road and riparian management, slope stability, and harvesting activities. Although the private timberland is managed under an HCP that reduces the effects of timber harvest, increased sediment yield, decreased sources of instream wood, and decreased stream shading are still expected to occur.

Mining/Gravel Extraction

Mining/gravel extraction presents a high threat to the fry, juvenile and smolt life stages, a moderate threat to the adults, and a low threat to the egg life stage, as coho salmon do not typically spawn in the gravel extraction area. Historic gravel extraction was very damaging to the habitat in the lower Mad River until 1994. Current instream mining practices are much improved over past practices. The current mining is permitted by the Army Corps of Engineers and the permit contains minimization measures to reduce the effects of gravel extraction on fish habitat, including a head-of-bar buffer to provide for channel steering around skimmed gravel bars, provisions to provide low to moderate channel confinement, mining volumes that are scaled to annual water yield (and modeled gravel recruitment volumes?), and annual estimates of sediment recruitment to the lower Mad River. However, even with minimization measures, gravel extraction reduces overall habitat complexity and reduces the quality and quantity of available pool habitat. Given the sensitivity of the channel to disturbance (i.e., current lack of floodplain and channel structure; low levels of instream wood), and the use of the gravel extraction reach by coho salmon juveniles for summer rearing, gravel extraction is a significant threat to rearing juveniles and a moderate threat to adults who require resting habitat in pools during upstream migration.

Channelization/Diking

Channelization and diking presents a high threat to the Mad River population. Levees confine some of the lower mainstem river and the lower North Fork and disconnect the lower river channel from its floodplain and wetlands, reducing the availability of off-channel winter rearing habitat in the lower basin.

Hatcheries

Hatcheries pose a medium threat to all life stages of coho salmon in the Mad River. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Dams/Diversions

Dams and diversions are a moderate threat to the Mad River population. Diversions and groundwater pumping at the HBMWD Essex facility (RM 9 to 10) reduce summer flows below the diversion and cause daily water level fluctuations during summer and fall months. Available rearing habitat is reduced below the diversions and stranding of juveniles may occur during fluctuating summer base flow, although stranding has not been documented (HBMWD and Trinity Associates 2004). However, the impoundment of the Mad River at Matthews Dam has also increased summer and fall flows throughout most of the mainstem Mad River and increased habitat availability from RM 84 to RM 10. Other water diversions for agriculture, some of which may be unauthorized, occur in the lower mainstem and North Fork Mad River.

Agricultural Practices

Agricultural practices pose an overall medium threat to coho salmon. Grazing occurs throughout the basin and may contribute to increased sediment generation and delivery and to decreased riparian vegetation. Other agriculture, such as the cultivation of hay, also occurs in the lower basin. However, specific information on the magnitude of these activities is limited.

High Intensity Fire

Altered vegetation characteristics throughout the basin pose a moderate threat to coho salmon from high intensity fires. Most of the basin contains forests of small diameter trees that are close together. These types of previously logged forests burn with greater intensity than late seral forest stands, and high intensity forest fires create an erosion hazard. The increased sediment yield from high intensity fires would likely deliver sediment to coho salmon habitat in the basin, filling pools and reducing habitat complexity. Riparian vegetation would also be reduced or eliminated, and issues associated with inadequate riparian cover, including increased water temperatures and decreased macroinvertebrate abundance would be aggravated.

Climate Change

Climate change poses a medium threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles and adult coho salmon. Although the current climate is generally cool, modeled regional average temperature shows a relatively large increase over the next 50 years (see Appendix B for modeling methods). Average air temperature could increase by up to 2° C in the summer and by 1° C in winter. Annual precipitation in this area is predicted to change little over the next century. The vulnerability of the estuary and coast to sea level rise is moderate in this population. Juvenile and smolt rearing are most at risk due to increasing temperatures and changes in the amount and timing of precipitation, which will affect water quality and hydrologic function in the summer. The range and degree of temperature and precipitation is likely to increase in all populations in the ESU, and adult coho salmon will be negatively affected by ocean acidification, and changes in ocean conditions, and prey availability (Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Urban/Residential/Industrial Development

Population growth and development, especially in the Arcata and McKinleyville area, will continue to present a moderate threat to coho salmon in the Mad River because it results in removal of vegetation, increased sediment delivery, introduction of exotic species, and increased landscape coverage with impervious surfaces that alters water transport on land and subsequently affects instream flows. Most of the growth within Humboldt County is in the Arcata and McKinleyville area (projected at 0.6 percent annually), resulting in more water diverted from the lower Mad River.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and near shore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Mad River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Road-Stream Crossing Barriers

Road-stream crossing barriers are a low threat to the population. Many of the road-stream crossing barriers in the lower Mad River and its tributaries have been removed or treated during the past 5 years.

24.7 Recovery Strategy

Abundance of coho salmon in the Mad River basin is severely depressed, and consequently, their spatial distribution is restricted. Recovery activities in the basin should promote increased spatial distribution, particularly in the tributaries of the lower Mad River, as well as increased productivity and abundance. Efforts to increase distribution may also yield increases in diversity, abundance and productivity. Preservation of observed life history traits (i.e., mainstem juvenile rearing) is necessary to ensure long-term viability. Activities to improve habitat conditions should focus on the low gradient tributaries that enter the lower Mad River, all with high IP values, and the mainstem Mad River from the mouth upstream to the boulder and bedrock falls that begin at RM 43.

Lack of floodplain and channel structure, impaired estuary function, impaired water quality, and altered sediment supply are the key limiting factors for coho salmon production in the Mad River basin. Top recovery priorities in the basin should include improving channel structure and off-channel rearing habitat, reducing sediment delivery, and reducing summer stream temperatures in the mainstem Mad River. Additional high priority activities include increasing amounts of LWD in the tributaries and mainstem, improving estuarine function, providing adequate instream flow, removing barriers, and addressing predation by and competition with hatchery steelhead. Conservation partnerships with the Blue Lake Rancheria Indian Tribe, gravel mining and timber industries, HBMWD, and other local and state agencies will be essential to improving instream habitat for recovery of coho salmon.

Table 24-5 on the following page lists the recovery actions for the Mad River population.

Table 24-5. Recovery action implementation schedule for the Mad River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MadR.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Lower Mad River and North Fork Mad	3
SONCC-MadR.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MadR.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-MadR.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Lower Mad River and high IP tributaries	2
SONCC-MadR.2.2.2.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MadR.2.2.2.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-MadR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Restore natural channel form and function	Lower Mad River	3
SONCC-MadR.2.2.3.1	*Re-evaluate existing gravel mining permit minimization measures*					
SONCC-MadR.2.2.3.2	*Update minimization measures in existing gravel mining permits if necessary*					
SONCC-MadR.10.2.20	Water Quality	Yes	Reduce pollutants	Set standard	Population wide	3
SONCC-MadR.10.2.20.1	*Develop TMDLs for 303(d) listed water bodies*					
SONCC-MadR.1.1.4	Estuary	No	Improve connectivity of tidally-influenced habitat	Reconnect estuarine habitat	Lower Mad River/Estuary	3
SONCC-MadR.1.1.4.1	*Identify opportunities in the estuary and lower river for reconnecting sloughs, tributaries and tidal and non-tidal wetlands*					
SONCC-MadR.1.1.4.2	*Re-connect sloughs and tidal wetlands to estuary*					
SONCC-MadR.1.2.36	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-MadR.1.2.36.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-MadR.1.2.36.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MadR.16.1.21	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MadR.16.1.21.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MadR.16.1.21.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-MadR.16.1.22	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MadR.16.1.22.1	*Determine actual fishing impacts*					
SONCC-MadR.16.1.22.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-MadR.16.2.23	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MadR.16.2.23.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-MadR.16.2.23.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-MadR.16.2.24	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MadR.16.2.24.1	*Determine actual impacts of scientific collection*					
SONCC-MadR.16.2.24.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-MadR.17.3.11	Hatcheries	No	Reduce ecological impacts of hatchery on SONCC coho salmon	Reduce steelhead ecological interactions	Lower Mad River	3
SONCC-MadR.17.3.11.1	*Identify means to reduce ecological interactions from hatchery-raised steelhead*					
SONCC-MadR.17.2.12	Hatcheries	No	Reduce adverse hatchery impacts	Identify and reduce impacts of hatchery on SONCC coho salmon	Lower Mad River	3
SONCC-MadR.17.2.12.1	*Develop Hatchery and Genetic Management Plan*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MadR.3.1.18	Hydrology	No	Improve flow timing or volume	Manage flow	Population wide	3
SONCC-MadR.3.1.18.1	*Collaborate with HBMWD to explore changes in releases, pumping and Essex diversion that will benefit coho salmon.*					
SONCC-MadR.3.1.18.2	*Implement recommended changes in releases*					
SONCC-MadR.3.1.19	Hydrology	No	Improve flow timing or volume	Reduce diversions	Population wide	3
SONCC-MadR.3.1.19.1	*Identify unauthorized diversions*					
SONCC-MadR.3.1.19.2	*Review authorized diversions for opportunities to increase instream flow during summer low flow period*					
SONCC-MadR.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-MadR.27.1.25.1	*Perform annual spawning surveys*					
SONCC-MadR.27.1.26	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-MadR.27.1.26.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-MadR.27.1.27	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track surrogate for genetic diversity	Mad River Hatchery	3
SONCC-MadR.27.1.27.1	*Describe annual ratio of naturally-produced fish to hatchery-produced fish spawned for hatchery production*					
SONCC-MadR.27.1.28	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-MadR.27.1.28.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-MadR.27.1.29	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Hatchery Management'	Population wide	3
SONCC-MadR.27.1.29.1	*Annually determine the percent of hatchery origin spawners (PHOS), percent of natural origin spawners (PNOS), and the proportion of natural influence (PNI)*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-MadR.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MadR.27.2.30.1		*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*				
SONCC-MadR.27.2.30.2		*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*				
SONCC-MadR.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-MadR.27.2.31.1		*Measure the indicators, pool depth, pool frequency, D50, and LWD*				
SONCC-MadR.27.2.32	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-MadR.27.2.32.1		*Measure the indicators, canopy cover, canopy type, and riparian condition*				
SONCC-MadR.27.2.33	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MadR.27.2.33.1		*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*				
SONCC-MadR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-MadR.27.2.34.1		*Measure the indicators, pH, D.O., temperature, and aquatic insects*				
SONCC-MadR.27.2.35	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-MadR.27.2.35.1		*Identify habitat condition of the estuary*				
SONCC-MadR.27.1.38	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MadR.27.1.38.1		*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*				
SONCC-MadR.27.1.39	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MadR.27.1.39.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MadR.27.1.39.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-MadR.27.2.40	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-MadR.27.2.40.1	*Determine best indicators of estuarine condition*					
SONCC-MadR.5.1.9	Passage	No	Improve access	Reduce flow barrier	Lower and middle Mad, North Fork, Canon Creek, Dry Creek, Lindsay Creek, Powers Creek, and other disconnected tributaries	3
SONCC-MadR.5.1.9.1	*Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.*					
SONCC-MadR.5.1.9.2	*Excavate, or otherwise treat, tributary mouths to restore connectivity, guided by the plan*					
SONCC-MadR.5.1.10	Passage	No	Improve access	Remove barriers	Tributaries to lower Mad river	3
SONCC-MadR.5.1.10.1	*Evaluate and prioritize barriers for removal*					
SONCC-MadR.5.1.10.2	*Remove barriers*					
SONCC-MadR.5.1.37	Passage	No	Improve access	Reduce invasive species	Lindsay Creek	2
SONCC-MadR.5.1.37.1	*Eradicate Reed Canary Grass*					
SONCC-MadR.7.1.5	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Lower and middle Mad; North Fork Mad	3
SONCC-MadR.7.1.5.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-MadR.7.1.5.2	*Thin, or release conifers, guided by prescription*					
SONCC-MadR.7.1.5.3	*Plant conifers, guided by prescription*					
SONCC-MadR.7.1.5.4	*Control invasives*					
SONCC-MadR.7.1.5.5	*On USFS lands, continue implementation of Aquatic Conservation Strategy and follow restoration plans developed under the CWA TMDL*					
SONCC-MadR.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve regulatory mechanisms	Lower and middle Mad; North Fork Mad	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-MadR.7.1.6.1	*Develop measures to protect existing LWD recruitment potential*					
SONCC-MadR.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Lower and middle Mad; North Fork Mad	3
SONCC-MadR.7.1.7.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-MadR.7.1.7.2	*Develop grazing management plan to meet objective*					
SONCC-MadR.7.1.7.3	*Plant vegetation to stabilize stream bank*					
SONCC-MadR.7.1.7.4	*Fence livestock out of riparian zones*					
SONCC-MadR.7.1.7.5	*Remove instream livestock watering sources*					
SONCC-MadR.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-MadR.7.1.8.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					
SONCC-MadR.7.1.8.2	*Apply best management practices for timber harvest*					
SONCC-MadR.8.1.13	Sediment	No	Reduce delivery of sediment to streams	Reduce erosion	Lower Mad River	3
SONCC-MadR.8.1.13.1	*Inventory sediment sources, and prioritize for treatment*					
SONCC-MadR.8.1.14	Sediment	No	Reduce delivery of sediment to streams	Reduce risk of catastrophic fire	Population wide	3
SONCC-MadR.8.1.14.1	*Identify forested stands for fire hazard reduction*					
SONCC-MadR.8.1.14.2	*Apply appropriate management techniques (e.g. thinning) to reduce risks of high intensity fire*					
SONCC-MadR.8.1.15	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-MadR.8.1.15.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MadR.8.1.15.2	*Decommission roads, guided by assessment*					
SONCC-MadR.8.1.15.3	*Upgrade roads, guided by assessment*					
SONCC-MadR.8.1.15.4	*Maintain roads, guided by assessment*					
SONCC-MadR.8.1.16	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-MadR.8.1.16.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					

25. Humboldt Bay Tributaries Population

- Southern Coastal Diversity Stratum
- Core, Functionally Independent Population
- Moderate Extinction Risk
- 5,700 Spawners Required for ESU Viability
- 157 mi²
- 191 IP km (118 mi) (62% High)
- Dominant Land Uses are Timber Harvest and Agriculture
- Principal Stresses are ‘Altered Sediment Supply’ and ‘Lack of Floodplain and Channel Structure’
- Principal Threats are ‘Agriculture’ and ‘Roads’

25.1 History of Habitat and Land Use

Vegetation in the upper watershed of the Humboldt Bay Tributaries population area was historically (pre-European) coniferous forest, dominated by coast redwood. Douglas-fir and tan oak occur in association with redwood, and other forest trees include grand fir, Sitka spruce, western red cedar, western hemlock, and red alder in riparian areas. Historic riparian canopy cover was likely high, and large wood was abundant in streams. Sediment delivery, storage, and transport processes within the streams were a function of the geology, climate, and channel morphology (Doughty 2003). Prior to the 1800s, the historic coho salmon habitat in the population area was largely unaffected by anthropogenic land use activities. After 1800, European settlement, land use activities, and resource extraction influenced landscape processes, which resulted in decreased quality, quantity, and accessibility of habitat for coho salmon adult spawning and juvenile rearing (Beechie et al. 2003).

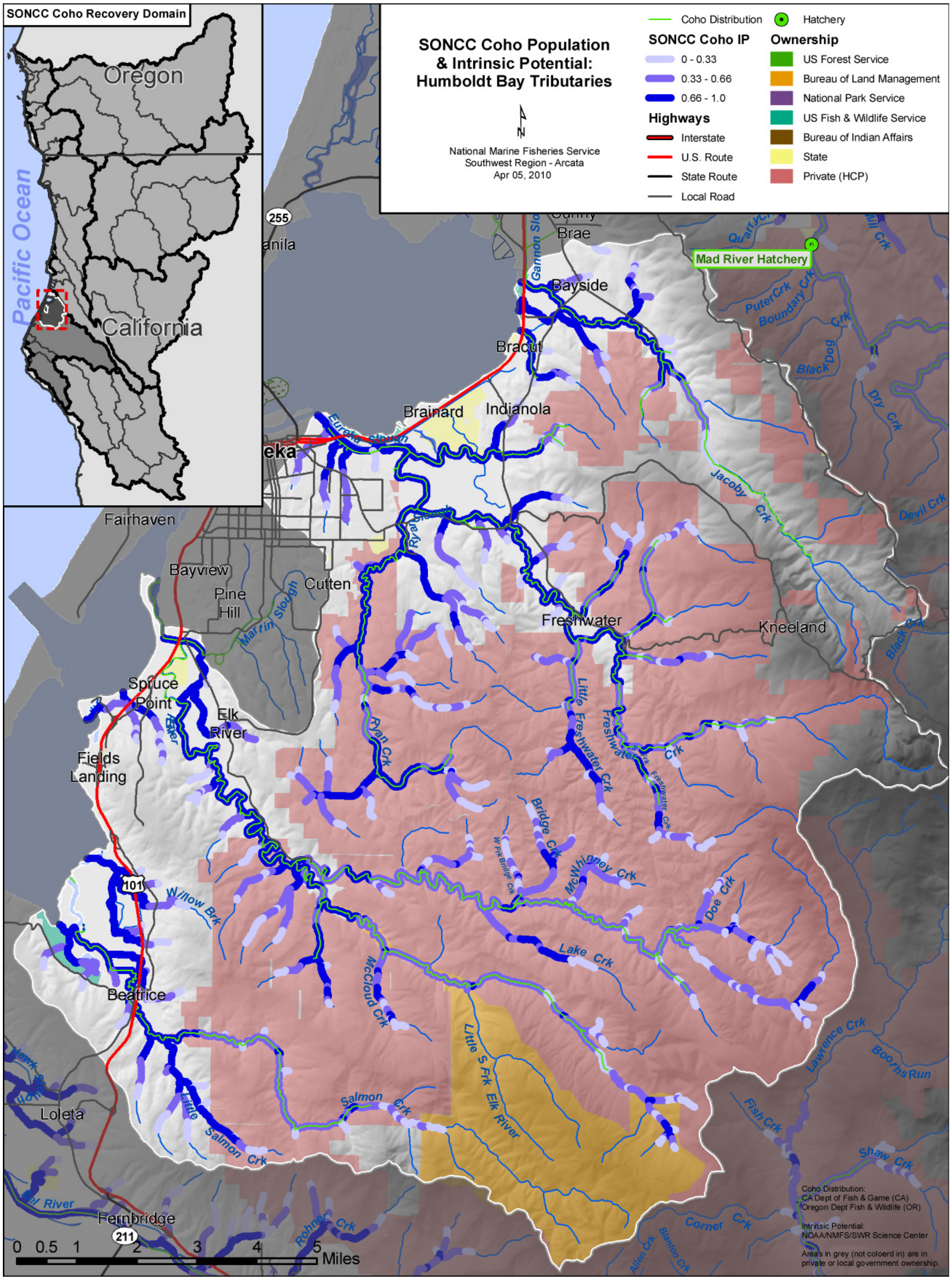

Figure 25-1. The geographic boundaries of the Humboldt Bay Tributaries coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Historic Land Use Activities

Harvest of old growth trees began in the 1860s with concomitant building of railroads linking the forests to the mills on the Humboldt Bay waterfront. Timber harvest practices that degraded aquatic habitat included: (1) large clear cuts that altered the hydrology and increased sediment delivery to the watercourse; (2) loss of riparian floodplain to harvest and road construction; (3) use of tributary stream channels as haul roads; (4) steam donkey dragging of logs within stream channels, and (5) use of larger stream channels for log transport and splash-dams. Several periods of timber harvest have occurred in the Humboldt Bay watershed; initially harvesting the easily accessible timber from 1860 to 1910, and then subsequent harvesting higher in the watershed .In the 1800s, a common road building practice for road-stream crossings was a "Humboldt" log crossing, where organic debris was pushed into the stream and buried with soil. The use of Humboldt crossings, instead of culverts, continued into the 1970s and created a persistent source of sediment delivery to watercourses [Humboldt Bay Watershed Advisory Committee (HBWAC 2005)].

Current Land Use and Ownership

Currently, the dominant land use in the population area is timber production and harvest in the upper tributary watersheds. Agriculture, along with urban, residential, and industrial development are the dominant land uses in the middle and lower portions of the tributary watersheds (Figure 25-2). The majority of land in the upper watershed of the population area is privately owned by two commercial timber companies, Humboldt Redwood Company and Green Diamond Resource Company. Approximately 78 percent of the Freshwater Creek (30.7 mi^2) and Ryan Slough (14.7 mi^2) watersheds are managed by these two companies for commercial timber harvest (Pacific Watershed Associates 2006). Urban, residential, and industrial land use is concentrated in the city of Arcata (population 16,651), the city of Eureka (population 26,128), and in five smaller communities near Humboldt Bay, with a total population of approximately 70,000 (HBWAC 2005). There is currently more residential development in the Arcata, Jacoby and Freshwater watersheds than in the Elk River or Salmon Creek watersheds.

Land ownership within the coastal zone, which includes the tidelands and submerged lands of Humboldt Bay to mean higher high water (MHHW) and surrounding lands from MHHW inland to California Coastal Zone Boundary, is both private and public. .Management of the submerged lands and historic tidelands in Humboldt Bay is primarily the responsibility of the Humboldt Bay Harbor, Recreation, and Conservation District (HBHRCD). In addition to the HBHRCD, numerous district, city, county state and Federal entities have ownership and regulatory jurisdiction over land use activities in the coastal zone (HBHRCD 2007).

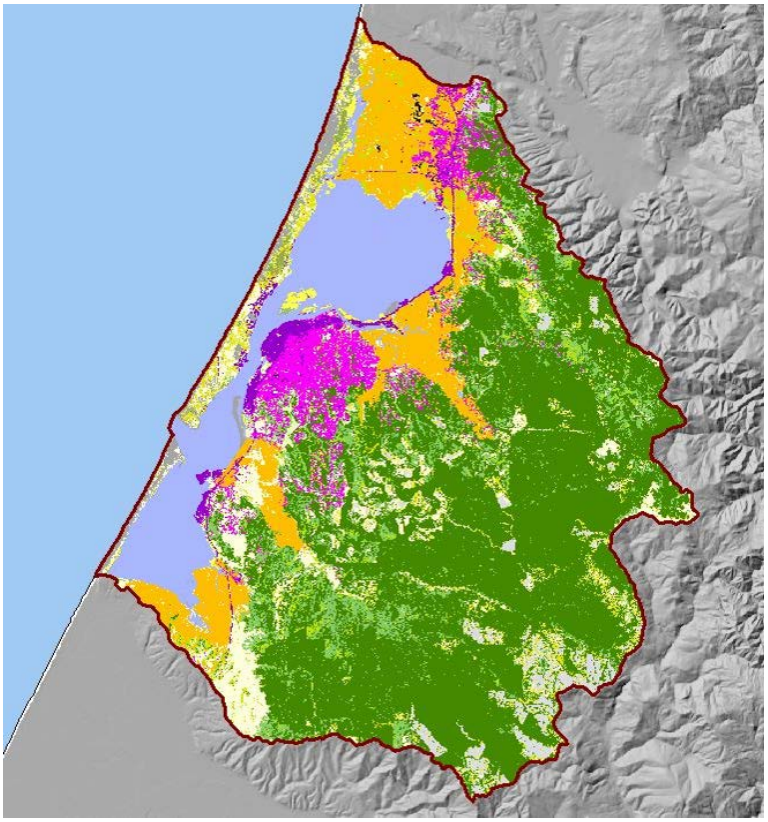

Figure 25-2. Major land use in the Eureka Plain HU. Key: (green = commercial timber; orange = agricultural, and pink = urban/residential/industrial; KRIS 2006).

Quality and Quantity of Aquatic Habitat

The aquatic habitat in the upland watersheds of the population area have been degraded through altered hydrology, accelerated sediment delivery, and loss of floodplain and channel structure due to land use practices. In the upper watersheds, timber harvest practices have historically increased sediment delivery to watercourses through mass wasting and landslides, and surface erosion from roads. In the lower watersheds, runoff from urban development, livestock grazing, and agricultural land use increased fine sediment supply to channels.

Loss of riparian vegetation from timber harvest in the mid-1800s to mid-1900s, and more recent increased rates of road building and timber harvest in the 1980s and 1990s, have degraded habitat by increasing delivery of sediment to the watercourses as a result of deep and shallow landslides, and gully and bank erosion. In addition, abundant road-stream crossings have altered the hydrology and sediment transport processes (Figure 25-3).

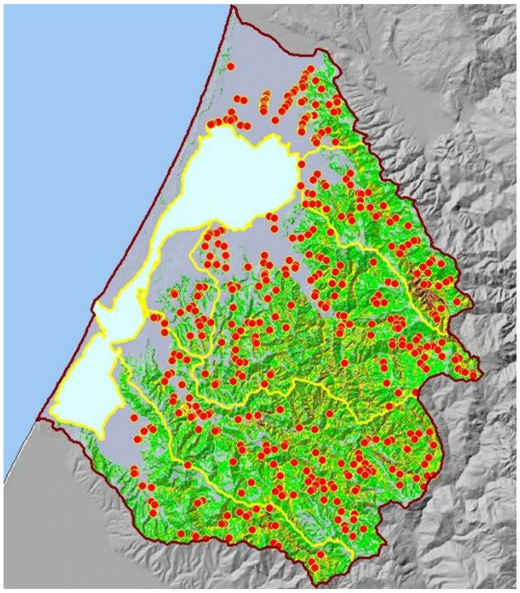

Figure 25-3. Road-stream crossings in the Eureka Plain HU. (KRIS 2006)

Accelerated erosion has increased the percentage of fine sediment and embeddedness, filled in pools, reduced pool depth and pool frequency, increased duration of suspension of sediments and subsequent turbidity, and reduced the quantity and quality of spawning and rearing of the habitat.

Humboldt Bay is California's second largest coastal estuary (Barnhart et al. 1992), encompassing over 17,000 acres (Pinnix et al. 2005), and is the fifth largest estuary along the U.S. Pacific Coast, excluding Alaska (Trianni 1996). However, most of the bays of the Pacific coast are essentially marine bays, not estuaries (Ricketts et al. 1985), and true estuarine conditions in Humboldt Bay occur only where bay waters are measurably diluted by fresh water from major winter storms (Barnhart et al. 1992). As stated in Barnhart et al. (1992), Humboldt Bay has been characterized as a "multibasin, tide driven coastal lagoon with limited fresh water input." Humboldt Bay, managed primarily as a deepwater port, links the freshwater habitat to the Pacific Ocean through the tidally influenced drowned river mouths of its tributaries (HBHRCD 2007).

Since the 1800s, the physical habitat and habitat forming processes within Humboldt Bay, as well as in the tidally influenced portions of the watersheds, have been altered by human activities associated with both upland and adjacent land use (agriculture, urban, residential, industrial) and construction and maintenance of transportation corridors (land and marine). Recent and ongoing activities within Humboldt Bay include: (1) annual dredging of the Federal Navigation Channels and deepwater port, (2) construction and maintenance of numerous port-related overwater and hardened shoreline structures; (3) maintenance of agricultural and urban levees and tidegates; and (4) planting and cultivation of approximately 300 acres of oyster aquaculture.

In the tidally-influenced lower watersheds, the physical alteration and disconnection of backwater, side channel and floodplain habitats and subsequent inaccessibility to juvenile and adult coho salmon, due to passage barriers (culverts, tide gates), have reduced the quantity and quality of the tidal freshwater and estuarine rearing habitat. An estimated 85 percent of the original salt marsh and tidal slough habitat around Humboldt Bay is no longer available to coho salmon (Shapiro and Associates 1980, Barnhart et al. 1992). The quantity and quality of existing rearing habitat was reduced from historic values due to construction of dikes and levees; draining, and filling of tidal sloughs for agricultural use; and fragmentation of tidal slough habitat by construction of the railroad and Highway 101. Annual maintenance dredging of the interior Federal Navigation Channels in Humboldt Bay, as well as the bar and entrance channels, increases turbidity and turbulence, and thereby reduces the rearing and migratory corridor functions at various locations from March through May.

25.2 Historic Fish Distribution and Abundance

The Humboldt Bay Tributaries population of SONCC coho salmon consists of all individuals that spawn and rear within the Eureka Plain Hydrologic Unit (HU) (Figure 25-1). Streams tributary to Humboldt Bay historically have been important to the local sport fishery, but Hull et al. (1989) report estimates of coho abundance in these streams are lacking. The watershed area of the main spawning tributaries in the population area from north to south are as follows: Jacoby Creek (17 mi²); Freshwater Creek, including Ryan Creek and Fay Slough (58 mi²); Elk River, including Martin Slough (58.2 mi²) and Salmon Creek (17 mi²). In the 1800s, these four main tributaries supported large numbers of coho salmon (CDFG 1994, Weitkamp et al. 1995), however, numbers of fish began to noticeably decline by the 1940s (HBWAC 2005). Prior to construction of the railroad, diking of agricultural lands and installation of tide gates, the Arcata watershed (Janes, Campbell and Beith creeks, as well as other smaller tributaries) likely supported low numbers of spawning coho salmon adults as well as provided non-natal estuarine juvenile coho salmon rearing habitat

Recent evidence of juvenile coho salmon rearing in non-natal tributaries to the Arcata and Freshwater Creek watersheds supports the inclusion of these tributaries (Wallace 2008a, 2008c). The model used for describing IP habitat was related to spawning potential and did not include the Arcata watershed within the population area. Regardless of the model output, importance of the Arcata watershed should not be discounted as rearing does occur in non-natal tributaries. In addition, the estuarine and tidal freshwater low-gradient habitats in the Arcata watershed, similar to the historic habitat (Figure 25-1) in the major spawning tributaries, were often hydrologically connected to each other as well as to the Jacoby Creek watershed during periods of concurrent high freshwater inflow and high tide. Non-natal rearing of coho salmon juveniles also occurs in the lower one-half mile of Elk River and in Martin Slough.

Hallock et al. (1952) seined 8,642 juveniles from Freshwater Creek, 17,671 from Elk River and 14,243 from Jacoby Creek, indicating substantial populations in those streams. Spawning surveys conducted in North Fork Elk River on two index reaches totaling 7.4 km (4.6 miles) during the 1986-1987 season documented 343 live coho adults, 53 carcasses and 206 redds. Total coho escapement in 1986-1987 was estimated at of 773 fish.

Juvenile coho salmon have been collected in Wood Creek (Wallace 2008d) and Martin Slough (Wallace 2008b) during the winter, presumably where they were escaping higher velocity flows in the main channel of Freshwater Creek and Elk River. In the Freshwater Creek watershed, age 0+ coho salmon rearing in the freshwater/estuarine ecotone grow larger than their upstream cohorts. Wallace (2008d) reported that age 1+ coho salmon smolts originating from Freshwater Creek used lower Elk River during rearing and outmigration through Humboldt Bay en route to the Pacific Ocean.

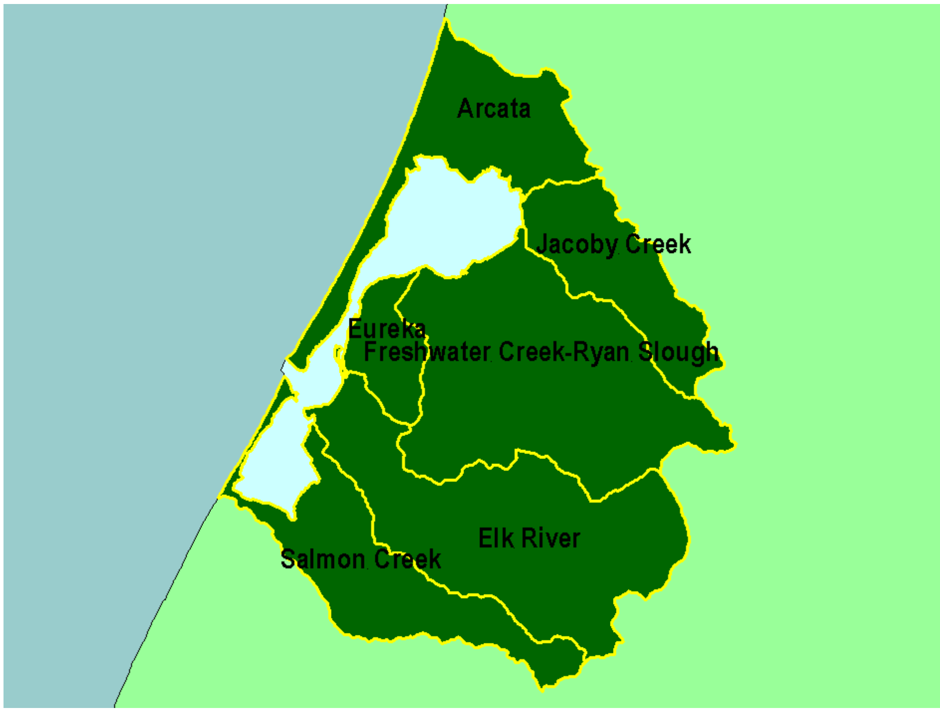

Figure 25-4 Watersheds within the Eureka Plain. Map from KRIS Humboldt Bay June 2006

Although high IP habitat appears to be most extensive in Freshwater Creek and Elk River and least extensive in Jacoby Creek (Table 25-1), the low gradient non-natal rearing function of the historic tidal wetlands in the Arcata and Jacoby Creek watersheds demonstrates the importance of these areas for rearing.

Table 25-1. Tributaries with instances of high IP reaches (IP > 0.66).

Stream Name	**Stream Name**	**Stream Name**
Janes Creek/McDaniel Slough[1]	Beith Creek/Gannon Slough[1]	Freshwater Creek
Jolly Giant Creek/Butcher Slough[1]	Grotzman Creek/Gannon Slough[1]	Elk River
Campbell Creek/Gannon Slough[1]	Jacoby Creek and tributaries	Salmon Creek
[1]IP in the streams in the Arcata subarea are not mapped in Figure 1-1. However NMFS included these streams in this table because (1) IP is derived from a model predicting juvenile rearing habitat, and (2) the streams are important to the population as non natal rearing sites.		

Although more precise delineation of the IP habitat (Figure 25-1), along with the locations identified by CDFG (2004b), would aid in prioritizing recovery actions, this information is currently unavailable. The actual length of (pre-1800s) spatial connectivity amongst the high IP habitat (channel and floodplain in riverine and tidally influenced reaches) used for rearing within each watershed is not currently known. Information about fluvial transport of inputs into reaches upstream of high value IP habitat in the riverine portion of the tributary, as well as the tidal transport of inputs in the tidally influenced region, is also necessary to understand the likely habitat utilization.

25.3 Status of Humboldt Bay Tributaries Coho Salmon

Spatial Structure and Diversity

Williams et al. (2008) determined that at least 30 coho salmon per-IP km of habitat are needed (5,700 spawners total) to approximate the historical distribution of Humboldt Bay Tributaries population of coho salmon. Since 2002, small numbers (relative to likely historic numbers) of juvenile coho salmon were observed in the sloughs and tributaries identified in Table 25-1.

Within the population area, Freshwater Creek is unique because it is relatively data rich. However, the existing spatial data on number and location of salmonid redds, number of juvenile outmigrants, and invertebrate prey resources are mapped at different scales and metrics (e.g., 1 in = 4,000 ft; 1 in=1,500 m,; 1 in =400 m) than the modeled habitat potential (i.e., IP reaches in Figure 25-1, 5/16 in =1 mile). Juvenile coho salmon residing upstream, in higher gradient reaches, migrate downstream in the fall to the stream-estuary ecotone, which contains low gradient and low velocity over-wintering habitat (Wallace 2008a), illustrating the importance of the connectivity among freshwater and tidally influenced habitats for growth and survival. The lower mainstem of Freshwater Creek had greater numbers of emigrating age 1+ coho salmon per km than the upper mainstem and tributary watersheds. In addition, these fish were larger and emigrating earlier than cohorts from upstream areas (Wallace et al. 2006, Ricker 2008a, Wallace 2008a). Juvenile coho salmon utilize non-natal sloughs and marshes while rearing or migrating through Humboldt Bay, e.g., individuals marked in Freshwater Creek have been recaptured in Elk River Slough.

Placement of all spatial data (redd location, outmigrant trap, invertebrate prey composition and food habits data, land use, timber harvest, *etc.*) for Freshwater Creek on one map would allow a better understanding of current habitat utilization for spawning and rearing relative to modeled high IP reaches. Presently this relation can only be inferred, and may not be accurate. For example, McCready Gulch should have more redds based on historic IP and may be under used because of degraded habitat. The areas in Clooney Gulch where numerous redds were observed in 2006 to 2007 (Ricker 2008a) actually appear to be located upstream of the modeled IP habitat. The documented importance of the mainstem of Freshwater Creek for spawning may be the consequence of being the only suitable habitat available, since much of the tributary habitat is degraded from industrial timber production (Goin 2009). In addition, individual fish have been found to spawn both in tributaries and in the mainstem, or in several tributaries, which may represent a life history strategy to increase egg survival in this small, dynamic stream (Goin 2009).

Population Size and Productivity

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 191 coho salmon must spawn in the Humboldt Bay tributaries each year to avoid such effects of extremely low population sizes The population size of the Humboldt Bay tributaries is unknown, and differences in sampling methodologies among years and locations makes some existing information of limited value for population estimates. The trend in adult abundance indicates the population of coho salmon is declining 35% per year (Ricker and Anderson 2011). The adult escapement estimates have declined, ranging from an estimated 1,807 in 2001 - 2002 to an estimated 89 in 2009 - 2010 (Ricker 2008b, Ricker and Anderson 2011). In Freshwater Creek, the estimated population growth rate for brood years 2001 to 2003 ranged from 0.43 to 0.54, indicating a declining population growth rate (Ricker 2008a). Published values of marine survival for wild populations of coho salmon range from 29% to 0.6% and average near 10%. Estimates of coho salmon marine survival from Freshwater Creek for 2007 (2.66%) and 2008 (0.85%) smolt cohorts are below this average and likely contribute largely to the short term negative trend in adult escapement (Ricker and Anderson 2011). . Although the number of juvenile coho salmon (smolts) emigrating from Freshwater Creek tributaries has remained relatively constant over 8 years, and is estimated at 3,000 individuals (Ricker 2008a), there appears to be a large variation in the annual number of juvenile coho salmon rearing in the stream-estuary ecotone. In Freshwater Slough, the CPUE of young of the year coho salmon caught by CDFG declined between 2005 and 2008.

Although estimates of adult escapement in Jacoby Creek are unknown, monitoring, Morrison Gulch, following a removal of a fish passage barrier in 2001 indicate the number of live adult coho salmon (10 individuals) observed in 2008 to 2009 were the lowest since 2001; and the overall eight-year trend in returning adult coho salmon and constructed redds in Morrison Gulch is downward (Taylor and Associates 2009). Recent (2002 to 2007) CDFG spawner and redd surveys of index reaches in Elk River (South Fork, Upper North Fork, and Lower North Fork) varied in number both among years and among locations so no direct comparison among years is possible (Collins 2008). Overall, the trend is a decline in number of live fish observed in Elk River at these locations.

Extinction Risk

The Humboldt Bay Tributaries coho salmon population is not viable and is at high risk of extinction based on the criteria established by Williams et al. (2008). Although the number of spawner likely exceeds the depensation threshold, the rate of population decline exceeds 10%.

Role in SONCC Coho Salmon ESU Viability

The Humboldt Bay Tributaries population is considered a “Functionally Independent” population meaning that it is sufficiently large to be historically viable-in-isolation and its demographics and extinction risk are minimally influenced by immigrants from adjacent populations (Williams et al. 2006). It is a core population and therefore the recovery target is to recover the population to at least a low risk of extinction; meeting the low risk spawner threshold (see Chapter 4). The low risk spawner threshold addresses the need for adequate spatial structure and diversity within the population (see Williams et al. 2008). Besides its role in achieving demographic goals and objectives for recovery, the Humboldt Bay Tributaries population fulfills other needs within the Southern Coastal stratum. The Humboldt Bay Tributaries population may serve as a source population for the Lower Eel River population, and provides connectivity and diversity within the stratum.

25.4 Plans and Assessments

Humboldt Redwood Company

Pacific Lumber Habitat Conservation Plan

Humboldt Redwood Company owns land in the upper Freshwater Creek and Elk River watersheds in the population area. The Pacific Lumber Company (PALCO) Habitat Conservation Plan (HCP), finalized in 1999 and valid through 2049, provides for (1) assessment of existing road network and associated sediment sources on HCP-covered lands (2) storm proofing of all medium and high priority sites within five years of completion of the assessment, and within 20 years of the effective date of the HCP; and (3) updating the road inventories within five years of the actual storm proofing. Elk River and Freshwater Creek were the first two watershed analyses to be completed. In 2004, the period for completion of road assessment and associated sediment sources was revised from 2005 to 2010. The HCP is intended to provide for storm proofing of 1,500 miles of road by 2019, at a minimum rate of 75 miles per year. The Freshwater Watershed Analysis and the Hillslope Management and Riparian Management Prescriptions were completed in 2003. The Elk River and Salmon Creek Watershed Analyses and the Hillslope Management and Riparian Management Prescriptions, were completed in 2005 (PALCO 2005).

U.S. Bureau of Land Management (Arcata Field Office)

Headwaters Forest Reserve Resource Management Plan

The 7,472- acre Headwaters Forest, located in the upper Elk River and Salmon Creek watersheds, was acquired by the Secretary of Interior and the State of California on March 1, 1999, to preserve old-growth redwood forest. . The acquisition was part of a comprehensive agreement between the Department of Interior and PALCO that created the Headwaters Forest, and required PALCO and the U.S. Fish and Wildlife Service (USFWS) to complete an HCP for PALCO’s remaining lands in Humboldt County. The Headwaters Forest Reserve Resource Management Plan (Jones & Stokes 2003, BLM and CDFG 2004) calls for the removal of 50 miles of abandoned logging roads within the Reserve. Approximately 45 percent of the watershed restoration work identified in the plan has been completed (Fuller 2010).

Green Diamond Resource Company

Habitat Conservation Plan

Green Diamond Resource Company owns 38,870 acres in the Eureka Plain HU, primarily within the Freshwater/Ryan Creek, Jacoby Creek, and Salmon Creek watersheds. Their Aquatic Habitat Conservation Plan, was finalized in 2006 and is valid through 2056. The plan has a number of provisions designed to protect coho salmon and aquatic habitat on their land within in the Humboldt Bay watershed. City of Eureka.

General Land Use Plan

This plan designates diked former tidelands, rivers, creek, sloughs, gulches, and associated riparian habitat as environmentally sensitive areas within the Coastal Zone, and requires that any land use activity occurring within 250 feet of any such area must avoid or minimize habitat disturbance and delivery of sediment to waterways. Where a federal nexus exists at a project scale, additional protections to coho salmon and their critical habitat may be identified during the ESA section 7 consultation.

City of Arcata

General Plan

The city of Arcata's Creeks Management Plan (CMP) provides policy direction for new and modified development along creeks in order to control watershed erosion, enhance riparian habitat, protect instream habitat and flows, and promote restoration. The CMP is generally protective of coho salmon habitat in Janes Creek (including North Fork South Fork and McDaniel Slough), Sunset Creek, Jolly Giant Creek (including Butchers Slough), Campbell Creek, Fickle Hill Creek, Grotzman Creek, Beith Creek, Jacoby Creek, and Washington Gulch. Also included are Liscom Slough, the Mad River and Gannon Slough. The city of Arcata also owns and manages, under a Non-industrial Timber Management Plan, the 793 acre Arcata Community Forest, in the upper watershed of Janes Creek, as well as the 1,312 acre Jacoby Creek Forest.

United States Fish and Wildlife Service (Humboldt Bay National Wildlife Refuge)

Humboldt Bay National Wildlife Refuge Comprehensive Conservation Plan (2009)

The Humboldt Bay National Wildlife Refuge Comprehensive Conservation Plan (CCP) outlines the management direction and strategies for U.S. Fish and Wildlife Humboldt Bay and Castle Rock National Wildlife Refuges (NWR) for the next 15 years. Management activities will focus on the conservation of the Refuges' resources, particularly migratory birds and wildlife species that are federally listed as threatened or endangered, and their habitats; and providing opportunities at Humboldt Bay NWR for compatible wildlife-dependent recreation including wildlife observation photography, environmental education, interpretation, and hunting. The Salmon Creek Delta Restoration plan was developed to improve fish passage, fish habitat, and water quality, create additional estuarine habitat, improve sediment transport, and reduce flooding upstream of the Humboldt Bay NWR.

Sea Grant: Eureka Office Humboldt Bay Ecosystem Based Management

Humboldt Bay Watershed Salmon and Steelhead Conservation Plan (2005)

This multi-stakeholder plan, which focused on the four main watersheds in the Humboldt Bay watershed (Jacoby Creek, Freshwater Creek, Elk River and Salmon Creek), compiled and evaluated watershed information and developed a list of high priority goals and objectives aimed at protecting or restoring watershed processes in order to preserve and enhance salmon and steelhead habitat. This document provides a template for recovery actions in freshwater and estuarine habitats.

Humboldt Bay Harbor, Recreation and Conservation District

Humboldt Bay Management Plan

In 1970, the HBHRCD was established to manage Humboldt Bay for the promotion of commerce, navigation, fisheries, recreation, and the protection of natural resources, and to acquire, construct, maintain, operate, develop, and regulate harbor works. The Humboldt Bay Management Plan was developed around ecosystem-based approach with stakeholder participation through an Advisory board. This approach will strive to balance priorities and policies for the District's legislatively directed obligation to manage harbor, recreation, and conservation-related goals for Humboldt Bay.

Humboldt Bay Initiative
http://www.westcoastebm.org/Humboldt_Bay_Initiative.html

The Humboldt Bay Initiative (HBI), led by NOAA's SeaGrant Extension Office in Eureka, California seeks, using an ecosystem-based management approach, to create a coordinated resource management framework that links the needs of people, habitats and species by increasing scientific understanding of the ecosystem. In order to address priority threats to the local ecosystem and communities including climate change, invasive species and human activities, HBI includes a set of strategies aimed at creating the conditions necessary to achieve their shared vision of a healthy ecosystem. These strategies include development of several models of natural science processes (e.g., conceptual ecosystem linkages, sea level rise and sediment/circulation) to be used as a decision-making tool for activities that may potentially affect eelgrass and salmonid rearing habitat.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004.

Water Quality Control Plan for the North Coast Region
http://www.swrcb.ca.gov/northcoast/water_issues/programs/basin_plan/

Enclosed Bays and Estuaries of California Water Quality Control Plan
http://www.waterboards.ca.gov/water_issues/programs/bptcp/docs/sediment/071808appendixa_draftpart%201.pdf

Natural Stocks Assessment Program (2003-ongoing)

The Natural Stocks Assessment Program (NSA) was developed to collect information on the distribution, growth, and estuarine residency times of juvenile salmonids in the tidal portion of selected Humboldt Bay tributaries and in McNulty Slough in the Eel River Estuary. The information collected by the NSA is shared with the restoration community to help improve marsh restoration projects around Humboldt Bay. Data was collected in Elk River Slough which was discontinued in June 2009. Data was collected in Gannon Slough/Jacoby Creek estuary, Rocky Gulch, and Martin Slough and was discontinued in June 2010. Data is currently being collected for Wood Creek, Freshwater Slough, Salmon Creek, Hookton Slough, and Ryan Slough and being used to assess ongoing or planned estuarine habitat restoration projects. Sites are monitored on a monthly basis; with the exceptions of Elk River Slough and Freshwater Slough, which are monitored weekly; and Salmon Creek and Hookton Slough, which are monitored every two weeks.

North Coast Integrated Regional Water Management Plan
http://www.northcoastirwmp.net/docManager/1000006299/NCIRWMP_Phase_I_maps_2007.pdf

Pacific Coast Joint Venture

Pacific Coast Joint Venture Coastal Northern California Component Strategic Plan
http://pcjv.org/california/pdfs/Strategic%20Plan%20CAL%20PCJV%202004.pdf

University of California Subtidal & Intertidal Habitat Goals Project

Subtidal Habitat Goals Project for Humboldt Bay and the Eel River Estuary
http://groups.ucanr.org/HumboldtHabitatGoals/files/45642.pdf

The Nature Conservancy

North Coast Anadromous Salmonid Conservation Assessment (Tussing and Wingo-Tussing *2005)*

This assessment was developed as a guide and reference to actively pursue opportunities related to aquatic biodiversity.

25.5 Stresses

Table 25-2. Severity of stresses affecting each life stage of coho salmon in the Humboldt Bay Tributaries. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Sediment Supply[1]	Very High	Very High	Very High[1]	High	Very High	Very high
2	Lack of Floodplain and Channel Structure[1]	Very High	Very High	Very High[1]	High	Very High	Very High
3	Impaired Estuary/Mainstem Function[1]	-	High	Very High[1]	High	Medium	High
4	Degraded Riparian Forest Conditions	-	High	High	High	High	High
5	Impaired Water Quality	High	High	High	High	Low	High
6	Barriers (tidegates)	-	High	High	High	High	High
7	Altered Hydrologic Function	Medium	Medium	Medium	Medium	-	Medium
8	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
10	Increased Disease/Predation/Competition	Low	Low	Low	Low	Low	Low

[1]Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limiting, primarily due to reductions in quality and quantity of summer and winter rearing habitat. The altered sediment supply, lack of floodplain and channel structure, and impaired estuary are the stresses that most limit rearing opportunities. The combined effect of excess sediment filling pools along with the lack of structure to meter out sediment or provide scour mechanisms, which create and maintain pools, significantly reduces the complexity of the instream habitat. Furthermore, the population historically depended on the rich tidally influenced habitat for rearing. The impaired state of the estuary has further limited the population's rearing opportunities.

Tidal freshwater habitat has been demonstrated to be important for the growth and survival of juvenile coho salmon (Koski 2009). The size of fish observed in off-channel ponds, both established and newly created, indicate that growth rates are significantly higher than those fish rearing in the mainstem channels, thereby likely increasing their survival once they enter the ocean. For example, Wood Creek, and likely Ryan Slough, provides winter habitat refugia from high flows for age 0+ and 1+ juvenile coho salmon in the Freshwater Creek watershed (Wallace 2011).

Altered Sediment Supply

Altered (increased) sediment supply represents a very high stress to all life stages of coho salmon in the Humboldt Bay Tributaries population except smolts, for which it poses a high stress. The severity of sediment as a stressor is reflected in the section 303(d) listing of Jacoby Creek, Freshwater Creek, and Elk River as sediment-impaired waterbodies. Increased sediment delivery and deposition has increased channel embeddedness, filled pools, widened channels, increased the amount of fine sediments that can be suspended, and simplified stream habitat throughout the watershed, including the estuary.

Embedded channel gravels reduce permeability of redds, which reduces the amount of oxygen available to coho salmon eggs, thereby potentially reducing growth and survival of eggs. Further, the success of coho salmon fry emergence from spawning gravels decreases as channel embeddedness increases. Increased suspension of sediments, and resultant increased turbidity, can cause avoidance responses, and physical damage to gills of fry, juveniles, smolts and adults, as well as reduced feeding and growth rates of fry, juveniles and smolts. High levels of fine sediment and embeddedness can also reduce the feeding success, and ultimately growth of 0+ and 1+ fish, because extended periods of high turbidity reduce visibility of prey as well as the type of invertebrate prey available. Epibenthic grazer and predator taxa of benthic macroinvertebrates, an important food source for salmonids, are limited or non-existent in channels with high levels of sedimentation. Sediments delivered to the streams and creeks are, over time, transported to tidally influenced habitats in the lower portions of the tributaries and ultimately into Humboldt Bay, as discussed in the subsequent section on impaired function of tidally influenced habitat.

The Humboldt Bay watersheds are comprised of moderately unstable geologic composition. Poor landing and stream crossing locations, and road construction practices (from the 1930s to the early 1970s) experienced very large stressing storms in the late 1990s following a high level of logging operations. Specifically, the large storms between 1993 and 1997 routed stored sediment from lower order tributary watersheds down to the low gradient storage reaches and caused significant amounts of landsliding associated with old roads and landings to occur, generating considerable volumes of new sediment to route downstream.

Lack of Floodplain and Channel Structure

Given the extensive timber harvesting that has occurred in the population area and the changes in riparian vegetation characteristics, lack of large wood is likely limiting the development of complex stream habitat throughout much of the watershed.

Altered floodplain and channel structure (pool frequency and depth, large woody structures) presents a very high stress to all life stages. Levees and dikes are limiting connectivity between mainstem slough channels and potential floodplain habitat in valley floor and stream-estuary ecotone sections of most Humboldt Bay tributaries. Lack of backwater pools along the channel margins reduces overwintering refugia from high flows. Reduced habitat connectivity and complexity of estuarine functions is detrimental to the juveniles and smolts found there.

Impaired Estuary/Mainstem Function

Since this population is inherently dependent on the estuary for rearing, changes in the estuary constitute a high or very high stress to all life history stages of coho salmon, except eggs. The life stages most affected are fry and juveniles that rear in the estuary and smolts that use estuarine habitat for rearing, transitional habitat, and refugia. Coho fry and juveniles rearing in the estuary are almost always found in tidally influenced freshwater habitat while smolts utilize fresh and brackish water habitat in the estuary (Wallace 2011). There is potential for estuarine rearing, although the quality and quantity are reduced compared to historic conditions. The structure and function of the tidally influenced habitat in the drowned river mouths around Humboldt Bay, as well as in the contiguous nearshore and deeper channel habitats in Humboldt Bay, have been significantly altered from natural conditions. The quality of rearing habitat for fry, juvenile and smolts has been reduced as a result. The physical and biological habitat-forming processes, the light regime, and the spatial extent of the intertidal and subtidal habitats in Humboldt Bay have been directly altered as a result of: (1) upland land use activities that increase sediment transport, reduce floodplain/tidal marsh storage of sediment, and limits large wood recruitment and delivery to the tidally influenced habitats; (2) agricultural practices that diked, drained and eliminated estuarine rearing habitat; (3) construction of roads and railroads that effectively act as dikes, altering hydrology and habit accessibility; (4) port and harbor development and interrelated commercial and recreational activities; and (5) urbanization and development of Arcata and Eureka.

Maintenance dredging of the Federal Navigation Channels and jetty construction to stabilize the mouth of Humboldt Bay; changed the volume of flood and ebb-tidal shoals, modified the tidal prism, and forced a new equilibrium state (Larson et al. 2002). Since 1950, from March through May, juvenile coho salmon present in Humboldt Bay may be exposed to the annual dredging. Overflow of the hopper dredge during annual maintenance dredging of the Federal Navigation Channels, results in water quality that has; (1) been degraded due to increased turbidity; (2) reduced the localized availability of the water column habitat for rearing and migration of juvenile coho salmon during each daylight dredge cycle; and (3) disoriented fish entrained in the prop wake and turbidity plume, and in turn increased the likelihood of predation by birds during the day.

Over-water structures (piers, piles, docks, and moored boats) in Humboldt Bay, along with associated shading and localized hydraulic effects, cause detrimental effects to coho salmon habitat. These structures: (1) reduce the amount of nearshore intertidal and subtidal eelgrass habitat, (2) reduce the connectivity of nearshore habitat, (3) alter the type of cover and prey available for juvenile salmonids, and (4) trigger salmonid behavioral habitat avoidance. Because coho salmon avoid swimming under over-water structures, individuals will occupy the middle to the surface of the water column in deeper water adjacent to structures, as opposed to occupying more shallow water as they would in the absence of the structures (Toft et al. 2004). As a result of fragmentation of nearshore habitat, including eelgrass habitat, juvenile salmonids likely increase the amount of time traveling between eelgrass patches, which (1) results in decreased foraging; and (2) increases their exposure to predators where eelgrass cover is reduced or over-water structures present.

Alteration and loss of salt marsh, intertidal and subtidal habitat in Humboldt Bay adjacent to the Eureka watershed resulted from the construction of the three State Highway 255 Humboldt Bay bridges (Bridges) in 1971 and Woodley Island Marina (Marina) in 1981. Hardening of the shoreline has reduced the extent of the intertidal habitat, restricted sediment transport, and likely increased nearshore turbulence. Artificial illumination in the nearshore during otherwise normal periods of darkness can provide enough light for visual feeders to see and capture prey (Yurk and Trites 2000, DeVries et al. 2003, Longcore and Rich 2004). Harbor seals prey on juvenile salmonids in water at least 2 m deep, and feed actively in the light-shadow boundary produced by halogen bridge lights and residual city lighting (Yurk and Trites 2000).

Degraded Riparian Forest Conditions

Degraded riparian forest conditions exist across the watershed and present high stresses across juvenile and adult life stages. Clearing of riparian forests is one factor that alters recruitment of large woody debris to streams (another being harvest of unstable or potentially unstable slopes), subsequently altering sediment transport and storage, deposition and storage of sediment, bed roughness, interaction between the channel and floodplain, channel habitat characteristics including pool habitat (spacing, area, and depth) both in freshwater and tidally influenced habitats. Riparian vegetation also provides (1) shade, which influences water temperature; (2) nutrients and organic material (leaves, insects); and (3) bank stabilization. The composition of the prey community is a factor in habitat use, for example, a study conducted in the Freshwater Creek watershed in 2004 (Cummins et al. 2005) found that greater numbers of juvenile coho salmon were present where the system was heterotrophic, relying on riparian inputs of energy. Reductions in large wood also modify the hydrology and hydraulics, as discussed, below, in the *Altered Hydrologic Function* subsection.

Impaired Water Quality

Water quality is ranked as a high stressor to all juvenile life stages, and a medium stress to eggs and adults. As described above, increased levels, or duration, of turbidity may reduce juvenile coho salmon growth. Low dissolved oxygen in combination with high summer water temperatures are stressors in lower Salmon Creek, lower Freshwater Creek, and in the lower South Fork of Elk River that limit habitat suitability (Wallace and Allan 2007). Nutrient loading from septic tank overflow, runoff from grazing lands, and reduced riparian vegetation, contribute to these conditions.

Barriers

Coho salmon juvenile and smolt fish passage barriers in tidally influenced areas pose a high stress. Numerous water control structures around Humboldt Bay drain agricultural, residential, urban, and industrial land. Tide gates block fish passage into formerly accessible estuarine rearing habitat and spawning tributaries in the Eureka Plain HU watersheds (USFWS 2007) and constitute the most problematic barriers to the population overall.

Altered Hydrologic Function

Altered hydrologic function poses a medium threat to coho salmon in the population area. Clearing of vegetation has increased surface runoff, and over-harvest of riparian vegetation has caused a consequent decrease in both the downed large wood and the amount of potential large wood in the future. Relative to hydrologic function, reductions in large woody debris decreases in-channel sediment storage, reduces channel roughness, and reduces the ability of the stream to attenuate peak flows. Inboard ditches collect and channelize surface runoff and subsurface flows, then efficiently route water, sediment and other pollutants to streams resulting in higher, earlier, and more frequent peak flows. Increased peak flow may increase the frequency of channel bed mobilization; thereby, increasing the probability of redd scour, disturbance of alevins in redds, as well as displacing over-wintering coho salmon juveniles.

Adverse Fishery-Related Effects

NMFS has determined that federally managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. A small egg collecting station operated on Freshwater Creek from 1978 to 1995. There are no operating hatcheries in the Humboldt Bay Tributaries population area. Hatchery-origin coho salmon may stray into the population area, but the proportion of spawning adults that are of hatchery origin is unknown. Numerous steelhead smolts produced by the Mad River hatchery were found in lower Elk River Slough shortly after their release in March 2006 (Wallace 2006), indicating some straying from that hatchery has occurred. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there is no hatchery in the basin (Appendix B).

Increased Disease/Predation/Competition

Non-native species pose a medium threat to juveniles and smolts both in freshwater and in tidally influenced habitat in the watersheds, as well as in Humboldt Bay. Capture of six Sacramento pikeminnow, a salmonid predator currently present in the Eel River, in Martin Slough in 2008 prompting CDFG to survey other tributaries within the Elk River watershed, and to begin a targeted eradication program. One additional pikeminnow was captured in Martin Slough in May 2011 roughly 2.5 years after the extensive eradication effort began (Wallace 2011).

25.6 Threats

Table 25-3. Severity of threats affecting each life stage of coho salmon in the Humboldt Bay Tributaries. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Agricultural Practices	Very High	Very High	Very High	Very High	Very High	Very High
2	Roads	Very High	Very High	Very High	Very High	Very High	Very High
3	Timber Harvest	Very High	Very High	Very High	Very High	Very High	Very High
4	Channelization/Diking	High	High	High	High	Medium	High
5	Urban/Residential/Industrial	Medium	High	High	High	Medium	High
6	Climate Change (sea level rise)	Low	Low	High	High	Medium	Medium
7	Dams/Diversions	Low	Low	Medium	Medium	Medium	Medium
8	Invasive Non-Native/Alien Species	Low	Medium	Medium	Medium	Low	Medium
9	Fishing and Collecting	-	-	-	-	Medium	Medium
10	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low
12	High Intensity Fire	Low	Low	Low	Low	Low	Low

[1]Mining/Gravel Extraction is not considered a threat to this population.

Agricultural Practices

Agricultural practices pose a very high threat to all life stages. Grazing and haying occurs throughout the lower watersheds and likely contributes to increased sediment generation and delivery. Cattle grazing and instream watering contribute to degraded riparian and aquatic habitat, primarily in the lower watershed, and reduce its function for rearing. Production of prey is also limited by increased turbidity and nutrient loading from feces. Diking of tidelands and installation of tidegates to create land for agriculture has eliminated the majority of the intertidal rearing habitat around Humboldt Bay.

Roads

Roads, which pose a very high threat to all life stages of coho salmon, are one of the most significant threats to coho salmon in the Humboldt Bay Tributaries population. Forest roads are a primary causative factor for both altered sediment supply and altered hydrologic function. The density of roads in the Eureka Plain HU is generally high throughout the watershed (>3 miles of roads per square mile). Pacific Watershed Associates (PWA 2006) reported that between 1989 and 2003 there were 76 miles of road constructed in Freshwater Creek (30.7 mi^2), which resulted in an overall road density of 7.6 mi/mi^2. They also reported that Ryan Slough and Fay Slough, both tributaries to Freshwater Creek, have road densities of 8.7 mi/mi^2, and 8.8 mi/mi^2, respectively. Roads and road ditches extend the stream channel network, concentrate hillslope runoff and capture subsurface flows, often resulting in changes to the natural hydrograph. Specifically, historic peak flows are exceeded due to the increase in road-stream connectivity and peak flows occur more frequently. Further, inboard ditches effectively convey road-related sediment to streams. In some watersheds, road erosion may annually contribute more sediment to the stream system than mass wasting (PWA 2006).

Timber Harvest

Timber harvest poses a very high threat to all life stages of coho salmon, and their aquatic habitat. Timber harvest activities in both Freshwater Creek and Elk River have resulted in cumulative adverse impacts. Timber harvest in Freshwater Creek increased from 668 acres/year between 1988 and 1997, to 1,166 acres/year between 1998 and 2003 (PWA 2006). Much of the existing streamside canopy in the Eureka Plain HU is either hardwood dominated or of insufficient size to provide large wood recruitment potential. In Freshwater Creek, the existing canopy closure within managed stands is expected to take 40 years to increase to 70 percent (Doughty 2003). The rate of timber harvest in Elk River increased in 1986 over historic rates. Between 1986 and 2008, 14,169 acres of the 14,386 acre North Fork Elk River drainage were approved for harvest under a number of THPs. The rates of landsliding and associated sediment delivery from recently harvested areas (areas harvested less than 15 years ago) were significantly higher than the rates of landsliding and sediment yield due to landslides from non-harvested areas during the period from 1994 to 1997. For example, landslide sediment yield from recently harvested areas was approximately 1300 percent (13 times) greater than background landslide sediment yield rates (sediment inputs from areas harvested more than 15 years ago) in the North Fork Elk River watershed (Reid 1998).

Past harvest of riparian and upland trees has limited large wood recruitment to stream channels, and the current age of trees limits shade provided by canopy. Interim prescriptions in the PALCO HCP may not be adequate to restore, protect or maintain water quality objectives and beneficial uses in 303(d)-listed waterbodies [North Coast Regional Water Control Board (NCRWQCB) 2005a]. The interim prescriptions have been modified and still may not be sufficient to recover the impaired watersheds. The Regional Board has issued cleanup and abatement orders (CAOs) for discharges into the waters of the state caused by PALCO's timber harvest-related activities in the following watersheds: North Fork Elk River (3 CAOs), South Fork Elk River and Mainstem Elk River, Freshwater Creek, and North Fork Elk River.

Channelization/Diking

Existing stream channelization and diking poses a high threat to coho salmon eggs, fry, juveniles, and smolts. The extent of channelization and diking in the lower portion of the Humboldt Bay watersheds, as well as the Reclamation District Levee in North Bay and associated tide gates, limits the availability of tidal freshwater and estuarine rearing habitats.

Urban/Residential/Industrial Development

Development in the population area poses a high threat to coho salmon fry, juveniles, and smolts, and a medium threat to eggs and adults. The Humboldt Bay Management Plan (HBHRCD 2007) identified the primary use in Humboldt Bay, in the area below the Samoa bridge to South Bay (which serves as a coho salmon migratory corridor and rearing habitat), for port related activities. Continued port development in the Samoa Channel (e.g., Redwood Marine Terminal Dock) would degrade habitat in an area where juvenile coho salmon concentrate (Pinnix 2008). Further, future development may degrade existing tidally influenced habitat and limit the efficacy of existing or planned restoration projects. Discharge of treated wastewater to Humboldt Bay is permitted from treatment plants for the city of Arcata, greater Eureka, and College of the Redwoods (NCRWQCB 2005a), and the volume of discharge would increase with fully realized potential of the land zoned for residential development. The Non-Point Discharge Permit for the city of Eureka’s Elk River wastewater treatment facility requires a study, completed by 2014, to verify that the wastewater discharged from the facility during an outgoing tide is transported into the ocean (NCRWCB 2005a).

Climate Change

Climate change poses an overall medium threat to this population due to its potential impact on juveniles, smolts, and adults. Although current water temperatures in the population area are currently a low risk, modeled regional average temperature shows a moderate increase over the next 50 years (see Appendix B for modeling methods). Average water temperature could increase by up to 0.5 ^{o}C in the summer and by approximately 1.0 ^{o}C in the winter. Annual precipitation in the Humboldt Bay watershed is predicted to change little over the next century.

The vulnerability of the estuary to sea level rise is high in the population area. Tidally influenced rearing and migratory habitat for juveniles and smolts are most susceptible to climate change. Increasing temperatures and rising sea level will reduce water quality and hydrologic function in the summer. Rising sea level will likely reduce the quality and quantity of tidal-wetland rearing habitat in Humboldt Bay, e.g., increase salt marsh and reduce intertidal flats (Galbraith et al. 2002). Wetlands could migrate inland with rising sea level, but there are currently few areas without levees where this could occur.

The tidally influenced habitat of the Humboldt Bay watershed is highly vulnerable to sea-level rise due the location of urban and residential developments, existing land use and public infrastructure (CNRA 2009, Heberger et al. 2009, NMFS 2009). Stressors previously described for estuarine function will likely be exacerbated, depending on decisions and subsequent implementation of actions to protect existing public sector infrastructure [transportation (e.g., highway, airport, port facilities); energy (e.g., power plant, natural gas pipeline, transmission lines); water (e.g., Humboldt Bay Municipal Water District water main, city of Arcata and Eureka wastewater treatment facilities) and public and private land use (e.g., city of Arcata and Eureka; Humboldt Bay National Wildlife Refuge, Humboldt Bay Reclamation District; Humboldt Bay Harbor, Recreation, and Conservation District). Because of the land and infrastructure ownership, these decisions will be made at multiple Federal, state, and local jurisdictional levels.

Also, as with all populations in the ESU, adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Sea level rise; associated with climate change http://www.cop.noaa.gov/stressors/climatechange/current/sea_level_rise.html

Dams/Diversions

There are no large dams in the Eureka Plain HU. The Union Water Company constructed a small dam on Jolly Giant Creek in 1930. The 50-foot high structure, located above the zone of anadromy, within the Arcata Community Forest, is no longer used as a water impoundment. The structure lacks a spillway and is drained by an undersized cast iron pipe. A large amount of sediment is stored in the old reservoir bed and sediment mobilizes downstream when the drainpipe is unclogged and head exists, following frequent plugging.

From the 1920's through 2001, a flashboard dam had been installed on Freshwater Creek at Freshwater Park from June through September to create a swimming area. Prior to 2002, this summer dam was a barrier to potential upstream and downstream movement of juvenile salmonids. In order to enable fish passage, the County of Humboldt, owner and operator of Freshwater Park, worked with fisheries biologists and engineers (private, academic, State, and Federal) in 2001 to design, and build: (1) a temporary dam bypass structure (operated 2002-2007); and (2) a permanent concrete fish ladder, embedded in the streambank (2009.) Neither the dam, nor the temporary bypass, were installed in 2008. Juvenile salmonids currently utilize the permanent fish ladder, and have been observed moving upstream and downstream of the flashboard dam (Humboldt County Department of Public Works 2010, 2011).

Diversions pose a medium threat to juveniles, smolts and adults. According to the Department of Water Resources (DWR) data base ttp://www.waterboards.ca.gov/ewrims/), there are 53 appropriative water rights and diversion points in the Eureka Plain, but they are not all active. However, not all water diversions are registered with DWR. Riparian residential and agricultural uses can comprise significant amounts of water especially during low flow periods. Although water users are required to obtain a 1600 permit from CDFG, this has not been common practice for small agriculture and residential withdrawals. Due to channel aggradation and subsequent limited instream water storage, water withdrawals in the summer months can reduce both the fluvial and tidal freshwater habitat available for rearing coho salmon. Consequently, the combination of reduced natural flow and anthropogenic withdrawals further reduces water quality (i.e., lowered dissolved oxygen) in the remaining habitat.

Invasive/Non-Native Species

Non-native species pose a medium threat to fry, juveniles and smolts both in freshwater and in tidally influenced habitat in the watersheds, as well as in Humboldt Bay. CDFG's Natural Stock Assessment Program captured six Sacramento pikeminnow, a salmonid predator currently present in the Eel River, during routine and subsequent sampling, and during a multi-agency eradication effort in Martin Slough in 2008. CDFG plans to sample Martin Slough monthly and is working with NOAA Fisheries and other agencies to develop a response plan for addressing future pikeminnow that are captured.

Bullfrogs have been captured in Freshwater Creek in lower watershed downstream migrant traps every year since 2006. In 2009, DFG found a pit-tagged coho smolt in the stomach of an adult bullfrog at the weir site in Freshwater Creek (Pagliuco 2009).

Non-native species are commonly introduced to estuaries that are ports because they are carried in ballast water, or on the vessel hulls. In Humboldt Bay, culture of the non-native oyster, *Crassostrea japonica*, introduced a number of non-native invertebrate species. Monitoring of non-native invertebrates and intertidal and salt marsh vegetation, as well as eradication programs, are ongoing: (http://coastalwatersheds.ca.gov/portals/1/HumboldtBay/Monitoring/FisheryResourcesProjects/tabid/661/Default.aspx#InvSp_SeaGrant_crab).

Several species of invertebrates, as well intertidal and saltmarsh vegetation are non-native and have the potential to replace native species. Many of the fouling organisms present within the Eureka boat basin and the Woodley Island Marina (WIM) are non-indigenous species, introduced either in ballast water of vessels or attached to vessel hulls (Ruiz et al. 2000, Boyd et al. 2002). The concrete piers and pilings of the WIM have been colonized by non-native species of amphipods *Corophium acherusicum* and *C. insidiosum*. The non-native dwarf eel grass *Zostera japonica*is also present in the bay, and the non-native denseflower cordgrass *Spartina densiflora*, occurs in salt and brackish marshes surrounding the bay.

The potential for non-native vegetation to establish in estuarine restoration sites is high because of the disturbance of the substrate.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Humboldt Bay tributaries. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Road-Stream Crossing Barriers

Based on the culverts associated with the Humboldt County road system, this threat is ranked as low. Taylor (2000) identified five culverts in the Humboldt County road system, within the Humboldt Bay population area that remain as potential fish barriers but were ranked as low priority (Table 25-4).

Table 25-4**.** List of Humboldt County barrier road culverts in the Eureka Plain HU (Taylor 2000).

Stream Name	**Road Name**	**Watersheds**
Martin Slough #1	Herrick Road	Elk River
Martin Slough #2	Compton Road	Elk River
Golf Course Creek	Jacoby Creek Road	Jacoby Creek
Wood Creek	Myrtle Avenue	Freshwater Creek
McCready Gulch	Kneeland Road	Freshwater Creek

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Humboldt Bay Tributaries population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

High Intensity Fire

The threat of high intensity fire in the population area is minimal because climatic conditions do not favor frequent or high-intensity fires in this area. The present fire risks in this area are the result of past timber harvest activities and fire suppression.

25.7 Recovery Strategy

Recovery actions to reduce the stresses in the IP habitat of the Humboldt Bay Tributaries population should focus on restoring the natural watershed processes (i.e., the fluvial transport of wood, water, sediment, nutrients, and energy). Improved quality and quantity of habitat, as well as increased accessibility of seasonally important rearing habitats (backwater freshwater habitats, and tidally- influenced wetland habitats in spring, summer, and fall) will increase the growth and survival of individuals. Increasing abundance of individual coho salmon, as well as the potential for expression of diverse life history strategies through increased diversity of spatially and temporally available spawning and rearing habitats should enhance the resilience and increase the viability of this population. Because many designated land uses in the population area have not yet been realized (e.g., land not yet developed, timber not yet harvested), the opportunity for protection of habitat through innovative incentive programs, alternative land-use scenarios, and partnerships provides a means to reduce the stresses and begin restoring the natural landscape processes.

Table 25-5 on the following page lists the recovery actions for the Humboldt Bay Tributaries population.

Table 25-5. Recovery action implementation schedule for the Humboldt Bay Tributariespopulation.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.1.3.4	Estuary	Yes	Increase tidal exchange of water	Remove or replace tidegates	Estuary	2
SONCC-HBT.1.3.4.2	*Remove or replace tidegates guided by the USFWS plan*					
SONCC-HBT.1.1.5	Estuary	Yes	Improve connectivity of tidally-influenced habitat	Remove, set back, or reconfigure levees and dikes	Focus on tidally influenced habitat in the lower portions of tributaries	3
SONCC-HBT.1.1.5.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-HBT.1.1.5.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-HBT.1.2.40	Estuary	Yes	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-HBT.1.2.40.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-HBT.1.2.40.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-HBT.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide, high priority in Jacoby Creek, Freshwater Creek and Elk River	3
SONCC-HBT.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-HBT.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-HBT.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide	3
SONCC-HBT.2.2.2.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-HBT.2.2.2.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-HBT.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Improve channel function by redirecting urban streams into above-ground channels ('daylighting')	Lower watersheds in the developed areas of Eureka and Arcata	3
SONCC-HBT.2.2.3.1	*Assess feasibility of daylighting urban streams. Prioritize sites, develop daylight plans*					
SONCC-HBT.2.2.3.2	*Daylight streams, guided by assessment results*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.8.1.11	Sediment	Yes	Reduce delivery of sediment to streams	Improve grazing practices	Low gradient stream reaches in pasture lands	2
SONCC-HBT.8.1.11.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-HBT.8.1.11.2	*Develop grazing management plan to meet objective*					
SONCC-HBT.8.1.11.3	*Plant vegetation to stabilize stream bank*					
SONCC-HBT.8.1.11.4	*Fence livestock out of riparian zones*					
SONCC-HBT.8.1.11.5	*Remove instream livestock watering sources*					
SONCC-HBT.8.1.12	Sediment	Yes	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3
SONCC-HBT.8.1.12.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-HBT.8.1.12.2	*Implement plan to stabilize slopes and revegetate areas*					
SONCC-HBT.8.1.13	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	2
SONCC-HBT.8.1.13.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-HBT.8.1.13.2	*Decommission roads, guided by assessment*					
SONCC-HBT.8.1.13.3	*Upgrade roads, guided by assessment*					
SONCC-HBT.8.1.13.4	*Maintain roads, guided by assessment*					
SONCC-HBT.8.1.14	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-HBT.8.1.14.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-HBT.16.1.24	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-HBT.16.1.24.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-HBT.16.1.24.2	*Identify fishing impacts expected to be consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.16.1.25	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-HBT.16.1.25.1	*Determine actual fishing impacts*					
SONCC-HBT.16.1.25.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-HBT.16.2.26	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-HBT.16.2.26.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-HBT.16.2.26.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-HBT.16.2.27	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-HBT.16.2.27.1	*Determine actual impacts of scientific collection*					
SONCC-HBT.16.2.27.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-HBT.3.1.19	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-HBT.3.1.19.1	*Encourage users to reduce stream diversions during the summer by providing educational materials describing how to increase water use efficiency*					
SONCC-HBT.3.1.20	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Tidally influenced habitat	BR
SONCC-HBT.3.1.20.1	*Conduct hydrologic analysis*					
SONCC-HBT.3.1.21	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	BR
SONCC-HBT.3.1.21.1	*Identify and characterize diversions and develop a plan to reduce amount of water diverted, which may include such measures as securing dedicated unused water diversion rights and negotiating purchase or easement of water rights*					
SONCC-HBT.3.1.21.2	*Reduce diversions as described in the plan*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.3.2.22	Hydrology	No	Increase water storage	Improve regulatory mechanisms	Population wide	3
SONCC-HBT.3.2.22.1	*Develop ordinance, permit requirements, and guidance to maintain open space*					
SONCC-HBT.3.2.23	Hydrology	No	Increase water storage	Educate stakeholders	Population wide	3
SONCC-HBT.3.2.23.2	*Develop an outreach and education program about preservation of open spaces*					
SONCC-HBT.27.2.28	Monitor	No	Track habitat condition	Develop an instream sediment monitoring plan	tributary streams with at least moderate IP values in tidally influenced habitat of Arcata sub-basin; non-natal rearing habitat	BR
SONCC-HBT.27.2.28.1	*Develop an in-stream sediment monitoring plan and establish monitoring stations*					
SONCC-HBT.27.2.29	Monitor	No	Track habitat condition	Monitor stream temperature	Population wide	BR
SONCC-HBT.27.2.29.1	*Conduct stream temperature monitoring at established stations, and establish additional stations in lower watershed to assess diel fluctuations in habitat availability*					
SONCC-HBT.27.1.30	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-HBT.27.1.30.1	*Perform annual spawning surveys*					
SONCC-HBT.27.1.31	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Develop survival estimates	Site to be determined	3
SONCC-HBT.27.1.31.1	*Install and annually operate a life cycle monitoring (LCM) station*					
SONCC-HBT.27.1.32	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-HBT.27.1.32.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-HBT.27.1.33.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-HBT.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-HBT.27.2.34.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-HBT.27.2.34.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-HBT.27.2.35	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-HBT.27.2.35.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-HBT.27.2.36	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-HBT.27.2.36.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-HBT.27.2.37	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-HBT.27.2.37.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-HBT.27.2.38	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-HBT.27.2.38.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-HBT.27.2.39	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-HBT.27.2.39.1	*Identify habitat condition of the estuary*					
SONCC-HBT.27.1.41	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.27.1.41.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-HBT.27.1.41.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-HBT.27.2.42	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-HBT.27.2.42.1	*Determine best indicators of estuarine condition*					
SONCC-HBT.5.1.10	Passage	No	Improve access	Remove barriers	Population wide	3
SONCC-HBT.5.1.10.1	*Inventory and prioritize barriers*					
SONCC-HBT.5.1.10.2	*Remove barriers*					
SONCC-HBT.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Educate stakeholders	Population wide	3
SONCC-HBT.7.1.6.1	*Develop an educational program that teaches landowners about alternative land use and opportunities such as carbon credits and conservation easements*					
SONCC-HBT.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	3
SONCC-HBT.7.1.7.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-HBT.7.1.7.2	*Develop watershed-specific guidance for managing riparian vegetation*					
SONCC-HBT.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	3
SONCC-HBT.7.1.8.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-HBT.7.1.8.2	*Thin, or release conifers, guided by prescription*					
SONCC-HBT.7.1.8.3	*Plant conifers, guided by prescription*					
SONCC-HBT.7.1.9	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-HBT.7.1.9.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.10.2.16	Water Quality	No	Reduce pollutants	Reduce point- and non-point source pollution	Population wide	3
SONCC-HBT.10.2.16.1	*Identify pollution sources, and develop a strategy to meet objective*					
SONCC-HBT.10.2.16.2	*Implement strategy to prevent pollution*					
SONCC-HBT.10.2.17	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	3
SONCC-HBT.10.2.17.1	*Promote pollution reduction*					
SONCC-HBT.10.2.18	Water Quality	No	Reduce pollutants	Set standard	Elk Creek, Freshwater Creek, Jacoby Creek	3
SONCC-HBT.10.2.18.1	*Develop TMDLs for 303(d) listed water bodies*					

26. Lower Eel and Van Duzen River Population

- Southern Coastal Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 7,900 Spawners Required for ESU Viability
- 726 mi²
- 394 IP km (244 mi) (50% High)
- Dominant Land Uses are Timber Harvest and Agriculture
- Principal Stresses are 'Altered Sediment Supply' and 'Impaired Estuary/Mainstem Function' and Impaired Water Quality
- Principal Threats are 'Roads', 'Timber Harvest', and Diversions

26.1 History of Habitat and Land Use

Historically, the Lower Eel/Van Duzen River subbasin consisted primarily of late-seral redwood/Douglas-fir (coniferous) forests with limited open oak woodland/prairies farther inland at higher elevations. Beginning near the turn-of-the twentieth century, logging along stream corridors and easily accessible areas led to development of hardwood-dominated forests and reduced large wood recruitment potential to streams. In addition, floodplain and estuarine wetland areas were cleared, diked, and drained to provide land for agriculture and urban development. Technological developments after World War II enabled logging and road building in steeper, more landslide prone areas. This caused excessive sediment delivery to streams, especially following large floods in 1955 and 1964, resulted in shallow pools and wide streams. Levees were constructed along portions of the lower Van Duzen and Eel rivers to protect agricultural land and urban areas from flooding.

Since 1922, Eel River flows have been regulated and water has been diverted to the Russian River for hydroelectric power and agriculture via the Potter Valley Project. There are two major dams on the Upper Eel River associated with the Potter Valley Project: the Cape Horn Dam which impounds the 700 acre-foot Van Arsdale Reservoir and the Scott Dam which impounds the 94,000 acre-foot storage reservoir, Lake Pillsbury. Sacramento pikeminnow were introduced to Lake Pillsbury in 1980 (California Department of Fish and Game (CDFG) 1997b), and have since colonized the entire Eel River watershed. This predator thrives in the warmer waters created by the reservoir, the lower instream flows in the Eel River, a wide and shallow channel caused by high sediment load, and degraded riparian forests.

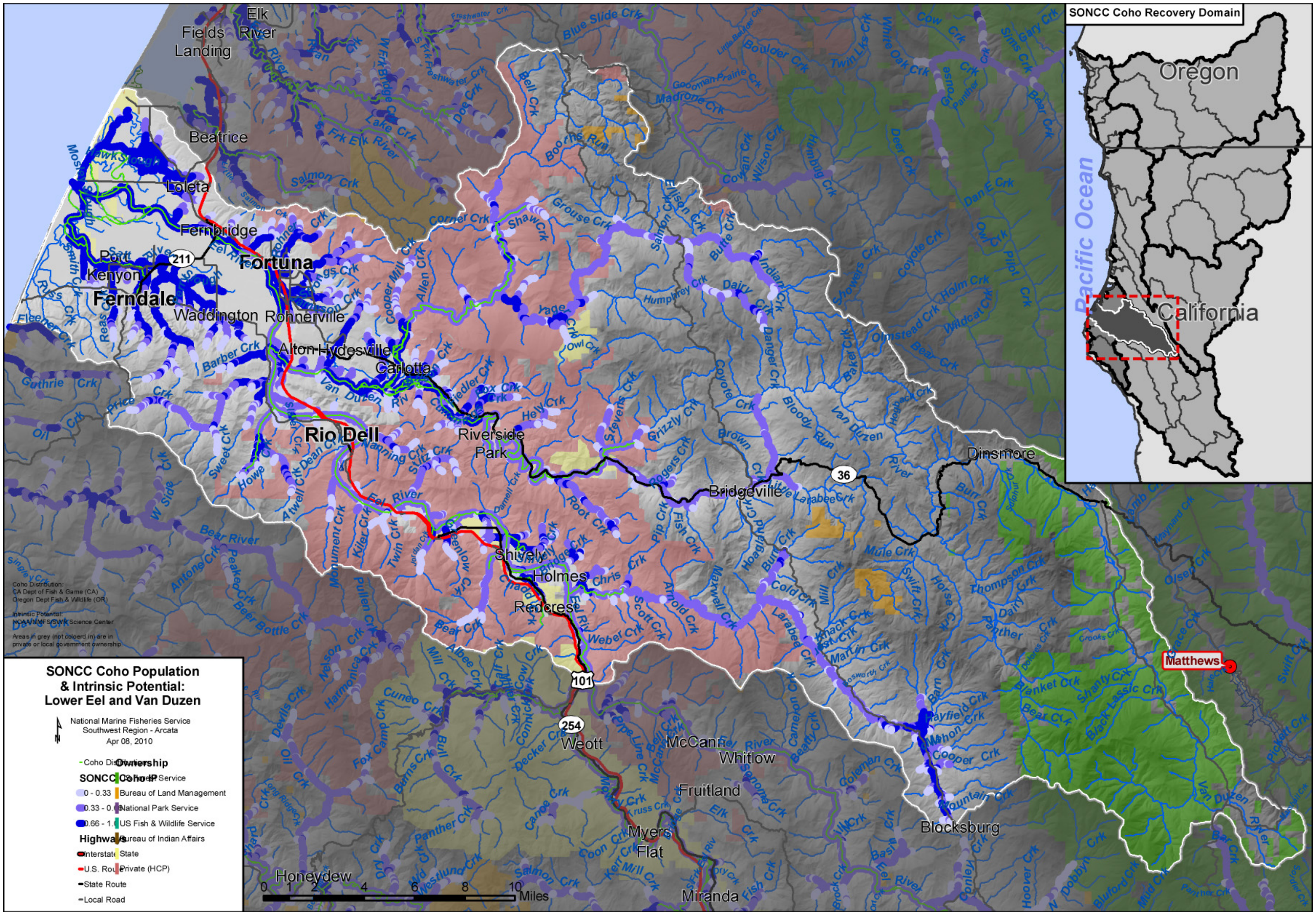

Figure 26-1. The geographic boundaries of the Lower Eel and Van Duzen rivers coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006. Grey areas indicate private ownership.

Pools that were refuges and reaches that had large wood are lacking because of sedimentation, dams, historic wood removal from stream channels, and degraded riparian forests. These pools and large woody debris would have provided juvenile coho salmon some protection from native predators and the pikeminnow.

Establishment of rural residences, smaller ranches, and agriculture increased the need for water. Currently, much of this demand is accommodated through in-stream diversions or shallow wells, which have lowered stream flows during summer low-flow periods. The Potter Valley Project also diverted 160,000 acre feet of water from the Eel River to the Russian River prior to 2002 (FERC 2000).

In the estuary, salt marsh was drained and riparian vegetation cleared to convert tidelands to pasture (Figure 26-2). The estuary appears to be mixing during the dry months and is stratified, or creates a "salt wedge" during wetter months (Gossard 1986). Tideland reclamation and the construction of dikes and levees have changed the function of the estuary considerably. Slough and creek channels that once meandered throughout the delta are now confined by levees, sufficiently slowing flow to a point that many have become filled with sediment. Remnant slough channels are visible throughout the delta. The estuary and tidal prism have been reduced by over half of their original size (CDFG 2010b).

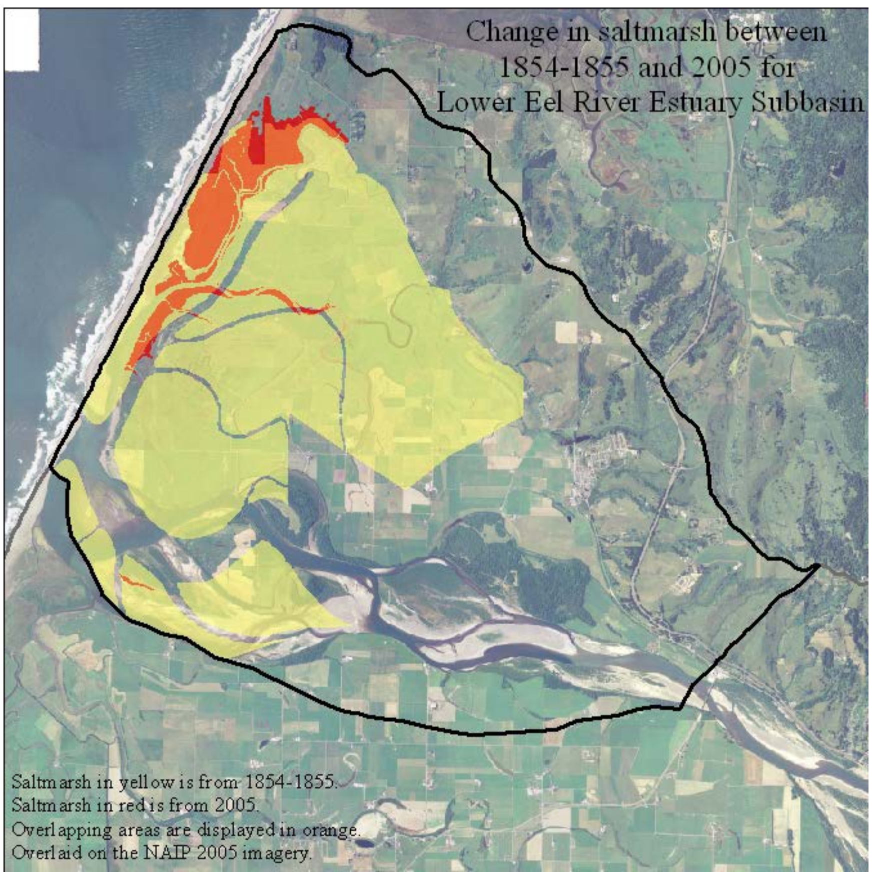

Figure 26-2. Change in salt marsh in the Eel River estuary between 1854 and 2005.

26.2 Historic Fish Distribution and Abundance

Historically, coho salmon occupied much of the Lower Eel and Van Duzen River subbasin. However, information on historic coho salmon use is limited. Coho salmon have been observed intermittently over the past few decades, but absent in many tributaries historically occupied by coho salmon. In 1965, CDFG estimated the escapement to be 500 each for the mainstem Eel River and the Van Duzen River (CDFG 1965). Two decades later, the escapement estimate for 1984 to 1985 declined to 200 for each (Wahle and Pearson 1987).

Survey records show that coho salmon spawned in Carson, Bear, Chadd, and Shaw creeks (CDFG 1994, Brown et al, 2007). In a recent 2011 spawning survey conducted by the CDFG in Fish Creek, a tributary to Lawrence Creek (and Van Duzen River), a total of eight adult coho salmon were observed spawning in a 1-km reach of IP habitat. If multiple surveys had been conducted in a more systematic fashion, it is likely that several more adult coho salmon spawners may have been detected in Fish Creek. This recent observation provides some optimism that the status of coho salmon in the population may be more stable than previously believed. The poor status of this population may be more indicative of a lack of survey effort rather than a lack of fish.

In addition, juveniles were observed in the Van Duzen River, Grizzly, Cummings, Cuddeback, Fiedler, Howe, Wolverine Gulch, Oil, Atwell, Newman, Poison Oak, Strongs, Reas, Francis, Palmer, Rohner, and Jordan creeks (CDFG 1972, Brown and Moyle 1991, PALCO 2006a, Crowser 2005, Downie and Gleason 2007) as well as the Eel River estuary (Puckett 1977), the slough portion of Salt River (CDFG 1977), Centerville Slough (CDFG 1984) and North Slough channels (Puckett 1977). Estuary use by juveniles has been observed in multiple seasons from winter to summer (Puckett 1977, CDFG 2010b).

High IP reaches are found in the Salt River watershed, the lower Van Duzen River, lower Eel River and estuary sloughs, and upper Larabee Creek (see Table 26-1 for all tributaries with instances of high IP habitat).

Table 26-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Stream Name	**Stream Name**	**Stream Name**
Reas Creek	Rohner Creek	Burr Creek
Francis Creek	Strongs Creek	Boulder Flat Creek
Williams Creek	North Fork Strongs Creek	Cooper Creek
Salt River	Jameson Creek	Van Duzen River
Sweet Creek	Rogers Creek	Yager Creek
Howe Creek	Stevens Creek	Cummings Creek
Atwell Creek	Root Creek	Hely Creek
Manning Creek	N. Fk. Yager Creek	Fox Creek
Price Creek	Dairy Creek	Wilson Creek
Nanning Creek	Lawrence Creek	Cuddeback Creek

Hawks Slough	Blanton Creek	Fiedler Creek
Van Duzen River	Yager Creek	Chadd Creek
Penny Slough	Cooper Mill Creek	Bridge Creek
Coffee Creek	Larabee Creek	Greenlow Creek
Oil Creek	Carson Creek	Jordan Creek
Barber Creek	Thurman Creek	Stitz Creek
Eel River	Chris Creek	Burr Creek

26.3 Status of Lower Eel and Van Duzen River Coho Salmon

Spatial Structure and Diversity

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 20 coho salmon per-IP km of habitat are needed (7,900 spawners total) to approximate the historical distribution of Lower Eel/Van Duzen River coho salmon. The current distribution of spawners is unknown, but expected to be extremely limited because the habitat has been severely degraded in most of the high to moderate IP reaches. The Lower Eel/Van Duzen River coho salmon population is at a high risk of extinction because its spatial structure and diversity are very limited compared to historical conditions.

Population Size and Productivity

The Lower Eel/Van Duzen River coho salmon population size is unknown, but extremely reduced compared to historic levels. Breeding groups have been lost or severely depressed in some Lower Eel/Van Duzen River streams (CDFG 2002b). Population growth rate is unknown, but expected to be negative in most years. Therefore, the Lower Eel/Van Duzen River coho salmon population is at an elevated risk of extinction given the extremely low population size and negative population growth rate.

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 394 coho salmon must spawn in the Lower Eel/Van Duzen River each year to avoid such effects of extremely low population sizes.

Extinction Risk

The Lower Eel/Van Duzen River coho salmon population is not viable and at high risk of extinction because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Lower Eel/Van Duzen coho salmon population is a non-core "Functionally Independent" population within the Southern Coastal diversity stratum, meaning that it has a high likelihood of persisting in isolation over a 100-year time scale with minimal demographic influence from adjacent populations. The recovery target for the Lower Eel/Van Duzen population is to recover the population to at least a moderate risk of extinction (see chapter 4). Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU.

Adjacent Mainstem Eel, Middle Fork Eel, South Fork Eel, Middle Mainstem Eel, and Upper Mainstem Eel populations benefit the Lower Eel/Van Duzen population as a source for genetic diversity, repopulation, and provide refugia during schooling in pools and the ocean. The tributaries and estuary located within this population may serve as essential non-natal rearing habitats for all populations in the Eel River watershed. Large-scale movements into non-natal streams have been documented in the Klamath River, tributaries to Humboldt Bay, and a variety of other locations where the 'nomad' life history pattern has been documented (Koski 2009). It is likely that Lower Eel and Van Duzen tributaries and estuarine habitats are key non-natal habitat for the entire Eel River watershed.

26.4 Plans and Assessments

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004.

California Department of Fish and Game Eel River Salmon and Steelhead Restoration Action Plan

In 1997, the California Department of Fish and Game completed their assessment of the Eel River watershed and provided recommendations for restoration of salmonid stocks. The issues and recommended action plans for the Eel River watershed are incorporated into this plan. Primary recommendations include removing barriers, reducing sediment inputs, improving riparian forest conditions, reducing water withdrawals, habitat enhancement, and controlling Sacramento pikeminnow.

The North Coast Watershed Assessment Program (NCWAP)
http://www.coastalwatersheds.ca.gov

Lower Eel River Basin Assessment Report

The NCWAP Lower Eel River Basin Assessment identifies limiting factors for anadromous salmonids including, estuarine conditions, lack of habitat complexity, increased sediment levels, and high water temperatures.

Environmental Protection Agency (EPA)

In 1999 and 2007, the EPA published the final Total Maximum Daily Loads (TMDL) for the Van Duzen and the Lower Eel River watersheds, respectively. The North Coast Regional Water Quality Control Board is required to develop measures which will result in implementation of these TMDLs in accordance with the requirements of 40 CFR 130.6 EPA's final TMDL identifies their water quality objectives for these watersheds.

Humboldt Redwood Company (HRC)

Habitat Conservation Plan

Pacific Lumber Company (PALCO) finalized a Habitat Conservation Plan (HCP) covering SONCC coho salmon and their habitats in 1999. Since then, in 2008 the Humboldt Redwood Company (HRC) acquired the bankrupt PALCO and formally adopted the PALCO HCP. The HCP requires that forest roads are treated to minimize erosion at the rate of 75 miles of road treatments per year, resulting in 1,500 miles of road treatments in the first two decades of the HCP permit term. The HCP also identifies measures which will help trend aquatic habitat conditions towards 'properly functioning conditions'.

26.5 Stresses

Table 26-2. Severity of stresses affecting each life stage of coho salmon in the Lower Eel and Van Duzen River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Sediment Supply[1]	Very High	Very High	Very High[1]	Medium	Very High	Very high
2	Impaired Estuary/Mainstem Function[1]	-	Medium	Very High[1]	High	Medium	High
3	Degraded Riparian Forest Conditions	-	High	High	High	High	High
4	Impaired Water Quality	Medium	High	High	High	High	High
5	Increased Disease/Predation/Competition	Low	High	High	Very High	Low	High
6	Lack of Floodplain and Channel Structure	Medium	High	High	High	High	High
7	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
8	Barriers	-	Low	Low	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low
10	Altered Hydrologic Function	Low	Low	Low	Low	-	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Based on the type and extent of stresses and threats affecting the population as well as the limiting factors influencing productivity, it is likely that the juvenile life stage is the most limited. Juvenile coho salmon summer and winter rearing success is most limited by elevated water temperatures, decreased flows resulting from the Potter Valley Project and other diversions, and an increased sediment supply that deteriorates the habitat quality in the tributaries. All of these factors contribute to preferable conditions for pikeminnow and a reduction in the size and quality of the estuary. Complexity of freshwater channels and a diverse estuary with suitable cover and deep channels and sloughs is important to juvenile coho salmon, increasing their size and fitness prior to ocean entry, and overall marine survival.

Complex stream channels with deep pools and woody structure as well as tidally influenced wetlands with off channel ponds are important refuge areas for juvenile coho salmon. Properly functional rearing habitat buffer other stresses affecting the population. Juvenile coho salmon would be more protected against predation, competition, and warm mainstem water temperatures if there were additional refugia areas.

Currently, refugia areas for coho salmon are limited in the Lower Eel/Van Duzen River population area. CDFG noted that Oil Creek has a high potential for providing refugia (Downie and Gleason 2007). To some extent, the estuary could serve as a refuge from the poor conditions in the mainstem if tidegates and levees did not prevent juvenile salmon from reaching that habitat.

Altered Sediment Supply

Excessive sediment poses a medium stress to smolts and a very high stress to all other life stages of coho salmon in this population. Except for two sampling sites with moderate percentages of fines (<1mm), all sampling sites throughout the lower Eel and Van Duzen rivers have excessive levels of fines and sand (>6.4 mm). High sediment loads result in excessive embeddedness and reduces pool depths. High sediment levels impair feeding, simplify habitat, reduce reproductive success, and result in adverse physiological stress responses. The EPA listed the Lower Eel and the Van Duzen rivers as impaired by sediment. The Eel River is one of the most erodible watersheds in the United States (Brown and Ritter 1971) because of the highly active tectonic setting, highly erodible soils in the area, and high precipitation. The Eel River carries fifteen times as much sediment as the Mississippi River and more than four times as the Colorado River (Brown and Ritter 1971). Anthropogenic activities in the Lower Eel/Van Duzen River population have exacerbated these naturally high sediment loads. A study of the continental shelf deposits offshore from the mouth of the Eel River indicates that there has been a sudden, three-fold increase in the rate of sedimentation since 1954 (EPA 2007b). Most of the deep pools that existed in the estuary were filled by sediment brought by the flood waters of 1964. Excessive amounts of sediments generated by land use are still delivered to the estuary from upstream sources (EPA 2007b).

Aggradation has interrupted the connectivity of surface flow in several areas. The Van Duzen River is often isolated from the Eel River by subsurface flows in late summer and early fall. An over abundance of gravels and sediment are deposited at the confluence of the Van Duzen and Eel River which results in sub-surface flows and dry channels (Downie and Gleason 2007). Sedimentation has also restricted access to the Salt River downstream of Williams Creek and has severely restricted fish access to Salt River tributaries. Salmon Forever has been monitoring Francis Creek since January 2007, and preliminary results show maximum turbidity levels have reached 2200 ntu during a single storm. Combined with flow data, 2200 ntu is equivalent to 8.5 tons of sediment moving downstream every 10 minutes (Downie and Gleason 2007).

Impaired Estuary/Mainstem Function

This stress refers to the estuary and mainstem conditions in the Eel River, since this population is a part of a larger basin containing multiple populations (see chapter 3 for further description of this stressor). Conditions in the Eel River mainstem and estuary are important to this population since all salmon and steelhead that originate from the Eel River migrate to and from the ocean through the mainstem Eel River and Eel River estuary.

The Eel River estuary was once a highly complex and extensive habitat area that played a vital role in the health and productivity of all Eel River coho salmon populations. The degraded function of the Eel River estuary and mainstem migratory corridor today constitutes a very high stress for juveniles, a high stress for smolts, medium stress for adults, and a medium stress for fry. The Eel River estuary is severely impaired because of past diking, and filling of tidal wetlands for agriculture and flood protection. Approximately 60 percent of the estuary has been lost through the construction of levees and dikes and CDFG (2010) estimates that only 10% of salt marsh habitats remain today. The estuary once supported a high degree of estuarine habitat and rearing potential, but very little of that historic function still exists. The function of the estuary (e.g., rearing, refugia, ocean transition) for coho salmon that originate in the Lower Eel/Van Duzen River is very important given the degraded habitat conditions and predation and competition from non-native Sacramento pikeminnow occurring upstream of the estuary in the mainstem river. Juveniles, smolts, and adults transitioning through mainstem and estuarine habitat are stressed by the degraded conditions in these migratory habitats. Juveniles and smolts suffer from the lost opportunity for increased growth, which would improve their survival at ocean entry. The loss and degradation of the formally-extensive and complex estuarine and mainstem habitat is a high stress for the population, with the most affected life stages being juveniles, smolts, and adults due to the degradation of rearing and migratory habitat.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions exist across the subbasin, and present a high stress to fry, juvenile, smolt, and adult coho salmon. Where data exist, streamside canopy cover shows a range of conditions, with some good cover in the headwater areas of some tributaries, primarily in the Lawrence Creek watershed, and poor cover and shade conditions in the mainstem channel of all of the major tributaries in the Lower Eel/Van Duzen River watershed, and in the mainstem of the Lower Eel downstream of about Alton, California. Riparian habitat has somewhat rebounded from past large flood events (e.g., 1964). However, even where streamside canopy cover is good, it consists of open and hardwood dominated riparian forest conditions. Mature coniferous riparian forests provide the size and amount of large wood necessary for coho salmon rearing habitat, shade streams, reduce sediment delivery, and provide terrestrial subsidies. Hardwood and small conifer-dominated riparian forests provide limited large wood recruitment into the Lower Eel/Van Duzen River.

Riparian corridors in the Salt River watershed are, in places, lacking riparian vegetation; particularly the tributaries in the wildcat geological formation. The trans-delta reaches of the Salt River tributaries, such as in Reas Creek, tend to have little to no riparian vegetation.

Sudden oak death (SOD) is an exotic pathogen affecting almost all native species of plants, shrubs, and trees. SOD is in epidemic stages in the population area and upstream of the population area. Because the SOD pathogen is water borne and can travel downstream in watercourses, the likelihood of SOD outbreaks in the population area are high. One of the largest areas infected by SOD occurs near Redway and is growing at a very fast rate. SOD was recently detected in 2011 in tributaries to the Van Duzen River.

Impaired Water Quality

Impaired water quality, specifically high water temperature, poses a high stress to all rearing life stages and a medium stress to eggs. The Lower Eel River and the Larabee Creek watershed are listed as impaired for elevated temperature under section 303(d) of the Clean Water Act. Water temperature in the Lower Eel/Van Duzen River and its tributaries approach lethal levels in a number of stream reaches and is stressful in most others, and severely limits the amount of habitat available to rearing coho salmon. An airborne thermal infrared remote sensing study of the main channel, as well as in-water monitoring, indicate water temperature is near lethal levels for rearing coho salmon in most of the mainstem of the Lower Eel River (EPA 2007b). However, modeling efforts show these water temperatures are only marginally higher than they would be with full riparian cover; because the mainstem of the Lower Eel is naturally very wide, much of it was likely not shaded even before the 1800s (EPA 2007b). Tributaries in the coastal zone such as Salt River are important because of their cold water contribution to the mainstem. Temperature problems in the tributaries were attributed to inadequate shading due to removal of riparian vegetation, and to excess sediment which widens streams, fills pools, and makes the river shallower. The loss of deep pools removes cooler-water refugia, which coho salmon could use to persist in areas with otherwise uninhabitable water temperatures.

Additionally, water quality problems from agricultural runoff have been identified in the Salt River watershed and conductivity, turbidity, and dissolved oxygen may be limiting factors in the middle subbasin. Therefore, water quality is likely a limiting factor, specifically nutrient enrichment, excess sediment, elevated water temperatures, and low dissolved oxygen.

Increased Disease/Competition/Predation

Competition and predation from non-native California roach and Sacramento pikeminnow poses a high stress to fry and juveniles and a very high stress to smolts. These invasive species have the greatest impact in watersheds such as the Lower Eel/Van Duzen, with the most impaired habitat conditions, because the altered conditions favor production of these non-native species over indigenous salmonids.

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure is a high stress for juveniles, smolts, adults, and fry; and a medium stress for eggs. The floodplains and channels have been degraded due to excessive sediment loads, coupled with the paucity of large wood and riparian vegetation. Except for one reach with fair levels of embeddedness, all surveyed reaches of Yager Creek and smaller tributaries to the Eel River have excessive embeddedness. These same surveyed reaches have mostly fair (2.01 to 3 ft) or poor (<2 ft) pool depths and mostly poor pool frequencies (<35 percent by length). Roads constrict the channel where they occur parallel to the stream. In addition, levees in the Lower Eel River from Fortuna to the Pacific Ocean significantly alter floodplain and channel structure (through altered connectivity) and significantly reduce the size of the estuary. Habitat complexity, via pools, large wood cover, and floodplains, is essential for juvenile rearing to optimize forage, avoid predation, and access thermal and velocity refuges.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Barriers

Barriers to fish passage do not present a major impediment to restoration and recovery of the Lower Eel/Van Duzen River coho salmon population, as reflected by their low stress ranking. Tidegates that separate the estuary from the river can be problematic, however, because they can block juvenile access to the estuary and therefore make it more difficult for them to utilize the estuary as a refuge from poor habitat conditions in the river. In addition, tide gates reduce the tidal prism of the estuary which is important for maintaining water quality, channel maintenance, and overall estuarine function.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Lower Eel/Van Duzen River population area. Hatchery-origin coho salmon may stray into the population area, but the proportion of spawning adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin

Altered Hydrologic Function

Altered hydrologic function (the timing and availability of water) poses a low stress to coho salmon. Base flows in tributaries to the Lower Eel/Van Duzen River are affected by rural and urban water withdrawals, but it is unknown whether these withdrawals alter water availability to the extent that it harms coho salmon or their habitat. Due to all the land changes that have occurred since the 1800s, the way that water runs off the land is altered compared to historic conditions; overall, peak flows are higher and base flows are lower.

Diversion records for the Eel River have been published for the 91 years from 1910 to 2000. During the high flow months of January, February, and March only 6 percent, 20 percent, and 15 percent of unimpaired flows have been diverted, respectively. During the lower flow months of June, July, August, and September, 81 percent, 88 percent, 69 percent, and 64 percent of the unimpaired flows are diverted, respectively (Center for Environmental Economic Development 2002). The Potter Valley Project diverted as much as 160,000 acre feet of water from the Eel River and into the Russian River prior to 2002 (FERC 2000).

26.6 Threats

Table 26-3. Severity of threats affecting each life stage of coho salmon in the Lower Eel and Van Duzen River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	Very High	Very High
2	Timber Harvest	Very High	Very High	Very High	Very High	Very High	Very High
3	Dams/Diversion	High	High	High	Medium	High	High
4	High Intensity Fire	High	High	High	Medium	High	High
5	Invasive Non-Native/Alien Species	Low	High	High	High	Low	High
6	Agricultural Practices	Medium	High	High	High	Medium	High
7	Channelization/Diking	Medium	High	High	High	Medium	High
8	Urban/Residential/Industrial	Medium	High	High	High	High	High
9	Mining/Gravel Extraction	Medium	Medium	Medium	Medium	Medium	Medium
10	Climate Change	Low	Low	High	Medium	Medium	Medium
11	Fishing and Collecting	-	-	-	-	Medium	Medium
12	Hatcheries	Low	Low	Low	Low	Low	Low
13	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low

Roads

Roads constitute a very high threat across all life stages. Road density is very high (>3 miles per square mile) in the Lower Eel/Van Duzen River subbasin. Unpaved roads deliver large volumes of sediment to stream channels. Roads also alter the hydrology of stream systems resulting in higher peak flows and lower summer base flows.

Timber Harvest

Timber harvest is a very high threat to all life stages. Many of the changes that have occurred to instream and riparian conditions in the Lower Eel/Van Duzen River reflect legacy effects of more intensive harvest from previous decades. However, given the percentage of the watershed that is privately owned by timber companies and actively managed as such, future timber harvest activities will continue to exacerbate the stresses caused by legacy logging activities. Nearly half of the subbasin has been logged on over 35 percent of its area, and continuing harvest on these areas has the potential to affect high IP-areas downstream by contributing to sediment deposition and reducing sources of large wood.

Dams/Diversions

Dams and diversions pose a medium threat to smolts and a high threat to all other life stages of coho salmon. Scott Dam and the Potter Valley Project altered the historic hydrologic regime under which the Lower Eel/Van Duzen River coho salmon evolved. In addition, localized water diversions for rural residential and agricultural use reduce streamflow during juvenile rearing periods. Tide gates restrict juvenile coho salmon use of the estuary and levees reduce the tidal prism necessary for flushing the high sediment load to the ocean (Figure 26-3 and Figure 26-4).

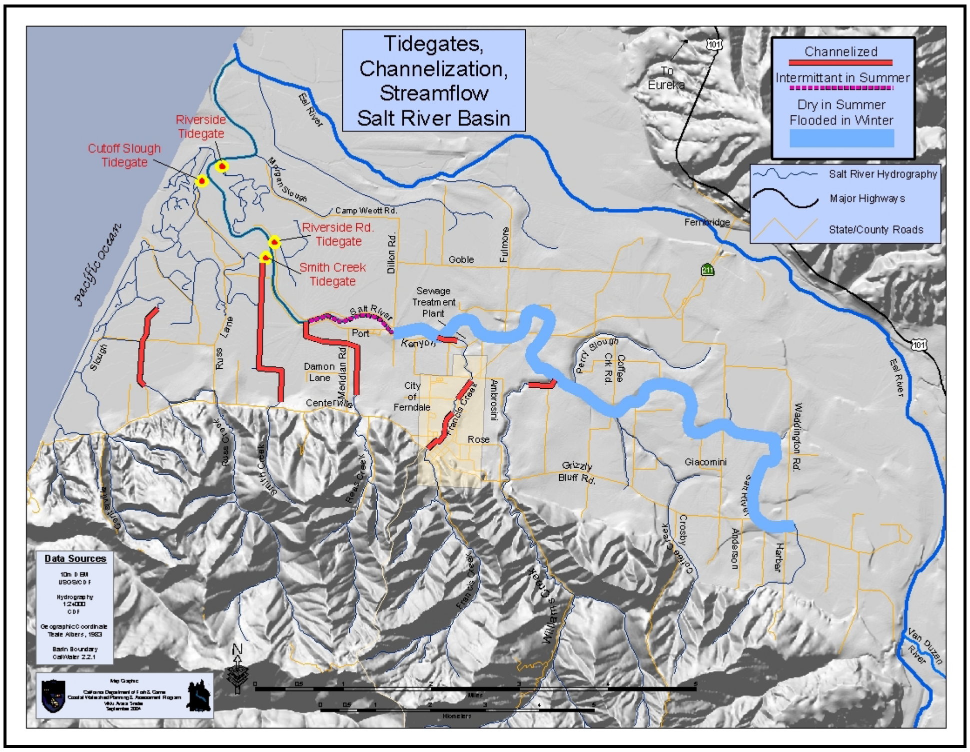

Figure 26-3. A map of tide gates and channelization in the Salt River watershed.

Figure 26-4. Photo of a tidegate on Cutoff Slough in the Lower Eel River estuary.

High Intensity Fire

Fires pose a medium threat to smolts and a high threat to all other life stages. The dense understory vegetation throughout the population area increases the probability for high intensity fires to alter sedimentation processes as well as riparian vegetation characteristics.

Invasive/Non-native Species

Sacramento pikeminnow thrive in the degraded habitat conditions in the Lower Eel/Van Duzen River which favor production of the non-native Sacramento pikeminnow, resulting in significant levels of competition and predation on coho salmon. The non-native Sacramento pikeminnow is a threat to fry, juveniles, and smolts because they compete with and prey on the young coho salmon. Sacramento pikeminnow were introduced to Lake Pillsbury in 1979 (Brown and Moyle 1997), and has spread throughout the entire Eel River watershed. The warm water temperatures in the Eel River and Lake Pillsbury make this voracious predator thrive in this system. The presence of the Sacramento pikeminnow in Lake Pillsbury makes eradication of this species extremely difficult.

Cordgrass (*Spartina densiflora*) is an introduced and invasive salt marsh plant that has spread across the estuarine wetlands. *S. densiflora* tends to displace native marsh species, can exacerbate sediment accumulations in wetlands, and may cause other undesirable changes to the estuarine ecosystem. Eradication projects have cleared areas of invasive cordgrass around Humboldt Bay. No efforts have been planned to control *S. densiflora* in the Eel River estuary. There are also a number of other invasives including non-native eel grass and reed-canary grass that may affect the success of restoration actions.

Agricultural Practices

Grazing occurs throughout the population area and increases sediment generation and delivery. In addition, much of the estuary is directly influenced by agriculture in historical tidelands. Agricultural land makes up 28 percent of the Lower Eel River subbasin, and increases in area closer to the mouth (Downie and Gleason 2007). Livestock have unrestricted access to many of the Lower Eel River tributaries and estuary sloughs, resulting in stream bank erosion. Much of the Lower Eel River subbasin has been cleared of riparian vegetation to create pastureland for cattle, and waste from the dairy industry has affected water quality. In the past, waste from dairies would flow into low lying areas, which are often former slough channels. During times of heavy precipitation, these often became active sloughs that would transport waste into the estuary.

An excess of nutrients can degrade water quality by fueling toxic algal blooms that increase biological demand either through respiration or decomposition. Algae blooms are naturally occurring, however, excess nitrogen can increase the extent and severity of effects (i.e., decreased dissolved oxygen). The Van Duzen River has chronic issues with toxic blooms of blue-green algae which have led to the deaths of several dogs. Blue green algal blooms are related to excess nitrogen and poor water quality conditions.

Grazing cattle is common in many of the tributaries and grassy openings throughout the population area, including the valley bottoms and ridges of the mainstem Eel and Van Duzen rivers. Grazing beef or dairy cattle is the most common land use in the lower sub-basin and estuary (CDFG 2010b), where rich grasslands thrive in the delta of the Eel and Van Duzen rivers. Although this area has rich grasslands which can support a significant cattle industry, the effects of cattle grazing are very apparent. There are only a few areas with riparian exclusion fencing and livestock are commonly allowed unrestricted access to the creek. .

Channelization/Diking

Channelization and diking is identified as high threat in the population area. The existence of extensive channelization and diking in the Lower Eel River, tributaries to the Eel River, especially in the Salt River watershed, and the estuary severely limits the function of the floodplain and estuary for production of coho salmon. For example, Reas Creek is contained in levees the entire length across the delta, and realigned with two 90 degree turns. The channelization and lengthening of the trans-delta reach of Reas Creek is suspected of causing problems related to sediment deposition and discharge within Reas Creek as well as in the Salt River. Williams Creek was levied in 1999 from the mouth to 2500 feet upstream. In addition, Williams Creek was diverted from the Salt River and now drains to the Eel River through the Old River, resulting in altered hydrology and sediment transport in the Salt River. Rohner Creek has been realigned and channelized through the City of Fortuna.

In 2006, the CDFG received permits to expand, raise, and widen the levee network in the vicinity of the Eel River Wildlife Area to address breaches of the levees which occurred in 1994 and 1998. The levees were enhanced to ensure that tidal action would not compromise the integrity of the levees and also to assist in keeping freshwater impoundments from being exposed to saltwater. Levees in the Eel River estuary are known to reduce the extent and intensity of tidal flushing which causes sedimentation and the resulting widening and reductions in depth. The Eel River estuary appears to be shrinking due to continued sedimentation and the number of species it harbors has apparently diminished from historic numbers (Puckett 1977). The exchange of tide water scours sediment and transports it to the ocean which helps maintain the depths of estuarine channels. In the late 1890's a court agreed that the construction of levees and the ensuing reduction of the tidal prism were responsible for the filling of the channels near the Salt River area (CDFG 2010b).

The Humboldt County Resource Conservation District is the lead agency on the Salt River Ecosystem Restoration Project. In the late 1800's the Salt River was a functioning river and large enough to accommodate small ocean vessels and steamers. At Port Kenyon, the Salt River was approximately 200 feet wide and 15 feet deep. Now the Salt River is so small that a person could jump over it. Over time fine sediments have eroded from the surrounding Wildcat Hills into the tributaries and deposited in the Salt River channel. Vegetation has sprouted up in the channel which traps more sediment, impedes fish passage and increases flooding on the surrounding agricultural lands, roads, and residences.

Reducing the amount of sediment that reaches the tributaries and the Salt River is one step in creating an open and functioning channel. This ecosystem-scale project includes a large tidal wetland restoration component that will create a succession of biologically rich and diverse tidal wetland habitats, including transitional wetlands and adjacent uplands as part of a sustainable estuary system. To offer some insight on the level of sedimentation involved, consider the following: in hydrologic year 2010 the annual suspended sediment yield from the Francis Creek watershed was 38 million pounds. This equates to an annual suspended sediment yield of 6091 tons/sq. mile. By comparison, the sediment impaired Freshwater Creek and Elk River watersheds in Humboldt County have yields of 300-600 tons/sq. mile/year, and the Eel River carries 4,330 tons of sediment/sq. mile/year (Buffleben 2009).

Urban/Residential/Industrial Development

Urban/residential/industrial development is a high threat because much of the watershed with high IP value is located in and around the cities of Ferndale and Fortuna. Future growth of this area is likely, with northerly migration from southern metropolitan areas due to declining water supplies. In addition, further rural residential development is likely as large agricultural holdings are subdivided into smaller ranches. All of this will combine to further increase road building, land clearing, and other development.

When flows are sufficiently high, the Eel River floods the treatment ponds of the Fortuna Wastewater Treatment Plant (Downie and Gleason 2007). In the winter months, the effluent from the Ferndale wastewater treatment plant is directed into Francis Creek, which historically had sufficient flow to meet dilution requirements year round. Sediment deposition has reduced the cross sectional area of the creek and now the wastewater treatment plant effluent exceeds one percent of receiving flows during winter months, which is a violation of Waste Discharge Requirements. The wastewater treatment facility has accumulated 241 water quality violations since 1996 (Spencer Engineering 2004). Improvements to the existing facility have been made in recent years and the number of water quality violations has declined. In addition, the City of Ferndale and the RWQCB have agreed on a design for tertiary treatment of effluent which will result in an improvement to water quality conditions in Francis Creek and the Salt River.

Treatment and percolation ponds are also constructed at the Town of Scotia to ensure that effluents from the mill and town site are allowed to settle and percolate into the sub-surface zones of the gravel bar to comport with NCRWQCB requirements, which does not allow treated or untreated effluents to be discharged into the Eel River. As high winter flow regimes approach in the fall, the percolation ponds are dismantled and allowed to be discharged into the Eel River when flows become high enough to capture the ponds.

Mining/Gravel Extraction

Past gravel mining in the Lower Eel subbasin likely contributed to braiding and flattening of the Eel River between the confluence with the Van Duzen River to one mile downstream of Fernbridge (Humboldt County 1992). A shallow, wide channel provides less cover from predation, less food, and higher water temperatures for juvenile fish as the channel is often decoupled from riparian vegetation. Braiding reduces water depth and can become a migration barrier for adult fish, sometimes leading to stranding on shallows and mortality. A significant level of gravel extraction still occurs in the Lower Eel/Van Duzen River, but is conducted with State and Federal oversight. The medium threat ranking reflects sensitivity of the channel to additional disturbances (i.e., lack of floodplain and channel structure). However, gravel extraction has been used successfully to address some of the problems associated with the high sediment load in the Lower Eel/Van Duzen River including an adult migration barrier that occasionally develops at the Van Duzen/Eel River confluence. Gravel mining methodologies have evolved over time to accommodate the narrowing and deepening of channels by using wet trenching techniques.

Climate Change

Climate change poses a medium threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. Although the current climate is generally cool, modeled regional average temperature shows a moderate increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 1.6 ^{o}C in the summer and by 1 ^{o}C in the winter. Annual precipitation in this area is predicted to trend downward over the next century. Snowpack in upper elevations of the Eel River basin, upstream of the Lower Eel and Van Duzen river subbasin, will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009). Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Rising sea level may also impact the quality and extent of wetland rearing habitat in the estuary. Wetlands could migrate inland with rising sea level but there are few places that are not armored and would allow for this migration and sea level may rise too quickly for adaptation of wetlands. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, with all populations in the ESU adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Lower Eel and Van Duzen Rivers. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Lower Eel/Van Duzen River population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

Road-stream Crossing Barriers

Barriers pose a low threat. However, there are five known barriers to fish habitat, including one on Francis Creek at Port Kenyon road, two on Barber Creek, and two more on an unnamed tributary extending north from the mainstem west of Carlotta, CA.

A culvert on Mill Creek does not meet CDFG and NMFS fish passage guidelines. Other creeks with possible fish passage restrictions include Palmer, Dean, Price, and Adams.

26.7 Recovery Strategy

The degraded condition of the Lower Eel/Van Duzen River population area, combined with the depressed coho salmon population size and restricted distribution significantly increases the risk of extinction of this important, coastal coho salmon population. Most of the population area is in private ownership, much of the high IP areas are in developed areas, and predation and competition from non-native Sacramento pikeminnow severely limits juvenile survival. Restoration activities that improve estuarine habitat, increase floodplain connectivity, reduce sediment inputs, increase riparian vegetation, increase summer instream flows, and reduce the influence of Sacramento pikeminnow should be immediately implemented.

Table 26-4 on the following page lists the recovery actions for the Lower Eel/Van Duzen River population.

Table 26-4. Recovery action implementation schedule for the Lower Eel/Van Duzen River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LEVR.1.1.12	Estuary	Yes	Improve connectivity of tidally-influenced habitat	Set back or remove dikes or levees	Mid-channel islands such as Cock Robin Island, Salt River Slough, Mosley Slough, and McNulty Slough	2
SONCC-LEVR.1.1.12.1	*Assess and prioritize levees for setback or removal.*					
SONCC-LEVR.1.1.12.2	*Remove or setback levees, guided by assessment results*					
SONCC-LEVR.1.1.13	Estuary	Yes	Improve connectivity of tidally-influenced habitat	Remove or replace tidegates	Estuary	2
SONCC-LEVR.1.1.13.1	*Inventory tidegates and develop a plan that prioritizes removal or replacement. Research possible incentive opportunities and work with landowners to replace tidegates with fish friendly versions*					
SONCC-LEVR.1.1.13.2	*Remove or replace tidegates as described in the plan*					
SONCC-LEVR.1.2.14	Estuary	Yes	Improve estuarine habitat	Restore salt marsh and tidal sloughs	State lands including, Hawk Slough, Hogpen Slough, Smith Creek Cuttoff Slough, and Sevenmile Slough	2
SONCC-LEVR.1.2.14.1	*Develop a management plan in the Eel River estuary to restore salt marsh and tidal slough habitat*					
SONCC-LEVR.1.2.14.2	*Restore salt marsh and tidal slough habitat*					
SONCC-LEVR.1.2.15	Estuary	Yes	Improve estuarine habitat	Re-connect tidal channels and wetlands	State lands including, Morgan Slough, Smith Creek, and Sevenmile Slough	2
SONCC-LEVR.1.2.15.1	*Develop a plan to re-connect historic tidal channels and tidal wetlands as well as restore channelized tidal channels to a more natural channel form*					
SONCC-LEVR.1.2.15.2	*Re-connect tidal channels and wetlands, guided by the plan*					
SONCC-LEVR.1.2.15.3	*Restore channelized tidal channels to a more natural channel form*					
SONCC-LEVR.1.2.16	Estuary	Yes	Improve estuarine habitat	Restore brackish wetlands	McNulty Slough and Salt River	2
SONCC-LEVR.1.2.16.1	*Develop a plan for the conversion of freshwater wetlands to functioning tidal habitat*					
SONCC-LEVR.1.2.16.2	*Convert formally brackish wetlands from freshwater wetlands back to functioning tidal habitat*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LEVR.1.2.38	Estuary	Yes	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-LEVR.1.2.38.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-LEVR.1.2.38.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-LEVR.8.1.5	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-LEVR.8.1.5.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-LEVR.8.1.5.2	*Decommission roads, guided by assessment*					
SONCC-LEVR.8.1.5.3	*Upgrade roads, guided by assessment*					
SONCC-LEVR.8.1.5.4	*Maintain roads, guided by assessment*					
SONCC-LEVR.8.1.6	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-LEVR.8.1.6.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-LEVR.8.1.7	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-LEVR.8.1.7.1	*Limit off-road use of the floodplain*					
SONCC-LEVR.8.1.9	Sediment	Yes	Reduce delivery of sediment to streams	Improve grazing practices	Ferndale and Bridgeville HSAs	BR
SONCC-LEVR.8.1.9.1	*Develop educational materials for landowners that encourage retention of riparian vegetation*					
SONCC-LEVR.8.1.9.2	*Develop riparian buffer ordinance for grazing and agriculture*					
SONCC-LEVR.8.1.11	Sediment	Yes	Reduce delivery of sediment to streams	Reduce risk of catastrophic fire	Population wide	BR
SONCC-LEVR.8.1.11.1	*Assess fire hazard and risk*					
SONCC-LEVR.8.1.11.2	*Promote appropriate treatment to reduce high intensity fire hazard*					
SONCC-LEVR.14.2.4	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of Sacramento pikeminnow	Population wide	2

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LEVR.14.2.4.1	*Determine the effectiveness of various pikeminnow suppression techniques and develop experimental control methods. Develop a plan that identifies watersheds suitable for experimental pikeminnow control*					
SONCC-LEVR.14.2.4.2	*Control Sacramento pikeminnow, guided by the control plan*					
SONCC-LEVR.16.1.22	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LEVR.16.1.22.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-LEVR.16.1.22.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-LEVR.16.1.23	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-LEVR.16.1.23.1	*Determine actual fishing impacts*					
SONCC-LEVR.16.1.23.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-LEVR.16.2.24	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LEVR.16.2.24.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-LEVR.16.2.24.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-LEVR.16.2.25	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LEVR.16.2.25.1	*Determine actual impacts of scientific collection*					
SONCC-LEVR.16.2.25.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-LEVR.2.1.17	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3
SONCC-LEVR.2.1.17.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-LEVR.2.1.17.2	*Place instream structures, guided by assessment results*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LEVR.2.1.36	Floodplain and Channel Structure	No	Increase channel complexity	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide, particularly Yager and Lawrence creeks	2
SONCC-LEVR.2.1.36.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-LEVR.2.1.36.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-LEVR.3.1.19	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	BR
SONCC-LEVR.3.1.19.1	*Reduce diversions*					
SONCC-LEVR.3.1.20	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-LEVR.3.1.20.1	*Provide education and training on conserving water while diverting*					
SONCC-LEVR.3.1.20.2	*Provide incentives to landowners to reduce water consumption*					
SONCC-LEVR.27.1.26	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-LEVR.27.1.26.1	*Perform annual spawning surveys*					
SONCC-LEVR.27.1.27	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-LEVR.27.1.27.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-LEVR.27.1.28	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-LEVR.27.1.28.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-LEVR.27.1.29	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the threat 'Invasive Species'	Population wide	3
SONCC-LEVR.27.1.29.1	*Annually estimate the density of non-native predators, such as the Sacramento pikeminnow in the Eel River basin*					
SONCC-LEVR.27.1.29.2	*Identify the status and trend of invasive species*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LEVR.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-LEVR.27.2.30.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-LEVR.27.2.30.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-LEVR.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-LEVR.27.2.31.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-LEVR.27.2.32	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-LEVR.27.2.32.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-LEVR.27.2.33	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-LEVR.27.2.33.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-LEVR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-LEVR.27.2.34.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-LEVR.27.2.35	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-LEVR.27.2.35.1	*Identify habitat condition of the estuary*					
SONCC-LEVR.27.1.39	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-LEVR.27.1.39.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-LEVR.27.1.40	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LEVR.27.1.40.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-LEVR.27.1.40.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-LEVR.27.2.41	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-LEVR.27.2.41.1	*Determine best indicators of estuarine condition*					
SONCC-LEVR.5.1.37	Passage	No	Improve access	Reduce sediment barriers	Tributary confluences with mainstem Eel and Van Duzen rivers	3
SONCC-LEVR.5.1.37.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-LEVR.5.1.37.2	*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*					
SONCC-LEVR.7.1.1	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	3
SONCC-LEVR.7.1.1.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-LEVR.7.1.1.2	*Develop watershed-specific guidance for managing riparian vegetation*					
SONCC-LEVR.7.1.2	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	High IP sub watersheds	3
SONCC-LEVR.7.1.2.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-LEVR.7.1.2.2	*Thin, or release conifers, guided by prescription*					
SONCC-LEVR.7.1.2.3	*Plant conifers, guided by prescription*					
SONCC-LEVR.7.1.3	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-LEVR.7.1.3.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					

27. Guthrie Creek Population

- Southern Coastal Stratum
- Dependent Population
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 20.74 mi²
- 14 IP km (9 mi) (57% High)
- Dominant Land Uses are Timber Harvest and Agriculture
- Principal Stresses are ‘Altered Sediment Supply’ and ‘Impaired Water Quality’
- Principal Threats are ‘Timber Harvest’ and ‘Agriculture’

27.1 History of Habitat and Land Use

The Guthrie Creek population occupies four streams along a three-mile stretch of coast south of the Eel River (Figure 27-1). These include, from north to south, Fleener Creek, Guthrie Creek, Bear Creek, and Oil Creek. These watersheds have been impacted by both natural and anthropogenic changes over the past century, leading to degraded habitat conditions for coho salmon. The soils in this area of coastal California are highly erodible and naturally tend to produce mass wasting, bank destabilization, and high volumes of silt and cementation of gravel. Landslides and bank failures are particularly common in the lower part of Guthrie, Fleener, and Oil Creek due to both natural soil instability in this area and decades of grazing. Land use throughout these watersheds has been limited by the rugged terrain and most areas have been used solely for grazing and timber production over the past century. There is little to no development in these watersheds.

Historically, the lower reach of all three major coho streams (Guthrie, Fleener, and Oil Creeks) have been highly grazed and consequently suffer from bank instability, degraded riparian forest conditions, and sediment loading. Early timber harvest in these areas originally removed any riparian cover and since then there has been little recovery due to the effects of grazing which continue to suppress regeneration. However, through a series of recent acquisitions by the California State Coastal Conservancy, the lower portions of Guthrie and Fleener Creek are now managed by the BLM as part of the Lost Coast Headlands.

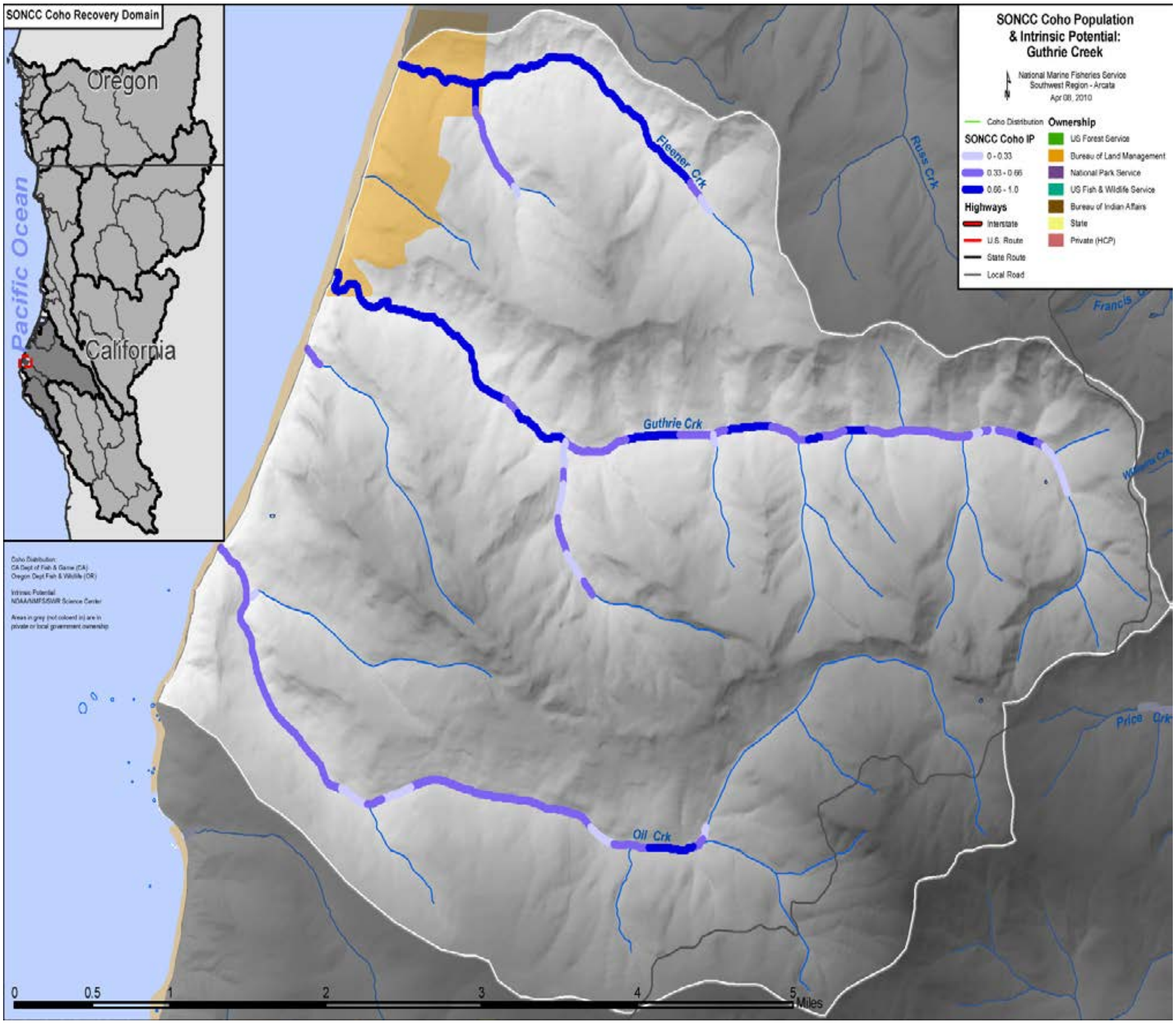

Figure 27-1. The geographic boundaries of the Guthrie Creek coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Management practices by the BLM include light and low impact passive recreational uses and managed livestock grazing. There is no public land grazing in Guthrie Creek and the established grazing allotment includes new fencing along Fleener Creek (and elsewhere) and a rotation strategy using five pastures per year with water troughs located away from riparian areas (Fuller 2010). As part of their goal to provide coastal access and recreation opportunities, the BLM has constructed two coastal trails, the Fleener Creek and Guthrie Creek trails, to provide visitor access to the coast.

Timber harvest continues to impact the middle and upper reaches of streams in the Guthrie Creek population area which are privately-owned and managed for timber production. Impacts primarily manifest through the loss of riparian conifers, lack of large woody debris in streams, and elevated rates of sediment loading and accretion. Currently, many areas are actively being harvested or remain in an early seral condition.

27.2 Historic Fish Distribution and Abundance

Based on the IP values for the streams included in the Guthrie Creek population area, Fleener, Guthrie, and Oil creek have potential for coho salmon spawning and rearing (Table 27-1). Guthrie Creek is the largest of these streams and comprises about 60 kilometers of stream channel. Habitat suitable for coho salmon quickly diminishes upstream of the lowest tributary, however isolated pockets of high IP habitat (>0.66) occur along the mainstem up to 4 miles upstream of the mouth (Figure 27-1). The tributaries of Guthrie Creek currently do not provide substantial spawning area because of degraded conditions within the smaller channels. Within most tributaries the wetted channel narrows to less than 4 inches and is characterized by a steep incline and silt deposits that make it unsuitable for anadromous fish habitat (CDFG 1982). The lowest tributary is currently the only tributary considered to offer habitat for salmonids based on low to moderate IP values (<0.66). Based on survey data from the CDFG North Coast California Coho Salmon Investigation Project (NCCCSI) between 1982 and 2003 there were no observations of coho salmon in Guthrie Creek. Surveys were completed over three years during the study, with collected data being supplemented by literature research and anecdotal information. One streamside observation of a coho salmon exists but the year of that observation was undocumented. Currently, coho salmon abundance in the Guthrie Creek watershed is unknown and the population is presumed to be extirpated or sustainably below historic levels because of habitat degradation and region-wide decline in coho salmon populations.

Based on IP habitat value, both Oil and Fleener Creeks also have potential to support coho salmon. Of the two watersheds, Fleener Creek has a larger proportion of IP habitat, with the majority of the mainstem having high IP (>0.66). The major tributary to Fleener Creek also has moderate to high IP (>0.33). Although little is known about fish use of Fleener Creek, the Bureau of Land Management in previous documents and in personal communications has stated that anadromous fish do not occupy this watershed (BLM 2004c). Residents along Fleener Creek support the claim that anadromous fish do not enter the creek and it is thought that the driftwood log jam may act as a barrier to migration (Fuller 2010). High sediment loads and accretion along with heavy grazing in the lower mainstem may prevent use of any high IP habitat in this watershed.

One young-of-the-year coho salmon was reported in Oil Creek in 1994 (CDFG 2004b) and the watershed has moderate IP habitat (0.33 to 0.66) throughout much of its mainstem. The stream has been significantly altered, however, and although few survey data exist, it likely is unable to support substantial numbers of coho salmon in its current state. Coho that do use Oil Creek must migrate upstream several miles to find suitable spawning and rearing habitat given that the lower part of the watershed has little if any riparian forest and has experienced high sedimentation. The last of the Guthrie Creek population area streams, Bear Creek, has a small amount (<0.5 miles) of moderate IP near its mouth, however the stream is unable to support coho salmon spawning due to its small size and degraded habitat conditions in the lower watershed. There are no records to indicate historic use of this stream by coho salmon.

Table 27-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Fleener Creek	Guthrie Creek	Oil Creek

27.3 Status of Guthrie Creek Coho Salmon

Spatial Structure and Diversity

The creeks in the Guthrie Creek population area are relatively short and have limited habitat available for spawning and rearing. Furthermore, the narrow and shallow qualities of most tributaries make them unsuitable for coho salmon. Although Fleener, Guthrie, and Oil Creek likely once supported coho salmon based on their IP values, there is little evidence to indicate that any of these creeks are currently used for coho spawning or rearing. The only observations of coho salmon over the past 20 years have been in Guthrie and Oil Creek. Habitat degradation through erosion, aggradation, and loss of riparian cover likely has contributed to the decline of salmon in these streams. All of the high IP reaches in the population area have been heavily grazed over the past century and lack suitable spawning gravel and or complex rearing habitat. The upper and middle reaches of the creeks have fewer historical impacts, however, IP habitat values are lower in these regions reducing the suitability for coho. The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Therefore the Guthrie Creek population is at an elevated risk of extinction.

The location of the Guthrie Creek population between two larger populations, the Eel and the Mattole, provides the potential for greater diversity within the population. The influx of genetic and life history traits from the Eel River population to the north and the Mattole River to the south is naturally common in this population due to the straying that likely occurs into these nearby coastal streams. Potential additions add diversity and genetic strength to the Guthrie Creek populations (Meffe 1986). Nonetheless, because the current extent of suitable spawning and rearing habitat is severely limited, the Guthrie Creek coho salmon population may not be able to support the opportunity for mixing, reducing overall diversity. The population is at an elevated risk of extinction based on its reduced capacity for resilience.

Population Size and Productivity

Guthrie Creek is known to have supported steelhead in numbers ranging from 15,000 to 25,000 in the 1930’s (CDFG 1982) however the historic abundance of coho salmon in these streams is unknown. Along with steelhead populations, the current population is suspected to be either extirpated or on levels much lower than in past decades due to the apparent habitat degradation through these watersheds. In surveys conducted over the past 20 years in Guthrie Creek and Oil Creek, there have only been two records of coho salmon being found. Coho spawning in these watersheds is rare and likely the result of straying from either the Mattole or Eel River. If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction.

As a dependent population, the population's abundance and productivity is highly influenced by nearby populations, which contribute spawners as strays. Both the Eel and Mattole River populations have been severely restricted and have low numbers of returning adults compared to historic runs, and are at high risk of extinction. The lack of productivity in these systems and the associated reduction in strays entering Guthrie, Fleener, and Oil Creek further increases this population's risk of extinction. The Guthrie Creek coho salmon population is considered to have an elevated risk of extinction given its low population size and negative population growth rate.

Extinction Risk

Not applicable because Guthrie Creek is not an independent population.

Role in SONCC Coho Salmon ESU Viability

The Guthrie Creek population is considered to be non-core "Dependent" population within the Southern Coast Diversity Stratum meaning that it has a low likelihood of persisting in isolation over a 100-year time scale, yet it receives sufficient immigration to alter its dynamics and extinction risk. The recovery target for the Guthrie Creek population is to recover the population to at least a moderate risk of extinction. Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU.

There are several populations which may interact with the Guthrie Creek population. The Eel River, which is located less than 10 miles to the north of this population, historically had a robust coho salmon run and likely contributed numerous stray adult spawners to the Guthrie Creek population. Adult coho salmon from the Mattole River to the south also likely spawn in Guthrie Creek and its tributaries. Both these populations help sustain the dependent Guthrie Creek population over the long term. By providing connectivity between populations, the Guthrie Creek population helps sustain the resiliency and diversity of the SONCC ESU and of individual independent populations. Because nearby populations have seen dramatic declines in productivity, there is far less interaction between populations. The individuals that do spawn in Guthrie, Fleener, or Oil Creek are likely strays from larger populations but the recruitment rate is probably close to zero.

27.4 Plans and Assessments

Bureau of Land Management (Arcata office)

CDFG Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004

Lost Coast Headlands Feasibility Study

In the process of first establishing the Lost Coast Headlands in 2001, the BLM conducted a feasibility study including potential acquisitions and management alternatives for the area. In this study they consulted with local residents, mapped significant resources in the area, and evaluated opportunities for protecting coastal resources, preserving coastal agriculture, and providing public coastal access.

Lost Coast Headlands Biological Assessment

As part of the Lost Coast Headlands Feasibility Study, the consulting group Mad River Biologists completed a biological assessment of the area in 2000.

27.5 Stresses

Table 27-2. Severity of stresses affecting each life stage of coho salmon in Guthrie Creek. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Sediment Supply[1]	High	High	High[1]	Medium	High	High
2	Impaired Water Quality	Medium	Medium	High	Medium	Medium	Medium
3	Lack of Floodplain and Channel Structure	Low	Medium	Medium	Medium	Medium	Medium
4	Degraded Riparian Forest Conditions	-	Medium	Medium	Low	Medium	Medium
5	Impaired Estuary/Mainstem Function	-	Low	Medium	Medium	Low	Medium
6	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
7	Barriers	-	Low	Medium	Low	Low	Low
8	Altered Hydrologic Function	Low	Low	Low	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Little information exists regarding the habitat quantity and quality available in Guthrie Creek and its tributaries. The data that is available indicates that spawning and rearing habitat do exist in the watershed, but are likely limited in quality and abundance. No information exists regarding appropriate habitat for adult migration and holding, but given the small size of the stream channel, it is unlikely that there are many, if any, pools and deep areas for adult salmonids to use for holding. When spawning does occur, eggs are highly susceptible to suffocation and death due to increased sediment inputs throughout the watersheds comprising the population. Additionally, elevated turbidity levels and decreased water quality can impair the health and survivability of rearing juveniles by decreasing food resources, increasing stress levels, and respiration rates. Excess sediment in the system is indicated as a known stress to existing habitat, and likely has played a role in filling in of the stream channel and the shallow pool depths seen throughout the watershed. All life stages are affected by this stress.

Within Guthrie, Fleener, and Oil Creek, the greatest potential refugia occurs in the middle and upper reaches where riparian cover is most extensive and the effects of sedimentation are least. Tributary streams within these reaches provide the greatest source of rearing and spawning habitat due to the lower turbidity (CDFG 1982). Guthrie Creek in particular has the greatest potential for coho salmon productivity because it is both larger than the other streams and appears to have higher quality habitat. Fleener Creek has a relatively large amount of High IP habitat for its size and should be investigated for restoration opportunities such as exclusionary fencing as done by the BLM.

Sediment Supply

Altered sediment supply has been determined as the highest stress affecting all life history phases of coho salmon, imposing a high stress on eggs, fry, and juveniles, and adults. High sediment loading, as a result of land use and geology, contributes to multiple problems including the simplification of stream habitat, increased turbidity, and increased embeddedness, which reduces emergence success. Areas along the stream near the coast are characterized by bare, unstable slopes and eroding stream banks. A CDFG stream survey of Guthrie Creek from 1982 documented, “steep and unstable” banks that were undercut and collapsing in many areas along the first 1,000 feet of the mainstem, upstream of the mouth (CDFG 1982). The mainstem was characterized by high silt content and cemented gravels for the entire length of the survey up to 3,000 feet from the mouth. The tributaries were noted to have considerably lower silt content. With subsequent reductions in grazing on lower Guthrie Creek since the time of this survey it is likely that conditions have improved somewhat as banks have stabilized and riparian areas have recovered. However, high sediment loading likely continues throughout the watershed as a result of timber harvest and grazing that occurs on private land upstream.

Impaired Water Quality

The primary impairment to water quality in Guthrie, Fleener, and Oil Creek is the high turbidity caused by sedimentation. Temperature was recorded between July and October of 2005 in Guthrie Creek and was very good (<15°C) to good (15 to 16°C) for most of that time. Only a few days did the temperature exceed 17° C. Despite cool temperatures, turbidity in these watersheds is likely very high due to the elevated erosion rates and high silt content of the soils. Although there is no direct data on turbidity, the aquatic insect EPT parameter has been measured in Fleener Creek and was rated as poor (≤12). This parameter is a measure of the number of pollution intolerant insect taxa present (Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies)). The limiting factor for these species is generally the high turbidity and fine sediment in the streambed. Turbidity primarily affects juvenile salmonids by interfering with gill function, feeding, and other normal behaviors. Impaired water quality is considered a medium to high stress to this population.

Floodplain and Channel Structure

Lack of floodplain and channel structure is a low to medium stress for coho salmon in the Guthrie Creek population. The history of logging and grazing along with bank instability in riparian areas has eliminated large legacy trees in the riparian zone along with the supply of LWD to streams. Wood is essential for the maintenance of pools through scouring and the general complexity of stream habitats. In addition, an excess of sediment has filled pools and caused the shallowing and widening of channels through aggradation. The overall simplified stream habitat no longer provides places of refuge for fish and lacks deep pools and side channels for use during high flow events or times of low water.

Riparian Forest Conditions

Riparian forests in all four watersheds in the population area have been negatively impacted by timber harvest and grazing in the area. Survey data from Guthrie Creek in 1982 (CDFG 1982) indicates that riparian cover is lacking from the mouth to about 1,000 feet upstream. Then, riparian vegetation increases to mostly alder and willow until approximately 6,000 feet from the mouth upstream of which a conifer forest canopy provides about 50 percent canopy cover for the rest of the upland channel. Although grazing has been eliminated from riparian areas in Guthrie and Fleener Creeks, lower reaches have yet to recover and riparian vegetation is still lacking. Timber harvest continues to limit riparian condition in middle and upper reaches. Overall degraded riparian condition is a medium stress to coho salmon in this population and limits the amount of cover, LWD, and rearing and spawning habitat in streams.

Impaired Estuary/Mainstem Function

The estuaries of Fleener, Guthrie, and Oil Creek are all small in size and contain little habitat for coho salmon rearing. Estuarine function has been impacted to some degree by elevated sediment aggradation which has led to decreased flows, a widened and shallowed channel, and the possible presence of fish passage barriers during low flow periods. The accumulation of driftwood, possibly due to changes in the geomorphology of the estuary in Fleener Creek, has potentially led to complete blockage of the watershed to anadromous fish (Fuller 2010). Guthrie Creek does not seem to accumulate driftwood at its mouth due to higher flows than Fleener Creek. One potential source of concern in the entire population area is the unstable headland geology, which can lead to mass wasting at the mouth of these streams. Overall, impaired estuarine function is not a significant issue for this population.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Barriers

There may be stream crossing barriers associated with logging roads on private timber land, but the extent of this issue is unknown. There are no documented fish passage barriers on Federal or

County roads. Fish barriers pose an overall low stress to Guthrie Creek coho salmon. There are some known diversions that could act as fish passage barriers if not properly screened.

Hydrologic Function

The hydrologic function in Guthrie Creek is good. Generally, the channel's morphology is that of a deep crevice and U-shaped channel, which maintains flow and sufficient water depth to sustain fish. The overall stress associated with hydrologic function is considered low.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Guthrie Creek population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin and there are no hatcheries in the basin (Appendix B).

27.6 Threats

Table 27-3. Severity of threats affecting each life stage of coho salmon in Guthrie Creek. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Timber Harvest	High	High	High	Medium	High	High
2	Agricultural Practices	Medium	Medium	Medium	Low	Medium	Medium
3	Roads	Medium	Medium	Medium	Low	Medium	Medium
4	Fishing and Collecting	-	-	-	-	Medium	Medium
5	Channelization/Diking	Low	Low	Low	Low	Low	Low
6	Dams/Diversion	Low	Low	Low	Low	Low	Low
7	High Intensity Fire	Low	Low	Low	Low	Low	Low
8	Climate	Low	Low	Low	Low	Low	Low
9	Urban/Residential/Industrial	Low	Low	Low	Low	Low	Low
10	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low

[1]Invasive Non-Native/Alien Species, and Mining/Gravel Extraction are not considered threats to this population.

Timber Harvest

The Guthrie Creek population area is made up of nearly 97 percent private land, much of which is used for timber production. Most land is likely on a 30 to 50 year rotation with 25 to 35 percent of a watershed being harvested based on CalFire's Forest Practices GIS data. Poor riparian conditions in Guthrie Creek and throughout the population area have been attributed to past and present timber harvest. The lack of mature riparian forest along streams and LWD in streams reflect the outcome of early harvest practices with no riparian buffers. Although some areas of the watershed have likely recovered some of their riparian structure and function, the cessation of logging in riparian areas was too recent for many areas to progress to the late seral stage. Also, because the area is already prone to erosion and high turbidity, additional sediment inputs associated with timber harvest can have major consequences for coho salmon in this population (see sediment stress section above). The overall threat associated with timber harvests is considered high for all life stages except smolts, which typically migrate to sea and beyond immediate impacts from timber harvesting.

Agricultural Practices

The coastal areas of these watersheds are frequently used for cattle grazing. Except in the lowest reaches of Guthrie and Fleener Creeks, which have managed grazing allotments with exclusionary fencing, cattle in most areas have direct access to the creek. Grazing and trampling by livestock typically causes bank destabilization, loss of riparian habitat, sedimentation, and consequent changes in benthic prey, turbidity, and loss of stream connectivity. Because this area is particularly prone to bank destabilization and erosion, grazing is especially harmful to stream habitat and coho salmon. These adverse effects are considered an overall medium threat to coho salmon. All life stages are affected.

Roads

These watersheds are predominantly private timberland and contain a network of private, unpaved logging roads. The overall density of roads in the Guthrie Creek population area is very high (>3 miles road per square mile of watershed). These roads are built on unstable soils and are prone to erosion and washouts. Of particular concern are road-stream crossings, which typically contribute the most to sediment loading. Sediment that originates from roads accretes in stream channels and leads to high levels of turbidity. The shallowing and widening of stream channels, cementation of gravels, and suspended sediment loads lead to decreased survival of eggs and decreased growth and survival of juveniles. Adults are impacted by the lack of suitable spawning habitat. The cumulative threat from roads is considered moderate.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in Guthrie Creek.

Channelization/Diking

Past and current channelization and diking on Guthrie Creek has not significantly affected the Guthrie Creek coho salmon populations. This practice currently poses a low threat to all life stages of coho salmon.

Dams/Diversions

Dams and diversions in the population area have not significantly affected the Guthrie Creek coho salmon population. There is only one documented diversion in the area, on Fleener Creek. Its impact is currently unknown but it could be affecting fish passage and flow in that creek. Based on current information, dams and diversions pose a low threat to all life stages of coho salmon in this watershed.

High Intensity Fire

Fire currently poses a low threat to all life stages of coho salmon in this watershed. During the summer months of the California fire season, cool foggy days are common in Humboldt County and therefore the overall fire hazard for the area is low. Managed livestock grazing in the area further reduces fire risk by eliminating fuel sources.

Climate Change

Climate change poses a low threat to this population due to its cooler climate, low risk of average temperature increase and precipitation change over the next 50 years (see Appendix B for modeling methods). Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. In addition, all populations will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Urban/Residential/Industrial Development

This watershed is presently not developed and is not likely to experience any urban, residential, or industrial development in the future. Although most land is privately owned, due to the rugged nature of the terrain, lack of infrastructure, and relative isolation, it will likely continue to be used for timber harvest in the future. Consequently, development poses a low threat to coho salmon in this population.

Road-Stream Crossing Barriers

There are no documented road-stream crossing barriers within the population area. The high density of roads, however, indicates the potential for barriers to exist on private timber land. Without proper upgrades to existing crossing barriers and prevention of future barriers this threat is likely to continue to increase in the future on private lands.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Guthrie Creek population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress

27.7 Recovery Strategy

The Guthrie Creek coho salmon population is either extirpated or has very low population abundance and productivity. For the past 100 years, grazing and timber harvest have been the dominant land uses. As a result, little spawning and rearing habitat remains within these watersheds. The acquisition of the lower portions of Guthrie and Fleener Creeks by the BLM is helping to remove some of the grazing pressure on the landscape; however issues in the remaining 97 percent of the watershed need to be addressed in order to recover this population. Minimizing the impacts from grazing and timber harvest should be a priority in reducing sedimentation and turbidity. Fencing riparian corridors and supplying adequate stock watering facilities away from creeks will prevent trampling and grazing in these areas.

Careful management of timber harvest in conjunction with decommissioning, improving, and maintaining roads will reduce sediment pollution, erosion, and improve riparian conditions. The highly erodible character of the soils will probably hinder riparian rehabilitation and continue to add to sediment loads even with the absence of grazing and harvest near the stream channel.

Although ultimate recovery of this population will help provide connectivity and refugia for the important nearby populations of the Eel and Mattole rivers, there are many challenges that hinder recovery in this area. Guthrie Creek seems to have the most potential for habitat recovery of all four creeks containing IP habitat.

Table 27-4 on the following page lists the recovery actions for the Guthrie Creek population.

Table 27-4 Recovery action implementation schedule for the Guthrie Creek population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-GutC.8.1.3	Sediment	Yes	Reduce delivery of sediment to streams	Reduce stream bank erosion	Population wide	BR
SONCC-GutC.8.1.3.1	*Complete stream bank sediment source inventory and map unstable hillslopes. Develop a plan that prioritizes and locations for treatment*					
SONCC-GutC.8.1.3.2	*Treat priority sediment source sites, guided by the plan*					
SONCC-GutC.8.1.3.3	*Provide educational materials to land owners that describes alternative land management practices that will result in reduced erosion and impacts to riparian forests*					
SONCC-GutC.8.1.4	Sediment	Yes	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	BR
SONCC-GutC.8.1.4.1	*Assess roads and determine feasibility for relocation in priority sites*					
SONCC-GutC.8.1.4.2	*Relocate roads off of unstable land features*					
SONCC-GutC.27.2.5	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-GutC.27.2.5.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-GutC.27.2.5.2	*Measure indicators for spawning and rearing habitat once every 15 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-GutC.27.1.6	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-GutC.27.1.6.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-GutC.27.2.7	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-GutC.27.2.7.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-GutC.27.1.8	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-GutC.27.1.8.1	*Develop supplemental or alternate means to set population types and targets*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-GutC.27.1.8.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-GutC.27.2.9	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-GutC.27.2.9.1	*Determine best indicators of estuarine condition*					
SONCC-GutC.7.1.1	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Lower Guthrie Creek	BR
SONCC-GutC.7.1.1.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-GutC.7.1.1.2	*Develop grazing management plan to meet objective*					
SONCC-GutC.7.1.1.3	*Plant vegetation to stabilize stream bank*					
SONCC-GutC.7.1.1.4	*Fence livestock out of riparian zones*					
SONCC-GutC.7.1.1.5	*Remove instream livestock watering sources*					
SONCC-GutC.7.1.2	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase vegetation	Population wide	BR
SONCC-GutC.7.1.2.1	*Plant native riparian species in denuded areas*					

28. Bear River Population

- Southern Coastal Stratum
- Non Core-2, Potentially Independent Population
- High Extinction Risk
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 83.61 mi^2
- 48 IP km (30 mi) (27% High)
- Dominant Land Uses are Timber Harvest and Agriculture
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Degraded Riparian Forest Conditions’
- Principal Threats are ‘Roads’ and ‘Timber Harvest’

28.1 History of Habitat and Land Use

Bear River is a fourth order, 30 km coastal stream draining approximately 151.5 km^2 (53,287 acres) to the Pacific Ocean (Ricker 2002b). The connection between the Bear River and the Pacific Ocean is periodically blocked by a temporary sand bar during summer low flow. The lagoon-type estuary is approximately one-quarter mile in length (Humboldt Redwood Company (HRC) 2008, Bliesner et al. 2006). The two major land uses in the basin consist of agricultural grazing and timber harvest. HRC (formerly Pacific Lumber) owns 16,537 acres of land in the upper portion of the watershed, all of which is covered by its 1999 Habitat Conservation Plan (HCP) (Wisniewski and Garinger 2006). The remaining acreage in the watershed is in private ownership (36,839 acres), and 161 acres is owned by State Parks.

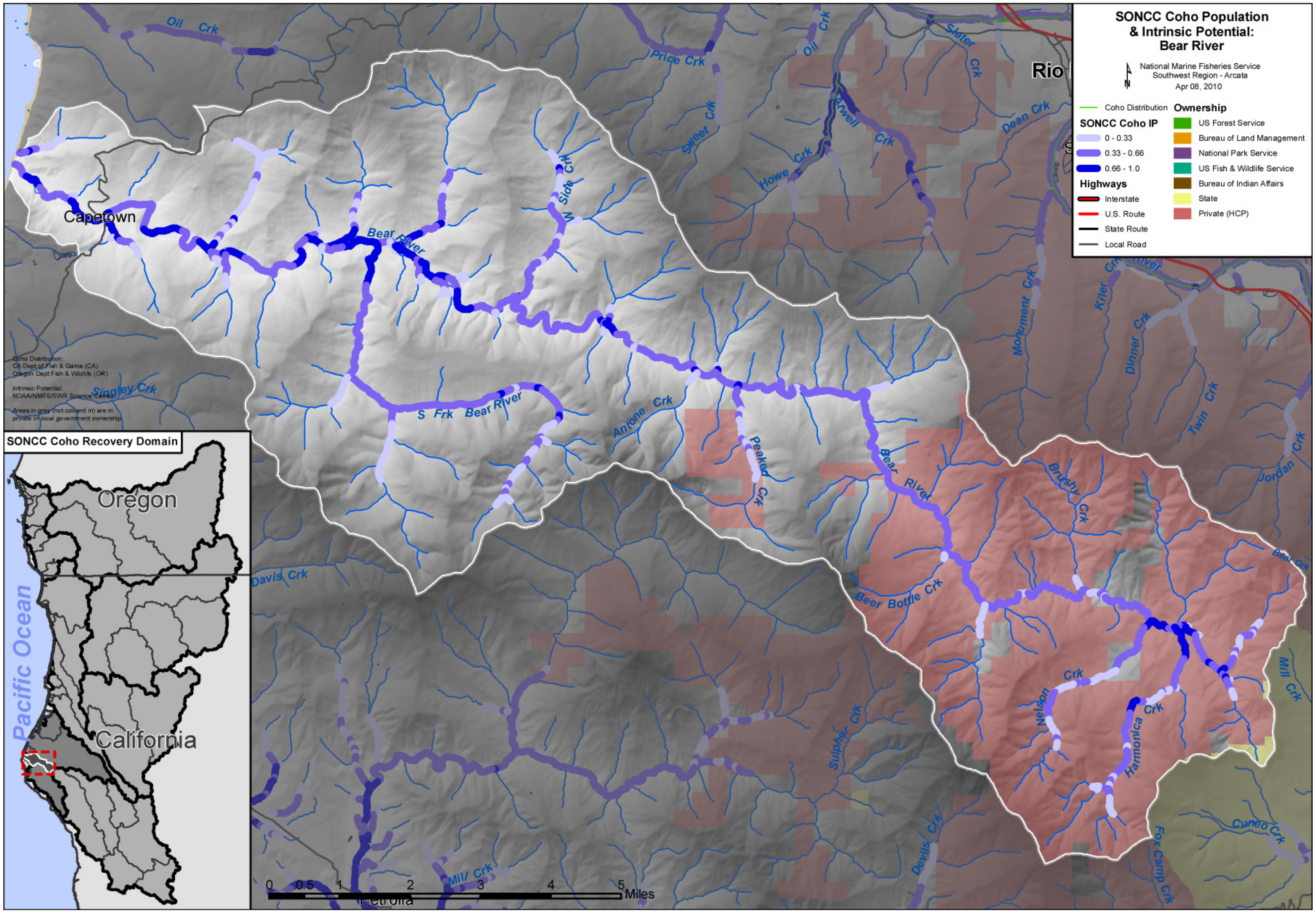

Figure 28-1. The geographic boundaries of the Bear River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

The headwaters of the watershed have been managed for timber production since 1950. Early logging operations harvested trees from large tracts and burned residual slash. Most of the trees in the riparian areas were harvested. Logs were skidded downhill with tractors, often utilizing watercourses for skid trails. There was little replanting of harvested sites during the 1950's and 1960's, and site regeneration was left to natural seeding or sprouting. Consequently, much of the area harvested during this period is now comprised primarily of hardwood (e.g., tanoak) (Blair et al. 2006). The flood of 1964 altered the morphology of the lower river, transporting large amounts of sediment, removing the majority of the remaining riparian vegetation and decreasing the size and depth of the estuary (Ricker 2002b).

Land use in the lower watershed (Figure 28-2) is predominately rangeland and grazed primarily by cattle and sheep (Ricker 2002b). No dams exist in the Bear River drainage, however small water diversions exist throughout the basin for domestic use, livestock watering, irrigation, and dust abatement (road watering). None of these diversions exceed 1 cubic foot per second (Bliesner et al. 2006).

Since 1998, CDFG (through the Fisheries Restoration Grants Program-SB 271) funded ten projects in the Bear River watershed, including landowner education, roads assessment , temperature monitoring, riparian enhancement and riparian planting, log structure placement, livestock exclusionary fencing, gully and streambank stabilization.

28.2 Historic Fish Distribution and Abundance

There is no historic documentation of coho salmon presence in Bear River (Bliesner et al. 2006); and no individuals were collected in juvenile outmigrant traps in 2000 to 2001 in Bear River (Ricker 2002b). Furthermore, CDFG's North Coast California Coho Salmon Investigation (NCCSI) sampled the mainstem and south fork Bear River between 2001 and 2003 with no coho salmon detected. CDFG habitat surveys indicated suitable habitat for coho salmon in lower Bear River and portions of South Fork Bear River (CDFG 2004b), including a high degree of sinuosity, low gradient, and deep pools in the lower river (Bliesner et al. 2006). The majority of the high IP reaches in the Bear River are in the lower river, in several reaches in South Fork Bear River, and in Upper Bear River near the mouths of Harmonica and Nelson Creeks (Figure 28-1, Figure 28-2 and Table 28-1). Bear River supports populations of CC Chinook and NC steelhead, and therefore likely historically supported SONCC coho salmon.

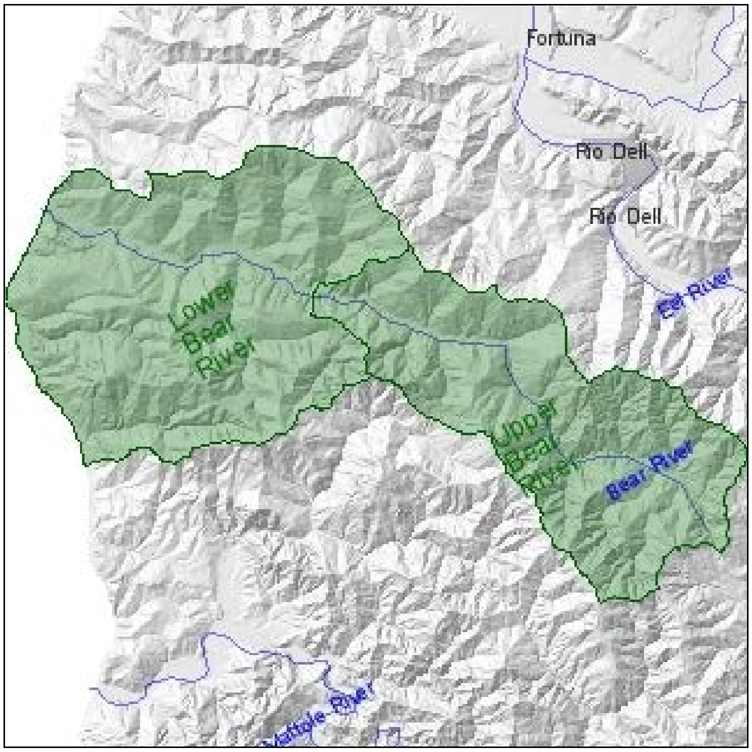

Figure 28-2. Location of lower and upper Bear River. Capetown HSA, Cape Mendocino HU.

Table 28-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Stream Name	Stream Name
Bear River	Harmonica Creek
South Fork Bear River	Nelson Creek

28.3 Status of Bear River Coho Salmon

Spatial Structure and Diversity

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 40 coho salmon per-IP km of habitat are needed (1,900 spawners total) to approximate the historical distribution of Bear River coho salmon and habitat. Although CC Chinook salmon and NC steelhead are present, SONCC coho salmon have not been documented in Bear River. There are no documented barriers within the Bear River watershed that currently restrict the spatial structure of the population. Because no coho salmon have been documented the population may be functionally extinct and therefore lacks diversity. Bear River coho salmon population is at an elevated risk of extinction based on its extremely low numbers and reduced capacity for resilience.

Population Size and Productivity

No adult or juvenile coho salmon have been documented in Bear River.

Extinction Risk

The Bear River coho salmon population is not viable and at high risk of extinction, because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Bear River population is considered to be a non-core 2 "Potentially Independent" population within the Southern Coastal diversity stratum meaning that it has a high likelihood of persisting in isolation over a 100-year time scale, but is too strongly influenced by immigration from other populations to exhibit independent dynamics. The demographic target for recovery is juvenile occupancy. Because the Bear River population may be functionally extinct, nearby populations such as the Mattole and Eel River populations are needed to provide a source of straying individuals that could recolonize the Bear River population area.

28.4 Plans and Assessments

Humboldt Redwood Company

Pacific Lumber Habitat Conservation Plan

The Pacific Lumber Company (PALCO) Habitat Conservation Plan (HCP) was finalized in 1999 and the associated Incidental Take Permit is effective through 2049. The HCP was inherited by the Humboldt Redwood Company upon acquisition of the PALCO lands in 2008. NMFS issued a Section 10(a)(1)(B) permit authorizing incidental take of SONCC coho salmon by PALCO and determined that this taking would not appreciably reduce the likelihood of survival and recovery of the species in the wild (PALCO 1999b). Although the goal of the HCP is to maintain or achieve, over time, a properly functioning aquatic habitat condition, it acknowledges that not all essential habitat elements (e.g., large wood recruitment) will be attainable within the 50-year life of the plan (PALCO 1999a). Site-specific prescriptions, which are designed to promote a properly functioning aquatic habitat condition, are contained in the Bear River watershed analysis (HRC 2008).

In August, 2004, Section 6.33 (Control of sediment from roads and other sources) was revised to extend the time frame for completion of road assessment and associated sediment sources from 2005 to 2010. The Bear River Watershed Analysis was completed in October 2006, and the Hillslope Management and Riparian Management Prescriptions were completed in April, 2007 (PALCO 2007). The hillslope management/mass wasting avoidance strategy uses a three-step approach for the identification and avoidance or mitigation of high hazard unstable areas during the planning and implementation of forestry activities. These steps are: slope stability training; site-specific and project-specific "screening" for unstable areas; and enforceable site-specific prescriptions for road construction, re-construction, or timber harvest on unstable areas designated as "High Hazard." Also required is review and approval of a professional licensed geologist.

In general, no harvest will occur within the Channel Migration Zone, defined as the flood-prone area in stream reaches with less than 4 percent gradient, which is generally the 100-year floodplain (PALCO 2007). In addition, all streams will have a Riparian Management Zone (RMZ). The RMZ of Class I (fish-bearing) streams is 150 feet wide, with no timber harvest permitted within the first 50 feet.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004.

28.5 Stresses

Table 28-2. Severity of stresses affecting each life stage of coho salmon in Bear River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	Medium	Very High	Very High[1]	Very High	Very High	Very High
2	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	Very High	High	Very High
3	Impaired Water Quality	Low	Very High	Very High	Very High	Low	High
4	Altered Sediment Supply	High	High	Very High	Medium	Very High	High
5	Impaired Estuary/Mainstem Function	-	Medium	High	Very High	Medium	High
6	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
7	Altered Hydrologic Function	Low	Medium	Medium	Low	-	Low
8	Barriers	-	Low	Low	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1]Key limiting factor(s) and limited life stage(s).
[2]Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Lack of floodplain and channel structure, degraded riparian forest conditions, impaired water quality, and altered sediment supply are all stressors that affect juvenile rearing success of Bear River coho salmon. Lack of LWD due to past logging practices and increased sediment supply reduce complexity by filling in pools and reducing habitat structure, limiting juvenile rearing and holding habitat. If coho salmon were present in the Bear River, substrate embeddedness would limit their spawning success and the lack of instream cover and pool refugia would limit rearing success.

Floodplain and Channel Structure

Floodplain and channel structure is ranked as a very high stress to nearly all life stages of coho salmon. In the high IP reaches, the pool depths in the Bear River mainstem average 3.3 ft or greater. However, in the South Fork Bear River and Nelson and Harmonica Creeks, pool depths are 2.0 ft or less, which is considered a poor condition for salmonid habitat function. Pool frequency throughout the watershed is poor, less than 35 percent by length, due to the lack of instream wood structures throughout the mainstem and certain tributaries. Delivery of large wood to the majority of Class I streams is problematic and will continue to be so for a period of least 10 to 25 years. After 25 years, an estimated 75 percent of the HCP-covered riparian forest will be of sufficient size to benefit aquatic habitat conditions. (Blair et al. 2006).

Riparian Forest Conditions

Riparian forest conditions are ranked as a high or very high stress to nearly all life stages of coho salmon, with an overall ranking of very high. The high IP habitat of lower Bear River, South Fork Bear River, as well as the upper watershed and its tributaries, generally lack canopy cover and are dominated by hardwoods, which provide poor shading and decompose faster than conifers. On HRC lands, current riparian conditions are primarily the result of intensive mid-twentieth century logging and two significant flood events of the same time period. Species composition is primarily a mixture of Douglas-fir, tanoak, red alder, willow, California bay-laurel, and big-leaf maple. Structurally, while large trees in excess of 24" diameter at breast height (dbh) occur throughout the Bear River, most stands consist of trees ranging from 12 to 24" dbh, with multiple canopy layers just beginning to develop (Blair et al. 2006).

Impaired Water Quality

Water quality is ranked as a high or very high stress to nearly all life stages of coho salmon. Seasonally warm air temperatures, at times exceeding 32° Celsius (C), emphasize the importance of maintaining over-stream shade canopy and cool riparian microclimate conditions to reduce solar heating of the water. Much of the Bear River, and the lower reaches of Harmonica Creek and Gorge Creek, have little over-stream shade canopy (Blair et al. 2006), and summertime water temperatures exceed 17°C.

Sediment Supply

Sediment supply is ranked as a high or very high stress to nearly all life stages of coho salmon. The high IP habitat of lower Bear River, South Fork Bear River, as well as the upper watershed and its tributaries, have a high degree of embeddedness that reduces survival of eggs and fry, and the production of invertebrate prey, thereby diminishing rearing for 0+ and 1+ individuals (if present). The embeddedness of substrate in riffle habitat, as well as shallow pool depths described in the *Floodplain and Channel Structure* section, is caused in part by excess fine sediment, which also increases instream turbidity. Effects to coho salmon from elevated turbidity include an impaired ability to find food, gill abrasion, food assemblage changes, smothering of eggs and filling of pools with fine sediment.

Impaired Estuary/Mainstem Function

This stress focuses on the estuary conditions in the Bear River, since this is a single population basin (see Chapter 2 for further description of this stressor). Mainstem conditions are addressed through other stressors such as floodplain and channel structure, riparian condition, hydrologic function, etc. Estuary function is important to the population because of its unique role in the life history and survival of coho salmon. The Bear River estuary is considered by Wisniewski and Garinger (2006) to be suffering from changes in sediment, water, and wood. The lack of LWD, reduced pool frequency, and lack of riparian vegetation have decreased the availability of refugia. Accretion of sediment is widespread in the estuary and reduces pool and channel complexity. Juveniles and smolts are the most affected by the loss of estuarine function due to the lost opportunity for estuarine rearing and refuge. The loss of estuarine function is a medium threat for these life stages.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Hydrologic Function

Hydrologic function ranks as a low or medium threat to all life stages of coho salmon. Timber harvest practices and road construction have altered the vegetation, which ultimately changed the timing and volume of runoff. Increased water velocity and increased suspended sediment diminish habitat suitability during times of high flow. Water drafting is a component of the activities covered under the PALCO HCP and is also covered by state 1600 permits. However, no estimate of annual volume or location of water withdrawal is available.

Barriers

No fish passage barriers have been identified (CalFish 2009).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Bear River population area. Hatchery-origin coho salmon may stray into the population area, but the proportion of spawning adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin (Appendix B)

28.6 Threats

Table 28-3. Severity of threats affecting each life stage of coho salmon in Bear River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	High	Very High	Very High	Very High	Very High	Very High
2	Timber Harvest	Medium	Very High	Very High	Very High	Very High	Very High
3	Agricultural Practices	Medium	High	Very High	High	High	High
4	High Intensity Fire	Low	Medium	Medium	Medium	Medium	Medium
5	Climate Change	Low	Low	Medium	Medium	Medium	Medium
6	Fishing and Collecting	-	-	-	-	Medium	Medium
7	Channelization/Diking	Low	Low	Low	Low	Low	Low
8	Dams/Diversion	Low	Low	Low	Low	Low	Low
9	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
10	Mining / Gravel Extraction	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low

[1]Urban/Residential/Industrial Development, and Invasive and Non-Native Species are not considered threats to this population.

Roads

Road density, which serves as part of the water and sediment transport system, is high (greater than 3 miles of road per square mile of watershed) throughout the majority of the watershed and ranked as a very high threat to the majority of coho life stages. Roads accelerate delivery of sediment to the riparian and aquatic habitat, and alter the stream hydrograph. The majority of the roads are associated with land managed for industrial timber and managed under the HRC HCP, and HRC required to stormproof roads on their land.

Timber Harvest

Timber harvest is ranked as a very high threat to the majority of coho life stages. Legacy effects of past harvest practices, such as accelerated sediment transport, lack of wood recruitment, and lack of riparian canopy, reduce the habitat quality in Bear River and its tributaries. Effects of industrial timber harvest may be reduced under the HCP prescriptions, but it may take many decades before the riparian and stream habitat can recover. The remaining areas within the watershed are privately owned, and data does not exist regarding timber harvest occurring in these areas.

Agricultural Practices

Grazing in the lower watershed provides an overall high threat ranking for coho salmon, contributing to degraded riparian and aquatic habitat. Increased bank erosion and suspension of sediments increases turbidity and reduces light penetration, thereby interfering with visual feeding of juveniles (0+ and1+) and smolts. Production of prey is also limited by increased turbidity levels and elevated nutrient loading.

High Intensity Fire

Based on information in the Humboldt County General Plan (2008), a fire in the Bear River watershed would likely be severe due to climate, vegetation characteristics, and remote location. Fire is identified as a medium threat because of its potential significance if a fire were to occur.

Climate Change

Climate change poses a medium threat, primarily to juveniles, smolts, and adults. Although the current climate is generally cool, modeled regional average temperature shows a moderate increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 1^{o} C in the summer and by the same amount in the winter. Annual precipitation in this area is predicted to trend downward over the next century. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. The vulnerability of the estuary and coast to sea level rise is low in this population. Rearing and migratory habitat is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation will impact water quality and hydrologic function in the summer. As with all populations in the ESU, adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Bear River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Channelization/Diking

There is little evidence of channelization or diking in the watershed.

Dams/Diversions

There are no appropriative water rights in the Bear River watershed according to the NCRWQCB, however, the extent of riparian water rights is unknown. There are no dams in the watershed.

Road-stream Crossing Barriers

No road-crossing barriers have been identified in the Bear River watershed, resulting in a low threat ranking.

Mining / Gravel Extraction

Historically, small-scale gravel mining has occurred in the Bear River, and the Humboldt County Public Works is currently permitted to extract 3,000 $yards^3$ per year and 10,000 $yards^3$ per three to five year period from their Branstetter Bar sites (RM 1.5). Due to the low level of extraction, mining/gravel extraction is believed to be a low threat to coho salmon.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Bear River population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

28.7 Recovery Strategy

The numbers of coho salmon in the Bear River are severely depressed, as evidenced by their apparent absence. The Bear River population is likely highly dependent on straying from the Mattole and Eel rivers for recolonization, and the majority of the high IP habitat occurs in the lower watershed, primarily west of Peaked Creek. Recovery activities in the watershed should promote increased abundance by improving the habitat function for spawning and rearing in the high IP habitat. Actions that improve spawning and rearing habitat include those that reduce sediment delivery, improve stream temperatures, improve long term prospects for large wood recruitment, and promote increased floodplain and channel structure. These actions should be a priority in the watershed, especially in the high IP reaches. Reducing sediment upstream of the high IP reaches is a priority since the sediment will be transported into the high IP reaches. Activities that accomplish these goals will have beneficial effects on the estuary as well, although the time for these effects to be observed will likely be several decades and possibly much longer.

Table 28-4 on the following page lists the recovery actions for the Bear River population.

Table 28-4. Recovery action implementation schedule for the Bear River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-BeaR.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	High IP sub watersheds	3
SONCC-BeaR.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-BeaR.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-BeaR.7.1.5	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	High IP sub watersheds	3
SONCC-BeaR.7.1.5.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-BeaR.7.1.5.2	*Develop grazing management plan to meet objective*					
SONCC-BeaR.7.1.5.3	*Plant vegetation to stabilize stream bank*					
SONCC-BeaR.7.1.5.4	*Fence livestock out of riparian zones*					
SONCC-BeaR.7.1.5.5	*Remove instream livestock watering sources*					
SONCC-BeaR.7.1.6	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	BR
SONCC-BeaR.7.1.6.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-BeaR.7.1.6.2	*Develop watershed-specific guidance for managing riparian vegetation*					
SONCC-BeaR.7.1.7	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	3
SONCC-BeaR.7.1.7.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					
SONCC-BeaR.16.1.10	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-BeaR.16.1.10.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-BeaR.16.1.10.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-BeaR.16.1.11	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-BeaR.16.1.11.1	*Determine actual fishing impacts*					
SONCC-BeaR.16.1.11.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-BeaR.16.2.12	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-BeaR.16.2.12.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-BeaR.16.2.12.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-BeaR.16.2.13	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-BeaR.16.2.13.1	*Determine actual impacts of scientific collection*					
SONCC-BeaR.16.2.13.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-BeaR.3.1.8	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	BR
SONCC-BeaR.3.1.8.1	*Identify alternative water sources, storage means, or seasonal withdrawal restrictions to increase streamflow during low flow periods*					
SONCC-BeaR.3.1.8.2	*Reduce diversions*					
SONCC-BeaR.3.1.9	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-BeaR.3.1.9.1	*Provide education and training on conserving water while diverting*					
SONCC-BeaR.3.1.9.2	*Provide incentives to landowners to reduce water consumption during low flow periods*					
SONCC-BeaR.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-BeaR.27.1.15.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-BeaR.27.1.16	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-BeaR.27.1.16.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-BeaR.27.2.17	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-BeaR.27.2.17.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-BeaR.27.2.17.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-BeaR.27.2.18	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-BeaR.27.2.18.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-BeaR.27.2.19	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-BeaR.27.2.19.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-BeaR.27.2.21	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-BeaR.27.2.21.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-BeaR.27.2.22	Monitor	No	Track habitat condition	Monitor stream temperature	Population wide	BR
SONCC-BeaR.27.2.22.1	*Continue stream temperature monitoring at established locations*					
SONCC-BeaR.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-BeaR.27.1.23.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-BeaR.27.1.23.2	*If appropriate, modify population types and targets using revised methodology*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-BeaR.27.2.24	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-BeaR.27.2.24.1	*Determine best indicators of estuarine condition*					
SONCC-BeaR.8.1.2	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-BeaR.8.1.2.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-BeaR.8.1.2.2	*Decommission roads, guided by assessment*					
SONCC-BeaR.8.1.2.3	*Upgrade roads, guided by assessment*					
SONCC-BeaR.8.1.2.4	*Maintain roads, guided by assessment*					
SONCC-BeaR.8.1.3	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-BeaR.8.1.3.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-BeaR.8.1.4	Sediment	No	Reduce delivery of sediment to streams	Reduce stream bank erosion	Population wide	BR
SONCC-BeaR.8.1.4.1	*Inventory sediment sources, and prioritize for treatment*					
SONCC-BeaR.8.1.4.2	*Treat priority sediment source sites, guided by the plan*					

29. Mattole River Population

- Southern Coastal Stratum
- Non-Core, Functionally Independent Population
- High Extinction Risk
- 1,000 Spawners Required for ESU Viability
- 296 mi²
- 250 IP km (155 mi) (24% High)
- Dominant Land Uses are Timber Harvest and Rural Residential
- Principal Stresses are ‘Impaired Water Quality’ and ‘Altered Hydrologic Function’
- Principal Threats are ‘Dams/Diversions’ and ‘Roads’

29.1 History of Habitat and Land Use

Historic Impacts to the Basin

Given the underlying tectonics of the region coupled with post WWII human activity and disturbance within the basin, coho salmon habitat have been extensively impacted. One of the activities which may have dramatically impacted coho salmon habitat post WWII is timber harvest. Timber harvest had a pronounced effect on the physical nature of the Mattole River. Rapid population growth in California occurred after the end of WW II, and by 1965 more than 60 percent of the basin’s large Douglas-fir had been high-grade or clear-cut logged. As an example of this level of disturbance, Figure 29-2 shows Dry Creek in 1942, when it had forest cover that was typical of the Mattole basin prior to extensive Douglas-fir logging as depicted in a comparative photo (Figure 29-3) of the same area taken in 1965 [Mattole Restoration Council (MRC) 200]8. The aerial photos show a significant amount of deforestation and road construction in this basin by the mid 1960’s. This rate of activity was typical throughout much of the population area.

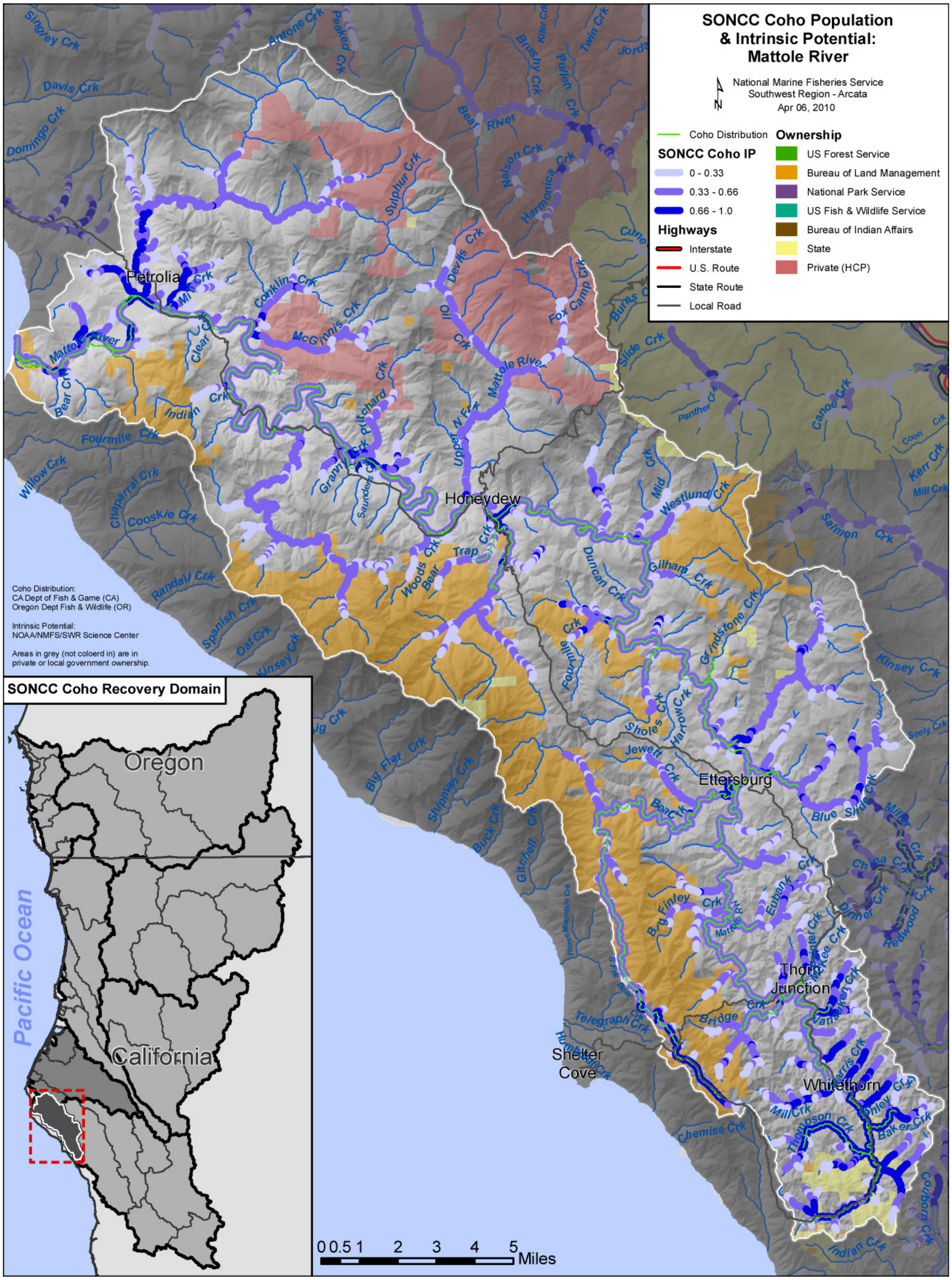

Figure 29-1. The geographic boundaries of the Mattole River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

A study in 1968 demonstrated that hardwoods, mainly tanoak, had increased significantly as a result of timber harvest practices. Unlike coastal redwood, Douglas-fir does not resprout, resulting in self-regeneration (Oswald 1978). Failure of logging operations to replant Douglas-fir seedlings after harvesting allowed for the establishment of more aggressive hardwood species. Once firmly established, hardwood stands are difficult and costly to restore back into conifer. Tractor and haul roads cut into recently logged hillsides, along with high amounts of rainfall, increased erosion and sediment delivery to Mattole River streams. The lack of reforestation also likely contributed to increased sediment loads, which in combination with other disturbances, left streams shallower, warmer, and more prone to flooding (Bodin et al. 1982; Raphael 1974). The 1955 and 1964 floods choked channels with sediment, filling deep pools (MRC 2008). Figure 29-4 shows how the North Fork of the Mattole, at the confluence with the mainstem, responded to basin disturbances post WWII (PALCO 2006b). The photographic evidence shows large accumulations of sediment within stream channels resulting in significant channel widening and loss of riparian forests. Such dramatic changes in stream conditions suggest there could have been significant reductions to coho salmon populations in this region by the late 1960's. Currently, timber harvest continues on private and industrial timberlands in the forested uplands throughout the Mattole River basin at a much reduced rate and under much stricter regulations. One large industrial timberland owner, the Pacific Lumber Company (PALCO), now HRC, in the Mattole basin operates under a state and federal Habitat Conservation Plan (HCP) on 18,350 acres in the western and northern basin (PALCO 1999a).

As a result of historical disturbances, as well as some ongoing disturbances, a river and estuary that likely once ran cold and deep now runs warm and shallow and the impacts to coho salmon and their habitat is severe (Downie et al. 2003). Overall, the current landscape is comprised of either small-diameter conifer forest, or hardwood-dominated forests that provide different ecological functions. Remaining late-seral conifer stands are fragmented and found largely on the public lands in the western and eastern basin. The PALCO HCP has a requirement to maintain a minimum of 10 percent late-seral stands on covered lands until 2049 (PALCO 1999b) and HRC is also designating several late seral stands as "high conservation value forest," which will be protected as long as the company remains the landowner.

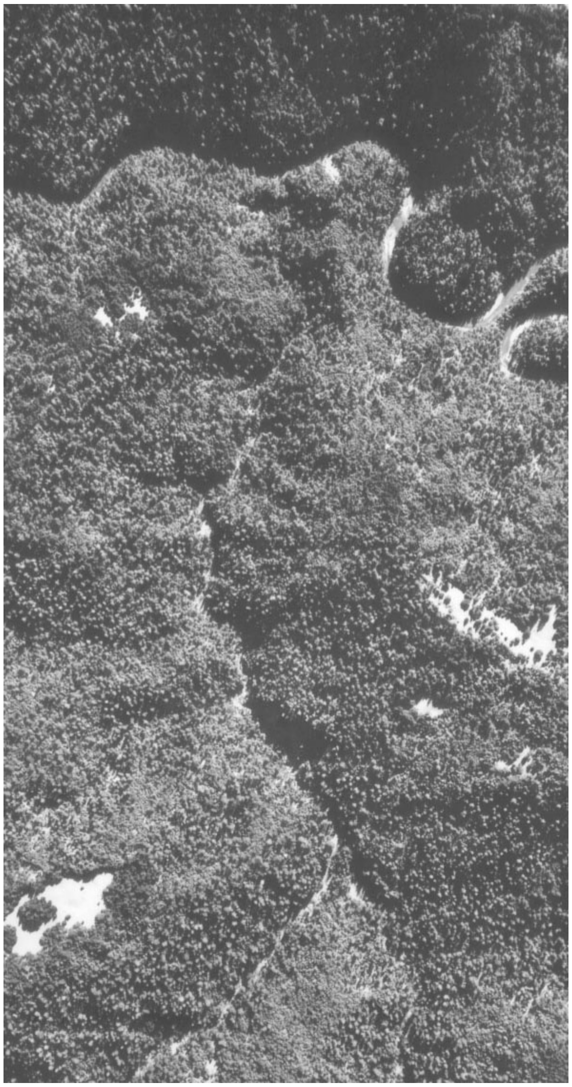

Figure 29-2 Aerial photo of Dry Creek, February 1942. Late-seral and mixed-aged stands of timber with good riparian and hill slope forest cover. Little evidence of increased sediment delivery to water courses (MRC 2008).

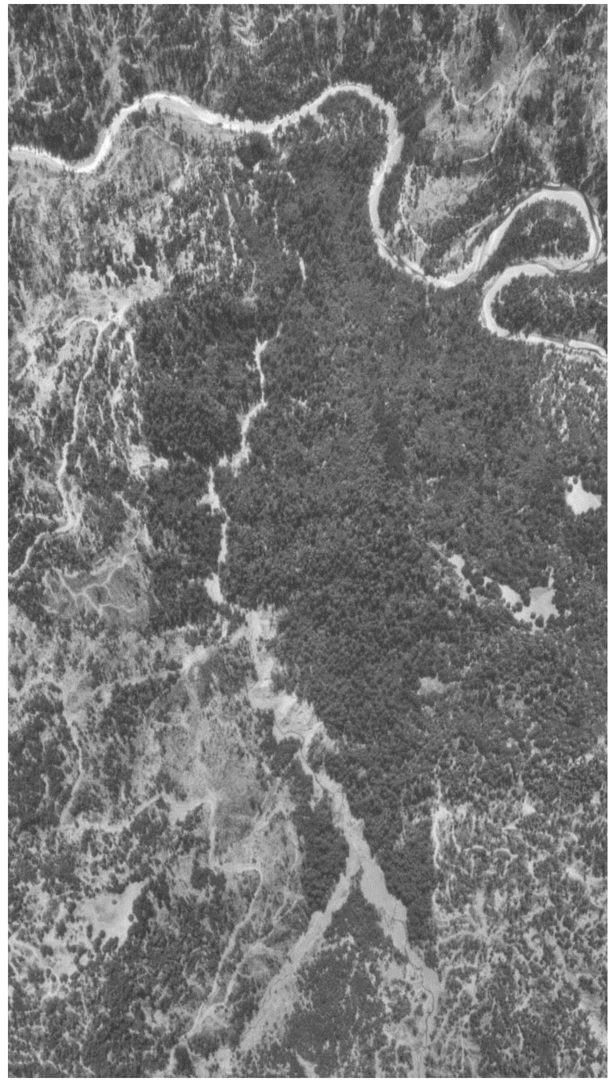

Figure 29-3. Aerial photo of Dry Creek, August 1965. High-grade and clear-cut logging exposed bare ground to rains. Tributary channel widening and filling is evident (MRC 2008*)*

Livestock grazing continues at various locations throughout the basin including lands managed by the Bureau of Land Management (BLM) King Range National Conservation Area (BLM 2004d). Livestock grazing within the geologically sensitive areas of the basin has also likely led to erosion as many riparian zones are not fenced allowing livestock to suppress vegetative growth and cause streambank instability.

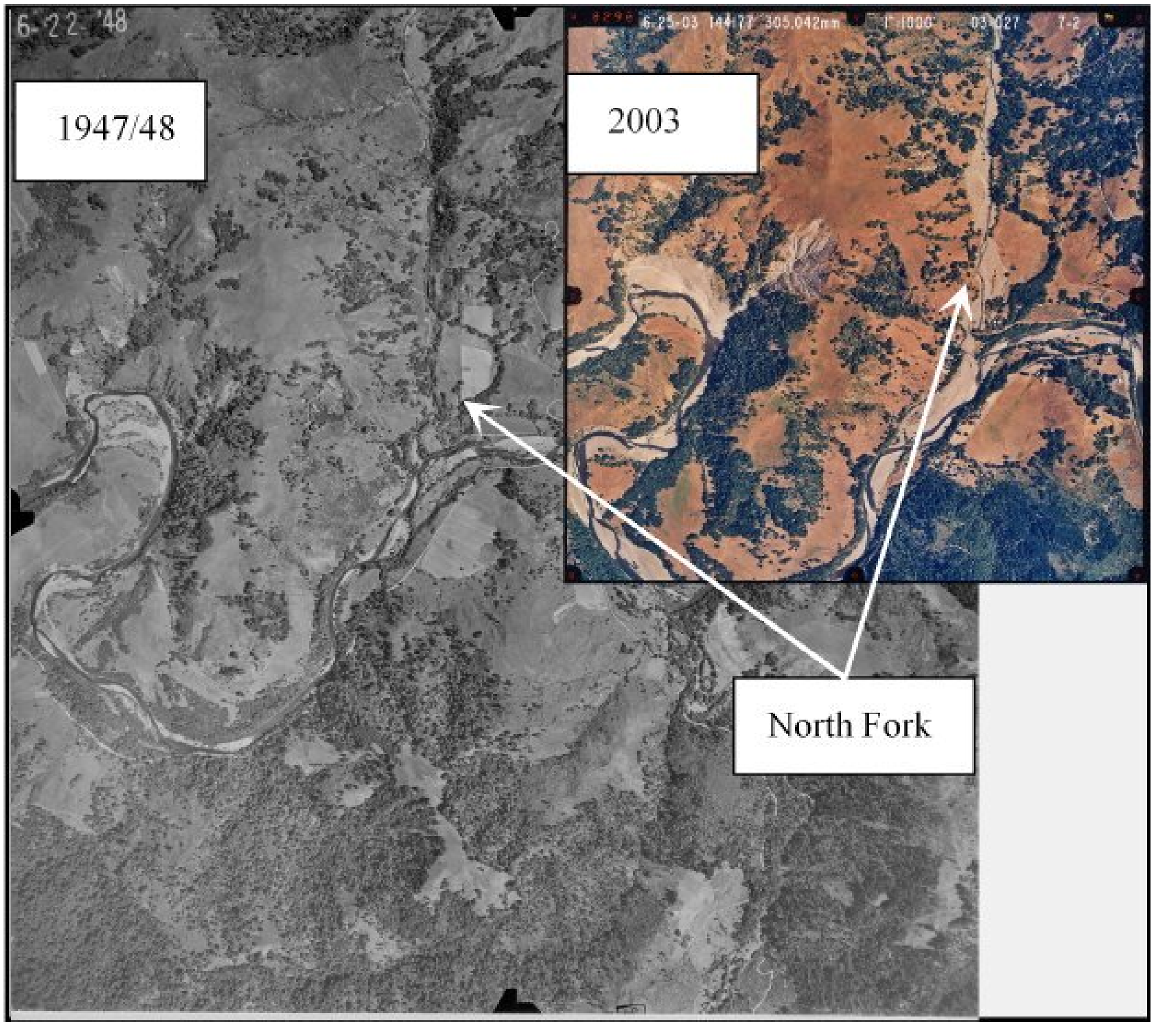

Figure 29-4. Comparative aerial photos between 1948 and 2003. Photos show wider (and aggraded) channel of the Upper North Fork Mattole near its confluence with the mainstem Mattole River.

With the establishment of rural residences and smaller ranches, water use has increased over the last 50 years. Currently, much of the demand for residential and agricultural uses is accommodated through in-stream diversions or shallow wells which may be affecting streamflows during summer low-flow periods. Much of the demand occurs in the southern basin where the last known stronghold on coho salmon spawning occurs. Additionally, the southern basin has experienced increasing levels of remote cultivation operations. Many of these operations require water sources during the summer, which coincides with juvenile coho salmon rearing. Water withdrawals in the mid- to late-summer may play a factor in late summer drying of stream reaches and stranding of juvenile coho. Unscreened water diversions (pumps) may entrain or impinge juvenile coho salmon.

The Mattole River basin is unique in the level of attention to natural resource conservation it has received for many decades. Although the human population size in the basin is relatively small and considered quite rural, the commitment from the local community to protecting and maintaining their natural environment is considerable. Conservation-oriented groups in the basin have taken actions to protect and restore the river's salmonid populations. Completed restoration projects include barrier removal, road upgrade and removal, fisheries science, water quality monitoring, and stream bank stabilization. .

29.2 Historic Fish Distribution and Abundance

Aside from the data described in the assessment of population viability detailed further in this section and the IP data shown in Figure 29-1, no data exist on run characteristics of coho salmon in the Mattole River prior to the 1950s. The IP data show the highest values (IP > 0.66) scattered throughout the basin's numerous tributaries. However, the southern basin headwaters have the highest concentration of high IP values. Somewhat unique to the SONCC ESU is that in the Mattole River basin the low gradient stream reaches suitable for coho spawning and rearing occur in headwater reaches (e.g., near the town of Whitethorn) where water temperature is consistently favorable to coho salmon growth and survival. Of interest to note are high IP values in the western portion of the northern basin such as the lower North Fork Mattole and East Mill Creek. However, historical data does not document extensive coho salmon distribution in these reaches, which raises concern as to whether coho salmon ever occupied these reaches. Table 29-1 lists those tributaries with high IP values. In the mid-to late 1950's, CDFG estimated an average run size of 8,000 coho salmon, 5,000 Chinook salmon, and 12,000 steelhead in the Mattole River (CDFG 1965). In 1960, the United States Fish and Wildlife Service (USFWS) estimated an average run size of 2,000 coho salmon, 5,000 Chinook salmon, and 12,000 steelhead; while the estimated potential population abundances were 20,000 coho salmon, 15,800 Chinook salmon, and 20,000 steelhead trout (Figure 29-5). The California Department of Water Resources (1965) reported that Chinook salmon were able to access 45 miles of the Mattole River, while coho salmon and steelhead trout used several more miles of the river. High intensity timber management in the basin (wide-scale road building and tractor logging) occurred during the 1950's and 1960's. Two significant storm seasons and wide-spread flooding occurred in 1955 and 1964, resulting in large scale mass-wasting and delivery of sediment to watercourses in areas where intensive timber harvest occurred. Some of the coho salmon population estimates provided above had been collected after these stochastic habitat altering events which may explain the reduction in coho salmon production throughout much of the population area.

Table 29-1. Tributaries with instances of high IP reaches (IP > 0.66) (Williams et al. 2006).

Stream Name	Stream Name	Stream Name
Mainstem Mattole upstream of Whitethorn	McNasty Creek	Indian Creek
Thompson Creek	Lost River	Bear Creek (near Estuary) Stansberry Creek
Baker Creek	McKee Creek	Unnamed tributary approx. 1 mile upstream of Pritchard Creek on right bank (Thornton Creek)
Stanley Creek	Unnamed tributary on right bank approx. 1 mile downstream of McKee Creek (Buck/Sinkyone Creek)	Pritchard Creek
Gibson Creek	Eubank Creek	McGinnis Creek
Harris Creek	Blue Slide Creek	Conklin Creek
Mill Creek	Mattole Canyon	East Mill Creek
Unnamed tributary on right bank approx. 1.5 miles downstream of Whitethorn (Ravasoni Creek)	Dry Creek	Lower North Fork Mattole River
Anderson Creek	Fourmile Creek	Jeffry Gulch
Vanauken Creek	Bear Creek (near Ettersburg)	Unnamed tributaries near estuary (Jim Goff Gulch)
Bridge Creek	Honeydew Creek	
Ancestor Creek	Granny Creek	

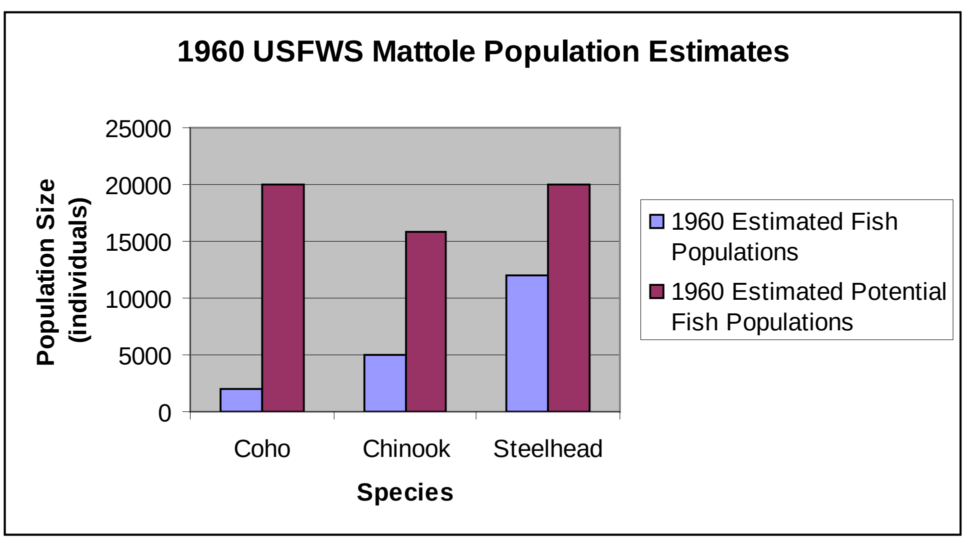

Figure 29-5. Population estimates from 1960. U.S. Fish and Wildlife Service-estimated actual and potential population abundance of adult Chinook salmon, coho salmon, and steelhead in the Mattole River basin (USFWS 1960).

29.3 Status of Mattole River Coho Salmon

Spatial Structure and Diversity

The diversity and complexity of the environmental conditions within the Mattole River basin have contributed to the evolutionary legacy of the coho salmon. The Mattole River population is functionally independent within the ESU (Williams et al., 2008). As a functionally independent population, the Mattole River population is sufficiently large to be historically viable-in-isolation and its demographics and extinction risk are minimally influenced by immigrants from adjacent populations (Williams et al. 2006).

Hatchery influences have been minimal in the Mattole River basin. Small-scale hatch box and captive rearing programs were implemented, but were discontinued in the 1980's. Coho salmon are found in only a small fraction of their historic habitat in the basin, possibly due to habitat degradation such as high water temperatures. Recently, the only known occurrences of coho salmon in the lower 27 miles of the Mattole have been in Lower Mill Creek (MRC 2008). Survey efforts in the upper Mattole basin have been limited. As the current distribution of spawning adults is limited to just a few tributaries with suitable habitat (such as Lower Mill Creek), the Mattole River coho salmon population is at a high risk of extinction because its spatial structure and diversity are very limited compared to estimated historical conditions.

Population Size and Productivity

There were an estimated 500 spawners in 1981 to 1982, a peak of more than 1,000 spawners in 1987 to 1988, and less than 200 spawners in 1994 to 1995. In 2009, it was estimated that the coho salmon population was in the low hundreds at best (Mattole River and Range Partnership (MRRP) 2009). However spawning surveys in the winter of 2009/2010 found only three live adults and one redd in the basin (Mattole Salmon Group (MSG) 2010). Due to extremely low catches of coho salmon juveniles during outmigrant trapping efforts, population estimates cannot be calculated.

Extinction Risk

Williams et al. (2008) determined at least 250 coho salmon must spawn in the Mattole River each year to avoid the effects of extremely low population sizes. The number of adults believed to currently occur in this basin is believed to be well below this level. Based on the criteria set forth by Williams et al. (2008) the Mattole population is at a high risk of extinction. This conclusion is based on the limited distribution, diversity, and small size of the population. An important priority for recovery of the Mattole River coho salmon population is to increase its distribution across the basin from the headwaters through the estuary. A diversity of well distributed and connected habitats, from the headwaters to the ocean, will enhance species diversity, abundance and productivity, and minimize the effects of climate change or the risk of extinction associated with stochastic events.

Role in SONCC Coho Salmon ESU Viability

The Mattole River population is a non-core1 population and its recovery target is to recover the population to at least a moderate risk of extinction; meeting the moderate risk spawner threshold (see Chapter 4). The moderate risk spawner threshold addresses the need for adequate spatial structure and diversity within the population (see Williams et al. 2008).

29.4 Plans and Assessments

Mattole River and Range Partnership:

Mattole Coho Recovery Strategy

The MRRP was formed between three watershed groups active in the basin. The partnership developed a coho salmon recovery strategy for coho salmon in the Mattole River basin. The strategy discusses population status, recovery targets, limiting factors, strategies for recovery, and a prioritized list of recovery actions.

State of California

CDFG Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish and Game Commission in February 2004.

The North Coast Watershed Assessment Program (NCWAP)
http://www.coastalwatersheds.ca.gov

The NCWAP Mattole River basin Assessment identifies limiting factors for anadromous salmonids including, estuarine conditions, lack of habitat complexity, increased sediment levels, high water temperatures, and inadequate flows during the summer.

Bureau of Land Management (BLM)

Mattole River Watershed Assessments

The BLM has conducted several watershed assessments and developed Resource Management Plans for BLM managed lands within the Mattole River basin. These include:

The King Range National Conservation Area Resource Management Plan (BLM 2004d)

Mill Creek Watershed Analysis (BLM 2001)

Honeydew Creek Watershed Analysis (BLM 1996c)

Bear Creek Watershed Analysis (BLM 1995a)

29.5 Stresses

Table 29-2. Severity of stresses affecting each life stage of coho salmon in the Mattole River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Impaired Water Quality[1]	Medium	Very High	Very High[1]	Very High	Medium	Very High
2	Altered Hydrologic Function[1]	Low	Medium	Very High[1]	Very High	High	Very High
3	Altered Sediment Supply	High	High	High	High	High	High
4	Lack of Floodplain and Channel Structure	Medium	High	High	High	High	High
5	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
6	Impaired Estuary /Mainstem Function	-	Low	High	High	Low	High
7	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
8	Barriers	-	Low	Low	Low	Low	Low
9	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).
[2] Increased Disease/Predation/Competition is not considered a stress for this population.

Limiting Stresses, Life Stages, and Habitat

Based on the type and extent of stresses and threats affecting the population as well as the limiting factors influencing productivity, it is likely that the juvenile life stage is most limited and that quality summer rearing habitat is lacking for the population. Low flow conditions increase water temperatures and even leave some tributaries dry during the summer season, creating an inhospitable environment for rearing and reducing the overall summer rearing habitat availability.

There are four primary and consistent sources of cold water in the lower seven miles of the Mattole River: Lower Mill Creek, which enters the Mattole at River Mile 2.8; Stansberry Creek at River Mile 1.3; Lower Bear Creek at River Mile 1.0, and the tidal prism. Additional sources of cold water in the lower river include Collins Gulch, Jeffrey Gulch, Jim Goff Gulch, Titus Creek, and Tom Scott Creek, although most of these tributaries likely do not flow year-round. Nevertheless, these drainages may still be sources of subsurface cold water to the mainstem providing some isolated pockets of cool water. They are also likely areas for placing habitat improvement structures to enhance already present coldwater refugia for juvenile salmonids.

Significant headwater tributaries that consistently provide cold water discharge to the mainstem Mattole include Thompson, Mill, Bridge, and Buck creeks. Three of these creeks are known to provide rearing habitat for coho. Finally, Klein (2009) concluded that greater participation in programs to cease pumping when mainstem flows reach 0.7 cfs are likely to result in measurable increases in low summer streamflows. Such an effect would likely increase the availability of cool water refugia to constrained coho salmon juveniles in this area of the basin.

In the western basin, Lower Bear Creek is part of a complex of cold seeps, springs and small streams that flow from the east side of the King Range. These cold water sources maintain temperatures in the 58 to 64° F degree range and flow into a well covered channel along the south bank. In August of 2004, there were pools of 58° F standing water in these channels (MSG 2004). As part of their assessment, Downie et al. (2003) identified several tributaries that provide high refugia value based on current habitat conditions. These are listed in Table 29-3.

Table 29-3. Potential refugia areas in the Mattole River basin.

Watershed	***Stream Name***	***Watershed***	***Stream Name***
Southern	Mainstem Mattole upstream of Whitethorn	Eastern	McKee Creek
	Thompson Creek	Western	Eubank Creek
	Baker Creek		Bear Creek (near Ettersburg)
	Mill Creek		
	Vanauken Creek		
	Bridge Creek		

Impaired Water Quality

High water temperature is problematic in many areas of the Mattole River population area, including the estuary. Water quality is most stressful for the fry and juvenile life history stages because they are present during the summer and early fall when temperatures are highest. The coolest temperatures were measured in the southern basin. Low dissolved oxygen (DO) levels in the headwaters during the late summer months are a water quality concern for juvenile survival.

Adding to the stresses of low flow and stranding of juvenile coho, in years with extremely low flow in the headwaters of the Mattole River, DO levels dropped to a point where they may be fatal to coho salmon juveniles. An extremely dry year in 2002 recorded a DO of 0.2 mg/L, while a guideline of greater than 6.0 mg/L is considered the level at which adverse effects to salmonids is not an issue (MRRP 2009). Low DO is common during the summer and may have contributed to the death of thousands of juveniles in 2002.

Altered Hydrologic Function

Altered hydrologic functions are most stressful for juveniles and smolts. Low stream flows are problematic for coho salmon throughout the basin. These conditions are most acute when little or no rainfall occurs during summer months and where rural and residential water use is the highest. Reaches in the southern basin are particularly prone to seasonal drying.

Klein (2009) conducted a study of low flow conditions in the headwater reaches of the Mattole River and found that small amounts of rainfall (0.25”) and multiple days of fog in the driest part of summer can provide relief to low or no flow conditions in the Mattole River headwaters. This study found that one inch of rainfall in July, 2007 elevated subsequent mainstem flows for almost two weeks. Another finding of this study was that mainstem discharges in the Upper Mattole River were less than the sum of upstream tributary discharges and concluded that, among other things, water withdrawal in the mainstem may be a contributing factor to frequent low flow conditions downstream.

Altered Sediment Supply

Altered sediment supply presents a high stress across all life history stages. Increased sediment delivery has filled pools, widened channels, and simplified stream habitat throughout the basin including the estuary. The widening of channels in the mainstem and major tributaries has likely exacerbated the rates of streambank failures as thalwegs are not stable resulting in channel braiding.

In many reaches stream beds have aggraded, reducing surface flows and limiting access for migrating juveniles. Measurements suggest that pools in the southern basin may be mostly free of fine sediment accumulation. However, the preponderance of poor rankings throughout the population area suggests that sediment delivery to stream channels is a critical stress affecting the population.

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure present a high stress across multiple life stages. Habitat conditions within the channel and adjacent floodplain vary depending on which metric is used. Pool depths are generally poor to fair throughout most of the basin, with the exception of the headwaters region. Pool frequency varies widely, with most of the very good ratings occurring in the smaller tributaries of the southern basin. Data on instream large wood is limited, but does not appear to be a significant limiting factor in the headwaters region. However, increasing levels of instream wood may improve rearing conditions resulting in potential increases in egg to smolt survival rates. In many of the middle and lower mainstem tributaries a lack of large, pool forming wood does appear to be a problem (PALCO 2006b). Given the extensive timber harvesting that has occurred in the basin and the changes in riparian vegetation characteristics, lack of large wood is likely limiting the development of complex stream habitat throughout the lower two thirds of the basin. This lack of complex overwintering habitat throughout much of the system may be a significant factor in the historical population decline and current low population numbers.

Riparian Forest Conditions

Degraded riparian forest conditions exist across the basin and present high stress across many life stages. Streamside canopy cover is variable. Conditions in the southern tributaries are mostly very good, but elsewhere canopy cover exists in a range of conditions. Much of the streamside canopy is either hardwood dominated or of insufficient size to provide large wood. .

Impaired Estuary/Mainstem Functions

Prior to major land disturbances, the Mattole estuary/lagoon was notable for its depth and numerous functioning slough channels on both the north and south banks of the river (MRC

1995). Currently, the estuary is severely aggraded and lacks channel complexity and riparian cover. Stored sediment in the mainstem and slough channels of the lower river is a critical problem for the Mattole estuary as is the bar that forms across the mouth during low flows and blocks access to and from the ocean. The lack of access can be a major stressor for smolts and adults, depending on the timing and duration. At times in the recent past, efforts have been made to artificially breach the river mouth bar due to concerns of low survival rates for salmonids from an extended period of residence time in the estuary.

Water temperatures in the estuary during late summer periods have been found to be poor for developing salmonids and may be impairing their survival at ocean entry (MRRP 2009). The lack of habitat for juveniles and smolts to use for rearing and holding and poor water quality in the estuary may also be a stressor for the population as they may be more susceptible to predation without adequate cover habitat.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Barriers

Barriers are a low stress to the Mattole River population. Currently, there are five barriers that are potentially limiting coho salmon distribution. They are listed in order of priority for remediation: South Fork Vanauken Creek, Eubank Creek, High Prairie Creek, Harris, and Painter creeks. Over the last two decades substantial funding has been provided to remove barriers, and the last remaining barriers do not occur in tributaries with substantial coho salmon habitat upstream of the barrier.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Mattole River population area. Hatchery-origin coho salmon may stray into the population area, but the proportion of spawning adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin.

29.6 Threats

Table 29-4. Severity of threats affecting each life stage of coho salmon in the Mattole River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Dams/Diversions	High	Very High	Very High	High	High	Very High
2	Roads	High	High	High	High	High	High
3	Timber Harvest	High	High	High	High	High	High
4	Urban/Residential/Industrial	High	High	High	High	High	High
5	High Intensity Fire	High	High	High	High	High	High
6	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
7	Channelization/Diking	Medium	Medium	Medium	Medium	Medium	Medium
8	Climate Change	Low	Low	Medium	Low	Medium	Medium
9	Fishing and Collecting	-	-	-	-	Medium	Medium
10	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low
12	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low

[1]Invasive Non-Native/Alien Species is not considered a threat to this population.

Dams/Diversions

Numerous wells and diversions for agricultural and domestic uses occur throughout the basin and reduce streamflows during critical low-flow periods. Of particular importance is the southern basin where many of the highest IP reaches occur coincident with numerous rural residences. Bear Creek and the North Fork Mattole may also be influenced by agricultural and residential withdrawals, although due to their size, water withdrawals may not be as noticeable as in the smaller tributaries of the southern basin.

Roads

Roads are a significant threat across all life stages. Although significant efforts have been made in the basin to upgrade and decommission roads to reduce their sediment generating potential, road density remains high throughout the basin, with some areas having greater than 5 road miles/square mile of basin (PALCO 2006b). Given the extensive problem of sedimentation, roads throughout the basin should continue to be considered for removal or treatments to reduce sediment delivery.

Roads in the northern and western basin should continue to receive high priority as they occur in the region most susceptible to mass-wasting and significant landslide events. The continuation of such occurrences impedes the ability of important tributaries to route sediment, and return to more balanced states of channel and riparian stability.

Timber Harvest

Timber harvest has been most concentrated in the North Fork Mattole, Oil Creek and southern basin. Numerous smaller non-industrial timber harvesting activities occur throughout the basin. Many of the changes in stream and riparian conditions are the result of more intensive historic harvest. However, given the percentage of the basin that is in private ownership, future timber harvest is still considered a high threat and should be carefully considered with regards to its effects on coho salmon, particularly in the southern basin and other tributaries with high IP values. There is a program-level environmental impact report for timber harvesting practices available for landowners in the Mattole River population area to use when preparing timber harvest plans. .

Urban/Residential/Industrial Development

Rural population growth will continue to present a high threat to coho salmon in the Mattole as there is no water development agency in the basin and landowners are left to finding their own sources of water. Lack of a structured water right permitting program is a significant deficiency in this basin for the protection of vestigial coho salmon populations. Additionally, such growth results in removal of vegetation, increased sediment generation and delivery, increased road density, and introduction of exotic species. Subdivision of existing parcels is likely to exacerbate this threat.

High Intensity Fire

The altered vegetation characteristics throughout the basin present a high threat for high intensity fires. High intensity fires can significantly contribute to large-scale mass-wasting events if not properly treated with high levels of erosion control devices after the fire has ended. Even with the best efforts made at controlling post-fire erosion, the first rains typically produce much higher rates of sediment delivery than pre-fire conditions and can contribute to high sediment loading in affected watercourses.

Agricultural Practices

Livestock grazing occurs throughout the basin and is known to cause increased erosion and sediment delivery if not properly managed. However, specific information on the magnitude of grazing impacts is limited. Water withdrawals for agricultural uses were considered in the “Dams/Diversions” threat.

Channelization/Diking

Although channelization and diking is not widespread, localized restrictions may occur where roads that run parallel to streams reduce floodplain connectivity and function. Other instances of channelization near tributary confluences should be identified and considered for alteration to improve floodplain function and potentially provide off-channel habitat.

Climate Change

Climate change modeling indicates climate change poses a medium threat to this population. As mentioned previously, air temperatures in this basin depend on proximity to the coastline. Along the coastal areas of the basin (essentially west of Petrolia), summertime temperatures are strongly influenced by the coastal marine layer (fog) and remain relatively cool throughout the summer. East of Petrolia, with the King Range blocking marine influence, daytime summer temperatures often remain above 80˚ F. Generally, as inland temperatures rise the marine layer becomes thicker and moves farther inland (the fog "belt"). If climate modeling proves correct, the impacts of climate change in this region will have the greatest impact on juveniles and adults. Modeled regional average temperature shows an increase over the next 50 years (see Appendix B for modeling methods). Juvenile and smolt life stages area most at risk to climate change. Average temperature could increase by up to 1^{o} C in the summer and by the same amount in the winter.

Annual precipitation in this area is predicted to trend downward over the next century; however, a critical factor is how precipitation is distributed over critical seasons. For example, if rains end sooner and begin later in the fall, the threat to coho salmon in this region is significant as the expectation would be that cool, rearing pools would be more susceptible to drying resulting in increasing mortality events as previously described. If, on the other hand, climate change results in slightly higher air temperatures, but more frequent instances of cool summer storms that generate overland flow, the opposite effect may be experienced (reduced rates of low or no flow events) potentially expanding the rearing habitat for juveniles.

Changes in precipitation patterns may not be beneficial in the estuary if changes to natural cycles of river mouth breaching and closing are a result. Early breaching events could negatively affect ocean survival of smolts to adults if smolts have not had enough time in the estuary to achieve optimal growth in preparation for ocean entry. In addition, these alterations in the freshwater input cycle to the marine environment could alter near-shore ecology and salmonid prey species. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, as with all populations in the ESU adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Mattole River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Mining/Gravel Extraction

Gravel extraction and mining was ranked as a low threat as very little in-stream gravel mining occurs in the Mattole. The County of Humboldt infrequently removes gravel from a single bar on the lower North Fork Mattole. Currently, upslope mining does not occur in the basin. Due to the remote location of the basin and the high cost of trucking gravel out of the basin, increased rates of gravel extraction are not anticipated. This threat ranking reflects sensitivity of the channel to additional disturbances due to the lack of floodplain and channel structure.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Mattole River population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

Road-Stream Crossing Barriers

Much work has been done to remove barriers in the basin and as such, barriers are a low threat. As mentioned previously there are five barriers that remain to be treated which will allow access to a relatively limited amount of coho salmon habitat.

Table 29-5. List of prioritized road-stream crossing barriers.

Barrier Treatment Ranking*	Stream Name	Watershed	County	Miles of habitat**
1	South Fork Vanauken Creek	Southern	Humboldt	<0.5
2	Eubank Creek	Eastern	Humboldt	<0.5
3	High Prairie Creek		Humboldt	<1
4	Harris Creek	Southern	Humboldt	<1
5	Painter Creek	Eastern	Humboldt	<0.5

* MSG (2010)
** MSG (2010) and GIS estimate

29.7 Recovery Strategy

Coho salmon abundance in the Mattole River is severely depressed with a constricted distribution. Recovery activities in the basin should promote increased spatial distribution as well as increased productivity and abundance. Activities should occur basin-wide, with a focus on those tributaries with high IP values listed in Table 29-1. Activities that reduce the instances of low or no flow conditions, decrease sediment delivery, improve stream temperatures, improve long term prospects for large wood recruitment, and promote increased floodplain and channel structure should be a priority in the basin. Recovery actions for the estuary should include enhancing riparian functions to provide cover and moderate stressful water temperatures as well as actions to increase available cover habitat for protection against predation. Table 29-6 on the following page lists the recovery actions for the Mattole River population.

Table 29-6. Recovery action implementation schedule for the Mattole River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MatR.3.1.2	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	2
SONCC-MatR.3.1.2.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-MatR.3.1.3	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	2
SONCC-MatR.3.1.3.1	*Create water budgets that avoid over allocating water diversions*					
SONCC-MatR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	2
SONCC-MatR.3.1.4.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-MatR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Headwaters	2
SONCC-MatR.3.1.5.1	*Increase participation in forbearance program*					
SONCC-MatR.3.1.5.2	*Monitor forbearance compliance*					
SONCC-MatR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Headwaters	2
SONCC-MatR.3.1.6.1	*Reduce diversions*					
SONCC-MatR.3.1.7	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MatR.3.1.7.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-MatR.3.1.8	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MatR.3.1.8.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-MatR.3.1.9	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MatR.3.1.9.1	*Establish a comprehensive statewide groundwater permit process*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MatR.3.2.10	Hydrology	Yes	Increase water storage	Increase water retention	Headwaters	2
SONCC-MatR.3.2.10.1	*Develop water storage and recharge plan*					
SONCC-MatR.3.2.10.2	*Implement projects identified in water storage and recharge plan*					
SONCC-MatR.3.2.10.3	*Maintain water storage structures*					
SONCC-MatR.1.2.11	Estuary	No	Improve estuarine habitat	Restore estuarine habitat	Estuary	2
SONCC-MatR.1.2.11.1	*Assess factors limiting coho rearing in the estuary including temperature, excess sediment, and size of estuary*					
SONCC-MatR.1.2.11.2	*Develop a plan to restore the estuary including restoration of the south slough and potentially removing excess sediment*					
SONCC-MatR.1.2.11.3	*Implement the estuary restoration plan*					
SONCC-MatR.1.2.35	Estuary	No	Improve estuarine habitat	Assess estuary and tidal wetland habitat	Estuary	3
SONCC-MatR.1.2.35.1	*Identify parameters to assess condition of estuary and tidal wetland habitat*					
SONCC-MatR.1.2.35.2	*Determine amount of estuary and tidal wetland habitat needed for population recovery*					
SONCC-MatR.16.1.21	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MatR.16.1.21.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MatR.16.1.21.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-MatR.16.1.22	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MatR.16.1.22.1	*Determine actual fishing impacts*					
SONCC-MatR.16.1.22.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-MatR.16.2.23	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MatR.16.2.23.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MatR.16.2.23.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-MatR.16.2.24	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MatR.16.2.24.1	*Determine actual impacts of scientific collection*					
SONCC-MatR.16.2.24.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-MatR.2.1.12	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	High IP subwatersheds in the Upper Mattole	3
SONCC-MatR.2.1.12.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MatR.2.1.12.2	*Place instream structures, guided by assessment results*					
SONCC-MatR.2.2.13	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	High IP subwatersheds in the Upper Mattole	2
SONCC-MatR.2.2.13.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MatR.2.2.13.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-MatR.26.1.1	Low Population Dynamics	No	Increase population abundance	Implement an enhancement program	Population wide	2
SONCC-MatR.26.1.1.1	*Assess impacts and benefits associated with different enhancement programs such as captive broodstock, rescue rearing, and conservation hatcheries*					
SONCC-MatR.26.1.1.2	*Develop a facility to rear fish*					
SONCC-MatR.26.1.1.3	*Operate enhancement program as a temporary strategy to 26.1*					
SONCC-MatR.26.1.1.4	*Monitor fish populations at all life stages including juvenile snorkel counts, downstream migrant counts, spawning surveys, and PIT tagging*					
SONCC-MatR.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-MatR.27.1.25.1	*Perform annual spawning surveys*					
SONCC-MatR.27.1.26	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MatR.27.1.26.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-MatR.27.1.27	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-MatR.27.1.27.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-MatR.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MatR.27.2.28.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-MatR.27.2.28.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-MatR.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-MatR.27.2.29.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-MatR.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-MatR.27.2.30.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-MatR.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MatR.27.2.31.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-MatR.27.2.32	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-MatR.27.2.32.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-MatR.27.2.33	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-MatR.27.2.33.1	*Annually measure the hydrograph and identify instream flow needs*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MatR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Estuarine Function'	All IP habitat	3
SONCC-MatR.27.2.34.1	*Identify habitat condition of the estuary*					
SONCC-MatR.27.1.36	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MatR.27.1.36.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-MatR.27.1.37	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-MatR.27.1.37.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MatR.27.1.37.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-MatR.27.2.38	Monitor	No	Track habitat condition	Determine best indicators of estuarine condition	Estuary	3
SONCC-MatR.27.2.38.1	*Determine best indicators of estuarine condition*					
SONCC-MatR.5.1.19	Passage	No	Improve access	Remove barriers	South Fork Vanauken, Eubank, High Prairie, Harris, Painter, South Fork Bear, Buck, and Baker creeks	3
SONCC-MatR.5.1.19.1	*Inventory and prioritize barriers*					
SONCC-MatR.5.1.19.2	*Remove barriers*					
SONCC-MatR.7.1.14	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	High IP subwatersheds	3
SONCC-MatR.7.1.14.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-MatR.7.1.14.2	*Develop grazing management plan to meet objective*					
SONCC-MatR.7.1.14.3	*Plant vegetation to stabilize stream bank*					
SONCC-MatR.7.1.14.4	*Fence livestock out of riparian zones*					
SONCC-MatR.7.1.14.5	*Remove instream livestock watering sources*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MatR.7.1.15	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	High IP subwatersheds	3
SONCC-MatR.7.1.15.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-MatR.7.1.15.2	*Thin, or release conifers, guided by prescription*					
SONCC-MatR.7.1.15.3	*Plant conifers, guided by prescription*					
SONCC-MatR.7.1.16	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-MatR.7.1.16.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					
SONCC-MatR.8.1.17	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-MatR.8.1.17.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MatR.8.1.17.2	*Decommission roads, guided by assessment*					
SONCC-MatR.8.1.17.3	*Upgrade roads, guided by assessment*					
SONCC-MatR.8.1.17.4	*Maintain roads, guided by assessment*					
SONCC-MatR.8.1.18	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3
SONCC-MatR.8.1.18.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					

30. Illinois River Population

- Interior Rogue Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 11,800 Spawners Required for ESU Viability
- 400 mi^2
- 590 IP km (367 mi) (47% High)
- Dominant Land Uses are Agriculture and Urban/Residential/Commercial Development
- Principal Stresses are 'Altered Hydrologic Function' and 'Degraded Riparian Forest Conditions'
- Principal Threats are 'Roads' and 'Dams/Diversions'

30.1 History of Habitat and Land Use

From 1780 to 1840, trappers swept Oregon coastal rivers, including the Rogue River basin, reducing the robust beaver population to remnant levels (Oregon Department of Fish and Wildlife (ODFW) 2005b). Beaver ponds provide excellent rearing habitat for coho salmon, and thus beaver trapping was likely the first negative effect of European settlers on coho salmon. Gold mining in the Illinois Valley began in the 1850s (U.S. Bureau of Land Management (BLM) 2003). Flood terraces were turned over, which disrupted riparian areas and in some cases unleashed large quantities of sediment (U.S. Forest Service (USFS) 1999a).

The first agricultural development arose to support the community of miners. After the gold rush, agriculture continued to expand in the fertile lowlands surrounding the river. Meadows and valley bottom forests were converted to pasture where thousands of cows grazed, and more than 100,000 sheep occupied upland meadows of the Illinois subbasin and other watersheds in Siskiyou Mountains (USFS 1999a).

Logging on a large scale began in the Illinois Valley after World War II (USFS 1997a, USFS and BLM 2000), when there were few restrictions on harvesting near streams or using stream beds to skid logs. Channel damage from the 1964 flood was widespread and exacerbated by timber harvest and road building activities. Affected areas included the East Fork Illinois River and its tributaries Chicago and Dunn creeks (USFS and BLM 2000), and Sucker Creek and its tributaries Grayback, Cave, Tannen creeks (USFS 1997a).

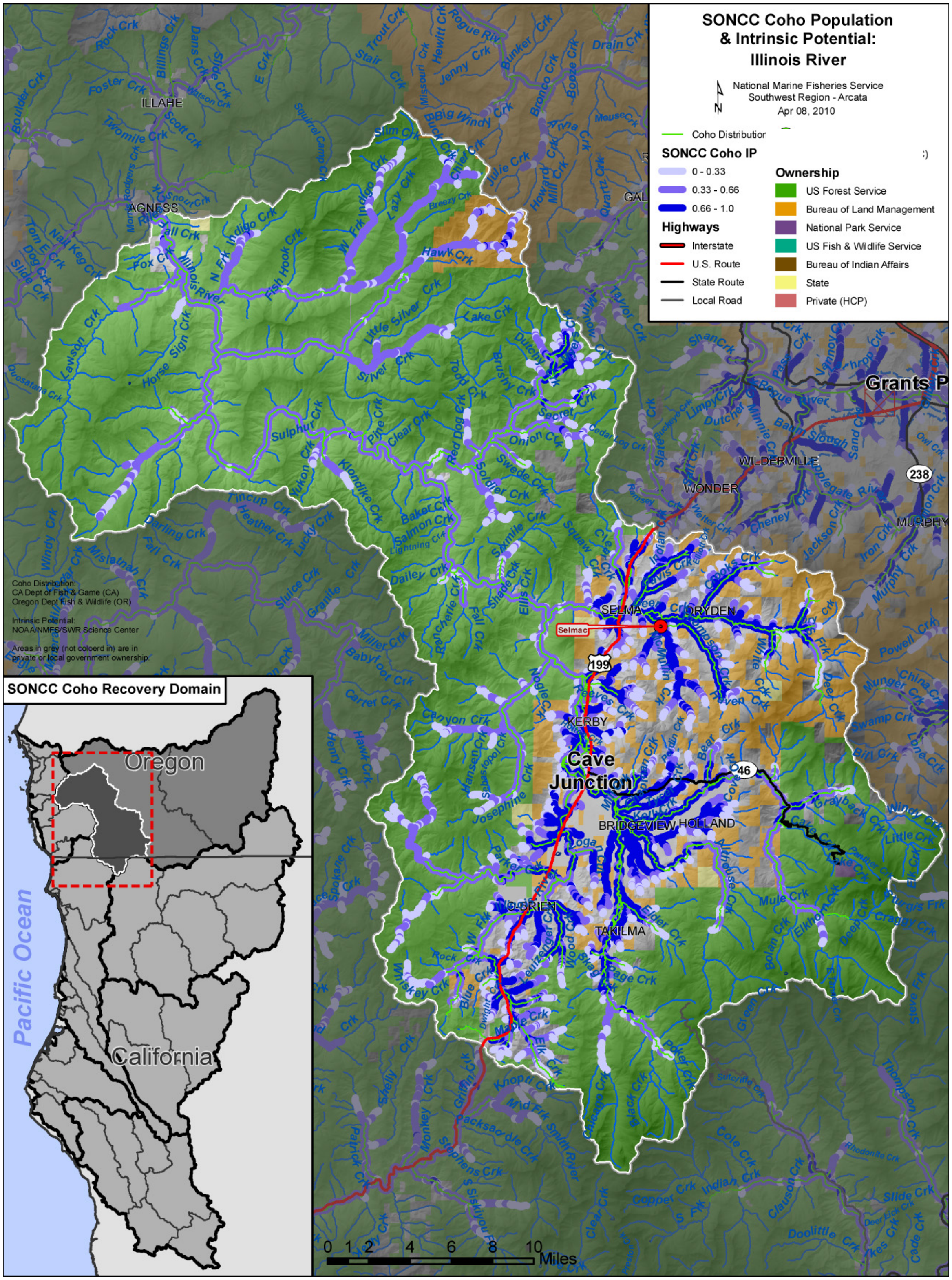

Figure 30-1. The geographic boundaries of the Illinois River coho salmon population. Figure shows modeled Intrinsic Potential habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Less ground-disturbing methods of logging were used by the USFS and U.S. Bureau of Land Management (BLM) in the 1970s and 1980s, but many landslides still occurred as a result from failures on steep harvested slopes (USFS 2000b) and extensive road networks (BLM 1997, USFS 1998c). This triggered another sediment pulse that compounded adverse effects to habitat.

Alluvial valley reaches near the mouth of the Illinois River that strongly overlap with extensive high IP (>0.66) coho salmon habitat (Williams et al. 2006) were formerly winding channels with complex wetlands and likely numerous beaver ponds (BLM 2005). These reaches would have had substantial groundwater and surface water connections (Oregon Department of Environmental Quality (ODEQ) 2008) as well as slow water habitats suitable for both summer and winter rearing of coho salmon juveniles. These mainstem summer and winter refugia for coho salmon juveniles have been largely lost.

Although federal ownership covers 81 percent of the Illinois River population, the vast majority of stream reaches on USFS and BLM lands are too steep or otherwise unsuitable for coho salmon. Both the USFS and BLM have adopted new timber harvest practices which are less detrimental to salmonid habitat. Forests are now being thinned to meet conservation and recreation objectives (USFS 2007), rather than cleared for timber sale. Aquatic habitat on federal lands in the Illinois River subbasin is recovering in response to these land use changes.

Rural residential growth in the watershed has followed a pattern similar to other areas of Josephine and Curry counties, with related increased demand on surface and groundwater (Southwest Oregon Resource Conservation and Development Council (SO RC&D) 2003).

30.2 Historic Fish Distribution and Abundance

Historically, coho salmon were widely distributed in the Illinois River watershed; however most of the high intrinsic potential (IP >0.66) coho salmon habitat (Williams et al. 2008) is in low gradient tributaries in the upper portion of the subbasin (Figure 30-1). Coho salmon production potential is limited in other areas. Tributaries of the lower Illinois River subbasin, such as Silver, Lawson, and Indigo creeks, are too steep and confined for coho salmon to flourish. High IP coho salmon habitat occurs on a bench in the upper North Fork of Silver Creek (Figure 30-1) but coho salmon access to that reach is blocked (BLM 2004a) by a series of culverts; natural falls downstream are additional potential impediments to passage. Briggs Creek Valley near the headwaters of Briggs Creek contains high IP habitat (Figure 30-1) and is accessible to coho salmon, but NMFS is not aware of any record of coho presence in upper Briggs Creek since 1983 (USFS undated). A substantial portion of the western Illinois River subbasin has serpentine soils that naturally support sparse riparian conditions (USFS 2000b) that likely result in warm stream temperatures. Therefore, streams that flow from this terrain, such as Rough and Ready and Josephine creeks, are unsuitable for coho salmon. This profile focuses on the upper Illinois River subbasin where tributaries with high IP coho salmon habitat exist: the mainstem Illinois River, East Fork Illinois River, West Fork Illinois River, Althouse Creek, Sucker Creek, Briggs Creek, and Deer Creek.

A cannery operated at the mouth of the Rogue River beginning in 1876. Records from that cannery were used to estimate an annual run size of approximately 114,000 adult coho salmon in the late 1800s (Meengs and Lackey 2005). There is no way to know how many of these fish were returning to the Illinois River subbasin, rather than elsewhere in the 5,600 square mile Rogue River basin. The Illinois River subbasin contains 25 percent of the basin-wide IP kilometers of habitat (Williams et al. 2008), suggesting possible returns of 28,500 fish during the time of cannery operation if fish were distributed in proportion to IP kilometers.

Table 30-1. Tributaries with instances of modeled high IP reaches (IP > 0.66) in the Illinois River subbasin (Williams et al. 2006).

Watershed	**Stream Name**	**Watershed**	**Stream Name**
West Fork Illinois	Brushy Creek	**Mainstem and East Fork Illinois**	Althouse Creek
	Dwight Creek		Althouse Slough
	Elk Creek		Bear Creek
	Gilligan Creek		Briggs Creek
	Logan Creek		Chapman Creek
	Mendenhall Creek		Democrat Gulch
	Trapper Gulch		Elder Creek
	West Fork Illinois River		Free and Easy Creek
	Whiskey Creek		George Creek
	Woodcock Creek		Grayback Creek
			Holton Creek
			Horse Creek
			Kelly Creek
Deer Creek	Anderson Creek		Khoeery Creek
	Clear Creek		Little Elder Creek
	Crooks Creek		Long Gulch
	Davis Creek		Mill Creek
	Deer Creek		Myers Creek
	Draper Creek		North Fork Silver Creek
	Haven Creek		Page Creek
	McMullin Creek		Poker Creek
	North Fork Deer Creek		Reeves Creek
	Potter Gulch		Senior Gulch
	Salt Gulch		Scotch Gulch
	South Fork Deer Creek		Skagg Creek
	Thompson Creek		Sucker Creek
	Whites Creek		Tycer Creek

30.3 Current Status of Coho Salmon in the Illinois River

Spatial Structure and Diversity

ODFW (2005a) surveys from 1998 to 2004 confirmed that coho salmon still migrate to Illinois River tributaries in an extensive area, but rearing is concentrated in small patches in upper reaches of Illinois Valley streams, just below federal land. Comparatively high densities of juvenile coho salmon have been found in Deer, Sucker, and Althouse creeks as well as the East and West Forks of the Illinois River (Figure 30-2). During the 2004 to 2009 run years, on average about 70 percent of sites were occupied by wild adult coho salmon with an estimated average of 25 spawners per mile (hatchery or wild origin unstated) (Lewis et al. 2009). In most cases, coho salmon are naturally absent from steep lower Illinois River tributaries and those that drain the serpentine bedrock area of the western part of the subbasin (e.g., Rough and Ready and Josephine creeks).

Population Size and Productivity

ODFW (2011b) estimated the abundance of wild adult coho salmon from 2002 to 2008 in the Illinois River. Wild adult coho salmon spawner abundance for the Illinois population was estimated to be 2,117 in 2007 and 745 in 2008 (Figure 30-3). Data were not collected in 2005, 2008, and 2010 which complicated efforts to track the strength of year classes. The lowest three-year running average of the number of spawners was 1431. Therefore, the Illinois River population of coho salmon is at moderate risk of extinction with regard to the spawner density criteria, because the spawner density is above the depensation threshold of 590 but below the low risk threshold of 11,800 adults.

Huntley Park seine mark-recapture seine estimates occur in the lower Rogue River (river mile 8) and are the most robust and precise estimates of adult coho salmon abundance in the Rogue River (ODFW 2011a). It is impossible to determine, with existing information, how many of the estimated coho salmon at Huntley Park were returning to the Illinois River, but if the trend in abundance is assumed to reflect trends in the Illinois River the data can inform whether the population is at high risk of extinction due to the population decline criterion (Williams et al. 2008). The three year running average of the number of spawners at Huntley Park has declined at an annual rate of 12 percent over the last 12 years (Figure 10-2), greater than the 10% decline associated with a high risk of extinction (Williams et al. 2008). Therefore, the population is at high risk of extinction due to its sharply declining productivity.

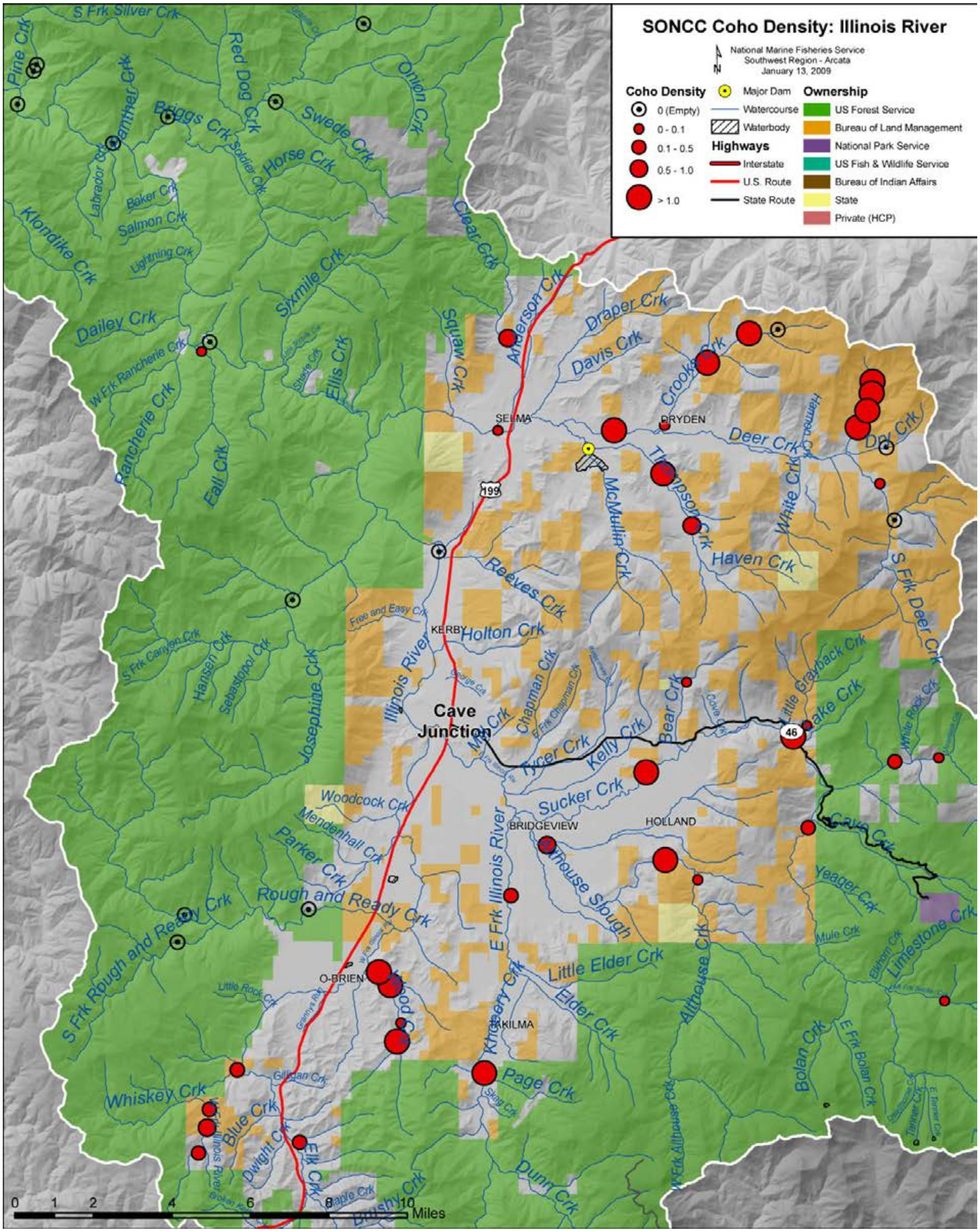

Figure 30-2. Upper Illinois River juvenile coho salmon survey results. Data are from 1998 to 2004 and show presence, absence and density of fish per square meter. (ODFW 2005a).

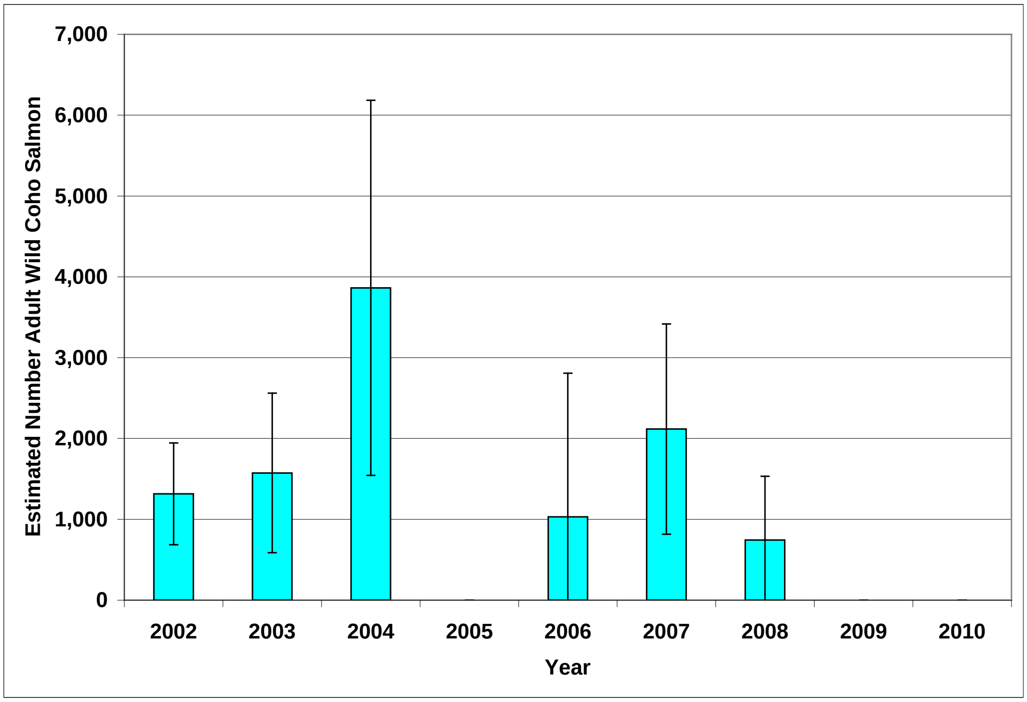

Figure 30-3. Estimated number of adult coho salmon in the Illinois River, from 2004 through 2010. No sampling occurred in 2005, 2009, or 2010 (ODFW 2011b).

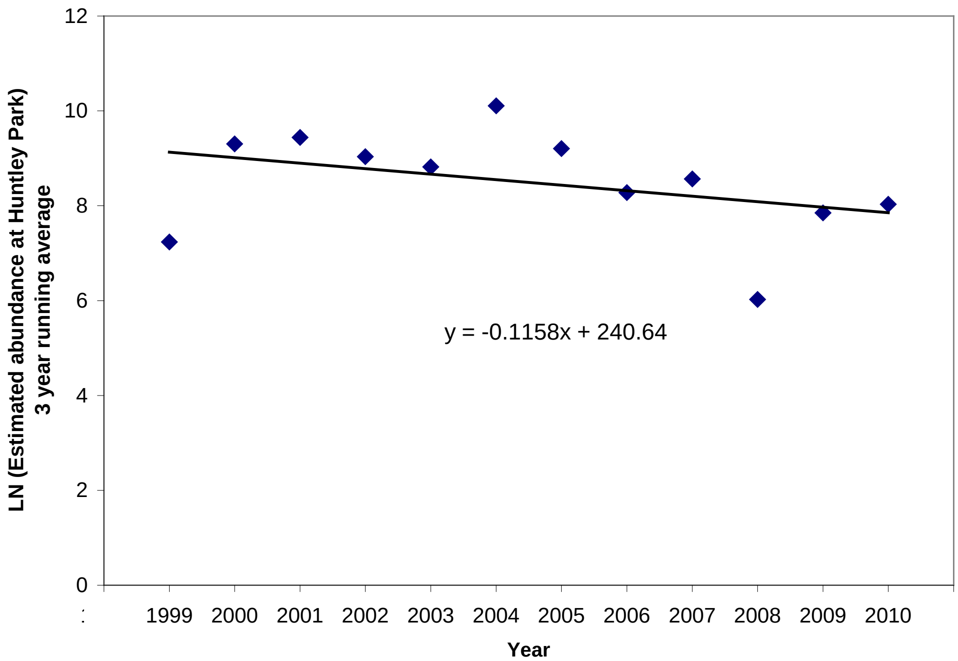

Figure 30-4. Rate of decline of estimated population abundance at Huntley Park, 1999-2010. (Data from ODFW 2011a).

Using seine mark-recapture data from Huntley Park, ODFW (2005c) calculated productivity for wild adult coho salmon in the Illinois, Middle, and Upper Rogue populations aggregated together for each year from 1980 to 2000. Recruits per spawner were less than replacement levels in eight of the years, indicating low productivity during those years (Figure 30-5).

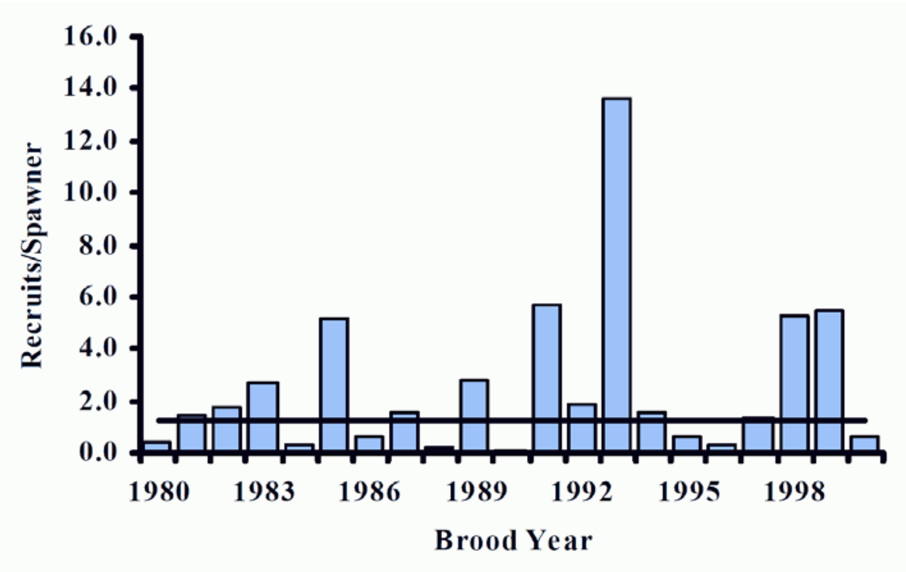

Figure 30-5. Recruit per spawner for brood years 1980 through 2000. Data are for the Rogue River Species Management Unit, which includes the Middle Rogue, Upper Rogue, and Illinois River populations. Figure from ODFW 2005c.

Extinction Risk

The Illinois River coho salmon population is not viable and at high risk of extinction. The estimated number of spawners exceeds the depensation threshold, but the estimated number of spawners at Huntley Park has declined at a rate greater than 10% over the past four generations (Figure 10-2).

Role in SONCC Coho Salmon ESU Viability

The Illinois River coho salmon population is considered functionally independent because of the large amount of modeled IP habitat. When the SONCC coho salmon ESU was healthy, this population would have been large enough to persist over 100 years without immigration from other populations (Williams et al. 2006). The Illinois River population would have been a likely contributor of colonists to other nearby independent and dependent populations, including those in the Rogue River basin. At present, the capacity of this population to supply colonists to adjacent independent populations is limited due to low spawner abundance. Recovery of this population may be enhanced by stray colonists from the nearby Lower Rogue, Middle Rogue/Applegate, and Upper Rogue river populations.

30.4 Plans and Assessments

U.S. Forest Service, Rogue River-Siskiyou National Forest

Sucker Creek Watershed Aquatic Restoration Plan (USFS 2007)

This plan proposes to improve aquatic habitat in the Sucker Creek watershed through placing instream large wood, planting disease resistant Port Orford cedar, riparian thinning, increasing beaver supplementation populations, replacing culverts, and upgrading and decommissioning roads.

Sufficiency Assessment: Forest Service and Bureau of Land Management Programs in Support of SONCC Coho Salmon Recovery (USFS and BLM 2011)

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, Middle Sucker Creek, Grayback Creek, and Dunn Creek were identified as high priority 6th field subwatersheds in Rogue-Siskiyou National Forest (USFS and BLM 2011). Watershed Restoration Action Plans (WRAPs), which update existing watershed analyses, are part of the WCF and were completed for each priority sub-watershed. USFS and BLM (2011) summarizes these WRAPs and describes, for each subwatershed: the rationale for its priority status, key issues, essential projects, and partnership opportunities.

U.S. Bureau of Land Management (Medford District)

Lower East Fork Illinois Watershed Water Quality Restoration Plan (BLM 2006)

West Fork Illinois Watershed Water Quality Restoration Plan (BLM 2007)

These plans describe base flow, riparian condition, and channel condition in the watersheds and identify goals, objectives, and proposed management measures to improve water quality.

State of Oregon

Expert Panel on Limiting Factors for Oregon's SONCC coho salmon populations

ODFW (2008b) convened a panel of fisheries and watershed science experts as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on perceived limiting factors and threats to recovery. Based on the input of panel members, ODFW (2008b) summarized the concerns for the Illinois River are as follows:

> Key concerns were related to loss of over-winter tributary habitat complexity and access and over-summer water temperatures and habitat access. Over-winter tributary habitat, especially in the lowlands, has been impacted by past and current agricultural practices and an interruption in the transport and presence of large wood. Access to habitat has been limited by road crossings. Summer habitat is limiting because high water temperatures have resulted from land management actions in the riparian zone and straightening of channels and water management actions for agricultural purposes. Water withdrawals and diversions have also limited the amount of, and access to, summer habitat and thermal refuge.
>
> Secondary concerns spanned a number of life history stages and locations. Unscreened diversions and non-criteria screens at diversions affect fry, summer parr, and out-migrating smolts. Summer juvenile habitat has been impacted by a loss of tributary habitat complexity, especially in the lowlands, caused by past and current agricultural practices and an interruption in the transport and presence of large wood. Access to

summer thermal refuge habitat by juveniles has also been affected by road crossings. Non-native vegetation is a secondary factor contributing to higher water temperatures affecting summer parr by limiting native riparian vegetation. A reduction in floodplain connectivity has affected winter parr. Access to spawning habitat by returning adults is limited by road crossings and diversion structures. Finally, reduced estuarine habitat for smolts due to past and current forestry practices and rural residential development is another impact.

Oregon Plan for Salmon and Watersheds
http://www.oregon.gov/OPSW/about_us.shtml

The state of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is comprehensive and includes voluntary actions for all of the threats currently facing coho salmon in these ESUs and involves all relevant state agencies. Reforms to fishery harvest and hatchery programs were implemented by ODFW in the late 1990s. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary. The action plans, implementation, and annual reports can be found at the web site.

ODFW Coastal Salmonid Inventory Project

ODFW has monitored coho salmon in the Illinois River as part of their Coastal Salmonid Inventory Project. From 1998 to 2004, ODFW conducted dives to count juvenile coho salmon in the Illinois Valley (ODFW 2005a)(Figure 30-2). ODFW also estimated the abundance of adult coho salmon in the Illinois River from 2002 to 2004 and from 2006 to 2008 (ODFW 2011b).

Southwest Oregon Salmon Restoration Initiative

The Southwest Oregon Salmon Restoration Initiative (Prevost et al. 1997) was created to help fulfill a memorandum of understanding between ODFW and the National Marine Fisheries Service (NMFS) to recover coho salmon. The initiative provides the framework for recovery in southwest Oregon and helped foster formation of watershed councils. The initiative designated Sucker/Grayback Creek, East Fork Illinois, Althouse Creek, Elk Creek/Broken Kettle Creek, and Dunn Creek as "core areas" in the Illinois River watershed that are the highest priority for restoration in the Oregon component of the SONCC coho ESU.

Water Requirements of Rogue River Fish and Wildlife

ODFW fisheries biologists (Thompson and Fortune 1970) conducted widespread surveys of the Rogue River basin to assess water flow and its effect on fish habitat and carrying capacity for salmonids. The study was designed to inform the Oregon Water Resources Board so that a "beneficial water use program" could be developed. Thompson and Fortune (1970) contains comprehensive flow tables for all major coho salmon producing tributaries in the Rogue River basin, including recommended minimum flows. It also provides a summary of the Rogue River basin fish community, including the Illinois River. The report identified flow depletion as a major cause of stress, disease, and predation to Pacific salmonids.

Illinois River Total Maximum Daily Load Reports

Total Maximum Daily Load (TMDL) reports have been completed for lower (ODEQ 2002c) and upper Sucker Creek (ODEQ 1999). In addition, a TMDL for the remainder of the Illinois and Rogue River basin was recently completed (ODEQ 2008).

Illinois Valley Watershed Council

Rogue River Watershed Health Factors Assessment

The Rogue Basin Coordination Council (RBCC) produced the Rogue River Watershed Health Factors Assessment on behalf of the all the watershed councils within the basin (RBCC 2006). The assessment rates aquatic health and watershed conditions, including wildfire risk. Key problems in different Rogue River watersheds are identified and potential solutions are proposed. Recognized problems in the Illinois River subbasin are related to low stream flows and high summer water temperature.

30.5 Stresses

Table 30-2. Severity of stresses affecting each life stage of coho salmon in the Illinois River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

Stresses (Limiting Factors)		Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Hydrologic Function[1]	Very High	Very High	Very High[1]	Very High	High	Very High
2	Degraded Riparian Forest Conditions[1]	Medium	Very High	Very High[1]	Very High	Very High	Very High
3	Lack of Floodplain and Channel Structure[1]	Medium	High	Very High[1]	High	High	Very High
4	Impaired Water Quality[1]	Low	High	Very High[1]	High	Low	Very High
5	Altered Sediment Supply	High	High	High	Medium	High	High
6	Impaired Estuary/Mainstem Conditions	-	Low	High	High	High	High
7	Barriers[1]	-	Medium	High[1]	High	High	High
8	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
9	Increased Disease/Predation/Competition	Low	Medium	Medium	Medium	Low	Medium
10	Adverse Fishery Impacts	-	-	-	-	Low	Low
[1]Key limiting factor(s) and limited life stage(s).							

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited and quality winter rearing habitat, as well as summer rearing habitat, is lacking. Juvenile summer rearing habitat is impaired by deficient floodplain and channel structure, high temperatures resulting from degraded riparian conditions, and altered hydrologic function from water withdrawals. Furthermore, degraded riparian forests inhibit future potential input of large wood and cannot provide bank stability that assists in a stable and complex channel. Finally, barriers throughout the sub-basin limit access to rearing habitat. These findings are consistent with those of the Oregon Expert Panel (ODFW 2008b) (Section 30.4).

Altered Hydrologic Function

Hydrologic function in the Illinois River subbasin is severely altered by water diversion. The USFS (1999a) noted that Reeves Creek, a tributary with high IP habitat, was dry in three of five reaches surveyed in 1994, likely due to diversion. Thompson and Fortune (1970) assessed flows in 1967 and found that sections of the Illinois River system become seriously low and warm, or even dry, during the summer when irrigation diversions were particularly active and runoff was low. The extent to which these conditions persist is unknown.

High road density and widespread clear cutting, especially in rain-on-snow terrain, have somewhat altered peak flows (USFS 1997a, BLM 2004b). Base flows may decrease when dense stands of young trees that consume large amounts of water are established after clear cuts (Murphy 1995).

Lake Selmac, on Deer Creek tributary McMullin Creek, blocks several miles of coho salmon habitat (Figure 30-6). Channelization in portions of Deer and Thompson has resulted in disconnected floodplains in areas known to support juvenile coho salmon. Filling of wetlands and elimination of beaver caused loss of water storage capacity and reduced the areas of contact between surface water and groundwater.

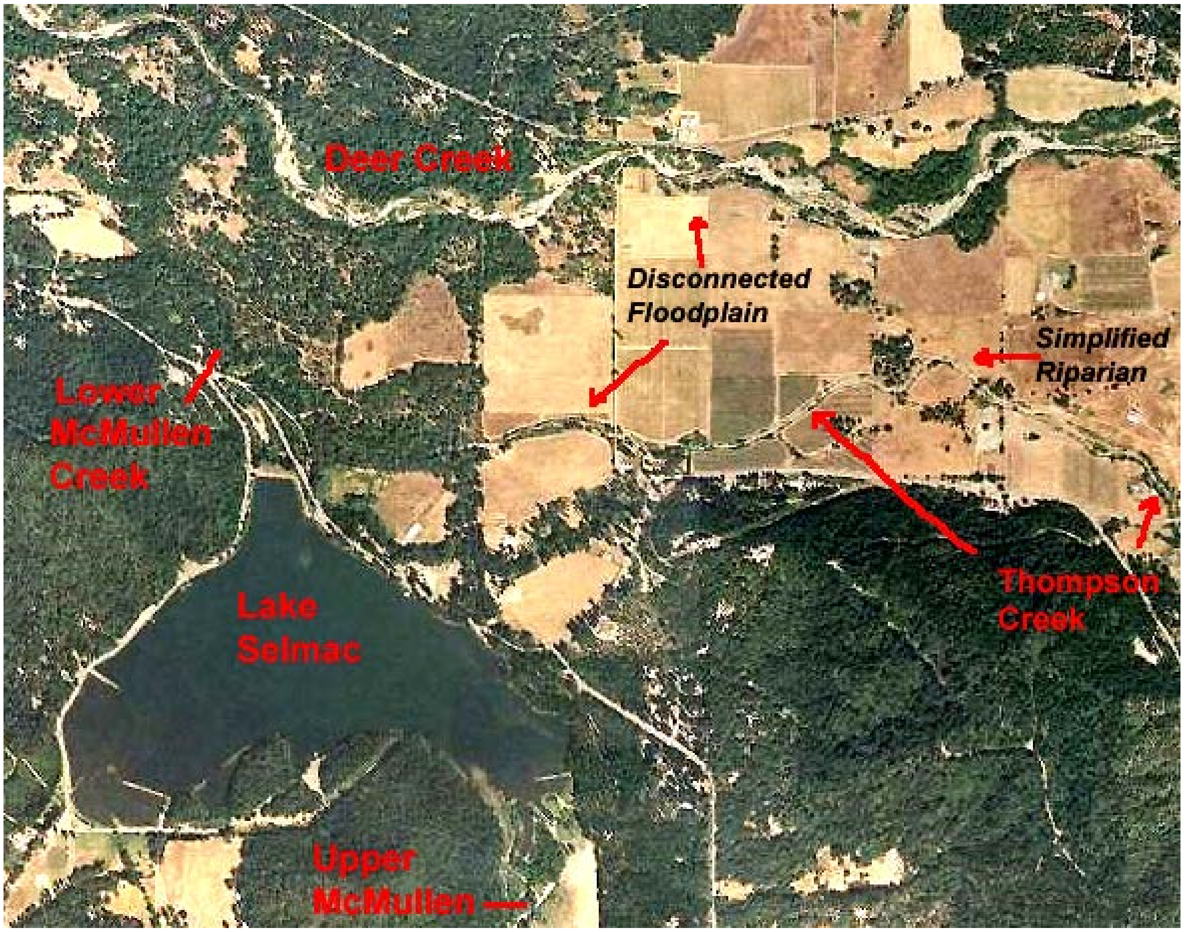

Figure 30-6. Lake Selmac blocks access to high IP coho salmon habitat. The habitat is in upper McMullin Creek. Hydrologic alteration is apparent in Thompson and Deer creeks, which have simplified channels disconnected from floodplains. June 2005.

Riparian Forest Conditions

Degraded riparian forest condition is one of the most significant stresses affecting coho salmon recovery in the Illinois River watershed. Reduction of riparian trees and gallery forests that once covered the alluvial valley floor has led to reduced pool frequency and habitat simplification, has increased bank erosion, and contributed to stream warming by widening the waterways (BLM 1997, 2006, USFS 1997a). ODFW surveyed extensive reaches of coho salmon-bearing Illinois River reaches and tributaries (e.g., EF Illinois, WF Illinois, Deer, Sucker, Althouse, Elk) and found poor conifer density with fewer than 75 trees (>36” dbh) per 1000 feet. Only one upper Sucker Creek reach and the lower North Fork Deer Creek had 75 to 125 trees of this size, which rates as fair riparian conditions. Recent aerial photos show very simplified conditions in both tributary and mainstem Illinois River riparian zones. The riparian zones have been cleared or substantially modified along the mainstem Illinois River and at the mouth of Free and Easy Creek. Overall, there is a very low amount/volume of large wood in channels throughout the Illinois River subbasin (USFS 1997a, BLM 2005).

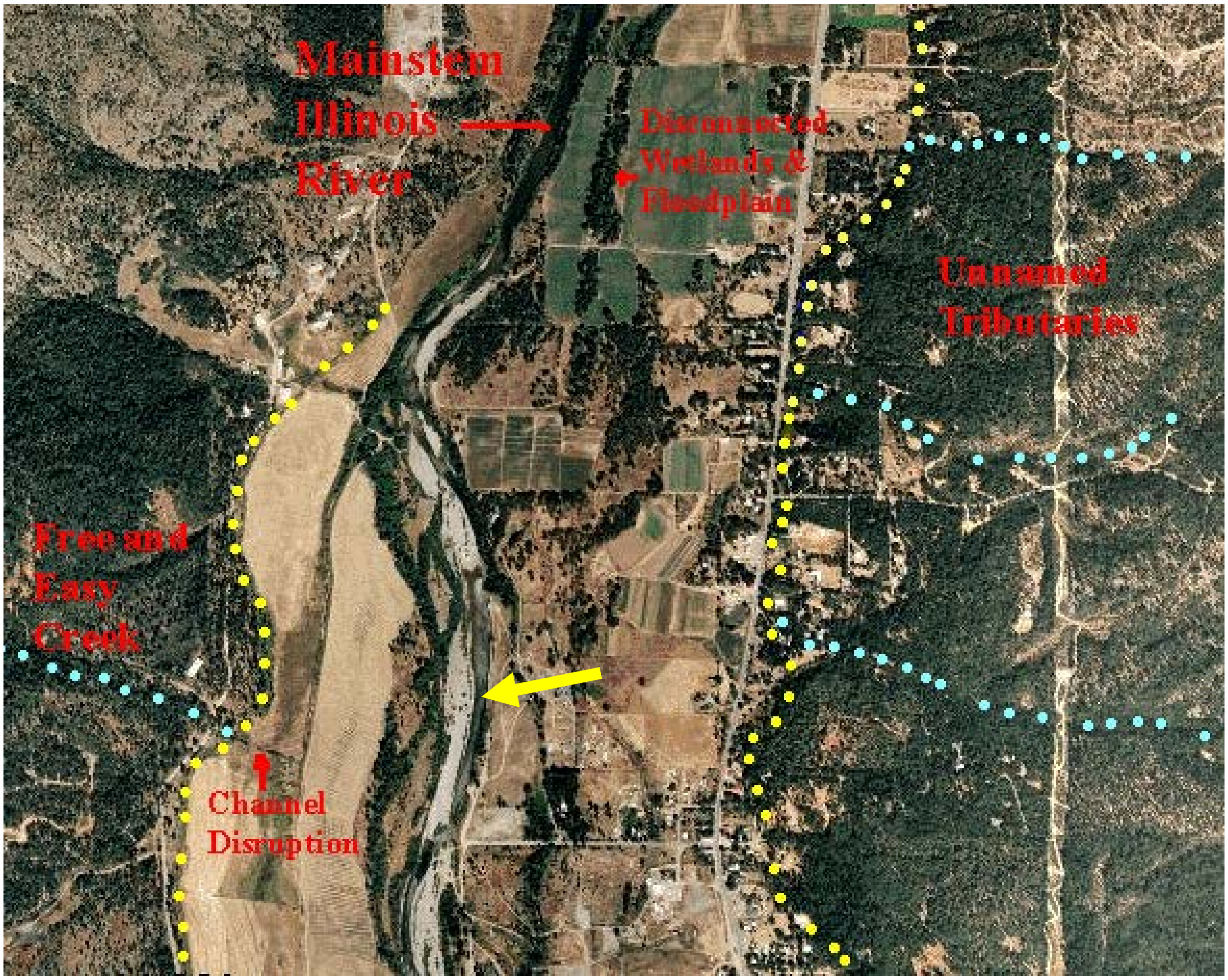

Figure 30-7. Aerial photo of Mainstem Illinois River. Free and Easy Creek (at left) appears to flow subsurface or into a ditch as it crosses the flood terrace. Wetlands and the floodplain of the mainstem are disconnected and there are few riparian trees (shown by large arrow at bottom of photograph). Dots aligned in an east/west configuration are USGS (1984) streams, and dots aligned in a south/north configuration are ditches.

Lack of Floodplain and Channel Structure

The straightening and simplification of streams has reduced the amount of slow, cool edgewater habitats where coho salmon fry and juveniles thrive (ODEQ 2008). Beaver have been greatly reduced along with the pools they create (ODFW 2005b). Although there are patches of functional coho salmon habitat, many Illinois River reaches and tributary channels do not support coho salmon (BLM 1997, USFS 1997a). Channelization of the mainstem Illinois River has disconnected it from much of its floodplain, reducing the physical processes that form coho salmon rearing and spawning habitat. These processes include side channel formation, accumulation of large wood jams, formation of slower water velocities, formation of pools, and lower shear stress. Smaller alluvial valley tributaries that cross the Illinois River floodplain have been channelized, which increases bed shear stress, causes down cutting, and can also trigger upstream gully erosion. A similar situation has occurred in the middle portion of the Illinois River subbasin in the modeled high IP habitat at Briggs Valley, where historically the stream channel meandered across a broad marsh-like floodplain but has now downcut with a straightened channel, resulting in a lowered water table and a dry meadow (USFS undated) that offers a much lower quality of rearing habitat for coho salmon.

ODFW habitat surveys indicate poor wood levels (< 1 key piece per 100 meters) in most surveyed areas of the Illinois River watershed. Exceptions are Sucker Creek below Grayback Creek and headwater stream reaches, mostly on USFS or BLM lands, such as South and North Fork Deer, Bear, Elk, Crooks, Draper and White creeks. USFS large wood surveys found relatively higher wood levels in some lower and middle Illinois River watersheds; however, these reaches lack high IP habitat, with the notable exception of Horse Creek in the upper Briggs Creek watershed. In the upper portion of the Illinois River subbasin, USFS surveys indicate higher levels of wood in much of Grayback, Left Fork Sucker, Sucker, and Bolan creeks, as well as the upper East Fork Illinois and its tributary Poker Creek. While the December 1996 storms washed out some large wood habitat improvement structures, natural large wood recruitment increased (USFS 1998c).

Altered Sediment Supply

Sediment contribution from landslides and erosion occurs naturally in the Illinois River basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. Excess fine sediment directly impact egg viability and can reduce food for fry, juveniles and smolts. Key reaches of the West and East Fork Illinois River, Sucker Creek, Anderson and Draper creeks all have poor scores for fine sediment (<1 mm) in ODFW habitat surveys because spawning gravels have greater than 17 percent fines. Extensive reaches of Deer Creek, Crooks Creek, lower Sucker Creek, and Althouse Creek have very good fine sediment scores (<12 percent fines), indicating suitable coho salmon spawning conditions. Poor pool frequency and depth throughout the Illinois River subbasin are likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening.

Water Quality

While the Illinois River has better ambient water quality than many other Rogue River subbasins, it has widespread temperature impairment (ODEQ 1999, 2002c, 2008). Low summer flows contribute to warming as well as stagnation, algae blooms, elevated pH, and depressed dissolved oxygen (Thompson and Fortune 1970, ODEQ 1996). Pesticides and herbicides have the potential to harm coho salmon (NMFS 2008), but data are lacking for the Illinois River subbasin. Poor water quality is a high stress to juvenile coho salmon and a low stress to adults.

Sixty-two percent of 126 stream miles surveyed by ODEQ failed to meet water quality standards (SO RC&D 2003). Headwaters streams in the Illinois River watershed often flow from federal lands where cool water temperatures allow high densities of coho salmon in the summer. ODEQ maximum weekly maximum temperature (MWMT) data shows that when streams cross onto private land they generally become too warm for coho salmon rearing within a short distance and can rise to nearly lethal temperatures as they are progressively dewatered. Variations between locations in streams like lower Sucker Creek show that temperatures are cooler where flows are replenished by springs or tributaries, then warm again as flows are diverted by downstream land owners. This pattern is also apparent in Deer Creek, Althouse Creek and the upper East and

West forks of the Illinois River. Cold groundwater contributions may also be reduced or eliminated by groundwater pumping, but groundwater withdrawals have not been quantified (BLM 2004b). Water temperatures and summer flows are suitable for coho salmon rearing in high IP habitats in Briggs Valley; however, coho are not currently present, likely due to inadequate floodplain connectivity and channel structure.

Impaired Estuary/Mainstem Function

Modification of the Rogue River estuary resulted in a loss of much of its historic function. Some portion of coho salmon fry and juveniles migrate out of their stream of origin in search of viable habitat patches, and these fish opportunistically use estuarine and slough habitats (Miller and Sadro 2003, Koski 2009). The lack of rearing habitat in the estuary limits the potential productivity of the entire Rogue River basin and NMFS ranked *Impaired Estuary/Mainstem Function* as an overall high stress for coho salmon. The Lower Rogue River population profile contains a discussion of the causes of reduced estuarine function.

Barriers

The high level of stress caused by barriers to migration in the Illinois River basin are a result of high numbers of road stream crossings (i.e., as shown in Bredensteiner et al. 2003 maps); small, temporary agricultural dams (Prevost et al. 1997); permanent diversion structures; and large mainstem diversion dams. The Illinois River Watershed Council has worked cooperatively with diverters in the Illinois River subbasin to decrease use of “push-up” gravel dams to divert irrigation water and often block adult and juvenile movement (Prevost et al. 1997). In addition, unscreened diversions and non-criteria screens at diversions affect fry, juveniles, and smolts (ODFW 2008b). Pomeroy Dam, used to divert water just below the convergence of the East and West forks of the Illinois River, was identified as a fish passage barrier at some flow levels (USFS 1999a). Road stream crossings that prevent juvenile and adult access to habitat are also a concern (ODFW 2008b).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. Cole Rivers Hatchery is located upstream of the Illinois population area in the Upper Rogue River sub-basin, and produces approximately 200,000 coho salmon smolts annually in addition to millions of hatchery spring Chinook, winter steelhead, and summer steelhead (ODFW 2008d). Straying into the Illinois River is thought to be uncommon (Good et al 2005). From 1996 to 1998, none of the adults observed in spawner surveys of the Illinois River were of hatchery origin (Jacobs et al. 2002). Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of Cole Rivers Hatchery in the Rogue River basin (Appendix B).

Disease/Competition/Predation

Salmonids in the Rogue River basin, including the Illinois River, had higher incidences of the fish diseases *furunculosis* and *columnaris* in reaches that were warm due to flow depletion (Thompson and Fortune 1970). Largemouth bass and other warm water species are stocked in Lake Selmac and private farm ponds (USFS 1999a). These fish can escape and pose the risk of competition with, and predation on, salmonids in the mainstem Illinois River (USFS 1999a).

Umpqua pikeminnow, are present in the lower reaches of Sucker Creek (USFS 1999a) as well as other warm, low-elevation streams of the Illinois River, and prey upon coho salmon. Exotic redside shiners also occur in these streams. Japanese knotweed, an invasive plant, has also been documented in the basin (ODA 2010).

Adverse Fishery-Related Effects

NMFS has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

30.6 Threats

Table 30-3. Severity of threats affecting each life stage of coho salmon in the Illinois River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	High	Very High	Very High	Very High	Very High	Very High
2	Dams/Diversion	Medium	Very High	Very High	Very High	Very High	Very High
3	Agricultural Practices	Medium	High	High	High	High	High
4	Channelization/Diking	Medium	Medium	High	High	High	High
5	Timber Harvest	High	High	High	Medium	Medium	High
6	Mining/Gravel Extraction	High	High	High	Medium	Medium	High
7	Climate Change	Low	Low	High	High	Medium	High
8	Road-Stream Crossing Barriers	-	Low	High	High	High	High
9	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
10	Urban/Residential/Industrial	Low	Medium	Medium	Medium	Medium	Medium
11	High Intensity Fire	Low	Medium	Medium	Medium	Medium	Medium
12	Invasive and Non-Native/Alien Species	Medium	Medium	Medium	Low	Low	Medium
13	Fishing and Collecting	-	-	-	-	Low	Low

Roads

Road density is high in many areas of the Illinois River subbasin. Roads were built to support timber harvest, residential and urban development, and highway systems. An extensive network of small, unpaved roads exists in many areas of the Illinois River watershed (Figure 30-8 and Figure 30-9). Many of these roads run alongside streams, and are known to yield chronic fine sediment and to pose elevated risk of catastrophic failure on steep slopes (USFS 1998c). NMFS (1995) recommended a road density limit of 2 miles of road per square mile of watershed (mi/sq mi) to protect anadromous salmonids in interior Columbia River basins to limit sediment and cumulative watershed effects. Road density in the Illinois River subbasin (Figure 30-10) is typically 2 to 4 mi/sq mi on federal land (Prevost et al. 1997, USFS and BLM 2000, BLM 2005), but may be higher than 8 mi/sq mi on private timberlands and over 10 mi/sq mi in rural residential areas (BLM 1997). Landslides triggered by roads during the November and December 1996 storms resulted in extensive sedimentation in Sucker and Grayback creeks (USFS 1998c). Damage resulted from road crossing failures and diversion of streams onto roadways, which increased fine sediment delivery to levels 2 to 3 times higher than unaffected watersheds (USFS 1998c).

Hydrologic effects of extensive road networks persist even when the roads are no longer used, because roads often continue to contribute fine sediment to streams and alter hydrology by intercepting ground water, channelizing water and transporting sediment down inboard ditches, or both. Erosive geology may require lower road density targets in some watersheds. For example, upper Sucker Creek has decomposed granitic soils that are prone to landsliding as well as chronic gully and surface erosion (USFS 1998c).

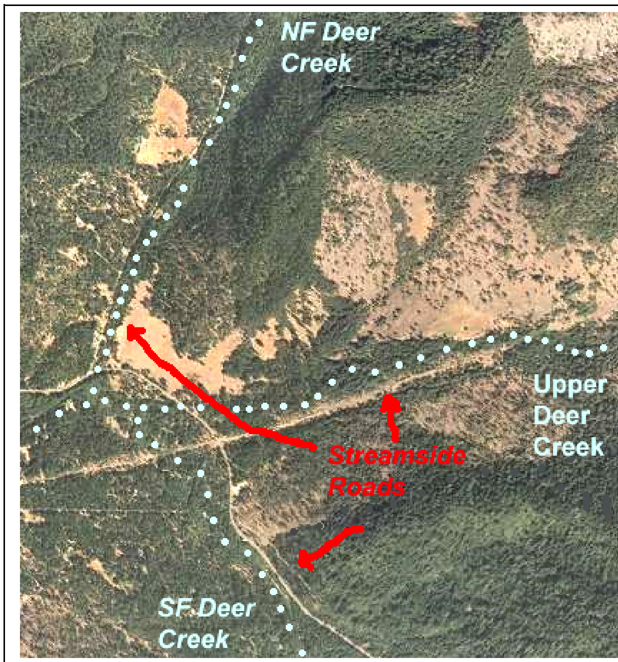

Figure 30-8. Aerial photo showing stream side roads. Roads parallel upper Deer Creek as well as the NF and SF. These roads chronically leach fine sediment into Deer Creek. Dots are USGS (1984) stream courses (1:24 K). Photo from 2005.

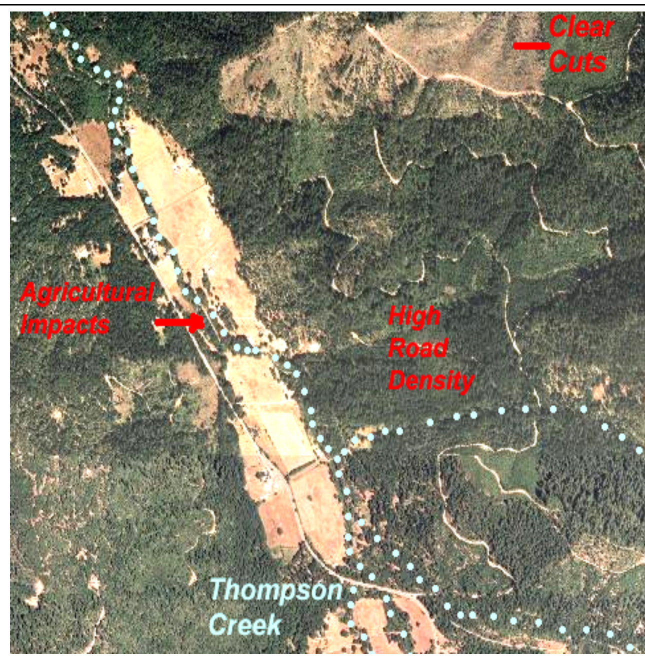

Figure 30-9. Aerial photo showing very high road densities in upper Thompson Creek. All of upper Deer Creek, which includes Thompson Creek, has a road density of 4 mi./sq.mi. Photo from 2005.

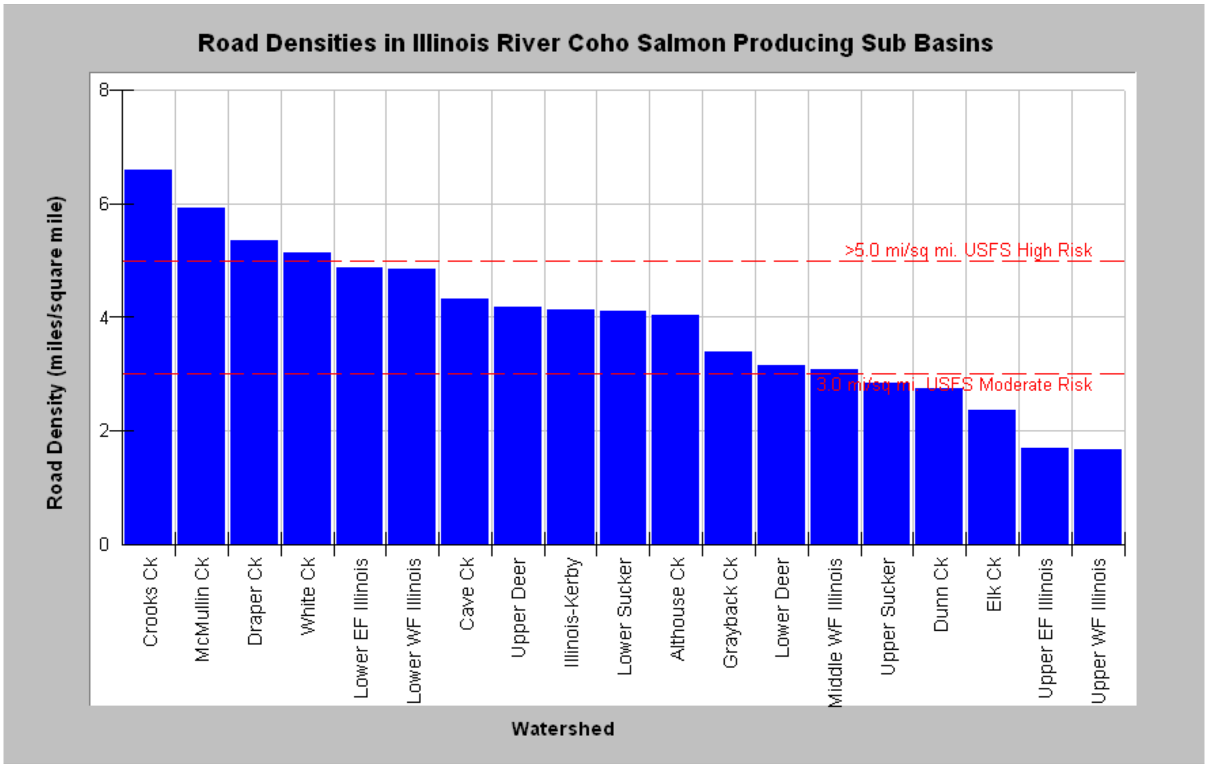

Figure 30-10. Road density in Illinois River coho salmon producing watersheds.

Dams and Diversions

Dams and diversions pose a very high threat to Illinois River coho salmon. Many diverted streams have the potential of drying during low flow periods (Thompson and Fortune 1970). Dry reaches were documented in Illinois River tributaries in late summer and fall 1967 including Deer, Anderson, Thompson, Elder, Little Elder, and Parker creeks. Many stream reaches still go dry annually. Figure 30-11 shows Deer Creek, which falls within high IP coho salmon habitat, running dry as a result of diversion in 2009. Studies of the Illinois River watershed conclude that flows are the most limiting factor for fisheries, coho salmon habitat continues to be dewatered, and water quality impairment continues as a result of flow depletion (Thompson and Fortune 1970; USFS 1997a, 1999a; BLM 2004b, 2005, 2006, 2007).

The two large dams in the Illinois River subbasin are at Lake Selmac (Figure 30-6) and the Pomeroy Diversion Dam approximately 0.5 miles below the convergence of the East Fork and West Fork Illinois. Pomeroy Dam is known to hinder salmonid migration in some seasons, particularly for downstream migrating juveniles (USFS 1999a). While passage has been improved, some small diversions still pose the risk of entraining juvenile coho salmon and smolts.

Figure 30-11. A high IP coho salmon reach of Deer Creek, a tributary to the Illinois River. Photo taken September 22, 2009.

Agricultural Practices

The extent of agriculture, while not large, coincides with broad alluvial valleys associated with high IP (>0.66) coho salmon habitat (Williams et al. 2008). Agricultural impacts include water diversion (BLM 1997, USFS 1997a), wetland filling, channelization and diking, riparian removal, channel simplification, and chemical application. It is likely that pesticides known to harm salmonids (NMFS 2008) are used in the region. However, information regarding pesticide and herbicide use in the Illinois River subbasin and the SONCC coho salmon ESU is unavailable (Riley 2009). Herbicide use in the nearby Upper Rogue subbasin has resulted in fish kills that included coho salmon (Ewing 1999).

Channelization/Diking

Channelization and confinement of mainstem and tributary reaches of the Illinois River is widespread. Disconnecting high IP coho salmon streams from their floodplains and constricting their channels into straight, narrow stream courses greatly diminishes their summer and winter habitat carrying capacity (BLM 1997). These activities also tend to reduce surface-groundwater connections that help maintain cool stream temperatures (ODEQ 2008).

Timber Harvest

Timber harvest levels were estimated to be between 10 to 25 percent on USFS and BLM lands in the East Fork Illinois River and Sucker, Grayback and Althouse creeks according to Landsat comparisons between 1972 and 1992 imagery. Many Illinois River tributaries are surrounded by harsh terrestrial conditions, such as decomposed granitic soils in upper Sucker Creek (USFS 1997a), that make re-establishing forests problematic. Logging in these types of locations can lead to very dry soil conditions if duff is removed or burned. Failure to re-establish forest cover can lead to increased fine sediment delivery to streams for decades. In addition, the Independent Multidisciplinary Science Team (IMST 1999) concluded that the Oregon Forest Practice Rules (OFPRs) for riparian protection, large wood management, sedimentation, and fish passage are not adequate to recover depressed stocks of wild salmonids. Approximately 81 percent of the land in the Illinois River population area is managed by the federal government; therefore, the threat from ongoing and future timber harvest will likely decrease.

Mining/Gravel Extraction

Potential impacts of mining on Illinois River salmonids threaten the ecological integrity of the area (Bredensteiner et al. 2003). The majority of the occupied IP in the Illinois River watershed occurs on federal lands (Figure 30-1), where mining access is permitted under the 1872 Mining Law. There are two gold mining claims under consideration on lower gradient federal lands in Sucker Creek, an area with high IP that currently supports juvenile coho salmon (Section 30.3). The location of such mining contributes to the severity of the threat to coho salmon in the Illinois River. Gold mining on federal lands often occurs on those lower gradient stream reaches that are located just upstream of private lands; these reaches are very important to coho salmon and they represent the best low gradient habitat available. Gravel mining has intensified along the lower East Fork Illinois and pits that can capture juvenile coho salmon, coho salmon smolts, and adult coho salmon during high flows events have been excavated in the floodplain. Most of these stranded fish perish if no outlet is available when flows recede.

Climate Change

The current climate is generally warm and modeled regional average air temperature suggests a large increase over the next 50 years (see Appendix D for climate change threat ranking methodology). Average air temperature could increase by over 2 ^{o}C in the summer and by 1 ^{o}C in the winter. Annual precipitation in this area is predicted to stay within the natural range of current variability; however seasonal patterns in precipitation may change (Mote and Salathe 2010). Van Kirk and Naman (2008) documented decreasing snow pack below 6,000 feet over the last 20 years in the Klamath Mountains. If this trend continues, the water supply will be affected in watersheds such as Deer, Grayback and Sucker creeks, and the upper East and West Fork Illinois rivers. Coho salmon juvenile and smolt rearing and migratory habitat are most at risk to climate change. Rising sea level may affect the quality and extent of wetland rearing habitat. Adult Illinois River coho salmon will be negatively affected by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Road-Stream Crossing Barriers

Road densities in portions of the Illinois River subbasin are very high and stream-side roads are common. Culverts under road-stream crossings may block upstream migration for adults or passage for juveniles and smolts during low flow periods.

Hatcheries

Hatcheries pose a medium threat to all life stages of coho salmon in the Middle Rogue/Applegate River. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Urban/Residential/Industrial

Rural residential development is expanding and may have a substantial impact on water supply in the Illinois River subbasin. Each landowner may use surface water from nearby streams or drill a well, which may in some cases be connected to, and deplete, surface flows (BLM 2004b). Rural residences can also contribute to pollution due to extensive road networks, leakage from septic systems, and the use of pesticides and herbicides.

High Intensity Fire

The potential for fire is great due to high summer air temperatures and degraded forest conditions. Early seral stage forests, which are common in this population's range, lead to dry site conditions and increased fire risk (SO RC&D 2003). Recent extensive fires include the 1987 Silver Fire and the 2002 Biscuit Fire, which was the largest fire in Oregon history and burned a great deal of the western part of the watershed (Azuma et al. 2004). Much of the area that burned is serpentine terrain within the Kalmiopsis Wilderness, which has frequent fires due to sparse vegetation and dry site conditions resulting from naturally poor soils (USFS 1999a). However, the shallow soil depth and low topographic relief in this terrain lessen risk of mass wasting and sediment pulses to streams below. Coho salmon are not commonly found in serpentine watersheds, so fires in those watersheds do not directly impact the species.

Invasive Non-Native/Alien Species

Thompson and Fortune (1970) documented widespread presence of introduced warm water game fish in the Rogue River basin. Lake Selmac and private agricultural ponds in the Illinois River subbasin are noted as sources of these fish and ponds may be increasing in number with continued residential development (USFS 1999a). Competition or predation on juvenile coho salmon by most non-native warm water species is likely limited in the winter because warm water species are washed downstream by high winter flows. However, in the summer, warm water conditions created by flow depletion give these introduced species a competitive advantage over salmonids. Umpqua River pikeminnow have been documented in lower Sucker Creek (USFS 1999a). This species is of particular concern because it is adapted to swift rivers and may pose a risk of competition and predation on coho salmon smolts during spring out-migrations. A similar situation occurs in the Eel River basin in California where the introduction of the Sacramento pikeminnow has caused major ecological problems (Brown and Moyle 1990).

Fishing and Collecting

The recreational fishery for hatchery coho salmon in Oregon likely encounters more federally-listed coho salmon than does the Chinook salmon fishery that accounts for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the recreational fishery. NMFS (1999) concluded that the exploitation rate associated with this and other freshwater fisheries in Oregon are not likely to jeopardize the continued existence of SONCC coho salmon (Good et al. 2005). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because no recovery objectives to achieve species viability had been established for SONCC coho salmon at that time (NMFS 1999). Regional-scale effects may be enough to impede recovery of the Interior Rogue River diversity stratum, even if they are not severe enough to jeopardize the continued existence of the ESU. Specifically, wild coho salmon in the Rogue River basin likely experience more exploitation effects than those in other areas, because they co-occur with the adult hatchery coho salmon that were produced in the Rogue's Cole Rivers Hatchery, return to the Rogue River to spawn, and are targeted there by recreational fishermen. As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in the Illinois River.

30.7 Recovery Strategy

The most immediate need for habitat restoration and threat reduction in the Illinois River subbasin is in those areas currently occupied by coho salmon in the following watersheds: West Fork Illinois River, Wood Creek, East Fork Illinois River, Althouse Creek, Sucker Creek, and Deer Creek. Unoccupied areas must also be restored to provide sufficient habitat to achieve coho salmon recovery. For example, the upper Briggs Creek watershed currently lacks coho salmon but has suitable water temperature, summer water flow, low stream gradient, and is entirely owned by the USFS; thus, if channel structure and floodplain connectivity were restored it could provide excellent habitat.

The severely degraded condition of habitat in the Illinois River subbasin, combined with the depressed coho salmon population size and distribution, significantly increases the risk of extinction of this inland coho salmon population which is expected play a critical role in recovery of the Interior Rogue River diversity stratum. The most important factor limiting recovery of coho salmon in the Illinois River is a deficiency in the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by restoring flow, increasing habitat complexity within the channel, restoring off-channel rearing areas, and reducing threats to instream habitat.

Table 30-4 on the following page lists the recovery actions for the Illinois River population.

Table 30-4. Recovery action implementation schedule for the Illinois River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-IIIR.2.2.7	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Reconnect floodplains, wetlands, and off channel habitat	Private lands	2
SONCC-IIIR.2.2.7.1	*Assess habitat to determine where potential exists for floodplain reconnection. Prioritize sites and determine best means for reconnection at each site using tools such as hydrologic analysis*					
SONCC-IIIR.2.2.7.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-IIIR.2.2.8	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	3
SONCC-IIIR.2.2.8.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-IIIR.2.2.8.2	*Implement beaver program (may include reintroduction)*					
SONCC-IIIR.2.1.9	Floodplain and Channel Structure	Yes	Increase channel complexity	Improve suction dredging practices	Population wide	3
SONCC-IIIR.2.1.9.1	*Develop suction dredging regulations that minimize or prevent impacts to coho salmon. Consider special closed areas, closed seasons, and restrictions on methods and operations*					
SONCC-IIIR.2.1.34	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2
SONCC-IIIR.2.1.34.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-IIIR.2.1.34.2	*Place instream structures, guided by assessment results*					
SONCC-IIIR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide, especially East and West Forks of the Illinois, Deer, Sucker, Elk, and Althouse creeks	2
SONCC-IIIR.3.1.4.1	*Quantify groundwater withdrawal and determine maximum amount available for use without significantly reducing instream flows*					
SONCC-IIIR.3.1.4.2	*Study groundwater withdrawal and prevent development if insufficient supply exists*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-IIIR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide, especially East and West Forks of the Illinois, Deer, Sucker, Elk, and Althouse creeks	3
SONCC-IIIR.3.1.5.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-IIIR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-IIIR.3.1.6.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-IIIR.5.1.16	Passage	Yes	Improve access	Remove barriers	Population wide	3
SONCC-IIIR.5.1.16.1	*Assess and prioritize barriers using the ODFW fish passage barrier database*					
SONCC-IIIR.5.1.16.2	*Remove barriers, guided by the assessment*					
SONCC-IIIR.7.1.10	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	3
SONCC-IIIR.7.1.10.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-IIIR.7.1.10.2	*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat*					
SONCC-IIIR.7.1.11	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Grayback, Sucker, Elk, Althouse, and Deer creeks	3
SONCC-IIIR.7.1.11.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-IIIR.7.1.11.2	*Thin, or release conifers, guided by prescription*					
SONCC-IIIR.7.1.11.3	*Plant conifers, guided by prescription*					
SONCC-IIIR.7.1.12	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Privately held timberlands	2
SONCC-IIIR.7.1.12.1	*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-IIIR.7.1.31	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Private lands	BR
SONCC-IIIR.7.1.31.1	*Develop HCPs or GCPs with interested owners of private timberlands*					
SONCC-IIIR.7.1.33	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	BLM lands	3
SONCC-IIIR.7.1.33.1	*Manage timber harvest (and associated activates) on Federal lands in accordance with the Aquatic Conservation Strategy of the NWFP to achieve riparian and stream channel improvements for coho salmon*					
SONCC-IIIR.10.2.13	Water Quality	Yes	Reduce pollutants	Educate stakeholders	Population wide	3
SONCC-IIIR.10.2.13.1	*Develop an educational program that promotes Salmon Safe methods for agricultural operations and Integrated Pest Management for rural residents*					
SONCC-IIIR.10.1.32	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Improve regulatory mechanisms	Population wide	3
SONCC-IIIR.10.1.32.1	*Develop riparian placer mining regulations that minimize or prevent impacts to coho salmon and their habitat. Consider special closed areas, closed seasons, and restrictions on methods and operations*					
SONCC-IIIR.10.1.32.2	*Educate miners regarding the ESA, coho salmon, and effects to habitat from proposed mining activities*					
SONCC-IIIR.14.2.15	Disease/Predation/ Competition	No	Reduce predation and competition	Manage non-native species	Population wide	3
SONCC-IIIR.14.2.15.1	*Assess feasibility and benefits of eradicating non-native fish species*					
SONCC-IIIR.14.2.15.2	*Take measures to manage non-native fish species*					
SONCC-IIIR.1.2.35	Estuary	No	Improve estuarine habitat	Improve estuary condition	Rogue River Estuary	3
SONCC-IIIR.1.2.35.1	*Implement recovery actions to address strategy "Estuary" for Lower Rogue River population*					
SONCC-IIIR.16.1.17	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-IIIR.16.1.17.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-IIIR.16.1.17.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-IIIR.16.1.18	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-IIIR.16.1.18.1	*Determine actual fishing impacts*					
SONCC-IIIR.16.1.18.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-IIIR.16.2.19	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-IIIR.16.2.19.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-IIIR.16.2.19.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-IIIR.16.2.20	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-IIIR.16.2.20.1	*Determine actual impacts of scientific collection*					
SONCC-IIIR.16.2.20.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-IIIR.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-IIIR.27.1.21.1	*Perform annual spawning surveys*					
SONCC-IIIR.27.1.22	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Develop survival estimates	Site to be determined	3
SONCC-IIIR.27.1.22.1	*Install and annually operate a life cycle monitoring (LCM) station*					
SONCC-IIIR.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-IIIR.27.1.23.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-IIIR.27.1.24	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-IIIR.27.1.24.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-IIIR.27.2.25	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-IIIR.27.2.25.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-IIIR.27.2.25.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-IIIR.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-IIIR.27.2.26.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-IIIR.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-IIIR.27.2.27.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-IIIR.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-IIIR.27.2.28.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-IIIR.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-IIIR.27.2.29.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-IIIR.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-IIIR.27.2.30.1	*Annually measure the hydrograph and identify instream flow needs*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-IIIR.27.1.39	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-IIIR.27.1.39.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-IIIR.27.1.39.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-IIIR.27.1.40	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Measure VSP parameters of coho salmon in remote areas	Population wide	3
SONCC-IIIR.27.1.40.1	*Develop techniques to estimate abundance, productivity, spatial structure, and diversity in remote areas.*					
SONCC-IIIR.5.1.36	Passage	No	Improve access	Remove barriers	BLM lands	3
SONCC-IIIR.5.1.36.1	*Evaluate and prioritize barriers for removal*					
SONCC-IIIR.5.1.36.2	*Remove barriers*					
SONCC-IIIR.8.1.1	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	USFS and BLM lands	3
SONCC-IIIR.8.1.1.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-IIIR.8.1.1.2	*Decommission roads, guided by assessment*					
SONCC-IIIR.8.1.1.3	*Upgrade roads, guided by assessment*					
SONCC-IIIR.8.1.1.4	*Maintain roads, guided by assessment*					
SONCC-IIIR.8.1.2	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-IIIR.8.1.2.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					

31. Middle Rogue / Applegate Rivers Population

- Interior Rogue Stratum
- Non-Core, Functionally Independent Population
- High Extinction Risk
- 2700 Spawners Required for ESU Viability
- 1,561 mi^2
- 683 IP km (424 mi) (45% High)
- Dominant Land Uses are Agriculture and Urban/Residential/Commercial Development
- Principal Stresses are 'Degraded Riparian Forest Conditions' and 'Altered Hydrologic Function'
- Principal Threats are 'Dams/Diversions' and 'Agricultural Practices'

31.1 History of Habitat and Land Use

From 1780 to 1840, trappers swept Oregon coastal rivers, including the Rogue River basin, reducing the robust beaver population to remnant levels (Oregon Department of Fish and Wildlife (ODFW) 2005b). Historically, beaver were so prevalent that the Takelma native people called the Applegate River valley "the beaver place" (U.S. Bureau of Land Management (BLM) 1998a). In the mid-to-late 1800s, extensive gold mining in the Rogue and Applegate valleys resulted in major changes to coho salmon habitat that is still evident today. In the 1850s, settlers began developing the flat alluvial valley bottoms and filling wetlands to increase agricultural productivity. Over a period of 150 years, these ideal coho salmon reaches were straightened and disconnected from their floodplains, wetlands and meanders filled, beaver and their ponds eliminated, flows diverted, and riparian shade reduced (BLM 1998a).

The remoteness of the Rogue River basin delayed widespread forest harvest until railroad lines made it possible to export timber. Profound changes in watershed and streams associated with logging occurred after World War II, when availability of heavy equipment and the high demand for wood led to extensive timber harvest in the Rogue River basin. Stream channels were modified extensively by timber harvest, which included using stream channels for skidding logs. Channel damage and erosion from the 1964 flood was widespread, exacerbated by timber harvest and road building activities (USFS 1999b).

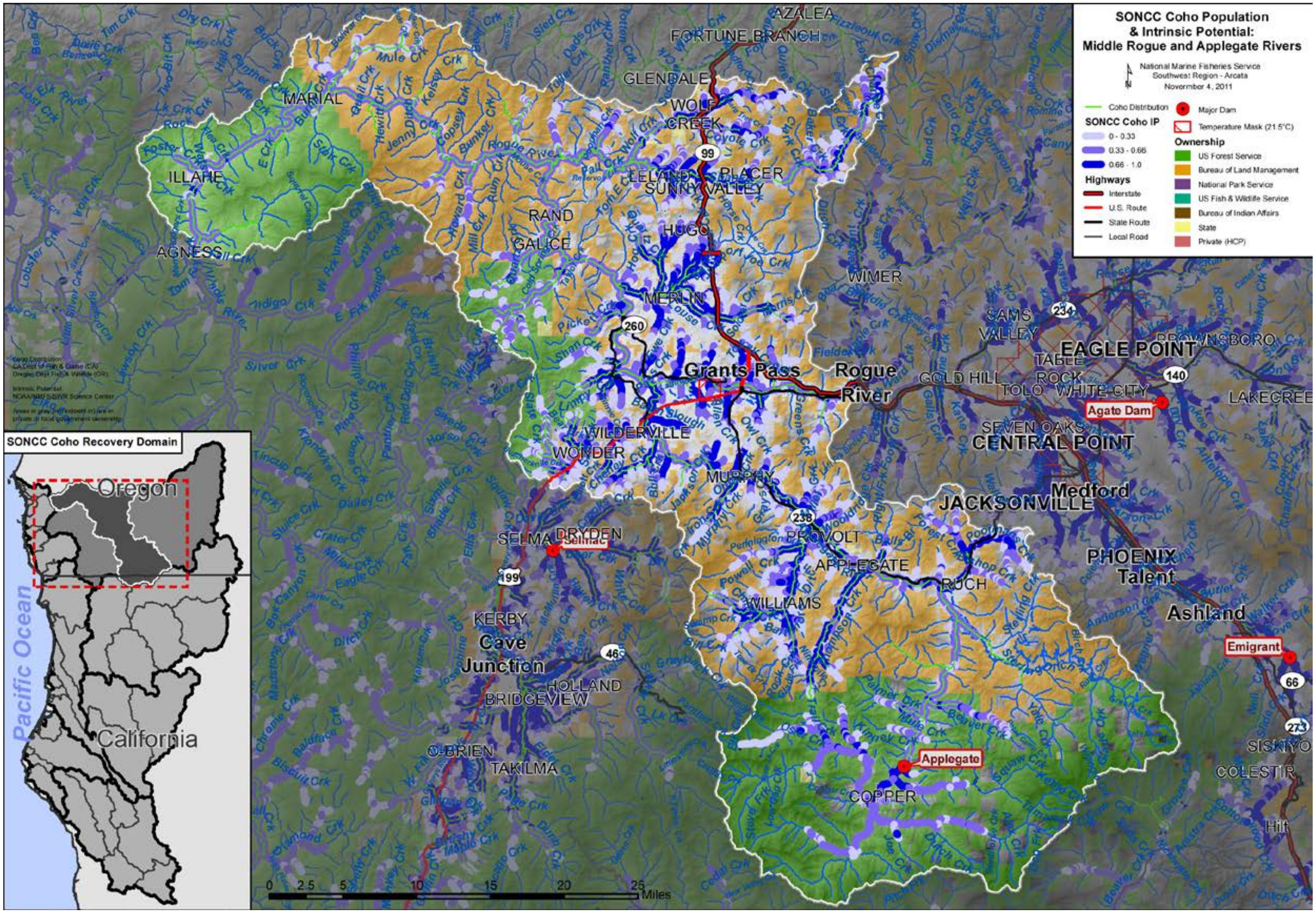

Figure 31-1. The geographic boundaries of the Middle Rogue / Applegate rivers coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern Oregon/Northern California Coast Coho Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

For example, gravel beds were scoured down to bedrock on Steves Fork and Sturgis Fork (upper Applegate River tributaries now above Applegate Dam) and Galice Creek (tributary to the Rogue River) (Thompson and Fortune 1970), and large alluvial fans formed at the mouth of Middle Rogue tributaries Billings, Foster, and Shasta Costa creeks (USFS 1999b). Clear-cut logging continued on public lands into the 1970s and 1980s and although harvest technology improved, this activity resulted in another pulse of sediment that further degraded water quality and coho salmon habitat in downstream reaches (BLM 1996a, USFS 1999b). The USFS and BLM manage their lands more conservatively since the adoption of the Northwest Forest Plan (U.S Department of Agriculture (USDA) and U.S. Department of the Interior (USDI) 1994) and its adoption (USFS and BLM 1995a). The eastern portion of the Middle Rogue subbasin has a checkerboard pattern of BLM and private ownership. Logging is the most common activity on private land.

In 1980, the U.S. Army Corps of Engineers completed construction of the Applegate Dam, on the upper mainstem of the Applegate River. The dam, which was built for irrigation, flood control, and recreation, blocks 154.7 km of high intrinsic potential coho salmon habitat (Williams et al. 2006). Although the dam prevents damaging winter floods, the timing of flow releases, especially in spring, is very different from historic patterns.

The Middle Rogue River flows through Josephine and Jackson Counties, an area which includes the city of Grants Pass, one of the urban growth centers in southern Oregon (Figure 31-1 and Figure 31-2). In addition, there has been substantial residential development in many parts of the subbasin, accompanied by surface water and groundwater extraction. Water supply for human, fish, and wildlife use is a critical issue in the entire Rogue River basin.

Figure 31-2. Middle Rogue tributary Gilbert Creek. Large arrow points to the creek, flowing south through Grants Pass, Oregon. Dots represent USGS (1984) stream lines. June 2005.

31.2 Historic Fish Distribution and Abundance

There are 760 intrinsic potential (IP) kilometers (km) in the Middle Rogue-Applegate subbasin (Figure 31-1). Much of the high IP habitat is concentrated in low gradient reaches of Grave, Wolf, Coyote, and Jumpoff Joe creeks, which extend east from the mainstem Middle Rogue between Grave Creek and the Applegate River. Western tributaries important for coho salmon are Taylor, Galice, and Limpy creeks. The Middle Rogue from the Applegate River to its upper boundary at Evans Creek has a number of tributaries with high IP that are now urbanized, including Allen, Fruitdale, Gilbert, Jones, Savage, and Sand creeks. Other concentrations of high IP habitat occur in alluvial reaches of the Applegate River and tributaries such as Slate, Cheney, Murphy, Thompson, Little Applegate, and Beaver Creek. While much of the Rogue River from Grave Creek to Agness is public land, most tributaries are too steep to support coho salmon. Streams with high IP habitat organized by sub-areas are listed below.

Table 31-1. Tributaries of Lower Middle Rogue River Subbasin (Agness to Grave Creek) with instances of high IP habitat.

Stream Name	Stream Name
Middle Rogue- Lower (Mule Cr. to Agness)	Mule Creek

Table 31-2. Tributaries of Grave Creek, a large watershed in the Middle Rogue River subbasin, with instances of high IP habitat.

Stream Name	**Stream Name**
Benjamin Gulch	Salmon Creek
Brushy Gulch	Shanks Creek
Coyote Creek	Sourdough Creek
Flume Gulch	Tome East Creek
Grave Creek	Unnamed Creek (Tributary of Wolf Creek below I-5)
Mackin Gulch	Wolf Creek
Poorman Creek	

Table 31-3. Tributaries of Main Middle Rogue River (Grave Creek to Applegate River) with instances of high IP habitat.

Stream Name	**Stream Name**
Bummer Creek	Madams Creek
Cove Creek	Middle Rogue – Lower (Grave to Mule Cr.)
Dutcher Creek	Pass Creek
Galice Creek	Pickett Creek
Harris Creek	Quartz Creek
Jacks Creek	Shan Creek
Jumpoff Joe Creek	Slate Creek
Limpy Creek	Taylor Creek
Little Pickett Creek	Tunnel Creek
Louse Creek	

Table 31-4. Tributaries of Upper Middle Rogue River (Evans Creek to Applegate River) with instances of high IP habitat.

Stream Name	**Stream Name**
Allen Creek	Middle Rogue – Upper (Applegate to Evans Creek)
Fruitdale Creek	Sand Creek
Gilbert Creek	Savage Creek
Jones Creek	Vannoy Creek
Lathrop Creek	

Table 31-5 Tributaries of Applegate River subbasin with instances of high IP habitat.

Stream Name	**Stream Name**
Applegate - Mainstem	Murphy Creek
Beaver Creek	Ninemile Creek
Bishop Creek	Onion Creek
Board Shanty Creek	Osler Creek*
Branch Gulch*	Palmer Creek*
Brush Creek*	Poorman Creek
Bull Creek	Powell Creek
Caris Creek	Rocky Creek
Cheney Creek	Round Prairie Creek

Forest Creek	Slate Creek
Grays Creek	Squaw Creek*
Grouse Creek	Sterling Creek
Humbug Creek	Thompson Creek
Little Applegate River	Williams Creek
Little Cheney Creek	Wooldridge Creek
Minnie Creek	Yale Creek
Munger Creek	
*Above Applegate Dam.	

A cannery operated at the mouth of the Rogue River beginning in 1876. Records from that cannery were used to estimate an annual run size of approximately 114,000 adult coho salmon in the late 1800s (Meengs and Lackey 2005). There is no way to know how many of these fish were returning to the Middle Rogue-Applegate area, rather than elsewhere in the 5,600 square mile Rogue River basin such as the Upper Rogue River. The Upper Rogue subbasin contains 33 percent of the basin-wide IP kilometers of habitat (Williams et al. 2008), suggesting possible returns of 38,000 fish during the time of cannery operation, if fish were distributed in proportion to IP kilometers.

31.3 Current Status of Coho Salmon in the Illinois River

Spatial Structure and Diversity

Williams et al. (2006) estimated 760 IP km of coho salmon habitat in the Middle Rogue-Applegate, but 52 IP km of that habitat are currently inaccessible due to Applegate Dam. Data for the Middle Rogue subbasin (Figure 31-3) and the Applegate River subbasin (Figure 31-4) from 1998 to 2004 show that juvenile coho salmon presence is fragmented and occurs mostly in small patches in upper reaches of alluvial valley streams, just below federal land (ODFW 2005a). Middle Rogue-Applegate reaches currently used by coho salmon represent a fraction of the high IP habitat. High IP habitat farther downstream is substantially dewatered, too warm, or has channels too simplified to support coho salmon rearing. Coho salmon are also mostly absent from Wolf and Coyote creeks, and are present only in the upper-most reaches of Grave Creek (ODFW 2005a). Coho salmon are naturally absent from many steep, lower Middle Rogue tributaries between Mule Creek to Agness; however, coho salmon are present in Foster and Shasta Costa creeks in the lower Middle Rogue (USFS 1999b). Coho salmon are also present in Taylor and Galice creeks, tributaries that join the Middle Rogue from the west below the Applegate River (ODFW 2005a). The spatial distribution of the Middle Rogue-Applegate coho salmon population has been significantly reduced through dam construction and habitat degradation.

During the 2004 to 2009 run years, on average about 47 percent of sites were occupied by wild adult coho salmon with an estimated average of 9 spawners per mile (hatchery or wild origin unstated) (Lewis et al. 2009).

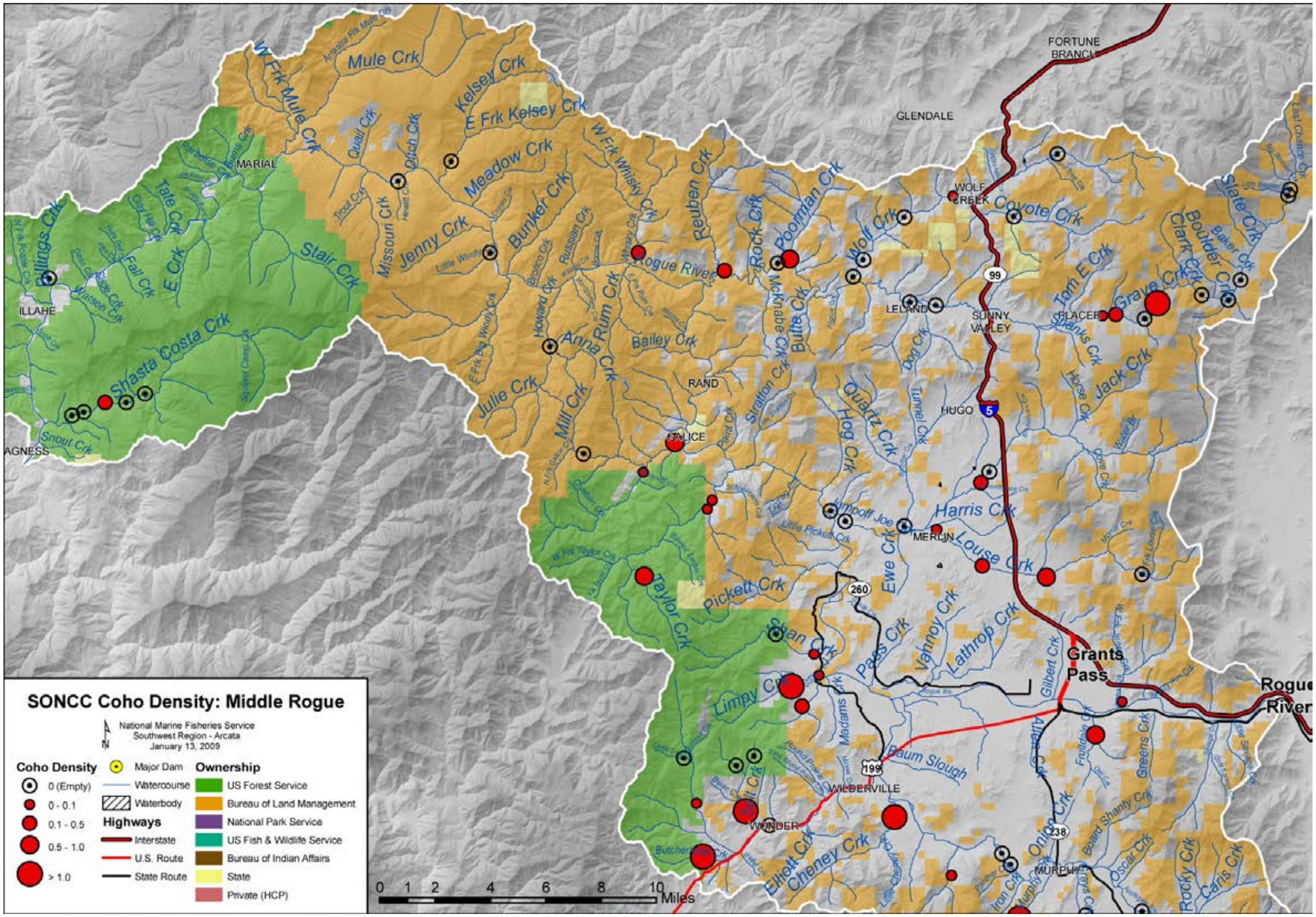

Figure 31-3. Juvenile coho salmon density (fish per square meter) for the Middle Rogue River watershed (ODFW 2005a). Stations with highest densities are in Grave, Taylor, Galice, Limpy and Louse creeks. Note that coho salmon are largely missing from urbanized areas west of I-5.

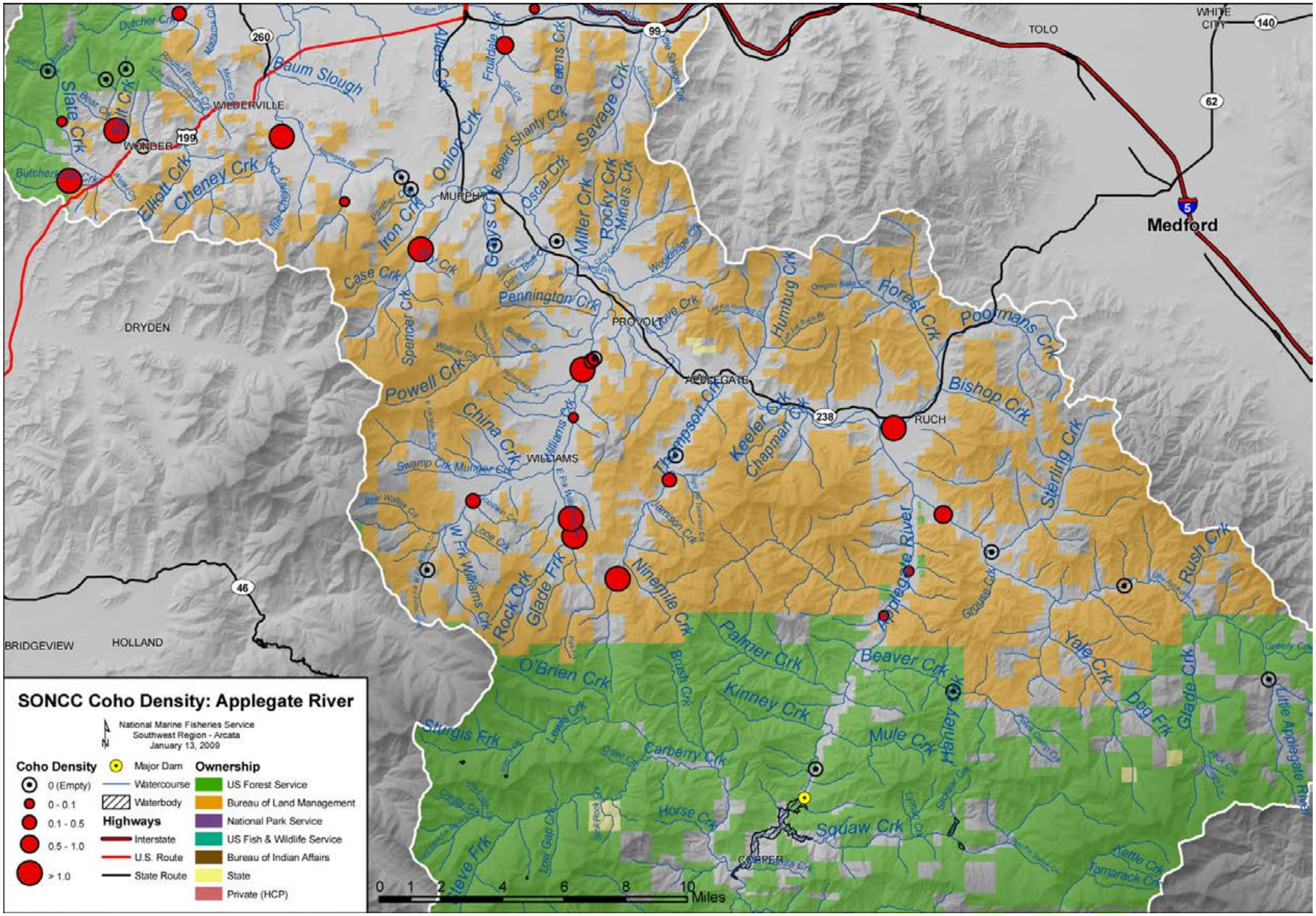

Figure 31-4. Juvenile coho salmon density (fish per square meter) for the Applegate River watershed (ODFW 2005a). Stations with highest densities are located in Williams, Cheney, Slate, and Forest creeks.

Population Size and Productivity

The depensation threshold for the Middle Rogue/Applegate River population is 759 spawners, and the moderate risk threshold is 2,700 spawners. Wild adult coho salmon spawner abundance for the Middle Rogue - Applegate population was estimated to be 1,930 in 2007 and 459 in 2008

The number of coho salmon adults in the Middle Rogue-Applegate river population was likely below the depensation threshold in two of the four years surveyed (Figure 31-5). However, the three year running average never fell below 1264. Therefore, the Middle Rogue-Applegate population of coho salmon is at moderate risk of extinction in regards to population size because it is above the depensation threshold of 759. However, it is at high risk of falling below the depensation threshold because it is below the moderate risk threshold of 2,700.

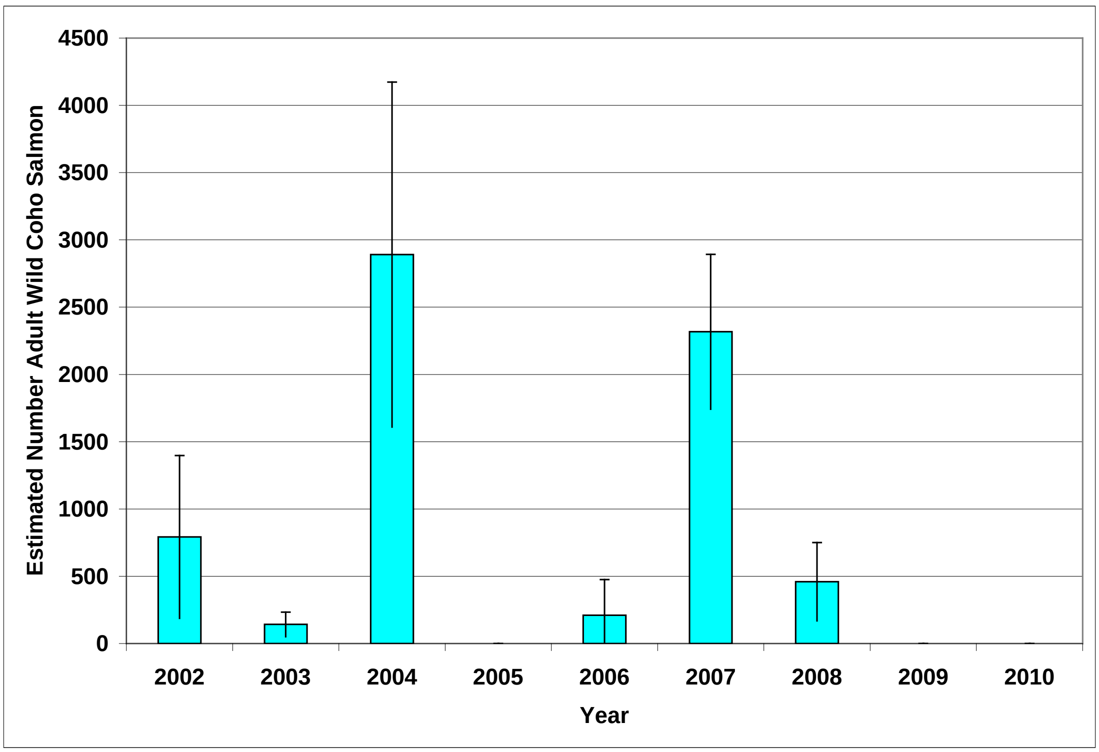

Figure 31-5. Estimated number of adult coho salmon in the Middle Rogue and Applegate rivers population, 2002 to 2010. No sampling occurred in 2005, 2009, or 2010 (ODFW 2011b).

Huntley Park seine mark-recapture seine estimates occur in the lower Rogue River (river mile 8) and are the most robust and precise estimates of adult coho salmon abundance in the Rogue River (ODFW 2011a). It is impossible to determine, with existing information, how many of the estimated coho salmon at Huntley Park were returning to the Middle Rogue and Applegate rivers. If the trend in abundance is assumed to reflect trends in the Middle Rogue and Applegate rivers the data can inform whether the population is at high risk of extinction according to the population decline criterion (Williams et al. 2008). The three year running average number of adults estimated at Huntley Park has declined at an annual rate of 12% over the last 12 years (Figure 31-6), greater than the 10% decline associated with a high risk of extinction (Williams et al. 2008). Therefore, the population is at high risk of extinction due to its sharply declining productivity.

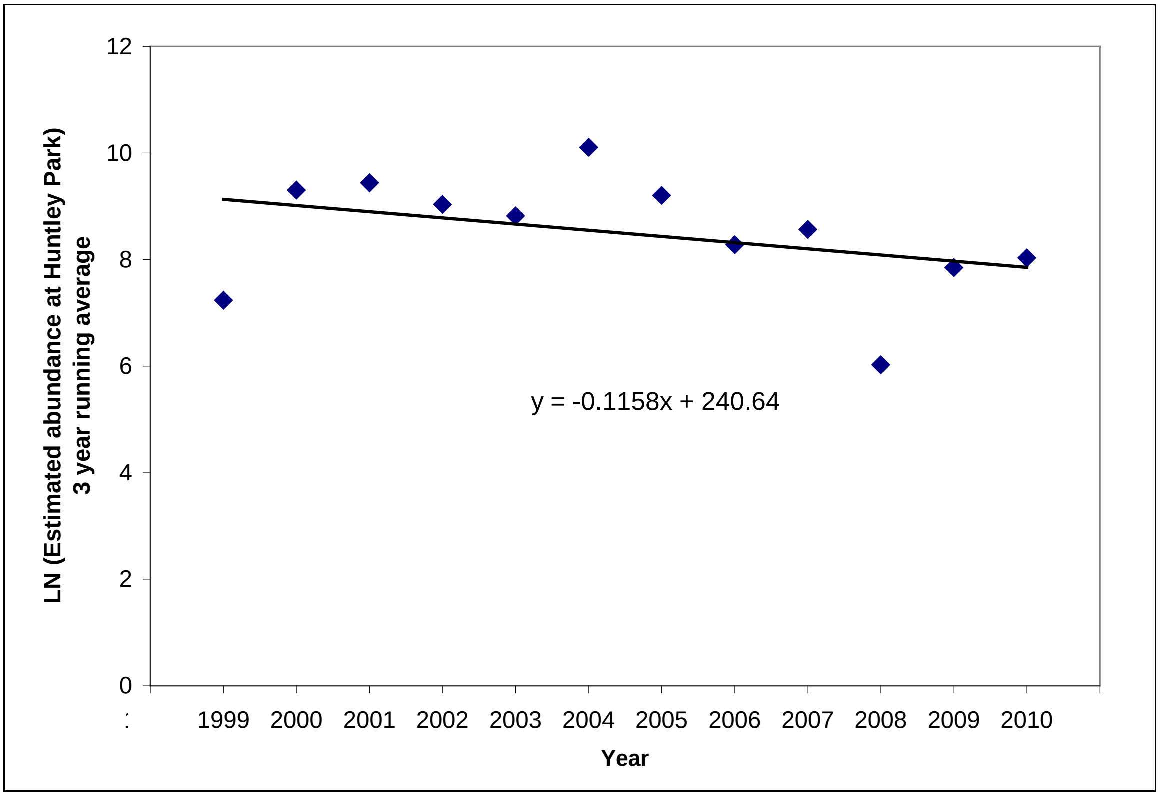

Figure 31-6. Rate of decline of estimated population abundance at Huntley Park, 1999-2010. (Data from ODFW 2011a).

Using seine mark-recapture data from Huntley Park, ODFW (2005c) calculated productivity for wild adult coho salmon in the Illinois, Middle, and Upper Rogue populations aggregated together for each year from 1980 to 2000. Recruits per spawner were less than replacement levels in eight of the years, indicating low productivity during those years (Figure 31-7).

Extinction Risk

The Middle Rogue/Applegate River coho salmon population is not viable and at high risk of extinction. The estimated number of spawners exceeds the depensation threshold, but the estimated number of spawners at Huntley Park has declined at a rate greater than 10% over the past four generations (Figure 31-6) and more than 5% of spawning adults are likely of hatchery origin.

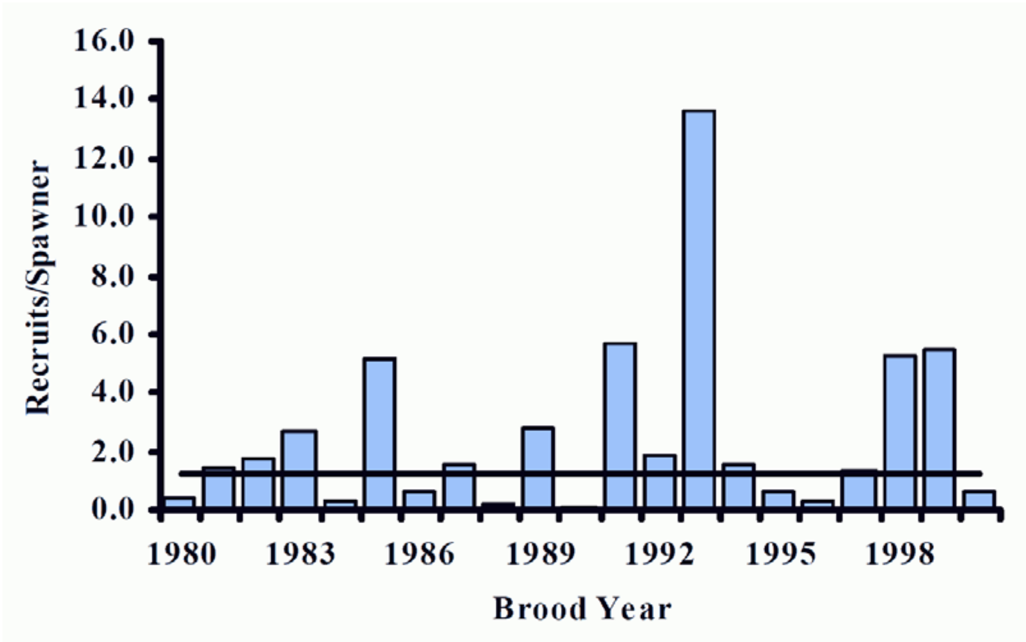

Figure 31-7. Recruit per spawner for brood years 1980 through 2000 for the Rogue River Species Management Unit, which includes the Middle Rogue, Upper Rogue, and Illinois River populations. Figure from ODFW 2005c

Role in SONCC Coho Salmon ESU Viability

The Middle Rogue-Applegate coho salmon population is considered functionally independent because of the large amount of modeled IP habitat. When the SONCC coho salmon ESU was healthy, this population would have been large enough to persist over 100 years without immigration from other populations (Williams et al. 2006). The Middle Rogue-Applegate population would have been a likely contributor of colonists to other nearby independent and dependent populations, including those in the Rogue River basin. At present, the capacity of this population to supply colonists to adjacent independent populations is limited due to low spawner abundance. Recovery of this population may be enhanced by stray colonists from the nearby Lower Rogue, Illinois, and Upper Rogue river populations.

31.4 Plans and Assessments

U.S. Forest Service, Rogue River-Siskiyou National Forest

U.S. Bureau of Land Management (Medford District)

State of Oregon

Expert Panel on Limiting Factors for Oregon's SONCC coho salmon populations

ODFW (2008b) convened a panel of fisheries and watershed science experts as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on perceived limiting factors and threats to recovery. Based on the input of panel members, the key concerns for Middle Rogue-Applegate subbasin are as follows:

> Key concerns were related to loss of over-winter tributary habitat complexity, floodplain connectivity, and access and over-summer water temperatures and habitat access. Over-winter tributary habitat and floodplain connectivity, especially in the lowlands, has been impacted by past and current agricultural practices and an interruption in the transport and presence of large wood. Access to habitat has been limited by road crossings. Summer habitat is limiting because high water temperatures have resulted from land management actions in the riparian zone and straightening of channels and water management actions for agricultural purposes. Water withdrawals and diversions and road crossings have also limited the amount of, and access to, summer habitat and thermal refuge.

Oregon Plan for Salmon and Watersheds
http://www.oregon.gov/OPSW/about_us.shtml

The state of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is comprehensive and includes voluntary actions for all of the threats currently facing coho salmon in these ESUs and involves all relevant state agencies. Reforms to fishery harvest and hatchery programs were implemented by ODFW in the late 1990s. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary. The action plans, implementation, and annual reports can be found at their web site.

ODFW Coastal Salmonid Inventory Project

ODFW has monitored coho salmon in the Middle Rogue River as part of their Coastal Salmonid Inventory Project. From 1998 to 2004, ODFW carried out dives to detect juvenile coho salmon in both the Middle Rogue and Applegate rivers (ODFW 2005a). ODFW also estimated the abundance of adult coho salmon in the Middle Rogue-Applegate population from 2002 to 2004 and from 2006 to 2008 (ODFW 2011b).

Southwest Oregon Salmon Restoration Initiative

The Restoration Initiative provides a regional framework for coho salmon recovery in southwest Oregon (Prevost et al. 1997) and has helped foster the formation of watershed councils. Core areas identified include Slate, Cheney and Williams Creek in the Applegate subbasin, and Quartz Creek in the Middle Rogue.

Water Requirements of Rogue River Fish and Wildlife

ODFW fisheries biologists (Thompson and Fortune 1970) conducted widespread surveys of the Rogue River basin to assess water flow and its effect on fish habitat and carrying capacity for salmonids. The study was designed to inform the Oregon Water Resources Board so that a “beneficial water use program” could be developed. Thompson and Fortune (1970) contains comprehensive flow tables for all major coho salmon producing tributaries in the Rogue River basin, including recommended minimum flows. It also provides a summary of the Rogue River basin fish community, including the Middle Rogue and Applegate Rivers. The report identified flow depletion as a major cause of stress, disease, and predation to Pacific salmonids.

Middle Rogue-Applegate Total Maximum Daily Load Reports

An Applegate River TMDL (Oregon Department of Environmental Quality (ODEQ) 2003) has been completed for temperature, and includes the Beaver Creek TMDL for temperature, sediment, and habitat impairment. A larger scale Rogue River TMDL (ODEQ 2008) covers all tributaries that are listed as impaired (ODEQ 2002a) but not covered by other TMDLs.

Middle Rogue River Watershed Council

Applegate Partnership and Watershed Council

Rogue River Watershed Health Factors Assessment

The Rogue Basin Coordination Council (RBCC 2006) produced the Rogue River Watershed Health Factors Assessment on behalf of all the watershed councils within the basin. The assessment rates aquatic health and watershed conditions, including wildfire risk. Key problems in different Rogue River subbasins are described and potential solutions are proposed. Recognized problems in the Middle-Rogue are related to stream flows and summer water temperature.

31.5 Stresses

Table 31-6. Severity of stresses affecting each life stage of coho salmon in the Middle Rogue-Applegate River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rate
1	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	Very High	Very High	Very High
2	Altered Hydrologic Function[1]	Very High	Very High	Very High[1]	Very High	Medium	Very High
3	Impaired Water Quality[1]	Medium	Very High	Very High[1]	High	Medium	Very High
4	Lack of Floodplain and Channel Structure[1]	Medium	Very High	Very High[1]	Medium	Medium	Very High
5	Impaired Estuary/Mainstem Conditions	-	Low	High	High	High	High
6	Barriers[1]	-	Medium	Very High[1]	Low	Medium	Very High
7	Altered Sediment Supply	High	Medium	Low	Low	High	Medium
8	Adverse Hatchery-related Effects	Medium	Medium	Medium	Medium	Medium	Medium
9	Disease/Predation/Competition	Low	Medium	Medium	Low	Low	Low
10	Adverse Fishery-related Effects	-	-	-	-	Low	Low

[1]Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited and quality winter rearing habitat, as well as summer rearing habitat, is lacking. Juvenile summer rearing habitat is impaired by deficient floodplain and channel structure, high water temperatures resulting from degraded riparian conditions and altered hydrologic function from water withdrawals. Furthermore, degraded riparian forests inhibit future potential input of large wood and cannot provide bank stability that assists in a stable and complex channel. Finally, barriers throughout the sub-basin limit access to rearing habitat. These findings are consistent with those of the Oregon Expert Panel (ODFW 2008b) (Section 31.4.

Degraded Riparian Forest Conditions

Many of the old growth conifers that historically lined the banks of the Middle Rogue-Applegate tributaries have been removed (USFS 1995b, 1999b, BLM 1998a, 1998b). Extensive ODFW riparian surveys found fewer than 75 conifers over 36 inches in diameter per 1000 feet of stream length, which rates as poor. These conditions were found in Grave and Jumpoff Joe creeks and their tributaries, and in almost all Applegate River tributaries. In headwater reaches of Mule, Howard, Galice, Pickett, upper Williams, upper Thompson, upper Grave, and Yale creeks, there were 75 to 125 conifers per 1000 feet, which rates as fair. More large conifers provide cooler ambient air temperatures near streams, providing a moderating influence on water temperature (Poole and Berman 2001). Large conifers are also a source of large wood recruitment that helps maintain habitat complexity.

Riparian vegetation along tributaries like Grave, Wolf, and Coyote creeks reflect 150 years of intensive land use; consequently, early seral species like alder and willow are dominant. The same is true of alluvial valley reaches of Applegate River tributaries on private land, such as Slate, Cheney, Williams, Thompson, and Yale creeks, and the Little Applegate River (USFS 1995b, 1996a, ODEQ 2003). Riparian alteration and simplification are also widespread in the mainstem Applegate River (BLM 1998a) and a constraint on coho salmon recovery (Figure 31-8). The riparian condition stress score is consequently very high across all life history phases except egg.

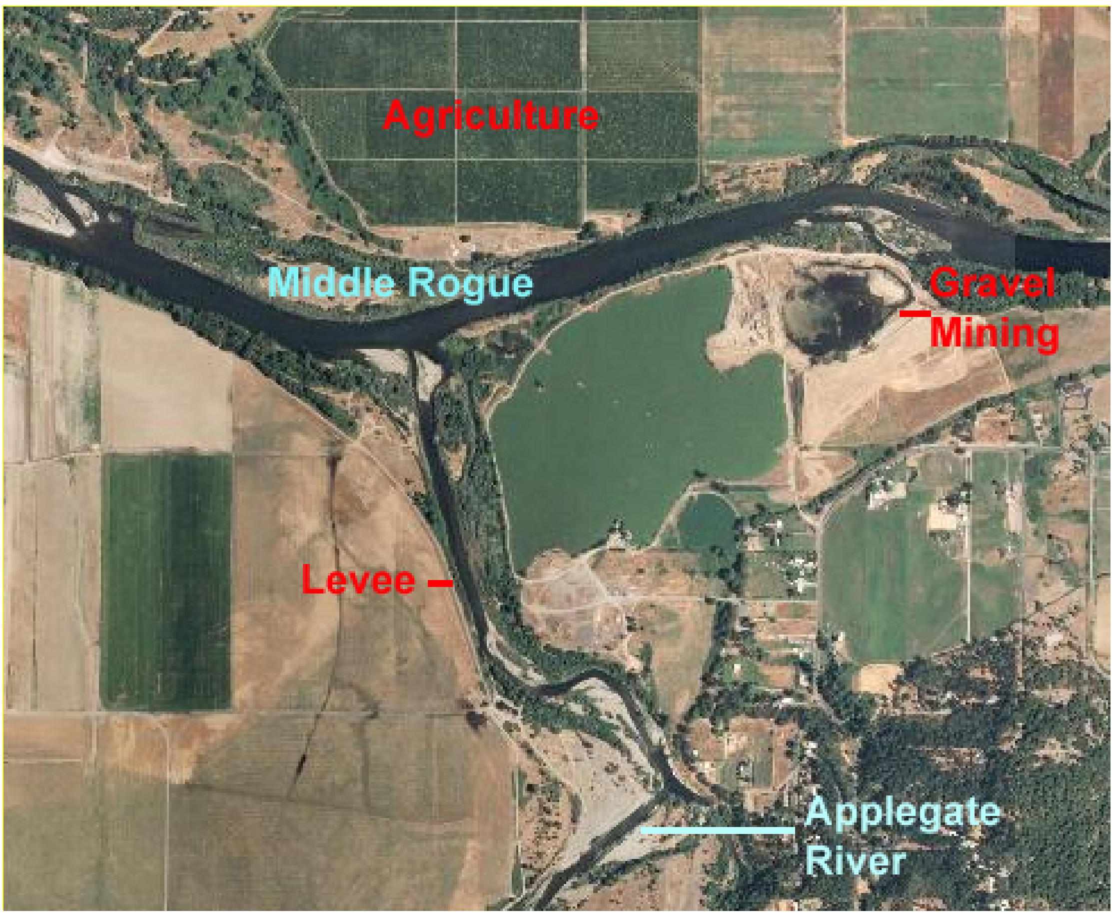

Figure 31-8. Photo of convergence of Applegate and Middle Rogue rivers. Photo shows intensive land use in the floodplain, disconnected channels, and greatly simplified riparian habitat, all contributing to poor ecosystem function.

Altered Hydrologic Function

Altered hydrologic function is a very high stress for the Middle Rogue-Applegate coho salmon population due to several factors but is primarily the result of dewatering tributary streams (Thompson and Fortune 1970, BLM 1996a). Lack of instream flow limits water quality and salmonid production, including coho salmon (Prevost et al. 1997, RBCC 2006).

The Applegate Dam on the upper mainstem Applegate River reduces winter flood peaks and eliminates natural spring flow peaks that coho salmon downstream migrants adapted to. The reduced magnitude and frequency of peak flows may have detrimental effects on channel morphology. In the early period of operation of Lost Creek Dam, on the Upper Rogue River (RM 157), flows in the mainstem Middle Rogue were very low which affected Middle Rogue-Applegate River fish on their seaward migration. However, increased releases during the summer and fall from the reservoir have benefited coho salmon (ODFW 1989).

Impaired Water Quality

The state of Oregon (ODEQ 2002a, 2003, 2008) identified extensive water quality problems in the Middle Rogue-Applegate subbasin that account for the high to very high stress scores for fry, juvenile, and smolt coho salmon life history phases. Only 21 percent of Middle Rogue and 44 percent of Applegate reaches surveyed by ODEQ met water quality standards (SO RC&D 2003). Elevated water temperature is the most pervasive water quality impairment, and is often caused by stream flow diversions (Thompson and Fortune 1970). Other water quality parameters listed as impaired include dissolved oxygen, fecal coliform (Middle Rogue River only in this population area), sedimentation (Beaver Creek only), and biological criteria (Beaver Creek only) (ODEQ 2003, 2008).

Water temperatures in the mainstem Middle Rogue River, Applegate River, and the larger tributaries are elevated during the summer months, likely approaching or exceeding coho salmon tolerance levels in most reaches (Appendix H); one exception is the tailwater below Applegate Dam. Elevated stream temperatures in coho salmon rearing streams decrease the survival and growth of fish and are a key limiting factor in this population area. Tributaries in the Wild Rogue Wilderness Area are cooler, as are headwater streams on public lands; however, most have stream gradients that are too high to be provide high quality coho salmon rearing habitat. Water temperature in Forest Creek, Williams Creek below Rock Creek, and Thompson Creek above Nine Mile Creek met ODEQ standards and coho suitability (Applegate River Watershed Council (ARWC) 2007) (Figure 31-9).

It is unlikely that high fecal coliform bacterial levels in the Rogue River (ODEQ 2008) would directly harm coho salmon; however, the coliform levels might indicate livestock access to creeks or leaking septic systems. Dissolved oxygen impairment, which is apparent in the Applegate tributaries Williams, Thompson, Cheney, Forest and Slate creeks is likely related to both nutrient enrichment and decreased flows. Pesticides and herbicides have the potential to harm coho salmon (NMFS 2008), but data are lacking for the Illinois River subbasin.

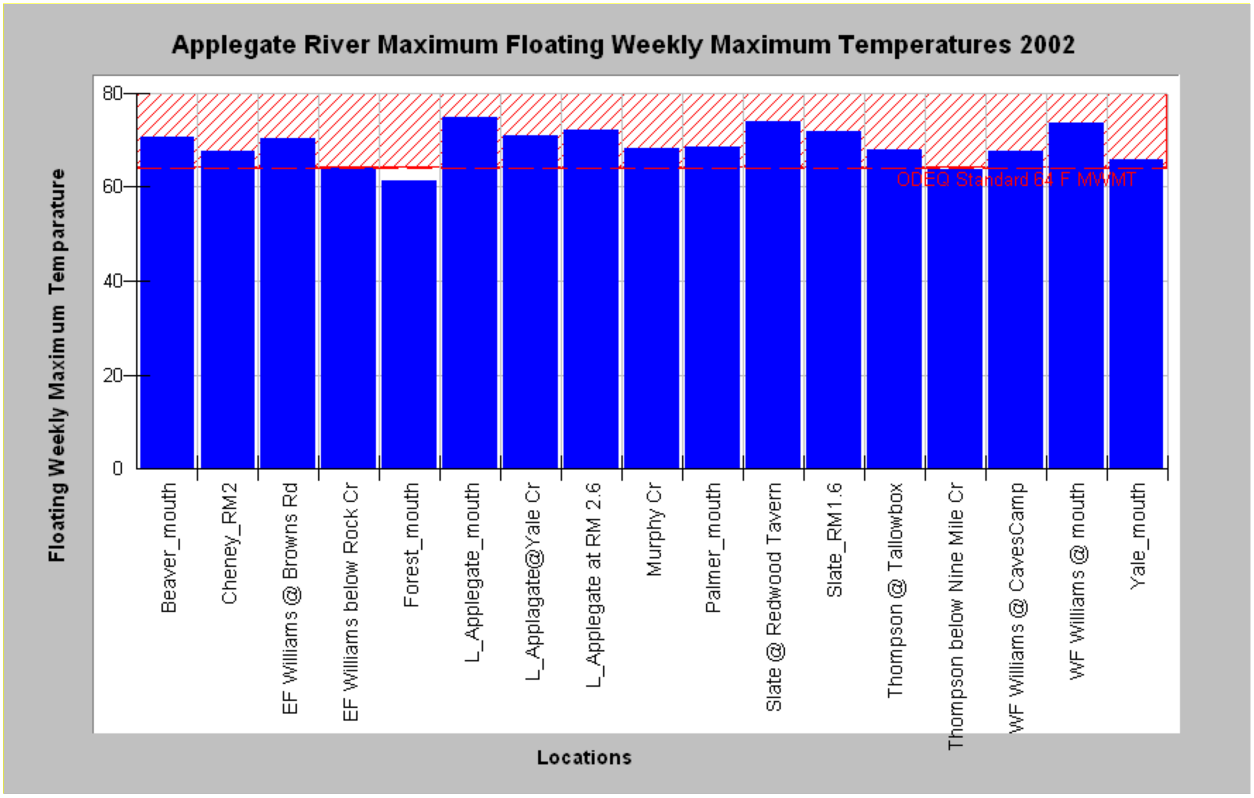

Figure 31-9. Floating weekly maximum temperature (MWMT) for several Applegate River tributaries. Temperatures in nearly all tributaries exceed Oregon Department of Environmental Quality (ODEQ) standards of 64° F (red line) (ARWC 2007).

Lack of Floodplain and Channel Structure

The straightening and simplification of streams has reduced the amount of slow, cool edgewater habitats where coho salmon fry and juveniles thrive (ODEQ 2008). Beaver have been greatly reduced along with the pools they create (ODFW 2005b). Although there are patches of functional coho salmon habitat, many river reaches and tributary channels do not support coho salmon (Prevost et al. 1997, ODFW 2008b). Channelization of the mainstem Rogue and Applegate rivers has disconnected them from much of their floodplain, reducing the physical processes that form coho salmon rearing and spawning habitat. These processes include side channel formation, accumulation of large wood jams, formation of slower water velocities, formation of pools, and lower shear stress. In the Applegate subbasin, small tributaries on both the east and west sides of the river drain into irrigation canals; consequently, there is no connection of the tributary channel or riparian area to the mainstem (BLM 1998a). Although the hydrologic effects of Applegate Dam on downstream channel morphology have not been studied, research on other river systems with large dams has shown that lack of flushing flows causes channel confinement that increases velocities and diminishes the amount of slow, edgewater habitats favored by rearing juvenile coho salmon (McBain and Trush 2002). Removal of large woody debris within the stream channels (USFS 1999b), timber harvest in riparian areas and associated road building have all contributed to reducing channel complexity and pool habitat, thus reducing juvenile coho salmon rearing capacity and survival.

Pool frequency and depth are important indicators of channel structure and both show impairment. Although some larger tributary mainstems have very good pool frequency (>35 percent of stream area), many have a rating of good (20 to 35 percent). Although some small headwater streams throughout the subbasin have cool water temperatures, maximum average pool depths are less than 3 feet and are marginal or unsuitable for coho salmon rearing throughout the summer and winter. Shallow pool depths (<3 feet) also exist in alluvial valley tributaries like the Little Applegate, Thompson, Forest, Cheney, Slate, Murphy, Wolf, Coyote, and Williams creeks. Mainstems of large tributaries like Grave and Jumpoff Joe creeks score well on the 3-foot depth criteria, but since they are larger order streams they likely had much greater depths before disturbance. Some Lower Middle Rogue (Stair and Shasta Costa creeks), Wild Rogue (Mule, Big Windy, Bunker, Howard, and Whiskey creeks) and west-side tributaries that flow from public land (Galice Creek) have average maximum pool depths greater than 3 feet, indicating that their depth and carrying capacity for salmonids is increasing.

Spatial patterns from ODFW and USFS large wood surveys of Middle Rogue-Applegate stream channels are very similar to those observed in the riparian conifer surveys. Most mainstem reaches surveyed on private lands throughout the subbasin, including most of Grave and Jumpoff Joe creeks, had less than one key piece of large wood per 100 meters, which rates as poor. Reaches in the Applegate River tributaries Thompson, Cheney, Slate, Beaver, and Williams creeks all have poor large wood scores. Upper reaches on private and public lands tend to have slightly better scores with many rated fair (1 to 2 key pieces/100 m), but only USFS and BLM headwater tributaries have good and very good large wood scores).

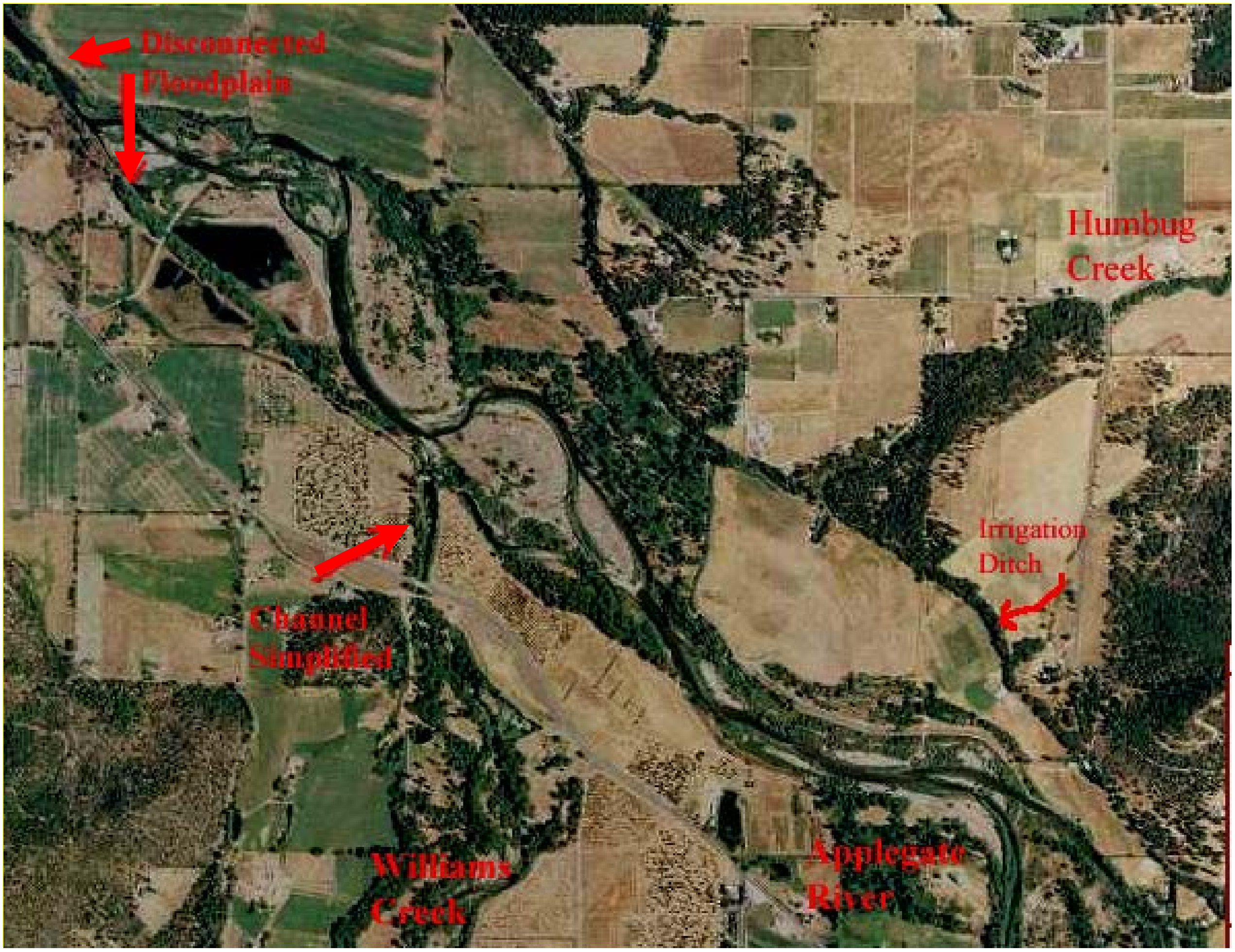

Figure 31-10. Aerial photo of convergence of Applegate River and Williams Creek. In this alluvial valley reach the river has a narrow riparian buffer zone as does Williams Creek at their point of convergence. The channel of Humbug Creek (right) appears to terminate in a diversion ditch.

Impaired Estuary/Mainstem Function

The Rogue River estuary is highly altered and has lost some of its historic function. Loss of rearing habitat in the estuary limits productive potential of the entire basin and is a moderate stress for juveniles in all Rogue basin populations. Insufficient refugia habitat for smolts and adults likely results in high rates of predation from birds and pinnipeds during migration to and from the ocean. These degraded conditions cause impaired estuarine function to be a medium stress for the population overall but a high stress to smolts. A discussion of the causes of reduced estuarine function can be found in the Lower Rogue River population profile.

Barriers

Barriers pose a medium threat to the population overall, but a high stress to juveniles. Access to 19 miles of historic coho salmon habitat in the Applegate Subbasin is blocked by Applegate Dam (ODFW 2005c, Figure 31-1). This blocked habitat is not essential to this population achieving its spawner target, so NMFS does not recommend removing the dam or providing passage. A substantial amount of historic habitat in the Middle Rogue-Applegate subbasin may be inaccessible due to road-stream crossings associated with extensive road networks, and maps indicate barriers in Cheney and Slate creek watersheds (Bredensteiner et al. 2003). The Rogue Basin Fish Access Team (RBFAT) is developing a coordinated plan for assessment and removal of fish passage barriers in the Rogue River basin and nine of the top twenty targets are in the Middle Rogue subbasin (Mosser and Graham 2004). Temporary gravel agricultural diversion dams, known as push up dams, may impede access in alluvial valley reaches of coho salmon tributaries (Prevost et al. 1997). The USFS (1995b) identified permanent agricultural diversion structures that impede both adult and juvenile salmonid migration. Savage Rapids Dam, which was previously recognized as an impediment to salmonid migration (RBCC 2006), was removed in 2009 (U.S Bureau of Reclamation (BOR) 2009a).

Altered Sediment Supply

Sediment contribution from landslides and erosion occurs naturally in the Middle Rogue-Applegate River basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. Excess fine sediment directly impacts egg viability and can reduce food for fry, juveniles and smolts. Applegate Dam blocks coarse and fine sediment supply to the lower mainstem Applegate River. Beaver Creek's headwaters, in the Applegate subbasin, intersect with a band of decomposed granitic soils that have little cohesion and contribute very large quantities of sand (ODEQ 2003). As a result, Beaver Creek is considered sediment impaired by ODEQ (2003). Poor pool frequency and depth throughout the Middle Rogue-Applegate River basin (USFS 1995b, BLM 1998a) are likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening.

Adverse Hatchery Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. Cole Rivers Hatchery is located upstream of the Middle Rogue/Applegate population area in the Upper Rogue River sub-basin, and produces approximately 200,000 coho salmon smolts annually in addition to millions of hatchery spring Chinook, winter steelhead, and summer steelhead (ODFW 2008d). Some coho salmon returning to the hatchery stray into the mainstem tributaries and to a lesser extent into the Applegate River. From 1996 to 1998, less than five percent of adults observed in spawner surveys in the Applegate River were of hatchery origin (Jacobs et al. 2002). Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of Cole Rivers Hatchery in the Rogue River basin (Appendix B).

Disease/Predation/Competition

Water temperatures in Middle Rogue and Applegate tributaries in recent years are above those recognized by McCullough (1999) as causing increased disease risk for juvenile coho salmon. Competition with and predation by non-native fishes is an ongoing problem, especially in the lower Applegate River (Wheeler 2009). In very temperature-impaired streams, such as portions of Jumpoff Joe Creek, introduced species like redside shiners may predominate (BLM 1998b). Umpqua pikeminnow, an introduced species, is prevalent in the mainstem Rogue River.

Adverse Fishery-related Effects

NMFS has determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

31.6 Threats

Table 31-7. Severity of threats affecting each life stage of coho salmon in the Middle Rogue-Applegate River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Dams/Diversions	High	Very High	Very High	Very High	High	Very High
2	Agricultural Practices	High	Very High	Very High	Very High	High	Very High
3	Urban/Residential/Industrial	High	Very High	Very High	High	Very High	Very High
4	Roads	High	Very High	Very High	High	High	High
5	Channelization/Diking	High	Very High	Very High	High	High	High
6	Timber Harvest	Medium	High	High	High	Medium	High
7	Road-Stream Crossing Barriers	-	Medium	Medium	High	High	Medium
8	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
9	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
10	Invasive Non-Native/Alien Species	-	Medium	Medium	Medium	Medium	Medium
11	Mining/Gravel Extraction	Medium	Low	Low	Low	Medium	Medium
12	Climate Change	Low	Low	Medium	Low	Low	Medium
13	Fishing and Collecting	-	-	-	-	Low	Low

Dams/Diversions

Multiple diversions de-water most of the prime coho salmon rearing areas in the Middle Rogue-Applegate subbasin (Thompson and Fortune 1970, Prevost et al. 1997, RBCC 2006, ODFW 2008b). ARWC (2007) noted that many streams in the Applegate watershed are over-allocated and irrigation withdrawals exacerbate low summer flows. Agricultural diversions diminish flows in alluvial reaches of Middle Rogue tributaries with high IP coho salmon habitat, including Pickett, Little Pickett, Limpy, Pass, and lower Taylor creeks (Thompson and Fortune 1970). Unscreened diversions may also cause significant loss of downstream migrating coho salmon juveniles (ODFW 2008b). In addition, approximately 19 miles of coho salmon habitat is blocked by Applegate Dam (ODFW 2005c).

Agricultural Practices

Agricultural impacts include flow depletion, elevated water temperature, channel simplification, riparian removal, and chemical application. The most intensive agricultural land use overlaps substantially with the highest IP coho salmon habitat. Agricultural impacts were assessed in part based on Landsat imagery (Homer et al. 2004). The lower mainstem Applegate, Little Applegate, Baum Slough, Yale, Williams, and East Fork Williams creeks all have high (5 to 10 percent of land area) or very high (>10 percent) agricultural land-use. Middle Rogue River tributaries located just above and below the Applegate River that were rated high include Lathrop, Vannoy, Pass, Minnie, Dutchman, Limpy, Pickett, Little Pickett, and Taylor creeks. Grazing may change soil infiltration rates and can cause deleterious channel changes (Spence et al. 1996). It is likely that pesticides known to harm salmonids (NMFS 2008, Laetz et al. 2009) are used in the region. However, information regarding pesticide and herbicide use in the Middle Rogue-Applegate subbasin and the SONCC coho salmon ESU is unavailable (Riley 2009). Herbicide use in the nearby Upper Rogue subbasin has resulted in fish kills that included coho salmon (Ewing 1999).

Urban/Residential/Industrial

Urbanization and rural development pose a very high threat for Middle Rogue-Applegate coho salmon due to existing impacts to high IP habitat that are likely to continue in the future. Grants Pass, Merlin, the Applegate Valley, and Jumpoff Joe, Grave, Wolf, and Coyote creek watersheds contain high IP habitat and the vast majority of the human residences. Effects of urbanization increase with total impervious area which causes increased peak flow, simplification of downstream channels, increased channel width to depth ratio, and toxic non-point source pollution (Booth and Jackson 1997, Booth et al. 2006). In urban centers such as Grants Pass, industrial development may add to non-point source pollution. Rural residential development is growing rapidly in Jackson County within the Middle Rogue-Applegate subbasin (SO RC&D 2003), and septic system leakage or failure can lead to pollution. Backyard use of pesticides and fertilizers can also be significant in areas with concentrated development (Booth et al. 2006). Residential development outside cities and towns often relies on surface water from streams or groundwater wells that may deplete nearby surface flows. Rural residential developments are specifically noted as a concern in Jumpoff Joe Creek (BLM 1998b), Little Applegate (USFS 1995b), and Star Gulch (BLM 1998a) in the Applegate subbasin.

Roads

Very high road densities, numerous road-stream crossings, and roads on steep slopes combine to pose a high to very high threat to all coho salmon life stages in the Middle Rogue-Applegate subbasin. Road densities are very high (>3 mi/mi^2) in almost all areas of the subbasin. The only Middle Rogue watersheds with low (0 to 1.6 mi/mi^2) road densities are Rogue Wilderness areas between Agness and Mule Creek, and the Howard Creek watershed. In the Applegate subbasin, Palmer Creek is the only watershed below Applegate Dam with low road density. The aggregated Wild Rogue tributary watersheds near Whiskey Creek on BLM lands have high (2.5 to 3.0 mi/mi^2) road densities, as does Taylor Creek, a USFS Key Watershed.

The greatest road densities are in urban areas near Grants Pass, in some cases exceeding 7 mi/mi^2 (Bredensteiner et al. 2003). BLM (1998b) found road densities in the urbanized lower Jumpoff Joe watershed to be 8.29 mi/mi^2, but 4.63 mi/mi^2 on BLM land. Upper Grave Creek has nearly 6 mi/mi^2 due to a combination of urban, rural residential and logging roads. Private forest lands, such as Cheney and Slate creeks in the lower Applegate subbasin, have road densities of 4 to 5 mi/mi^2. Rural residential, forest, and agricultural roads combine to elevate the road density in Williams Creek in the Applegate subbasin to near 5 mi/mi^2. There are far more un-surfaced than paved roads in the western Middle Rogue and Applegate watersheds. East-side tributaries in urban areas have mostly paved roads. While paved roads yield less fine sediment than dirt roads, they have greater hydrologic impacts (Booth and Jackson 1997) and can contribute toxic runoff (Booth et al. 2006).

Channelization and Diking

Channelization and diking threat is a high to very high threat across all Middle Rogue-Applegate coho life stages, and high overall, because of extensive channel changes related to historic mining, agriculture and urbanization (Prevost et al. 1997). Disruptions include key locations such as the convergence of the Applegate and Middle Rogue (Figure 31-8) and Williams Creek and the Applegate River (Figure 31-10). When a channel is disconnected from its floodplain, slow water habitats in the stream margins preferred by coho salmon are reduced or eliminated. Channelization of streams and disconnection from wetlands (Figure 31-11) has resulted in decreased water storage and disrupted surface water connections to cooler groundwater, causing loss of summer and fall rearing refugia (ODEQ 2008). This type of disruption is typical in the entire reach from Evans Creek downstream to the Applegate River. Applegate tributaries impacted by agriculture, such as Williams, Thompson, Slate, Cheney, and Yale creeks are channelized or confined, as is the Little Applegate River. Channelization in Jumpoff Joe Creek by agriculture, mining, and road construction has resulted in substantial negative impacts to coho salmon habitat (BLM 1998b).

Figure 31-11. The middle mainstem Rogue River is disconnected from its floodplain and wetlands. Red arrows point to disconnected portions. This eliminates stable side channels that provide coho salmon rearing habitat. June 2005.

Timber Harvest

Reeves et al. (1993) found that the rate of timber harvest in Oregon coastal watersheds should not exceed 25 percent of a watershed to minimize risks and disturbances to aquatic resources. The study covered a period of 30 years (Reeves 2003) and watersheds exceeding that level of harvest did not maintain channel integrity or Pacific salmon species diversity. Middle Rogue-Applegate subbasin timber harvest rates are typically greater than this threshold on private timber land; therefore, the threat from timber harvest on private land will likely remain high. However, logging on public land is now largely restricted to selective harvests in previously logged areas in order to improve forest health. The greatest risk from timber harvest is on private industrial timberlands that are managed under the Oregon Forest Practices Act, such as in private in-holdings in upper Slate Creek, Cheney Creek, and the decomposed granitic soils of the upper Beaver Creek watershed.

Road-Stream Crossing Barriers

The high threat score for smolts and adults, and the medium threat score overall for fish passage at culverts and stream crossings is a result of high road densities in urban areas, industrial timber lands, and rural residential areas of the Middle Rogue-Applegate watershed. Bredensteiner et al. (2003) show particularly high road densities, road stream crossings, and associated potential barriers in watersheds of Mule, Grave, Wolf, Coyote, Jumpoff Joe, and Upper Middle Rogue tributaries (Grants Pass). In the Applegate subbasin, road stream crossings are highest in the Cheney Creek and Slate Creek watersheds.

High Intensity Fire

Fire risk is acknowledged as a regional concern (RBCC 2006, BLM 1998b). Early seral stage forests, which are common in this population's range, lead to dry site conditions and increased fire risk (SO RC&D 2003). Of all areas in the subbasin, elevated fire risk poses the greatest threat to watershed recovery in the Wild Rogue tributaries between Mule and Grave creeks. Large areas of even-age plantations and areas converted from Douglas fir to hardwood or chaparral may have elevated fire risk.

Hatcheries

Hatcheries pose a medium threat to all life stages of coho salmon in the Middle Rogue/Applegate River. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Invasive Non-Native Species

Thompson and Fortune (1970) documented large populations of warm water fish in the lower Applegate River and in the mainstem Rogue River upstream of diversion dams such as Savage Rapids and Gold Ray dams. Non-native Umpqua pikeminnow, a coldwater predator, is present in the mainstem Rogue River. Removal of Gold Hill Diversion Dam in the Upper Rogue subbasin in 2008 and Savage Rapids dam in in the Middle Rogue subbasin 2009 are expected to have made this habitat less favorable for these invasive species. Agricultural and residential ponds provide a source of warm water game fish. Although the magnitude of competition and predation by introduced warm water species has not been assessed recently, NMFS believes it is a continuing problem in the lower Applegate River.

Mining/Gravel Extraction

Legacy effects from past gold mining may persist in some reaches (BLM 1999a) and there are still many active mining claims. BLM (1998b) notes that gravel extraction is widespread in the vicinity of the I-5 corridor and in urban areas of the Jumpoff Joe Creek watershed. The gravel operation in the mainstem Rogue River at the mouth of the Applegate occupies what was likely a wetland complex and salmonid refugia before disturbance. The ARWC (2007) expressed concern regarding gravel extraction because mainstem reaches are already depleted of coarse substrate due to Applegate Dam. One commercial operator removes approximately 500,000 cubic yards from the lower Applegate River annually, but much now comes from pits outside of the ordinary high water mark (Wheeler 2009). Pits excavated in the floodplain can capture juvenile coho salmon, coho salmon smolts, and adult coho salmon during high flow events. Most of these stranded fish perish if no outlet is available when flows recede.

Climate Change

Climate change scenarios for Middle Rogue-Applegate subbasin (Independent Science Advisory Board (ISAB) 2007, Feely et al. 2008, Portner and Knust 2007) predict increasing air temperature for the years 2030 to 2050. Impacts of climate change in this region may affect all life history stages, but the greatest impact will likely be on juveniles. The projected increase in July air temperature ranges from 1.5 to 3.0 °C, and January temperatures are predicted to increase 1.0 to 1.5 °C at all elevations. This will likely result less snow accumulation throughout most of the Middle Rogue-Applegate subbasin, and the resulting decreased flow will directly diminish available habitat.

Van Kirk and Naman (2008) documented decreasing snow pack below 6,000 feet over the last 20 years in the Klamath Mountains just south of the Applegate subbasin. Warming may increase rain-on-snow events, which result in increased runoff that can scour redds and eggs and can flatten channel profiles, resulting in loss of rearing habitat. Overall, the range and degree of variability in temperature and precipitation are likely to increase in all populations. Adults may be negatively impacted by ocean acidification and changes in ocean conditions and prey.

Fishing and Collecting

The directed recreational fishery for hatchery coho salmon in Oregon likely encounters more coho salmon than the Chinook-directed fisheries that account for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the directed fisheries. The exploitation rate associated with this and other freshwater fisheries in Oregon has been found to be low enough to avoid jeopardizing the continued existence of the ESU (Good et al. 2005). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because no recovery objectives to achieve species viability had been established for SONCC coho salmon at that time (NMFS 1999). Regional-scale effects may be enough to impede recovery of the Interior Rogue River diversity stratum, even if they are not severe enough to jeopardize the continued existence of the ESU. Specifically, wild coho salmon in the Rogue River basin likely experience more exploitation effects than those in other areas, because they co-occur with the adult hatchery coho salmon that were produced in the Rogue's Cole Rivers Hatchery, return to the Rogue River to spawn, and are targeted there by recreational fishermen. NMFS has authorized future collection of coho salmon for research purposes in the Middle Rogue/Applegate River. NMFS has determined these research collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

31.7 Recovery Strategy

The most immediate need for habitat restoration and threat reduction in the Upper Rogue River is in those areas currently occupied by coho salmon in the watersheds of the Applegate River, Jumpoff Joe Creek, and Graves Creek. Unoccupied areas must also be restored to provide enough habitat for coho salmon recovery.

The severely degraded condition of the Middle Rogue-Applegate River habitat, combined with the depressed coho salmon population size and distribution, significantly increases the risk of extinction of this important, inland coho salmon population. The most important factor limiting recovery of coho salmon in the Middle Rogue-Applegate River is a deficiency in the amount of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by restoring flow, increasing habitat complexity within the channel, restoring off-channel rearing areas, and reducing threats to instream habitat.

Table 31-8 on the following page lists the recovery actions for the Middle Rogue/Applegate rivers population.

Table 31-8. Recovery action implementation schedule for the Middle Rogue/Applegate rivers population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MRAR.2.1.2	Floodplain and Channel Structure	Yes	Increase channel complexity	Educate stakeholders	Population wide	BR
SONCC-MRAR.2.1.2.1	*Develop an educational program that promotes Salmon Safe methods for agricultural operations and Integrated Pest Management for rural residents*					
SONCC-MRAR.2.2.10	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels and restore features if needed	Population wide	3
SONCC-MRAR.2.2.10.1	*Assess habitat to determine where potential exists for floodplain reconnection. Prioritize sites and determine best means for reconnection at each site using tools such as hydrologic analysis*					
SONCC-MRAR.2.2.10.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-MRAR.2.2.11	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	3
SONCC-MRAR.2.2.11.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-MRAR.2.2.11.2	*Implement beaver program (may include reintroduction)*					
SONCC-MRAR.2.1.12	Floodplain and Channel Structure	Yes	Increase channel complexity	Improve suction dredging practices	Population wide	BR
SONCC-MRAR.2.1.12.1	*Develop suction dredging regulations that minimize or prevent impacts to coho salmon. Consider special closed areas, closed seasons, and restrictions on methods and operations*					
SONCC-MRAR.2.1.13	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	All tributaries within private lands	3
SONCC-MRAR.2.1.13.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MRAR.2.1.13.2	*Place instream structures, guided by assessment results*					
SONCC-MRAR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-MRAR.3.1.4.1	*Develop an educational program about water conservation programs and instream leasing programs*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MRAR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MRAR.3.1.5.1	*Study groundwater withdrawal and prevent development if insufficient supply exists*					
SONCC-MRAR.3.1.5.2	*Establish a comprehensive statewide groundwater permit process*					
SONCC-MRAR.3.1.31	Hydrology	Yes	Improve flow timing or volume	Manage flows	Applegate Dam	3
SONCC-MRAR.3.1.31.1	*Evaluate the effect of Applegate Dam flow releases on juvenile salmon rearing habitat*					
SONCC-MRAR.5.1.15	Passage	Yes	Improve access	Remove barriers	Population wide	BR
SONCC-MRAR.5.1.15.1	*Assess and prioritize barriers using the ODFW fish passage barrier database*					
SONCC-MRAR.5.1.15.2	*Remove barriers, guided by the assessment*					
SONCC-MRAR.7.1.7	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Privately held timberlands	2
SONCC-MRAR.7.1.7.1	*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*					
SONCC-MRAR.7.1.8	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Wild Rogue tributaries, Galice, Taylor, Pickett, Limpy, Williams, Thompson, Forest, and Beaver creeks, Little Applegate River	BR
SONCC-MRAR.7.1.8.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-MRAR.7.1.8.2	*Thin, or release conifers, guided by prescription*					
SONCC-MRAR.7.1.8.3	*Plant conifers, guided by prescription*					
SONCC-MRAR.7.1.9	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	BR
SONCC-MRAR.7.1.9.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-MRAR.7.1.9.2	*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MRAR.7.1.30	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Private lands	BR
SONCC-MRAR.7.1.30.1	*Develop HCPs or GCPs with interested owners of private timberlands*					
SONCC-MRAR.7.1.32	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	BLM lands	3
SONCC-MRAR.7.1.32.1	*Manage timber harvest (and associated activities) on Federal lands in accordance with the Aquatic Conservation Strategy of the NWFP to achieve riparian and stream channel improvements for coho salmon*					
SONCC-MRAR.10.2.3	Water Quality	Yes	Reduce pollutants	Increase regulatory oversight	Population wide	BR
SONCC-MRAR.10.2.3.1	*Develop local regulatory mechanisms that limits development and reduces amount of total impervious area through incentives*					
SONCC-MRAR.10.2.29	Water Quality	Yes	Reduce pollutants	Set standard	Applegate River RM 0 to 32.4, tributaries to Applegate River	3
SONCC-MRAR.10.2.29.1	*Develop TMDLs for 303(d) listed water bodies*					
SONCC-MRAR.14.2.14	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of warm-water, non-native fish species	Population wide	BR
SONCC-MRAR.14.2.14.1	*Determine presence of warm water, non native fish species and develop a plan for eradication or control*					
SONCC-MRAR.14.2.14.2	*Eradicate or control invasive fish species, guided by the plan*					
SONCC-MRAR.1.2.34	Estuary	No	Improve estuarine habitat	Improve estuary condition	Rogue River Estuary	3
SONCC-MRAR.1.2.34.1	*Implement recovery actions to address strategy "Estuary" for Lower Rogue River population*					
SONCC-MRAR.16.1.16	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MRAR.16.1.16.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MRAR.16.1.16.2	*Identify fishing impacts expected to be consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MRAR.16.1.17	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MRAR.16.1.17.1	*Determine actual fishing impacts*					
SONCC-MRAR.16.1.17.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-MRAR.16.2.18	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MRAR.16.2.18.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-MRAR.16.2.18.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-MRAR.16.2.19	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MRAR.16.2.19.1	*Determine actual impacts of scientific collection*					
SONCC-MRAR.16.2.19.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-MRAR.27.1.20	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-MRAR.27.1.20.1	*Perform annual spawning surveys*					
SONCC-MRAR.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MRAR.27.1.21.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-MRAR.27.1.22	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	3
SONCC-MRAR.27.1.22.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MRAR.27.2.23	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MRAR.27.2.23.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-MRAR.27.2.23.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-MRAR.27.2.24	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-MRAR.27.2.24.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-MRAR.27.2.25	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-MRAR.27.2.25.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-MRAR.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MRAR.27.2.26.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-MRAR.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-MRAR.27.2.27.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-MRAR.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-MRAR.27.2.28.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-MRAR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-MRAR.27.1.33.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-MRAR.27.1.36	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MRAR.27.1.36.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MRAR.27.1.36.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-MRAR.5.1.35	Passage	No	Improve access	Remove barriers	USFS lands	BR
SONCC-MRAR.5.1.35.1	*Evaluate and prioritize barriers for removal*					
SONCC-MRAR.5.1.35.2	*Remove barriers*					
SONCC-MRAR.8.1.6	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Wild Rogue tributaries, Galice, Taylor, Pickett, Limpy, Williams, Thompson, Forest, and Beaver creeks, Little Applegate River	BR
SONCC-MRAR.8.1.6.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MRAR.8.1.6.2	*Decommission roads, guided by assessment*					
SONCC-MRAR.8.1.6.3	*Upgrade roads, guided by assessment*					
SONCC-MRAR.8.1.6.4	*Maintain roads, guided by assessment*					

32. Upper Rogue River Population

- Interior Rogue Stratum
- Core, Functionally Independent Population
- Moderate Extinction Risk
- 16,100 Spawners Required for ESU Viability
- 2,422 mi^2
- 805 IP km (500 mi) (56% High)
- Dominant Land Uses are Agriculture and Urban/Residential/Commercial Development
- Principal Stresses are ‘Altered Hydrologic Function’ and ‘Degraded Riparian Forest Conditions’
- Principal Threats are ‘Roads’ and ‘Agricultural Practices’

32.1 History of Habitat and Land Use

From 1780 to 1840, trappers swept Oregon coastal rivers, including the Rogue River basin, reducing the robust beaver population to remnant levels (Oregon Department of Fish and Wildlife (ODFW) 2005b). Beaver ponds provide excellent rearing habitat for coho salmon, and thus beaver trapping was likely the first negative effect of European settlers on coho salmon. In the mid- to late 1800s, proliferation of gold mining in the Rogue Valley further decreased coho salmon rearing, spawning, and migratory habitat. After the 1850s, settlers began reclaiming and development of the flat, alluvial valley bottoms and wetlands, and increased agricultural production. Many Rogue River streams were straightened and disconnected from their floodplains, wetlands and meanders filled, flows diverted and riparian shade reduced. Due to habitat alteration and flow depletion, summer air temperatures (which often exceed 100° F) in the Upper Rogue River subbasin are now more likely to cause higher stream temperatures than in the past, thereby reducing the quality and quantity of summer rearing habitat, and decreasing juvenile coho salmon survival.

The Upper Rogue River headwaters, primarily managed by the U.S. Forest Service (USFS), are located along the crest of the Cascade Range. Public and private lands in the Upper Rogue River subbasin were extensively logged after World War II, when there were few restrictions on harvesting near streams or using stream beds to skid logs. Channel damage from the 1964 flood was widespread in areas downstream of logging activity (Thompson and Fortune 1970, USFS 1997a).

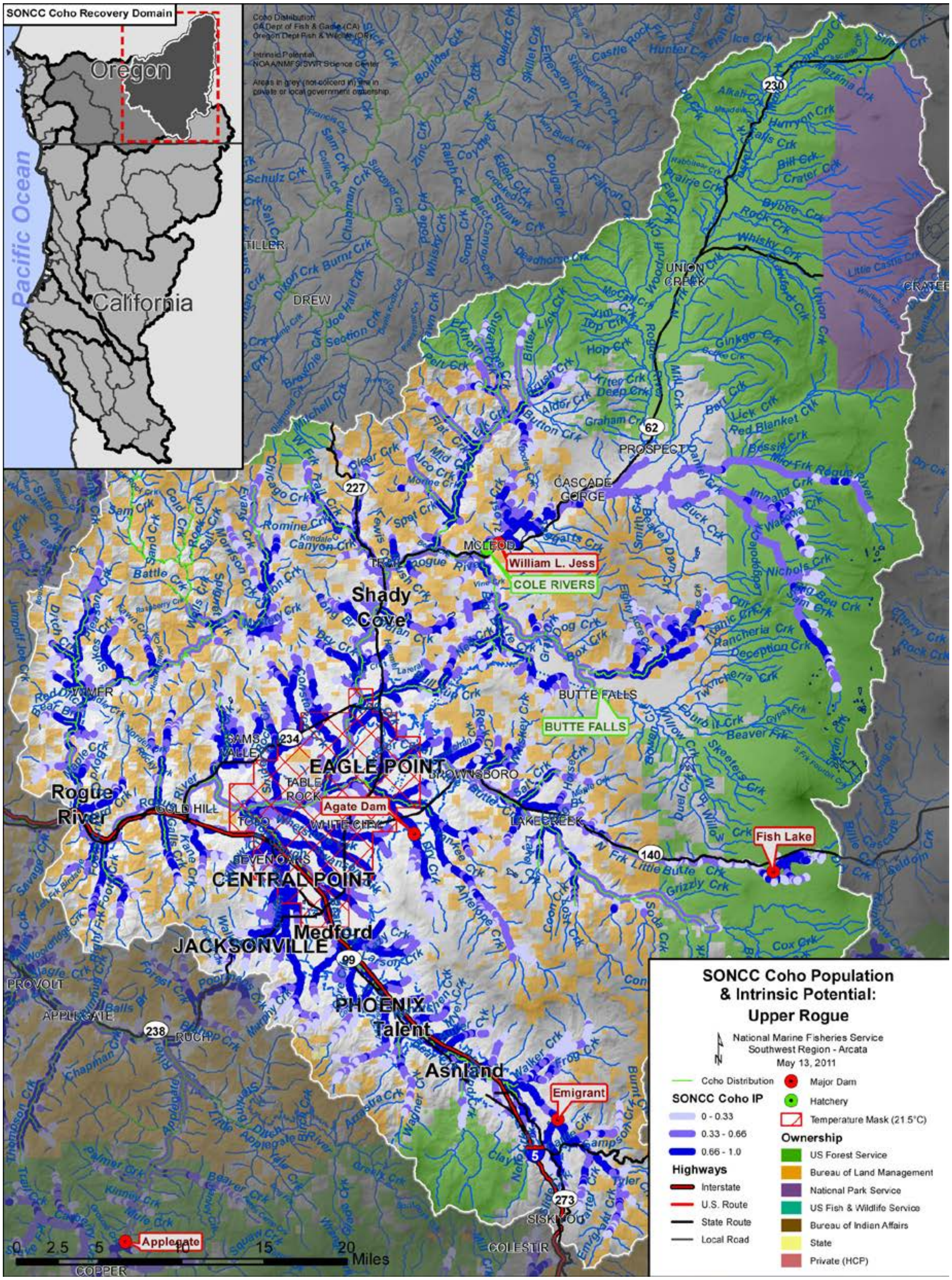

Figure 32-1. The geographic boundaries of the Upper Rogue River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (ODFW 2010a), and location within the Southern-Oregon/Northern California Coast Coho

Salmon ESU and the Interior Rogue diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

The USFS adopted more conservation-based management in 1994 when the Record of Decision for the Northwest Forest Plan was signed, but almost all National Forest lands in the subbasin are above the current range of coho salmon. Lands managed by the BLM are extensive in the watersheds of Evans, Trail, Big and Little Butte, and upper Bear creeks but alternate with private land in a checker board pattern. Urban development is extensive in Lower Bear Creek and the Upper Rogue Valley, where most land is privately owned. In addition, there has been substantial residential development in many parts of the subbasin, accompanied by surface water and groundwater extraction.

The completion of Lost Creek Dam (later renamed William L. Jess Dam) in 1977 created Lost Creek Reservoir, altered the natural hydrograph of the mainstem Rogue River, and the associated Cole Rivers Hatchery mitigation program annually produces 200,000 coho salmon smolts. The notching of the Elk Creek Dam on Elk Creek, an important tributary that joins the Rogue River five miles downstream of Lost Creek Reservoir, in 2008 provided coho salmon with unrestricted access to that watershed after nearly 20 years of trapping and hauling coho salmon upstream (Oregon Wild 2008). Other recent major fish passage improvements include the removal of three diversion dams on the mainstem Rogue River: Savage Rapids Dam in 2009 in the Middle Rogue subbasin (U.S. Bureau of Reclamation (BOR 2009a) and Gold Hill Dam in 2008 (Oregon Water Watch 2008) and Gold Ray Dam in 2010 (Freeman 2010) in the Upper Rogue subbasin

32.2 Historic Fish Distribution and Abundance

The 1977 construction of William L. Jess Dam (Figure 32-2) at river mile (RM) 157 in the Upper Rogue River subbasin reduced coho salmon distribution by only 12 miles (ODFW 2005c) because geologic barriers near Prospect above the dam naturally prevented anadromous fish migration to the uppermost reaches of the mainstem Rogue River (USFS 1998d). Major tributaries below the dam include Evans, Trail, Elk, Bear, Big Butte, and Little Butte creeks; however, some high coho salmon IP habitat is blocked by dams within these watersheds. Dams impounding Emigrant Reservoir on Bear Creek, Agate and Fish Lake Reservoirs on Little Butte Creek, and Willow Lake Reservoir on Big Butte Creek are the most significant barriers.

A cannery operated at the mouth of the Rogue River beginning in 1876. Records from the cannery were used to estimate an annual run size of approximately 114,000 adult coho salmon in the late 1800s (Meengs and Lackey 2005). There is no way to know how many of these fish were returning to the subbasin, rather than elsewhere in the 5,600 square mile Rogue River basin. The subbasin contains 39 percent of the basin-wide IP kilometers of habitat (Williams et al. 2008), suggesting possible returns of 45,000 fish during the time of cannery operation.

Figure 32-2. William L. Jess Dam. The dam blocks anadromous fish access upstream, but provides a perennially cold mainstem Rogue River flows below the dam (at center left). Aerial photo from June 2005.

32.3 Current Status of Coho Salmon in the Upper Rogue River

Spatial Structure and Diversity

Coho salmon juvenile surveys performed in the Upper Rogue River subbasin (ODFW 2005a) confirmed presence and varying levels of abundance in Little Butte, Big Butte, Evans, Trail, Elk, and Antelope creeks (Figure 32-3). Most high density rearing occurs in the upper watersheds and often immediately below public land that supplies cool water. Potential coho salmon habitat periodically lacks sufficient flow (Rogue Basin Coordinating Council (RBCC) 2006), and Trail Creek seasonally has no flow (Nawa 1999).

Densities of juvenile coho salmon throughout the Upper Rogue River population vary by location (Figure 32-3). Most of the juvenile coho salmon observed recently were in the headwater areas of Little and Big Butte creeks, Elk Creek, Trail Creek, and Evans Creek. Historically, Bear Creek had more than 25 miles of estimated high IP habitat (Figure 32-1); however, no juvenile coho salmon were observed during summer sampling (Figure 32-3), likely due to high water temperatures and habitat degradation in this highly urbanized watershed. Coho salmon juveniles died in Bear Creek during an herbicide-related fish kill on May 6, 1996 (Ewing 1999), indicating some juveniles are present in this watershed at least during times of year with lower temperatures. Juvenile coho salmon were documented in Larson Creek (VanDyke 2006a) and Military Slough (VanDyke 2006b), both in the Bear Creek watershed, during sampling with hoop traps from November 2005 to March 2006. No juvenile coho salmon were observed during sampling on Sand Creek during that same period (VanDyke 2006c).

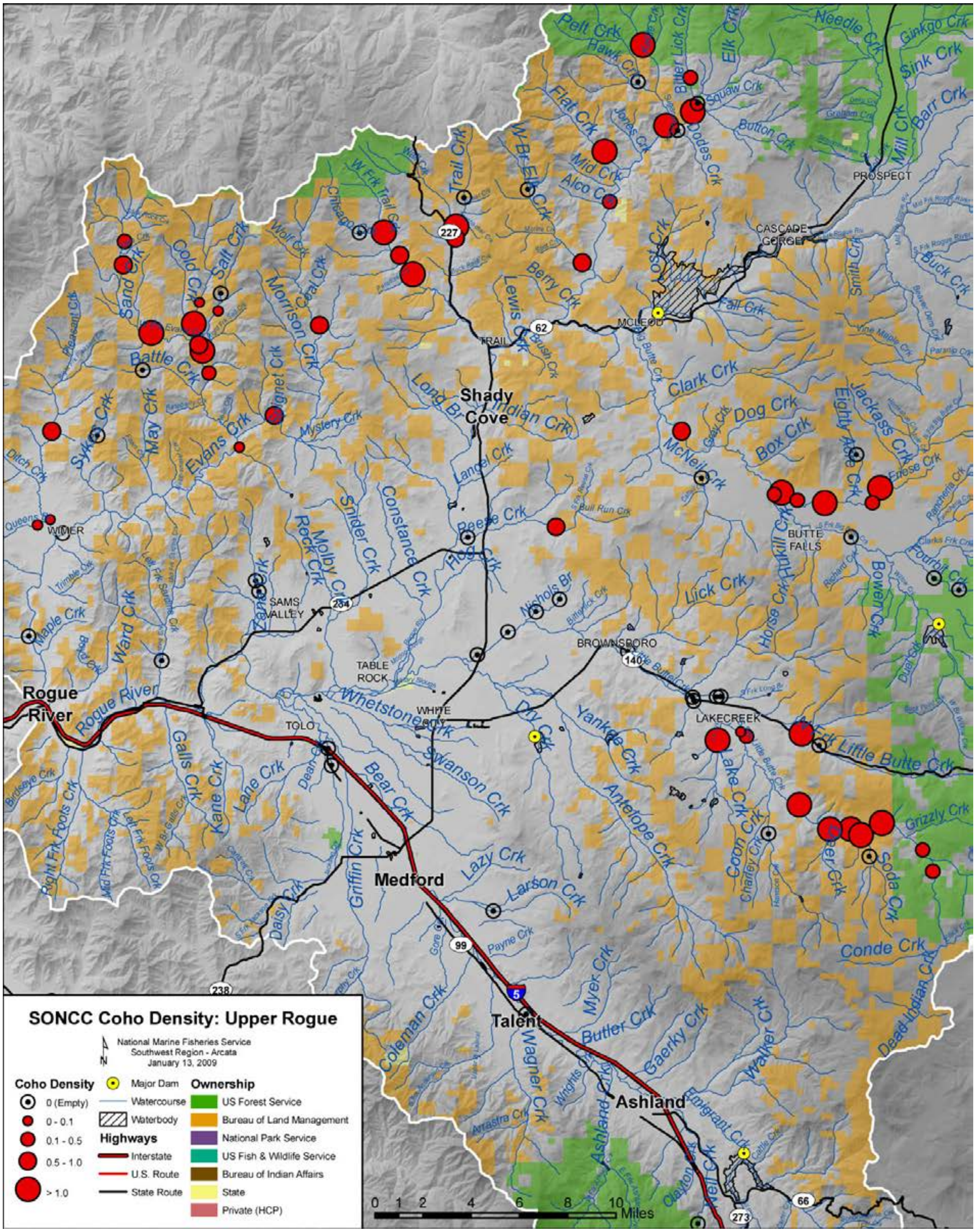

Figure 32-3. Upper Rogue River juvenile coho salmon survey results from 1998 to 2004. Map shows density of fish per square meter. The highest densities were located in upper watershed areas, and coho salmon were absent in lower reaches of all tributaries and at all stations in Bear Creek ODFW (2005a).

During the 2004 to 2008 run years, on average about 17 percent of sites were occupied by wild adult coho salmon with an estimated average of 6 spawners per mile in the Upper Rogue subbasin (hatchery or wild origin unstated) (Lewis et al. 2009).

Williams et al. (2008) expressed concern about potential loss of genetic diversity of Rogue River coho salmon due to very low returns from 1966 to 1990 and the high contribution of hatchery coho salmon to the overall number of returning adults. Overall, Williams et al. (2008) rated the threat of hatchery fish on population diversity as moderate, because although many hatchery fish were observed in surveys of adult coho salmon, few were observed on the spawning grounds.

Population Size and Productivity

ODFW estimated the abundance of wild adult coho salmon from 2002 to 2008 in the Upper Rogue River (Figure 32-4). Data were not collected in 2005, 2009, and 2010 which makes it difficult to track the strength of year classes. From 2002 to 2004, estimates of wild adult coho salmon were above the depensation threshold of 805, but from 2006 to 2008 estimates of wild adult coho salmon returns were low (Figure 32-4). However, interpretation of these data is problematic because the number of miles surveyed in each of the first three years (average 19 miles) was considerably greater than in the second three years (average 8 years; ODFW 2011b).

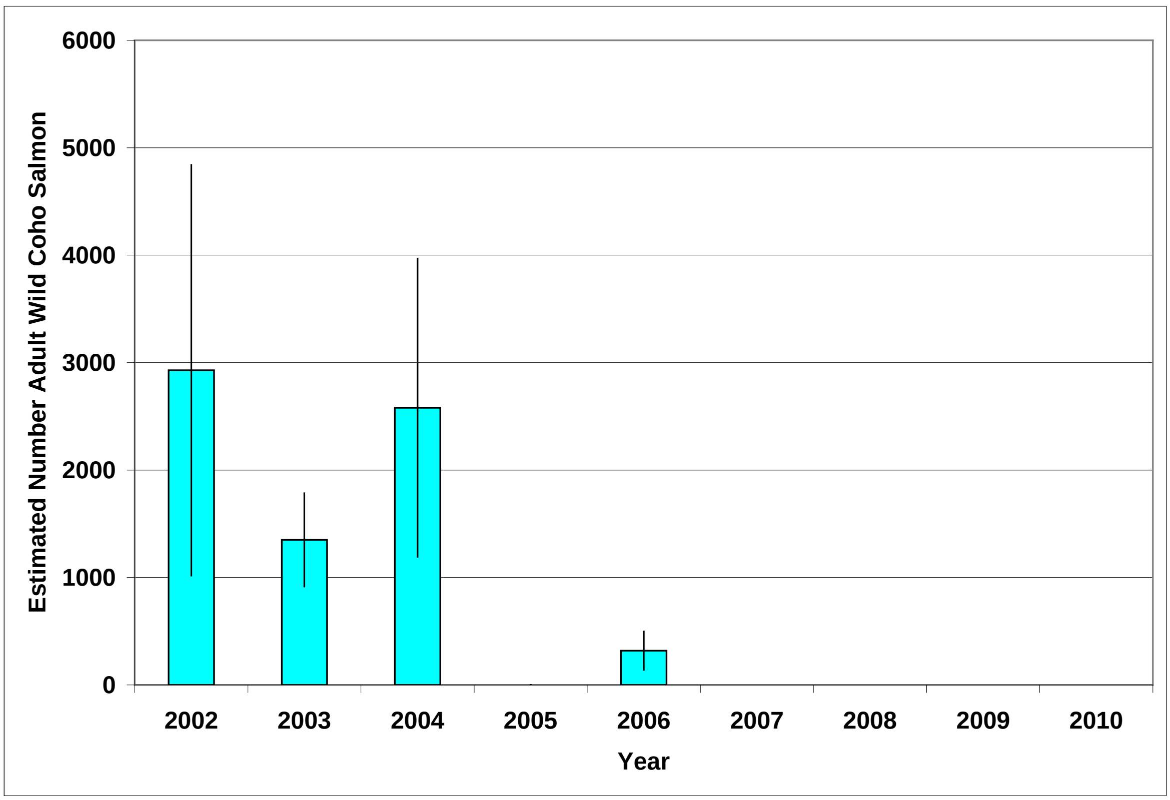

Figure 32-4. Estimated number of adult coho salmon in the Upper Rogue River, 2002 to 2010. No surveys were conducted in 2005, 2009, and 2010. No wild fish were captured in 2007 and 2008. Error bars indicate the 95% confidence interval. Data from ODFW (2011b).

Monitoring of returning adult coho salmon at Gold Ray Dam presents a rare opportunity to evaluate a long-term data set within the Upper Rogue River coho salmon population (Figure 32-6). Between 1942 and the early 1980s, the number of adult coho salmon returns suggested a downward trend. While the average number of adult coho salmon returning (including jacks) to the entire Rogue River from 1942 to 1950 was 3936 adults, populations averaged only 750 adults between 1951 and 1979 (ODFW 2009b). For 15 out of 16 years from 1964 to 1979 fewer than 500 adults returned to the Rogue River (ODFW 2009b). Returns reached their lowest level during the 1976 drought, when only 44 coho salmon were counted at Gold Ray Dam. Hatchery coho salmon began returning to the Upper Rogue River in the late 1970s following the initiation of the hatchery mitigation program associated with the construction of Lost Creek Dam (later renamed William L. Jess Dam). The number of wild and hatchery coho salmon adults peaked in 2000 and 2002, respectively. Thereafter, a declining trend in both wild and hatchery coho salmon escapement has been observed (Figure 32-6). In 2007, approximately 4,500 wild coho salmon returned to Gold Ray Dam. Coho salmon returns declined in the Rogue River basin in 2008, and remained low in 2009 (Oregon State University 2009, ODFW 2009b). In 2008 and 2009, total adult coho salmon returns including both hatchery and wild fish were about 2,500 per year. If we assume the current returns of adult coho salmon contain the approximate proportion of hatchery fish as observed from 1996 to 2007, then 60 percent of these fish, or about 1,500 spawners, were wild fish.

The downward trend in adult abundance over the last four generations (1998-2009) has been weakly negative, but much less than a 10 percent decline. Relying on the population decline criterion found in Williams et al. (2008), we conclude that the extinction risk is moderate relative to abundance.

Using seine mark-recapture data from Huntley Park, ODFW (2005c) calculated productivity for wild adult coho salmon in the Illinois, Middle, and Upper Rogue populations aggregated together for each year from 1980 to 2000. Recruits per spawner were less than replacement levels in eight of the years, indicating low productivity during those years.

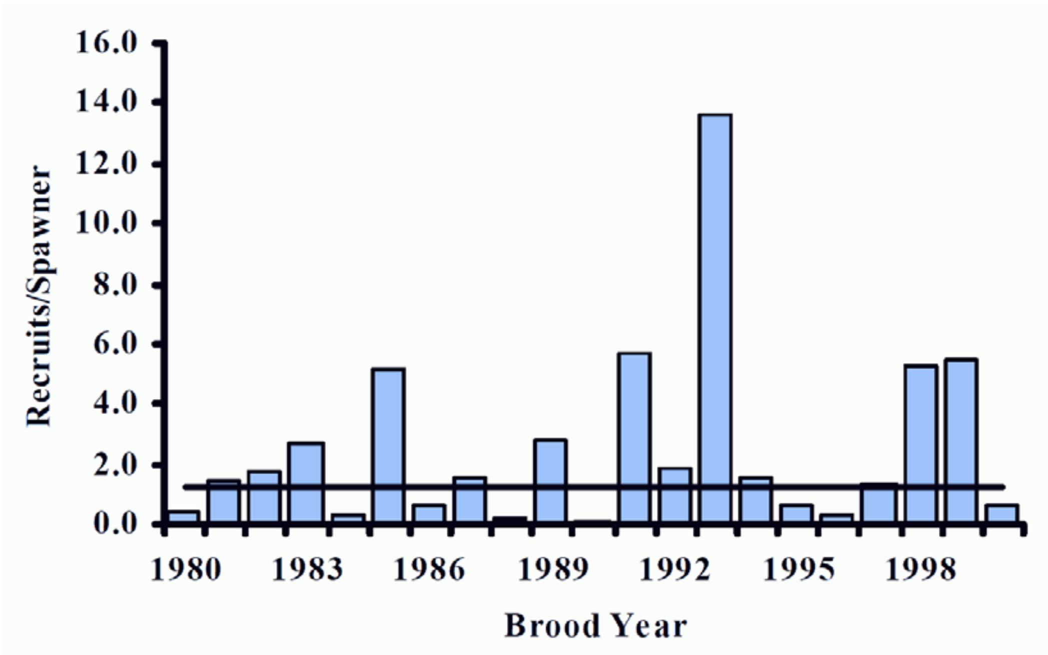

Figure 32-5. Recruit per spawner for brood years 1980 through 2000. Data are for the Rogue River Species Management Unit which includes the Middle Rogue, Upper Rogue, and Illinois River populations. Figure from ODFW (2005c).

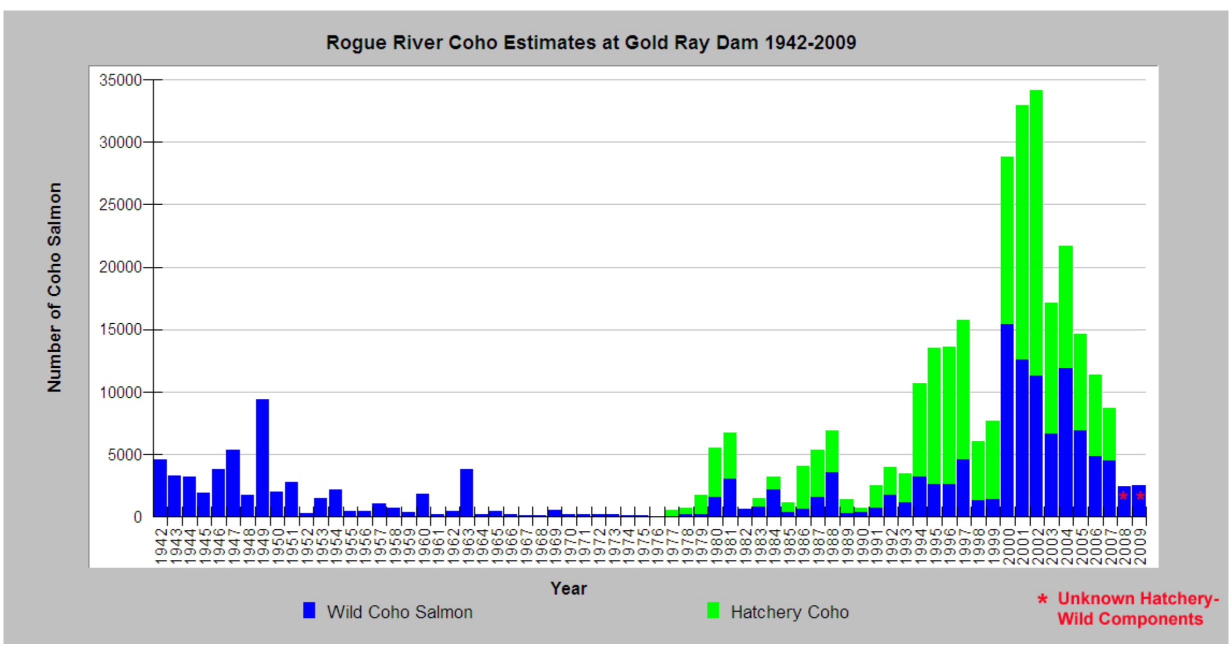

Figure 32-6. Coho salmon returns from 1942 to 2009 at Gold Ray Dam, including jacks (ODFW 2010b). Hatchery fish are not distinguished from wild fish in 2008 and 2009 because estimates are preliminary.

Extinction Risk

In order to be at moderate risk of extinction, the Upper Rogue River population must consistently exceed the annual depensation threshold of 805 adults (Williams et al. 2008). If abundance is below the depensation threshold, the population is at high risk of extinction. Based on Gold Ray Dam data, the running 3-year average of adult returns over the past 12 years (from 1998 to2009) has not fallen below 2,128. Therefore, NMFS concludes that the Upper Rogue River coho salmon population is at a moderate risk of extinction.

Role in SONCC Coho Salmon ESU Viability

The Upper Rogue River coho salmon population is considered functionally independent because of the large amount of IP habitat it contains. As a functionally independent population, we expect that the Upper Rogue River population would contribute recruits to nearby populations, such as those in the Rogue River basin. At present, the capacity of the Upper Rogue River coho salmon population to provide recruits to adjacent independent populations is limited due to its low spawner abundance. Conversely, recruits straying from the nearby Lower Rogue, Middle Rogue/Applegate, and Illinois rivers may enhance recovery of the Upper Rogue River population.

32.4 Plans and Assessments

U.S. Forest Service, Rogue River-Siskiyou National Forest

Sufficiency Assessment: Forest Service and Bureau of Land Management Programs in Support of SONCC Coho Salmon Recovery (USFS and BLM 2011)

The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, Sugarpine Creek, a tributary of Elk Creek, was identified as a high priority 6th field subwatershed in the Rogue-Siskiyou National Forest (USFS and BLM 2011).

U.S. Bureau of Land Management (Medford District)

U.S. Bureau of Reclamation (BOR)

Rogue River Basin Project Coho Salmon Instream Flow Assessment

BOR (Sutton et al. 2007) modeled stream flow needs of SONCC coho salmon in two drainages in southern Oregon in order to assess the effects of BOR's Rogue River Basin Project on the species. The Rogue River Basin Project (RRBP) is a series of reservoirs and diversions designed to provide water to 35,000 acres of irrigated cropland in Oregon (BOR 2009b). Sutton et al. (2007) was relied upon when analyzing and describing the future effects of the RRBP on SONCC coho salmon and other listed species (BOR 2009b).

State of Oregon

Expert Panel on Limiting Factors for Oregon's SONCC coho salmon populations

ODFW (2008b) convened a panel of fisheries and watershed scientists as an initial step in their development of a recovery plan for Oregon's SONCC coho salmon populations. Deliberations of the expert panel provided ODFW with initial, strategic guidance on perceived limiting factors and threats to recovery. Based on the input of panel members, ODFW (2008b) summarized the concerns the Upper Rogue River are as follows:

> Key concerns were related to loss of over-winter tributary habitat complexity, floodplain connectivity, and access and oversummer water temperatures and habitat access. Over-winter tributary habitat and floodplain connectivity, especially in the lowlands, has been impacted by past and current agricultural, urban, rural residential, and forestry development and practices and an interruption in the transport and presence of large wood. Access to habitat has been limited by road crossings. Summer habitat is limiting because high water temperatures have resulted from land management actions in the riparian zone and straightening of channels and water management actions for agricultural purposes. Water withdrawals and diversions and road crossings have also limited the amount of, and access to, summer habitat and thermal refuge.
>
> Secondary concerns spanned a number of life history stages and locations. Unscreened diversions and non-criteria screens at diversions affect fry, summer parr, and out-migrating smolts. Summer juvenile habitat has been impacted by a loss of tributary habitat complexity, especially in the lowlands, caused by past and current agricultural, urban, rural residential, and forestry development and practices and an interruption in the transport and presence of large wood. Non-native vegetation is a secondary factor contributing to higher water temperatures affecting summer parr by limiting native riparian vegetation. Runoff from urban and agricultural areas impacts summer parr through poor water quality and the presence of toxins. Access to spawning habitat by returning adults is limited by road crossings and diversion structures. Spawners are affected by both a lack of gravel due to alteration of large wood processes (i.e., some tributaries have bedrock) and sedimentation of existing gravel. Finally, reduced estuarine habitat for smolts due to past and current forestry practices and rural residential development is another impact.

Oregon Plan for Salmon and Watersheds
http://www.oregon.gov/OPSW/about_us.shtml

The State of Oregon developed a conservation and recovery strategy for coho salmon in the SONCC and Oregon Coast ESUs (State of Oregon 1997). The Oregon Plan for coho salmon is comprehensive, and includes voluntary actions for all of the threats currently facing coho salmon in these ESUs and involves all relevant state agencies. ODFW implemented fishery harvest and hatchery program reforms in the late 1990s. Many habitat restoration projects have occurred across the landscape in headwater habitat, lowlands, and the estuary. The action plans, implementation, and annual reports can be found on the above web site.

ODFW Coastal Salmonid Inventory Project

ODFW has monitored coho salmon in the Upper Rogue River as part of their Coastal Salmonid Inventory Project. From 1998 to 2004, ODFW dived the Upper Rogue River subbasin to detect juvenile coho salmon (ODFW 2005a) (Figure 32-3). ODFW also estimated the abundance of adult coho salmon in the Upper Rogue River from 2002 to 2004 and from 2006 to 2008

Southwest Oregon Salmon Restoration Initiative

The Southwest Oregon Salmon Restoration Initiative (Prevost et al. 1997) was created to help fulfill a memorandum of understanding between ODFW and NMFS (Northwest Region) to recover coho salmon. The initiative provides the framework for recovery in southwest Oregon and helped foster formation of watershed councils. Prevost et al. (1997) designated upper South Fork Little Butte Creek, West Fork Trail Creek, Sugarpine Creek (Elk Creek), West Branch Elk Creek, and West Fork Evans Creek as "core areas" in the Upper Rogue River watershed that are the highest priority for restoration in the SONCC.

Water Requirements of Rogue River Fish and Wildlife

ODFW fisheries biologists (Thompson and Fortune 1970) conducted widespread surveys of the Rogue River basin to assess water flow and its effect on fish habitat and carrying capacity for salmonids. The study was designed to inform the Oregon Water Resources Board so that a "beneficial water use program" could be developed. The document contains comprehensive flow tables for all major coho-salmon-producing tributaries in the Rogue River basin, including recommended minimum flows. Thompson and Fortune (1970) also provides a summary of the Rogue River basin fish community, including the Upper Rogue River. The report identified flow depletion as a major cause of stress, disease, and predation to Pacific salmonids.

Upper Rogue River Total Maximum Daily Load Reports

A large-scale Rogue River TMDL (ODEQ 2008) covers all tributaries, which are listed as impaired (ODEQ 2002a), but not covered by other TMDLs.

Bear Creek Watershed TMDL

The Bear Creek Watershed TMDL (ODEQ 2007) addresses the listed parameters of temperature, bacteria (fecal coliform and *E. coli*) and sedimentation. The TMDL includes shade targets for the Bear Creek watershed and a water quality management plan.

Rogue River Watershed Health Factors Assessment

The Rogue Basin Coordination Council (RBCC 2006) produced the Rogue River Watershed Health Factors Assessment on behalf of the watershed councils within the basin. The assessment rates aquatic health and watershed conditions, including wildfire risk. Key problems in different Rogue River watersheds are described and potential solutions proposed.

Bear Creek Habitat and Temperature Study 1990-1991

Dambacher et al. (1992) investigated the temperature and habitat in Bear Creek and its tributaries during the summers of 1990 and 1991, and made recommendations for rehabilitation of the watershed. Temperatures in lower Bear Creek and in tributaries approached and exceeded, respectively, 80 °F. Temperature in Bear Creek increased downstream, was strongly influenced by solar input, and reached a maximum in late July. High water temperature was found to be the greatest factor limiting production of salmonids. Redside shiners were found in Bear Creek, and the authors were concerned that they were outcompeting and displacing salmonids.

Upper Rogue Watershed Association

Upper Rogue Watershed Assessment

The assessment (URWA 2006) describes various aspects of the Upper Rogue River subbasin, including hydrology, water quality, fish populations, fish habitat, riparian conditions, and wetland conditions. The assessment also identifies the issues and restoration opportunities within each of five sub-watersheds of the Upper Rogue watershed.

Bear Creek Watershed Council (BCWC)

Ashland Watershed Management & Action Plan

The plan (BCWC 2007) considers the Ashland Creek and Neil Creek drainages in the Bear Creek watershed. BCWC (2007) includes an assessment of hydrology and water use, riparian and wetlands, sediment sources, channel modifications, water quality, and fish and aquatic wildlife. A number of projects are suggested to restore habitat, manage stormwater, address fish passage barriers, and inform and educate the public. The plan focuses on voluntary activities on private and municipal land.

32.5 Stresses

Table 32-1. Severity of stresses affecting each life stage of coho salmon in the Upper Rogue River Subbasin. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rate
1	Altered Hydrologic Function[1]	Very High	Very High	Very High[1]	Very High	Very High	Very High
2	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	Very High	Very High	Very high
3	Impaired Water Quality[1]	High	Very High	Very High[1]	High	High	Very High
4	Lack of Floodplain and Channel Structure[1]	Medium	Very High	Very High[1]	High	High	Very High
5	Altered Sediment Supply		Medium	Medium	Medium	Very High	Very High
6	Barriers[1]	-	Medium	High[1]	High	High	High
7	Impaired Estuary/Mainstem Conditions	-	Low	High	High	High	High
8	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
9	Increased Disease/Predation/Competition	Low	Medium	Medium	Low	Low	Low
10	Adverse Fishery-Related Effects	-	-	-	-	Low	Low

[1]Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is most limited and quality winter rearing habitat, as well as summer rearing habitat, is lacking. Juvenile summer rearing habitat is impaired by deficient floodplain and channel structure, high water temperature resulting from degraded riparian conditions, and altered hydrologic function from water withdrawals. Furthermore, the degraded nature of the riparian forests inhibits future input of large wood and cannot provide bank stability that assists in a stable and complex channel. Finally, barriers throughout the basin limit access to rearing habitat. These findings are consistent with those of the Oregon Expert Panel (ODFW 2008b) (Section 32.4).

Altered Hydrologic Function

The Rogue River Basin Project (RRBP) is a series of reservoirs and other facilities used to collect, impound, and divert water from the Rogue River for delivery to irrigated cropland (BOR 2009b). The RRBP adversely affects coho salmon in the Bear Creek and Little Butte Creek watersheds of the Upper Rogue River subbasin. Forty-seven percent of the high-IP habitat in the Upper Rogue River subbasin is located in these watersheds. Another major source of hydrologic alteration affecting the Upper Rogue River coho salmon population is flow depletion due to groundwater extraction. Many types of groundwater uses do not require a water right, including stock watering, lawn or noncommercial garden watering of up to 0.5 acres, and domestic use of up to 15,000 gallons per day (U.S. Bureau of Land Management (BLM) 1998c). Data are lacking regarding groundwater use, its interaction with surface flow, and potential impacts to coho salmon (ODEQ 2008). However, due to the presumed large number of wells, groundwater pumping is likely contributing to inadequate stream flows and reduced groundwater inflow to many streams in the Upper Rogue River subbasin. Streams sometimes lose flow entirely (Thompson and Fortune 1970). The overall stress rating for Upper Rogue River coho salmon from this factor is very high.

Degraded Riparian Forest Conditions

Riparian zones on the mainstem and in tributaries exhibit impacts from 150 years of land use leading to a very high level of stress rating for coho salmon. In forested reaches conifers have been removed (ODEQ 2007, 2008) and early seral species like alder and willows are dominant in the Upper Rogue River. ODFW found low numbers of large conifers in Upper Rogue River riparian surveys, with almost all reaches having fewer than 75 conifers over 36” in diameter per 1,000 feet of stream surveyed. Streams surveyed include Evans, Little Butte, Big Butte, Elk and Trail creeks.

On valley floors where there may have previously been cottonwood gallery forests, marshes, and beaver ponds, the straightening of channels and draining of wetlands has altered the most productive coho salmon habitat (ODEQ 2008). The resulting disruption of surface and groundwater connections has led to stream warming (ODEQ 2008). Downcutting due to channel confinement is widespread in the Rogue River basin. Regional studies (Spence et al. 1996) found that downcutting may change near-stream soil moisture, which can inhibit recovery of riparian forest species. The most degraded streams in the Upper Rogue are channelized urban streams that are nearly devoid of riparian vegetation.

Impaired Water Quality

Thirty-three percent of the 137 sampled reaches in the Upper Rogue River subbasin met water quality standards (Southwest Oregon Resource Conservation and Development Council (SO RC&D) 2003). The most pervasive problem affecting coho salmon is water temperature. Very few reaches in the Upper Rogue River Subbasin meet ODEQ (2008) water standards compatible with coho salmon recovery. Few locations other than the tailwater of William L. Jess Dam contain both cold water temperatures (<64.4 °F) and pools deep enough to harbor coho salmon (>3 feet). The urbanized Bear Creek watershed is listed as temperature impaired (ODEQ 2007), with summer water temperatures in lower Bear Creek and its tributaries approaching 80 °F in 1990 and 1991 (Dambacher et al. 1992). However, in August 2007, detailed surveys detected 13 coldwater springs, seeps, and tributaries in the Bear Creek watershed (Sutton 2007), suggesting that there are some localized areas with temperatures suitable for summer rearing. Most potential thermal refugia were located in the upper half of Bear Creek watershed, with the majority being tributary inflows originating in the southwest portion of Bear Creek watershed.

Flow depletion reduces water volume and slows water velocity, thus promoting warming, stagnation, and depressed dissolved oxygen (D.O.) (Thompson and Fortune 1970). Nawa (1999) documented loss of coho salmon juveniles in Trail Creek due to flow depletion and low D.O. Little Butte Creek is similar to Trail Creek and has both low flow and D.O. problems. Growth of free-floating and attached algae may indicate nutrient enrichment, and algal photosynthetic activity may cause daily fluctuations in pH and D.O. (ODEQ 2007). The Larson and Lazy Creek watersheds are considered impaired due to high pH. It is unlikely that high fecal coliform bacterial levels in the Upper Rogue would directly harm coho salmon; however, the coliform levels might indicate livestock access to creeks or leaking septic systems.

Lack of Floodplain and Channel Structure

The straightening and simplification of streams has reduced the amount of slow, cool edgewater habitats where coho salmon fry and juveniles thrive (ODEQ 2008). Beaver have been greatly reduced along with the pools they create (ODFW 2005b). Although there are patches of functional coho salmon habitat, juvenile surveys indicate that many lower elevation Upper Rogue tributary channels are too altered to support them (Figure 32-7). Channelization of the Upper Rogue River has disconnected it from much of its floodplain, reducing the physical processes that form coho salmon rearing and spawning habitat. These processes include side channel formation, accumulation of large wood jams, formation of slower water velocities, formation of pools, and lower shear stress. Extensive ODFW habitat surveys of Evans, Elk, Trail, Little and Big Butte creeks had poor wood levels (< 1 key piece per 100m), except in headwaters at a few locations, usually on or below USFS and BLM lands. All these factors lead to a high stress ranking for Upper Rogue River coho salmon.

Figure 32-7. The Upper Rogue River running through Shady Cove. This 2005 aerial photo shows channelization, lack of a functional riparian vegetation, and potential risk of non-point source pollution.

Altered Sediment Supply

Sediment contribution from landslides and erosion occurs naturally in the Upper Rogue River basin; however, roads, timber harvest, and bank erosion following removal of riparian vegetation have elevated fine sediment input. Excess fine sediment directly impacts coho salmon egg viability and can reduce food for fry, juveniles and smolts. The majority of stream reaches measured for surface fine sediment in Upper Rogue River habitat surveys rated poor (>17 percent surface fines), with only Little Butte above the confluence with Antelope Creek rated as very good (<12 percent surface fines). Lower Evans Creek has particular problems with sand-sized sediment pollution because its watershed has extensive areas of decomposed granite (BLM 1995b). Other than a short reach of Big Butte Creek, most other tributaries with low levels of fine sediment are steeper, confined channels often on BLM or USFS lands. Poor pool frequency and depth throughout the Upper Rogue River basin (URWA 2006) are likely due to elevated levels of fine sediment partially filling pools, a lack of scour-forcing obstructions such as large wood, and in some reaches diminished scour due to channel widening.

Barriers

The high level of stress caused by barriers to migration in the Upper Rogue River subbasin is a result of high numbers of road stream crossings (i.e., shown in Bredensteiner et al. 2003 maps), small temporary agricultural dams (Prevost et al. 1997), large diversion dams, and seasonal complete loss of stream flow in tributaries such as Trail Creek (RBCC 2006, Nawa 1999).

William L. Jess Dam was constructed in 1977 at river mile 157 in the Upper Rogue basin and blocks passage into the Rogue River headwaters. NMFS believes recovery of the Upper Rogue population of SONCC coho salmon can occur without access to habitat above this dam. Several dams in the Middle and Upper Rogue Subbasin have been evaluated for removal or fish passage improvement (Mosser and Graham 2004). Five of the top ten dams targeted are on Evans Creek, including Freeman (RM 3.0) and Wimer (RM 9.0) which impede passage to nearly the entire Evans Creek watershed.

Impaired Estuary/Mainstem Function

The Rogue River estuary is highly altered and retains little of its historic function. Studies of other rivers in the region have shown that some portion of coho salmon fry and juveniles migrate out of their stream of origin in search of viable habitat patches, and these fish opportunistically use estuarine and slough habitats (Koski 2009, Miller and Sadro 2003). The lack of rearing habitat in the estuary limits the productive potential of the entire Rogue River basin and is rated as an overall high stress for coho salmon. A discussion of the causes of reduced estuarine function can be found in the Lower Rogue River population profile.

Adverse Hatchery Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. Cole Rivers Hatchery is located in the Upper Rogue River sub-basin, and produces approximately 200,000 coho salmon smolts annually in addition to millions of hatchery spring Chinook, winter steelhead, and summer steelhead (ODFW 2008d). Adult coho salmon are counted at Gold Ray Dam. From 1977, when hatchery production started, to 2007 (last year for which hatchery proportion was available), the proportion of hatchery adults passed as Gold Ray Dam nearly always exceeded 50 percent. However, these data are not a good indicator of the proportion of spawning adults that are of hatchery origin. There are many miles of habitat between Gold Ray Dam and Cole Rivers Hatchery, and hatchery fish are not spawning yet at Gold Ray Dam, they are continuing past it to the hatchery which is their ultimate goal. A trap is maintained at Elk Creek, about 5 miles from Cole Rivers Hatchery. This trap is an ideal location to estimate stray rates, because it is at the terminal end of the current anadromous distribution of coho salmon in the Rogue River basin. From 1995 to 2008, on average 10 percent of adult coho salmon trapped at Elk Creek were of hatchery origin. Adverse hatchery-related effects pose a medium threat to all life stages because greater than or equal to 5 percent and less than or equal to 10 percent of observed adults are of hatchery origin (Appendix B).

Disease/Competition/Predation

Thompson and Fortune (1970) found that salmonids in the Rogue River basin, including the Upper Rogue River, had higher incidences of the fish diseases *furunculosis* and *columnaris* in reaches that were warm due to flow depletion. They also noted that warm water conditions favored introduced species in the mainstem Rogue and Applegate rivers. Warm water and low flows are still pervasive in the Upper Rogue River subbasin; therefore, problems related to disease, competition and predation likely persist for coho salmon.

Adverse Fishery-Related Effects

NMFS determined that federally- and state-managed fisheries in Oregon are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B).

32.6 Threats

Table 32-2. Severity of threats affecting each life stage of coho salmon in the Upper Rogue River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	Very High	Very High
2	Agricultural Practices	High	Very High	Very High	Very High	Very High	Very High
3	Urban/Residential/Industrial	Medium	Very High	Very High	Very High	Very High	Very High
4	Channelization/Diking	Medium	High	High	High	High	High
5	Timber Harvest	Medium	Very High	Very High	Medium	Medium	High
6	Dams/Diversion	Medium	Medium	High	High	High	High
7	Mining/Gravel Extraction	Low	High	High	High	Medium	High
8	Climate Change	Low	High	High	Medium	Medium	High
9	Invasive Non-Native/Alien Species	Medium	Medium	Medium	Medium	Medium	Medium
10	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
11	Road-Stream Crossing Barriers	-	Medium	Medium	Medium	Medium	Medium
12	High Intensity Fire	Low	Low	Low	Low	Low	Low
13	Fishing and Collecting	-	-	-	-	Low	Low

Roads

Upper Rogue River subbasin road density associated with timber harvest, residential and urban development, and major highway systems are high (Bredensteiner et al. 2003). For example, the lower Big Butte watershed (BLM 1999b) has approximately 4.6 miles of road per square mile of watershed (mi. /sq. mi.). The Bear Creek watershed in the Upper Rogue likely has similar values. NMFS (1995) recommended a road density limit of 2 mi./sq. mi. to protect anadromous salmonids in interior Columbia River basins to limit sediment and damaging cumulative watershed effects. Streamside roads, known to yield chronic fine sediment and elevate the probability of landslides, are common in Upper Rogue watersheds with timber harvest activities (BLM and USFS 1997, BLM 1999b) (Figure 32-8).

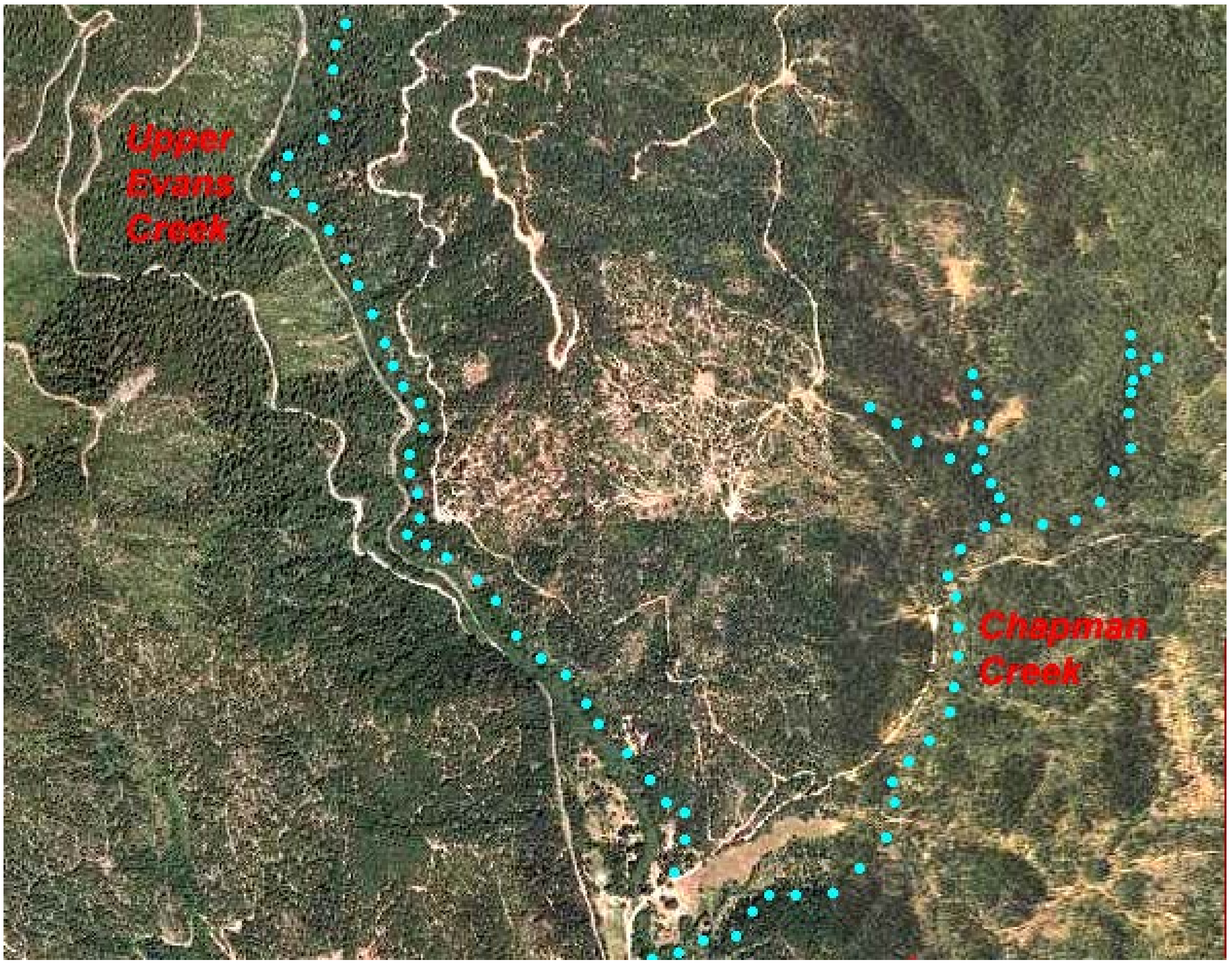

Figure 32-8. Upper Evans Creek and tributary Chapman Creek shown with dots. Logging roads are immediately next to the channel and there is an extensive network of skid trails that can alter watershed hydrology and sediment yield. Stream courses are based on the USGS (1989) topographic map. June 2005.

Agricultural Practices

Although the extent of agriculture in the Upper Rogue River subbasin is not large, these lands substantially overlap high IP (>0.66) coho salmon habitat. Much of the water withdrawals causing insufficient flow are used for agriculture. Other agricultural impacts include wetland filling, channelization and diking, riparian removal, channel simplification, and chemical application. Herbicide use has resulted in fish kills in the Rogue River basin, including juvenile coho salmon in Bear Creek in 1996 (Ewing 1999). Risk to coho salmon resulting from agriculture chemical use has been identified as a concern throughout the Pacific Northwest (Laetz et al. 2009), and it is likely that pesticides known to harm salmonids (NMFS 2008) are used in the region.

Urban/Residential/Industrial

The city of Medford and surrounding areas have grown substantially over the last several decades and future projections suggest that Rogue Valley urban and rural development will continue to increase. Maps of impervious areas (Homer et al. 2004) indicate extensive urbanization occurred in the Upper Rogue River subbasin. For example, total impervious area (TIA) in the lower Bear Creek watershed is greater than 10 percent, a level which studies in other river systems found caused increased peak flows, decreased base flows, simplified channel conditions, increased non-point source storm water pollution, and resulted in loss of aquatic system function (Booth and Jackson 1997). An acute regional example of this phenomenon is that toxic storm water runoff is leading to high pre-spawn mortality of adult coho salmon in tributaries to Washington's Puget Sound (Booth et al. 2006). Urbanization and commercial development are expected to continue in the Interstate 5 corridor along Bear Creek.

Streams, such as Big Butte Creek and Little Butte Creek, supply water for urban areas and agriculture (RBCC 2006), and new residents add to growing water demand. Rural residential development also uses water and presents potential for pollution from septic systems (SO RC&D 2003). The threat to coho salmon from urban/residential and industrial development in the Upper Rogue River is very high.

Figure 32-9. Jackson Creek with channel altered by agricultural and urban land uses. Bear Creek is at right along the I-5 corridor in the city of Medford. Photo from 2005.

Channelization/Diking

Channelization and confinement of mainstem and tributary reaches of the Upper Rogue River is common and shown in Figure 32-8 and Figure 32-9. Disconnecting high IP coho salmon streams from their floodplains and constricting their channels into straight, narrow stream courses greatly diminishes their summer and winter habitat carrying capacity (BLM 1997). These activities also tend to reduce surface-groundwater connections that help maintain cool stream temperatures (ODEQ 2008).

Timber Harvest

Studies in coastal basins of Oregon found that when timber harvest exceeds approximately 25 percent of a watershed (Reeves et al. 1993) in 30 years (Reeves 2003), aquatic habitat becomes degraded and simplified and Pacific salmon species diversity diminished. The extent of early- to mid-seral-stage forests on private land in the Upper Rogue River subbasin (BLM 1999b) indicates that harvest rates on those lands were typically greater than this threshold. Aerial photos show that harvest rotations on private lands may be as short as 30 to 50 years, with very early seral stand conditions and high road densities near stream areas. Studies in other areas of the region have shown that timber harvest in unstable headwater areas increase sediment yield substantially (PWA 1998), depleting the supply of large wood delivered to streams during natural landsliding (May and Greswell 2003). In addition, the Independent Multidisciplinary Science Team (IMST 1999) concluded that the Oregon Forest Practice Rules for riparian protection, large wood management, sedimentation, and fish passage are not adequate to recover depressed stocks of wild salmonids. The primary timber harvest areas within this population are Evans Creek, Trail Creek, Elk Creek, and some parts of Little Butte Creek.

Dams and Diversions

The high number of dams and diversion systems in the Upper Rogue River subbasin resulted in a high threat score. Agricultural diversions on major low gradient tributaries can impede upstream adult passage or strand downstream-migrating juveniles, if fish screens are not in place. Major diversions by the City of Medford and large agricultural districts are particularly problematic with regard to reduced stream flows (RBCC 2006).

Mining/Gravel Extraction

Large scale gravel operations along the Upper Rogue River have resulted in the river abandoning its channel and forming a new one, and degrading formerly productive coho salmon rearing areas. Off channel ponds formed by pits excavated in the floodplain can capture juvenile coho salmon, coho salmon smolts, and adult coho salmon during high flow. Gravel extraction reduces overall habitat complexity and reduces the quality and quantity of available pool habitat. Given the sensitivity of the channel to disturbance (i.e., due to the current lack of floodplain and channel structure, low levels of instream wood), and the use of the gravel extraction reach by coho salmon juveniles for summer rearing, gravel extraction is a significant threat to rearing juveniles and a moderate threat to adults who require resting habitat in pools during upstream migration.

Climate Change

The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 years (see Appendix B for the climate change stress assessment methods). Average temperature could increase by over 2.8 ^{o}C in the summer and 1 ^{o}C in the winter. Annual precipitation in this area is predicted to stay within the natural range of current variability; however, seasonal patterns in precipitation may change (Mote and Salathe 2010). Juvenile and smolt rearing and migratory habitat are most at risk from climate change. Rising sea level may reduce the quality and extent of wetland rearing habitat. Adult Upper Rogue River coho salmon will likely be negatively affected by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Invasive Non-Native/Alien Species

Thompson and Fortune (1970) noted that warm water favored introduced species in the mainstem Rogue River, with large mouth bass, black crappie, bluegill, pumpkin seed, and brown bullhead present at fishable levels in the mainstem near Shady Cove prior to dam construction. In the Gold Ray Dam pool, carp were previously abundant (Thompson and Fortune 1970), but this dam has now been removed. In the nearby Middle Rogue, BLM (1999b) noted that private farm ponds related to agriculture and rural residential development have been stocked with introduced warm water species such as largemouth bass and sunfish. Umpqua pikeminnow, introduced in the Rogue River, have become established and likely represent the greatest threat to coho salmon of all the non-native species present. The threat of non-native fish species predominately occurs in the mainstem Rogue River. The risk of non-native fish species to the recovery of Upper Rogue River coho salmon is medium.

Hatcheries

Cole Rivers Hatchery releases 200,000 smolts annually, in addition to millions of hatchery spring-run Chinook salmon, winter-run steelhead, and summer-run steelhead (ODFW 2008d). Consequently, Upper Rogue River coho salmon are exposed to risks posed by hatcheries. The greatest hatchery-related concerns for this population are spawning between hatchery coho salmon and wild coho salmon in the wild, and predation by and competition with hatchery fish. The management goal for this population is to have less than 10 percent of the spawning coho salmon be hatchery-origin (ODFW 2008d). There is some uncertainty on whether this goal is being attained because randomized sampling of spawning sites has been sporadic. Available information suggests that the incidence of hatchery fish spawning in the wild is likely in the range of 5 to 15 percent.

Road-Stream Crossing Barriers

Road densities in portions of the Upper Rogue River subbasin are very high and stream side roads are common. Culverts may block upstream migration for adults or passage for juveniles during low flow periods. Watersheds with particularly high road densities, road stream crossings, and associated barriers are Bear Creek, Evans Creek and lower Little Butte Creek. Stream crossings have been, and continue to be, improved on federal lands in the subbasin. .

High Intensity Fire

Fire risk is acknowledged as a regional concern (RBCC 2006, BLM 1998b). Early seral stage forests, which are common in the Upper Rogue River subbasin, lead to dry site conditions and increased fire risk (SO RC&D 2003). Overall, high intensity fire is a medium threat to Upper Rogue River coho salmon.

Fishing and Collecting

The recreational fishery for hatchery coho salmon in Oregon likely encounters more federally listed coho salmon than does the Chinook salmon fishery that accounts for much of the bycatch mortality of SONCC coho salmon. This is because coho salmon are the targeted species in the recreational fishery. NMFS (1999) concluded that the exploitation rate associated with this and other freshwater fisheries in Oregon are not likely to jeopardize the continued existence of SONCC coho salmon (Good et al. 2005). The standard applied to make that determination was a jeopardy standard, not a species viability standard, because no recovery objectives to achieve species viability had been established for SONCC coho salmon at that time (NMFS 1999). Regional-scale effects may be enough to impede recovery of the Interior Rogue River diversity stratum, even if they are not severe enough to jeopardize the continued existence of the ESU. Specifically, wild coho salmon in the Rogue River basin likely experience more exploitation effects than those in other areas, because they co-occur with the adult hatchery coho salmon that were produced in the Rogue's Cole Rivers Hatchery, return to the Rogue River to spawn, and are targeted there by recreational fishermen. As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in the Upper Rogue River.

32.7 Recovery Strategy

The most immediate need for habitat restoration and threat reduction in the Upper Rogue River is in those areas currently occupied by coho salmon in the headwaters of Evans, Trail, Elk, Big Butte, and Little Butte Creeks. Unoccupied areas must also be restored to provide enough habitat for coho salmon to achieve recovery.

The severely degraded conditions of the Upper Rogue River habitat, combined with the depressed coho salmon population size and distribution, significantly increases the risk of extinction of this inland coho salmon population, which is critical to recovery of the Interior Rogue River diversity stratum. The greatest factor limiting recovery of coho salmon in the Upper Rogue River is the lack of suitable rearing habitat for juveniles. The processes that create and maintain such habitat must be restored by restoring flow, increasing habitat complexity within the channel, restoring off-channel rearing areas, and reducing threats to instream habitat.

Table 32-3 on the following page lists the recovery actions for the Upper Rogue River population.

Table 32-3. Recovery action implementation schedule for the Upper Rogue River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-URR.2.2.9	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Reconnect floodplains, wetlands, and off channel habitat	Private lands	3
SONCC-URR.2.2.9.1	*Assess habitat to determine where potential exists for floodplain reconnection. Prioritize sites and determine best means for reconnection at each site using tools such as hydrologic analysis*					
SONCC-URR.2.2.9.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-URR.2.2.10	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	3
SONCC-URR.2.2.10.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-URR.2.2.10.2	*Implement beaver program (may include reintroduction)*					
SONCC-URR.2.1.11	Floodplain and Channel Structure	Yes	Increase channel complexity	Improve suction dredging practices	Population wide	3
SONCC-URR.2.1.11.1	*Develop suction dredging regulations that minimize or prevent impacts to coho salmon. Consider special closed areas, closed seasons, and restrictions on methods and operations*					
SONCC-URR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-URR.3.1.4.1	*Quantify groundwater withdrawal and determine maximum amount available for use without significantly reducing instream flows*					
SONCC-URR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-URR.3.1.5.1	*Study groundwater withdrawal and prevent development if insufficient supply exists*					
SONCC-URR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-URR.3.1.6.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-URR.3.1.7	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-URR.3.1.7.1	*Develop an educational program about water conservation programs and instream leasing programs*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-URR.3.1.8	Hydrology	Yes	Improve flow timing or volume	Manage flow	William L. Jess Dam	2
SONCC-URR.3.1.8.1	*Review dam management practices to ensure operations benefit the survival of all life stages of coho salmon*					
SONCC-URR.3.1.8.2	*Modify dam management, if needed*					
SONCC-URR.5.1.20	Passage	Yes	Improve access	Remove barriers	Population wide	3
SONCC-URR.5.1.20.1	*Assess and prioritize barriers using the ODFW fish passage barrier database*					
SONCC-URR.5.1.20.2	*Remove barriers*					
SONCC-URR.7.1.12	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	3
SONCC-URR.7.1.12.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-URR.7.1.12.2	*Develop watershed-specific guidance for managing riparian vegetation. Consider larger riparian buffers in coho occupied habitat*					
SONCC-URR.7.1.13	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	USFS and BLM lands	3
SONCC-URR.7.1.13.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-URR.7.1.13.2	*Thin, or release conifers, guided by prescription*					
SONCC-URR.7.1.13.3	*Plant conifers, guided by prescription*					
SONCC-URR.7.1.14	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Privately held timberlands	2
SONCC-URR.7.1.14.1	*Revise Oregon Forest Practice Act Rules in consideration of IMST (1999) and NMFS (1998) recommendations*					
SONCC-URR.7.1.36	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Private lands	BR
SONCC-URR.7.1.36.1	*Develop HCPs or GCPs with interested owners of private timberlands*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-URR.7.1.37	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	BLM lands	3
SONCC-URR.7.1.37.1	*Manage timber harvest (and associated activities) on Federal lands in accordance with the Aquatic Conservation Strategy of the NWFP to achieve riparian and stream channel improvements for coho salmon*					
SONCC-URR.14.2.19	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of warm-water, non-native fish species	Population wide	3
SONCC-URR.14.2.19.1	*Determine presence and absence of warm water, non native fish species and develop a plan for eradication or control*					
SONCC-URR.14.2.19.2	*Eradicate or control invasive fish species, guided by the plan*					
SONCC-URR.1.2.39	Estuary	No	Improve estuarine habitat	Improve estuary condition	Rogue River Estuary	3
SONCC-URR.1.2.39.1	*Implement recovery actions to address strategy "Estuary" for Lower Rogue River population*					
SONCC-URR.16.1.21	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-URR.16.1.21.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-URR.16.1.21.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-URR.16.1.22	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-URR.16.1.22.1	*Determine actual fishing impacts*					
SONCC-URR.16.1.22.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-URR.16.2.23	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-URR.16.2.23.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-URR.16.2.23.2	*Identify scientific collection impacts expected to be consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-URR.16.2.24	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-URR.16.2.24.1	*Determine actual impacts of scientific collection*					
SONCC-URR.16.2.24.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-URR.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-URR.27.1.25.1	*Perform annual spawning surveys*					
SONCC-URR.27.1.26	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-URR.27.1.26.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-URR.27.1.27	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track surrogate for genetic diversity	Cole Rivers Hatchery	3
SONCC-URR.27.1.27.1	*Describe annual ratio of naturally-produced fish to hatchery-produced fish used to produce hatchery fish*					
SONCC-URR.27.1.28	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-URR.27.1.28.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-URR.27.1.29	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Hatchery Management'	Population wide	3
SONCC-URR.27.1.29.1	*Annually determine the percent of hatchery origin spawners (PHOS), percent of natural origin spawners (PNOS), and the proportion of natural influence (PNI)*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-URR.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-URR.27.2.30.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-URR.27.2.30.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-URR.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-URR.27.2.31.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-URR.27.2.32	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-URR.27.2.32.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-URR.27.2.33	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-URR.27.2.33.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-URR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-URR.27.2.34.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-URR.27.2.35	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-URR.27.2.35.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-URR.27.1.38	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-URR.27.1.38.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-URR.27.1.41	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-URR.27.1.41.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-URR.27.1.41.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-URR.5.1.40	Passage	No	Improve access	Remove barriers	USFS lands	3
SONCC-URR.5.1.40.1	*Evaluate and prioritize barriers for removal*					
SONCC-URR.5.1.40.2	*Remove barriers*					
SONCC-URR.8.1.1	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-URR.8.1.1.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-URR.8.1.1.2	*Decommission roads, guided by assessment*					
SONCC-URR.8.1.1.3	*Upgrade roads, guided by assessment*					
SONCC-URR.8.1.1.4	*Maintain roads, guided by assessment*					
SONCC-URR.8.1.2	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-URR.8.1.2.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-URR.10.2.15	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	3
SONCC-URR.10.2.15.1	*Develop an educational program that promotes Salmon Safe methods for agricultural operations and Integrated Pest Management for rural residents*					
SONCC-URR.10.2.16	Water Quality	No	Reduce pollutants	Increase regulatory oversight	Bear Creek	3
SONCC-URR.10.2.16.1	*Develop local regulatory mechanisms that limits development and reduces amount of total impervious area through incentives*					
SONCC-URR.10.2.17	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	3
SONCC-URR.10.2.17.1	*Develop innovative ways to manage stormwater runoff*					
SONCC-URR.10.2.17.2	*Implement stormwater abatement plan*					

33. Middle Klamath River Population

- Interior Klamath Diversity Stratum
- Non-Core Potentially Independent Population
- Moderate Extinction Risk
- 450 Spawners Required for ESU Viability
- 1038 mi^2
- 113 IP km (70 mi) (4% High)
- Dominant Land Use is Forest Service Public Land
- Principal Stresses are ‘Impaired Water Quality’ and ‘Lack of Floodplain and Channel Structure’
- Principal Threats are ‘High Intensity Fire’ and ‘Climate Change’

33.1 History of Habitat and Land Use

Historical mining, excessive logging, and road building activities have contributed to environmental degradation in the Middle Klamath River subbasin. Throughout the 1850’s, hydraulic and placer mining methods were used to remove gravel and filter out gold in sections of the mainstem Klamath River. Piles of gravel tailings remain along the mainstem river and tributaries as remnants of these historic practices, continuing to create stress and alter channel structure throughout the watershed. Timber harvesting was prevalent in the late 1940’s to the 1990’s, but has rapidly declined largely due to recent Forest Service policy on maintaining ecosystem health. Today, most timber management projects on Six Rivers and Klamath NF include hazard tree removal, fuel reductions, salvage logging, and promoting the development and maintenance of diverse stand structures and species composition. Existing roads used for past timber harvesting remain in the watershed and in many places continue to contribute sediment to tributary and mainstem channels.

Hydropower dams were constructed upstream in the early to mid-1900s, and continue to alter mainstem flows. Although there are no notable dams in the Middle Klamath, the operations of upstream Iron Gate, Copco 1 and 2, JC Boyle and Keno dams reduce fall and winter flow variability, which create instream conditions that favor disease proliferation and facilitate increased fish infection rates (*Ceratomyxa Shasta*, *Icthyopthirius multifilis* (Ich), *Flavobacterium columnare* (columnaris), Aeromonid bacteria, *Nanophyetus salmonicola*, *Parvicapsula minibicornis*) (NMFS 2010; Stocking and Bartholomew 2007).

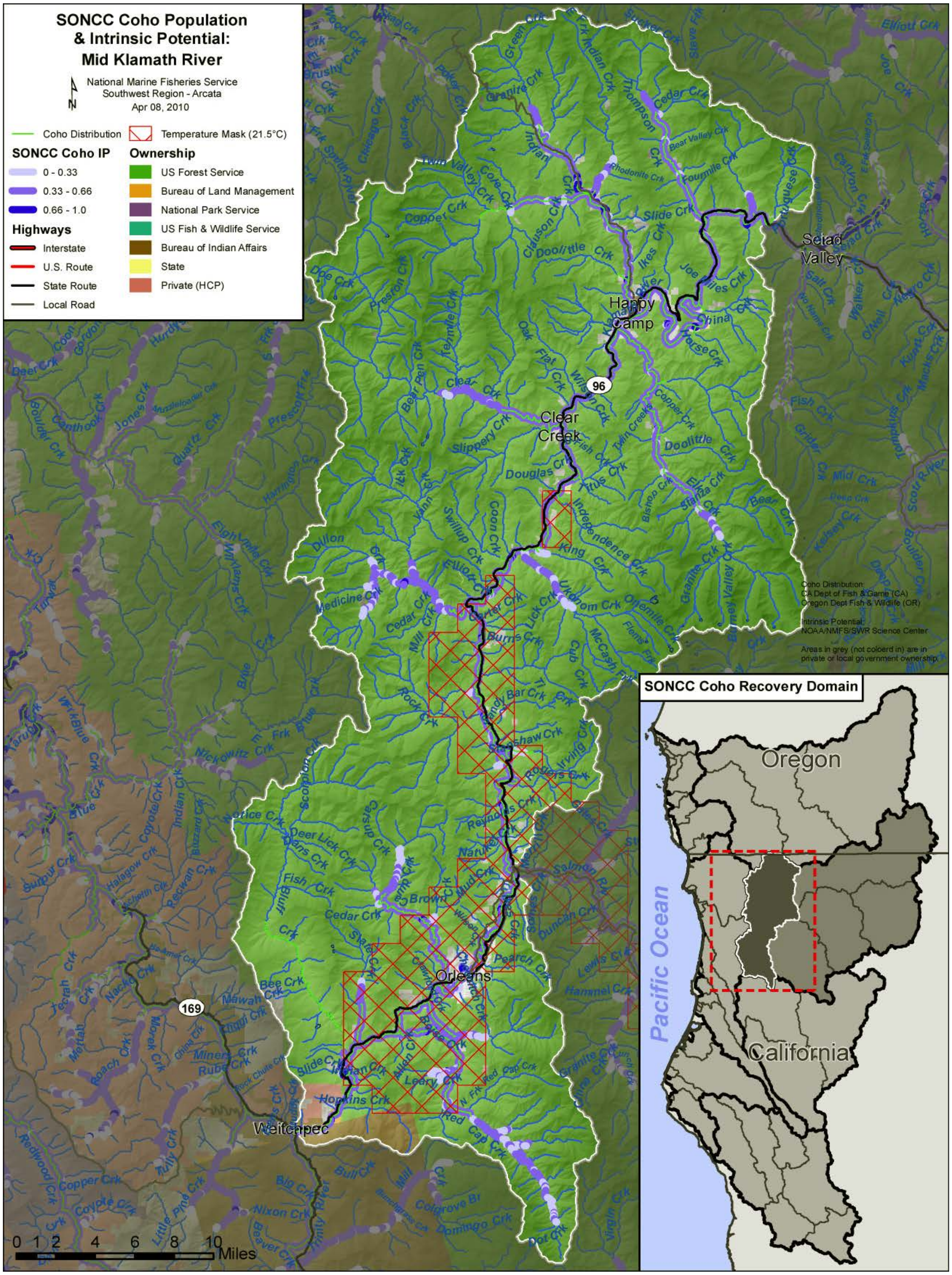

Figure 33-1. The geographic boundaries of the Middle Klamath River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership).

Low dissolved oxygen, altered water temperature regimes, and high nutrient levels are some of the water quality issues exacerbated by these upstream dams and upper basin agricultural practices (NMFS 2010). More information about how agricultural practices impact water quality can be found in the Upper Klamath population profile. Further upstream, water is diverted from the Klamath River for the Bureau of Reclamation's Klamath Project. This has altered the historic hydrologic regime of the mainstem Klamath, as well as reducing the total volume of water available for instream flows, which contributes to water quality degradation and directly affects critical periods of the life history of SONCC coho salmon (NMFS 2010). Significant volumes of water are also diverted to other non-Project irrigators from many tributaries in the Klamath River Basin, further reducing cold water inputs into the mainstem.

33.2 Historic Fish Distribution and Abundance

Very little historic data exists on coho salmon in the Middle Klamath region. Within the larger Klamath River basin we know that reports of early gill net catches were on the order of 11,000 for coho salmon in 1919 (Snyder 1931). Large declines in the basin were thought to occur between 1940 and 1960 due to large-scale timber harvest, mining, and associated habitat loss (Weitkamp et al. 1995). By the 1980's the annual escapement of coho salmon in the basin was down to around 15,000 to 20,000 fish and this estimate included a large portion of hatchery fish (Leidy and Leidy 1984). Some have concluded that salmon runs across the ESU declined by over 90 percent between the 1940's and 1980's (Weitkamp et al. 1995, California Department of Fish and Game (CDFG) 2004c). It is thought that since many tributaries in the Middle Klamath were affected by land use activities over this same time period it is likely that the Middle Klamath population was part of this decline. Historic runs in this population were likely never as large as in some tributaries such as the Scott or Shasta populations. The IP model shows that there are approximately 113 IP km of suitable juvenile rearing habitat spread throughout the mainstem Klamath River and tributaries in the Middle Klamath region. Most of this habitat is of moderate IP value (0.33 to 0.66) with a few very isolated patches of high IP value (>0.66). Historic use of Middle Klamath River tributaries by coho salmon has been documented in Aikens, Bluff, Slate, Red Cap, Boise, Camp, Irving, Dillon, Swillup, Ukonom, Independence Clear, Oak Flat, Elk, Little Grider, Indian, China, Thompson, Fort Goff, and Portuguese creeks (Brownell et al. 1999). Many other tributaries also likely supported natal and non-natal coho salmon spawning and rearing historically, as evidenced by current juvenile presence in most tributaries of the Middle Klamath River.

33.3 Current Status of Middle Klamath River Coho Salmon

Spatial Structure and Diversity

There are several monitoring efforts in the Middle Klamath including: 1) fish populations, 2) stream flow, 3) water quality, 4) physical habitat, and 5) restoration sites. Monitoring is conducted by state and federal agencies, tribes and community groups. These groups include: the Karuk Tribe, the U.S. Forest Service (USFS), the U.S Fish and Wildlife Service (USFWS), CDFG, the North Coast Regional Water Quality Control Board (NCRWQCB), the U.S. Geological Survey (USGS), and the Mid-Klamath Watershed Council (MKWC). These efforts have taken place in many tributaries of the Klamath over the past decade and have provided information on coho salmon distribution and abundance as well as habitat condition and restoration effectiveness.

Juvenile surveys have been conducted over the past several decades by various parties including the Karuk Tribe, the Mid-Klamath Watershed Council (MKWC), and the U.S. Forest Service (USFS). These surveys have found coho salmon juveniles rearing in Hopkins, Aikens, Bluff, Slate, Red Cap, Boise, Camp, Pearch, Whitmore, Irving, Stanshaw, Sandy Bar, Rock, Dillon, Swillup, Coon, Kings, Independence, Titus, Clear, Elk, Little Grider, Cade, Tom Martin, China, Thompson, Fort Goff, and Portuguese creeks (Corum 2010; Soto et al. 2008; Karuk Tribe 2009; USFS 2009b). Surveys conducted between 2002 and 2009 indicate that juvenile coho are most abundant in Aikens, Bluff, Boise, Camp, Red Cap, Sandy Bar, Slate, and Stanshaw Creeks (USFS and Karuk Tribe 2009). Most of the observations are of juveniles using the lower parts of the tributaries and it is likely that many of these fish are non-natal rearing in these refugial areas. Natal rearing is likely confined to those tributaries where spawning is occurring and where sufficient rearing habitat exists (Boise, Bluff, Slate, Thompson, Red Cap, Elk, Indian, Clear, and Camp Creeks).

Coho salmon spawning surveys have been limited in the Middle Klamath and therefore information on adult distribution is meager. Spawning adult coho salmon have been documented in Bluff, Red Cap, Camp, Boise, South Fork Clear, and Indian creeks (Soto et al. 2008) and spawning surveys by the Karuk Tribe found adults spawning in Aikens, China, Elk, and the South Fork of Clear Creek. A total of 13 streams in 2007 and 20 streams in 2008 were surveyed (Corum 2010). Outmigrant trapping between 2002 and 2008 on Red Cap and Camp Creeks found juveniles less than 40 mm, indicating that there was likely natal rearing occurring (USFS 2009b, Cyr 2010). In addition, coho salmon have been observed spawning in side channels, tributary mouths, and shoreline margins of the mainstem Klamath River between Beaver Creek (RM 161) and Independence Creek (RM 94) (Magneson and Gough 2006).

Williams et al. (2008) determined that at least 34 coho salmon per-IP km of habitat are needed (3,900 spawners total) for the Middle Klamath coho salmon population to be at low risk of extinction. Adults and juveniles appear to be well distributed throughout the Middle Klamath; however use of some spawning and rearing areas is restricted by water quality, flow, and sediment issues. Little is known about the genetic and life history diversity of the population, but it is expected to be limited because of the depressed population size and the influx of hatchery strays that is likely occurring. The Middle Klamath River coho salmon population is likely at an increased risk of extinction because its diversity is very limited compared to historical conditions. Its spatial distribution appears to be good, but since many of the Middle Klamath tributaries are used for non-natal rearing, too little is known to infer its extinction risk based on spatial structure.

Population Size and Productivity

Little data exists on the Middle Klamath coho salmon population, but runs are thought to be extremely reduced compared to historic levels. Regional biologists estimate that the total population size is around 1,000 to 1,500 in strong run years and less than 100 in weaker run years (Ackerman et al. 2006). A few tributaries in the Middle Klamath (e.g., Slate, Boise, Red Cap, Clear, Camp, and Indian Creeks) support significant returns of coho salmon, however total spawner abundance and population productivity is unknown. Spawning surveys by the Karuk tribe in 2003, 2004, 2007, and 2008 found a handful of redds and adult coho salmon each year. In 2003, nine tributaries were surveyed, two redds were found in South Fork Clear Creek and two were found in Elk Creek. In 2004, 17 tributaries were surveyed and 36 live adult coho, 3 dead coho, and 33 redds were found in Stanshaw, S.F. Clear, Independence, Cade, Titus, and Aikens Creeks (Karuk Tribe 2009). A total of two redds and three live coho adults were found in 2007 for a total of approximately 0.4 adult coho salmon per surveyed kilometer. During the 2008/2009 spawning season, a total of 8 redds were found for a total of 0.5 fish/km (Corum 2010).

Juvenile counts indicate that productivity is relatively low with less than 12,000 juvenile coho salmon found between 2002 and 2009 during surveys of Middle Klamath tributaries (USFS 2009b). Outmigrant trapping on Red Cap and Camp Creeks by the USFS exhibited consistent use of these Middle Klamath tributaries by young-of-the-year (YOY) and age-1 coho. Every year sampled (2002 to 2003 and 2007 to 2009) found YOY and age-1 outmigration from these streams during the late spring and early summer, although the number of outmigrating age-1 smolts was generally less than 100 during most years (USFS 2009b). Based on the returns of other Klamath populations, it is likely that the 2004/2007/2010 brood year is a relatively stronger year class than the other two (re: 2003/2006/2009 and 2002/2005/2008) (Ackerman et al. 2006). Generally the returns are more consistent between years in Middle Klamath tributaries than in other populations such as the Scott or Shasta, which have very weak year classes every year (Karuk Tribe 2009, Chesney and Knechtle 2008).

Based on the available data, it appears that the Middle Klamath River coho salmon population has an average spawner abundance of 500 individuals, and is at moderate risk of extinction given the low population size and negative population growth rate. Williams et al. (2008) determined at least 113 coho salmon must spawn in the Middle Klamath each year to avoid the effects of extremely low population sizes. Based on current estimates of the population, it is likely that the population is above depensation, but well below the low-risk threshold of 3,900 spawners.

Extinction Risk

Based on the criteria set forth by Williams et al. (2008), the Middle Klamath River coho salmon population is not viable and likely at moderate risk of extinction. The estimated number of spawners likely exceeds the depensation threshold, but does not meet the low-risk threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Middle Klamath River population is considered to be a non-core, Potentially Independent population within the Klamath diversity stratum; historically having had a high likelihood of persisting in isolation over 100-year time scales, but strongly influenced by immigration from other populations such that they did not exhibit independent dynamics (Williams et al. 2008). The Middle Klamath population is strongly influenced by upstream populations such as the Upper Klamath, Shasta, Scott, and Salmon River populations. Adult strays from these populations spawn and interact with coho salmon in the middle Klamath. For the stratum and ESU to be viable, the Middle Klamath non-core population needs to be above its moderate risk threshold of 450 spawners. Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU. Furthermore, the Middle Klamath population will contribute toward stratum and ESU viability by providing rearing, migratory, and refugial habitat to other Klamath populations.

33.4 Plans and Assessments

Karuk Tribal Fisheries Department and Restoration Division

Mid-Klamath Sub-basin Fisheries Resource Recovery Plan

In 2003, the Karuk Tribe developed this fisheries resource plan (Soto and Hentz 2003) to identify core variables pertaining to ecological function in the subbasin, and to provide management priorities and objectives to guide efforts to improve conditions in the subbasin. The Tribe will administer the long-range plan, in cooperation with federal and state management agencies, private landowners, and local communities. The resource plan focuses on active restoration of those processes most degraded by historic and current land uses and passive restoration for protection of currently functioning subbasin processes.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004 and is a guide for recovering coho salmon on the north and central coasts of California, including the Middle Klamath River. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts.

Klamath River TMDL

The purpose of the Klamath River TMDLs are to estimate the assimilative capacity of the system with respect to the total loads of nutrients and organic matter that can be delivered to the Klamath River without causing an exceedance of the water quality objectives for nutrients and dissolved oxygen. The TMDLs also establish the amount of protection from solar radiation and cold water withdrawals necessary to meet water quality objectives for water temperature. The current TMDLs for the Klamath River in California address temperature, dissolved oxygen, nutrient, and *microcystin* water quality impairments for the Klamath River Hydrologic Unit, Middle HA (Oregon to Trinity River) and Lower HA, Klamath Glen HSA (Trinity River to Pacific Ocean).

U.S. Forest Service

Watershed Condition Framework

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, Bluff Creek was identified as a high priority 6th field subwatershed in the Six Rivers National Forest (USFS and BLM 2011).

The Klamath (KNF) and Six Rivers National (SRNF) Forests have also conducted various other watershed assessments for National Forest lands within the Middle Klamath region.

33.5 Stresses

Table 33-1. Severity of stresses affecting each life stage of coho salmon in the Middle Klamath River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
3	Altered Sediment Supply[1]	High	High	Very High[1]	High	High	High
1	Impaired Water Quality[1]	Low	Medium	Very High[1]	High	Medium	High
2	Lack of Floodplain and Channel Structure[1]	Low	High	High[1]	High	Medium	High
4	Barriers	-	Low	High	High	High	High
5	Increased Disease/Predation/Competition	Low	Medium	High	High	Medium	High
6	Altered Hydrologic Function	Low	Low	High	High	Medium	High
7	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	High
8	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
9	Degraded Riparian Forest Conditions	-	Medium	Medium	Medium	Medium	Medium
10	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, life Stages, and Habitat

Several factors limit the function of habitat for certain life stages in the Middle Klamath and therefore limit productivity of this population. The lack of quality summer and winter rearing habitat that is protected from warm temperatures and high winter flows is one of the most likely factors limiting productivity (Soto et al. 2008). Summer rearing occurs in cold-water tributaries and other thermal refugia along the mainstem. This type of rearing habitat is limited in terms of its quality, quantity and connectivity within the Middle Klamath. In the summer, the diversion of water leads to poor hydrologic function, disconnection and diminishment of thermal refugia, and poor water quality. Accretion of sediment at creek mouths also continues to limit access to important thermal refugia and summer rearing habitat. Winter rearing occurs primarily in confluence and tributary habitat where off-channel ponds and wetlands have formed. Winter rearing habitat has been primarily impacted by past mining activities in many tributaries, which has led to the loss and degradation of floodplain and channel structure. The majority of winter habitat that does exist is small, of poor quality, and is poorly connected. In addition to juvenile rearing habitat, it is likely that mainstem disease issues may be limiting the productivity of the population during certain years.

Looking at the overall productivity of the population, the juvenile life stage is most limited due to the degradation of summer and winter rearing habitat and the issues associated with disease and water quality that affect survival and growth in the mainstem river during migration. In order to improve the viability of this population, it will be imperative to address these limiting stressors and to improve habitat and conditions for the juvenile life stage. Addressing other stresses and threats and improving habitat for all life stages and life history strategies will also be an important component of recovery for this population.

Thermal refugia are one of the most important vital habitat types in the Middle Klamath due to their importance for rearing and migration in the Klamath River. USFS biologists in the Orleans and Happy Camp RD have been monitoring Klamath mainstem and tributary stream temperatures since 1996 (Cyr 2010). Results from this data and other studies along the Middle Klamath River have shown that once water temperatures in the mainstem become warm they typically remain warm, except for stream reaches gaining significant groundwater inflow. The additive nature of cold water from these tributaries plays a vital role in reducing salmonid thermal stress and mortality. Cool water from smaller tributaries is as critical as larger tributaries in maintaining water quality in the Klamath and providing thermal refugia for coho. The Mid-Klamath Watershed Council and Yurok Tribe have also collected temperature data in tributaries and the mainstem Middle Klamath River (MKWC 2006) and surveyed potential refugia areas to asses where refugial areas are available and used by juvenile coho salmon. These data indicate that many tributaries may serve as thermal refugia because of their cooler water temperatures relative to the warm mainstem Klamath River (Table 33-2). The presence of juveniles in these tributaries, especially when water temperatures in the mainstem Klamath River are high, supports the conclusion that they are used as refugia areas. Other important tributaries for juvenile rearing include Sandy Bar, Stanshaw, China, Little Horse, Pearch, and Boise (Harling 2009). Intact, high quality rearing and spawning tributary habitat is also vital to the recovery of this population. Habitat in Indian, Elk, Camp, Boise, Red Cap, Clear, Thompson, Dillon, Slate, and Bluff Creeks provide the highest quality spawning and rearing habitat for coho salmon in the Middle Klamath (Mid-Klamath Restoration Partnership (MKRP) 2010).

Table 33-2. Thermal refugia areas known to exist within the geographic boundaries of the Middle Klamath River subbasin (NCRWQCB 2010; MKWC 2006).

Stream Name	Stream Name
Aikens Creek	Swillup Creek
Bluff Creek	Ukonom Creek
Slate Creek	Independence Creek

Red Cap Creek	Little Grider Creek
Boise Creek	Elk Creek
Camp Creek	Indian Creek
Pearch Creek	Little Horse Creek
Stanshaw Creek	China Creek
Sandy Bar Creek	Thompson Creek
Ti Creek	Ft. Goff Creek
Dillon Creek	Portuguese Creek

Altered Sediment Supply

Altered sediment supply poses a high or very high stress to all of the life stages of coho salmon. Access to tributary rearing habitat and refugia during some parts of the summer is also blocked at times by alluvial barriers. Many of these hydrologic and connectivity issues increase the risk of infections from C. *shasta* and/or Parvicapsula *minibicornis*. Soils in this area are highly erodible and in combination with the steep terrain, recent intense fires, and a legacy of past timber harvest and road-building, fine sediment loading has contributed to impaired conditions throughout the Middle Klamath. Excessive sedimentation reduces habitat diversity, embeds spawning gravel, and reduces channel stability. Changes in the natural structure of the river and water flow cause alluvial sills to form at many tributary confluences and can either physically block fish or force flows subsurface, thereby limiting or eliminating access to important refugia and spawning/rearing habitat. Habitat complexity in many tributaries has been reduced by fine sediment filling of pools, off-channel ponds and wetlands.

Impaired Water Quality

Coho salmon in the Middle Klamath River watershed have numerous interacting stresses. High water temperatures, exacerbated by water diversions and seasonal low flows restrict juvenile rearing in the mainstem Klamath River, and lessen the quality of tributary rearing habitat. The water quality issues are a primary concern due to issues of elevated water temperatures, low dissolved oxygen, and high nutrient levels. Water quality conditions in the Middle Klamath are impaired by seasonal high temperature, low DO, and high pH (NMFS 2007b). Seasonal decreases in water quality can be a very high stress for juveniles and a high stress for smolts due to poor rearing and migratory conditions. Although benthic macroinvertebrate indicators of water quality (via the IBI and EPT metrics) were ranked as good for the watershed, other water quality parameters were either poor or fair. Water quality conditions including pH and temperature (>17 ºC MWAT) are rated as poor in the mainstem Klamath and several key tributaries were found to have fair water temperatures (16.1 to 17 ºC). Grider, Indian, Elk, sandy Bar, and Whitmore Creeks all had water temperatures found to be above the 17º MWAT as recommended as suitable for juvenile fish. Dissolved oxygen (DO) was found to be fair (6 to 6.75 mg/l 7 DA-min) in the upper Middle Klamath, while the lower Middle Klamath had good (6.75- 7 mg/l) to very good (>7 mg/l) DO levels. Overall, the water quality in the Klamath River is impaired and is on the 303(d) Clean Water Act list.

Use of mainstem habitat is most limited by water quality during the summer months (June through September) when water temperatures are high throughout the day. Juveniles must utilize tributaries and other off-channel areas where cooler water can be found. Juvenile foraging and migration during early summer is most affected by poor mainstem conditions which force individuals into cold water tributaries, and in some years adult migration in the fall may be impacted as well (NMFS 2007b). Dissolved oxygen is also impaired in areas during this same time period and can reach as low as 5.5 mg/L in the mainstem (NCRWQCB 2010), effectively making these areas unusable for rearing or foraging. Highly fluctuating DO concentrations are common throughout the mainstem and pH tends to rise throughout the summer, peaking in late August and fluctuating widely between day and night (NMFS 2007b). This fluctuating condition further likely limits use of mainstem areas for juveniles and restricts rearing to tributary and confluence habitat where water quality is better. The impacts of disease may also be affected by water quality with recent increased documented incidences of sub-lethal and lethal effects on juveniles, smolts, and adults with elevated temperatures (Bartholomew and Courter 2007). MKWC (2006) documented mainstem and tributary temperatures in the summer of 2006 and showed that while mainstem temperatures are often higher than the range of coho salmon suitability (>19 ºC), most tributary temperatures were suitable (<19 ºC) for coho salmon.

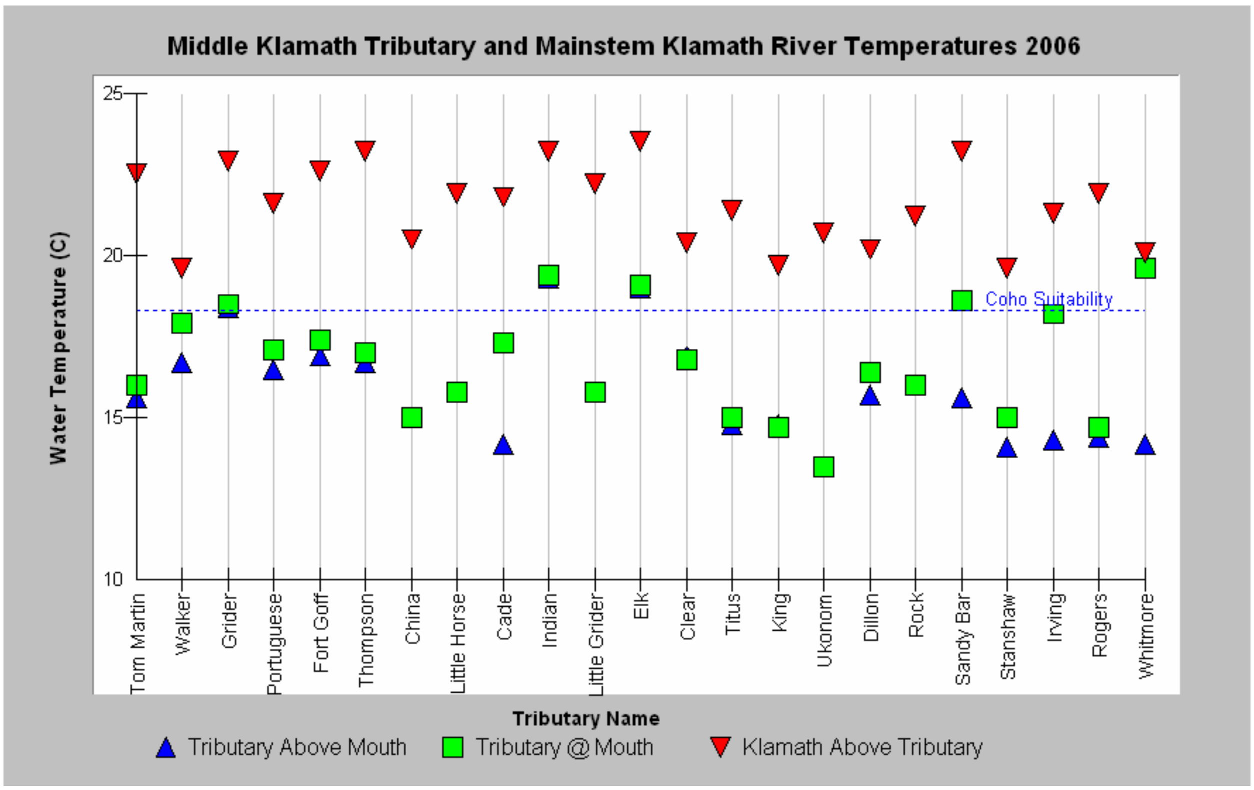

Figure 33-2. Temperature data collected during 2006 surveys (mid-June through mid-October). The data show that most tributaries were cool enough at the time of survey to support coho salmon, while mainstem Klamath River water temperatures were in the highly stressful range (MKWC 2006).

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure is also a high stressor given the need for juvenile coho salmon to rear in tributaries and utilize thermal refugia during summer. Habitat complexity in the form of pools, LWD cover, and off-channel floodplains, is essential for juvenile rearing to optimize prey availability, avoid predation, and access thermal and velocity refugia; and in general the Middle Klamath subbasin lacks these characteristics. The lack of floodplain and channel structure is a high stress for most life stages in this population. Fry, juveniles and smolts have been shown to often utilize floodplains, side channels, and slow water habitats where available, especially in winter when high flows inhibit use of mainstem channel habitat. Generally, floodplain structure is not available in many Middle Klamath tributaries due to the steeper gradients and channel confinement in these areas, as well as the remnant dredge tailings on the floodplain in many areas. Floodplain connectivity is believed to be poor in the Indian Creek sub-watershed and the area between Dillon Creek and the Salmon River confluence. CAP data on large wood are lacking, but NMFS (2007b) noted that wood was inadequate in many Middle Klamath tributaries and therefore contributes stress to certain life stages that utilize more complex habitats. Sediment loading in some tributaries has affected the quality and availability of off-channel habitat as well. Fine sediment has filled many off-channel ponds and wetlands and the lack of flushing flows on the mainstem Klamath prevents the creation and maintenance of side and off-channel habitat. Adults are impacted through the lack of suitable spawning habitat as a result of poor gravel recruitment and retention.

Barriers

Alluvial dams, low flow conditions, road-crossings, and diversions cause many seasonal and permanent barriers in the Middle Klamath. Of these, alluvial dams at the mouths of many tributaries present the greatest number of barriers. In total, there are almost 50 known seasonal or permanent barriers in the Middle Klamath blocking or impairing access to over 170 miles of coho salmon habitat (MKRP 2010). Hwy 96 has several poorly designed culverts that block upstream and downstream migration in key watersheds (Portuguese, Fort Goff, and Cade Creeks) and unscreened diversions in streams are likely an issue. Overall, barriers pose a low stress for fry and a high stress for juveniles, smolts, and adults due to the numerous barriers that exist throughout the tributaries of the Klamath. Barriers throughout the Middle Klamath are especially important because they may block access for juvenile coho salmon to summer and winter refugia and rearing areas, as well as blocking spawning grounds for returning adults.

Increased Disease/Predation/Competition

Disease, predation, and competition are a moderate to high stress for the population. Of these three stressors, disease is the most significant. Pathogens that cause diseases in juveniles and adults include *Ceratomyxa shasta*, Ichthyopthirius *multifilis* (Ich), *Flavobacterium columnare* (columnaris), Aeromonid bacteria, *Nanophyetus salmonicola*, and the kidney myxosporean *Parvicapsula minibicornis* (Federal Regulatory Energy Commission (FERC) 2007, National Research Council (NRC) 2004). Disease occurs when conditions for the pathogen are favorable and when fish are susceptible. Ich and columnaris were responsible for the significant die-off event in the Lower Klamath River in the summer of 2002. Infection by *P. minibicornis* may occur at a prevalence of greater than 50 percent of juvenile coho salmon. It is unknown how often they cause direct mortality (Bartholomew and Courter 2007). Juvenile mortality rates from short term and longer term exposures at various locations in the Klamath River vary by location and time of year, but are consistently higher at Beaver Creek (Upper Klamath) and Seiad Valley (Table 33-3). In 2008 mortality ranged from 12.5 to 20.5 percent at the Orleans site (Bartholomew 2008).

Table 33-3. Percent loss of coho salmon exposed at various Mid-Klamath River sentinel sites. The salmon were exposed for 72 hours in May or June 2008 and subsequently held for 65 or more days at the Salmon Disease Laboratory in a 16 to 18°C water supply. ND = no fish were exposed (Bartholomew 2008).

Exposure sites	May	June
Seiad Valley (Up. Klamath Pop.)	46.0	87.5
Orleans	20.5	12.5
Young's Bar	ND	20.0

Altered Hydrologic Function

Altered hydrologic function poses a high stress for the population. The timing, magnitude and volume of flows in the mainstem Klamath River has been altered compared to historic conditions. The high stress rank for juveniles and smolts is due to the altered flow regime in the mainstem and human-induced seasonal low flows in many Middle Klamath tributaries. The altered hydrology in the mainstem has led to decreases in water quality, and thermal refugia have been lost due to lack of access to tributaries and other suitable rearing habitat. Alteration of the natural hydrograph is primarily due to diversions and water withdrawals in the Upper Basin and in upstream tributaries, and the managed flow from Iron Gate Dam. Although the impacts of the hydropower and agricultural projects decrease with distance downstream from Iron Gate, significant impacts remain to the Middle Klamath mainstem hydrograph. Generally, spring and summer flows are lower than historically unimpaired flows, and tend to peak approximately a month earlier, subsiding to summer baseflow approximately two months earlier during most years. As a result, important life history strategies/traits (e.g., smolt outmigration timing, spring juvenile/fry redistribution) have now been either modified or lost entirely due to the hydrologic shift. The earlier onset of low baseflows also precipitates poor water conditions that now coincide with a greater proportion of the smolt outmigration through the mainstem reach.

Many of the flow impairments in tributary streams are due to the diversion of water for private and municipal use. Diversions cause some tributaries to go subsurface intermittently during the summer and may eliminate or reduce thermal refugia in tributaries or tributary outlets at other times of the year. Also detrimental are the high sediment loads that have caused some reaches to flow subsurface intermittently during the summer. Refugia and off-channel rearing habitat are often cut off from mainstem and tributary streams from low flow conditions in the summer. Summer water diversions can contribute to degraded habitat and/or fish passage issues in Stanshaw, Red Cap, Boise, Camp, Elk Creek, and Fort Goff Creeks during low water years. Many of these areas lack the summer base flows needed to maintain connectivity to summer rearing habitat and refugia after diversions have been removed from streams.

Impaired Estuary/Mainstem Function

All anadromous fish natal to Middle Klamath River tributaries must migrate through the Lower Klamath River and estuary to complete its life history cycle. The Klamath River estuary plays an important role in providing holding habitat, foraging and refuge opportunities for juvenile coho salmon and smolts from the Middle Klamath. Although the estuary is short and small compared to the large size of the watershed, it does provide complex habitat as well as rearing opportunities for juvenile coho salmon. The degraded conditions that exist throughout the

Klamath Basin today may mean that the estuary must play an even greater role for all Klamath populations by providing opportunities for juvenile and smolt growth and refugia prior to entering the ocean. The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain. Additionally, diking and development on the floodplain along the Lower Klamath has led to the loss and degradation of riparian vegetation and side channel habitat in the estuary. More information about the Klamath River estuary can be found in the other population profiles concerning the Lower and Upper Klamath River.

Disease, access to and availability of thermal refugia and off-channel habitat, and lack of connectivity between tributaries and the mainstem are all issues that impact the quality of migratory habitat downstream of the Middle Klamath. Juveniles, smolts, and adults transitioning through estuarine and mainstem habitats are stressed by the degraded conditions in these migratory habitats and suffer from the lost opportunity for increased growth, and consequently, may have a lower survival rate. The loss and degradation of estuarine and mainstem habitat is considered a moderate to high stress for the population, with the most affected life stages being juveniles and smolts due to the degradation of rearing and migratory habitat.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. No hatcheries or artificial propagation occur in the Middle Klamath population area, but there are two hatcheries in the Klamath River basin. Iron Gate Hatchery is upstream on the Klamath River, and Trinity River Hatchery is on the Trinity River, which breaks from the Klamath near the Middle Klamath population area. The proportion of spawning adults of hatchery origin in the Middle Klamath River is unknown. Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of Iron Gate Hatchery and Trinity River Hatchery in the Klamath basin (Appendix B).

Degraded Riparian Forest Conditions

Degraded riparian forest conditions pose a medium stress for all life stages. Aerial photos show that while there are areas of disturbance, the majority of riparian areas surrounding tributaries and high quality refugia contain abundant riparian vegetation and have adequate structure and diversity. The medium rating is due to areas of degraded riparian condition resulting from high intensity fires, mining, major floods (such as the 1964 flood), and past timber harvests. These disturbances create localized, short term reductions in riparian vegetation that can have major impacts depending on the degree and extent of coho salmon use of the area. Areas such as Elk Creek, where wildfire has recently denuded riparian vegetation, will experience higher water temperatures and higher sediment loads over the short term, but will slowly recover their riparian function in the long term.

Adverse Fishery Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

33.6 Threats

Table 33-4. Severity of threats affecting each life stage of coho salmon in the Middle Klamath. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	High Intensity Fire	High	High	High	High	High	High
2	Climate Change	Low	Low	High	High	High	High
3	Roads	Medium	Medium	High	Medium	Medium	Medium
4	Dams/Diversion	Low	Medium	High	High	Medium	Medium
5	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
6	Road-Stream Crossing Barriers	-	Low	Medium	Medium	Medium	Medium
7	Mining/Gravel Extraction	Low	Medium	Medium	Medium	Low	Medium
8	Fishing and Collecting	-	-	-	-	Medium	Medium
9	Channelization/Diking	Low	Low	Low	Low	Low	Low
10	Agricultural Practices	Low	Low	Low	Low	Low	Low
11	Timber Harvest	Low	Low	Low	Low	Low	Low

[1] Invasive Non-Native/Alien Species and Urban/Residential/Industrial are not considered threats to this population.

High Intensity Fire

High intensity fire is a high threat to all life stages in the Middle Klamath. Because of past timber harvest practices and fire-suppression efforts, understory forest fuel loads have become excessive. High intensity fires result from these excessive forest fuel loads and are seen regularly throughout the area (e.g., Dillon, Pony, Swillup, Stanza, Titus, and Panther). Large, high intensity fires can cause chronic sediment transport from upslope sources to stream channels, particularly when coupled with salvage and other logging activities. Landscapes scorched by intense fire loosen soil integrity as plant and tree roots degrade, triggering landslides that introduce large quantities of sediment into creeks and rivers. Areas that are prone to future fire events (based on fuel loading) include important coho salmon habitat in Red Cap, Boise, Bluff, Slate, Camp, Indian, Elk, Goff, Portuguese, Clear, Dillon, and Thompson creeks.

Climate Change

Climate change has emerged as an important threat to coho salmon in the Middle Klamath due to the predicted changes in fire regimes, snow pack, ambient temperatures, and precipitation. Climate change poses a high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperatures shows a large increase over the next 50 years (see Appendix B for modeling methods). Average ambient temperature could increase by up to 3 ^{o}C in the summer and by 1 ^{o}C in the winter, while annual precipitation in this area is predicted to trend downward over the next century. Additionally it is predicted that snowpack in upper elevations of the Klamath basin will decrease with changes in response to changes in temperature and precipitation (California Natural Resources Agency 2009). Rearing and migratory habitat are most at risk to climate change. Increasing water temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Adults will also be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007). Overall, the range and degree of variability in ambient temperature and precipitation are likely to increase in all populations, creating long term threats to the persistence of coho salmon in this area.

Roads

Historic logging, road building, and wildfires in the Middle Klamath have contributed to degraded instream and floodplain conditions and unnatural sediment loads in the watershed. Roads are a high threat to juveniles and a medium threat to eggs, fry, smolts and adults. Road density is high (≥2.5 to 3 mi/sq mi) or very high (>3 mi/sq mi) throughout half of the watershed, including areas where limited high IP reaches and high quality refugia areas are located. The majority of these roads are located on U.S. Forest Service public land and are being prioritized and treated (upgraded, storm-proofed, and/or decommissioned). Currently, the areas with the greatest remaining road densities and greatest risk for slope failure include the China, Cade, Dillon, Rock, Reynolds, and Slate Creek watersheds. The Klamath and Six Rivers National Forest have developed a Forest Road Analysis and a Motorized Travel Management Plan that determines much of the road work done on the Forest for natural resource benefit. Many roads have been decommissioned and storm-proofed by the Forest Service, and this threat will continue to be addressed along with other upslope threats. Because road decommissioning and road improvements are costly and there are high priority roads that still remain untreated, it is expected that the high density of roads will continue to contribute to sedimentation in the Middle Klamath over the next several decades. Excessive sedimentation leads to simplification of streams, embeds spawning gravel, decreases pool depth for rearing juveniles and reduces channel stability. Such habitat changes hinder successful spawning and emergence, limit access to rearing habitats, increase competition and predation, and affect macro-invertebrate densities.

Dams/Diversions

Dam construction on the mainstem Klamath River has resulted in severely degraded instream and floodplain conditions and unnatural sediment loads in the watershed. Dams and diversions are a high threat to juveniles and smolts, and medium threat to all other life stages other than egg. The threat from dams and diversions primarily stems from the diversion of water from tributaries of the Middle Klamath and from the influence of upstream dams and diversions on mainstem habitat, tributary access, and refugia. The diversion of water from tributaries is largely undocumented and is expected to continue to degrade habitat and refugia into the future. Within the Middle Klamath itself there are approximately 170 documented diversions (CalFish 2009).

Diversion of water from tributaries limits summer base flows, decreases the potential for summer rearing, and limits access to thermal refugia. These diversions further diminish instream flows and exacerbate water quality issues. Unscreened, undocumented diversions throughout the Middle Klamath likely act as fish passage barriers, preventing migration of juveniles. Each summer, diversion of water from Middle Klamath tributaries leads to the disconnection of rearing habitat, the impairment of water quality, and the reduction in thermal refugial area and quality.

Upstream dams including Iron Gate, Copco 2 and 1, JC Boyle, and Keno dams, create significant water quality and hydrology issues in the Middle Klamath. These water quality issues are thought to facilitate increased infection rates, disease occurrence, as well as creating low dissolved oxygen levels, altered water temperature regimes, and increased nutrient levels. The operation of these dams have changed the hydrologic regime and have resulted in an earlier onset of base flow conditions and changes in the timing and magnitude of peak flows. Fish passage or dam removal above Iron Gate dam is expected to occur within the next 10 years, thereby reducing or removing the threat posed by the hydroelectric project over the long term. In the interim period, efforts will be made to avoid, minimize, or reduce the impacts from the dams through the PacifiCorp Habitat Conservation Plan and the Klamath Basin Restoration Agreement.

In addition to the dams on the Klamath River, upstream diversions by the Klamath Project in the Upper Klamath basin and in the Scott and Shasta Rivers decrease flows required to maintain adequate water temperatures in the mainstem Klamath River, and increase the occurrence and severity of alluvial barriers at many tributary mouths. These diversions are expected to continue, however conservation efforts are attempting to reduce diversions, making them less of a threat into the future. Together, upstream dams and diversions threaten all life stages of coho salmon through their impacts on habitat quality and availability, water quality and quantity, sedimentation, and disease/infection rates.

Hatcheries

Hatcheries pose a medium threat to other life stages in the Middle Klamath River basin. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress. .

Road-stream Crossing Barriers

Road related barriers are a medium threat and primarily affect juveniles, smolts, and adults in this population and juveniles and smolts from upstream populations that utilize rearing and refugial habitat in the Middle Klamath. Over the past decade, the Klamath and Six Rivers National Forests have removed most of the critical anadromous fish passage barriers on Forest roads, however there are still a number of passage problems associated with Highway 96 (Table 33-5). Road-stream crossings are important not only because they block tributary habitat and access to refugia, but also because they may impact the hydrologic function of tributaries and lead to increased road failures. Some of the remaining road-stream crossing barriers have been prioritized for removal (Fort Goff Creek) and the remaining barriers are being evaluated for removal.

Table 33-5. List of important road-stream crossing barriers in the Middle Klamath area.

Barrier Treatment Ranking	Stream Name	Road Name	USFS District	County	Miles of habitat*
2	Portuguese Creek	Hwy 96	Happy Camp	Siskiyou	0.4
2	Fort Goff Creek	Hwy 96	Happy Camp	Siskiyou	0.9
2	Cade Creek	Hwy 96	Happy Camp	Siskiyou	0.5
2	Negro Creek	Private	Ukonom	Siskiyou	unknown
1	Crawford Creek	Hwy 96	Orleans	Humboldt	0.6
1	Stanshaw Creek	Hwy 96	Ukonom	Siskiyou	0.2
1	Sandy Bar Creek	Hwy 96	Ukonom	Siskiyou	0.4

*Miles of habitat and ranking is estimated by the MKRP (2010). Ranking is on a scale from 0 to 3 with 3 being the highest.

Mining/Gravel Extraction

Although suction dredging occurs in the Middle Klamath, this activity is not believed to impede adult migration and should not affect eggs since dredging only occurs during the late spring to early fall. Suction dredging mostly affects juveniles and can have both beneficial as well as detrimental effects. Degradation can deplete the entire depth of gravel on a channel bed, exposing other substrates that may underlie the gravel, which would reduce the amount of usable anadromous spawning habitat (Collins and Dunne 1990, Kondolf, 1994, Oregon Water Resources Research Institute 1995). Gravel removal not only impacts the extraction site, but may reduce gravel delivery to downstream spawning areas (Pauley et al. 1989). Beneficial effects include removing fine sediments from spawning gravel, increasing the availability of benthic macro-invertebrates, creating pools, and restoring pool depths. Adverse effects include increasing turbidity, modifying spawning channels, decreasing emergent macro-invertebrate prey, and disturbing and displacing juveniles and smolts from refugia. Past mining activities have also left heavy metal contamination (i.e., mercury, copper, arsenic, etc.) at sites on Indian and Copper creeks (a tributary of Dillon creek). The Forest Service recently capped the mill tailings with fill at the Siskon Mine superfund site, and plans are underway to revegetate the mill tailing pond and mill site area, and storm-proof and stabilize the mine road. No details of the Luther Gulch superfund site near Indian Creek are available. Overall, mining and gravel extraction are not a significant threat for coho salmon and are given a rating of low to medium in the CAP analysis.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath/Trinity basin. The effects of the fisheries managed by the State of California and the Yurok and Hoopa Tribes, on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Middle Klamath River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Channelization/Diking

According to the CAP analysis channelization and diking is not a major issue in the Middle Klamath. There is little residential and agricultural development in the Middle Klamath and therefore only small-scale channelization and diking of tributaries, except for Indian Creek.

Agricultural Practices

Other than the effects from water diversions in this part of the subbasin, agricultural practices pose a low threat to all life stages for coho salmon. Because of the small number of existing ranches and farms in this watershed, agricultural practices are a low threat to this population and are not thought to cause significant decreases in water quality, are not significantly altering streambanks or floodplains, and are not decreasing riparian habitat in the Middle Klamath subbasin. However, effects from water withdrawals are seen in these areas, and act cumulatively with withdrawals occurring upstream. Grazing does occur in the Marble Mountain Wilderness and in the Upper Bluff Creek watershed, however, the extent of grazing impacts to these watersheds is not considered to be significant. Upstream agricultural practices in the Upper Basin and the Scott and Shasta valleys are affecting water quality and flow volumes in the Middle Klamath River mainstem (See appropriate profiles for more information). In particular, upstream agricultural practices may be contributing to extended summer low flow conditions, reduction in available rearing habitats, and overall increased stress to juveniles.

Timber Harvest

Timber harvest is not a threat to coho salmon in this area due to the protective measures in place on National Forest timberlands. Timber harvesting has been low throughout this watershed the past few decades, and is not expected to increase in the near future. Under current management practices and the financial, administrative and legal restrictions on timber harvest, the USFS is unlikely to implement large timber sales. Additionally, timber practices are governed by the rigorous protective measures for water quality that are required under the Northwest Forest Plan (NWFP). There has not been a vegetation management action (such as timber harvest) on the KNF that was determined likely to have an adversely affect on SONCC coho salmon for at least a decade.

33.7 Recovery Strategy

The potential for coho salmon recovery in the Middle Klamath is very high, however the population is currently depressed in abundance and habitat is degraded in many areas. Summer and winter rearing habitat is in poor quality in many areas and is limited in its extent and connectivity. Mainstem conditions during the summer are prohibitive for migration and rearing. Recovery activities in the watershed should focus on the key limiting stressors and life stages. Restoration should include the ongoing long term reduction in sediment through road decommissioning and timber harvest management, and reduction in high intensity fire risks through fuels reduction on private and public lands.

The removal of the four mainstem hydroelectric dams will also be important to the improvement of hydrologic function, water quality, and disease conditions in the mainstem Klamath. The immediate restoration and maintenance of tributary water quality, hydrologic function, and floodplain and channel structure for spawning and rearing will help increase productivity, abundance, and distribution of the population. Recovery actions should focus on protecting and restoring those tributaries that have been identified as being important to natal and non-natal coho salmon. Specific goals for restoration are listed below and in the table of recovery actions that follows.

The highest potential for restoring summer migratory and rearing habitat is in the mainstem Klamath River and in Slate, Elk, and Indian Creeks (MKRP 2010). Reducing stream temperatures, maintaining and improving thermal refugia, improving hydrologic function, and removing barriers will all help to increase the opportunity and capacity for summer rearing and migration in the Middle Klamath. These actions will benefit both the natal population as well as the other Interior Klamath diversity stratum populations.

The highest potential for restoring winter rearing habitat is in the mainstem Klamath River and in Elk and Indian Creeks (MKRP 2010). Improving channel and floodplain complexity and connectivity and reducing sediment supplies to tributaries will help to increase the opportunity and capacity for winter rearing. These actions will benefit both the natal population as well as the other Klamath populations in the stratum.

Table 33-6 on the following page lists the recovery actions for the Middle Klamath River population.

Table 33-6. Recovery action implementation schedule for the Middle Klamath River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MKR.2.2.1	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide	2
SONCC-MKR.2.2.1.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MKR.2.2.1.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-MKR.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Stanshaw, Red Cap, Boise, Camp, Elk, Dillon, Slate, and Fort Goff Creeks	3
SONCC-MKR.2.2.2.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-MKR.2.2.2.2	*Implement beaver program (may include reintroduction)*					
SONCC-MKR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Improve regulatory mechanisms	Population wide	BR
SONCC-MKR.2.2.3.1	*Limit hunting or removal of beaver*					
SONCC-MKR.2.2.4	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels	Population wide	2
SONCC-MKR.2.2.4.1	*Assess instream flow conditions and side channel connectivity and develop a plan to obtain adequate flows for channel connectivity*					
SONCC-MKR.2.2.4.2	*Mechanically alter side channels, off channel ponds and wetlands to achieve connectivity*					
SONCC-MKR.2.2.5	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	All leveed streams	3
SONCC-MKR.2.2.5.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-MKR.2.2.5.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-MKR.2.1.6	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	3
SONCC-MKR.2.1.6.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MKR.2.1.6.2	*Place instream structures, guided by assessment results*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MKR.8.1.20	Sediment	Yes	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	BR
SONCC-MKR.8.1.20.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-MKR.8.1.20.2	*Implement plan to stabilize slopes and revegetate areas through planting and best management practices*					
SONCC-MKR.8.1.21	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	BR
SONCC-MKR.8.1.21.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MKR.8.1.21.2	*Decommission roads, guided by assessment*					
SONCC-MKR.8.1.21.3	*Upgrade roads, guided by assessment*					
SONCC-MKR.8.1.21.4	*Maintain roads, guided by assessment*					
SONCC-MKR.10.3.10	Water Quality	Yes	Protect cold water	Protect existing or potential cold water refugia	Population wide	2
SONCC-MKR.10.3.10.1	*Develop emergency plan to protect thermal refugia during warm periods*					
SONCC-MKR.10.3.11	Water Quality	Yes	Protect cold water	Educate stakeholders	Population wide	BR
SONCC-MKR.10.3.11.1	*Develop an educational program that teaches to reduce channel encroachment, reduce usage of toxic chemicals, maintaining septic systems, water conservation, and landscaping with native species.*					
SONCC-MKR.10.3.12	Water Quality	Yes	Protect cold water	Improve regulatory mechanisms	Population wide	2
SONCC-MKR.10.3.12.1	*Develop regulatory mechanisms that protect critical cold water refugia*					
SONCC-MKR.10.2.13	Water Quality	Yes	Reduce pollutants	Remove pollutants	Indian Creek, Copper Creek, and Luther Gulch	2
SONCC-MKR.10.2.13.1	*Assess contamination from tailing piles and develop mining activities remediation plan*					
SONCC-MKR.10.2.13.2	*Take necessary actions to ensure responsible parties remediate mine tailing piles, guided by the plan*					
SONCC-MKR.1.2.43	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3
SONCC-MKR.1.2.43.1	*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MKR.16.1.28	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MKR.16.1.28.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MKR.16.1.28.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-MKR.16.1.29	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MKR.16.1.29.1	*Determine actual fishing impacts*					
SONCC-MKR.16.1.29.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-MKR.16.2.30	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MKR.16.2.30.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-MKR.16.2.30.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-MKR.16.2.31	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MKR.16.2.31.1	*Determine actual impacts of scientific collection*					
SONCC-MKR.16.2.31.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-MKR.3.1.15	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2
SONCC-MKR.3.1.15.1	*Assess diversion impact and develop a program to increase flow during low flow periods*					
SONCC-MKR.3.1.15.2	*Increase flows during low flow periods, as described in the program*					
SONCC-MKR.3.1.16	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-MKR.3.1.16.1	*Develop an educational program about water conservation programs and instream leasing programs*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-MKR.3.1.17	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MKR.3.1.17.1		*Prioritize and provide incentives for use of CA Water Code Section 1707*				
SONCC-MKR.3.1.18	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MKR.3.1.18.1		*Establish a categorical exemption under CEQA for water leasing*				
SONCC-MKR.3.1.19	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MKR.3.1.19.1		*Establish a comprehensive statewide groundwater permit process*				
SONCC-MKR.3.1.42	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	3
SONCC-MKR.3.1.42.1		*Install flow gages to ensure appropriate flows*				
SONCC-MKR.3.1.42.2		*Maintain flow gages annually*				
SONCC-MKR.27.1.32	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate survival of juvenile coho salmon	Population wide	2
SONCC-MKR.27.1.32.1		*Develop comprehensive PIT tagging and retrieval project that assesses habitat use and survival*				
SONCC-MKR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-MKR.27.1.33.1		*Perform annual spawning surveys*				
SONCC-MKR.27.1.34	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MKR.27.1.34.1		*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*				
SONCC-MKR.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MKR.27.1.35.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-MKR.27.1.36	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Disease'	Population wide	3
SONCC-MKR.27.1.36.1	*Annually estimate the infection and mortality rate of juvenile coho salmon from pathogens, such as Ceratomyxa shasta and Parvicapusla minibicornis*					
SONCC-MKR.27.2.37	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MKR.27.2.37.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-MKR.27.2.37.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-MKR.27.2.38	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-MKR.27.2.38.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-MKR.27.2.39	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MKR.27.2.39.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-MKR.27.2.40	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-MKR.27.2.40.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-MKR.27.2.41	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-MKR.27.2.41.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-MKR.27.1.44	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-MKR.27.1.44.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MKR.27.1.44.2	*If appropriate, modify population types and targets using revised methodology*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MKR.5.1.22	Passage	No	Improve access	Reduce sediment barriers	Population wide	2
SONCC-MKR.5.1.22.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-MKR.5.1.22.2	*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*					
SONCC-MKR.5.1.23	Passage	No	Improve access	Remove barriers	Population wide	BR
SONCC-MKR.5.1.23.1	*Develop breaching and dam removal program to address man-made rock dams*					
SONCC-MKR.5.1.23.2	*Breach or remove man-made rock dams*					
SONCC-MKR.5.1.24	Passage	No	Improve access	Remove structural barrier	Population wide	2
SONCC-MKR.5.1.24.1	*Assess culvert barriers and prioritize for removal*					
SONCC-MKR.5.1.24.2	*Remove culvert barriers*					
SONCC-MKR.5.1.25	Passage	No	Improve access	Reduce flow barrier	Dillon Creek	BR
SONCC-MKR.5.1.25.1	*Assess low flow tributaries and their sediment sources that contribute to seasonal flow barriers. Develop a plan to alleviate sediment delivery and remove current barriers*					
SONCC-MKR.5.1.25.2	*Alleviate sediment delivery in areas with low flow conditions and seasonal flow barriers as described in the plan*					
SONCC-MKR.5.1.26	Passage	No	Improve access	Reduce flow barrier	Independence, Boise, Camp, Titus, and Thompson Creeks	BR
SONCC-MKR.5.1.26.1	*Identify areas where fish stranding occurs and develop a plan to create low flow channels, concentrate existing flows, and prevent stranding*					
SONCC-MKR.5.1.26.2	*Implement plan to prevent stranding*					
SONCC-MKR.5.2.27	Passage	No	Decrease mortality	Screen all diversions	Population wide	3
SONCC-MKR.5.2.27.1	*Assess diversions and develop a screening program*					
SONCC-MKR.5.2.27.2	*Screen all diversions*					
SONCC-MKR.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Population wide	BR
SONCC-MKR.7.1.7.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-MKR.7.1.7.2	*Develop grazing management plan to meet objective*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MKR.7.1.7.3	*Plant vegetation to stabilize stream bank*					
SONCC-MKR.7.1.7.4	*Fence livestock out of riparian zones*					
SONCC-MKR.7.1.7.5	*Remove instream livestock watering sources*					
SONCC-MKR.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Mainstem	BR
SONCC-MKR.7.1.8.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-MKR.7.1.8.2	*Thin, or release conifers, guided by prescription*					
SONCC-MKR.7.1.8.3	*Plant conifers, guided by prescription*					
SONCC-MKR.7.1.9	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce fire hazard	Private land in mid-Klamath	BR
SONCC-MKR.7.1.9.1	*Develop fire hazard reduction educational materials for landowners*					
SONCC-MKR.7.1.9.2	*Develop a plan for fire break stewardship and defensible space*					
SONCC-MKR.7.1.9.3	*Implement fire-safe community action plans in identified areas*					

34. Upper Klamath River Population

- Interior Klamath Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 8,500 Spawners Required for Population Viability
- 1,400 mi^2
- 425 IP km (264 IP mi) (49% High)
- Dominant Land Uses are Timber Harvest, Grazing, and Rural Development
- Principal Stresses are ‘Impaired Water Quality’ and ‘Lack of Floodplain and Channel Structure’
- Principal Threats are ‘Dams/ Diversions’ and ‘Roads’

34.1 History of Habitat and Land Use

Severe hydrologic alteration of the Upper Klamath River basin has been occurring for over 100 years. Current facilities and operations for irrigation and hydropower include 5 dams and hundreds of miles of canals and pumps which support significant water withdrawals, transfers, and diversions throughout the subbasin. In 1905, the Bureau of Reclamation began developing the Klamath Irrigation Project (KIP) near Klamath Falls, Oregon. Starting around 1912, construction and operation of the numerous facilities associated with the KIP significantly altered the natural hydrographs of the Upper and Lower Klamath River and continues today. Marshes were drained, dikes and levees were constructed (National Research Council 2008), water withdrawal and transfer infrastructure was developed and in 1922 the level of Upper Klamath Lake was raised. The Link River and Keno dams also support the current irrigation project. The KIP now consists of an extensive system of canals, pumps, diversion structures, and dams capable of routing water to approximately 200, 200 acres of irrigated farmlands in the Upper Klamath River subbasin.

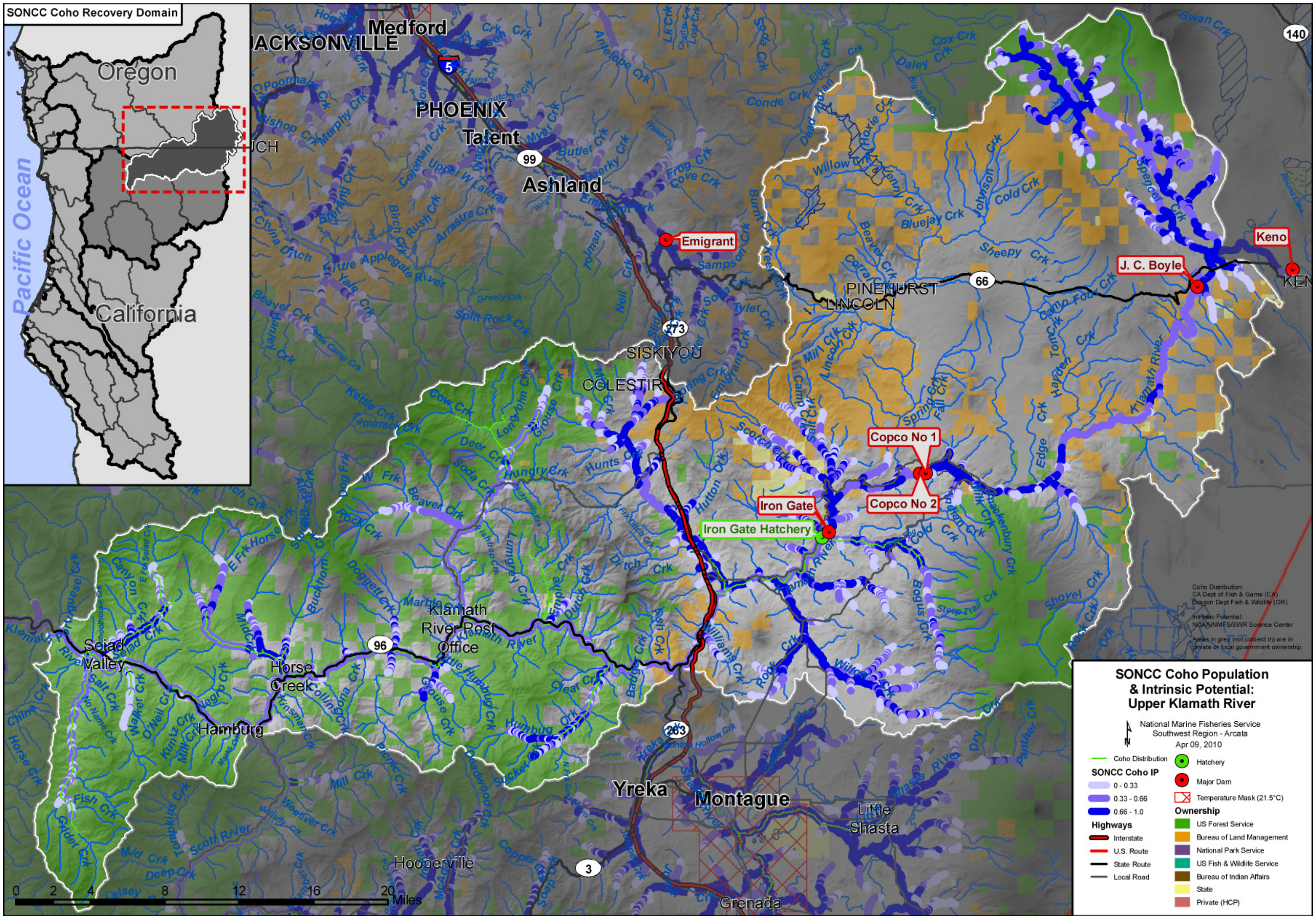

Figure 34-1. The geographic boundaries of the Upper Klamath River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership).

PacifiCorp operates the Klamath Hydroelectric Project, now consisting of five mainstem dams between river mile 190 and 233. The construction of Copco Dam in 1918 (river mile 199) created the first hydroelectric structure blocking salmon migration into the Upper Klamath River subbasin. The construction of the impassable Copco 2 Dam (1925) and Iron Gate Dam (1962) followed. The reservoir network blocks approximately 58 miles of coho salmon habitat, interrupts the natural passage of flow and sediment, alters the natural hydrograph and degrades Klamath River water quality (Hamilton et al. 2005, NMFS 2007c).

PacifiCorp's license expired on March 1, 2006, and the Project is currently operating on annual extensions granted by the Federal Energy Regulatory Committee (FERC).

Numerous processes are underway to provide long-term fisheries and ecological restoration through fish passage prescriptions or dam removal and to provide interim conservation for coho salmon prior to these large-scale restoration actions.

Hecht and Kamman (1996) analyzed the hydrologic records for similar water years (pre- and post-Project) at several locations throughout the Klamath River basin and concluded that the timing of peak and base flows changed significantly after construction of the KIP, and that the operation unnaturally increases flows in October and November and decreases flows in the late spring and summer as measured at Keno, Seiad, and Klamath. The modeled dataset also clearly shows a decrease in the magnitude of peak flows, a two-month shift in timing of flow minimums from September to July, and a reduction in the amount of discharge in the summer months. Hecht and Kamman (1996) also noted that water diversions in areas outside the Project boundaries occur as well and likely are further influencing the changes in the hydrology in these areas. NMFS (2010) recently analyzed the effects of the KIP on the Upper Klamath population and found impacts to water quality, hydrologic function, habitat quality, access, habitat availability, and disease. In addition to the KIP, agricultural diversions in both the Shasta and Scott Rivers, especially during dry water years, can dewater sections of these rivers, impacting coho salmon making opportunistic use of these streams as well as those in the Klamath River (Moyle 2002). Furthermore, the Bureau of Reclamation's operation of the Rogue River basin project annually diverts an average of 26,973 acre-feet of water from the Klamath River basin (Jenny Creek) to the Rogue River basin (La Marche 2001) further impacting the hydrology in the Klamath River basin.

Timber production has historically been the dominant land use below Iron Gate Dam. Almost all of the Seiad Valley HSA is federally-owned land managed by the Klamath National Forest and approximately half of the Beaver Creek HSA is part of the Klamath National Forest, with the other half composed largely of private timber company holdings. The Klamath National Forest was the principle timber-producing national forest in California during the past several decades, and land in this area continues to be plagued by high road densities and concomitant environmental impacts, namely high watershed erosion rates and compromised fish passage at road/stream crossings. In recent years the Klamath National Forest has aggressively addressed fish passage issues on many of their roads and aquatic conservation policies mandated under the 1994 Northwest Forest Plan have reduced timber harvest activity in sensitive areas and generally improved aquatic function in many Klamath River tributaries. Also, recently in watersheds under private landowner control, habitat conservation plans (HCPs) have begun to be developed to minimize and mitigate timber harvest effects on listed SONCC coho salmon and their habitat (e.g., Fruit Growers HCP). The Hornbrook, Iron Gate and Copco HSAs lie outside the national forest boundaries, but share a similar legacy of human-caused disturbance across the landscape.

34.2 Historic Fish Distribution and Abundance

Historically, coho salmon are thought to have inhabited all accessible stream reaches within the Upper Klamath population unit up to, and including, Spencer Creek (Hamilton et al. 2005, Williams et al. 2008). The current upstream limit for Klamath River salmon is Iron Gate Dam at river mile 190. Based on the historic IP model it appears that coho salmon likely occupied much of the area upstream of the dam and occupied numerous large tributaries. Areas with the highest IP and therefore the likeliest places for historic coho salmon production are listed in Table 34-1.

Table 34-1. Tributaries with instances of high IP reaches. (IP > 0.66).

Subarea[1]	**Stream Name**	**Subarea[1]**	**Stream Name**
Seiad Valley	Seiad Creek	**Iron Gate**	Bogus Creek
	Horse Creek	**Copco**	Scotch Creek
Beaver Creek	Barkhouse Creek		Jenny Creek
	Humbug Creek		Spencer Creek
Hornbrook	Cottonwood Creek	**Hornbrook**	Little Bogus Creek
	Willow Creek		

[1]Subarea refers to hydrologic subarea (HSA) in the CALWATER classification system.

Little information exists to provide insight on the historical abundance of coho salmon within the Upper Klamath River subbasin. Population estimates mostly arose from fishing and canning records within the Lower Klamath River and estuary, and reach-specific estimates for upstream sections of the river do not exist. Snyder (1931) reported the first commercial gill net catch of 11,162 coho salmon in the lower reaches of the Klamath River in 1919 and was the first author to report a concern for declining salmon populations in California, due to commercial fishing, forestry and agricultural practices. Long-term monitoring data suggests a marked decrease in abundance of adult coho salmon by the 1950s, which likely resulted from over-harvest and habitat loss (Klamath River Basin Fisheries Task Force 1991, Weitkamp et al. 1995, California Department of Fish and Game (CDFG) 2004c). By 1983, the annual escapement abundance of Klamath River basin adult coho salmon was estimated to range from 15,000 to 20,000 fish (Leidy and Leidy 1984). These estimates, which include hatchery stocks, could be less than six percent of the abundance in the 1940s (Weitkamp et al., 1995, CDFG 2004b). Ackerman et al. (2006) recently developed a run size approximation for tributaries in the Upper Klamath using reports from the USFWS and making the assumption that approximately 100 fish spawn in the mainstem. The total estimated returns for the population from 2001 to 2004 were between 600 to 4,000 fish and returns and strays from Iron Gate Hatchery make up a substantial portion of the overall population abundance.

34.3 Status of Upper Klamath River Coho Salmon

Spatial Structure and Diversity

The Upper Klamath River population unit is currently comprised of approximately 64 miles of mainstem habitat and numerous tributaries to the mainstem Klamath River upstream of Portuguese Creek to Iron Gate Dam. Historically, the population extended upstream of Iron Gate Dam to Spencer Creek. The PacifiCorp Hydropower Project, of which Iron Gate Dam is the lowest of five mainstem dams, blocks access to approximately 58 miles of spawning, rearing and migratory habitat for anadromous fish. As a result, coho salmon within the Upper Klamath River population spawn and rear primarily within several of the larger tributaries between Portuguese Creek and Iron Gate Dam, namely Bogus, Horse, Beaver, and Seiad Creeks. A small proportion of the population spawns within the mainstem channel, primarily within the section of the river several miles below Iron Gate Dam. A population of coho salmon parr and smolts rear within the mainstem Klamath River by using thermal refugia near tributary confluences to survive the high water temperatures and poor water quality common to the Klamath River during summer months.

Many of the streams comprising the Upper Klamath population unit are small and may go dry near their confluence with the mainstem Klamath River. Yet these intermittent tributaries remain important rearing habitat for coho salmon. Coho salmon have adapted life history strategies (spatial and temporal) to use intermittent streams. For example, adult coho salmon will often stage within the mainstem Klamath River at the mouth of natal streams until hydrologic conditions allow them to migrate into tributaries, where they are able to find more suitable spawning conditions, and juveniles can find adequate rearing conditions and cover. In summer when the lower sections of these tributaries may go dry, the shaded, forested sections upstream provide cold water over-summering rearing habitat for juvenile coho salmon. By early spring, when outmigration of one-year old coho salmon primarily occurs, base flows of these small streams are relatively high and full connectivity to the mainstem Klamath River exists.

Surveys by CDFG between 1979 to 1999 and 2000 to 2004 showed coho salmon as being moderately well distributed downstream of Iron Gate Dam in the Upper Klamath population unit. Juveniles were found in 21of the surveyed 48 tributary streams (Jong et al. 2008). Streams with coho salmon presence in both 1979 to 1999 and 2000 to 2004 included Grider, Seiad, Horse, Walker, Beaver, W. Fork Beaver, Cottonwood, Bogus, Little Bogus, and Dry creeks. Additional juvenile surveys conducted between 2002 and 2005 found fish using Tom Martin, Walker, Seiad, Grider, Beaver, Humbug, O'Neil, and Horse Creeks (Karuk Tribe 2009). No juveniles were found in Lumgrey, Willow, Bittenbender, Barkhouse, Empire, Cottonwood, Bogus, and Kuntz Creeks during these surveys. Adult spawning surveys between 2003 and 2005 found adults spawning in Canyon Creek (tributary to Seiad), Seiad Creek, and Grider Creeks (Karuk Tribe 2009). No evidence of spawning was found in Little Horse Creek.

Little is known about the genetic and life history diversity of the population, however, the population is highly influenced by the hatchery and has likely experienced a loss of life history diversity due to environmental conditions and loss of habitat. Currently, genetic work is being conducted to determine the genetic makeup of wild and hatchery fish from the Upper Klamath and it is likely to show that the combination of high stray rates and inbreeding at the hatchery has reduced the genetic diversity of the population. Given that most of the fish in the population come from the hatchery and the fact that hatchery fish are also known to have reduced life history diversity (e.g., all released as yearling smolts from one location), the overall life history diversity of the population is likely limited. The loss of habitat upstream of Iron Gate Dam and poor conditions in the mainstem between April and September also contribute to the loss of life history diversity. Smolt and adult migration is now confined to a short period of time when conditions in the mainstem are favorable and mainstem rearing and spawning is likely reduced from historic levels given the degradation of mainstem habitat.

In summary, the more restricted and fragmented the distribution of individuals within a population, and the more diversity, spatial distribution, and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 20 coho salmon per-IP km of habitat are needed (8,500 spawners total) to approximate the historical distribution of Upper Klamath River coho salmon and habitat. The current population is well below this and has a reduced genetic and life history diversity. Overall, the Upper Klamath River coho salmon population is at an elevated risk of extinction because its spatial structure and diversity are substantially limited compared to historical conditions.

Population Size and Productivity

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 425 coho salmon must spawn in the Upper Klamath River each year to avoid such effects of extremely low population sizes (depensation threshold). The low risk spawner threshold for the population is 8,500 spawners.

Based on juvenile surveys in the Upper Klamath between 2002 and 2005 there is low production in the Upper Klamath tributaries with fewer than 200 juveniles found in most tributaries and most years (Karuk Tribe 2009). The greatest number of juveniles was just over 1000, which were found in Horse Creek in 2005. Spawning surveys also give an indication of the population size and productivity. In 2003 the total spawner abundance for surveyed streams was 10 adults and in 2004 it was 108 adults with the majority of fish found spawning in Seiad and Grider Creeks (Karuk Tribe 2009).

A weir on Bogus Creek, monitored returns to the hatchery, and various tributary spawner surveys provide some indication of what the population size might be presently (Figure 34-2). Returns to the hatchery between 2004 and 2009 have averaged around 900 fish with the lowest returns (70) in 2009 and the highest returns (1,495) in 2004. Returns to Bogus Creek are largely driven by hatchery strays but have averaged around 150 fish. Tributary spawner surveys indicate low numbers of coho salmon (<100) in the remaining habitat. Using a variety of methods, including these data and an Intrinsic Potential (IP) database, Ackerman et al. (2006) developed run size approximations for tributaries in the Upper Klamath River reach. Ackerman et al. (2006) estimated the recent abundance of the Upper Klamath River population unit to be between 100 and 4,000 adults, far lower then the 8,500 spawners needed for the low risk spawner threshold that Williams et al. (2008) defined for the Upper Klamath River. Therefore, the Upper Klamath

River population unit is at high risk of extinction given its low population size and negative population growth rate.

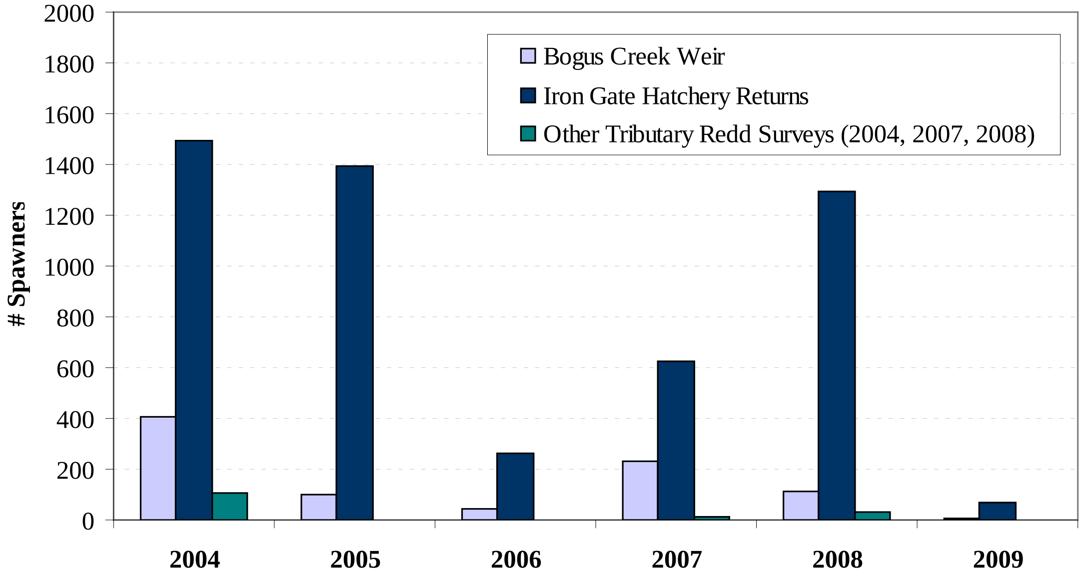

Figure 34-2. Returns of coho salmon to the Upper Klamath population. Based on data from various sources.

The population growth rate of the Upper Klamath population has not been estimated but given the current trends in spawner abundance and the high incidence of hatchery fish and inbreeding depression, it is likely that population growth is negative. The combination of low population abundance and a negative population growth rate mean that the population is at an elevated risk of extinction.

Extinction Risk

The Upper Klamath River coho salmon population of coho salmon is not viable and at high risk of extinction according to the population viability criteria. The number of spawners is below the depensation threshold and more than 5 percent of the spawners were born in a hatchery (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Upper Klamath population is considered a non-core “Functionally Independent” population within the Interior Klamath diversity stratum. This means that it is sufficiently large to be historically viable-in-isolation and its demographics and extinction risk are minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005, Williams et al. 2006). As a non-core population the recovery target for the population is for it to have at least a moderate risk of extinction according to the population viability criteria (see Chapter 2). Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU. Besides its role in achieving demographic goals and objectives for recovery, the Upper Klamath population fulfills other needs within the Interior Klamath diversity stratum. Upper Klamath tributaries, refugia, and mainstem habitat function as migration and rearing habitat for Scott and Shasta juveniles, smolts, and adults. Therefore restoration of the Upper Klamath is important for recovery of these populations as well.

34.4 Programs and Plans

Mid-Klamath Watershed Council

U.S. Forest Service

The Klamath National Forest (KNF) has conducted numerous watershed assessments and developed a Forest Land and Resource Management Plan (RMP) for National Forest lands within the Upper Klamath River subbasin. Relevant management plans and analysis reports that affect coho salmon in the Upper Klamath include:

Sufficiency Assessment: Forest Service and Bureau of Land Management Programs in Support of SONCC Coho Salmon Recovery (USFS and BLM 2011)

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, Seiad Creek and Antelope Creek were identified as high priority 6th field subwatersheds in the Klamath National Forest (USFS and BLM 2011)

The Klamath National Forest Land and Resource Management Plan

Klamath National Forest Road Analysis

Forest-Wide Late Successional Reserve Analysis

Watershed Condition Assessment

Thompson/Seiad/Grinder Ecosystem Analysis

Horse Creek Watershed Analysis

Callahan Watershed Analysis

Karuk Tribal Fisheries Department and Restoration Division

Middle Klamath Restoration Partnership (MKRP)

Klamath River Basin Conservation Area Restoration Program

Mid-Klamath Sub-basin Fisheries Resource Recovery Plan

In 2003, the Karuk Tribe developed this fisheries resource plan (Soto et al. 2003) to identify core variables pertaining to ecological function in the subbasin, and to provide management priorities and objectives to guide efforts to improve conditions in the subbasin. The Tribe will administer the long-range plan, in cooperation with federal and state management agencies, private landowners, and local communities. The resource plan focuses on active restoration of those processes most degraded by historic and current land uses and passive restoration for protection of currently functioning subbasin processes.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004. The recommendations developed by CDFG for the mid-Klamath population have been considered and incorporated into the recovery strategy and list of recovery actions for this population.

34.5 Stresses

Table 34-2. Severity of stresses affecting each life stage of coho salmon in the Upper Klamath River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt[1]	Adult	Overall Stress Rank
1	Barriers[1]	-	Very High	Very High	Very High	Very High	Very High
2	Adverse Hatchery-Related Effects	Very High	Very High	Very High[1]	Very High[1]	Very High	Very High
3	Impaired Water Quality[1]	Low	Medium	Very High[1]	High	High	High
4	Altered Hydrologic Function[1]	Low	Medium	Very High[1]	High	High	High
5	Lack of Floodplain and Channel Structure	Low	High	Very High[1]	High	Medium	High
6	Increased Disease/Predation/Competition	Low	High	High	Very High[1]	Medium	High
7	Altered Sediment Supply	High	High	High	High	High	High
8	Degraded Riparian Forest Conditions	-	Medium	High	High	High	High
9	Impaired Estuary/Mainstem Function	-	High	High	High	High	High
10	Adverse Fishery-Related Effects		-	-	-	Medium	Medium

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Several factors limit the viability of the Upper Klamath population. The most dominant of these factors stem from the effects of the mainstem hydroelectric dams on water quality, hydrologic function, floodplain and channel structure, disease, and habitat access upstream of Iron Gate Dam. The hatchery also plays an important role in limiting the Upper Klamath population through negative genetic and ecological interactions. Looking at the overall productivity of the population, the juvenile and smolt life stages are most limited due to the degradation of summer and winter rearing habitat and the issues associated with disease and water quality that affect survival and growth in the mainstem Klamath.

Key limiting stresses are barriers, altered hydrologic function, and impaired water quality. The loss of approximately 58 miles of habitat upstream of Iron Gate Dam, much of which is high quality spawning and rearing habitat, severely limits the spatial structure and natural productivity of the population. The presence of the KIP and hydroelectric project has led to additional limiting stresses related to the loss of flow variability and impaired water quality. These impairments have led to the loss of rearing and migratory habitat and an increase in the incidence of disease among other, less significant impacts (NMFS 2007c, NMFS 2010).

In terms of the types of habitat that are limited in the Upper Klamath it appears that summer and winter rearing habitat for juveniles is lacking but that spawning habitat is likely adequate given the number of adult coho salmon returning. The period of time when smolt migratory conditions in the mainstem are adequate has also been shortened and therefore is limited in time. In the summer, the diversion and impoundment of water continues to lead to poor hydrologic function, disconnection and diminishment of thermal refugia, and poor water quality in tributaries and the mainstem. Most tributaries with summer rearing potential are highly impacted by agriculture and past timber harvest. There exist very few remaining areas downstream of Iron Gate Dam with the potential and opportunity for summer rearing. Based on the low abundance of streams with age-1 coho salmon, it appears that overwintering survival may also be low or overwintering habitat may be limited in the Upper Klamath. Five of the nine streams with juvenile coho salmon presence had no age-1 juveniles found (Karuk Tribe 2009). Winter rearing habitat has been primarily impacted by the past mining and diking activities in many tributaries, which has led to the loss and degradation of floodplain and channel structure. The majority of winter habitat that does exist is small, degraded, and poorly connected. Because of the increased incidence of disease and water quality issues in the mainstem in late spring and summer the time period of adequate migratory conditions is limited to early spring (March-May). After this time period, growth and survival are appreciably reduced.

In order to improve the viability of this population it will be imperative to address these limiting stressors and to improve habitat and conditions for the juvenile life stage. Addressing other stresses and threats and improving habitat for all life stages and life history strategies will also be an important component of recovery for this population.

Tributary thermal refugia are one of the most vital habitat types in the Upper Klamath population unit due to its importance for rearing and migration in the Klamath River. The Mid Klamath Watershed Council and Yurok tribe have collected temperature data in tributaries and the mainstem Middle Klamath River (MKWC 2006) and surveyed potential refugia areas to assess where refugial areas are available and used by juvenile coho salmon. These tributaries provide cooler water temperatures important as refuge from the elevated water temperatures in the mainstem Klamath River (Table 34-3). The presence of juveniles in these tributaries, especially when water temperatures in the mainstem Klamath River are high, supports the conclusion that they are used as refugia areas. Based on the estimated 250 cfs of constant cold groundwater accretion to the mainstem Klamath River in the JC Boyle reach, the highest quality refugial habitat likely lies upstream of Iron Gate Dam.

Table 34-3. Potential refugia areas. Areas are within the geographic boundaries of the Upper Klamath population unit.

Subbasin	**Stream Name**	**Subbasin**	**Stream Name**
Hornbrook	Bogus Creek	Hornbrook	Cottonwood Creek
Hornbrook	Willow Creek	Beaver Creek	Barkhouse Creek
Beaver Creek	Humbug Creek	Seiad Valley	O'Neil Creek
Beaver Creek	Beaver Creek	Seiad Valley	Seiad Creek
Seiad Valley	Horse Creek	Seiad Valley	Grider Creek

Other important vital habitat exists in Seiad Creek where habitat conditions are good enough to support consistent coho salmon use throughout the year and from year to year. Its distance from Iron Gate Hatchery also means that it has less hatchery influence than other, more proximate, tributaries. Restoration to improve winter rearing habitat in this watershed will add to its importance in supporting natural fish production in this population.

Barriers

Instream barriers restrict the spatial structure and prohibit access to upstream habitat therefore creating a very high stress to the population. The most significant barriers within the watershed are Iron Gate Dam and Copco 1 and 2 Dams, which have blocked upstream access to approximately 58 miles of coho salmon habitat for several decades. Diversion dams, alluvial barriers, low flow conditions, and poorly functioning road/stream crossings also block passage by juvenile and/or adult fish in several mainstem tributaries within the watershed (e.g., Seiad and Cottonwood Creeks). Records indicate that there are approximately 57 unscreened diversions and 43 total or partial road crossing barriers that could exist in the Upper Klamath population area (CalFish 2009). The most notable road-stream crossing barriers exist on Highway 96 at Tom Martin Creek and on Seiad Creek Road at Canyon Creek. Many push up dams and diversions seasonally block access to high IP habitat and vital cold-water rearing habitat. A push-up dam on Horse Creek acts as a barrier when combined with low flow conditions in the stream, preventing both upstream and downstream access to high quality rearing habitat and refugia. Low flow conditions in Empire, Willow, Cottonwood, Lumgrey, Barkhouse, Seiad, Horse, and Humbug Creeks create flow barriers as well (MKRP 2010). Also, the loss of flushing flows in the mainstem Klamath has caused alluvial barriers to seasonally form at the mouths of mainstem tributaries (e.g., Walker, O'Neil, and Grider Creeks) where they act as barriers to fish migration, further decreasing spatial structure and habitat availability (MKRP 2010).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. Iron Gate Hatchery (IGH), which is located in the Upper Klamath River population area, releases approximately 6 million Chinook salmon, 75,000 coho salmon, and 200,000 steelhead annually. The hatchery releases Chinook salmon under a volitional release program from the middle of May to the end of June, a time when discharge from Iron Gate Dam is usually in decline and water temperatures are increasing, further increasing stressful conditions for wild, juvenile coho salmon. Adult coho salmon are counted at Iron Gate Hatchery, where the proportion of hatchery fish is likely to be the highest in the entire basin due to the homing of hatchery fish to the place they were born. From 1996 to 2010, on average 77 percent of these adults were born in a hatchery (Chesney and Knechtle 2011a). Adult coho salmon were observed at a video weir on Bogus Creek, a tributary of the Klamath which breaks from the Klamath at Iron Gate Hatchery. From 2004 to 2010, on average 34 percent of observed adults at Bogus Creek were of hatchery origin (Knechtle and Chesney 2010). Adverse hatchery-related effects pose a very high stress to all life stages because hatchery origin adults make up greater than 30 percent of the total number of adults (Appendix B).

Impaired Water Quality

Impaired water quality within the Upper Klamath River watershed creates a high stress for the population and is especially harmful for juvenile coho salmon. Water quality within the Upper Klamath subbasin varies spatially and temporally. Water temperature and quality within both mainstem and tributary reaches are often stressful to juvenile and adult coho salmon during late spring, summer, and early fall months. Generally, water quality conditions are suitable for coho salmon from late fall through early spring. However, by late spring (April-May) water quality can become impaired, especially in the mainstem Klamath River, where the combination of elevated water temperatures and high nutrient loads can create stressful conditions for coho salmon and increase risks to survival of juveniles. Water quality is generally poor within the Upper Klamath watershed during much of the summer and early fall when mainstem water temperatures can exceed lethal thresholds above 25°C. MKWC documented mainstem and tributary temperatures in the summer of 2006 and showed that while mainstem temperatures are often higher than the range of coho salmon suitability (>19 ºC), tributary temperatures are suitable (<19 ºC) in these areas for coho salmon in the summer (MKWC 2006). Upstream impoundments and water withdrawals contribute to seasonal and daily changes in temperature regimes in the mainstem Upper Klamath. Seasonally, these impoundments create a thermal lag resulting in a delay in spring warming and fall cooling of mainstem temperatures. Daily, there is little diurnal variation in temperature and little if any of the natural nighttime cooling that would also help fish to recover. Summer water quality can vary within Upper Klamath River tributaries as well, and is heavily influenced by riparian corridor condition, instream sediment levels, and the extent to which diversions dewater the stream channel. Tributaries tend to have cooler stream temperatures in their upper reaches and warmer temperatures in their degraded lower reaches. Most reaches with IP habitat have fair to poor water temperatures (>16.1 °C MWAT) (CAP data). Elevated seasonal stream temperatures impact juvenile coho salmon growth and survival during the summer, and, to a lesser degree, fry and smolt growth and survival in tributaries during late spring.

During the summer dissolved oxygen (DO) concentrations and pH can also become degraded downstream of Iron Gate Dam due to temperature trends and the decreased quality and quantity of water emanating from reservoirs upstream. The mainstem Klamath generally has fair to poor DO conditions (<6.75 mg/l) (CAP data). Levels of pH in the mainstem are also rated as fair to poor (>8.5 annual maximum based on CAP data). Dissolved oxygen can reach as low as 5.5 mg/L in the mainstem downstream of the dam (North Coast Regional Water Quality Control Board 2010). Related to DO and temperature trends, pH tends to rise throughout the summer, peaking in late August and fluctuating widely between day and night (NMFS 2007b). Elevated levels of nutrients and algae also contribute to poor water quality conditions since nutrient cycles and algae levels are altered by reservoir dynamics and can influence water quality in downstream reaches below Iron Gate. In tributaries, measures of aquatic invertebrates indicate there could be pollution in some reaches of Spencer Creek, Beaver Creek, and Walker Creek. Impaired water quality in the mainstem during the summer likely limits use of these habitats by juveniles and restricts rearing to tributary and confluence habitat where water quality is better. Poor water quality also contributes to increased stress levels, reduced growth, and increased susceptibility to disease.

Altered Hydrologic Function

Coho salmon in the Upper Klamath are negatively impacted by the altered hydrologic function within the Upper Klamath River and its tributaries. Spawning and rearing habitat and individuals in the mainstem are primarily impacted by the irrigation and hydroelectric projects both upstream of Iron Gate Dam and within the Scott and Shasta watersheds. Both the timing and volume of flows is manipulated by diversion and dam activities leading to altered life-history adaptations and degraded rearing and migratory conditions critical to juvenile coho salmon survival. The altered hydrologic regime and poor water quality conditions likely increase disease susceptibility within the upper Klamath River, elevating disease infection rates and ultimately the loss of juvenile coho salmon. The altered hydrologic function is primarily the result of extensive water withdrawals and the impoundment and control of flows in the mainstem as a result of the Klamath Irrigation Project and PacifiCorp Hydroelectric Project (NMFS 2007c, NMFS 2010). These activities have severely altered the natural timing and volume of flows in the mainstem Klamath River. This change in hydrologic function has shifted the timing and duration of the spring peak-flow event, causing spring flows to peak approximately a month earlier and subside to summer baseflow approximately two months earlier during most years. As a result, important life history strategies/traits (e.g., smolt outmigration timing, spring juvenile/fry redistribution) have now been either modified or lost entirely due to the hydrologic shift. The earlier onset of summer baseflow conditions also prolongs poor water conditions and causes them to overlap with the timing of peak smolt outmigration through the mainstem reach. Changes to the flow regime have also been linked to increased incidences of disease (Bartholomew 2008). In addition to altered hydrologic regimes in the mainstem river, several tributary streams also experience significant alterations to their hydrology and summer base flow are often too low to support rearing and migration. Low flow conditions in Empire, Willow, Cottonwood, Lumgrey, Barkhouse, Seiad, Horse, and Humbug Creeks have been shown to create flow barriers and impaired summer rearing conditions (MKRP 2010). Generally the flow regime has been rated as fair (partially functional) in Cottonwood Creek, Seiad Creek, and Walker Creek and poor (non-functional) in Beaver Creek, Humbug Creek, Horse Creek, and

Bogus Creek. Grider Creek and Shovel Creek are thought to have functional flow regimes (CAP data based on USFS judgment).

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure presents a high stress for the population and primarily affects fry, juveniles, and smolts. Tributary and mainstem habitat complexity is limited by a lack of coarse sediment and wood, modified flows, remnant dredge piles, and impaired riparian function. Additionally, many tributary streams suffer from high sediment levels, poor riparian habitat, and overall poor instream habitat complexity and volume. In many tributaries fine sediment has also filled pools, off-channel ponds, and wetlands. Past mining activities and levy construction have also led to limited floodplain complexity and connectivity (e.g., Seiad and Horse Creeks). The primary issue in the mainstem is the lack of flushing flows which would naturally lead to the creation and maintenance of side and off-channel habitat. Although large wood and complex floodplain habitat were not dominant features of the historic mainstem Klamath River channel, this area continues to lack adequate rearing and spawning habitat. Floodplain connectivity (based on USFS judgment) is generally fair (partially functional) in the Beaver Creek, Seiad Creek, Walker Creek, Bogus Creek, and Shovel Creek watersheds and generally poor (non-functional) in the Humbug Creek, Cottonwood Creek, and Horse Creek watersheds. The one exception was Grider Creek which was rated as having very good (fully functional) floodplain connectivity (CAP data). Wood frequencies have not been quantified in many tributaries but in Camp Creek and at Jenny Creek they were found to be poor (<1 key piece/100m) (ODFW CAP data). Juveniles and smolts are most limited by poor habitat complexity within tributary reaches and refugia due to the need for off-channel winter refugia and complex rearing and refugial habitat. Fry are affected by the lack of refugia from high flows and predation and a lack of complex rearing habitat in tributaries.

Increased Disease/Predation/Competition

The combined effect of increased disease, predation, and competition is a high to very high stress for juveniles and smolts and a medium stress for adults. Of these three stressors, disease is the most significant; however competition and predation by hatchery fish are also issues occurring in all Klamath River populations. Pathogens that cause diseases in juveniles include *Ceratomyxa shasta*, *Flavobacterium columnare* (columnaris), Aeromonid bacteria, *Nanophyetus salmonicola*, and the kidney myxosporean *Parvicapsula minibicornis* (FERC 2007). Of the aforementioned biological vectors, infection by the myxozoan *C. shasta* (and co-infection by a second myxozoan, *Parvicapsula minibicornis*) has the most significant effect on survival of coho salmon in the subbasin (Nichols et al. 2003, Bartholomew 2008). Disease effects vary annually based on water temperature, water year, and other factors (Bartholomew 2008). Spatially and temporally, mortality rates from exposure to disease vary by location and time of year but are consistently higher between Iron Gate Dam and the Scott River and are highest April through July (Bartholomew 2008). Given that most juveniles rear in tributaries (Lestelle 2007) the greatest impacts are to smolts during emigration. Average mortality is estimated to be approximately 50 percent at 17 °C and approximately 12 percent at 15 °C in the Upper Klamath and studies show mortality could be much higher at some sites (Table 34-4). The long migration and exposure of this population to disease means that it is one of the most susceptible to disease and most likely to experiences abnormally high disease-induced mortality (Bartholomew 2008).

Table 34-4. Percent loss of coho salmon exposed at various Upper Klamath River sentinel sites. The salmon were exposed for 72 hours in May or June 2008 and subsequently held for 65 or more days at the Salmon Disease Laboratory in a 16 to18 °C water supply (Bartholomew 2008).

	Percent Loss	
Exposure Sites	**May**	**June**
Klamathon	21.4	20.0
Beaver Creek	82.9	88.6
Seiad Valley	46.0	87.5

Researchers believe modifications to the river's historical hydrologic regime have likely created instream conditions that favor disease proliferation and fish infection (Stocking and Bartholomew 2007). Less frequent fall pulse-flows are likely affecting disease transmission from adult salmon carcasses to the intermediate polychaete host, increasing the potential for juveniles and smolts to become infected. In an unaltered hydrologic regime, fall and winter freshets help distribute salmon carcasses downstream into lower sections of the watershed, effectively dispersing nutrients, as well as infective spores that enter the aquatic environment as the carcass decomposes. The current flow regime does not effectively redistribute carcasses within the reach between Iron Gate Dam and the Shasta River, resulting in high densities of decomposing fish downstream of popular spawning areas.

In addition to disease impacts, there are competition and predation pressures that act to limit coho salmon productivity and survival. Competition with hatchery fish for habitat and refugia may affect the growth and survival of juvenile coho salmon. Chinook, steelhead, and coho salmon fingerling released from Iron Gate Hatchery may not only compete with yearling and sub-yearling wild coho salmon but may also predate on sub-yearling coho salmon. Some steelhead may also remain in the Upper Klamath and exert additional predation pressure on juvenile coho salmon. These types of impacts have been identified in other Klamath tributaries such as the Trinity River (Naman 2008) but their prevalence and impacts are unknown for this population. Another important but unknown impact may be predation by non-native brown trout on juvenile coho salmon. Brown trout are rarely found in the Scott, Shasta, and Bogus Creek but they have been documented to co-occur with juvenile coho salmon and may have seasonal or local effects on juvenile populations (Hampton 2010).

Altered Sediment Supply

Altered sediment supply is considered a high threat to the population due to the excess of fine sediment delivery and the lack of adequate spawning gravel. Past and present land use practices continue to deliver fine sediment into the mainstem and many important tributary streams between Iron Gate Dam and Seiad Creek. High sediment levels degrade tributary rearing habitat by filling in pools and simplifying instream habitat complexity. Many Upper Klamath tributaries contain excessive sediment which, besides degrading habitat quality, can also lower egg survival and spawning success. Furthermore, the supply of spawning gravel has decreased due to blockage by the mainstem dams and tributary road crossings. The volume and quality of spawning gravel available to adult coho salmon is especially compromised below Iron Gate Dam where the majority of mainstem spawning occurs.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions are considered a high stress for this population because of the reduced quality and quantity of riparian forest along the mainstem and in tributaries of the Upper Klamath. The extent of degraded riparian habitat within the Upper Klamath River population is primarily due to grazing, altered hydrology, past mining, fire, and timber harvest. These disturbances create localized, short term reductions in riparian vegetation and/or long-term widespread loss of riparian forest. The extent of impacts to coho salmon depends on the degree and extent of coho salmon use of the area. Most stream reaches within the Upper Klamath are either lacking riparian forest altogether or lack complex, late seral forest. This lack of functional riparian forest has resulted in the degradation of water quality, unstable banks, and simplified channel and floodplain structure. Grazing and flow impairments along the mainstem and in tributaries such as Horse, Humbug, Willow, and Cottonwood Creeks have severely degraded riparian function. Stream corridor vegetation was rated at fair (partially functional) to poor (non-functional) in all surveyed reaches of the Upper Klamath (based on USFS judgment, CAP data). Past mining activities and flood control in areas such as Seiad Valley and along the mainstem Klamath have also altered floodplain sediment, elevation, and connectivity and led to depleted riparian forests. The seasonal diversion of water in many Upper Klamath tributaries limits the availability of areas where riparian vegetation can persist.

Impaired Estuary/Mainstem Function

All salmon that originate from the Upper Klamath River migrate to and from the ocean through the mainstem Klamath River and the Klamath River estuary. The Klamath River mainstem and estuary play an important role by providing holding habitat and foraging and refuge opportunities for juvenile coho salmon and smolts from the Upper Klamath River subbasin (Soto et al. 2008, Hillemeier et al. 2009). Although the estuary is short and small compared to the large size of the watershed, it does provide numerous habitat types and rearing habitat for juvenile coho salmon. The degraded conditions that exist throughout the Klamath River basin today may mean that the estuary plays an even larger role for all Klamath populations by providing the opportunity for juvenile and smolt growth and available refugia prior to entering the ocean.

The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain. Levees along the Lower Klamath and development on the floodplain have led to the loss and degradation of habitat in the estuary. Despite the degraded state of habitat in the estuary, research in two tributaries near the mouth of the Klamath River, have shown that juveniles from natal streams in the Upper subbasin disperse to and fully utilize small, coastal tributaries and estuarine habitats before moving out to the ocean, and that these fish are significantly larger and more robust then individuals who move through the system without stopping (Soto et al. 2008, Hillemeier et al. 2009). Mainstem conditions downstream in the Middle and Lower Klamath contribute additional stress to the population because of the propagation of issues related to water quality, disease, and degradation of habitat. The Middle and Lower Klamath River watersheds provide non-natal rearing habitat and refugia for juveniles that disperse into the lower, coastal areas of the watershed when conditions in the Upper subbasin become uninhabitable (Soto et al. 2008).

Adverse Fishery-Related Effects

NMFS has determined that federally managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

34.6 Threats

Table 34-5. Severity of threats affecting each life stage of coho salmon in the Upper Klamath River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

Threats		Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Dams/Diversion	Very High	Very High	Very High	Very High	Very High	Very High
2	Hatcheries	Very High	Very High	Very High	Very High	Very High	Very High
3	Roads	Very High	Very High	Very High	Very High	Very High	Very High
4	Climate Change	Medium	Medium	Very High	Very High	High	High
5	Agricultural Practices	High	High	High	High	High	High
6	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
7	Channelization/Diking	Low	Medium	Medium	Medium	Medium	Medium
8	Road-Stream Crossing Barriers	-	Medium	Medium	Medium	Medium	Medium
9	Fishing and Collecting	-	-	-	-	Medium	Medium
10	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low
11	Timber Harvest	Low	Low	Low	Low	Low	Low
12	Urban/Residential/Industrial	Low	Low	Low	Low	Low	Low
13	Invasive Non-Native/Alien Species	Low	Low	Low	Low	Low	Low

Dams/ Diversions

The Klamath River suffers from numerous threats to coho salmon. Foremost is the over-allocation (as defined by the 1992 Oregon Water Resources Commission) of water resources throughout the mainstem Klamath River and major tributaries. This over-allocation is generally acknowledged as the primary mechanism responsible for the poor water quality, elevated disease incidence, and impaired passage conditions common to much of the Klamath River basin.

Irrigation and hydroelectric dams are a major threat to coho salmon within the Upper Klamath River watershed and cause a very high threat to all life stages. PacifiCorp's series of five mainstem hydroelectric dams, beginning with Iron Gate Dam at RM 190, precludes upstream passage of coho salmon into approximately 58 miles of historic habitat. The threat from these mainstem dams will continue until fish passage or dam removal occurs. This is expected to occur by the end of 2020 either through dam removal if there is an affirmative Secretarial Determination under the terms of the Klamath Hydroelectric Settlement Agreement (KHSA), or through mandatory fishway prescriptions in the Federal Energy Regulatory Commission relicensing process if the Secretarial Determination is negative or the KHSA is terminated for any other reason. Smaller private manmade diversion dams also block passage on several important streams within the Upper Klamath, including Cottonwood Creek and Horse Creek. In addition to seasonal and permanent dams in the Upper Klamath, diversions in tributaries reduce flow and act as fish barriers when unscreened. There have been some efforts to screen diversions in Horse Creek and some other tributaries, however, the California Fish Passage Assessment Database (CalFish 2009) indicates that there could be over 60 additional diversions in the Upper Klamath subbasin. Diversion of water in Empire, Willow, Cottonwood, Lumgrey, Barkhouse, Seiad, Horse, and Humbug Creeks is known to impair and/or eliminate coho salmon habitat and water quality during critical low flow periods. Diversion of water in the Scott and Shasta rivers also impairs hydrologic function and water quality in the mainstem Klamath, further exacerbating low flow conditions, high disease transmission rates, and poor water quality conditions. Flow barriers are common in the Upper Klamath and many of these low flow conditions are a direct result of legal and illegal summer diversions.

Hatcheries

Hatcheries pose a very high threat to all life stages in the Upper Klamath River sub-basin. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Roads

High road densities within the Upper Klamath subbasin pose a very high threat to the coho salmon and its habitat. The construction and maintenance of roads across the landscape have detrimental effects on the essential features of coho salmon habitat primarily through hydrological effects (e.g., disconnecting watercourses) and through erosion and sedimentation. Road-related erosion is a problem in many of the larger tributaries below the Shasta River where timber harvest was historically most pronounced. Watersheds with the highest road densities (>3 mi./sq. mi.) include Beaver, Horse, McKinney, Doggett, O'Neil, Empire-Lumgrey, Cottonwood, lower reaches of Grider Creek, and upper reaches of Humbug Creek and Seiad Creek. Road densities are substantially lower in tributaries upstream of Iron Gate Dam, due largely to the lack of timberland within the hydropower reach. Roads will continue to act as sediment sources to tributaries although the threat from roads is likely to decrease as roads on public land are decommissioned and upgraded.

Climate Change

Climate change poses a high threat to this population. As the result of current fuel loads and the impacts of climate change, fire could have a major impact on habitat quality in the future. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 3° C in the summer and by 1.3° C in the winter. Recent studies have already shown that water temperatures in the mainstem Klamath have already been increasing at a rate of 0.4 to 0.6 °C/decade since the early 1960s. The season of high temperatures that are potentially stressful to salmon has lengthened by about 1 month and the average length of mainstem river with cool summer temperatures (<15 °C) has declined by about 5 mi/decade (Bartholow 2005). Annual precipitation in this area is already very low and is predicted to trend downward over the next century (Thieler and Hammer-Klose 2000). Snowpack in upper elevations of the basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009). The vulnerability of the Klamath estuary to sea level rise is low to moderate and therefore does not pose a significant threat to estuarine rearing habitat downstream. Juvenile and smolt rearing and migratory habitat in the Klamath River and its tributaries is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Overall, the range and degree of variability in temperature and precipitation are likely to increase in all populations. Adults will also be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Agricultural Practices

Agricultural practices pose a high threat to Upper Klamath River coho salmon through effects on water quality, flow, bank stability, and riparian function. Runoff from agricultural lands has the potential to negatively impact water quality in the Klamath Basin by increasing nutrient loads, increasing biological oxygen demand, and increasing thermal loading (USGS 1999). Agricultural diversions from Upper Klamath Lake and from the larger tributaries flowing into the Upper Klamath River watershed (e.g., Shasta and Scott rivers) have severely altered the timing, duration and volume of the historic Upper Klamath River hydrologic regime. Summer low-flow conditions now occur at an earlier date and persist for a longer period than historically occurred, subjecting rearing juvenile coho salmon to poor water quality for up to 4 months of the year. Smaller-scale agricultural diversions in tributaries such as Beaver, Willow, Grider, Bogus, Horse, Seiad, Walker, Elliot, Little Girder, Little Horse, and Tom Martin Creeks can lead to the loss of summer rearing habitat and refugia and to stranding in some instances. Another important impact of agricultural practices in the Upper Klamath is the negative effects of grazing on riparian vegetation and instream habitat. Grazing is common in many tributaries but the highest grazing intensity occurs on private land in Cottonwood, Bogus, Willow, Horse, Beaver, and along the mainstem Klamath corridor. Agriculture in general is highest within the lower reaches of the Willow Creek, Cottonwood, and Bogus Creek watersheds where 5 to 10 percent of the subwatershed area is used for agriculture (CAP data).Without the exclusion of cattle from riparian areas and a lower grazing intensity these agricultural practices will continue to lead to poor water quality, bank instability, loss of riparian vegetation, and the simplification of stream habitat. Agricultural operations, if unaltered, will continue to degrade instream habitat in many tributary reaches through impacts to water quality, flow, riparian function, and bank stability (62 FR 24588).

High intensity Fire

High intensity fire is a medium threat to coho salmon in the Upper Klamath population unit and hazardous fuel loads have been identified in Seiad, Barkhouse, and Williams Creek watersheds (Soto et al. 2008). Historically fire played a natural function within the Klamath River watershed, and small, low-intensity forest fires were common. However, more recently the fire regime within the basin has been altered as drought conditions and active fire suppression has increased the amount of understory brush available to burn. The result has been that large-scale, high-intensity forest-fires are more common in the Upper Klamath. High-intensity fire can lead to increased erosion rates, loss of riparian forest, and decreased stability of streambanks and upslope areas in many areas of the basin. Erosion rates can be especially severe on steep hillslopes exposed to high-intensity burn conditions.

Channelization/Diking

Although channelization and diking is not widespread throughout the watershed, some stream reaches in the Upper Klamath have been levied for flood control and agriculture. Roads and dredge tailings from past mining activities also act to channelize and dike some stream reaches in the Upper Klamath. The most affected streams include Seiad and Horse Creek although localized channelization and diking likely occurs in almost every tributary with extensive streamside private land (e.g., Cottonwood, Bogus, and Willow creeks). Dikes in affected reaches lead to floodplain disconnection and reduced habitat capacity. Overall, channelization and diking is a moderate threat to the population since the problem is not widespread in the area and existing channelized and diked reaches are being restored.

Road-Stream Crossing Barriers

Road-stream crossings continue to block fish passage within the Upper Klamath River watershed, although recent restoration efforts have addressed many of the problem culverts on National Forest land. A number of culverts located on private, county, and state roads continue to preclude upstream fish passage and constitute a medium threat to coho salmon. Road crossings on Highway 96 (Tom Martin) and Seiad Creek Road (Canyon Creek) have the greatest known impacts due to the high quality of habitat that exists in these areas.

Table 34-6. List of potential barriers.

IP Priority	Stream Name	Subbasin	County
High	Canyon Creek	Seiad Valley	Siskiyou
High	Tom Martin	Beaver Creek	Siskiyou
Medium	Empire Creek	Beaver Creek	Siskiyou
Medium	Soda Creek	Beaver Creek	Siskiyou
Medium	Clear Creek	Beaver Creek	Siskiyou
Medium	Collins Creek	Beaver Creek	Siskiyou
Medium	Dona Creek	Beaver Creek	Siskiyou
High	McKinney Creek (LB+RB)	Beaver Creek	Siskiyou
Medium	Vesa Creek(LB+RB)	Beaver Creek	Siskiyou
High	Middle Fork Humbug Creek	Beaver Creek	Siskiyou
High	South Fork Humbug Creek	Beaver Creek	Siskiyou
Medium	Little Bogus Creek	Iron Gate	Siskiyou

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath/Trinity basin. The effects of the fisheries managed by the State of California and the Yurok and Hoopa Tribes, on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Upper Klamath River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Mining/Gravel Extraction

Past and present mining activities pose a moderate to low threat to the population. Hydraulic mining (placer and suction dredging) can degrade habitat through the disturbance and alteration of streambed substrate. Oftentimes, material is excavated into tailing piles, leaving unnatural channel formations where flows are created. The persistence of such features is variable and the impacts are mostly seasonal and site-specific. The number of claims that could be utilized in the future suggests this is a threat that still needs to be addressed. Adverse effects could include increasing turbidity, modifying spawning channels, decreasing emergent macroinvertebrate prey, and disturbing and displacing juveniles and smolts from refugia. The level of this threat is primarily dependent on the types of methods used and the way in which these methods are applied. Currently, mining is regulated by CDFG to ensure safe environmental practices and minimal impacts on salmon and salmon habitat. Regulations include special closed areas, closed seasons, and restrictions on methods and operations (Hillman et al. v. CDFG *et al*. 2009). Mining activities in the region have decreased significantly from historic levels, however recent mining operations had been increasing until the cessation of suction dredging permits by the state of California in 2009. At present, a court order prohibits DFG from issuing suction dredge permits. In 2009, Governor Schwarzenegger signed into law SB 670 (Wiggins), instituting a moratorium on suction dredging (to include existing permit holders), with the exception of dredging for the purpose of maintaining energy or water supply management infrastructure, flood control or navigation. This prohibition will remain in effect until DFG completes a court-ordered environmental review of its permitting program, and institutes any changes that may occur to the former regulations. Careful monitoring of mining activity must continue, to ensure that future regulations are followed such that mining threats remain low to moderate.

Timber Harvest

Although timber harvest and concomitant road building has the potential to adversely affect coho salmon or salmon habitat, most former timber lands in the Upper Klamath River subbasin are now under sustainable timber harvest management. Potential timber resources are also limited in the Upper Klamath and future timber sales are likely to be small-scale. Timber harvest has generally been greatest (>25 percent total area) in the upper reaches of Beaver Creek, Cottonwood Creek, and in Doggett Creek (CAP data). The USFS, BLM, and private timber companies manage most timber land in the watershed and detrimental impacts on fish habitat from timber harvest are expected to remain low to moderate. Federal agencies operate under the Aquatic Conservation Strategy of the Northwest Forest Plan and a portion of private timber lands will be managed under the proposed Fruitgrowers Habitat Conservation Plan (HCP). Overall timber harvest is considered to be a low threat to the population.

Urban/Residential/Industrial Development

The number of people currently living in the Upper Klamath River watershed is small (likely less than a few thousand residents), and is unlikely to change significantly in the near future. Large-scale residential and industrial development is not widespread within the Upper Klamath River watershed and therefore poses only a low threat to coho salmon. The largest cities and towns have populations well under 1,000 residents, and populations have remained unchanged or decreased over the past several decades. Impervious surface area is low throughout the Upper Klamath (0 to 5 percent based on CAP data). Small residential communities on important tributaries, such as Horse, Seiad and Beaver Creeks will likely continue to impact water quality, instream habitat conditions, streamflow, and riparian vegetation. However these impacts are not believed to be increasing. Invasive Non-Native/Alien Species

Several populations of non-native species exist below Iron Gate Dam and could pose a threat to the Upper Klamath population. The extent of this threat is currently unknown but presumed to be low. Brown trout are rarely found in the Scott, Shasta, and Bogus Creek but they have been documented to co-occur with juvenile coho salmon and may have seasonal or local effects on juvenile populations (Hampton 2010). Populations of warm-water species are also established in the mainstem below Iron Gate Reservoir and may exert some competitive and predatory pressure on the population.

34.7 Recovery Strategy

The potential for coho salmon recovery in the Upper Klamath is high, however the population is currently unviable and habitat is degraded and unavailable in many areas. Summer and winter rearing habitat is in poor condition in many areas and is limited in its extent and connectivity. Mainstem conditions during the summer are prohibitive for migration and rearing and hatchery influences on the population are very high. Recovery activities in the watershed should focus on the key limiting stressors and life stages and restoration should include both small-scale, short-term improvement of habitat, as well as long-term restoration of the function of the mainstem river.

Ongoing efforts to develop a PacifiCorp Hydroelectric Power Company settlement package will affect the strategy for recovering the Upper Klamath River population unit. Included in the settlement discussion are proposals to remove four mainstem Klamath River dams (Iron Gate, Copco 1 and 2, and J.C. Boyle). Over the long-term (10 to 20 years), removing the dams would allow coho salmon passage into 58 miles of historic mainstem habitat located above the dams (Hamilton et al. 2005) and help to restore hydrological function through increased flow variability (NMFS 2007c). As a result of restored hydrological function, NMFS anticipates that disease rates in the Upper Klamath River reach will be reduced. Water quality benefits are also expected, which would reduce stressors to juvenile coho salmon that may reside in the mainstem Klamath River during late spring and summer (NMFS 2007b). Overall, the removal of the four mainstem Klamath River dams up to Keno Dam is the most significant action that can be taken to restore the viability of the Upper Klamath population unit. As such, dam removal is the highest priority for recovery of this population. If and when dam removal is complete, new recovery actions for the hydropower reach may need to be developed. PacifiCorp has applied for an incidental take permit under ESA Section 10(a)(1)(b), and plans to initiate several conservation measures, including providing funding for fish disease research to benefit coho salmon, and for the installation of large woody debris below IGD, as well as coordinating efforts with BOR and NMFS to allow for flow variability to the Klamath River.

The KBRA has been signed, and is awaiting a decision by Secretary Salazar, to determine if the Agreement will be implemented. The KBRA was reached through agreements between the Karuk, Klamath, and Yurok Tribes, Commercial Fishermen, downstream irrigators, the Klamath Irrigation Project, the Klamath Hydroelectric Project, BLM, USFS, BOR, USFWS, and NMFS. The KBRA will increase water flows to the Klamath River providing more and higher quality habitat to coho salmon. It will allow for the reintroduction of salmon upstream of the dams. It will provide for large scale habitat restoration in the upper and lower Klamath basin, and it will provide certainty of water deliveries to irrigators.

Over the time period prior to dam remediation, the restoration and maintenance of tributary water quality, hydrologic function, and floodplain and channel structure for spawning and rearing will help increase productivity, abundance, and distribution of the population. Recovery actions should focus on protecting and restoring those tributaries that have been identified as being important to natal and non-natal coho salmon and contain high IP habitat. In addition, hatchery reform at Trinity and Iron Gate hatchery is important to reducing negative interactions and allowing for a more natural population.

Table 34-7 on the following page lists the recovery actions for the Upper Klamath River population.

Table 34-7. Recovery action implementation schedule for the Upper Klamath River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.2.2.1	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Seiad and Horse creeks	2
SONCC-UKR.2.2.1.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-UKR.2.2.1.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-UKR.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels	Seiad, Horse, Little Horse, and Cottonwood creeks	2
SONCC-UKR.2.2.2.1	*Assess instream flow conditions and side channel connectivity and develop a plan to obtain adequate flows for channel connectivity*					
SONCC-UKR.2.2.2.2	*Mechanically alter side channels, off channel ponds and wetlands to achieve connectivity*					
SONCC-UKR.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	High IP subwatersheds (especially, Seiad, Horse, Little Horse, Cottonwood, and Tom Martin creeks)	2
SONCC-UKR.2.2.3.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-UKR.2.2.3.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-UKR.2.1.4	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Mainstem Klamath corridor, Seiad, Bogus, Cottonwood, Willow, Barkhouse, Humbug, O'Neil, Beaver, Horse, Tom Martin, and Grider creeks	2
SONCC-UKR.2.1.4.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-UKR.2.1.4.2	*Place instream structures, guided by assessment results*					
SONCC-UKR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Restore peak flows	Mainstem Klamath River	2
SONCC-UKR.3.1.5.1	*Assess current hydrograph and develop a flow variability/environmental water account plan to re-establish a natural hydrograph that reduces alluvial barriers*					
SONCC-UKR.3.1.5.2	*Maintain minimum flow requirements below IGD and implement plan to restore a more natural hydrograph prior to dam removal*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Seiad Valley, Beaver, Hornbrook, Cottonwood, Bogus, Grider, Little Grider, Willow, Horse, Little Horse, Walker, Elliott, and Tom Martin creeks	2
SONCC-UKR.3.1.6.1	*Develop program to decrease diversion during critical periods of seasonal low flows*					
SONCC-UKR.3.1.6.2	*Encourage users to reduce stream diversions during the summer by providing educational materials describing how to increase water use efficiency*					
SONCC-UKR.3.1.6.3	*Review water allocations and mandate compliance of water rights through an empowered "water master"*					
SONCC-UKR.3.1.7	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-UKR.3.1.7.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-UKR.3.1.8	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-UKR.3.1.8.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-UKR.3.1.9	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-UKR.3.1.9.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-UKR.3.2.10	Hydrology	Yes	Increase water storage	Improve regulatory mechanisms	Population wide	3
SONCC-UKR.3.2.10.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-UKR.3.2.11	Hydrology	Yes	Increase water storage	Increase beaver abundance	Seiad, Horse, Cottonwood, Little Horse, Horse, and Beaver creeks	3
SONCC-UKR.3.2.11.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-UKR.3.2.11.2	*Implement beaver program (may include reintroduction)*					
SONCC-UKR.3.2.12	Hydrology	Yes	Increase water storage	Improve regulatory mechanisms	Population wide	BR
SONCC-UKR.3.2.12.1	*Limit hunting or removal of beaver*					
SONCC-UKR.3.1.48	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Seiad, Horse, Little Horse, and Cottonwood creeks	BR

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	***Step Description***					
SONCC-UKR.3.1.48.1	*Install flow gage to ensure appropriate flows for coho salmon*					
SONCC-UKR.3.1.48.2	*Maintain flow gage annually*					
SONCC-UKR.5.1.19	Passage	Yes	Improve access	Remove barriers	Iron Gate, Copco 1 and 2, and JC Boyle dams	2
SONCC-UKR.5.1.19.1	*Implement KHSA/KBRA fish passage strategy or install fish ladders*					
SONCC-UKR.5.1.20	Passage	Yes	Improve access	Reduce sediment barriers	Walker, O'Neil, Humbug, and Grider creeks	2
SONCC-UKR.5.1.20.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-UKR.5.1.20.2	*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*					
SONCC-UKR.5.1.21	Passage	Yes	Improve access	Remove structural barriers	Highway 96 crossing on Tom Martin Creek and Seiad Creek Road culvert on Canyon Creek (tributary to Seiad)	2
SONCC-UKR.5.1.21.1	*Assess road-stream crossing barriers and prioritize for removal*					
SONCC-UKR.5.1.21.2	*Remove road-stream crossing barriers and upgrade culvert*					
SONCC-UKR.5.1.22	Passage	Yes	Improve access	Remove push-up dam type barriers	Horse Creek	BR
SONCC-UKR.5.1.22.1	*Develop a plan to remove the push up dam and increase flows*					
SONCC-UKR.5.1.22.2	*Remove push up dam, guided by the plan*					
SONCC-UKR.5.1.22.3	*Install flow measuring devices to ensure that water rights and flows are maintained*					
SONCC-UKR.5.1.22.4	*Maintain flow measuring devices*					
SONCC-UKR.5.1.23	Passage	Yes	Improve access	Reduce flow barriers	Empire, Willow, Cottonwood, Lumgrey, Barkhouse, Seiad, Horse, and Humbug creeks	BR
SONCC-UKR.5.1.23.1	*Assess low flow tributaries and their sediment sources that contribute to seasonal flow barriers. Develop a plan to alleviate sediment delivery and remove current barriers*					
SONCC-UKR.5.1.23.2	*Alleviate sediment delivery in areas with low flow conditions and seasonal flow barriers as described in the plan*					
SONCC-UKR.5.2.24	Passage	Yes	Decrease mortality	Screen all diversions	Horse, Cottonwood, and Bogus creeks	2

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.5.2.24.1	*Assess diversions and develop a screening program*					
SONCC-UKR.5.2.24.2	*Screen all diversions*					
SONCC-UKR.10.1.16	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Reduce warm water inputs	Bogus, Willow, Horse, Seiad, Beaver, Barkhouse, Tom Martin, Elliott, and Cotttonwood creeks	3
SONCC-UKR.10.1.16.1	*Develop a program that identifies, designs, and constructs projects that will reduce warm tailwater input*					
SONCC-UKR.10.1.16.2	*Implement tailwater reduction program*					
SONCC-UKR.14.1.25	Disease/Predation/ Competition	No	Reduce disease	Disrupt the disease cycle between salmon, myxospore, polychaetes, and actinospore stages.	Population wide	2
SONCC-UKR.14.1.25.1	*Assess all means possible to disrupt disease cycle and develop a plan to do so*					
SONCC-UKR.14.1.25.2	*Disrupt the disease cycle, guided by assessment results*					
SONCC-UKR.14.1.26	Disease/Predation/ Competition	No	Reduce disease	Conduct monitoring and research actions as described in the Klamath River Fish Disease Research Plan	Mainstem Klamath River	3
SONCC-UKR.14.1.26.1	*Develop monitoring plan and research actions as described in the Klamath River Fish Disease Research Plan*					
SONCC-UKR.14.1.26.2	*Implement Klamath River Fish Disease Research Plan*					
SONCC-UKR.1.2.49	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3
SONCC-UKR.1.2.49.1	*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*					
SONCC-UKR.16.1.30	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UKR.16.1.30.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-UKR.16.1.30.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-UKR.16.1.31	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-UKR.16.1.31.1	*Determine actual fishing impacts*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.16.1.31.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-UKR.16.2.32	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UKR.16.2.32.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-UKR.16.2.32.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-UKR.16.2.33	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UKR.16.2.33.1	*Determine actual impacts of scientific collection*					
SONCC-UKR.16.2.33.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-UKR.17.2.18	Hatcheries	No	Reduce adverse hatchery impacts	Identify and reduce impacts of hatchery on SONCC coho salmon	Iron Gate Hatchery	2
SONCC-UKR.17.2.18.2	*Implement Hatchery and Genetic Management Plan and revise when necessary*					
SONCC-UKR.27.1.34	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate survival of juvenile coho salmon	Population wide	2
SONCC-UKR.27.1.34.1	*Develop comprehensive PIT tagging and retrieval project that assesses habitat use and survival*					
SONCC-UKR.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-UKR.27.1.35.1	*Perform annual spawning surveys*					
SONCC-UKR.27.1.36	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Develop survival estimates	Site to be determined	3
SONCC-UKR.27.1.36.1	*Install and annually operate a life cycle monitoring (LCM) station*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.27.1.37	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-UKR.27.1.37.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-UKR.27.1.38	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track surrogate for genetic diversity	Iron Gate Hatchery	3
SONCC-UKR.27.1.38.1	*Describe annual ratio of naturally-produced fish to hatchery-produced fish spawned for hatchery production*					
SONCC-UKR.27.1.39	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-UKR.27.1.39.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-UKR.27.1.40	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Disease'	Population wide	3
SONCC-UKR.27.1.40.1	*Annually estimate the infection and mortality rate of juvenile coho salmon from pathogens, such as Ceratomyxa shasta and Parvicapusla minibicornis*					
SONCC-UKR.27.1.41	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Hatchery Management'	Population wide	3
SONCC-UKR.27.1.41.1	*Annually determine the percent of hatchery origin spawners (PHOS), percent of natural origin spawners (PNOS), and the proportion of natural influence (PNI)*					
SONCC-UKR.27.2.42	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-UKR.27.2.42.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-UKR.27.2.42.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-UKR.27.2.43	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-UKR.27.2.43.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-UKR.27.2.44	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-UKR.27.2.44.1		*Measure the indicators, canopy cover, canopy type, and riparian condition*				
SONCC-UKR.27.2.45	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-UKR.27.2.45.1		*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*				
SONCC-UKR.27.2.46	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-UKR.27.2.46.1		*Measure the indicators, pH, D.O., temperature, and aquatic insects*				
SONCC-UKR.27.2.47	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-UKR.27.2.47.1		*Annually measure the hydrograph and identify instream flow needs*				
SONCC-UKR.27.1.50	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-UKR.27.1.50.1		*Develop supplemental or alternate means to set population types and targets*				
SONCC-UKR.27.1.50.2		*If appropriate, modify population types and targets using revised methodology*				
SONCC-UKR.7.1.13	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Private lands along the mainstem Klamath Corridor, Horse, Cottonwood, Willow, Bogus, and Beaver creeks	3
SONCC-UKR.7.1.13.1		*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*				
SONCC-UKR.7.1.13.2		*Develop grazing management plan to meet objective*				
SONCC-UKR.7.1.13.3		*Plant vegetation to stabilize stream bank*				
SONCC-UKR.7.1.13.4		*Fence livestock out of riparian zones*				
SONCC-UKR.7.1.13.5		*Remove instream livestock watering sources*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UKR.7.1.14	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce fire hazard	Private land in the Upper Klamath Basin	BR
SONCC-UKR.7.1.14.1	*Develop fire hazard reduction educational materials for landowners*					
SONCC-UKR.7.1.14.2	*Develop a plan for fire break stewardship and defensible space*					
SONCC-UKR.7.1.14.3	*Implement fire-safe community action plans in identified areas*					
SONCC-UKR.7.1.15	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reestablish natural fire regime	Seiad, Barkhouse, and Williams creeks	BR
SONCC-UKR.7.1.15.1	*Identify areas prone to high intensity fire and develop a plan to reestablish a natural fire regime that benefits coho habitat*					
SONCC-UKR.7.1.15.2	*Carry out fuel reduction projects such as thinning and prescribed burning, guided by the strategic plan*					
SONCC-UKR.8.2.27	Sediment	No	Increase spawning gravel	Enhance spawning substrate	Mainstem, downstream of Iron Gate dam	2
SONCC-UKR.8.2.27.1	*Develop a spawning substrate management plan that identifies quantity, quality, location, and timing of gravel supplements*					
SONCC-UKR.8.2.27.2	*Supplement gravel, guided by the plan*					
SONCC-UKR.8.1.28	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Beaver, Horse, Walker, McKinney, Cottonwood, Doggett, Kohl, Empire, Lumgrey, and Dutch creeks	2
SONCC-UKR.8.1.28.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-UKR.8.1.28.2	*Decommission roads, guided by assessment*					
SONCC-UKR.8.1.28.3	*Upgrade roads, guided by assessment*					
SONCC-UKR.8.1.28.4	*Maintain roads, guided by assessment*					
SONCC-UKR.8.1.29	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Recently burned Humbug Creek	2
SONCC-UKR.8.1.29.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-UKR.8.1.29.2	*Implement plan to stabilize slopes and revegetate areas*					

35. Salmon River Population

- Interior Klamath Stratum
- Non-Core, Potentially Independent Population
- High Extinction Risk
- 460 spawners needed for ESU Viability
- 751 mi^2
- 115 IP km (71 mi) (2% High)
- Dominant Land Uses are Wilderness, Conservation, and Vegetation Management via Commercial Thinning and Fuels Treatment
- Principal Stresses are Impaired Water Quality, Degraded Riparian Conditions, and Lack of Floodplain and Channel Structure
- Principal Threats are Climate Change and High Intensity Fire

35.1 History of Habitat and Land Use

Karuk, Shasta, and Konomihu Indians first inhabited the Salmon River. As in the past, the Karuk and Shasta still emphasize the importance of Salmon River aquatic resources in their ceremonial and daily use activities (Klamath River Basin Fisheries Task Force (KRBFTF) 2002). Starting in the 1850s, land use changes in the Salmon River watershed, such as large scale hydraulic mining and timber harvest, began to alter river channels, tributaries, and riparian areas. Between 1870 and 1950 it is estimated that over 15 million cubic yards of sediment was discharged into the Salmon River as a result of gold mining activities (Elder et al. 2002).

Major modifications, especially in the upper South Fork of the Salmon River, ensued. Mining activities impacted the landscape, vegetation, soil, water quality, and channel structure in many fish-bearing streams (United States Forest Service (USFS) 1995c). Many of these impacts are still apparent in the present on the many bare slopes and large tailing piles seen throughout the watershed. Remnant mine tailings and riparian disturbance continue to affect coho salmon habitat in the Salmon River and mined-over floodplains and terraces have remained poorly vegetated many decades after large-scale mining has ended. The removal of soil down to bedrock in the Petersburg and Summerville areas has severely hampered vegetation growth (USFS 1994a).

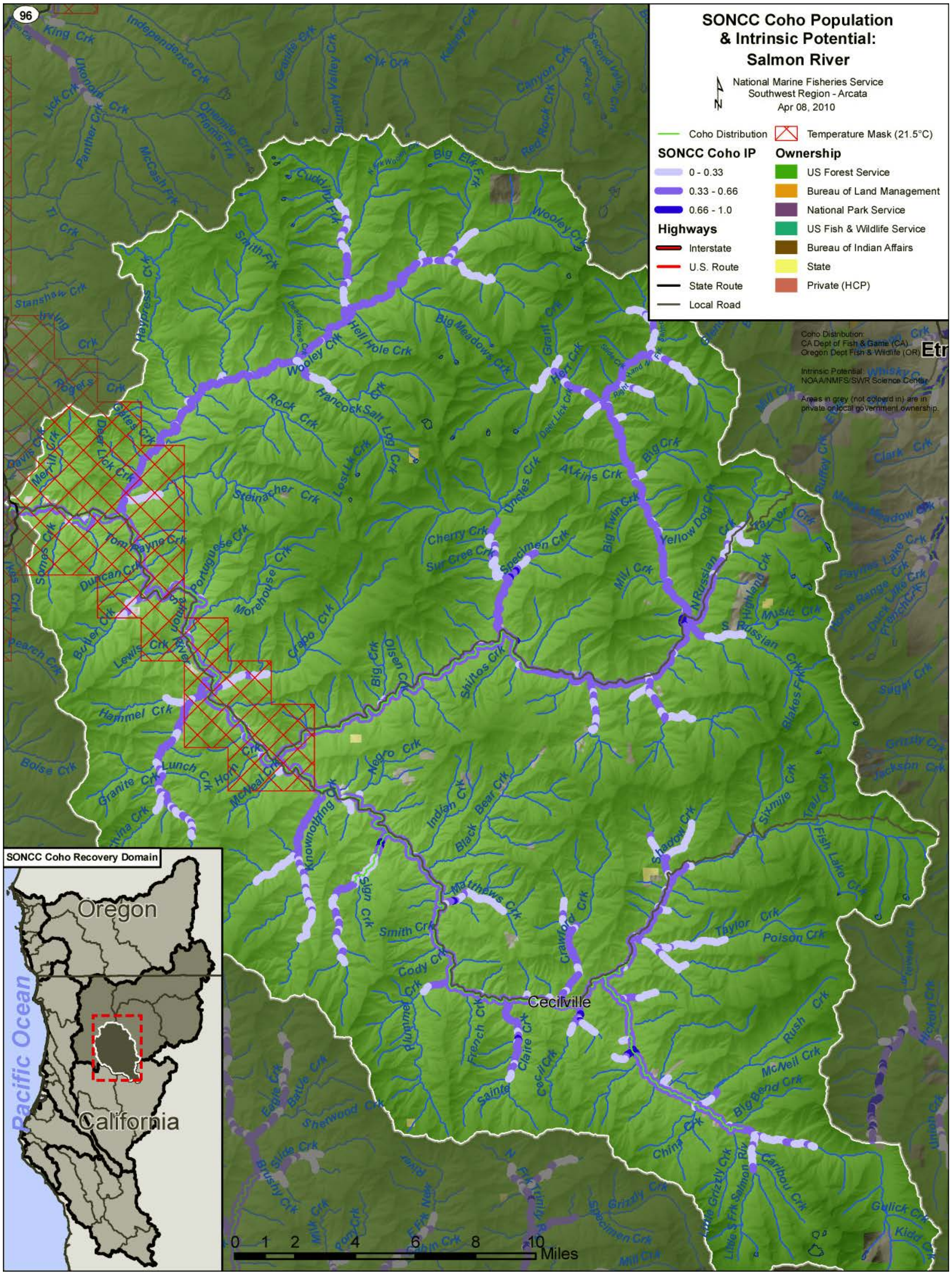

Figure 35-1. The geographic boundaries of the Salmon River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

When mining activities peaked in the watershed, the Salmon River and many of its tributary streams were dammed, diverted or drained, which blocked fish migration (Taft and Shapovalov 1935, Handley and Coots 1953). A dam near Sawyers Bar on the North Fork of the Salmon River prevented fish from passing until the 1950s. Another dam located four to five miles above the Forks of Salmon on the South Fork of the Salmon River blocked migration for 50 years or more (Elder et al. 2002).

Over the years, major flood events have led to large scale disturbance and landscape modification. Historical accounts indicate that there were major floods in 1861 to 1862 and again in 1889 to 1890 (McGlashan and Briggs 1939). Major floods also occurred in the Salmon River in 1953, 1955, 1964, 1970, 1971, 1972, 1974, and 1997 (KRBFTF 2002). The floods of 1955, 1964, and 1970 to 1974 created large scale landslide episodes and the 1964 flood resulted in major stream channel widening and modification (Elder et al. 2002). Floods caused channel migration, aggradation, scour, and widespread loss of riparian vegetation, with most low gradient floodplains stripped of riparian vegetation and covered with fresh sediment.

Timber harvest historically occurred in much of the watershed. Early timber harvest in the Salmon River basin was associated with mining and homesteading activities, with commercial harvest on public land beginning in earnest in the 1950s. This federally-managed land comprises nearly 99 percent of the Salmon River basin. By 1974, there were approximately 7,500 acres of harvested public land in the watershed, and by 1989, there were about 30,000 acres. To date, timber has been harvested from 47,995 acres, or 10 percent of the watershed. Prior to implementation of the Northwest Forest Plan (NWFP), timber harvest extended into the riparian zone in many areas of the watershed (USFS 1994a). Two of the most significant outcomes of these logging activities have been the associated changes in the natural fire regime and the substantial building of road networks throughout the basin. Much of the damage to riparian areas in the Little North Fork is the result of landslides associated with this kind of road construction and timber harvest that occurred in the early 1970s, in conjunction with major flood events (USFS 1995d). Although timber harvest since 1995 rarely extends into the riparian zone, several thousand acres of uplands are currently in plantation and will likely be thinned in the near future. Over the past 50 years, roads have been an on-going source of sediment to streams through surface erosion and landslides. Primarily built in association with timber harvest, by 1944 there were about 188 miles of roads in the Salmon River watershed. By 1989, the miles of road on federal lands had increased to 762 miles (3,639 acres, KRBFTF 2002), and this total was revised to 766.1 miles in 2011 (USFS 2011a). By 2011, there were over 900 miles of federal and private roads in the watershed, most located within the Klamath National Forest. An active Klamath National Forest road decommissioning and storm proofing program has, as of 2011, produced an inventory of the Salmon River Basin's 766 miles of federally-maintained roads, completed decommissioning of 84.4 miles of roads with high sediment source potential, along with full storm proofing of 76.2 miles of priority roads (USFS 2011a).

35.2 Historical Fish Distribution and Abundance

The 480,619 acre Salmon River watershed hosts all the native salmon runs present in the Klamath River watershed, including: Chinook, both spring and fall runs; coho; and steelhead. Yet many of these runs exist as remnant populations. Several species of fish are at risk of extinction including coho salmon. Little is known about historic run sizes of coho salmon in the basin; however, the IP model of the Salmon River suggest it has a moderate carrying capacity for coho salmon, with less than 5 kilometers having a high IP value (>0.66). The majority of the 115 kilometers of potential habitat has a medium IP value (0.33 to 0.66) and portions of many small tributaries have low IP value (<0.33).Historic coho salmon habitat in the Salmon River includes 105 miles found along the mainstem and several tributaries and run sizes were on the order of 2,000 fish at that time (California Department of Water Resources (DWR) 1965). Data collected from the early 1960s show coho salmon runs in the Salmon River were already on the decline, with California Department of Fish and Game (CDFG) estimating an annual coho spawning escapement for that year of only 800 fish (CDFG 1965). This decline continued between 1985 and 1991, based on data from a weir operated by CDFG near the mouth of the Salmon in conjunction with spawning ground surveys, when adult abundance estimates fluctuated between a record low of only two coho salmon in 1985 and a high of 75 in 1987 (CDFG 1992).

Juvenile presence/absence and abundance data from a variety of surveys in the late 1970s to late 1980s indicate that many of the tributaries throughout the watershed were being used for rearing. Juvenile coho salmon were found in 11 tributaries in the watershed including tributaries to the lower Salmon, Wooley Creek, and the North and South Fork Salmon (Brownell et al. 1999).

35.3 Status of Salmon River Coho Salmon

Spatial Structure and Diversity

Twelve percent of the 1,414 miles of stream within the Salmon River watershed are able to support anadromous salmonids, due to the mountainous topography and associated hydrology of the landscape (Williams et al. 2006), Of this total, 42 percent (115 km) has IP value for coho salmon. Coho salmon habitat includes the Mainstem Salmon River, Wooley Creek, the North Fork and South Fork Salmon Rivers, and the lower reaches of a few smaller tributaries. For this reason, coho salmon in the Salmon River population are naturally restricted in their distribution and able to utilize only a small portion of the watershed.

Known coho salmon spawning has been observed in the Nordheimer Creek, Logan Gulch, Brazil Flat, and Forks of Salmon areas along the mainstem Salmon River, in the Knownothing and Methodist Creek reaches of the South Fork Salmon River, and in the lower North Fork Salmon River (Salmon River Restoration Council (SRRC) 2007, SRRC 2010a). The total linear stream distance used by spawning coho salmon from 2004 to 2010 is at least 8 km of surveyed stream habitat, or 7 percent of the available spawning habitat (based on IP data). Surveys suggest that specific spawning areas are re-visited each year and that fish in certain spawning areas may have specific life history traits, such as different run timing (Pennington 2009). This is the only indication of the diversity of the population as no data on genetic diversity exists at this time. Based on the low hatchery influence and small population size, it is likely that genetic structure of the population retains much of its wild character, but overall the level of natural genetic diversity has likely declined.

According to available juvenile fish survey information beginning in 2002, juvenile coho salmon have been found rearing in most of the available tributary habitat with moderate or high IP values. These streams are tributaries to the South Fork Salmon (Knownothing and Methodist

Creek), at least nine tributaries to the North Fork Salmon, and in mainstem Salmon River tributaries (Nordheimer and Butler Creeks, SRRC 2008a). The lower reaches of these tributaries provide substantially cooler summer habitat than mainstem river habitat. Current data only includes presence/absence information, however, there is some indication that juvenile coho salmon move up from the mainstem Klamath into the cooler Salmon River tributaries during summer months when stressed by mainstem water temperatures (USFS 2009c). Some of juveniles found in surveys are thought to reflect non-natal as well as natal rearing. It remains difficult to determine the exact rearing distribution of juveniles from the Salmon River population.

The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 35 coho salmon per-IP km of habitat are needed (4,000 low-risk spawner threshold) to approximate the historical distribution of Salmon River coho salmon and habitat. Based on current spawning densities and locations, the Salmon River population is at a high risk of extinction because its spatial structure and diversity are very limited compared to pre-European conditions.

Population Size and Productivity

Streamflow level and visibility in the Salmon River watershed often make coho salmon surveys difficult or impossible. Survey data indicates that there are low numbers of coho salmon, and that the population is below depensation levels. In most years only a handful of adults and/or redds are found during the spawning season. Annual returns of adults are likely less than 50 per year (SRRC 2008b). These estimates could be the result of the inability to count all individuals present as well as the low abundance of the population.

Spawning surveys in the late 1980s (USFS 1991) and early 1990s failed to document the existence of coho salmon (Olson and Dix 1992). Since 2002, the SRRC along with CDFG, the Karuk Tribe, the USFS and the USFWS have conducted spawning and juvenile surveys throughout the watershed. Annual adult coho salmon abundance in the Salmon River varied between 0 and 14 spawning adults from 2002 to 2005 (SRRC 2006). As mentioned above, coho salmon spawning has been observed in the Nordheimer Creek, Logan Gulch, Brazil Flat, and Forks of Salmon areas of the mainstem Salmon River, in the Knownothing and Methodist Creek reaches of the South Fork Salmon River, and in the Lower North Fork Salmon River (SRRC 2010a). In spawning/redd surveys in 2003 and 2004, which covered a large extent of suspected coho salmon distribution within the watershed, only 3 and 14 coho salmon were observed respectively (SRRC 2006). Surveys in 2006 resulted in observations of one adult coho salmon and five redds, in Knownothing and Nordheimer Creeks (SRRC 2007). Between 2002 and 2007, a total of 18 adults (average of 3 spawners per year) and 12 redds were found in the roughly 25 km of surveyed habitat. In 2009, surveys limited to Knownothing and Nordheimer Creeks resulted in the observation of 7 redds in Nordheimer Creek (SRRC 2010a).

YOY and yearling abundance is also low in the Salmon River, indicating that production is low. Between 2002 and 2004, only 112 young of the year (YOY) and 2 yearlings were captured during outmigrant trapping in the lower Salmon River at RKM 1.5 (Sartori 2006). Juveniles have been found utilizing the lower reaches of many of the tributary streams during both the winter and summer; however, abundance data is unavailable (SRRC 2010a). It's possible that some juveniles originate from outside the Salmon River and rear in the Salmon River (USFS 2009c).

Extinction Risk

The potentially independent non-core Salmon River coho salmon population is not viable and at high risk of extinction, because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The recovery target for the non-core independent Salmon River population is to recover this population to at least a moderate risk of extinction (see Chapter 4). Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU. In addition to its demographic role in stratum and ESU viability, the Salmon River has the potential to act as a refugia population within the Interior Klamath diversity stratum because its ecosystem function and habitat values remain relatively intact and is not significantly influenced by hatchery fish.

35.4 Plans and Assessments

State of California

Salmon River Total Maximum Daily Load for Temperature and Implementation Plan
http://www.swrcb.ca.gov/northcoast/water_issues/programs/tmdls/salmon_river/

The North Coast Regional Water Quality Control Board (NCRWQCB) has identified the Salmon River as a 303(d) impaired water body under the Clean Water Act as a result of excessive stream temperatures and nutrients. The objective of the Salmon River temperature TMDL is to provide estimates of the assimilative capacity of the river by identifying the total load of thermal inputs that can be delivered to the Salmon River and its tributaries without causing exceedence of water quality standards. The total load must then be allocated among the sources of thermal loading in the watershed. The load allocation, when achieved, is expected to result in the attainment of the applicable water quality standard for temperature for the Salmon River and its tributaries. This TMDL focuses on stream temperature conditions in the watershed, for which the Salmon River is listed under Section 303(d). Because of a recommendation to the State Water Resources Control Board to delist the Salmon River for nutrients, there is currently only a (TMDL) for temperature.

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004. The recommendations developed by the Coho Recovery Team and CDFG for the Salmon River basin have been considered and incorporated into the table of population-specific recovery actions at the end of this document.

The Salmon River Restoration Council (SSRC)

SRRC Salmon River Subbasin Restoration Strategy
http://www.srrc.org/publications/general/SRRC%20Salmon%20River%20Subbasin%20Restoration%20Strategy.pdf

This joint strategy developed in 2002 by the Klamath National Forest and SRRC was built upon watershed analyses, transportation planning documents and other administrative investigations. The focus of the strategy is on restoring the biological, geologic, and hydrologic processes that shape aquatic habitat and the resulting plan focuses on reduction of upslope risks and hazards in watersheds with high quality habitat and native fish populations. Restoration objectives and recommendations on target watershed conditions are included in the strategy. Specific analyses and restoration recommendations developed through this strategy have been considered and incorporated in this population profile and in recovery strategy and table of population-specific recovery actions.

Salmon River Road Sediment Source Assessment (2001)

Private Roads Sediment Reduction Project, Final Report (2011)
http://www.srrc.org/publications/programs/roads/Salmon%20River%20Private%20Roads%20Sediment%20Reduction%20Project%20Final%20Report.pdf

Salmon River Riparian Assessment, 2006 to present

Salmon River Cooperative Noxious Weed Program Strategy for Restoring Native Plant Communities (2003)

Limiting Factors for Salmon River Spring Chinook Life Stages (draft)

U.S. Forest Service – Klamath National Forest (KNF)

Evaluation of Fish Habitat Condition and Utilization in Salmon, Scott, Shasta, and Mid-Klamath Sub-basins 1988/89.

Forest-Wide Late Successional Reserve Assessment (1999)

Salmon Sub-Basin Sediment Analysis (1994)

Upper South Fork of the Salmon River Ecosystem Analysis (1994)

South Fork of the Salmon River Ecosystem Analysis (1994)

Main Salmon Ecosystem Analysis (1995)

North Fork Watershed Analysis (1995)

Lower South Fork of the Salmon River Ecosystem Analysis (1997)

North Fork Salmon River Watershed Access and Travel Management Plan (1998)

Upper South Fork Salmon River Watershed Access Analysis (1997)

Ukonom Travel and Access Management Plan (1996)

Klamath National Forest Forestwide Roads Analysis (2002)

Roads Analysis Process (RAP) for North (2003) and South Forks of Salmon River (2005)

Klamath Motorized Travel Management Plan, Siskiyou County, California (2010)

Sufficiency Assessment: Forest Service and Bureau of Land Management Programs in Support of SONCC Coho Salmon Recovery (USFS and BLM 2011).

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, the South Fork of the Salmon River was identified as a high priority 6th field subwatershed in the Klamath National Forest (USFS and BLM 2011).

Salmon River Fire Safe Council

Recent Salmon River Community Wildfire Protection Plans
http://www.srrc.org/publications/index.php)

35.5 Stresses

Table 35-1. Severity of stresses affecting each life stage of coho salmon in the Salmon River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	High	High	High[1]	Medium	Medium	High
2	Degraded Riparian Forest Conditions[1]	-	High	High[1]	Medium	Medium	Medium
3	Impaired Water Quality[1]	Low	Medium	High[1]	Medium	Medium	Medium
4	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
5	Altered Sediment Supply	Medium	Medium	Medium	Low	Low	Medium
6	Altered Hydrologic Function	Low	Low	Medium	Low	Low	Medium
7	Impaired Estuary/Mainstem Function	-	Low	Medium	Medium	Medium	Medium
8	Adverse Fishery Related Effects	-	-	-	-	Medium	Medium
9	Increased Disease/Predation/Competition	Low	Low	Low	Low	Low	Low
10	Barriers	-	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages and Habitat

Water quality and riparian conditions are both degraded in the watershed and off-channel habitat is minimal due to the bedrock geology and steep terrain. The SRRC analyzed what limiting factors were important for Spring Chinook salmon in the watershed and found that temperature (in the mainstem Klamath and Salmon River), pool size and quantity, thermal barriers, flow, disease, and sediment embeddedness were all important factors limiting productivity of that population and likely the Salmon River coho salmon population as well (SRRC 2008b). Water temperature is one of the most important limiting factors along with floodplain and channel structure, both of which influence the quantity and quality of rearing habitat in the Salmon River and the access and availability of thermal refugia.

It is likely that the juvenile life stage is most limited and that quality summer and winter rearing habitat is lacking as vital habitat for the population. Juvenile summer rearing habitat is impaired by high temperatures with few thermal refugia areas accessible. Winter off-channel rearing habitat is naturally lacking in the area and therefore many juveniles may be forced downstream where they may rear in the estuary or in off-channel habitat in the mainstem (National Marine Fisheries Service (NMFS) 2007b).

Floodplain and Channel Structure

Floodplain and channel structure are generally based on physical characteristics that create complex habitat (e.g., pool depths, substrate size, and large woody debris quantity). Floodplain and channel structure in the Salmon River generally do not support many of the life history requirements of coho salmon due to the natural confinement of the watershed and the high frequency of disturbance. The IP model supports this presumption based on the low amount of high IP habitat in the Salmon River (Figure 35-1). Man-made activities have further limited floodplain, channel form, and function by altering floodplain habitat through mining activities (e.g., South Fork Salmon), changes in the natural fire regime, and erosion related to road-building and timber harvest. Natural disturbance regimes have been impacted by human activities and the consequences for floodplain and channel structure are that some disturbances such as fire and slope failure are more common and intense. Large wood is often flushed from the system by flooding and the associated stream power of the Salmon River, This results in excessive mobilization and input of sediment to streams. Floodplain habitat is often naturally disconnected, but in some cases it has been disconnected by large scale landslides, road building, and mine tailings. Sediment loading in some areas has filled pool habitat and simplified stream reaches.

Because off-channel and low-velocity habitat is already limited in the basin, any loss or alteration of exiting habitat can have a disproportionate negative impact. Effects of floodplain and channel structure on the egg stage occur from channel confinement, substrate size, and the amount of bedrock in some reaches. Effects on fry and juveniles occur from the loss and degradation of off-channel and low-velocity rearing and refugial habitat, and to a lesser extent on smolts. A low stress effect occurs on adults from a lack of suitable spawning habitat and a result of altered channel form and function.

Riparian Forest Conditions

The degraded condition of riparian areas throughout the system is the single greatest cause for elevated summer temperatures. Riparian forests in the Salmon River have been primarily impacted by disturbances such as flooding and fire. Although these disturbances are natural to the Salmon River, their increased frequency and intensity have caused large scale impacts to ecosystem processes. Based on the altered composition (decreased diversity and age class distribution) and decreased size of vegetation, the poor condition of riparian forests within the Salmon River watershed has been identified as a high stress to juvenile coho salmon and medium stress for other life stages. Available data (USFS 2000c) indicate that this issue is especially significant in the North Fork and South Fork Salmon Rivers where it has been documented that there is greater than 25 percent (of which more than 10 percent was recent) disturbance. By comparison, in the lower mainstem Salmon River and Wooley Creek stream corridor vegetation is considered “very good” (fully functioning), and contains less than 10 percent disturbance (5 percent recent) (USFS 2000c). Many riparian areas are changed from large mass wasting events, high intensity fires, and anthropogenic activities. Almost 25 percent of riparian areas have been scoured by debris torrents or degraded by fire (USFS 1994a) and only 27 percent of riparian areas have forest cover greater than 70 percent crown closure (USFS 1995e). Disturbance has resulted in fewer large trees in the riparian area, especially conifers, and a much greater extent of bare areas. Most of these changes are attributed to the 1964 flood, others are attributed to disturbance by human activity or a combination of floods, fires and human activity (USFS 1995e).

Currently riparian vegetation consists of fewer stands of large, dense conifers than were present before European settlement. The lack of functional riparian forest throughout the basin also limits the amount of large wood entering streams, leads to increased erosion and bank instability, and can lead to high stream temperatures. In areas where riparian forest conditions are impaired, rearing habitat for fry and juveniles is likely limited and/or impaired and holding habitat for adults is often lacking. Water quality is also impaired in many of these areas and can affect growth and survival of juveniles during the summer.

Impaired Water Quality

Data from the Salmon River indicate that although water quality is good for many parameters, it experiences impaired temperatures (>17^{o} C), fair dissolved oxygen (DO) (8.5 to 8.75), and elevated pH levels (8.5 to 8.75) at times during the summer, early fall and especially during low-flow conditions. Aquatic invertebrate EPT and species richness scores were both indicative of good aquatic health in the watershed although there are potentially site-specific issues with contamination from past mining activities and fire retardant misapplication. Little information is available as to the extent of contamination from these types of activities. Water temperature is the most significant issue affecting water quality in the Salmon River and exerts a stress on all life stages of coho salmon in the Salmon River population. Data from throughout the basin indicates that impaired water temperatures, sometimes exceeding sublethal levels, (>17^{o}C) occur during late summer in all the major tributaries and mainstems of the North Fork, South Fork, and Lower Salmon. This results in a high stress on juveniles, a medium stress on smolt and adult, and a low stress on egg and fry life stages. Most tributary temperatures are below lethal levels (NCRWQCB 2005b).

In areas that would be cooled by riparian shade (e.g., smaller tributaries), the reduction and compositional alteration of riparian vegetation along the river and its tributaries has led to increased water temperatures. This issue is exacerbated in dry years when stream flows are low, and in summer and early fall when water temperatures are highest. The only sources of cool water are smaller tributaries with adequate shading. The lack of available cool summer habitat is especially stressful for rearing juveniles, which can be at risk of reduced growth, disease, infection, and eventual mortality during these periods.

Adverse Hatchery Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. No hatcheries or artificial propagation occur in the Salmon River population area, but Iron Gate Hatchery is upstream on the Klamath River. Strays from other Klamath Basin hatcheries are known to utilize the Salmon River for spawning and potentially rearing (Pennington 2008). The proportion of spawning adults in the Salmon River that are of hatchery origin is unknown. Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of Iron Gate Hatchery and Trinity River Hatchery in the Klamath basin (Appendix B).

Sediment Supply

The quality and type of sediments delivered to stream channels within the Salmon River watershed do not generally present a significant stress to coho salmon. Based on measurements of V* from 1992, 1994 (De la Fuente 1994), and 2010 (USFS 2010a) (SRRC 2011) there is little accumulation of fine sediment in channels and pools within the watershed, except in Crapo Creek and Taylor Creek. In areas where excess sediment loading has occurred, the early life stages of coho salmon are most affected since it often results in simplified rearing habitat and impaired water quality. Due to the Salmon River basin's steepness, and localized soil instability, sediment loading continues to be elevated in some reference stream reaches, resulting in a, an overall medium stress for the population.

Hydrologic Function

Altered hydrologic function has been rated as medium stress factor for the juvenile stage, and as a low stress factor for all other life stages. There is little impervious surface area within the watershed and no major barriers or diversions to block or reduce flow. However, there are numerous small diversions throughout the watershed that can have a cumulative impact on the amount of surface flow, particularly diminished summer flows from tributaries providing rearing refugia for juvenile salmonids, as occurs in McNeal Creek (USFS 2011b). The lower Salmon River was ranked by the U.S. Forest Service as having a "fair", or partially functional, flow regime (USFS 2000c). This was based on the timing, rate of change, and/or duration of mid-range discharges, which were considered to impair aquatic habitat availability in this drainage area. Peaks and low flows are thought to remain unaltered in this area.

Estuary/Mainstem Function

All salmon and steelhead that originate from the Salmon River migrate to and from the ocean through the mainstem Klamath River and the Klamath River estuary. Also, due to the lack of winter rearing habitat in the Salmon River many juveniles move downstream during high flow events and must find rearing and refugia habitat in the lower Klamath River and estuary. The importance of the lower basin to this population is largely unknown but it is likely that a portion of fish from the population spend a substantial amount of time rearing downstream of the Salmon River and for these fish mainstem and estuary conditions play an important part in their growth and survival. Other fish may just pass through the mainstem and estuary on their way to and from the ocean, using habitats here on a short term basis during migration. Although the estuary is small compared to the large size of the watershed, it does provide rearing habitat for juvenile coho salmon. The estuary, although relatively intact, suffers from impaired water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain. More information about the Klamath River estuary can be found in the Lower Klamath population profile.

Mainstem conditions contribute to this stress because of the issues with water quality, sedimentation and accretion, disease, and degraded habitat in mainstem reaches. Juveniles, smolts, and adults in mainstem habitats are stressed by the degraded conditions in these migratory and rearing habitats. Disease, access and availability of rearing and migratory (holding) habitat, and lack of connectivity between tributaries and the mainstem are all issues that impact the quality of rearing and migratory habitat downstream of the Salmon River. Although the prevalence of diseases is lower in mainstem reaches downstream of the Salmon River it is still an issue when water temperatures are high and fish are stressed.

Adverse Fishery Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

Disease/Predation/Competition

Although disease, predation, and competition are not limiting factors for coho salmon in the Salmon River, adult coho migrating through the Klamath River to spawn in the Salmon River are exposed to disease. For this reason, disease is considered a medium stressor for adults. Diseases that may affect adult coho salmon include *columnaris* (gill rot) and *parvicapsula* (kidney disease). Further discussion of disease issues occurring in the mainstem Klamath River is included in the Upper, Middle, and Lower Klamath population profiles.

Barriers

Although scattered man-made barriers exist on small tributaries throughout the Salmon River, most of these barriers exist outside the range of coho salmon and do not affect the population with respect to passage (CalFish 2009). Several fish passage barriers at road-stream crossings have been prioritized for fish passage in the past but the most significant barriers have been removed or remediated (Taylor et al. 2002). An example of coordinated barrier removal is the Whites Gulch dams removal project (http://www.srrc.org/programs/riparian.php), and the subsequent upgrade of a Siskiyou County road crossing downstream on lower Whites Gulch in August 2009. One remaining large barrier, associated with the road crossing over lower Hotelling Gulch, is under review for barrier removal (USFS 2010b). In addition to man-made barriers, natural seasonal low flow barriers block passage to some reaches. Because many tributaries act as thermal refugia when mainstem water temperature rises in the summer, it is important to ensure access to all fish bearing tributaries.

35.6 Threats

Table 35-2. Severity of threats affecting each life stage of coho salmon in the Salmon River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Climate Change	Medium	Medium	Very High	Very High	High	Very High
2	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
3	Roads	Medium	Medium	Medium	Medium	Medium	Medium
4	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
5	Mining/Gravel Extraction	Low	Medium	Medium	Medium	Low	Medium
6	Fishing and Collecting	-	-	-	-	Medium	Medium
7	Dams/Diversion	Low	Low	Low	Low	Low	Low
8	Invasive Non-Native/Alien Species	Low	Low	Low	Low	Low	Low
9	Agricultural Practices	Low	Low	Low	Low	Low	Low
10	Timber Harvest	Low	Low	Low	Low	Low	Low
11	Urban/Residential/Industrial	Low	Low	Low	Low	Low	Low
12	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low

[1] Channelization/Diking is not considered a threat to this population.

Climate Change

The greatest threat is likely to come from climate change, from the predicted changes in temperature and precipitation that are likely to occur. Climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperatures show a large increase over the next 50 years (see Appendix B for modeling methods). Average ambient temperature could increase by up to 3° C in the summer and by 1.3° C in the winter. Recent studies have already shown that water temperatures in the mainstem Klamath have been increasing at a rate of 0.4 to 0.6 ° C/decade since the early 1960s. The season of high temperatures that are potentially stressful to salmon has lengthened by about 1 month and the average length of mainstem river with cool summer temperatures (<15° C) has declined by about 8.2 km/decade (Bartholow 2005). Annual precipitation in this area is already low and is predicted to trend downward over the next century, while snowpack in upper elevations of the basin is expected to decrease with changes in temperature and precipitation regime (California Natural Resources Agency 2009). Juvenile rearing and migratory habitat in the Salmon River and mainstem Klamath is most at risk to climate change as are migratory conditions in the Klamath River for adults. Increasing ambient temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Overall, the range and degree of temperature increase and precipitation volatility are likely to continue in all populations. Eggs and fry will be impacted by this through larger and more frequent flooding and mass wasting events, which will be especially significant in this area due to the steep terrain and unstable geology. Adults will also be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

High Intensity Fire

The Salmon River watershed is naturally a fire-adapted landscape with a relatively frequent recurrence of wildfire. The fire regime historically was highly variable in terms of frequency, severity, and spatial pattern (Frost and Sweeney 2000). The predominant fire regime was of relatively frequent fires (every 10 to 50 years) of mostly low and moderate severity, with varying-sized patches of high severity fire. However, because of land management activities over the past 150 years including clearcut logging and fire suppression, high fuel loading occurs throughout the watershed and causes fires to burn much hotter and longer. In many lower and mid-elevation areas and in high elevation areas that have not burned in the last 45 years, current vegetative structure and patterns strongly favor high intensity, frequent fires (SRRC 2007).

After several fires in 1917 and 1918, which burned 6,270 and 15,660 acres respectively, effective fire suppression began in the 1920s and continues to the present in some areas. Without natural fire on the landscape to reduce fuel loads, areas without fuels treatment now have a higher risk of catastrophic fire. The result is a system with less frequent, more intense fires. In the latter quarter of the 20th century, high severity fires became more common and more detrimental to watershed health. It is estimated that 29 percent of the Salmon River basin has burned since the early 1970s with isolated pockets of high intensity fire occurring in some sub-watersheds (Elder et al. 2002). Under natural fire regimes, a much higher percentage of the watershed likely would have been affected by fire, however, these fires would have been at a much lower intensity, thereby preventing high intensity, stand replacing fires as seen recently. Recent efforts have shifted from suppression to strategic landscape level fuels reduction, prescribed fire, and controlled burns as a means to mitigate high intensity fire.

The impacts to coho salmon associated with high intensity fire make this an immediate threat to this population. Fires affect salmon and salmon habitat in the Salmon River in a number of ways. Catastrophic fires denude riparian areas, which in turn increase water temperatures through the loss of riparian shading. Snow pack and water retention has been reduced in denuded areas, affecting the hydrology of the basin (Vajda et al. 2006). Fire in upslope areas has also led to increased soil erosion and sediment delivery, which in turn has resulted in stream aggradation, pool filling, and in extreme cases landslides, debris torrents, or other forms of mass wasting (Elder et al. 2002). Recent large-scale fires that resulted in lost or degraded coho salmon habitat include the Backbone and Red Spot (6,324 acres in 2009), Ukonom Complex (80,000 in 2008), and the Uncles Complex (48,085 in 2006) (SRRC 2010b). Current efforts to reduce fuels and reintroduce low intensity fire into the landscape through fire use and under-burning aim to address this problem and should lessen this threat over time.

At present, fuel loading is at a high hazard level in many areas of the watershed and the Salmon River Subbasin Restoration Strategy (KRBFTF 2002) identifies fire as the primary long-term risk to the aquatic and terrestrial ecosystems within the Salmon River watershed, due to resulting impacts on sediment and water temperatures (Elder et al. 2002).

Roads

Sedimentation from roads will continue to threaten the population. Road-related sediment mobilizations, however, expected to decrease over time as road decommissioning and upgrading continues by the Klamath National Forest. Existing roads are considered a medium threat to all life stages of coho salmon in the Salmon River. In 2011, there were over 900 miles of roads within the Salmon River watershed. Most of these roads are within the South Fork and North Fork Salmon River drainages and their density within specific drainages is variable. The drainages with the highest density of roads (very high; >3 mi./sq. mi.) include Negro Creek, McNeal Creek, Eddy Gulch, Cecil Creek, Indian Creek, and Crawford Creek. At least 14 other drainages have a rating of "high" road density (2.5 to 3.0 mi. /sq mi, KRBFTF 2002). At these levels, salmon habitat is considered to be "not properly functioning" or as having degraded functions (National Marine Fisheries Service (NMFS) 1996) due to the impacts of increased sedimentation, riparian condition, hydrology, water quality, slope stability, habitat complexity (especially large wood transportation and delivery), and fish passage.

In the Salmon River, roads account for 90 percent of the human caused sediment and 43 percent of expected surface erosion (USFS 1993, Elder et al. 2002). Roads have a significant impact on slope stability in an area which is naturally prone to landslides and erosion. It has been established that roads are significantly correlated with the number of landslides within the watershed, with roaded areas in the Salmon River watershed being 27 times more likely to yield landslides than undisturbed sites (De la Fuente and Elder 1998). When roads are built within the riparian corridor, they impact stream habitat through the loss and/or degradation of riparian function. Within the Salmon River basin, approximately 79 miles of road are within Riparian Reserves (USFS 1995c). Within these areas, opportunities for the establishment of riparian vegetation are limited, particularly along major road arteries that track the mainstem and forks of the Salmon River. Given the elevated summertime water temperatures along these reaches of the Salmon River, it will be important to reduce the impacts of roads in order to increase riparian shading and decrease stream filling due to sedimentation. The Salmon River Private Roads Sediment Reduction Project (U.S. Department of the Interior 2011),has upgraded and decommissioned approximately 3.1 miles of roads in the Salmon River basin, to address sediment sources on 15 road-related sediment mobilization sites The Klamath National Forest also continues to mitigate road-related hydrologic connection on public land in the Salmon River basin, has implemented many road decommissioning and storm proofing projects in the South Fork Salmon River watershed, and is implementing several road improvement projects in the North Fork Salmon River and Upper South Fork Salmon River watersheds (Perrochet 2011). These efforts should reduce the impacts of roads on watershed conditions in the future.

Hatcheries

Hatcheries pose a medium threat to all other life stages in Salmon River basin. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Mining/Gravel Extraction

Several thousand acres of public lands are currently reserved as mining claims including more than 400 placer and lode mining claims in the Salmon River basin. Most mining activity is currently pursued at a part-time or hobby level by individuals. The active gold mining occurs mostly as placer mining along the South Fork Salmon and Knownothing Creek and as hard-rock mining at the Discovery Day Mine and recreational gold suction dredging or panning has occurred at various locations along the river. The last commercial gold mine closed in the 1990s (Elder et al. 2002), though three hard rock mining special use permits were issued during the 2000s. Overall mining activities in the Salmon River have decreased significantly from historic levels, though there remain significant legacy effects from remnant tailings piles associated with past placer mining. . Suction dredge mining operations had been increasing more recently, until the cessation of suction dredging permit issuance by the state of California in 2009. A five-year moratorium on suction dredging permitting became law in California in July 2011. In response, high banking practices are becoming more common. Finally, the potential for future mining operations, and the number of claims that could be utilized, suggest that Mining/Gravel Extraction is a medium threat to coho salmon.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, Tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath/trinity basin. The effects of these fisheries on the continued existence of the SONCC coho salmon ESA, under current management by the State of California and the Yurok and Hoopa Tribes, have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Salmon River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Dams/Diversions

Although small scale diversions and scattered dams exist within the watershed, they are mostly confined to smaller tributaries and are not believed to significantly impact coho salmon. The diversions that exist are mostly associated with mining activities and residential use, and may have the cumulative potential to affect stream hydrology or migration and rearing of juveniles.

Invasive Non-Native/Alien Species

Noxious weeds in the Salmon River watershed have become an ongoing problem throughout the basin. Fire and fire suppression crews are thought to play a major role in the introduction and establishment of weed species. The SRRC manages a noxious weed program for 11 species of weeds found in the watershed and has been successful in hindering the establishment and spread of these species. Once the largest infestation of Spotted Knapweed, the SRRC has now eradicated 99 percent of the population. Invasive species are currently considered a low threat to this population because of the success of this program.

Agricultural Practices

Unlike the Klamath Basin, the Salmon River watershed does not lend itself to large-scale agricultural or grazing, although grazing has occurred within the watershed at some level since the mid-1800s. The Salmon River watershed is highly forested and steeply sloped, and current grazing is primarily within transitory rangeland in or adjacent to USFS wilderness areas. There are currently all or portions of four grazing allotments within the boundary of the watershed. They are: Big Flat, Carter Meadows, Garden Gulch, and South Russian Creek. The total area of such allotments is small, and the Klamath National Forest currently manages such areas for ecological benefits (USFS 1995c). In terms of grazing impacts, there is little evidence to suggest a direct linkage between existing grazing management and increased stream temperatures in the Salmon River watershed. Most grazing occurs in the headwater drainages well above anadromous fish habitat and it is likely that current levels do not pose a significant threat to coho salmon. Therefore, agricultural practices are considered a low threat for all life stages.

Timber Harvest

Timber harvest, although once a major land use in the basin and a significant threat to coho salmon, is now restricted to just a few thousand acres of upland habitat. Much of the land that was once logged is now part of National Forest Riparian Reserves, Late Successional Reserves (LSRs), or wilderness, none of which are designated for this use. Since 2000, timber harvesting and other vegetation treatments have primarily emphasized maintenance and/or improvement of resource values and objectives, such as maintenance of habitat diversity and strategic wild fire hazard reduction. Timber harvest is a low level threat for the population.

Urban/Residential/Industrial Development

Residences are dispersed throughout the watershed with concentrations located in, or near, the towns of Sawyers Bar, Cecilville, Somes Bar and Forks of Salmon. In addition the community is made up of several outlying small neighborhoods and isolated forest residencies. With only 250 residents within the watershed, and expected future population growth under 2 percent, urban, residential, and industrial development is very minor and is not considered a threat to coho salmon in this population.

Road-stream Crossing Barriers

Several road-stream crossing within the watershed are considered barriers to adult and juvenile coho migration. The SRRC has helped to identify the known man-made fish barriers in the Salmon River watershed and is cooperating with partners to remove these barriers. Several were ranked as priorities for removal by the Siskiyou County Culvert Inventory and Fish Passage Evaluation (Taylor et al. 2002). In fact, four of the top six priority sites were within the Salmon River watershed. Currently, all four fish passage issues have been, or are currently being, addressed by the SRRC, the county, and their partners. Several impassable culverts have already been replaced (Whites Gulch, Kelly Gulch, Merrill Creek) and the remaining significant barrier on lower Hotelling Gulch is undergoing a feasibility study for treatment. Because of the limited scope of this problem in the watershed and the ongoing efforts to address it, road-stream crossing barriers in the watershed currently constitute a low threat to coho salmon.

35.7 Recovery Strategy

Summertime temperatures and a lack of winter rearing habitat remain the single greatest stressor for juvenile coho and overall the small population size limits the potential for natural salmon recovery. Although restoration opportunities are limited, because the majority of land within the watershed is public and managed by the U.S. Forest Service, many of the hurdles facing restoration in other watersheds are not present in the Salmon River. In addition, the Forest Service has designated the Salmon River as a Key Watershed under the Northwest Forest Plan (USFS 1994a), assigning it a high priority for mitigating problems under the long range plan and restoration strategy.

Improvements of mainstem rearing and migratory habitat are expected to occur as a result of recovery actions in the three mainstem Klamath populations. It is expected that the threat from climate change will be mitigated by addressing the primary stressors and limiting factors. Specific emphasis has been placed in this recovery strategy on meeting habitat needs associated with the current TMDL for temperature (NCRWQCB 2005b) and on the recommendations outlined in the Salmon Subbasin Restoration Strategy (KRBFTF 2002).

The highest priority should be improving the quality and extent of rearing habitat and refugia. For summertime rearing, reducing water temperatures in the basin, along with protecting and restoring thermal refugia will be the top priority. For winter rearing, improving connectivity to existing off-channel habitat, and increasing the extent and quality of winter rearing areas will be essential. This habitat, located primarily in lower tributary reaches, should be restored or re-created wherever possible, to provide increased opportunities for winter rearing in the basin. Efforts to improve riparian habitat condition will be important longer-term actions in the recovery strategy.

Table 35-3 on the following page lists the recovery actions for the Salmon River population.

Table 35-3. Recovery action implementation schedule for the Salmon River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SalR.2.1.7	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	High IP sub watersheds, guided by Karuk tribe data and SRRC Riparian assessment information.	2
SONCC-SalR.2.1.7.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-SalR.2.1.7.2	*Place instream structures, guided by assessment results*					
SONCC-SalR.2.1.8	Floodplain and Channel Structure	Yes	Increase channel complexity	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	High IP sub watersheds, guided by Karuk tribe data, SRRC Riparian assessment information, and CDFG/USFS data.	2
SONCC-SalR.2.1.8.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-SalR.2.1.8.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-SalR.7.1.1	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	High IP sub watersheds, guided by SRRC Riparian Assessment information	2
SONCC-SalR.7.1.1.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-SalR.7.1.1.2	*Thin, or release conifers, guided by prescription*					
SONCC-SalR.7.1.1.3	*Plant conifers, guided by prescription*					
SONCC-SalR.7.1.1.4	*Control non native/invasive species in prioritized areas*					
SONCC-SalR.7.1.2	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Reestablish natural fire regime	Basin-wide, guided by priorities in USFS WCF and SRCC WCPP	BR
SONCC-SalR.7.1.2.1	*Identify areas prone to high intensity fire and develop a plan to reestablish a natural fire regime*					
SONCC-SalR.7.1.2.2	*Carry out fuel reduction or modification projects such as thinning, prescribed burning, and piling, guided by the plan*					
SONCC-SalR.10.3.5	Water Quality	Yes	Protect cold water	Protect existing or potential cold water refugia	Population wide	2
SONCC-SalR.10.3.5.1	*Develop resource protection measures for water drafting, fire suppression, and other actions to avoid adverse affects to water temperature in coho*					
SONCC-SalR.10.3.5.2	*Develop educational materials for landowners to expand stewardship program*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-SalR.10.2.6	Water Quality	Yes	Reduce pollutants	Reduce point- and non-point source pollution	Population wide, using WCF and road inventory data to update Salmon River SRR strategy	3
SONCC-SalR.10.2.6.1		*Implement restoration plan for TMDLs per 303(d) listing for temperature (shade)*				
SONCC-SalR.10.2.6.2		*Identify and inventory discharge and polluted sites (e.g., nutrients, algae, metals, coliform) that are not road-related*				
SONCC-SalR.1.2.20	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3
SONCC-SalR.1.2.20.1		*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*				
SONCC-SalR.16.1.11	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SalR.16.1.11.1		*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*				
SONCC-SalR.16.1.11.2		*Identify fishing impacts expected to be consistent with recovery*				
SONCC-SalR.16.1.12	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-SalR.16.1.12.1		*Determine actual fishing impacts*				
SONCC-SalR.16.1.12.2		*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*				
SONCC-SalR.16.2.13	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SalR.16.2.13.1		*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*				
SONCC-SalR.16.2.13.2		*Identify scientific collection impacts expected to be consistent with recovery*				
SONCC-SalR.16.2.14	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SalR.16.2.14.1		*Determine actual impacts of scientific collection*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SalR.16.2.14.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-SalR.3.1.4	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide, guided by RWQCB 2005 TMDL Implementation Plan	3
SONCC-SalR.3.1.4.1	*Assess basin wide water diversion projects and prioritize areas in need of increased flows. Develop a plan to obtain adequate flows for riparian resources*					
SONCC-SalR.3.1.4.2	*Reduce diversions, guided by the plan*					
SONCC-SalR.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-SalR.27.1.15.1	*Perform annual spawning surveys*					
SONCC-SalR.27.1.16	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-SalR.27.1.16.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-SalR.27.1.17	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-SalR.27.1.17.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-SalR.27.2.18	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-SalR.27.2.18.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-SalR.27.2.18.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-SalR.27.1.19	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-SalR.27.1.19.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-SalR.27.2.21	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SalR.27.2.21.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-SalR.27.2.22	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-SalR.27.2.22.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-SalR.27.2.23	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-SalR.27.2.23.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-SalR.27.1.24	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-SalR.27.1.24.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-SalR.27.1.24.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-SalR.5.1.9	Passage	No	Improve access	Restore access to overwinter areas	Guided by 5 Counties data and SRRC Riparian Assessment information; including Hotelling Gulch, Little Cronan Gulch	2
SONCC-SalR.5.1.9.1	*Identify and prioritize removal of remaining high priority barriers that prevent access to side channels and over wintering areas, and allow passage of all coho life stages*					
SONCC-SalR.5.1.9.2	*Remove or modify high priority barriers to allow passage of coho salmon at all life stages*					
SONCC-SalR.5.1.10	Passage	No	Improve access	Remove barrier	Population wide in lower reaches of tributaries (e.g., Nordheimer Creek)	3
SONCC-SalR.5.1.10.1	*Restore and maintain habitat connectivity between the Salmon River and Nordheimer Creek where low flow or sediment aggradation has been known to restrict coho salmon passage.*					
SONCC-SalR.5.1.10.2	*Determine whether to maintain or decommission the Nordheimer Creek fish ladder*					
SONCC-SalR.8.1.3	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Areas identified in USFS WCF and SRCC WCPP	BR
SONCC-SalR.8.1.3.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-SalR.8.1.3.2	*Decommission roads, guided by assessment*					
SONCC-SalR.8.1.3.3	*Upgrade roads, guided by assessment*					
SONCC-SalR.8.1.3.4	*Maintain roads, guided by assessment*					

36. Scott River Population

- Interior Klamath Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 8,800 Spawners Required for ESU Viability
- 813.4 mi^2
- 441 IP km (274 mi) (71% High)
- Dominant Land Uses are Agriculture and Ranching
- Principal Stresses are ‘Altered Hydrologic Function’ and ‘Degraded Riparian Forest Conditions’
- Principal Threats are ‘Agricultural Practices’ and ‘Dams/Diversions’

36.1 History of Habitat and Land Use

Habitat for coho salmon within the Scott River basin has been altered by numerous human activities, affecting both instream conditions and adjacent riparian and upland slopes. Alterations to habitat and changes in land uses include previous removal of beaver, road construction, agricultural practices, river channelization, dams and diversions, timber harvest, mining/dredging, gravel extraction, high intensity fires, and rural residential development. These anthropogenic impacts, combined with natural factors such as recurring floods (e.g., 1955, 1964, and 1997) erosive soil, and a warm and dry climate, have simplified, degraded, and fragmented migrating, spawning, and rearing habitat throughout the Scott River basin.

Agriculture and grazing have been, and continue to be the major land use on the Scott and Shasta Valley floors, with commercial timber harvest and recreation in wilderness areas predominating in upland areas. Water diversions for agricultural practices, groundwater extraction, cattle grazing, residential/domestic water use, and flood control have diminished surface flows and greatly reduced or eliminated access to and use of historical coho salmon habitat in the Scott Valley (California Department of Fish and Game (CDFG) 2002b). In addition, livestock grazing persists in six Klamath National Forest Westside grazing allotments in the Marble Mountains along the western boundary of the Scott River basin (U.S. Forest Service (USFS) 2006). Improved monitoring of grazing allotment condition and trend began in 2006, and is designed to inform changes in grazing pressure, timing, and duration, as needed.

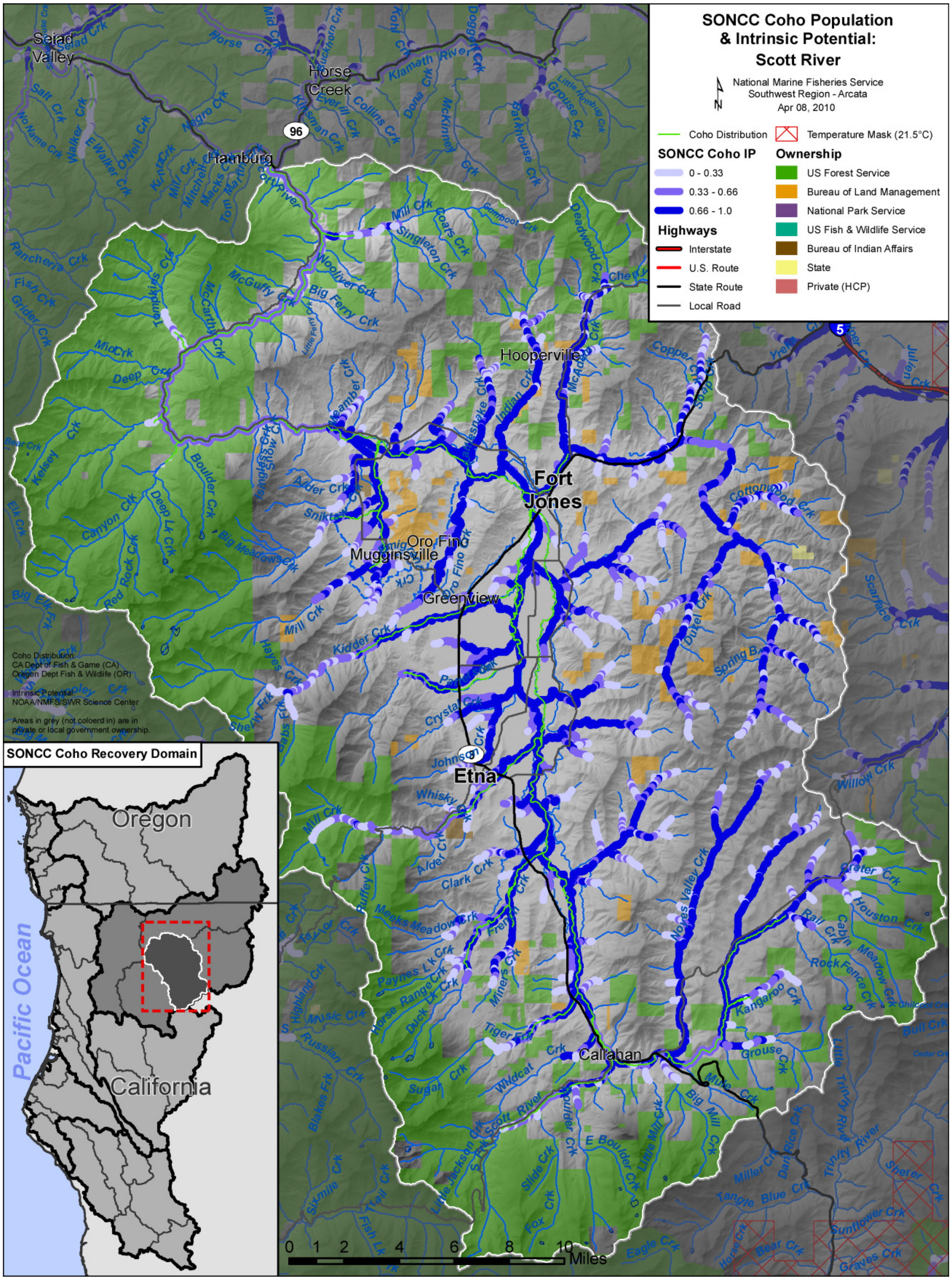

Figure 36-1. The geographic boundaries of the Scott River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

The loss of vegetative cover, bank erosion, and reduced stream flow has increased summer water temperatures throughout the watershed, decreasing the quantity and quality of rearing habitat, and limiting the fitness and survival of juveniles throughout the system. Additionally, decreases in habitat complexity through the loss of woody debris, instream cover, deep pools, accessible off channel habitat, and temperature-buffered water sources have contributed to reduced summer and winter rearing capacity for juvenile coho salmon (CDFG 2002b).

Road construction and ground disturbance have adversely affected water quality and flows in the Scott River basin. The quantity and location of vegetation removal, surface grading, and ground compaction have modified drainage patterns and surface runoff throughout the basin. Such modification has also exacerbated surface erosion resulting in excess sediment delivery to coho salmon habitat (National Research Council (NRC) 2004). Land use activities involving vegetation removal have also led to mass wasting by reducing root soil binding strength and decreasing the extent of riparian buffers where sediment and polluted water can be intercepted before entering watercourses. Following the floods of the 1930s, the US Army Corps of Engineers, at the request of Siskiyou County, removed the remaining vegetation through the middle of the Scott Valley, straightened portions of the Scott River channel, and built levees for flood control. Additional flood control levees were later built along lower Etna, Kidder and Moffett creeks (Scott River Watershed Council (SRWC) 1997, Mack 1958). Such channelization of the mainstem Scott River has resulted in channel simplification and incision, channel destabilization, and vegetation instability in areas immediately adjacent to and contained by these levees (Van Kirk and Naman 2008, SRWC 2005a). Investigation of the relationship between groundwater and surface flow has been undertaken via a community groundwater study plan (Harter *et al.* 2008), which will document interactions between groundwater use and water availability in adjacent riparian habitat. Many beaver ponds, which historically provided important impoundments and diverse channel margin habitat attractive to coho salmon, were lost with the removal of beavers from the valley. These changes in habitat have decreased the availability and extent of off channel rearing habitat, altered the hydrology of the lower mainstem river, and caused changes in bedload movement and available spawning habitat throughout the channelized area. This alteration of habitat, that accompanied the loss of beavers, has further decreased the fitness and survivability of coho salmon in the Scott River basin. Beaver reoccupation of portions of the Scott Valley is occurring slowly, and is expected to progressively expand and improve coho salmon rearing habitat.

Mechanized timber harvest began in the 1950s, and overstory removal was the dominant regeneration harvest method (USFS 2006). From the 1960s to the 1980s, clear-cutting was common, and many plantations were established on KNF-managed lands in the Scott River basin. Timber harvest practices changed in the early 1990's with clear cutting practices giving way to selective cutting on KNF-managed land, using reduced impact timber harvesting methods. Legacy clear cut and plantation areas, along with lands affected by wildland fires, have created large stands of young, regeneration forests in upland portions of the Scott River basin (USFS 2002). Road building, tree felling, skidding, and haul road use adversely affected water quality and peak/base flows in coho salmon habitat. Ground disturbance, compaction, and/or vegetation removal adjacent to streams during timber harvest modified drainage patterns and surface runoff, exacerbating surface erosion, creating a hydrologic connection to the stream network, and resulting in sediment delivery to coho salmon habitat downstream. Sediment source reduction projects were implemented during the 1990s and 2000s, treating significant sediment-generating road segments on both public and private lands.

Pervasive changes to the landscape began in 1850 with the discovery of gold, when many riparian areas along the Scott River and its tributaries were disturbed by gold mining of alluvial deposits using panning, sluicing, or dredging (i.e., placer mining). Dredge mining, using pressurized water later became common along many streams, and continued through the 1940s (USFS 2006). Large areas were stripped of vegetation and the remaining gravel deposits were hydraulically or mechanically worked to retrieve deposited gold. These activities left a legacy of unvegetated, heavily disturbed gravel deposits (e.g., tailings piles) mostly devoid of soil, and created permanent changes in floodplain and channel characteristics. Tailings piles are especially apparent along nearly five miles of the mainstem Scott River downstream from Callahan. Floating dredge operations occurring there from the mid-1930s through the early 1950s have reconfigured the entire valley floor, confining the active Scott River channel to one side of its historical floodplain. Many riparian areas in the Scott River basin remain poorly vegetated and erodible up to the present day (USFS 1997b).

36.2 Historical Fish Distribution and Abundance

The Scott River basin has historically been an important native coho salmon river in the Klamath River diversity stratum (Brown et al. 1994). Spawning and/or redds of coho salmon have been observed in the mainstem Scott River and its tributaries, including: East Fork Scott River, South Fork Scott River, Sugar Creek, French Creek, Miners Creek, Etna Creek, Kidder Creek, Patterson Creek, Shackleford Creek, Mill Creek, Canyon Creek, Kelsey Creek, Tompkins Creek, and Scott Bar Mill Creek (Quigley 2007, Calfish.org). The IP data show the highest values (IP > 0.66) throughout the Scott Valley and low gradient reaches of tributaries to the Scott River (Table 36-1). Other Scott River tributaries that have high IP values include Rail, Kangaroo, Grouse, Sniktaw, Emmigrant, Oro Fino, Cottonwood and Duzel creeks.

Table 36-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Subarea	**Stream Name**	**Subarea**	**Stream Name**
Scott Valley	Shackleford Creek[1]	**Scott Valley**	Wildcat Creek
	Mill Creek[1]		Etna Creek[1]
	French Creek[1]		Boulder Creek[1]
	Miners Creek[1]		Kidder Creek[1]
	South Fork Scott River[1]		Noyes Valley Creek
	Sugar Creek[1]		Moffett Creek
	Wooliver Creek[1]	**Scott Bar**	Canyon Creek[1]
	Big Mill Creek[1]		Kelsey Creek[1]
	East Fork Scott River[1]		Mill Creek (near Scott Bar) [1]
	Patterson Creek[1]		Tompkins Creek[1]

[1] Denotes a "Key Stream" as identified in the State of California's Coho Recovery Strategy, and in which SONCC coho salmon have been observed since 2001.

The Department of Water Resources (1965) estimated the Scott River's adult coho salmon population in the early 1960s to be 2,000. Lanse (1971) estimated that a total of 111 juvenile and zero adult coho salmon were harvested by anglers in a study of the mainstem Scott River from its mouth to the town of Callahan. Between 1982 and 1991, the California Department of Fish and Game (CDFG) operated a weir in the Scott River near the confluence with the Klamath River to obtain fall-run Chinook salmon escapement estimates. The weir was removed each year before the conclusion of the coho salmon migration and spawning period (early November to early January), but early returning coho salmon were counted while the weir was operating (Table 36-2).

Table 36-2. Year, dates of operation and counts of coho salmon observed at the Scott River weir. Weir was operated by the CDFG Klamath River Project (Shasta Scott Recovery Team (SSRT) 2003).

Year	**Dates of Operation**	**Jacks**	**Adults**	**Total***
1982	9/14 to 10/29	0	5	5
1983	9/14 to 11/3	1	21	22
1984	9/10 to 10/31	12	38	50
1985	9/3 to 11/12	0	1	1
1986	9/11 to 11/19	18	49	67
1987	9/25 to 11/18	12	248	260
1988	9/24 to 11/9	No coho salmon reported		
1989	9/8 to 10/22	1	7	8
1990	9/8 to 10/28	1	6	7
1991	9/10 to 11/5	0	3	3

*Total numbers of coho salmon observed should not be construed as escapement values as the weir was removed prior to the peak adult coho salmon migration.

Coho salmon spawning surveys were initiated in the Scott River watershed in the fall 2001/winter 2002 spawning year (Maurer 2002), and have been conducted yearly since then to provide annual estimates of returning adult SONCC coho salmon (Siskiyou Resource Conservation District (SRCD) website). Installation of a video weir by CDFG on the Scott River in 2007 has allowed for better estimation of returning adult coho salmon to the Scott River. Figure 36-2 and shows recent adult return data, reported by CDFG.

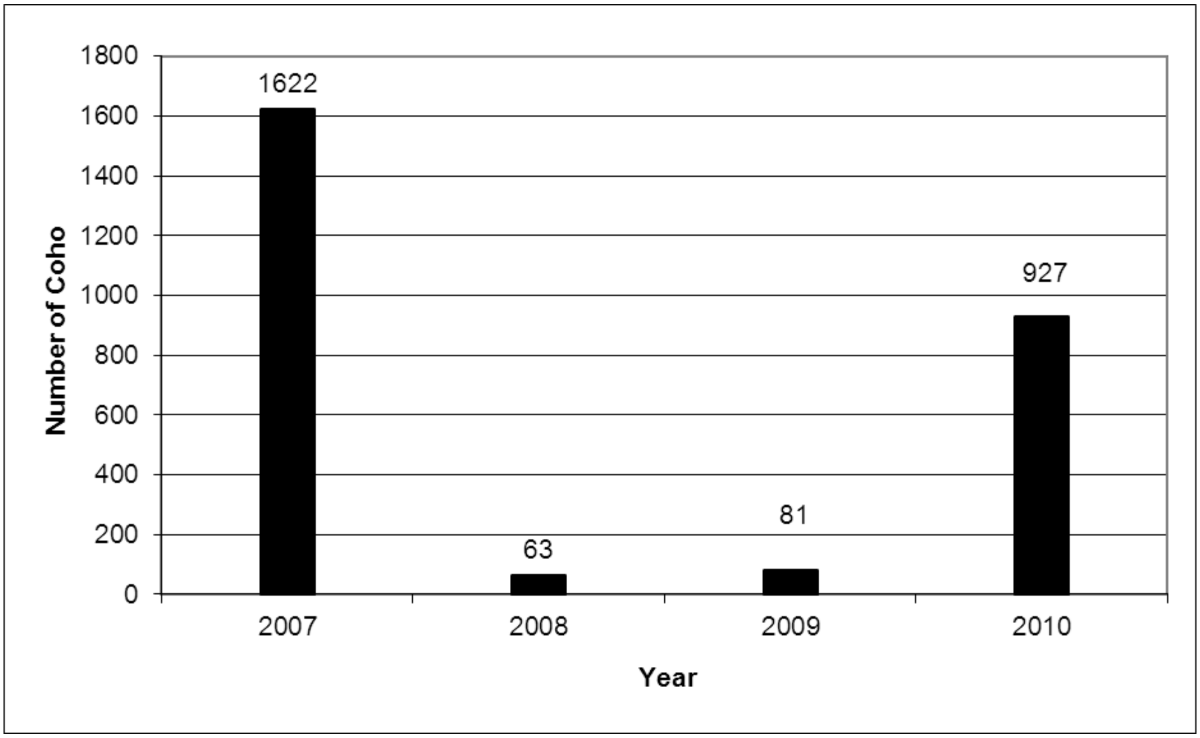

Figure 36-2. Video weir estimates of adult coho salmon. The Scott River population estimates for 2007 to 2010. (Data from M. Knechtle, CDFG.)

36.3 Status of Scott River Coho Salmon

Spatial Structure and Diversity

The diversity and complexity of the physical and environmental conditions found within the Scott River basin have contributed to the evolutionary legacy of coho salmon in the SONCC ESU, and contributed to this population being considered a Functionally Independent population (Williams et al. 2008). Juvenile fish have been found rearing in the mainstem Scott River, East Fork Scott River, South Fork Scott River, Shackleford Creek and its tributary Mill Creek, Etna Creek, French Creek and its tributary Miners Creek, Sugar Creek, Patterson Creek, Kidder Creek, Canyon Creek, Kelsey Creek, Tompkins Creek, and Mill Creek (near Scott Bar) (SSRT 2003, Yokel 2006, CDFG 2008a). Routine fish surveys of the Scott River and its tributaries have been occurring since 2001, and in French Creek from 1992 to 2005 (CDFG 2006). This monitoring has documented the varying strength of the three coho salmon brood years and coho salmon presence in 11 tributaries, with the six most productive of these tributaries consistently sustaining rearing salmon juveniles in limited areas. The other five tributaries do not consistently sustain juvenile coho salmon, indicating that the diversity of this population is restricted by available rearing habitat.

Population Size and Productivity

Williams et al. (2008) determined at least 441 coho salmon must spawn in the Scott River each year to avoid such effects of extremely low population sizes. Continuing adult spawning surveys and fish counting weir information that restarted in 2007 indicate adult spawning coho salmon number approaching 1,000 or more every third brood year (Figure 36-2), with abundance numbers ranging from 60 to 80 during other two brood years.

Table 36-3 shows coho salmon yearling outmigrant point estimates, adult coho salmon abundance estimates, the ratio of outmigrant yearlings to adult returns, and the percent of yearling outmigrants that successfully returned to the Scott River Basin, for brood years 2004 to 2008.

Table 36-3. Yearling coho salmon outmigrant abundance. Adult coho salmon abundance estimates, ratio of outmigrant yearlings to adult returns, and proportion of outmigrant yearlings returned as adults, by Scott River brood years, 2004-2008 (Knechtle and Chesney 2011).

Brood Year	Yearling Year	Yearling Point Estimate	Adult Year	Adult Estimate	Yearlings to Adult	Percent Yearling Survival
2004	2006	75097	2007	1622	46.30	2.16
2005	2007	3931	2008	62	63.40	1.58
2006	2008	941	2009	81	11.62	8.61
2007	2009	62207	2010	927	67.11	1.49
2008	2010	2174	2011	37 /2	58.94 /2	1.74 /1

/1 Average percent yearling survival from brood years 2004, 2005 and 2007.
/2 Projected adult estimate and yearling to adult ratio based on yearling point estimate of 62,207 and average percent yearling survival from brood years 2004, 2005 and 2007.

Extinction Risk

Williams et al. (2008) determined that at least 20 coho salmon per-IP km of habitat are needed (8,800 total spawners) to approximate the historical distribution of Scott River coho salmon and habitat. The Scott River coho salmon population is currently low and unstable, typically less than the 441 spawners that are necessary to avoid the effects of low population sizes. Additionally, data shows that only one out of three brood years has abundance numbers over 100 individuals, making the chances of extinction even higher if a catastrophic event, such as a flood, impacts the stronger brood year. Recurring past flooding could be responsible for the current weakness of the other two brood years. Juvenile fish numbers are reduced by stranding as summer flows recede and rearing habitat disappears, constraining both diversity and spatial structure. Based on the criteria set forth by Williams et al. (2008) the Scott River population is at high risk of extinction. This conclusion is based on the small population size of the natural population (below the low risk spawner threshold), and continuing low and static productivity of all three brood years. Therefore, all four population viability parameters are impaired.

Role in SONCC Coho Salmon ESU Viability

The Scott River population is considered to be a "functionally Independent" population within the Interior Klamath diversity stratum, meaning that it was sufficiently large to be historically viable in isolation and historically had demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005, Williams et al.

2006). The Scott River is also a core population, due to its location in the most eastern part of the ESU, its delayed interior basin run timing, its large run size compared to other SONCC coho salmon populations (Brown et al. 1994), and its unique life history traits. As a core population, the recovery target for the Scott River population is for it to be viable, and to have a low risk of extinction according to population viability criteria. Sufficient spawner densities and spatial structure/distribution are needed to maintain connectivity and diversity within the stratum, and will need to be confirmed by future monitoring if the Scott River population is to sustain its historical contribution to the viability of the ESU.

36.4 Plans and Assessments

Siskiyou Resource Conservation District (RCD)

The Siskiyou RCD works to identify and address conservation and restoration needs through voluntary landowner and resource user participation, and by providing technical, financial, and educational leadership, primarily within the Scott River Basin. The Siskiyou RCD performs an extensive array of projects to protect the natural resources and the rural lifestyle of the Scott River watershed. RCD projects include agricultural and diversion improvement, barrier removal, riparian protection and enhancement, water conservation, fisheries and wildlife habitat improvement, water quality monitoring, and biological monitoring.

Scott River Watershed Council

Scott River Watershed Council Strategic Action Plan
http://www.scottriver.org/planning-analysis-2/

This action plan sets priorities for future actions and practices to restore and manage Scott River basin resources, emphasizing salmonids. This plan builds on previous Fall Flows (Scott River Watershed Council (SRWC) 1999) and Fish Habitat & population (SRWC 1997) studies, emphasizing restoration of native anadromous fish stocks. The action plan includes: analysis of current and historic conditions, identification of limiting factors, data and restoration needs (including type and location), prioritization of restoration project opportunities, and monitoring plans. A 2005 draft version of a limiting factor analysis (LFA) of the Scott River coho salmon population was included as an appendix to the Strategic Action Plan, and an update of this LFA began in 2011.

Scott River Water Trust

The Scott River Water Trust was established in 2006, and continues its efforts to improve stream flow in priority fish habitat reaches of the Scott River and its tributaries. This is accomplished through voluntary water leases and instream dedications of water with agricultural water users in the Scott Valley.

Scott River Fire Safe Councils

Northern California Resource Center (NCRC)

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish and Game Commission in February 2004. This report contains specific pilot program recovery recommendations for coho salmon in the Scott River Watershed that include: improved water management/water use efficiency, water augmentation, improved habitat management, protection, assessment and monitoring, and outreach and education. The recommendations developed by CDFG for the Scott River have been considered and incorporated into the recovery strategy and list of recovery actions for this population. Recent CDFG efforts to institute a programmatic watershed-wide permitting program with take coverage for agricultural water users in the Scott Basin has been terminated by Superior Court decision, having deemed the program insufficient to ensure CESA and CEQA protections.

Total Maximum Daily Loads
http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/scott_river/

Federal regulations require that a total maximum daily load (TMDL) be established for 303(d) listed water bodies for each pollutant of concern. In December 2003, the EPA published the final Total Maximum Daily Loads (TMDL) for temperature and sediment for the Scott River. On December 7, 2005, the North Coast Regional Water Quality Control Board adopted Resolution No. R1-2005-0113, amending the Water Quality Control Plan for the North Coast Region (Basin Plan) to include the Action Plan for the Scott River Watershed Sediment and Water Temperature Total Maximum Daily Loads. The TMDL and Action Plan set load allocations and assigned implementation responsibilities. The Regional Water Board is required to develop measures which will result in implementation of the TMDLs.

Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program
http://www.krisweb.com/biblio/gen_usfws_kierassoc_1991_lrp.pdf

In 1987, Congress adopted the “Klamath Act” (Public Law 99-552) which authorized a 20-year long Klamath River Basin Conservation Area Restoration Program to help rebuild anadromous fish populations in the basin. The “Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program” was produced by the Kier Associates for the Task Force in 1991. This plan emphasized diversion improvement / barrier removal to provide fish passage, spawning survey assessments, watershed education, and communication.

U.S. Forest Service – Klamath National Forest

Watershed and Road Analyses by the Klamath National Forest

The KNF completed the Callahan (USFS 1997b) and Lower Scott Watershed Analyses (USFS 2000d) that assess resource conditions in the uplands of the southern and northern boundaries of the Scott River basin. The KNF has also completed a Forest-wide Roads Analysis (USFS 2002) that provides recommendations for road maintenance, road closures, and road decommissioning projects to reduce road-related erosion on KNF-managed lands. Prioritized road stormproofing and decommissioning on KNF-managed lands in the Scott River watershed is ongoing. Completion of the KNF's Watershed Condition Framework in 2011 resulted in the selection of the Sugar Creek 6^{th} field watershed for focused restoration activity in the Scott Basin during the next five years.

Sufficiency Assessment: Forest Service and Bureau of Land Management Programs in Support of SONCC Coho Salmon Recovery (USFS and BLM 2011)

The USFS has adopted a Watershed Condition Framework assessment and planning approach (USFS and BLM 2011). The Watershed Condition Framework (WCF) is a comprehensive approach for proactively implementing integrated restoration on priority watersheds on national forests and grasslands. The WCF provides the Forest Service with an outcome-based performance measure for documenting improvement to watershed condition at forest, regional, and national scales. As part of the WCF, Sugar Creek was identified as a high priority 6th field subwatersheds in the Klamath National Forest (USFS and BLM 2011).

French Creek Watershed Advisory Group

Created in 1990 as pilot study for the State Board of Forestry, the 12-member French Creek WAG comprising landowners and agencies has worked cooperatively to reduce excessive granitic sediment mobilization to French Creek. The WAG developed and approved a Road Management Plan in 1992, then a Monitoring Plan and a Fuel and Fire Management Plan. Road rehabilitation work on public and private roads has included outsloping and rocking sections of upslope roads that would have a high delivery rate of sediment to the French Creek and its tributaries.

36.5 Stresses

Table 36-4. Severity of stresses affecting each life stage of coho salmon in the Scott River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Hydrologic Function[1]	Very High	Very High	Very High[1]	Very High	Medium	Very High
2	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	Very High	Medium	Very High
3	Impaired Water Quality	Very High	High	High	High	Very High	Very High
4	Impaired Estuary/Mainstem Function	-	Low	High	Very High	Very High	Very High
5	Lack of Floodplain and Channel Structure	Low	High	Very High	High	High	Very High
6	Altered Sediment Supply	Very High	Very High	Medium	Medium	High	High
7	Adverse Hatchery-Related Effects	Medium	Medium	Medium	Medium	Medium	Medium
8	Increased Disease/Predation/Competition	Low	Low	Low	Medium	Medium	Low
9	Barriers	-	Low	Medium	Low	Low	Low
10	Adverse Fishery Related Effects	-	-	-	-	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The limiting stresses for the Scott River coho salmon population are the degraded riparian habitat conditions, altered hydrologic function, lack of floodplain and channel structures and the impaired water quality that is occurring throughout the system. These stresses are limiting the fitness and survival of juvenile coho salmon throughout the Scott River basin, by decreasing access to off channel rearing habitat, creating stressful and lethal water quality conditions, decreasing water quantity and spawning habitat, and disconnecting floodplains and other off channel rearing habitat. The juvenile life stage is currently the limiting life stage for continued viability and success of the Scott River coho salmon population (CDFG 2004b, SRWC 2005b).

Numerous water diversions, associated small diversion dams and interconnected groundwater extraction for agricultural purposes, and the diking and leveeing of the mainstem Scott River have reduced summer and winter rearing habitat in the Scott River basin, limiting juvenile success. Although rearing habitat still exists in some tributaries, access to and from these areas is hindered by dams and diversions, the existence of alluvial sills, and the formation of thermal barriers at the confluence of tributaries and stagnant, disconnected pools in summer. Where passage is possible, juvenile fish can reach thermal refugial pools and tributaries where the water temperature is several degrees cooler than in adjacent channels. A list of these known thermal refugia for rearing is in Table 36-5 (Yokel 2006). These refugial areas occur in reaches with high IP values and are vital to the continued existence and success of coho salmon in the Scott River.

Table 36-5. Potential refugial areas within the geographic boundaries of the Scott River population.

Subarea	Stream Name	Subarea	Stream Name
Scott Bar	Scott River from Boulder Creek to Tompkins Creek	**Scott Valley**	Shackleford/Mill Creek
Scott Valley	French Creek	**Scott Bar**	Canyon Creek
Scott Valley	Patterson Creek	**Scott Bar**	Kelsey Creek
Scott Valley	Kidder Creek	**Scott Bar**	Tompkins Creek
Scott Valley	South Fork & East Fork Scott River		

Altered Hydrologic Function

Altered hydrologic function presents a very high stress for all life history stages, with the exception of the adult stage, which is moderately affected by this stress. Water quantity and flow regime is poor in the southern portion of the Scott Valley from Etna Creek around to Noyes Valley Creek. The East Fork Scott River often becomes nearly dewatered during the summer, due to water diversion. Portions of the Scott Canyon area upstream from River Mile 15, in contrast, have fair water quantity (North Coast Regional Water Quality Control Board (NCRWQCB) 2004). Numerous legal and some illegal water diversions and withdrawals occur throughout the basin, decreasing summer flows, increasing water temperature to lethal levels, and generally extending the period of surface flow disconnection on the valley floor. Termination of Department of Water Resources watermaster service at the end of 2011 will cause interruption in consistent water master service associated with the three water decrees in the basin, until a new Scott/Shasta Special Water Master District begins operation. This may result in unquantified surface and groundwater withdrawals in many areas. Gauging and observational data indicate, and the 1980 Scott River Decree requires that a minimum flow of at least 30 cfs must be achieved at the River Mile 21 USGS gage to provide both surface connectivity in the mainstem Scott River from the Canyon area up into the Scott Valley floor (Sommarstrom 2010) and sufficient flows for salmonids. Surface flows of approximately 40 cfs must be achieved to ensure volitional migration of salmonids throughout the Scott Valley floor (Pisano 2010). Currently, valley-wide agricultural water withdrawals and diversions, groundwater extraction, and drought have all combined to cause premature surface flow disconnection along the mainstem Scott River. In addition, summer discharge has continued to decrease significantly over time, further exacerbating detrimental effects on coho salmon in the basin. These conditions restrict or exclude available rearing habitat, elevate water temperature, decrease fitness and survival of over-summering juveniles, and sometimes result in juvenile fish strandings and death.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions, caused by conversion of historic valley floor wetlands and riparian corridors to agricultural lands, pose a very high stress to all juvenile life stages and a medium stress to adults. Stream corridor shade is generally poor on the Scott Valley floor, due to both the crowding of agricultural fields up against the bank of the Scott River, and insolation exposure caused by the north-south orientation of the mainstem Scott River from Callahan downstream to Ft Jones, CA. Further downstream, the Scott Canyon area has fair to good shade cover, but spawning and rearing habitat is limited due to the steeper terrain. Dredge mining ended around 1950, but many riparian areas in the Scott River basin remain poorly vegetated, incised, and erodible up to the present day (USFS 1997b). This is especially apparent along the nearly five mile long “tailings pile reach” of the Scott River downstream from Callahan. Floating dredge operations there have reconfigured the entire valley floor, confining the active Scott River channel to one side of its historic floodplain.

The clearing of extensive beaver-occupied wetlands and swamp forests, which once covered much of the Scott Valley, has resulted in relict valley riparian forests that are often devoid of canopy cover, or at best, dotted with willow, alder, and cottonwood clumps. This has reduced channel margin habitat and associated cover, which is favored by juvenile coho salmon, while increasing solar exposure and water temperature during the summer and early fall. Also, straightening, rocking, and confinement of channels on the valley floor has resulted in high intensity, bank-eroding flood events that have carried away remaining riparian vegetation and soil from riparian gallery forests, creating additional areas lacking riparian vegetation and further increasing water temperatures (CDFG 2004b, SRWC 2005a).

Impaired Water Quality

Water quality is a high to very high stress for all life history stages and is caused by the degraded riparian forest condition, extensive agricultural and grazing activities, and over allocated water withdrawal occurring throughout the basin. High water temperatures, increased nutrient and sediment loading, and pollution inputs from grazing cattle have created poor water quality conditions in many side channel and off-channel rearing areas used by coho salmon. Although water quality has been found to be good in some tributaries, water quality conditions are poor overall and are stressful for juvenile fish throughout summer and much of the fall (NCRWQCB 2004, Bowman 2010).

Benthic macroinvertebrate richness and Ephemeroptera/Plecoptera/Tricoptera taxa metrics range from fair to poor in Kelsey and Tompkins creeks, but are very good in much of lower Canyon Creek and upper French Creek. Water temperatures in the summer are poor throughout the mainstem Scott River, Wildcat Creek, Patterson Creek, and lower French Creek, while water temperatures are generally fair (current indicator status 16.74 ^{o}C) in the upper reaches of other perennial tributaries. Water quality degrades continuously through the summer in the Scott River, and also in the terminal reaches of its tributaries. By July, lethal water temperatures of 80 ^{o}F (26.7 ^{o}C) routinely occur in the mainstem, including portions of the Scott River Canyon (Chesney and Yokel 2003). pH levels have been reported as poor near the mouth of the Scott River and fair where the lower Scott Valley enters the Scott River Canyon. Dissolved oxygen has been measured as poor in both the Scott River Canyon reach and near the mouth of the Scott River. All of these water quality impairments reduce juvenile survival through the summer and decrease the viability of the population overall.

Impaired Estuary/Mainstem Function

This stress refers to the estuary and mainstem conditions in the Klamath River, since this population is part of a larger basin containing multiple populations. Degraded mainstem conditions in both the Scott River and the Klamath River create a low stress for fry, a high stress for juveniles, and a very high stress for smolts and adults. Mainstem conditions in the Scott River contribute to this stress because of reduced water quality, sedimentation, channel aggradation, and degraded habitat in mainstem reaches. Conditions in the Klamath River mainstem and estuary are important to this population since all salmon that originate from the Scott River migrate to and from the ocean through the mainstem Klamath River and the Klamath River estuary. This can be detrimental for juveniles when high concentrations of *C. Shasta*, *P. minibicornis*, and other pathogenic diseases are occurring. Additionally, because of the long distance that this population must travel to and from the ocean, the time spent in the mainstem Klamath River increases stresses associated with mainstem conditions and residence time.

The degraded conditions that exist throughout the Klamath basin today may mean that the estuary plays an enhanced role for all Klamath anadromous fish populations, by providing the opportunity for juvenile and smolt growth and refuge prior to entering the ocean (Wallace 1995). Juveniles, smolts, and adults transitioning through mainstem and estuarine habitat are stressed by the degraded conditions in these migratory zones, suffer from the lost opportunities for increased growth, and consequently experience a lower survival rate. The loss and degradation of estuarine and mainstem habitat is considered a high to very high stress for the population, with the most affected life stages being juveniles, smolts, and adults, due to degradation of rearing and migratory habitat. Although the estuary is short and small compared to the large size of the watershed, it does provide numerous habitat types and rearing habitat for juvenile coho salmon. The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain. Levees along the Lower Klamath and development on the floodplain have led to the loss and degradation of habitat in the estuary. More information about the Klamath River estuary can be found in the Lower Klamath population profile.

Lack of Floodplain and Channel Structure

The ongoing alteration of floodplain and channel structure from mining and other anthropogenic activities has reduced complex channel margin and pool habitat availability, disconnected the floodplain from the adjacent channel, and simplified instream habitat throughout the Scott River basin, creating a high stress for all life stages except for the egg stage. In many locations, especially along the mainstem Scott River near Callahan, Oro Fino Creek and in lower Kidder Creek, large areas have been stripped of vegetation and the remaining gravel deposits have been hydraulically or mechanically worked to retrieve deposited gold and/or aggregate. These activities have left a legacy of unvegetated, heavily disturbed gravel deposits mostly devoid of soil and have caused disconnections between floodplains and instream channel habitats.

Coho salmon need channel margins, complex woody debris and associated deep pools to rear in and for adults to rest in while migrating upstream. Monitoring data indicates that pool frequency is poor throughout the watershed, while pool depth varies from poor in Miners Creek to good or very good in French Creek. While it is encouraging that pool depth in some areas is good or very good, these areas may not always be accessible to rearing salmonids due to poor water quality conditions that create thermal barriers, and due to sediment deposition coupled with low flows that create physical barriers. Compounding these issues is a lack of woody debris, both large and small, which is also an important component of rearing habitat, as it creates complex channel structure. Woody debris is lacking throughout the mainstem Scott River and its tributaries. Surveys assessing rearing habitat associated with complex woody debris confirm juvenile coho salmon presence around woody debris, and that such debris recruitment is lacking both in the Scott Valley and along tributary reaches above the valley floor (Yokel 2006).

Altered Sediment Supply

Altered sediment supply occurring in the Scott River imposes a medium stress to juvenile, smolt, and adult coho salmon, and a very high stress to the egg and fry coho salmon life history stages. The movement of fine sediment into streams can cause substrate embeddedness, preventing spawning and smothering eggs in redds. Additionally, excessive levels of fine sediment in pools and low gradient reaches of the Scott River and its tributaries also reduce the amount of rearing habitat available for juvenile coho salmon. While unaltered background levels of sediment were around 10 percent volumetrically, monitoring in the French Creek watershed has shown large fluctuations in the percentages of fine sediment occurring in this watershed. Data from the early 1990s indicate a high of 32 percent fine sediment occurring in French Creek at one time, then subsiding to a healthy sustained level of less than10 percent, with a temporary increase to 17 percent occurring following the 1997 flood (Power 2001, Sommarstrom et al. 1990). More recent monitoring indicates that there is still a large percentage of fine sediment in the channel substrate in the upper portions of French Creek, which is one of the two most productive spawning and rearing tributaries in the Scott River basin.

Excessive fine sediment loading was also found to cause poor substrate conditions in Miners (French/Miners) Creek, Sugar Creek and the lower mainstem of the Scott River. The largest causes of the altered sediment supply throughout the Scott River are the high density of unpaved and unmaintained roads and other compacted surfaces, unstable lands, and streamside degradation, which all mobilize excessive fine sediment into the mainstem Scott River and its tributaries. Large areas of erosive decomposed granite originating from slopes on the west side of the Scott Valley contribute to these high percentages of fine sediment in channel substrate. These unstable conditions are exacerbated by detrimental anthropogenic land uses occurring throughout the basin. Fine sediment levels in lower Etna Creek are considered fair, although this decrease in fine sediment may be the effect of the sediment sampling location not being in a depositional reach, rather than a true reduction in sediment supply.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. A small egg collecting station operated on Shackleford Creek from 1925 to 1940 (Leitritz 1970). No hatcheries or artificial propagation occur in the Scott River basin, but Iron Gate Hatchery is about 50 miles (80.5 km) upstream of the mouth of the Scott River, within the Klamath River basin. Juvenile fish often outmigrate from the Scott River into the Klamath River when they are still undersized, to escape rising spring water temperatures. These juvenile outmigrants encounter large numbers of released Iron Gate hatchery fish also utilizing cold water refugia along the mainstem Klamath River and experience competition for prey resources and exposure to disease. A limited survey of Scott River spawning grounds occurred in 2004, 2005, 2008, 2009, and 2010; in most years, no hatchery fish were observed (Quigley 2005, Siskiyou RCD, CDFG). Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of Iron Gate Hatchery and Trinity River Hatchery in the Klamath basin (Appendix B)

Increased Disease/Predation/Competition

Increases in disease, predation, and competition present a medium stress for smolt and adult life history stages, and a low stress for egg, fry, and juvenile life history stages. This stress increases as anadromous fish health is reduced by elevated water temperatures during the spring and summer. Warm water temperatures make fish more susceptible to diseases, and decrease fitness levels and the ability to fend off predators and competitors, including non-native piscivorous fish. Elevated mainstem temperatures force juvenile fish into the remaining cold water refugia (e.g., portions of the so-called "thermal reach" from the USGS Scott River gage to Townsend Gulch) where increased competition occurs for limited resources. If juvenile fish are forced into the Klamath River, they are exposed to disease and are vulnerable to other wildlife.

Juvenile fish are exposed to a variety of pathogens including *Ceratomyxa shasta* which leads to ceratomyxosis, *Flavobacterium columnare* (columnaris), aeromonid bacteria *Nanophyetus salmonicola*, and the kidney myxosporean *Parvicapsula minibicornis* (Federal Energy Regulatory Commission 2007). Actinospore concentrations of both *C. Shasta* and *P. minibicornis* in the mainstem Klamath River are often above the threshold necessary to induce infection and disease (Stocking et al. 2006, Nichols and True 2007) and have been shown to infect juveniles inhabiting the mainstem river in this area. By late spring and summer, both diseased hatchery and wild juveniles are seen dead or moribund in Klamath River screw traps.

Barriers

Barriers present a medium stress for juvenile coho salmon, and a low stress for fry, smolt and adult life history stages. Diversion dams, small impoundments, and road/stream crossings pose partial or complete barriers to high IP habitat in the following Scott River basin locations. Big Mill Creek, a tributary to the East Fork Scott River, has a complete fish passage barrier caused by down cutting at a road culvert outfall. The Big Mill Creek site can be corrected by returning Big Mill flow to its original channel, but this has been delayed until the landowner can be assured necessary access to private property across Big Mill Creek. Rail Creek, another tributary to the East Fork Scott River, poses a complete fish passage barrier and impoundment, caused by an irrigation pond levee. A project to provide fish passage at Rail Creek has been developed, but its implementation has been postponed while an analysis is done to determine if the 0.7 mile of upstream habitat to be regained justifies the project's expected cost. The Scott Valley Irrigation District's Youngs Dam has been outfitted with a fishway that needs correction to ensure fish passage in varying flow conditions. The City of Etna's municipal water diversion dam on Etna Creek effectively blocked fish passage into upper Etna Creek, but this dam was retrofitted with a volitional fishway in 2010. Work has been done recently to convert seasonal gravel push up dams to boulder weirs and the evaluation and upgrading of previously constructed boulder vortex weirs is ongoing. There are currently three known vortex weirs within SONCC coho salmon critical habitat in Shackleford and French Creeks that require treatment to ensure complete fish passage. Passage at the first of these weirs in French Creek is to be upgraded in 2012.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

36.6 Threats

Table 36-6. Severity of threats affecting each life stage of coho salmon in the Scott River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Agricultural Practices	Very High	Very High	Very High	Very High	Very High	Very High
2	Dams/Diversion	Medium	Very High	Very High	Very High	Very High	Very High
3	Channelization/Diking	Very High	Very High	Very High	High	High	Very High
4	Timber Harvest	Very High	Very High	High	High	High	Very High
5	Climate Change	Very High	Very High	Very High	Very High	Medium	Very High
6	Roads	High	High	High	High	High	High
7	High Intensity Fire	High	High	Medium	Medium	Medium	High
8	Hatcheries	Medium	Medium	Medium	Medium	Medium	Medium
9	Mining/Gravel Extraction	Medium	Medium	Medium	Medium	Medium	Medium
10	Urban/Residential/Industrial	Medium	Medium	Medium	Medium	Medium	Medium
11	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
12	Fishing/Collecting	-	-	-	-	Low	Low

[1]Invasive Non-Native/Alien Species is not considered a threat to this population

Agricultural Practices

Agricultural practices are a very high threat to all life history stages, and therefore have a very high overall threat ranking. Subbasins of the Scott Valley floor where pasture/hay and cultivated crops comprise more than 10 percent of the landscape include Clark Creek, lower Johnson

Creek, lower Patterson Creek, lower Kidder Creek, Rattlesnake Creek, and lower Shackleford /Mill creeks. These subbasins have become altered by the high percentage of agricultural land occurring within them. Grazing and other ranching activities are pervasive throughout the lower portions of the Scott Valley. Where exclusionary fencing has not been installed and maintained, approximately 20 percent of all pastures/fields adjacent to stream channels (Black 2011), these activities still contribute to increased bank erosion, degradation of riparian vegetation, and alteration of instream habitat characteristics.

Agriculture and related activities have been, and continue to be the major land use within the Scott and Shasta Valleys (Van Kirk and Naman 2008). Agricultural land use currently consists of approximately 29,000 acres of irrigated land with an estimated annual irrigation withdrawal of approximately 83,500 acre feet per year (Van Kirk and Naman 2008). There has been an increase in irrigation withdrawals in the Scott Valley of 115 percent between 1953 and the period 1988 to 2001, which was accompanied by an 89 percent increase in irrigated land area. Another important shift in the recent past was the change from flood to sprinkler irrigation, which increased efficiency and reduced return flows to the Scott River (Van Kirk and Naman 2008). Currently, a large proportion (50 percent or more) of water used for irrigation comes from ground water (Van Kirk and Naman 2008). Having a recognized area of interconnected surface and groundwater (Scott River Decree 1980), has quantification and modeling of groundwater dynamics has begun via a community groundwater study plan (Harter et al. 2008), which is documenting interactions between groundwater use and water availability in adjacent riparian habitat. In most years, low flows occurring in the Scott River Basin from June to November have become more pronounced with enhanced agricultural use of water (Van Kirk and Naman 2008). Low surface flows result in elevated water temperature and loss of connectivity to side-channel and off-channel habitat areas. During the summer, and especially during critically dry periods, large portions of the mainstem Scott River become completely dry (SRWC 1997), cutting off access to summer rearing habitat in many tributaries and high IP areas. In some years, many thousands of juvenile salmon and steelhead are stranded and killed in the Scott River basin (SRWC 1997) when stream flows go subsurface in the lower reaches of Etna, Patterson, Kidder (including Big Slough), and Shackleford Creeks each summer through early fall. This drying is documented to be a natural event (Siskiyou County Historical Society 1978), but it has become exacerbated by water withdrawal in the form of seasonal agricultural diversions, groundwater pumping, and by aggradation in low gradient tributary reaches. The end result is the dewatering of miles of instream habitat, lack of access to and from rearing habitat, and poor water quality, all of which yield stressful and sometimes lethal water temperatures. Scott Valley eastside tributaries tend to be ephemeral (Mack 1958), but their lower reaches have high IP which could provide enhanced over-summering habitat to juvenile fish, with improved hydrologic connection to the Scott River channel (Figure 36-1). Unless market factors bring about changes in cropping or amount of land in production, current agricultural activities and associated water use are expected to continue, and the associated stresses discussed above will continue to be a problem for the Scott River coho salmon population.

Dams/Diversions

Dams and diversions are a medium threat to egg and fry life history stages, and a very high threat to juvenile, smolt and adult life history stages. Dams and diversions occur throughout the basin and are usually associated with agricultural practices and other ranching and grazing activities.

Multiple water diversions currently hasten surface flow disconnection in the mainstem Scott River each summer, resulting in the reduction of available rearing habitat, increases in water temperatures, fish stranding, and death. Additionally, the impoundment of water behind dams and the diversion of stream flows affects juvenile and smolt life stages by decreasing instream flows, increasing water temperatures, blocking passage to and from vital rearing habitat, and causing stranding during peak diversion times. Although virtually all diversions within SONCC coho salmon critical habitat have been outfitted with fish exclusion screens, there is no consistent screen monitoring and maintenance to ensure that bypass flows around these screens is sufficient to sustain rearing juvenile coho salmon and their habitat downstream.

Van Kirk and Naman found that late summer baseflows in the Scott River were 60 percent lower (6.541 Mm^3 versus 10.96 Mm^3) in the recent past (1977 to 2005) than in the historic period (1942 to 1976). Climate change was found to be responsible for approximately 39 percent of this decline in late summer base flow. The minimum baseflow of 30 cfs during the summer months was determined necessary for the survival of salmon and steelhead stocks within the 1980 Scott River Decree. Gaging records at Fort Jones show that it is common for discharge to fall below this level, and often below 10 cfs in drier water years. At this level of discharge, the Scott River exists as a series of stagnant pools of water inhospitable to salmonids. Water diversions for agricultural practices, groundwater extraction, cattle grazing, residential/domestic water use, and flood control have diminished surface flows and greatly reduced or eliminated access to and use of historical coho salmon habitat in the Scott Valley.

Until diversion operations are remediated, demands are decreased, and dams are removed, this threat will continue to impact the Scott River coho salmon population. Work has begun in many areas of the watershed to begin to diminish the impacts from this threat. At Youngs Dam, efforts are underway to determine how to improve/increase the range of flows at which the fishway, constructed in 2006, will ensure consistent fish passage at the dam. Rail Creek, a tributary to the East Fork Scott River, has a complete fish passage barrier and impoundment caused by an irrigation pond levee. A project to provide fish passage at Rail Creek has been developed, but its implementation has been postponed while an analysis is done to determine if the 0.7 mile of upstream habitat to be regained justifies the project’s expected cost. There are currently three known vortex weirs within SONCC coho salmon critical habitat in French and Shackleford Creeks that require treatment to ensure complete fish passage. Passage at one of these French Creek weirs is to be upgraded in 2012. All Scott Valley agricultural water diversions within the known range of Chinook and coho salmon have been outfitted with fish exclusion screens. Approximately15 irrigation diversion dams in tributaries to the Scott River continue to block steelhead passage. Priorities have been set to progressively address these remaining barriers through projects to both improve passage and properly screen all diversions within the range of anadromy.

Channelization/Diking

The channelization and diking of the Scott River mainstem and tributaries poses a very high threat to egg and fry life history stages, and a high threat to juvenile, smolt and adult life stages. Floodplain connectivity is poor (non-functional) in South Fork Scott River, Wildcat Creek, Sugar Creek, French/Miners Creeks, and Etna Creek watersheds, due to past hydrologic mining and conversion of beaver-occupied wetlands to drained agricultural lands. Floodplain connectivity is fair in the East Fork Scott River and the Scott River Canyon. In the 1930s, the US Army Corps of Engineers, at the request of Siskiyou County, removed the remaining vegetation through the middle of the valley and built levees for flood control (SRWC 1997), in turn altering the hydrology and morphology of the mainstem river and tributaries downstream. The construction and maintenance of levees disconnects floodplain habitat, alters the hydrograph throughout the system, decreases riparian vegetation success by lowering and disconnecting the water table, and increases flows during storm events. Since the construction of the first levees in the 1930s, much of the remaining mainstem Scott River has also been channelized in a continuing effort to control flood impacts and maximize acreage of agricultural lands adjacent to the river. This has destroyed low velocity margin and side channel habitat, making winter rearing habitat a significant limiting factor to juvenile coho salmon survival.

Timber Harvest

Timber harvest is a very high threat to egg and fry life history stages, and a high threat to juvenile, smolt and adult life history stages. High (25 to 35 percent of watershed harvested) and very high (>35 percent of watershed harvested) rates of timber harvest have occurred in the following tributary subbasins: Noyes Valley Creek, Mule Creek, Wildcat Creek, French/Miners creeks, Etna Creek, Moffett Creek, McAdams Creek, and lower Scott River (upper Canyon Reach). These high rates of timber harvest, though reduced since the mid-1990s, still contribute to the altered sediment supply, impaired water quality, degraded riparian forest conditions and impaired mainstem function stresses that are occurring in the Scott River basin. The Kidder Creek drainage had been extensively logged and suffered a major fire prior to a 1955 flood, when sediment and debris washed from the watershed by the flood contributed to an alluvial fan at its confluence with the Scott River. The creek flows underground through this fan for much of the year. These impacts have caused decreased pool volumes, poor water quality, disconnection of floodplain and off channel habitat, and simplification of instream habitats. Timber harvest activities have decreased in the last 15 years and upland riparian forest areas are in early stages of recovery. This recovery is expected to proceed slowly as clear cutting diminishes in favor of density-dependent thinning and understory fuels reduction, which are intended to reduce wildland fire risk and attendant sediment mobilization.

Climate Change

Climate change poses a high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. Climate change will likely decrease summer base flow, reduce summer rearing habitat, and increase irrigation demand in the Scott River basin. The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 2.7 °C in the summer and by 1.3 °C in the winter. Snowpack in upper elevations of the basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009). The vulnerability of the Klamath estuary to sea level rise is low to moderate and therefore does not pose a significant threat to estuarine rearing habitat downstream. Juvenile rearing and migratory habitat in the Scott River and mainstem Klamath is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, all populations in the ESU will be negatively impacted by ocean acidification, rising sea surface temperatures and stratification, loss of calcareous shell-forming species, which will affect prey availability (Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Roads

Roads are a high threat across all life history stages, and a significant overall threat for coho salmon in the Scott River population. These roads are virtually all unpaved forest roads that, unless receiving a high level of use, receive minimal routine maintenance. High road density in watersheds concentrates and channelizes surface runoff, resulting in slope failures and landslides, which can mobilize sediment to streams, cause substrate embeddedness, smother eggs in redds, and fill in pools. Road density is high in the following tributary subbasins, where high IP reaches predominate: South Fork Scott River, upper East Fork Scott River, French/Miners creeks, Johnson Creek, Patterson Creek, Kidder Creek, Moffett Creek, McAdams Creek, Shackleford/Mill creeks, Boulder Creek, and Scott Bar Mill Creek. In the Scott River basin, human-related land sliding averages 36 tons/mi2/yr, which significantly exceeds natural background land sliding in other neighboring watersheds (NCRWQCB 2005c). Road construction in upland areas has stabilized since the mid 1990s, providing opportunities to storm proof priority use roads and to decommission redundant roads. Currently, there are ongoing Klamath National Forest and private projects to upgrade, storm proof, and decommission roads in priority areas of the Scott River basin (USFS 2011c). While road related sediment issues remain a high threat across the basin, continuation and further funding of these efforts will likely decrease the magnitude of this threat in the future.

High Intensity Fire

High intensity fire, and the associated riparian forest habitat destruction and surface erosion to streams it causes is a high threat to both egg and fry and a medium threat to juvenile, smolt and adult life history stages. Because of past timber harvest practices, coupled with the fire-suppression efforts over the past century, understory forest fuel loads have become excessive. A wildland fire resulting from these excessive forest fuel loads occurred in the Scott River Canyon portion of the watershed in 1987 (USFS 2000d). Such fire mobilize sediment downslope to streams when they do occur, and can smother eggs in redds, decrease pool volume and habitat complexity, and create alluvial sills in tributary mouths (Maria 2002). High intensity fire risk is expected to continue into the future, until current understory fuels reduction actions have strategically treated upland areas, and a more natural fire regime is reestablished throughout the basin.

Hatcheries

Hatcheries pose a medium threat to all life stages in the Scott River basin. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

Mining/Gravel Extraction

Mining activities and gravel extraction are a medium threat to all life history stages. Effects from historic mining activities have created a legacy of impacts throughout the basin, with tailings piles and constrained active channels highlighting the altered structure of floodplains. Placer and hard rock mining continue today (USFS 2006), and are concentrated in the Canyon reach of the mainstem Scott River. A five-year moratorium on suction dredging permitting became law in California in July 2011. In response, high banking practices are becoming more common. Current gravel extraction is incrementally removing a portion of historic tailings piles along the mainstem Scott River near Callahan, may aid in the restoration of floodplain and channel connections, and a more natural hydrograph in areas downstream of the channelized reach (USFS 2006). Gravel extraction also has the potential to improve surface flow connection between the mainstem Scott River and tributaries that have been disconnected by alluvial sills, incised channels, and a lowered water table. This gravel can be relocated to nearby river reaches that currently require substrate enhancement for improved spawning habitat conditions.

Urban/Residential/Industrial Development

Urban/residential/industrial development is a medium threat to all life history stages. The human population of the Scott Valley has grown from 2,900 in 1930 to nearly 8,000 in 2000 (SRWC 2005a), which represents 1,800 acre feet of annual water use, at 200 gallons per person per day. In contrast, current irrigated agriculture/pasture uses approximately 81,070 acre feet of annual water diversion/withdrawal for 29,000 acres (Van Kirk and Naman 2008). This usage is expected to continue without major change for the foreseeable future, due to the Scott Valley's relative isolation. The Scott Valley Area Plan and Environmental Impact Report (SRWC 2005a) projected the Scott Valley population to reach 18,000 by 2010, but the actual population size at this time is less than half of this estimate. While human population growth is currently stable or even decreasing in the Scott Valley, establishment of center pivot irrigation systems using groundwater, and development of small ranches are increasing demand for water. Much of this demand is met through shallow groundwater wells, or through exercise of adjudicated in-stream diversions, which can markedly reduce stream flows during summer low-flow periods. Water use associated with rural residential development along tributaries to the Scott River may result in pronounced reductions in tributary summer surface flows. The number of domestic drilled wells increased from 108 to 913 between 1970 and 2002 (SSRT 2003) and this growth in groundwater use is likely to continue into the future, representing a continued threat to the Scott River coho salmon population.

Road-stream Crossing Barriers

Road-related barriers are a low threat to all life history stages, with the exception of the egg stage which is not affected by such barriers. Available information in the Passage Assessment Database on the Calfish.org website and on the 5 Counties website indicate several road/stream crossings that require fish passage evaluation to determine necessary follow-up treatment (Table 36-7). The Hwy 3/Big Mill Creek road/stream crossing is a Caltrans facility located within SONCC coho salmon critical habitat, and is a high priority for treatment. Remediation of this barrier can be accomplished by returning Big Mill Creek flow to its original channel, but this has been delayed until the landowner can be assured necessary access to property across Big Mill Creek. There are currently no passage barriers within coho salmon critical habitat located on the U.S. Forest Service roads system in the Scott River basin.

Table 36-7. List of road/stream crossing barriers, Scott River basin

IP priority	Stream Name	Road Name	Subbasin	Miles of habitat
1	Big Mill Creek	State Hwy 3	East Fork Scott River	1.5
1	Meamber Creek	Scott River Road	Lower Scott River	1.0
1	Sniktaw Creek	Big Meadows Road	Lower Scott River	2.0
1	Little Jackson Creek	Forest Service Road	South Fork Scott River	
1	West Boulder Creek	Forest Service Road	South Fork Scott River	
2	Kangaroo Creek	Forest Service Road	East Fork Scott River	
2	Tiger Fork	Forest Service Road	Sugar Creek	
2	Duzel Creek #1	Duzel Creek Road	Moffett	
2	Soap Creek	Hwy 3	Moffett Creek	

The number and kind of passage barriers associated with road-stream crossings on private land in the Scott River basin are unknown but potentially significant, given that many private roads cross high-IP reaches on the valley floor (e.g., lower Scott Bar Mill Creek-road crossing). Access to private land to inventory these crossings remains limited.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath/Trinity basin. The effects of the fisheries managed by the State of California and the Yurok and Hoopa Tribes, on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Scott River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU

36.7 Recovery Strategy

Sustained efforts to restore aquatic habitat condition and function have been occurring on the Scott Valley floor and in upland areas since the 1970s (USFS 2000d, SRWC 2005a). Coho salmon in the Scott River basin, including the relatively productive 2010 brood year, are severely depressed in abundance, with a restricted distribution. Unless agricultural water use efficiency increases, water use is reduced, floodplain and channel structure is reestablished, and riparian habitat is restored, instream flows and riparian ecosystem functions are expected to remain in degraded condition. Fenced stream reaches on the Scott Valley floor and along its tributaries are in an early seral state of recovery, although riparian canopy, large wood recruitment processes, and complex stream habitat will take decades to recover. Sediment loads resulting from agriculture-related channel alteration, degraded roads and compacted surfaces continue to impair salmon habitat. Residential development in the valley and lower tributary reaches of the watershed, many miles of untreated private roads, and ongoing stream channelization and straightening will continue to present a threat from sediment inputs into stream channels.

Recovery activities in the watershed should be aimed at continuing to increase spatial distribution, productivity and abundance. Where possible, activities should occur watershed-wide, with a focus on those tributaries with high IP values. Recovery activities that enhance and extend surface flow connectivity to ensure sufficient instream flows should be given priority, along with efforts to increase summer and winter rearing habitat, and reduce lethal stream temperatures and fine sediment mobilization. Specific goals for each stressor are listed in the recovery actions that follow. These goals identify activities that are expected to reduce the stresses currently affecting the Scott River SONCC coho salmon population.

Table 36-8 on the following page lists the recovery actions for the Scott River population.

Table 36-8. Recovery action implementation schedule for the Scott River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ScoR.2.2.20	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide	2
SONCC-ScoR.2.2.20.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-ScoR.2.2.20.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-ScoR.2.2.21	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Restore natural channel form and function	Scott River including Westside Channel and Wolford Slough areas	2
SONCC-ScoR.2.2.21.1	*Identify and prioritize mining reaches, developing a plan to restore the floodplain and channel by removing tailing piles and reconstructing the channel*					
SONCC-ScoR.2.2.21.2	*Remove tailing piles and reconstruct the channel, guided by the restoration plan*					
SONCC-ScoR.2.2.22	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	3
SONCC-ScoR.2.2.22.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-ScoR.2.2.22.2	*Implement beaver program (may include reintroduction)*					
SONCC-ScoR.2.2.24	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Population wide	2
SONCC-ScoR.2.2.24.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-ScoR.2.2.24.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-ScoR.2.1.25	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2
SONCC-ScoR.2.1.25.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-ScoR.2.1.25.2	*Place instream structures, guided by assessment results*					
SONCC-ScoR.3.1.1	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Population wide	2
SONCC-ScoR.3.1.1.1	*Identify, map, and quantify all surface water diversions*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ScoR.3.1.1.2	*Secure dedicated unused water diversion rights*					
SONCC-ScoR.3.1.1.3	*Verify permitted water diversions and bring water mastering allocations into compliance with CA state water law, including place of use restrictions*					
SONCC-ScoR.3.1.2	Hydrology	Yes	Improve flow timing or volume	Monitor flow for compliance	Population wide	2
SONCC-ScoR.3.1.2.1	*Install flow measuring devices*					
SONCC-ScoR.3.1.2.2	*Maintain all flow measuring devices*					
SONCC-ScoR.3.1.2.3	*Install head gates and NOAA Fisheries compliant fish exclusion screens on all water diversions in coho salmon habitat*					
SONCC-ScoR.3.1.3	Hydrology	Yes	Improve flow timing or volume	Manage flow	Population wide	3
SONCC-ScoR.3.1.3.1	*Water master all irrigation water diversions*					
SONCC-ScoR.3.1.3.2	*Implement water mastering allocations compliant with applicable water law*					
SONCC-ScoR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Improve water management techniques	Population wide	3
SONCC-ScoR.3.1.4.1	*Develop integrated water management plan and water budget, including identifying the relationship between groundwater and surface flow*					
SONCC-ScoR.3.1.4.2	*Improve water use efficiency through the investigation and implementation of alternative agricultural crops and practices (e.g., grass fed beef, winter wheat, alternative pasture crops)*					
SONCC-ScoR.3.1.4.3	*Upgrade and expand alternative stock watering systems to increase instream flows*					
SONCC-ScoR.3.1.4.4	*Develop and disseminate an on-farm water use efficiency monitoring system*					
SONCC-ScoR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Improve irrigation practices	Population wide	BR
SONCC-ScoR.3.1.5.1	*Apply a variety of techniques (e.g., Farm Irrigation Rating Index Model) to make irrigation system water use efficiency comparisons, and implement efficiency improvements*					
SONCC-ScoR.3.1.5.2	*Evaluate irrigation water fees/pricing in the Scott Valley, and recommend revenue neutral changes that encourage water use efficiency and/or dedications to instream flows*					
SONCC-ScoR.3.1.5.3	*Line or pipe surface irrigation ditch systems to increase efficiency, and do QA/QC to improve ditch lining/piping techniques*					
SONCC-ScoR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-ScoR.3.1.6.1	*Develop an educational program addressing water conservation programs, instream leasing and water dedication programs, and water diversion/screen connectivity in tributaries to Scott River*					
SONCC-ScoR.3.1.7	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-ScoR.3.1.7.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ScoR.3.1.8	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-ScoR.3.1.8.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-ScoR.3.1.9	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-ScoR.3.1.9.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-ScoR.3.2.10	Hydrology	Yes	Increase water storage	Increase water retention	Population wide	2
SONCC-ScoR.3.2.10.1	*Develop water storage and recharge plans that help recharge groundwater, increase summer base flows, and extend surface connectivity in tributaries to Scott River*					
SONCC-ScoR.3.2.10.2	*Implement projects identified in water storage and recharge plan*					
SONCC-ScoR.3.2.10.3	*Maintain water storage structures*					
SONCC-ScoR.3.1.42	Hydrology	Yes	Improve flow timing or volume	Secure and maintain sufficient instream flows	Population wide	2
SONCC-ScoR.3.1.42.1	*Assess water diversions, prioritize, and treat areas in need of increased flows to complement the life history requirements of coho salmon*					
SONCC-ScoR.3.1.42.2	*Use real time flow, precipitation, snowpack, groundwater, and climate information to guide Water Trust work to augment surface flows at priority locations for coho, via water leases and dedications*					
SONCC-ScoR.7.1.18	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Low gradient private lands	BR
SONCC-ScoR.7.1.18.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-ScoR.7.1.18.2	*Develop grazing management plans to meet objectives*					
SONCC-ScoR.7.1.18.3	*Plant vegetation to stabilize stream bank*					
SONCC-ScoR.7.1.18.4	*Maintain fencing or fence livestock out of riparian zones*					
SONCC-ScoR.7.1.18.5	*Remove instream livestock watering sources*					
SONCC-ScoR.7.1.19	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-ScoR.7.1.19.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ScoR.7.1.43	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Reestablish natural fire regime	Population wide, guided by assessment priorities (particularly USFS WCF 2011, in uplands on the Westside and in the Scott River Canyon)	3
SONCC-ScoR.7.1.43.1	*Identify areas prone to high intensity fire and develop a plan to reestablish a natural fire regime*					
SONCC-ScoR.7.1.43.2	*Carry out fuel reduction or modification projects such as thinning, prescribed burning, and piling, guided by the plan*					
SONCC-ScoR.10.1.14	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Increase flow	Population wide, especially mouth of Shackleford/Mill, mouth of Sugar, South Fork Scott River, Patterson, Upper Kidder,Noyes Valley, Meadow Gulch, candidate pond sites in McConnaughy Gulch, mountain catchments outside of wilderness areas	2
SONCC-ScoR.10.1.14.1	*Develop a plan to increase minimum instream flows, using flow rate information to guide priority flow augmentation sites*					
SONCC-ScoR.10.1.15	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Restore surface flow	Tributaries to mainstem Scott River, including Kidder Creek, Patterson Creek, Moffett Creek, etc.	2
SONCC-ScoR.10.1.15.1	*Develop plan to restore/enhance connectivity of surface flow between tributaries and mainstem Scott River*					
SONCC-ScoR.10.1.15.2	*Secure enhanced instream flows, especially in dry/critically dry water years*					
SONCC-ScoR.10.1.16	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Reduce warm water inputs	Population wide	3
SONCC-ScoR.10.1.16.1	*Develop a program that identifies, designs, and constructs projects that will reduce warm tailwater inputs*					
SONCC-ScoR.10.1.16.2	*Implement tailwater reduction program*					
SONCC-ScoR.10.2.17	Water Quality	Yes	Reduce pollutants	Set standard	Population wide	3
SONCC-ScoR.10.2.17.1	*Continue implementation of TMDLs for 303(d) listed water bodies*					
SONCC-ScoR.1.2.46	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ScoR.1.2.46.1	*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*					
SONCC-ScoR.16.1.28	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ScoR.16.1.28.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-ScoR.16.1.28.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-ScoR.16.1.29	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-ScoR.16.1.29.1	*Determine actual fishing impacts*					
SONCC-ScoR.16.1.29.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-ScoR.16.2.30	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ScoR.16.2.30.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-ScoR.16.2.30.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-ScoR.16.2.31	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ScoR.16.2.31.1	*Determine actual impacts of scientific collection*					
SONCC-ScoR.16.2.31.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-ScoR.27.1.32	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Evaluate impacts to coho salmon from specific restoration project types	Population wide	BR
SONCC-ScoR.27.1.32.1	*Develop a monitoring program that evaluates impacts to coho salmon from tailing pile removal, rock weir installation, and floodplain restoration projects*					
SONCC-ScoR.27.1.32.2	*Implement monitoring program, guided by the plan*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ScoR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-ScoR.27.1.33.1	*Perform annual spawning surveys*					
SONCC-ScoR.27.1.34	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-ScoR.27.1.34.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-ScoR.27.1.34.2	*Develop comprehensive PIT tagging and retrieval project that assesses habitat use and survival*					
SONCC-ScoR.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-ScoR.27.1.35.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-ScoR.27.2.36	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-ScoR.27.2.36.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-ScoR.27.2.36.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-ScoR.27.2.37	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-ScoR.27.2.37.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-ScoR.27.2.38	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-ScoR.27.2.38.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-ScoR.27.2.39	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-ScoR.27.2.39.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ScoR.27.2.40	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-ScoR.27.2.40.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-ScoR.27.2.41	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-ScoR.27.2.41.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-ScoR.27.1.45	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-ScoR.27.1.45.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-ScoR.27.1.47	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-ScoR.27.1.47.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-ScoR.27.1.47.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-ScoR.5.1.11	Passage	No	Improve access	Remove structural barriers	Population wide, including Big Mill Creek, Rail Creek, Youngs Dam, and improperly functioning diversion weirs	BR
SONCC-ScoR.5.1.11.1	*Assess barriers and prioritize for removal*					
SONCC-ScoR.5.1.11.2	*Remove all barriers guided by assessment results*					
SONCC-ScoR.5.1.12	Passage	No	Improve access	Provide artificial passage	French Creek, East Fork Scott River, mainstem Scott River upstream of Fay Lane, etc.	3
SONCC-ScoR.5.1.12.1	*Identify and prioritize all barriers at diversions (rock weirs) and develop plan to provide short- and long-term passage*					
SONCC-ScoR.5.1.12.2	*Provide passage for all life stages, guided by plan*					
SONCC-ScoR.5.1.13	Passage	No	Improve access	Reduce sediment barriers	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ScoR.5.1.13.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-ScoR.5.1.13.2	*Using reach-based fluvial geomorphology information, remove alluvial deposits, construct low flow channels through alluvial reaches, or reduce stream gradient to provide fish passage for all life stages*					
SONCC-ScoR.8.2.26	Sediment	No	Increase spawning gravel	Enhance spawning substrate	Sugar Creek, South Fork Scott River, Shackelford Creek, French Creek, Scott River, Patterson Creek, Etna Creek, Kidder Creek, etc.	3
SONCC-ScoR.8.2.26.1	*Continue to develop a spawning substrate management plan that identifies quantity, quality, location, and timing of gravel supplements*					
SONCC-ScoR.8.2.26.2	*Supplement gravel, guided by the plan*					
SONCC-ScoR.8.1.44	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	South Fork Scott River, upper East Fork Scott River, French/Miners creeks, Johnson Creek, Patterson Creek, Kidder Creek, Moffett Creek, McAdams Creek, Shackleford/Mill creeks, Boulder Creek, Scott Bar Mill Creek, etc.	3
SONCC-ScoR.8.1.44.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-ScoR.8.1.44.2	*Decommission roads, guided by assessment*					
SONCC-ScoR.8.1.44.3	*Upgrade roads, guided by assessment*					
SONCC-ScoR.8.1.44.4	*Maintain roads, guided by assessment*					

37. Shasta River Population

- Interior Klamath Stratum
- Functionally Independent Core Population
- High Risk of Extinction
- 8,700 Spawners Required for ESU Viability
- 793 mi^2
- 435 IP km (270 mi) (60% high)
- Dominant Land Uses are Agricultural and moderate Timber Harvest
- Principal Stresses are ‘Impaired Water Quality’ and ‘Impaired Estuary/Mainstem Function’
- Principal Threats are ‘Agricultural Practices’ and ‘Dams/Diversions’

37.1 History of Habitat and Land Use

The Shasta Valley is situated on the western side of the Cascade Range in far northern California. The majority of this valley receives approximately 15 inches of annual precipitation, and its geology is influenced by Cascadian volcanism. Freshwater springs provide continuous flow of cool water originating primarily from Mt. Shasta, and this keeps the Shasta River watered throughout the year (Snyder 1931). The hydrology of the Shasta River has been and continues to be affected by Dwinnell Dam, surface water diversions, and interconnected alluvial groundwater pumping. Dwinnell Dam has blocked about 22 percent of Shasta River anadromous fish habitat since 1926 (National Research Council (NRC) 2004), and diverts flow from the upper Shasta River, Parks Creek, and Carrick Creek for irrigation and the local municipal water supply. The loss of woody debris, pools, side channels, springs, and accessible wetlands from land use conversions, have also contributed to reduced summer and winter rearing capacity for juvenile coho salmon. Further alterations to stream channel function from agricultural practices includes the loss of beaver ponds, which provide important impoundments and diverse channel margin habitat attractive to coho salmon, further simplifying instream habitat and reducing the quantity and quality of cold, deep pools needed for summer rearing.

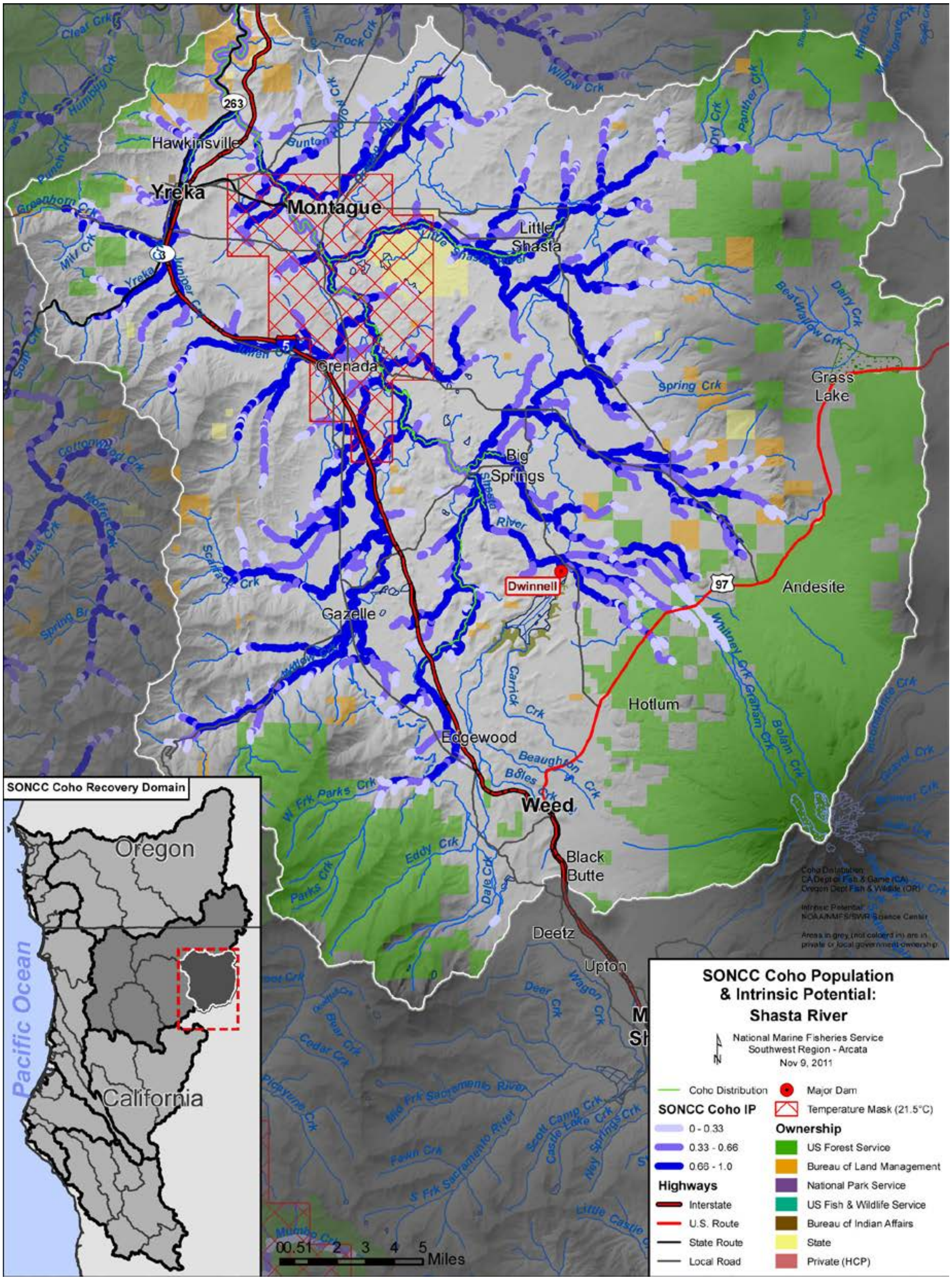

Figure 37-1. The geographic boundaries of the Shasta River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Historic gold mining along Yreka Creek and the lower seven miles of the Shasta River occurred from the 1850s through the 1930s. Early mining activities were dependent on the development of water diversion systems to meet mining needs and gravel extraction was focused along the mainstem Shasta River. Large dredge mining activities ended around 1950 in the Shasta River basin, including Yreka Creek, but riparian areas remain poorly vegetated and erodible in these sites (Shasta Valley Resource Conservation District (SVRCD 2005)). These past operations continue to be a threat for coho salmon along the west side of the Shasta River Basin through legacy effects of remnant tailing piles, altered channel morphology, and areas of potential remaining pollution inputs.

Intensive logging of the region surrounding the Shasta River watershed began in the 1850s, reached a peak in the 1950s (Kier Associates 1991) and is currently occurring at a much reduced harvest rate and intensity. Extensive road networks were built to facilitate the intensive logging, and many of them are on steep, naturally fragile terrain. Increased sediment loads resulting from these roads and upslope timber harvesting (e.g., Parks Creek drainage) have accumulated in the Shasta Valley. This resulted in the covering of substrate, decreased availability of spawning gravel, and simplified pool and riffle habitats. This sediment has not been thoroughly flushed since construction of the Dwinnell Dam in 1926 and continues to be a threat to the Shasta River SONCC coho salmon population.

Wildland fire risk has increased in the Shasta River during the recent past due to fire suppression activities that have resulted in a buildup of understory fuels. These understory fuels were historically reduced by low-intensity fires that occurred every 12 to 19 years (Taylor and Skinner 1998). Fire suppression activities over the past 50 years have inadvertently created a new fire regime around the margins of the Shasta Basin, which can be characterized by frequent high intensity, stand replacing fires, replacing the natural fire regime that is characteristic of the region.

37.2 Historical Fish Distribution and Abundance

Information suggests that coho salmon abundance is depressed relative to historical population numbers but, until recently, actual run numbers could not be accurately estimated. Coho salmon runs in the Shasta Valley probably averaged a little more than 1,000 fish annually (Snyder 1931 and California Department of Fish and Game (CDFG) 1959) in the late 1950s and began to decline soon after. In the early 1960s, the runs were estimated to average 600 fish (CDFG 1979). More recently, data suggest (Figure 37-2) the 2001 adult returning brood year class is the strongest, although still lower than historical numbers. Returns for the 2002 and 2003 brood classes have been extremely depressed.

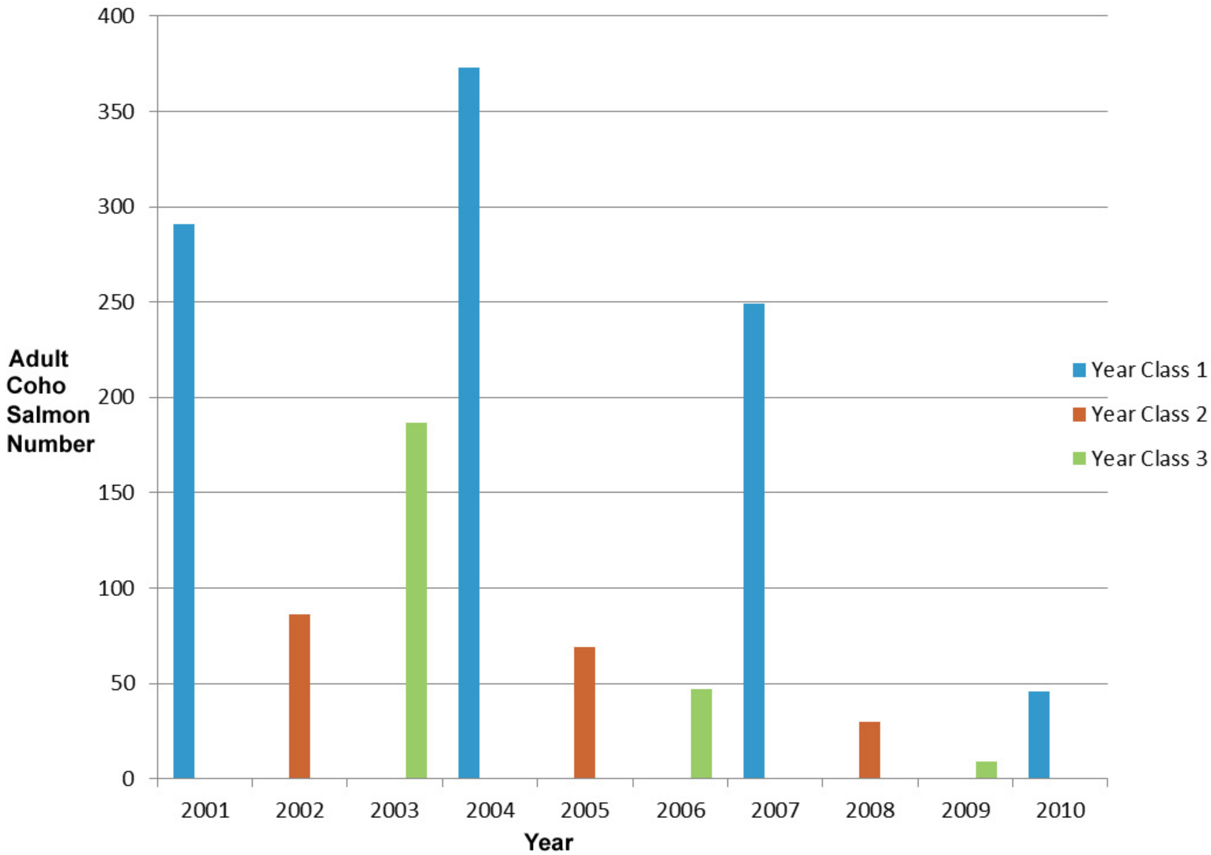

Figure 37-2. Video weir estimates of adult coho salmon in the Shasta River. Data are from 2001 to 2010 (Data from M. Knechtle, California Department of Fish and Game).

Adult coho salmon have been observed spawning in the Shasta River Canyon, lower Yreka Creek, throughout the Big Springs Complex area, and in lower Parks Creek. Juvenile coho salmon have been observed rearing in these same areas, continuing further upstream (Mount et al. 2008), and in the Little Shasta River. Potential coho salmon habitat is distributed throughout the Shasta River basin and IP data show the highest values (IP > 0.66) are throughout the Shasta Valley floor and low gradient reaches of tributaries to the Shasta River.

Table 37-1. Historical tributaries in the Shasta River population with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Stream Name	**Stream Name**
Shasta River[1]	Yreka Creek[1]
Big Springs Creek[1]	Little Shasta River[1]
Parks Creek[1]	Willow Creek[1]
Oregon Slough	Juniper Creek
Dale Creek	Boles Creek
[1] Denotes a "Key Stream" as identified in the State of California's Coho Recovery Strategy	

37.3 Status of Shasta River Coho Salmon

Spatial Structure and Diversity

The diversity and complexity of the physical and environmental conditions found within the Shasta River basin created unique life history strategies and diverse coho salmon habitat. The Shasta River population is considered a Functionally Independent population within the SONCC Coho ESU (Williams et al. 2008). Historical instream river conditions, fostered by unique cold spring complexes, that created abundant summer rearing habitat, and abundant off channel overwintering habitat, aided in the success and survival of coho salmon utilizing the Shasta River basin.

The current distribution of coho salmon spawners is concentrated in the mainstem Shasta River from river mile 32 to river mile 38, Big Springs Creek, lower Parks Creek, and the Shasta River Canyon (river mile 0 to 7). Juvenile rearing is also currently occurring in these same areas, and occasionally in lower Yreka Creek (Baldwin 2002) and the upper Little Shasta River (Whelan 2006). This is both a small fragment of the current Shasta River stream network and of the IP.

The genetic diversity of Shastas River coho salmon is likely impacted by the continued operation of the Iron Gate Hatchery. Hatchery coho salmon adult straying into the Shasta River Basin has been estimated at 2, 73, 20, and 25 percent, for the years 2007, 2008, 2009, and 2010 respectively (Chesney and Knechtle 2010), with low adult return numbers contributing to this wide variation. Ackerman and Cramer (2006) estimated that hatchery origin adult coho comprise 16 percent of adult carcasses recovered in the Shasta River basin. These data suggest that hatchery effects may be considerable.

The Shasta River coho salmon population is at high risk of extinction because its spatial structure and diversity are very limited compared to historical conditions, and more than 5% of spawners are of hatchery origin.

Population Size and Productivity

The number of spawners in all three year classes is low, well below the depensation threshold. Productivity may also be impaired. Recent comparisons of estimated Shasta River yearling coho salmon production to returning adult Shasta River coho salmon have ranged from 4.4 to 38 (Chesney and Knechtle 2010, Table 37-2). By brood year, the number of yearlings produced per returning adult has been trending downwards, suggesting that in-river conditions have not improved sufficiently to initiate recovery of the Shasta River coho salmon population.

Adult spawning surveys and fish counting weir information started in 1934, and are conducted by the California Department of Fish and Game. These weir counts indicate that adult spawning coho salmon have varied between 0 to 400 for most years, with a high of approximately 900 returning adults in 1978 (Knechtle 2011). These brood year population estimates are low, and have not trended upward over time. Therefore, the Shasta River coho salmon population is at high risk of extinction given the unstable and low population size and presumed negative population growth rate.

Table 37-2 Adult coho salmon estimates. Yearling coho salmon production point estimates, and ratio of yearling coho salmon produced per adult return for the Shasta River population, brood years 2001-2008 (Chesney and Knechtle 2010)

Adult Brood Year	Adult Estimate	Yearling Year	Yearling Point Estimate	Yearlings Produced Per Adult
2001	291	2003	11,052	38
2002	86	2004	1,799	20.9
2003	187	2005	2,054	11
2004	373	2006	10,833	29
2005	69	2007	1,178	17.1
2006	47	2008	208	4.4
2007	255	2009	5,396	21.2
2008	31	2010	169	5.5
Average				**18.4**

Extinction Risk

Williams et al. (2008) determined that at least 20 coho salmon per-IP km of habitat are needed (8,700 spawners total) to approximate the historical distribution of Shasta River coho salmon and habitat. Based on Williams et al. (2008) criteria, the Shasta River population is at a high risk of extinction for two reasons. First, the number of spawners in the Shasta River is less than the depensation threshold of 531. Second, more than 5% of the spawners are of hatchery origin.

Role in SONCC Coho Salmon ESU Viability

The Shasta River population is considered a “Functionally Independent” population, meaning that it has been sufficiently large to be historically viable-in-isolation, and its demographics and extinction risk have been minimally influenced by immigrants from adjacent populations (Williams et al. 2006). Recent genetic analysis does indicate that coho salmon produced at Iron Gate Hatchery exhibit greater variation between brood years than currently exists between the various wild populations comprising the Interior Klamath stratum, which include the Upper Klamath, Shasta, Scott, Salmon, and Middle Klamath populations (Garza 2010). The Shasta River population, nevertheless, remains a core population and therefore its recovery target is the low risk of extinction; meeting the adjusted low risk spawner threshold (see Chapter 4). The low risk spawner threshold addresses the need for adequate spatial structure and diversity within the population (Williams et al. 2008). Besides its role in achieving demographic goals and objectives for recovery, the Shasta River population fulfills other needs within the Interior Klamath stratum. The Shasta River population may serve as a source population for the Middle and Lower Klamath River populations, and provides connectivity and diversity within the stratum.

37.4 Plans and Assessments

The Nature Conservancy

Shasta Valley Coordinated Resources Management and Planning (CRMP)

Shasta Valley Resource Conservation District

Shasta Valley RCD Strategic Plan

This strategic plan is being revised to meet the RCD's mission of enhancement, conservation, and economic stability of natural resources through support of landowner activities, education and project implementation. It will guide RCD program development, setting measures of success, identifying and acquiring necessary program resources, and evaluating program outcomes.

Klamath Basin Adaptive Management Plan (2002)

The primary goal of this NRCS-supported plan in the Shasta Valley RCD service area is to achieve a reliable water supply for agriculture. The core objectives are to: decrease water demand, increase water storage, improve water quality, and develop fish and wildlife habitat. Planning, design, and implementation of on-farm projects within the Shasta River basin are ongoing, and include assistance from a variety of NRCS programs.

Shasta Valley RCD/CRMP Monitoring

The Shasta CRMP began monitoring Shasta River water temperature, air temperature, and flow in the mid 1990s, and dissolved oxygen in the late 1990s. The Shasta Valley RCD/CRMP has provided support to help operate CDFG outmigrant screw traps, since 2005. The RCD has recently begun stream flow monitoring in support of its nascent Shasta Water Trust and a Shasta Valley RCD groundwater study began in 2004, completed Phase One in 2007, and is continuing now with Phase Two. The Shasta Valley RCD continues its streambank protection program, has revived its riparian planting program, and is implementing prioritized irrigation tailwater reduction strategies. Efforts have started to fund the lease/purchase of cold water for dedication to the Shasta River and Parks Creek. Efforts are also underway to expand accessible SONCC coho salmon habitat, especially in the Big Springs Complex area, Little Shasta River, and Upper Parks Creek. Approximately six miles of habitat is being restored along Big Springs Creek and the adjacent reach of the Shasta River. This restored area is already being used by SONCC coho and other salmonids. The Shasta River Coho Salmon Working Group is exploring alternatives to supplement the coho salmon population in the Shasta River Basin, working with a wide range of stakeholders and agencies.

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Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program
http://www.krisweb.com/biblio/gen_usfws_kierassoc_1991_lrp.pdf

In 1987, Congress adopted the "Klamath Act" (Public Law 99-552) which authorized a 20-year long Klamath River Basin Conservation Area Restoration Program to help rebuild anadromous fish populations in the basin. The "Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program" was produced by Kier Associates for the Task Force in 1991. This program includes work through the Jobs in the Woods Program, the Fish Passage Program, and the Partners for Fish and Wildlife Program. The Partners program is funded through the US Fish and Wildlife Service and provides funding for fish habitat restoration activities, planning and implementation, project monitoring, and education/outreach in the Klamath basin.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

This report contains specific pilot program recovery recommendations for coho salmon in the Shasta River Watershed, and include: improved water management/water use efficiency, water augmentation, improved habitat management, protection, assessment and monitoring, and outreach and education.

Shasta River TMDL
http://www.swrcb.ca.gov/northcoast/

The Shasta River watershed was listed as impaired due to both high water temperatures and low dissolved oxygen under Section 303(d) of the Clean Water Act. Federal regulations require that a total maximum daily load (TMDL) be established for 303(d) listed water bodies for each pollutant of concern. In June 2006, a Total Maximum Daily Load (TMDL) was established for water temperature and dissolved oxygen in the Shasta River watershed, along with an action plan to implement it. The TMDL and Action Plan set load allocations and assigned implementation responsibilities. In September 2011, The Shasta Valley RCD provided the NCRWQCB with a five-year Shasta Valley TMDL Progress Report.

Shasta River Fish Counting Facility (SRFCF)

The Shasta River Fish Counting Facility is part of the Klamath River Project (KRP) of the California Department of Fish and Game (Department) and is responsible for estimating the number of fall-run Chinook salmon (Oncorhynchus tshawytscha) that return to the Shasta River. Although the primary responsibility of the KRP is to enumerate and describe fall-run Chinook salmon populations with in the basin to assist harvest managers, data is recorded for other fish species observed at the SRFCF during its normal period of operation from September through the first week of November. Consistent with this effort, the KRP continues to operate the SRFCF beyond its normal period of operation in an effort to document migration of coho salmon into the Shasta River.

37.5 Stresses

Table 37-3. Severity of stresses affecting each life stage of coho salmon in the Shasta River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Impaired Water Quality[1]	Very High	Very High	Very High[1]	Very High	Very High	Very High
2	Impaired Estuary/Mainstem Function	-	Low	High	Very High	Very High	Very High
3	Altered Hydrologic Function	Medium	Very High	Very High	Very High	Medium	Very High
4	Increased Disease/Predation/Competition	Low	Medium	Very High	Very High	Medium	Very High
5	Lack of Floodplain and Channel Structure[1]	High	High	High[1]	High	High	High
6	Adverse Hatchery-Related Effects	High	High	High	High	High	High
7	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
8	Altered Sediment Supply	Medium	Medium	Medium	Low	Medium	Medium
9	Barriers	-	Low	Medium	Medium	Low	Medium
10	Adverse Fishery Related Effects	-	-	-	-	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The Shasta River coho salmon population evolved with areas of big spring complexes, which provided them with sustained sources of cold, clean, high quality water, and provided them with abundant areas for rearing during hot, dry summer months. With changes in land use to large scale water diversions and associated agricultural practices, these springs are no-longer adequate, or at times even accessible, to provide suitable cold water habitat essential to the survival of over summering coho salmon (Mount et al. 2009). Data indicates that impaired water quality and altered hydrologic function are the limiting stressors for the Shasta River coho salmon population, and that juveniles are the limiting life stage for the population, due to poor water quality and stressful conditions encountered during hot, dry summer months.

The most vital habitat in the Shasta River basin are its cold springs, which create cold water refugia for juvenile coho salmon, decrease overall water temperatures throughout the basin, and allow for successful summer rearing of individuals in natal and non-natal creeks and mainstem areas. Yreka Creek, Julian Creek, Willow Creek, Parks Creek, Dale Creek, Eddy Creek and the Shasta River upstream from Lake Shastina receive runoff from west side mountains. Boles Creek, Carrick Creek, Beaughton Creek and Big Springs Creek are all spring creeks originating from snowmelt percolating from Mt. Shasta. Recent UC Davis investigations have indicated the high potential productivity and capability of the Big Springs Creek system to support large salmonid populations (Mount et al. 2009). Known cool water refugia are listed in Table 37-4 They are all located in reaches with high IP values.

Table 37-4. Potential refugia areas within the geographic boundaries of the Shasta River population.

Subbasin	Stream Name	Subbasin	Stream Name
Shasta River	Big Springs Complex: Big Springs Creek, Hole in the Ground Springs and Creek, Clear Springs, and other unnamed springs downstream from Dwinnell Dam	Shasta River	Mainstem Shasta River, river mile 32 to 38
Shasta River	upper Little Shasta River	Shasta River	upper Yreka Creek
Shasta River	Parks Creek, and springs flowing into the lower reaches of Parks Creek: Shasta Springs, Kettle Springs and Creek, and Bridge Field/Black Meadow Springs and Bridge Field Creek	Shasta River	upper Greenhorn Creek (N.B. upstream from Greenhorn Dam)

Impaired Water Quality

Impaired water quality is a very high stress for all coho salmon life stages. Reduced quantity of instream flows creates extremely stressful water quality conditions for rearing juveniles, and decreases the cold water input from vital cold spring complexes throughout the basin. The hydrology in the Shasta River is dominated by a large spring complex that provides the majority of the water for the Shasta River, particularly during the summer. The water that emerges from the springs is very cold, high in nutrients, and provides for exceptionally high primary and secondary productivity. The flow of the river is enhanced by snow melt from Mt. Shasta that historically maintained a consistent cold water flow of at least 103 cubic feet per second (cfs) to the Klamath River during the summer (Mack 1958). This spring-fed system was noted for producing large runs of both spring-run and fall-run Chinook salmon, coho salmon, and steelhead (Snyder 1931).

Stream temperatures for summer rearing are poor throughout the mainstem Shasta River from its mouth to the Big Springs area, and upstream of Lake Shastina. At times water temperatures become lethal to anadromous fish (Gwynne 1993, North Coast Regional Water Quality Control Board (NCRWQCB) 2006). The pH is poor (9.4) near the mouth of the Shasta River where during the summer conditions upstream are similar. In other areas of the basin, dissolved oxygen has been measured as poor (current indicator status 5.1 mg/L) near the mouth of the Shasta River. These conditions are created by low stream flows, increasing ambient temperatures from climate change, and decreases in riparian cover, which historically kept stream temperatures low, and refugia areas plentiful. Impaired water quality creates a very high stress for all life stages of coho salmon, and decreases survival and fitness of juveniles throughout the Shasta River watershed.

In undertaking annual Shasta River downstream migrant trapping studies, CDFG observed a relationship between reduced base flows, increasing water temperatures, and early outmigration of young-of-the-year (YOY) coho salmon (CDFG 2003b). In years when spring base flows were reduced early due to drought conditions and the onset of agricultural water deliveries, YOY coho salmon outmigration to the mainstem Klamath River occurred earlier than in years when Shasta River base flows were sustained at a higher level through the spring (CDFG 2003b). This suggests that juvenile coho salmon, while known to naturally exhibit non-natal rearing in the Klamath River, are prematurely forced to redistribute within the basin in response to diminishing spring flow conditions. It is noteworthy that the mainstem Klamath River below Iron Gate Dam is impaired by elevated nutrient levels, organic enrichment/low dissolved oxygen levels, elevated water temperatures (NCRWQCB 2008), and fish diseases (Stocking et al. 2006, Nichols and True 2007). Thermal impairment of lower Shasta River water in late summer/early fall can slso result in morbidity and mortality of in-migrating adult coho salmon, which occurred during the late September of 2009 in the lower Shasta River. This impairment therefore reduces the health and survival of both out-migrating and in-migrating Shasta River coho salmon.

Impaired Estuary/Mainstem Function

This stress refers to the estuary and mainstem conditions in the Klamath River, since this population is part of a larger basin containing multiple populations. Conditions in the Klamath River mainstem and estuary are important to this population since all salmon and steelhead that originate from the Shasta River migrate to and from the ocean through the mainstem Klamath River and the Klamath River estuary. The Klamath River estuary plays an important role in providing holding habitat, foraging and refuge opportunities for outmigrating juvenile coho salmon from the Shasta River. Previous studies have shown that naturally produced yearling coho salmon can have extended estuarine residence times, up to several weeks (Miller and Sadro 2003). Although the estuary is short and small compared to the large size of the watershed, it does provide numerous habitat types and vital rearing habitat for juvenile and smolting coho salmon (Wallace 1995). The degraded conditions that exist throughout the Klamath basin today may mean that the estuary plays an even more important role for all Klamath populations by providing the opportunity for juvenile and smolt growth and refugia prior to entering the ocean. The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain. Levees along the Lower Klamath and development on the floodplain have led to the loss and degradation of habitat in the estuary. More information about the Klamath River estuary can be found in Section 11.19.

Mainstem conditions in the Shasta and Klamath Rivers are stressful because of poor water quality, sedimentation, and degraded habitat. Because of the distance that this population must travel to and from the ocean, and the time spent in the mainstem Klamath River, this stress is especially significant for the Shasta River population. Juveniles, fry, and smolts transitioning through estuarine and mainstem habitat are stressed by the degraded conditions in these migratory habitats and suffer from the lost opportunity for increased growth and consequently a lower survival rate. The loss and degradation of estuarine and mainstem habitat is considered a high to very high stress for the population, with the most affected life stages being juveniles, smolts, and adults due to the degradation of rearing and migratory habitat.

Altered Hydrologic Function

Altered hydrologic function presents a very high stress to fry, juvenile, and smolt life history stages, a medium stress to the egg stage, and medium stress to adults. Dwinnell Dam and over 100 other adjudicated irrigation diversions now divert more than 110 cfs from the Shasta River from April 1 to October 1 (NRC 2004) providing irrigation for approximately 52,000 acres of land (about 10 percent of the watershed) during the growing season. Estimated consumptive use of irrigation water is approximately 100,000 acre feet per year. Shasta River surface water is over-allocated during the irrigation season, leaving inadequate summer instream flows of approximately 15 to 20 cfs in the lower Shasta River, sometimes dropping to 5 cfs in dry years (Hampton 2009). In response, the Shasta TMDL Implementation Plan set a target summer flow of 45 cfs of water cool enough to sustain salmonids at the the DWR Montague gage (NCRWQCB 2006). Water quantity/flow regime is generally good (fully functional) in the southern portion of the Shasta Valley including upper Parks Creek, the upper Shasta River, and tributaries originating from the flanks of Mt. Shasta: Dale, Boles, Broughton and Carrick creeks, but poor in other key areas from over allocated water diversions and Dwinnell Dam.

Hydrologic function is severely altered by a rapid decrease in flows beginning with the onset of the irrigation season, when large numbers of Shasta Valley irrigators begin diverting water simultaneously. The reduced discharge along the mainstem Shasta River forces rearing juvenile coho salmon to move either upstream towards spring-fed habitat, or downstream to the Klamath River. Reduced flows during the spring often result in decreases in summer rearing habitat and reduced opportunities for juvenile fish movement within the basin.

Increased Disease/Predation/Competition

Disease, predation, and competition present a very high stress for juveniles and smolts, a medium stress for adults and fry, and a low stress for egg. Disease does become a significant stressor to Shasta River coho salmon when they enter the Klamath River, where pathogens and toxins become pervasive during the late spring and summer. Pathogens that have caused diseases in juvenile fish include Ceratomyxa shasta (resulting in ceratomyxosis), *Flavobacterium columnare* (columnaris), aeromonid bacteria *Nanophyetus salmonicola*, and the kidney *myxosporean Parvicapsula minibicornis* (Federal Energy Regulatory Commission 2007). Actinospore concentrations of both *C. Shasta* and *P. minibicornis* in the mainstem Klamath River are often above the threshold necessary to induce infection and disease (Stocking et al. 2006, Nichols and True 2007). By late spring and summer, both diseased hatchery and natural-stock juveniles are seen dead or moribund in Klamath River screw traps. In addition to disease, competition can occur when numerous, larger-sized hatchery fish displace wild juveniles in refugia along the Klamath River, take available prey, or eat undersized wild juvenile fish. Non-native piscivorous fish and amphibians also prey on juvenile coho salmon originating from the Shasta River population (Knechtle 2011).

Lack of Floodplain and Channel Structure

Lack of floodplain and channel structure presents a high stress for all life stages. Agricultural practices occurring adjacent to the mainstem Shasta River and several important tributaries has led to degradation and loss of rearing habitat, slackwater refugia, wetlands, and other off-channel habitats. The disconnection of the floodplain from the mainstem Shasta River and the conversion of riparian corridors to agricultural pastures has also altered instream channel morphology through accretion of sediment, increased winter flows, and changes in pool to riffle ratios. Loss of riparian vegetation cover throughout the Shasta Valley floor has caused the loss of LWD recruitment, channel margin degradation, and excessive sediment, decreasing available rearing summer and winter rearing habitat, pool depth, and instream cover. These impacts collectively limit the development of complex stream habitat necessary to sustain spawning and rearing throughout much of the high IP areas of the Shasta Valley.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no hatcheries nor artificial propagation in the Shasta River basin, but there is a fish hatchery on the Klamath River at the base of Iron Gate Dam, approximately 13 miles (21 km) upstream of the mouth of the Shasta River. Approximately 75,000 coho salmon fry, along with 6,000,000 fall Chinook salmon and 200,000 steelhead yearlings are released from the Iron Gate Hatchery each year. As adults, some of these fish stray into the Shasta River basin when migrating back upstream, and there they can interbreed with wild Shasta River coho salmon, simplifying their genetics and in the long term decreasing the productivity of wild coho salmon. On average, 16 percent of adult carcasses recovered in the Shasta River basin in 2001, 2003, and 2004 were of hatchery origin (Ackerman and Cramer 2006). Coho returns to the Shasta River fish counting facility from 2001 to 2004 (Ackerman et al. 2006), and from 2007 to 2010 (Chesney and Knechtle 2011b), averaged 23 percent. Adverse hatchery-related effects pose a high stress to all life stages because hatchery origin adults make up greater than ten but less than 30 percent of the total number of adults (Appendix B).

Degraded Riparian Forest Conditions

Degraded riparian forest conditions pose a medium stress to adults, and a high stress to fry, juvenile, and smolt life stages. Stream corridor vegetation and cover is considered very good (fully functional) in the southern portion of the Shasta Valley including upper Parks Creek, Eddy Creek, and the upper tributaries of the Shasta River (Dale, Boles, Broughton and Carrick creeks) while the upper Little Shasta River has fair, partially functional stream corridor cover. The loss of riparian cover in other areas of the basin has, however, left the mainstem Shasta River and tributary riparian areas downstream of Dwinnell Dam exposed, degraded, and unable to sustain productive biotic communities. Riparian assessments of the Shasta River on the Nelson Ranch (Mount et al. 2008) and the Shasta Big Springs Ranch (Mount et al. 2009) indicate that highly productive riparian habitat can be sustained and restored along portions of the Shasta River watershed, but natural recruitment of woody perennials is inconsistent, due to soil chemistry, current agricultural practices, and other anthropogenic changes in land use.

Altered Sediment Supply

Altered sediment supply presents a medium stress for the juvenile life stage, and a low stress for all other life stages. The Shasta Valley is geologically young and relatively stable (CH2M HILL 1985), and sediment that is delivered to the Shasta River derives from unstable sloughing stream banks, unpaved upland roads, and residential development. Alterations in sediment can simplify and fill in pool habitat, preclude the establishment and maintenance of riparian vegetation cover, cause embeddedness of gravels in spawning areas, and alter channel morphology. Since juvenile coho salmon rear for an extended period in freshwater environments, changes such as these can be detrimental to their fitness and ability to survive.

Barriers

Barriers present a medium stress for juvenile and smolt life stages and a low stress for fry and adult life history stages. There are two permanent dams that act as barriers in the Shasta River. Dwinnell Dam, blocks about 22 percent of Shasta River anadromous fish habitat, and in the 1950s a permanent dam was placed in Greenhorn Creek, a tributary to Yreka Creek, for municipal and industrial water storage. Greenhorn Dam blocks access to upstream areas in Greenhorn Creek, blocks the movement of gravel down Yreka Creek, and alters the Yreka Creek hydrograph. Multiple diversion dams, small impoundments, one small micro-hydro installation at the entrance to the Shasta River Canyon (Kier Associates 1991) and road/stream crossings also cause partial or complete barriers to high IP habitat in several Shasta River basin locations. Diversion dams reduce instream flows and allow impounded water to reach lethal temperatures during the summer, while the larger Dwinnell dam changes channel morphology, alters the hydrologic function of the mainstem Shasta River, but does serve to sustain water yield from some adjacent springs in the Big Springs Complex (Knechtle 2010). Diversion dams also create a pond-like environment, rich in nutrients, where algae bloom in abundance. Of the six flashboard summer irrigation dams on the mainstem Shasta River, four have been removed, locally improving the function and condition of the mainstem river.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and Tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

37.6 Threats

Table 37-5. Severity of threats affecting each life stage of coho salmon in the Shasta River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Agricultural Practices	Very High	Very High	Very High	Very High	Very High	Very High
2	Dams/Diversion	Very High	Very High	Very High	Very High	Very High	Very High
3	Channelization/Diking	High	High	High	High	High	High
4	Roads	High	High	High	High	High	High
5	Hatcheries	High	High	High	High	High	High
6	Climate Change	Low	Low	Very High	High	Medium	High
7	Timber Harvest	Medium	Medium	Medium	Medium	Medium	Medium
8	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
9	Mining/Gravel Extraction	Medium	Medium	Medium	Medium	Medium	Medium
10	Urban/Residential/Industrial	Medium	Medium	Medium	Medium	Medium	Medium
11	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
12	Fishing and Collecting	-	-	-	-	Low	Low

[1]Invasive Non-Native/Alien Species is not considered a threat to this population.

Agricultural Practices

Agricultural practices are a very high threat to all life stages of coho salmon. Many subbasins of the Shasta Valley have pasture/hay and cultivated crops, which together account for more than 10 percent of the land area. Agricultural areas adjacent to coho salmon habitat occur along the mainstem Shasta River downstream from Dwinnell Dam to the Shasta River Canyon entrance, the Little Shasta River, Parks Creek, Yreka Creek, and Big Springs Creek. Excessive fine sediment, low flows, and warm-water inputs damage spawning and rearing habitat and hinder migration. Erosion from agricultural practices can contribute fine sediment to the river. Livestock along the Shasta River can compound these problems by damaging stream banks and riparian vegetation, and by adding nutrients to the stream, thereby reducing oxygen levels. Beyond these system-wide impacts, there is considerable risk of trampling of redds in the upper portions of the Shasta Valley (Parks Creek and the upper Shasta River), where areas suitable for spawning are also frequently preferred by livestock for crossings and for in-channel grazing.

Livestock exclusion fencing now precludes these impacts on much of the Shasta Valley floor, with remaining unfenced reaches located along both the upper Shasta River near Dwinnell Dam and upper Parks Creek.

Water diversions and warm irrigation tailwater returns in scarce cool-water areas severely limits habitat values in critical refuge spawning and rearing areas. Even in areas where water temperatures are generally good, intermittent pulses of warm tailwater can overwhelm available cold water, forcing fish to relocate or killing them outright. The Shasta Valley RCD's Agricultural Water and Tailwater Management Program is improving on-farm management, beginning in high priority areas in the Big Springs Complex, including river miles 32 to 38 of the Shasta River and river mile 4 to 6 of Parks Creek: to reduce tailwater creation and to implement projects that contain, store, cool, and reuse agricultural tailwater.

The onset of the irrigation season in the Shasta River watershed has a dramatic impact on instream flows when large numbers of irrigators begin taking water simultaneously. This results in a rapid decrease in flows below the diversions, stranding coho salmon as channel margin and side channel habitat disappears (CDFG 1997a). Low stream flows can limit access to rearing areas and decrease rearing habitat for juvenile coho salmon. Diversion of surface water has limited the quantity of cold water from the spring complexes within the basin, causing water temperatures to rise above the lethal level of the 25.8ºC for salmon. Low dissolved oxygen levels also occur along the Shasta River, adversely affecting salmonids. Though much diminished since 1991, livestock access to the Shasta River contributes to these problems, by damaging stream banks and riparian vegetation that provide shade and cover, and by also adding excessive nutrients to the stream, contributing further to reduced dissolved oxygen levels. Warm, nutrient-rich tailwater entering cool-water reaches of the Shasta River severely degrade habitat quality in adjacent spawning and rearing areas that are already scarce.

Dams/Diversion

Dams, diversions, and associated reductions in water availability downstream, as well as the timing of that availability, are a very high threat to all life stages of coho salmon. In 1926 the Shasta River was dammed at River Mile 37 to form Dwinnell Reservoir (Lake Shastina), blocking about 22 percent of historic salmon habitat in the Shasta River basin (NRC 2004). In 1955, the capacity of the dam was increased, bringing the total storage capacity to 50,000 acre-feet. There are no instream flow release requirements from Dwinnell Dam, which further diminishes Shasta River flows during the summer irrigation season. During the winter Lake Shastina's capture of peak winter flows significantly reduces the ability of the Shasta River to flush fine sediment from spawning gravels and changes the hydrology downstream. In addition to Dwinnell Dam, another permanent dam was placed in Greenhorn Creek, a tributary to Yreka Creek, in the 1950s for municipal and industrial water storage. Greenhorn Dam blocks access to upstream areas in Greenhorn Creek, blocks the movement of gravel down Yreka Creek, and alters the Yreka Creek hydrograph. The City of Yreka does not routinely release water from this reservoir during the summer, and such releases could help maintain sufficient flow in Yreka Creek for coho salmon holding and rearing there.

Irrigation diversions block stream channels, reduce flows and often create riverine impoundments. These impoundments warm to lethal temperatures during the summer, become rich in nutrients, and foster algae blooms. Additionally, if not screened, irrigation diversions can trap fish and create passage problems for juveniles looking for refugia. Diverted irrigation water becomes warmed and nutrient rich before it drains back into the river as tailwater. Pervasive diversion of irrigation water results in diminished peak flow events that historically inundated the valley floor and expanded juvenile rearing habitat. Two flashboard irrigation diversion dams remain on the Shasta River, and continue to create passage problems for juvenile and smolt coho salmon. There are also 15 smaller diversion dams listed in the California Fish Passage Assessment Database CalFish (2009), most of which are located in high IP areas. Dams and diversions which pose significant barriers to fish passage, including upstream juvenile migration, are listed in Table 37-6.

Other barriers associated with small water diversion have been observed in lower Parks Creek, an area with several small, cold water springs that are critically important for the survival of juvenile coho salmon. Adult radio tagging information since 2004 confirms that many coho salmon tracked in the upper Shasta River ultimately spawned in lower Parks Creek (CDFG 2008b), the southwest portion of the Big Springs Complex.

Table 37-6. List of dams/diversion barriers in the Shasta River basin.

IP priority	Stream Name	Dam/Diversion Name	Passage Assessment Database ID number	Miles of habitat blocked, or partially blocked (*)
1	Shasta River	Dwinnell Dam (Shasta River Dam & diversion)	100003	93
1	Yreka Creek	Greenhorn Dam	100674	4
1	Shasta River	Novy/Rice Dam		28 (*)
1	Shasta River	Grenade Irrigation District Dam		23 (*)
2	Little Shasta River	Hart Diversion Dam		4 (*)
1	Parks Creek	Cardoza Diversion Dam		9 (*)
2				
1				
1				
2	Little Shasta River	Blair Smith / Musgrave Dam (diversion)		3 (*)

Channelization/Diking

Channelization and diking pose a high threat to all life stages of coho salmon, and occur primarily along many reaches of Parks Creek, Willow Creek, the Little Shasta River, and the urban reach of Yreka Creek. Channelization and diking of rivers and streams has been shown to decrease the quantity and quality of winter rearing habitat by eliminating the availability of low flow energy, off channel habitats: habitat which is already lacking in the Shasta River Basin. This channel alternation has resulted in the conversion of beaver-occupied wetlands to drained agricultural lands. In contrast, natural channel form and floodplain connectivity remain good (fully functional) in portions of the upper Shasta River and its other tributaries

Roads

Roads are a high threat to all life stages of coho salmon in the Shasta River population. Road density is very high (>3 miles of roads/sq. mile) in the following tributary subbasins, where high IP reaches predominate: upper Shasta River, upper Little Shasta River, Yreka Creek; and upstream of Dwinnell Dam/Reservoir in Boles Creek. Road density is high (2.5 to 3.0 miles of roads/sq. mile) in Eddy Creek, upper Parks Creek, Willow Creek, upper Juniper Creek; and upstream of Dwinnell Dam/Reservoir in Carrick Creek. The reaches occurring upstream from Dwinnell Reservoir currently have sediment mobilized from them captured in the reservoir. Road density improves downstream and is considered a medium to low threat throughout most of the Shasta Valley floor. Erosion potential from unmaintained roads is greatest in the upper portions of subbasins where heavy rain, and rain on snow occur in areas containing roads from past timber harvest activities. The associated increases in fine sediment from these conditions have been shown to suffocate redds, degrade pool quality, and decrease pool depth. Residential development on the Shasta Valley floor, and the increasing number of un-engineered private roads mobilize sediment to stream channels, thereby further increasing impacts to juvenile coho salmon rearing in adjacent streams.

Hatcheries

Hatcheries pose a high threat to all life stages. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

Climate Change

Climate change poses, in the balance, a high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 to 100 years (see Appendix B for modeling methods). Average temperature could increase by up to 3^{o} C in the summer and by 1.3^{o} C in the winter. Annual precipitation on the Shasta Valley floor is already less than 20 inches, and is predicted to trend downward over the same time period. Snowpack in upper elevations of the basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009). Changes will impact water yield of natural springs, which is an important component of the hydrologic regime of the Shasta River, and this will impact summer rearing habitat. The vulnerability of the Klamath estuary to sea level rise is low to moderate and therefore does not pose a significant threat to estuarine rearing habitat downstream. Juvenile and smolt rearing and migratory habitat in the Shasta River and Klamath mainstem is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Overall, the range and degree of variability in temperature and precipitation are likely to increase. Adults will also be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Timber Harvest

Timber harvest is a medium threat to all life stages of coho salmon, due primarily to residual impacts from logging-derived sediment mobilization issuing from west side drainages. Sediment is mobilized from faulty road ditches and water conveyance structures, unmaintained and/or undersized culverts, bare hillsides, and improperly designed and unmaintained roads. The volume of timber harvested on national forest land diminished in the early 1990s, and has remained low since the implementation of the Klamath National Forest's Land and Resource Management Plan in 1994 (USFS 1994b). General Forest Management Areas available for logging in the Shasta River basin are small and are confined to the western slopes of the Cascade Range. Small scale projects involving understory fuels reduction, hazard tree removal, and small commercial thinning projects are expected to continue at current rates into the future.

High Intensity Fire

High intensity fire, and the riparian habitat destruction and surface erosion it causes, is a medium threat to all life stages of coho salmon. Because of past timber harvest practices and fire-suppression efforts over the past century, understory forest fuel loads have become excessive and have severely altered the fire regime in the region. High intensity fires result from these excessive forest fuel loads and could occur in the uplands of the Shasta River watershed, creating erosion/ sedimentation problems, large areas of bare, unstable soil, and threatening riparian vegetation along stream banks. In addition, fire suppression activities could lead to impacts to coho salmon from misapplication of fire retardant, increased water withdrawals in summer months, and mobilization of sediment through the digging of fire lines and other fire prevention methods.

Mining/Gravel Extraction

Mining and gravel extraction are medium threats to all life stages of coho salmon. The legacy impacts of historic gold mining along Yreka Creek and the lower seven miles of the Shasta River continue to degrade habitat, through alterations in floodplain connectivity, changes in channel morphology, and continuing impacts from the historic removal of gravel. Gravel depletion remains a problem in the Shasta River downstream from Dwinnell Dam and in the depositional portions of many tributaries. Tailing piles and fill occupy large historic floodplains along Yreka and Greenhorn creeks, where riparian areas remain poorly vegetated and erodible (SVRCD 2005). Currently, neither suction dredging nor gravel mining commonly occur in the Shasta River basin, however, the legacy effects are long lasting and need to be addressed to decrease the threat to Shasta River coho salmon. A spawning gravel evaluation and enhancement plan for the Shasta River has been completed by McBain and Trush (2010), and can be used to inform and prioritize spawning gravel enhancement efforts in the basin.

Urban/Residential/Industrial Development

Urban, residential, and industrial development is a medium threat to all life stages. Within the Shasta Valley, modest densities of residences and urban development are located near Yreka, Weed, Montague, Little Shasta, Big Springs, Grenada, and Gazelle. Overall, this threat is not expected to change into the foreseeable future, as population growth is currently stable in this area. The extent to which roads in these areas are a threat to coho salmon is considered under the Roads threat, above.

Road-Stream Crossing Barriers

Road related barriers are a low threat to all juvenile and adult life stages of coho salmon. Readily available information from CalFish (2009, http://www.calfish.org/portals/0/Programs/CalFishPrograms/FishPassageAssessment/tabid/83/Default.aspx) and Five Counties Salmonid Conservation Program (2008) indicate road/stream crossings that require further evaluation for improved fish passage (see Table 37-7).

Table 37-7. List of road/stream crossing barriers in the Shasta River basin

IP-based priority	Stream Name	Road Name	Subarea	Passage Assessment Database ID number	Miles of habitat blocked
1	South Fork Willow Creek	Gazelle-Callahan RD	Shasta Valley	705936	1.5
1	Willow Creek #1	Gazelle-Callahan Road	Shasta Valley	705935	6
1	Willow Creek #2	Gazelle-Callahan Road	Shasta Valley	705937	1
1	Willow Creek, Julien Creek	Culvert I-5	Shasta Valley	707151	
1	Modoc Gulch	Estimated Hwy 5 culvert (@ PM 24.2)	Shasta Valley	723848	
2	Uunamed Tributary to Schulmeyer Gulch	Estimated Hwy 5 culvert (@ PM 41.6)	Shasta Valley	723853	
2	Juniper Creek	Estimated Hwy 5 culvert (@ PM 44.0)	Shasta Valley	723852	
2	Unnamed Tributary to Shasta River	Estimated Hwy 5 culvert (@ PM 50.67)	Shasta Valley	723851	
2	Unnamed Tributary to Shasta River	Estimated Hwy 5 culvert (@ PM 51.4)	Shasta Valley	723850	

IP-based priority	Stream Name	Road Name	Subarea	Passage Assessment Database ID number	Miles of habitat blocked
1	Red Gulch, Yreka Creek	culvert	Shasta Valley	732272	
1	Tributary to the Little Shasta River	Forest Service Road	Shasta Valley	713343	
1	Dry Gulch, Shasta River	Estimated Hwy 5 culvert (@ PM 53.0)	Shasta Valley	723849	

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries harvest has the potential to cause injury and death to coho salmon in the Klamath/Trinity basin. The effects of State of California, and Yurok and Hoopa Tribal fisheries management on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Shasta River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

37.7 Recovery Strategy

Coho salmon in the Shasta River are depressed in abundance with a restricted distribution. Recovery activities in the watershed should continue to promote increased spatial distribution as well as increased productivity and abundance. Activities should occur throughout the watershed, with a focus on mainstem and tributary reaches with high IP values. Recovery actions that reduce stream temperatures, increase dissolved oxygen concentrations, and achieve sufficient instream flow targets through the summer should be a priority in the watershed. Addressing the limiting factor of inadequate summer rearing habitat for juveniles should be of top priority, and multi-faceted, long term solutions should be sought. Winter rearing and spawing habitat improvement is also a priority, and should include beaver enhancement, large/complex woody debris recruitment, and spawning substrate enhancement. Additionally, working collaboratively with stakeholders and others working to restore mainstem and estuary conditions in the Klamath River should expand, to assure that the Shasta River coho salmon population have the necessary habitat requirements for all freshwater life stages. Specific goals for each stressor are listed in the compilation of recovery actions in Chapter 6. These goals identify activities that are expected to reduce the stresses currently affecting the Shasta River SONCC coho salmon population.

Table 37-8 on the following page lists the recovery actions for the Shasta River population.

Table 37-8. Recovery action implementation schedule for the Shasta River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ShaR.3.1.1	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Population wide	2
SONCC-ShaR.3.1.1.1	*Identify, map, and quantify all surface water diversions*					
SONCC-ShaR.3.1.1.2	*Assess water diversions, prioritize, and adjust management to benefit life history requirements of coho, attaining a 55 cfs target summer base flow at the mouth of the Shasta River*					
SONCC-ShaR.3.1.1.3	*Secure dedicated unused water diversion rights*					
SONCC-ShaR.3.1.1.4	*Verify permitted water diversions*					
SONCC-ShaR.3.1.1.5	*Use real time flow, precipitation, snowpack, groundwater, and climate information to guide Water Trust work to augment surface flows at priority locations for coho, via water leases and dedications*					
SONCC-ShaR.3.1.2	Hydrology	Yes	Improve flow timing or volume	Monitor flow for compliance	Population wide	2
SONCC-ShaR.3.1.2.1	*Install flow measuring devices*					
SONCC-ShaR.3.1.2.2	*Maintain all flow measuring devices*					
SONCC-ShaR.3.1.2.3	*Install head gates and NOAA Fisheries compliant fish exclusion screens on all water diversions in coho salmon habitat*					
SONCC-ShaR.3.1.3	Hydrology	Yes	Improve flow timing or volume	Manage flow	Population wide	BR
SONCC-ShaR.3.1.3.1	*Sustain Watermaster District to ensure all irrigation water diversions are water mastered*					
SONCC-ShaR.3.1.3.2	*Implement water mastering allocations compliant with applicable water law, including place of use restrictions*					
SONCC-ShaR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	GID Ditch diversion, Dwinnell Dam diversion	2
SONCC-ShaR.3.1.4.1	*Reduce impacts to coho salmon from the GID ditch diversion.*					
SONCC-ShaR.3.1.4.2	*Assess the effects of relocating or redesigning the diversion point to Dwinnell Dam Reservoir to decrease the impacts to coho salmon.*					
SONCC-ShaR.3.1.4.3	*Relocate or redesign the diversion structure to Dwinnell Dam Reservoir guided by assessment results*					
SONCC-ShaR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Improve water management techniques	Population wide	3
SONCC-ShaR.3.1.5.1	*Develop integrated water management plan and water budget, including groundwater surface flow dynamics, and drought year emergency contingencies*					
SONCC-ShaR.3.1.5.2	*Improve water use efficiency through the investigation and implementation of alternative agricultural crops and practices (e.g., grass fed beef, winter wheat, alternative pasture crops)*					
SONCC-ShaR.3.1.5.3	*Upgrade and expand alternative off-channel stock watering systems to increase instream flows*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ShaR.3.1.5.4	*Develop and disseminate an on-farm water use efficiency monitoring system*					
SONCC-ShaR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Improve irrigation practices	Population wide	3
SONCC-ShaR.3.1.6.1	*Apply a variety of techniques (e.g., Farm Irrigation Rating Index Model) to make irrigation system water use efficiency comparisons, and implement efficiency improvements*					
SONCC-ShaR.3.1.6.2	*Implement improved irrigation techniques and monitor associated flow and water quality enhancements*					
SONCC-ShaR.3.1.6.3	*Design an irrigation schedule to maximize cold water influence/extension from Clear Springs and other cold water sources*					
SONCC-ShaR.3.1.7	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Yreka Creek, Little Shasta River, Parks Creek, etc.	3
SONCC-ShaR.3.1.7.1	*Develop plans to detain stormwater runoff, increase infiltration, enhance floodplains, and deliver sub-surface flows*					
SONCC-ShaR.3.1.7.2	*Implement plans that increase groundwater recharge and connectivity*					
SONCC-ShaR.3.1.7.3	*Establish a water trust to sustain and reestablish flow connectivity.*					
SONCC-ShaR.3.1.8	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-ShaR.3.1.8.1	*Develop an educational program addressing water conservation programs, instream leasing and water dedication programs, and water diversion/screen hardware maintenance extension support information*					
SONCC-ShaR.3.1.9	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-ShaR.3.1.9.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-ShaR.3.1.10	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-ShaR.3.1.10.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-ShaR.3.1.11	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-ShaR.3.1.11.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-ShaR.10.1.16	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Increase flow	Big Springs Lake Dam, Parks Creek, Kettle Springs, Bridge Field Springs Complex, and the upper Shasta River	3
SONCC-ShaR.10.1.16.1	*Implement the flow strategy recommended by McBane and Trush (2011), that allows for the minimum diversion of water needed at Big Springs Lake and other spring complexes.*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ShaR.10.1.16.2	*Ensure the protection of an identified minimum cfs flow from cold water springs, including Big Springs Creek at the waterwheel (McBane and Trush 2011).*					
SONCC-ShaR.10.1.17	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Increase flow	Emmerson Ranch Properties	3
SONCC-ShaR.10.1.17.1	*Develop emergency action ranch management plan for Emmerson Ranch*					
SONCC-ShaR.10.1.17.2	*Create an irrigation diversion and water use operations manual that conserves as assists recovery of coho salmon*					
SONCC-ShaR.10.1.18	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Increase cold water	Big Springs Lake Dam, Parks Creek, Kettle Springs, Bridge Field Springs Complex, Little Shasta River, and the upper Shasta River	3
SONCC-ShaR.10.1.18.1	*Evaluate quantity and quality of refugia habitat*					
SONCC-ShaR.10.1.18.2	*Conduct water rights assessment at spring complexes*					
SONCC-ShaR.10.1.18.3	*Dedicate cold water*					
SONCC-ShaR.10.1.19	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Increase cold water	Dwinnell Dam, mainstem Shasta River and its downstream tributaries and springs	3
SONCC-ShaR.10.1.19.1	*Investigate feasibility of changing drawdown location on Dwinnell Dam to maximize cold water and dissolved oxygen*					
SONCC-ShaR.10.1.20	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Reduce warm water inputs	Bridge Field Springs Complex, Kettle Springs, Upper Shasta River	3
SONCC-ShaR.10.1.20.1	*Develop a program that identifies, designs, and constructs projects that will reduce warm tailwater input to streams*					
SONCC-ShaR.10.1.20.2	*Implement tailwater reduction program*					
SONCC-ShaR.10.2.21	Water Quality	Yes	Reduce pollutants	Set standard	Population wide	3
SONCC-ShaR.10.2.21.1	*Continue implementation of TMDLs for 303(d) listed water bodies*					
SONCC-ShaR.1.2.48	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3
SONCC-ShaR.1.2.48.1	*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ShaR.16.1.33	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ShaR.16.1.33.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-ShaR.16.1.33.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-ShaR.16.1.34	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-ShaR.16.1.34.1	*Determine actual fishing impacts*					
SONCC-ShaR.16.1.34.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-ShaR.16.2.35	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ShaR.16.2.35.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-ShaR.16.2.35.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-ShaR.16.2.36	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-ShaR.16.2.36.1	*Determine actual impacts of scientific collection*					
SONCC-ShaR.16.2.36.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-ShaR.2.2.27	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide	2
SONCC-ShaR.2.2.27.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-ShaR.2.2.27.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-ShaR.2.2.28	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Restore natural channel form and function	Population wide	2

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ShaR.2.2.28.1	*Identify and prioritize mining reaches, developing a plan to restore the floodplain and channel by removing tailing piles and reconstructing the channel*					
SONCC-ShaR.2.2.28.2	*Remove tailing piles and reconstruct the channel, guided by the restoration plan*					
SONCC-ShaR.2.2.46	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Increase beaver abundance	Population wide	2
SONCC-ShaR.2.2.46.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-ShaR.2.2.46.2	*Implement beaver program (may include reintroduction)*					
SONCC-ShaR.26.1.25	Low Population Dynamics	No	Increase population abundance	Implement an enhancement program	Population wide	3
SONCC-ShaR.26.1.25.1	*Assess impacts and benefits associated with different enhancement programs such as captive broodstock, rescue rearing, supplementation, and conservation hatcheries*					
SONCC-ShaR.26.1.25.2	*Develop a facility to rear fish*					
SONCC-ShaR.26.1.25.3	*Operate enhancement program as a temporary strategy to 26.1*					
SONCC-ShaR.26.1.25.4	*Monitor fish populations at all life stages including juvenile snorkel counts, downstream migrant counts, spawning surveys, and PIT tagging*					
SONCC-ShaR.26.1.26	Low Population Dynamics	No	Increase population abundance	Reduce take of coho salmon	Population wide	2
SONCC-ShaR.26.1.26.1	*Develop an Incidental Take Prohibition program*					
SONCC-ShaR.26.1.26.2	*Implement Incidental Take Prohibition program*					
SONCC-ShaR.27.1.37	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-ShaR.27.1.37.1	*Perform annual spawning surveys*					
SONCC-ShaR.27.1.38	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-ShaR.27.1.38.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-ShaR.27.1.38.2	*Develop comprehensive PIT tagging and retrieval project that assesses habitat use and survival*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-ShaR.27.1.39	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-ShaR.27.1.39.1		*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*				
SONCC-ShaR.27.2.40	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-ShaR.27.2.40.1		*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*				
SONCC-ShaR.27.2.40.2		*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*				
SONCC-ShaR.27.2.41	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-ShaR.27.2.41.1		*Measure the indicators, pool depth, pool frequency, D50, and LWD*				
SONCC-ShaR.27.2.42	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-ShaR.27.2.42.1		*Measure the indicators, canopy cover, canopy type, and riparian condition*				
SONCC-ShaR.27.2.43	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-ShaR.27.2.43.1		*Measure the indicators, pH, D.O., temperature, and aquatic insects*				
SONCC-ShaR.27.2.44	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-ShaR.27.2.44.1		*Annually measure the hydrograph and identify instream flow needs*				
SONCC-ShaR.27.1.47	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-ShaR.27.1.47.1		*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-ShaR.27.1.49	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-ShaR.27.1.49.1		*Develop supplemental or alternate means to set population types and targets*				
SONCC-ShaR.27.1.49.2		*If appropriate, modify population types and targets using revised methodology*				
SONCC-ShaR.5.1.13	Passage	No	Improve access	Reduce sediment barriers	Population wide, including Kettle Springs and Bridgefield Springs Complex	2
SONCC-ShaR.5.1.13.1		*Inventory and prioritize barriers formed by alluvial deposits*				
SONCC-ShaR.5.1.13.2		*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*				
SONCC-ShaR.5.1.14	Passage	No	Improve access	Provide artificial passage	Grenada Irrigation District and other diversions	2
SONCC-ShaR.5.1.14.1		*Design and plan fish passage*				
SONCC-ShaR.5.1.14.2		*Provide fish passage, guided by plan*				
SONCC-ShaR.5.1.15	Passage	No	Improve access	Remove barriers	Greenhorn Dam, Cardoza Diversion, mainstem Shasta River and all tributaries	3
SONCC-ShaR.5.1.15.1		*Identify and prioritize all barriers and diversions, and develop a plan to provide short- and long-term passage*				
SONCC-ShaR.5.1.15.2		*Provide passage for all life stages, guided by plan*				
SONCC-ShaR.7.1.22	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Population wide	2
SONCC-ShaR.7.1.22.1		*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*				
SONCC-ShaR.7.1.22.2		*Develop grazing management plans to meet objective*				
SONCC-ShaR.7.1.22.3		*Plant vegetation to stabilize stream bank*				
SONCC-ShaR.7.1.22.4		*Maintain fencing or fence livestock out of riparian zones*				
SONCC-ShaR.7.1.22.5		*Remove livestock watering sources away from riparian areas, including springs*				
SONCC-ShaR.7.1.23	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve protection and shading of spring complexes	Population wide	2
SONCC-ShaR.7.1.23.1		*Identify and prioritize locations for planting and thinning*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-ShaR.7.1.24	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide, unvegetated areas	2
SONCC-ShaR.7.1.24.1	*Plant riparian vegetation to increase shade/cover and habitat complexity, guided by prescription*					
SONCC-ShaR.7.1.24.2	*Thin, or release riparian vegetation, guided by prescription*					
SONCC-ShaR.7.1.45	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reestablish natural fire regime	Population wide, guided by recent assessment priorities (USFS WCF 2011)	3
SONCC-ShaR.7.1.45.1	*Identify areas prone to high intensity fire and develop a plan to reestablish a natural fire regime*					
SONCC-ShaR.7.1.45.2	*Carry out fuel reduction or modification projects such as thinning, prescribed burning, and piling, guided by the plan*					
SONCC-ShaR.8.2.29	Sediment	No	Increase spawning gravel	Enhance spawning substrate	Downstream of Dwinnell Dam, Parks Creek, and other tributary drainages	2
SONCC-ShaR.8.2.29.1	*Review the McBain and Trush (2010) spawning gravel plan that identifies quantity, quality, location, and timing of gravel supplements*					
SONCC-ShaR.8.2.29.2	*Supplement gravel, guided by the McBain and Trush (2010) spawning gravel plan for the Shasta River*					
SONCC-ShaR.8.1.30	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3
SONCC-ShaR.8.1.30.1	*Assess and map mass wasting hazards, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-ShaR.8.1.30.2	*Implement plan to stabilize slopes and revegetate exposed areas including agricultural lands*					
SONCC-ShaR.8.1.31	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide, including both upslope and valley floor roads	3
SONCC-ShaR.8.1.31.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-ShaR.8.1.31.2	*Decommission roads, guided by assessment*					
SONCC-ShaR.8.1.31.3	*Upgrade roads, guided by assessment*					
SONCC-ShaR.8.1.31.4	*Maintain roads, guided by assessment*					
SONCC-ShaR.10.1.12	Water Quality	No	Reduce water temperature, increase disssolved oxygen	Improve quality of water released from Dwinnell Reservoir	Dwinnell Dam	3
SONCC-ShaR.10.1.12.1	*Develop plan that includes range of alternatives to improve quality of water released from Dwinnell Reservoir to upper Shasta River*					
SONCC-ShaR.10.1.12.2	*Implement water quality improvement plan*					

38. Lower Trinity River Population

- Interior-Trinity Stratum
- Core Population
- Moderate Extinction Risk
- 3,900 Spawners Required for ESU Viability
- 746 mi^2
- 112 IP km (69 mi) (1% High)
- Dominant Land Uses are Forestry and Agriculture
- Principal Stresses are ‘Lack of Floodplain and Channel Structure’ and ‘Altered Hydrologic Function’
- Principal Threats are ‘Channelization/Diking’ and ‘Dams/Diversion’

38.1 History of Habitat and Land Use

Prior to 1944, the Lower Trinity River was occupied by Native Americans and turn-of-the century miners (U.S. Forest Service (USFS) 2000d). Their use of these lands probably had relatively minor impacts. Forest Service road construction and timber harvest did not begin until the 1950s (USFS 2000e). Land use activities in the Lower Trinity River watershed today include mining, timber harvesting, road construction, recreation and a limited degree of residential development (U.S. Environmental Protection Agency (EPA) 2001). The construction of Trinity and Lewiston dams in the early 1960s, and water diversion to the Sacramento Valley has had major impacts on the flow and function of the Trinity River (EPA 2001; USFS 2000e). Effects to coho salmon habitat in the Lower Trinity River include degradation of spawning and rearing habitat, lack of deep pools, sedimentation, channelization and channel confinement, and high water temperatures. Some streams with moderate IP value are relatively intact with regards to their historic condition and a few have federally designated Wilderness protection.

Fish habitat, especially anadromous fish habitat, was greatly degraded in the 1964 flood, which affected the Lower Trinity River and most anadromous habitat in California (USFS 2000e). Substantial habitat recovery has occurred since the 1964 flood, but wild anadromous fish populations and salmon habitat has generally not recovered in the Klamath basin (USFS 2000e). Fire has also been a source of catastrophic disturbance. Several high intensity fires have burned through the lower Trinity River since fire suppression activities on USFS land began in the mid 1900s.

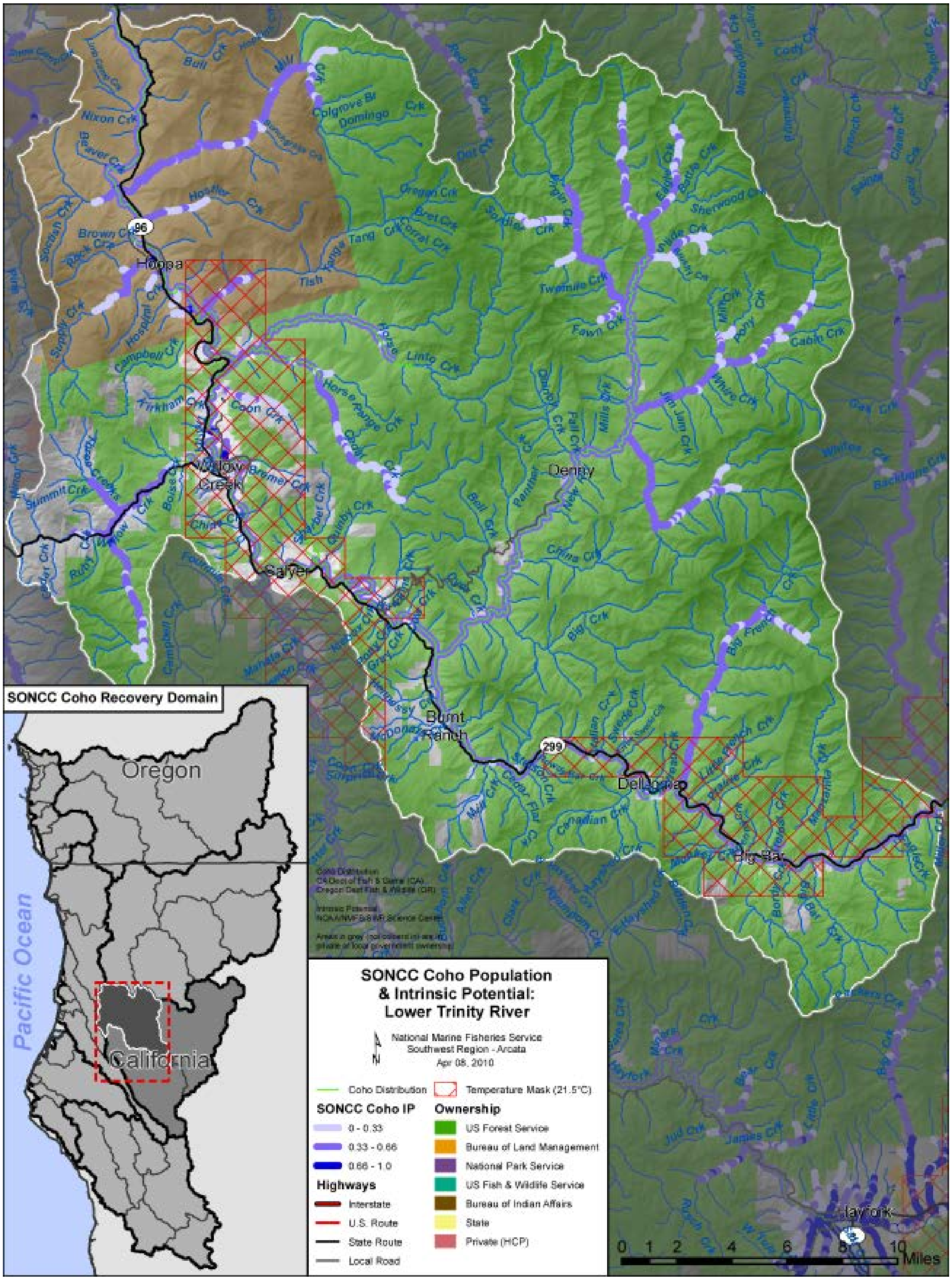

Figure 38-1. The geographic boundaries of the Lower Trinity River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

For instance, the 1999 Megram Fire, which burned 125,000 acres, and the Big Bar Complex, which burned close to 80,000 acres (53 percent) of the New River watershed in August 1999. Both impacted the riparian communities of some streams and accelerated the delivery of sediment to several streams in the Lower Trinity River drainage (USFS 2000e).

Logging practices and developments on floodplains within the Trinity River watershed have also contributed significantly to habitat degradation (U.S. Department of the Interior (DOI) 1981). A total of 28 percent of the Lower Trinity was harvested between 1940 and 1990 (EPA 2001) as a result of large-scale timber harvesting occurring on private land (especially Willow Creek and Sharber Creek) (USFS 2003). Clearcutting promoted increased sediment loading; removal of streamside vegetation increased water temperatures; and log jams at the mouths of tributaries (DOI 1981). In addition, logging within the subbasin has necessitated the construction of hundreds of miles of unpaved logging roads (DOI 1981). Road networks in the Lower Trinity and many other areas of the Pacific Northwest are the most significant source of anthropogenic sediment input to anadromous fish habitats, often exceeding all other combined sources from forest activities (USFS 2003). Roads have led to decreased hydrologic function and increased sediment loading. The resulting increased yield of sediment in the mainstem Trinity River and its tributaries has reduced the biological productivity and fish carrying capacity of the river (DOI 1981).

Much of the mainstem Trinity River and virtually all tributaries have been subjected to hydraulic mining activities (U.S. Fish and Wildlife Service (USFWS) and Hoopa Valley Tribe (HVT) 1999; EPA 2001). At one time, hydraulic mining destabilized streambanks, changed the channel structure, and caused large amounts of sediment to be washed into tributary streams. However, the form and function of the streams in areas where hydraulic mining has occurred seem to have persisted despite this disturbance. (USFWS and HVT 1999, EPA 2001).

It is likely that many watersheds within the Burnt Ranch and New River hydrologic subarea (HSA) are properly functioning with regard to aquatic habitat and watershed conditions. These streams have a large portion of their watersheds in the Trinity Alps Wilderness and remain in a relatively undisturbed state. Most of these streams remain accessible to coho salmon. Although these streams currently support small populations of anadromous steelhead and some coho salmon, because of their high gradient they may not have historically supported robust populations of coho salmon.

38.2 Historic Fish Distribution and Abundance

There is little information on the historic abundance of coho salmon in the lower Trinity River. It was noted by USFWS and California Department of Fish and Game (CDFG) (1956) that “Silver [coho] salmon enter most lower Trinity River tributaries to spawn.” Similarly, Moffet and Smith (1950) stated that “silver [coho] salmon enter the lower Trinity River to spawn” and reported that coho salmon were usually observed in the Hoopa Valley by October. In 1969 and 1970, CDFG estimated the coho salmon run size for the Trinity River to be 3,222 and 5,245, respectively (Smith 1975, Rogers 1973). Since 1978, coho salmon escapement above Willow Creek has ranged from 558 to 32,373 (USFWS and HVT 1999). These returns have largely been comprised of hatchery fish since Trinity River Hatchery (TRH) was built. Spawning surveys by the USFS in the mid to late 1990s have found scattered use of tributaries in the Lower Trinity by coho salmon with between 0 and 100 spawners found during any given year in the few surveyed streams (USFS 2003).

TRH first began releasing coho salmon in 1960. Although substantial efforts were made to trap and haul coho above the dam during the construction of Trinity Dam, adult returns fell to essentially zero during the 1962-63 run (zero females, seven males, nine grilse). Transfer of coho salmon eggs from outside of the Trinity basin often occurred, which imported coho salmon that were likely not as well adapted to the Trinity basin's habitat conditions as were the original stocks. The TRH facility originally used Trinity River fish for broodstock, though coho salmon from Eel River (1965), Cascade River (1966, 1967, and 1969), Alsea River (1970), and Noyo River (1970) have also been reared and released at the hatchery as well as elsewhere in the Trinity River basin. Actual production averaged 496,813 from 1987 to 1991, decreased to 385,369 from 1992 to 1996, then increased again to 527,715 fish from 1997 to 2002. During the period 1991–2001, an average of 3,814 adult coho salmon were trapped and 562 females were spawned at TRH.

Today, on average, over 90 percent of coho salmon spawning between Willow Creek and Lewiston Dam are of hatchery origin (USFWS and HVT 1999). Based on population estimates from 1991-1995, 1998, and 1999 the average escapement of naturally produced fish was approximately 400 fish. During this seven year period of sampling the Trinity coho salmon population experienced two years of no natural production and one additional year of extremely low natural production. The other three years had natural runs on the order of 1,000 coho or less (USFWS and HVT 1999).

Given that several tributary streams in Lower Trinity River provide spawning habitat, it can be inferred that coho salmon were historically widely distributed throughout the Lower Trinity River subbasin. Historically, it was probably rare for coho salmon to spawn in the mainstem Lower Trinity River. The steep nature of the surrounding terrain likely limited the amount of high quality habitat available to coho salmon and the majority of IP habitat is of moderate value (0.33- 0.66). There exist only a few scattered kilometers of high IP habitat (>0.66). The relatively steep nature of the area and the consequent lack of high IP habitat (<2 percent High IP) suggest this population never supported large runs of coho salmon but may have supported a moderately-sized population that was spread throughout most major tributaries (Big French Cr., New River, Willow Cr., Horse Linto Cr., Tish Tang Cr., Mill Cr., and Cedar Cr.)

38.3 Status of Lower Trinity River Coho Salmon

Spatial Structure and Diversity

Good spawning habitat does exist in a few tributaries in the Lower Trinity. The Burnt Ranch and New River HSAs have some of the best known spawning habitat in the population area. Tributaries known to support coho spawning and/or rearing include Mill Creek, Horse Linto Creek, Tish Tang Creek, and Sharber-Peckham Creek. The presence of juvenile coho salmon has also been confirmed within the last five years in Manzanita Creek, Big French Creek, East Fork New River, Cedar, Supply, Campbell, and Hostler creeks, as well as in Willow Creek as far upstream as the Boise Creek confluence (Everest 2008; Boberg 2008). Sharber-Peckham Creek likely supports the highest number of spawning coho salmon (USFS 2001; Boberg 2008). The

Six Rivers National Forest indicated that populations in the lower portions of Mill and Horse Linto creeks are extremely low, particularly in Horse Linto Creek since 1995 (USFS 2001). The USFS (2000f) reported that coho salmon are rarely found in the New River although this is one of the largest watersheds with the potential for coho salmon production based on the availability of IP habitat in the subbasin. Based on this current distribution of coho salmon in the Lower Trinity, most of the historic habitat of the Lower Trinity River remains accessible to coho salmon and coho salmon occur in many of the tributaries with IP habitat.

Although not well documented, there appears to be some diversity of life history strategies in the Lower Trinity River. Data on run timing and outmigration indicate that there is some variation in the life history characteristics of the population. Coho salmon enter the Trinity River between September and November and spawning in the river continues into December (CDFG 2009b). Also, both young-of-the-year and yearling coho salmon are captured at downstream migrant traps located in the Trinity River near Willow Creek (Pinnix et al. 2007). Redistribution of age 0+ coho occurs over a large time period between March and September as does outmigration of age 1+ (Pinnix et al. 2007).

Hatchery influences on the genetic diversity of the population are substantial in the Lower Trinity River subbasin. Each year, TRH releases approximately 500,000 coho salmon smolts. Currently, coho salmon returns to the Trinity River are dominated by hatchery fish (USFWS and HVT 1999). From 2003 to 2005, over 75 percent of adults returning to the Trinity River (as estimated at Willow Creek) were of hatchery origin. Trinity River hatchery coho salmon stray into many of the tributaries on the Six Rivers National Forest, such as Horse Linto Creek (Cyr 2008). Straying of hatchery fish into tributaries of the Trinity River presents a particular threat to the diversity viability parameter, as hatchery fish may reduce the reproductive success of the overall population (Mclean et al 2003) through outbreeding depression (Reisenbichler and Rubin 1999). In 1985, Jong and Mills (1992) found that 35.8 percent of adult coho salmon returning to the South Fork Trinity River were of hatchery origin. We assume that in years of high adult returns of hatchery coho salmon (>10,000), the proportion of hatchery coho salmon adult returns to tributaries in the Lower Trinity River is similar to that found in the South Fork, or greater. Because of the high numbers of adult hatchery coho salmon migrating through the lower Trinity River the Lower Trinity River population of coho salmon is at a moderate risk of extinction.

Table 38-1. Estimates of run sizes of coho salmon. Data are from the Trinity River's Willow Creek weir, 1997 to 2008. Hatchery-origin fish were identified by a mark (right maxillary clip). CDFG (2009).

Year	Number Unmarked	Number Marked	% Hatchery	% Natural
1997	651	7,284	92%	8%
1998	1,232	11,348	90%	10%
1999	586	4,959	89%	11%
2000	539	14,993	97%	3%
2001	3,373	28,768	90%	10%
2002	596	15,420	96%	4%
2003	4,093	24,059	86%	14%
2004	9,055	29,827	77%	23%
2005	2,740	28,679	92%	8%

Year	Number Unmarked	Number Marked	% Hatchery	% Natural
2006	1,624	18,454	92%	8%
2007	1,199	4,551	79%	21%
2008	1,312	8,671	87%	13%

Population Size and Productivity

Williams et al. (2008) determined at least 112 spawners are needed each year in the Lower Trinity River to avoid problems associated with low spawner density such as the failure to find mates leading to a reduced probability of fertilization, and the failure to saturate predator populations (Liermann and Hilborn 2001, Williams et al. 2008). Williams et al. (2008) also determined that there should be a spawner density of at least 35 coho salmon per IP-km of habitat in the Lower Trinity River subbasin, resulting in a total of 3,900 individuals to meet the low risk spawner threshold.

Limited presence/absence and spawning survey data are available from the U.S. Forest Service. Based on spawner surveys by the USFS run sizes in Sharber Creek between 1996 and 2001 ranged from 0 fish in 1999 to almost 150 fish in 2001 (USFS 2003). The average run size during this time was 56 fish (and 27 redds). No coho salmon were found during spawning surveys in Willow Creek between 1991-2000 although juveniles have been found during outmigrating trapping (USFS 2003). Captures of yearling coho salmon in the Trinity River during outmigrant trapping have been consistent, but numbers are generally low (CDFG 2009b). Based on the recent returns at Willow Creek, the Trinity River population is between 5,800 and 39,000 with the majority being hatchery-origin (>90 percent most years) (CDFG 2009b). The proportion of the unmarked run that spawns within the geographic area of the Lower Trinity River population is not known. However, if a moderate percentage (30-50 percent) of the run spawns in the Lower Trinity River population area, the unmarked adult population of the Lower Trinity River is likely to be less than the low risk spawner threshold of 3,900 and likely less than a few hundred fish during some years.

The population growth rate in Lower Trinity River subbasin has not been quantified. Recent data indicate that the amount of recruits produced per female spawner in the Trinity River is substantially less than two, meaning the population is failing to replace itself. The population growth rate for the Lower Trinity River is likely to be negative, and the population relies on the heavy influence of hatchery fish to maintain current abundance levels.

Extinction Risk

Based on the criteria set forth by Williams et al. (2008) the Lower Trinity River population is at a moderate risk of extinction because the number of spawners is above the depensation threshold. Although the number of spawners is above the depensation threshold, more than 5% of spawners are of hatchery origin. Most spawning areas seem to have relatively low numbers of spawners in any given year. Spatial structure is not thought to be limiting because most of the habitat remains accessible. In terms of diversity, there appears to be some variability in life history strategies that probably bolster the population's resiliency, however, hatchery strays probably reduce population productivity. Little is known about the population's growth rate, but it is thought to be low or negative. It is likely that the naturally-produced adult coho salmon population in the Lower Trinity River during any given year is less than the low risk spawner threshold established by Williams et al. (2008).

The Lower Trinity River coho salmon population is not viable and at moderate risk of extinction. The estimated number of spawners exceeds the depensation threshold, but does not meet the low-risk threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Lower Trinity population is considered to be a core "Potentially Independent" population within the Interior-Trinity diversity stratum meaning that it was sufficiently large to be historically viable-in-isolation and historically had demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005; Williams et al. 2006). As a core population, the recovery target for the Lower Trinity population is for the population to be viable and to have a low risk of extinction according to population viability criteria (see Chapter 5). Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU.

38.4 Plans and Assessments

Hoopa Valley Tribal Fisheries and Hoopa Valley Environmental Program

Yurok Tribal Fisheries Program

U.S. Forest Service- Shasta-Trinity and Six Rivers National Forests

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

North Coast Regional Water Quality Control Board (NCRWQCB)

Five Counties Salmonid Conservation Program

38.5 Stresses

Table 38-2. Severity of stresses affecting each life stage of coho salmon in the Lower Trinity River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult[1]	Overall Stress Rank
1	Adverse Hatchery-Related Effects[1]	Very High	Very High	Very High[1]	Very High	Very High[1]	Very High
2	Lack of Floodplain and Channel Structure[1]	Medium	Very High	Very High[1]	Medium	Medium	Very High
3	Altered Hydrologic Function[1]	Medium	Medium	High[1]	High	High	High
4	Altered Sediment Supply	High	High	High	Medium	Medium	High
5	Impaired Water Quality	Low	Low	High	Low	Medium	Medium
6	Degraded Riparian Forest Conditions	-	Medium	Medium	Low	Medium	Medium
7	Barriers	-	Low	Medium	Medium	Medium	Medium
8	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
9	Increased Disease/Predation/Competition	Low	Low	Medium	Medium	Low	Low
10	Impaired Estuary/Mainstem Function	-	Low	Medium	Medium	Low	Low

[1]Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Several factors limit the viability of the Lower Trinity population. The most dominant of these factors stem from negative impacts of the hatchery, altered hydrologic function, and altered floodplain and channel structure. Juveniles are likely the most limited life stage based on the impacts of these stresses on summer and winter rearing habitat. Overall, the capacity of the Lower Trinity to support juveniles and other life stages of coho salmon has been reduced by these impacts. In order to improve the viability of this population it will be imperative to address the issues related to the hatchery and to improve habitat conditions for juveniles and adults. Addressing other stresses and threats and improving habitat for all life stages and life history strategies will also be an important component of recovery.

The Trinity River Hatchery plays a role in limiting the Lower Trinity River population through negative genetic and ecological interactions. Stray rates of hatchery adults onto spawning ground the Lower Trinity are high; use of Lower Klamath rearing and migratory habitat by hatchery juveniles is common; and predation of coho salmon by hatchery fish also occurs. Looking at the overall productivity of the population, the hatchery has a major negative impact on population growth and habitat capacity. Through high stray rates and genetic interactions on the spawning grounds (Reisenbichler and Rubin 1999; Mclean et al 2003) hatchery fish reduce the overall fitness of the population. Competition with hatchery Chinook salmon released from Trinity River Hatchery limits refugia and rearing capacity in the Lower Trinity because competition between hatchery fish with naturally produced fish almost always has the potential to displace wild fish from portions of their habitat (Flagg et al. 2000). Cumulatively and in concert with other habitat-related stresses, adverse hatchery-related impacts are likely a limiting stressor for the population.

Lack of floodplain and channel structure impacts also have a major impact on the productivity of this population. Rearing opportunities and capacity are low due to disconnection of the floodplain, a lack of LWD inputs, poor riparian conditions, and sediment accretion. Low-lying areas of streams such as Supply, Mill, and Willow Creek have been channelized, diked, and disconnected from the floodplain. There exists very little off-channel habitat that can be used for rearing and refugia. Many tributaries in low-gradient areas of the Lower Trinity experience similar habitat characteristics due to development of the floodplain, sedimentation and changes in flow. The mainstem river also lacks side channel, backwater, and wetland habitat where juvenile coho salmon could find habitat in the winter. A lack of floodplain and channel structure impacts winter rearing because high flow events can displace juveniles from streams and there exists very little low-velocity rearing habitat. Lack of complex habitat also impacts summer rearing due to the loss of predatory refugia, low-flow refugia, and foraging habitat.

Given the number of diversions and the potential amount of water withdrawn from the mainstem Trinity River and its tributaries, a lack of hydrologic function could also be potentially limiting coho salmon production in the Lower Trinity population. Many tributaries likely experience unnatural seasonal low flow conditions that prohibit their use during the summer. Thermal refugia on the mainstem may also be impacted by reduced flows through a reduction in the extent, duration, or quality of refugia areas. Given the importance of tributary rearing habitat and thermal refugia on the mainstem a loss of hydrologic function could have a major impact on juvenile coho.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no hatcheries in the Lower Trinity River population area, but Trinity River Hatchery is upstream on the Trinity River. Trinity River Hatchery currently releases 4.3 million juvenile and yearling Chinook salmon, 500,000 yearling coho salmon, and 800,000 yearling steelhead. Hatchery-origin coho salmon make up most of the spawning run to the Trinity River each year. On average, only three percent of in-river spawners were not reared in a hatchery (USFWS and HVT 1999). Between 1997 and 2002, hatchery fish constituted between 85 percent and 97 percent of the fish (adults plus grilse) returning to the Willow Creek weir in the Lower Trinity River (CDFG 2009b). Spawning surveys in 1998-99 found a high proportion of hatchery strays (60-100 percent) in all Lower Trinity streams where coho salmon where found (Dutra and Thomas 1999). Adverse hatchery-related effects pose a very high risk to all life stages, because more than thirty percent of adults are of hatchery origin (Appendix B) and there is significant potential for ecological interactions.

Lack of Floodplain and Channel Structure

The lack of floodplain and channel structure presents a moderate to high stress across life stages. Data on instream large woody debris (LWD) is limited, but it is assumed to be low given the extent of logging in the areas and current lack of late seral riparian forest (e.g., Willow Creek and Sharber Creek; USFS 2003). Lack of LWD has resulted in loss of pool habitat and a reduction in overall habitat and hydraulic complexity in coho salmon streams (CDFG 2002b). Sediment loading in many streams has led to the filling of pools, disconnection from the floodplain, and the overall loss of stream complexity. Diking and channelization in many streams has reduced habitat complexity, connectivity with the floodplain, and increased water velocity, leading to lower survival of the egg, fry, and juvenile life stages. Historic floodplains in the area have been disconnected from tributary streams and converted to agricultural, grazing, or residential lands. This has further limited a relatively scarce yet important habitat type that is used for rearing of coho salmon fry and juveniles. Examples of floodplains that have been diked and simplified are the lower portions of Supply and Mill creeks on the Hoopa Valley Tribe Reservation. Complex floodplain habitats are crucial for overwintering survival and growth of juvenile coho salmon. Overwintering survival of juvenile coho salmon is likely to be low given that few unmarked yearling coho salmon are captured at Willow Creek, despite the prevalence of fry in the catch of the rotary screw traps. Many subyearling coho may be forced downstream into the Lower Klamath and estuary during high flow events due to the lack of adequate refugia from high flows.

Altered Hydrologic Function

Altered hydrologic function is a medium to high stress for all life stages. There were 381 diversions listed in CDFG's Fish Passage Assessment Database (CalFish 2009), and this does not included unpermitted or illegal diversions or groundwater use. The towns of Willow Creek and Hoopa both get drinking water from the Lower Trinity River subbasin through city water systems. Denny and Burnt Ranch also get water from tributaries in the Lower Trinity. Even when a stream is not fish bearing (e.g., McDonald Creek in Burnt Ranch) it will create vitally important thermal refugia for coho salmon where the creek meets the Trinity River. By reducing the summer stream flow in streams like McDonald Creek that are not fish bearing, water diversion can still have an impact on juvenile rearing by decreasing the size of thermal refugia within the mainstem Trinity River. Other smaller domestic wells also utilize ground water, but the cumulative impact from these various residential uses on surface flows is not well documented. Overall diversions likely impact flow in many tributaries, especially during summer and early fall low flow periods. Sharber Creek, an important stream for coho salmon production in the Lower Trinity, has limited flow during the summer and can go dry in some areas. In addition to water diversion for human uses, the hydrologic regime in the Lower Trinity has been affected by the road system and fire regime. Many streams in the Lower Trinity population unit are impacted by illegal diversions and water use for marijuana cultivation, which is a growing and substantial impact to streamflow in the area. Roads affect subsurface water flow, concentrate flow, and divert or reroute water from paths it would otherwise take (USFS 2003; Gucinski et al. 2001). The high density of roads mean that many streams experience changes in their hydrology as a result of roads. Less frequent fire in tributary watersheds has reduced or eliminated peak flow responses to the removal of duff, understory vegetation, and overstory vegetation by fire.

Altered Sediment Supply

Water quality of the Trinity River is listed as impaired for sediment throughout its length by California State Water Resources Control Board under Section 303 (d) of the Federal Clean Water Act. Increased sediment loading is thought to have filled pools, widened channels, and simplified stream habitat used for rearing and altered sediment supply presents a moderate to high stress for coho salmon in this population. In many reaches, aggradation has reduced surface stream flows, limiting tributary and habitat access to migrating juveniles. In the Willow Creek and Hoopa HSAs, sediment loading is especially high and likely limits the potential for spawning and rearing in these areas. Campbell and Willow Creek have experienced intensive land management and suffer from high sediment loading. Campbell Creek, Supply Creek, and Willow Creek have been noted as having extremely high rates of sedimentation and are highly impaired due to sediment/turbidity. Supply Creek was also recently impacted by large fine sediment input in winter of 2009. Mill and Tish Tang Creek are also considered impaired due to sedimentation as a result of timber harvest and road-building and experience high rates of sedimentation (EPA 2001). The majority of sediment in the Lower Trinity originates from roads and landslides (EPA 2001).

Impaired Water Quality

Impaired water quality poses a moderate stress to the Lower Trinity population. In some smaller tributary streams, water temperatures can increase to levels stressful for rearing coho salmon in the summer months (>16° C). Water temperature in the mainstem often reaches >20^{o} C. Mainstem and tributary migratory habitat is impaired by high summer temperatures and thermal barriers. Releases from Lewiston Dam to support North Coast Regional Water Quality Control Board (NCRWQCB) and ROD temperature criteria have substantially improved conditions (USFWS and HVT 1999), however, criteria for the Lower Trinity River do not prohibit temperature increases after July 9 (or June 15 in Dry and Critically Dry Water Years). Temperature readings at Hoopa often exceed the thermal tolerance of coho salmon starting in June and extending into September (USFS 2003). Juveniles often rely on thermal refugia during the summer in areas of the mainstem where water quality is poor. Localized areas of non-point source pollution likely exist (e.g., runoff from roads, parking lots, and agricultural lands). Recent large algae blooms in the Lower Trinity River likely associated with high levels of nutrients in runoff from various agricultural operations, particularly near the town of Willow Creek.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions pose a low to moderate stresses across all life stages. Evaluations of streamside canopy cover range from fair to very good throughout the watershed based on existing survey data. The Willow Creek HSA appears to have fair riparian conditions, while the Burnt Ranch and New River HSAs have very good riparian conditions. The Hoopa HSA was not rated for streamside canopy cover. Many of the riparian areas in the Lower Trinity have been disturbed through timber harvesting, natural storm events, landslides, and wildfires. Changes in timber management have helped foster recovery of riparian zones, although hardwoods now dominate canopy cover where it was once conifer dominated. While LWD recruitment potential may be reduced, the shade component along tributary streams has been reestablished through encroachment of alders and other riparian vegetation. While riparian canopy closure conditions have substantially recovered, forest openings and degraded riparian forest remain along most tributaries, particularly along Willow Creek. The mainstem Trinity generally does not have extensive shade-producing riparian cover because the width of the channel reduces closure.

Barriers

Barriers pose a moderate stress to coho salmon in the Lower Trinity River and are especially detrimental to juveniles, smolts, and adults. The extent of impact from barriers is largely unknown due to the number of private diversions in the Lower Trinity, however the impact could be large. There are no large dams in the Lower Trinity River drainage, except on McDonald Creek, where the town of Burnt Ranch gets its water. The dam is upstream of where coho salmon can migrate. There are 25 road-stream crossing structures that are total barriers to juvenile and adult salmonid migration in the Lower Trinity River population area and a total of 33 unscreened diversions (CalFish 2009). More of the remaining 30 diversions on private land may also be unscreened. Two barriers are a high priority for removal and two are a moderate priority (CalFish 2009). The location of most road crossings and diversions suggests that most of the watershed remains accessible to coho salmon and these barriers are not substantially restricting the availability of habitat. One exception is the barrier on Sharber Creek which is blocking access to approximately 2 miles of high quality rearing and spawning habitat on one of the last remaining productive streams. Low water barriers and thermal barriers (e.g., mainstem reaches) may seasonally limit coho salmon rearing and migratory habitat. Permanent natural barriers also prevent access to potential spawning and rearing habitat (e.g., Campbell Creek, Sharber Creek, and Hawkins Creek).

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the ESU have not been formally evaluated by the National Marine Fisheries Service (NMFS) (Appendix B).

Increased Disease/Predation/Competition

Disease is a medium to low stress across all life history stages in the Lower Trinity River. Coho salmon smolts may be exposed to diseases like Ceratomyxosis during their downstream migration in the Trinity and Klamath River. The rates of infection for these smolts are likely somewhat low given that disease rates in the Trinity are generally low and the zones with the highest rates of infection in the Klamath are upstream of the Trinity confluence (Bartholomew 2008). By the time adult coho salmon from the Trinity River enter the Lower Klamath River (late fall to early winter), *Ceratomyxa shasta* (Ceratomyxosis) and *Flavobacterium columnare* (Columnaris) are probably not a significant issue. Releases of Chinook salmon from Trinity River Hatchery may result in competition for limited rearing space and food in thermal refugia during the summer months.

Impaired Estuary/Mainstem Function

All salmon and steelhead that originate from the Lower Trinity River migrate to and from the ocean through the mainstem Lower Trinity, Lower Klamath River, and the Klamath River estuary. The Klamath River estuary may play an important role in providing foraging and refuge opportunities for juvenile coho salmon from the Lower Trinity River. This type of non-natal rearing may be especially important because a lack of summer and winter rearing habitat in the Lower Trinity which may force juveniles to move downstream and rear in the estuary. The degraded conditions that exist throughout the Trinity basin may mean that the estuary plays a very important role by providing the opportunity for growth and refugia prior to entering the ocean. The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain. Mainstem conditions contribute to this stress because of the issues with water quality, sedimentation and accretion, and degraded habitat in mainstem reaches of the Lower Klamath River. Juveniles, smolts, and adults transitioning through mainstem habitat are stressed by the degraded conditions in these migratory habitats and suffer from the lost opportunity for increased growth and consequently a lower survival rate. The loss and degradation of estuarine and mainstem habitat is considered a low to medium stress for the population, with the most affected life stages being juveniles and smolts.

38.6 Threats

Table 38-3. Severity of threats affecting each life stage of coho salmon in the Lower Trinity River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Hatcheries	Very High	Very High	Very High	Very High	Very High	Very High
2	Channelization/Diking	Low	Very High	Very High	High	Medium	Very High
3	Climate Change	Low	Medium	Very High	High	High	High
4	Roads	High	High	High	Medium	Medium	High
5	Dams/Diversion	Low	High	High	Medium	Medium	Medium
6	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
7	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
8	Urban/Residential/Industrial	Low	Medium	Medium	Medium	Low	Medium
9	Fishing and Collecting	-	-	-	-	Medium	Medium
10	Timber Harvest	Low	Low	Medium	Low	Low	Low
11	Road-Stream Crossing Barriers	Low	Low	Medium	Low	Low	Low
12	Mining/Gravel Extraction	Low	Low	Medium	Low	Low	Low
13	Invasive Non-Native/Alien Spices	Low	Low	Low	Low	Low	Low

Hatcheries

Hatcheries pose a very high threat to all life stages of coho salmon in the Lower Trinity River subbasin. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Channelization/Diking

Channelization and diking poses a low to very high threat to coho salmon. Although channelization and diking is not widespread in the population area, localized restrictions where roads parallel streams reduce floodplain connectivity and function. These areas are important for coho salmon rearing and growth. This reduces the amount of spawning and rearing habitat available to coho salmon by reducing habitat complexity and increasing water velocity, particularly during the winter months. For example, lower reaches of tributaries such as Supply and Mill Creeks in the Hoopa HSA have been straightened and diked, reducing the complexity and natural meandering tendency that produces complex habitat, diversity in foraging opportunities, and high quality rearing habitat. In cases where streams have been straightened and confined, swift currents and lack of habitat are expected to reduce survival of rearing juveniles, fry, and cause a reduction in egg-to-fry survival.

Climate Change

Climate change poses a high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 3° C in the summer and by 1° C in the winter. Predictions indicate annual precipitation will have little change in the next century. However, snowpack in upper elevations of the Trinity River basin will decrease with changes in temperature (California Natural Resources Agency 2009). Climate change is expected to reduce the amount of snowpack in the Trinity Alps (Mote et al. 2005; Regonda et al. 2005; Mote 2006) and shift streamflow timing (i.e. peak streamflow) by 20–40 days earlier in many streams during the 21st century (Stewart et al. 2005). NMFS expects that climate change will cause the amount of coldwater thermal refugia habitat and the amount of available rearing area to decline over time. The increase in water temperatures is expected to reduce growth or cause negative growth of juvenile coho salmon in the summer months by elevating metabolism beyond daily ration (McCarthy et al. 2009). The vulnerability of the downstream Klamath estuary to sea level rise is low to moderate and therefore does not pose a significant threat to estuarine rearing habitat downstream. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, with all populations in the ESU adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Roads

Roads are a moderate to high threat for this population. About one third of the area with high potential to support juveniles occurs in areas with high or very high road densities. Data indicate road density is very high (>3 mi/sq mi) in the Hoopa and Willow Creek HSAs where small tributary streams with high or medium IP value stream reaches are accessible to coho salmon. Given the sedimentation problems observed in the watershed, unpaved roads contribute to landslide potential and chronic sedimentation. It has been estimated that approximately 45 percent of sedimentation in the Lower Trinity originates from roads, especially road-related landslides (EPA 2001). Highway 299 significantly affects Willow Creek, as it runs along much of the stream's mainstem length. At the landscape scale, correlative evidence suggests that roads are likely to influence the frequency, timing, and magnitude of disturbance to aquatic habitats (Gucinski et al. 2001). Roads can act as barriers to migration, lead to water temperature changes, and alter flow regimes (Gucinski et al. 2001). The Road Hazard Potential indicator used by the USFS represents the potential for altered hydrologic regime (changes in runoff response) and stream diversions associated with roads (USFS 2003). USFS (2003) ranked the area from the New River to the South Fork Trinity River as having a high road hazard potential. The area from the South Fork Trinity River Trinity to Tish Tang a Tang Creek was given a moderate hazard rating. Given the large tracts of U.S. Forest Service land in the watershed and the current trends toward decreasing timber harvest and increasing road decommissioning and storm-proofing on public land, the number of new roads and impacts from legacy roads is likely to decrease in the future.

Dams/Diversions

Dams and diversions are a low to high threat across life history stages. Numerous wells and diversions varying from single domestic spring boxes to community water systems occur throughout the watershed. The impact of these diversions is dependent on the amount and location of the withdrawal. The reduction in surface and subsurface flow in tributaries can reduce the amount of cool water refugia at their confluence with the Trinity River and impacts can increase during dry water years. The towns of Willow Creek, Burnt Ranch, Hawkins Bar and Hoopa obtain water from streams in the Lower Trinity River. The Campbell Creek diversion supplies much of the west-side Hoopa Valley. Additionally, there are vineyards and small farms that utilize water in the Lower Trinity River subbasin, but their effect on stream flows has not been studied. Tributary accretions in the Lower Trinity River subbasin, combined with relatively unconfined floodplain and valley characteristics, probably ameliorate some of the impacts of the Central Valley Project.

High Intensity Fire

High intensity fire poses a moderate threat to the population due to current level of fire risk and the predicted future increase in fire risk that is expected as a result of climate change. Fires such as the Megram Fire in 1999 and the complex of fires in 2008 have swept through regions of the Lower Trinity River in the recent past. Fuel loads, climate, and vegetative characteristics in the subbasin have resulted in a high to extreme fire risk (USFS 2003). Human-related causes are the predominant type of fire starts within the area especially within the Trinity River corridor. Lightning fire starts, although relatively infrequent when compared to human related starts, are a significant cause of wildfires along the upper slopes and ridges of the watersheds (USFS 2003). Present and future challenges to fire and fuels management include significant areas of private lands which may prohibit fire use and prescribed fire; prevention of unnatural fire starts; limited access due to topography or intermixed ownership; and vegetation mortality and fuel accumulation in the area affected by the Megram Fire (USFS 2003).

Agricultural Practices

There are several agricultural operations in the Lower Trinity River subbasin, consisting of several small farms, vineyards and small cattle grazing operations. Agriculture is a medium threat to coho salmon in the Lower Trinity River watershed given the current and expected level of agriculture in the area. However, in the area of Willow Creek, where much of the agriculture occurs, localized impacts of reduction in thermal refugia areas and excessive nutrient loads could cause substantial impacts. These impacts may increase in the future as the demand for high quality fruits and vegetables in the area grows. Recent algae blooms in the Lower Trinity River are thought to be associated with agricultural practices near the town of Willow Creek. Also of concern is marijuana cultivation and the associated water, and fertilizer and pesticide use.

Urban/Residential/Industrial Development

Rural population growth will continue to present a low to moderate threat to coho salmon in the Lower Trinity River. Human population in the Lower Trinity River drainage is tempered by the large amount of publicly-owned land as well as the steep surrounding terrain. The principal communities near the Lower Trinity River are Willow Creek, Hoopa, and Burnt Ranch. There are also a few smaller towns, like Del Loma and Big Flat, which may increase in population during this time. Areas likely to experience the greatest impacts from development include Willow Creek and mainstem river near major population areas. The demand for water in the drainage is expected to increase in the future. Development generally results in floodplain disconnection, removal of vegetation, increased sediment generation and delivery and introduction of exotic species. Subdivision of existing parcels will exacerbate this threat. Increased diversions associated with the population growth were addressed under Dams/Diversions above.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath/Trinity basin. The effects of the fisheries managed by the State of California and the Yurok and Hoopa Tribes, on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the Lower Trinity River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU

Timber Harvest

Data indicate that a medium or low amount of timber harvest presently occurs in the population area, as reflected in the medium threat ranking in the CAP workbook above. Much of the area is in public ownership (USFS) and has a substantial portion of federally-designated wilderness. Current and future timber harvesting on Forest Service land is small in scale and is conducted under strict guideline designed to protect aquatic resources. Based on data from CalFire (2009) a total of 12,287 acres within the Upper and Lower Trinity and Lower Klamath River subbasins have THPs that could potentially be harvested in the future (0.5 percent of total watershed area). The Hoopa Valley Tribe owns 15 percent of the Lower Trinity population area. Timber harvest is ongoing on these lands, and the extent of its environmental impacts are unknown but presumed to be low given Tribal timber management practices. One of the greatest impacts of all timber harvest in the Lower Trinity is the input of sediment. Timber harvest makes up approximately 5 percent of all sedimentation in the Lower Trinity (EPA 2001).

Road-stream Crossing Barriers

There are 25 road-stream crossing structures that are total barriers to juvenile and adult salmonid migration in the Lower Trinity River watershed (CalFish 2009). There may be additional road-stream crossing barriers on private or Tribal land; however, their status and impacts are unknown at this time. The location of most known road crossings and diversions suggests that most of the watershed remains accessible to coho salmon and these barriers are not substantially restricting the availability of habitat. One exception to this is the barrier on private land on Sharber Creek, which blocks or reduces access to approximately 2 miles of high quality rearing and spawning habitat upstream.

Table 38-4. List of road-stream crossing barriers in IP habitat for coho salmon. (CalFish 2009).

Priority	Stream Name	Road Name	County	Barrier Status*
High	Sharber Creek	Fountain Ranch Rd	Trinity	Total
Low	Hawkins Creek	Hawkins Bar Rd	Trinity	Total
Low	Hawkins Creek	Flame Tree Rd	Trinity	Total
Low	Boise Creek	Hwy 299	Trinity	Total
Low	Bell Creek- New River	Denny Rd	Trinity	Total
Low	Panther Creek #1-New River	Denny Rd	Trinity	Total
Low	Quinby Creek- New River	Denny Rd	Trinity	Total
Low	Hospital Creek	Hwy 96	Trinity	Total
Low	Campbell Creek	Hwy 96	Trinity	Partial

Mining/Gravel Extraction

A number of gravel mining operations occur on private land and on Tribal land in the Lower Trinity River. A total of nine sites are mined on an annual, rotational or intermittent basis. NMFS issued a Biological Opinion on these operations in 2009 (NMFS 2009b) and a new consultation will likely be completed in 2013 when the permits expire. Suction dredge gold mining is common in the Trinity River however this activity was recently prohibited in any California stream, river or lake on public or private property (*Hillman v. CDFG* et al. 2009) until an environmental review is complete (earliest date is likely 2011). If the activity is allowed again, it will likely be modified so as to minimize impacts on protected species such as coho salmon and their habitat. Gravel and dredge mining primarily affect juvenile coho and their habitat and given the extent of mining in the area this is considered a moderate threat to this life stage but a low threat overall.

Invasive Non-Native/Alien Species

This threat is currently considered to be low for the population but has the potential to increase in the future if exotic species or New Zealand mud snails cause trophic shifts. Brown trout, although in substantial numbers in the Upper Trinity River, do not inhabit the lower Trinity River in substantial numbers.

38.7 Recovery Strategy

Naturally-produced coho salmon in the Lower Trinity River are depressed in abundance relative to their historical numbers. An important consideration for recovery of the Lower Trinity River population is how naturally-produced coho salmon interact with the 500,000 coho salmon smolts released annually in the Trinity River, or the 11 million hatchery salmonids that are released into the Klamath Basin. Minimizing these interactions and the stresses that naturally-produced coho salmon experience from residing in a river system with millions of hatchery fish should be a high priority for coho salmon recovery. Protecting and enhancing thermal refugia and streams that are relatively intact and support coho salmon (e.g., Horse Linto and Sharber-Peckham creeks) should be the primary focus of recovery efforts. Protection and restoration of spawning and rearing habitat in potential coho salmon habitat (e.g., Mill Creek, Willow Creek) is also important over the long-term to ensure adequate spatial distribution and productivity. Creeks with the potential for floodplain connectivity include Supply, Mill, Tish Tang a Tang and Willow creeks. Recovery of the Lower Trinity River population of coho salmon will not be possible without significant restoration efforts to reconnect and expand the floodplain habitat in these and other creeks. Activities that reduce sediment delivery, improve water quantity and quality, and promote increased floodplain and channel structure should be the highest priority because these are the primary stresses for the population. Set back or removal of levees and dikes as well as instream habitat projects aimed at increasing floodplain size and connectivity need to be priorities. Removal of the fish passage barrier on Sharber Creek is also a high priority for recovery given the area's importance to coho salmon production in the Lower Trinity.

Vital habitat in the Lower Trinity includes areas that provide thermal refugia for juveniles in the summer, areas of current production, and areas with relatively intact habitat features such as clean spawning gravel, functional floodplain and channel structure, and established riparian forest. Coldwater discharges from tributaries are a key component of the thermal regime of the mainstem of the Trinity River. Localized coldwater refugia are often found where tributary flows enter the Trinity River. Some streams such as Coon, Bremmer, China, Soctish, McDonald, and Kirkham creeks do not provide much anadromous habitat, but they are generally well-shaded and provide high quality thermal refugia and cool clean water for the Trinity River. Juvenile and adult salmonids hold in the Trinity River near the confluence of these tributaries or, when accessible, in the lower reaches of the tributaries during mid- to late summer. The stressful stream temperatures in July, August, and September within the mainstem underscore the importance of maintaining these cool water tributaries for these species. Horse Linto Creek provides an excellent refugia area for juvenile and adult coho salmon (Strange 2008). It has cool, clean water that originates in the Trinity Alps Wilderness, moderating the high temperature of the Trinity River in the summer months at the confluence of the two waterways. At times, hundreds of juvenile salmonids congregate in this area. Other potential refugia areas are given in Table 38-5, although there are numerous unnamed seeps and smaller tributaries, all of which are important to survival of coho salmon in the summer months.

Table 38-5 . Potential coho salmon temperature refugia areas in the Lower Trinity River watershed.

Watershed	Stream Name	Ownership
Hoopa	Horse Linto Creek	Public
Hoopa	Mill Creek	Tribal
Hoopa	Supply Creek	Tribal
Hoopa	Soctish Creek	Tribal
Hoopa	Coon Creek	Private
Hoopa	Tish Tang a Tang Creek	Tribal
Hoopa	Hostler Creek	Tribal
Burnt Ranch	Sharber Creek	Private
Willow Creek	Willow Creek	Private

It is likely that many watersheds within the Burnt Ranch and New River watersheds are properly functioning with regard to aquatic habitat and watershed conditions. These streams have a large portion of their watersheds in the Trinity Alps Wilderness and remain in a relatively undisturbed state. Given the low abundances of the population all these areas in Table 38-5 are considered vital habitat for the population and should be prioritized for recovery. Horse Linto Creek is a designated Tier-1 Key watershed by the Northwest Forest Plan meaning that it is intended to serve as refugia for maintaining and recovering habitat for at-risk stocks of anadromous salmonids (USDA and USDI 1994).

During recent discussions with personnel from the U.S. Forest Service, it became clear that an unnamed tributary (known to U.S. Forest Service biologists as Sharber-Peckham Creek) has one of the strongest populations of coho salmon in the Lower Trinity River (Cyr 2008, Boberg 2008). Between the area spanning the Hoopa Tribe reservation and the North Fork Trinity River, Sharber-Peckham Creek is the single greatest producer of coho salmon in the Lower Trinity River (Boberg 2008). The Sharber-Peckham Creek area is spring-fed, has side channel and overwintering habitat, and is low gradient (Cyr 2008, Boberg 2008). The coho salmon here are found mainly in an unnamed tributary that emanates from springs between Sharber and Quinby creeks near the Forest Service boundary (Cyr 2008, Boberg 2008). This unnamed tributary is perennial and during winter, part of Sharber Creek is diverted into this unnamed tributary (Cyr 2008, Boberg 2008). This diversion is part of an old mining activity. The rearing habitat is split between Forest Service and private property (Cyr 2008, Boberg 2008). The spawning habitat is on private property. Coho are probably using Sharber Creek, but it is overgrown with brush, is difficult to survey, and likely doesn’t have the spring support for rearing as does Sharber-Peckham Creek (Cyr 2008, Boberg 2008).

In order to recover the Lower Trinity River coho salmon population, special attention should be given to important tributaries discussed above. Creeks with the potential for floodplain connectivity include Supply, Mill, Tish Tang a Tang and Willow creeks. Recovery of the Lower Trinity River population of coho salmon will not be possible without significant restoration efforts to reconnect and expand the floodplain habitat in these and other creeks that are currently confined by diked and channelized reaches. A focus on habitat complexity and connecting off channel ponds, backwaters, and large woody debris should be an essential part of restoring these streams. Several crossing barriers in the population unit should also upgraded in order to maximize habitat area available to coho salmon. Many road systems throughout the population unit need to go through decommissioning or upgrading to limit sedimentation. Consumptive water use within the population unit should be quantified and monitored. Measures should be employed to reduce water consumption by farms, residencies, and municipalities.

Table 38-6 on the following page lists the recovery actions for the Lower Trinity River population.

Table 38-6. Recovery action implementation schedule for the Lower Trinity River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LTR.2.2.7	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	New River and Tish Tang a Tang, Hostler, Willow, Mill, Horse Linto, Sharber, Supply, Cedar, and Campbell creeks	2
SONCC-LTR.2.2.7.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-LTR.2.2.7.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-LTR.2.2.8	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Re-connect channel to existing off-channel ponds, wetlands, and side channels	New River and Tish Tang a Tang, Hostler, Willow, Mill, Horse Linto, Sharber, Supply, Cedar, and Campbell creeks	2
SONCC-LTR.2.2.8.1	*Assess habitat to determine where potential exists to re-connect existing off-channel ponds, wetlands, and side channels. Map existing features so that connection can be maintained*					
SONCC-LTR.2.2.8.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-LTR.2.2.9	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Increase beaver abundance	New River and Tish Tang a Tang, Hostler, Willow, Mill, Horse Linto, Sharber, Supply, Cedar, and Campbell creeks	3
SONCC-LTR.2.2.9.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-LTR.2.2.9.2	*Implement beaver program (may include reintroduction)*					
SONCC-LTR.2.2.10	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Improve regulatory mechanisms	Population wide	BR
SONCC-LTR.2.2.10.1	*Limit hunting or removal of beaver*					
SONCC-LTR.2.1.11	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	New River and Tish Tang a Tang, Hostler, Willow, Mill, Horse Linto, Sharber, Supply, Cedar, and Campbell creeks	3
SONCC-LTR.2.1.11.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-LTR.2.1.11.2	*Place instream structures, guided by assessment results*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LTR.2.2.12	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	New River and Tish Tang a Tang, Hostler, Willow, Mill, Horse Linto, Sharber, Supply, Cedar, and Campbell creeks	3
SONCC-LTR.2.2.12.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-LTR.2.2.12.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-LTR.3.1.2	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Hoopa, Willow Creek, Burnt Ranch, New River HSAs (particularly Willow, Sharber, Mill, and Supply creeks)	3
SONCC-LTR.3.1.2.1	*Perform studies to determine if consumptive water use in specific areas is reducing the amount of rearing habitat or limiting the availability of cold water refugia.*					
SONCC-LTR.3.1.3	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Hoopa, Willow Creek, Burnt Ranch, New River HSAs (particularly Willow, Sharber, Mill, and Supply creeks)	BR
SONCC-LTR.3.1.3.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-LTR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-LTR.3.1.4.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-LTR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-LTR.3.1.5.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-LTR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-LTR.3.1.6.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-LTR.3.1.28	Hydrology	Yes	Improve flow timing or volume	Improve water management techniques	Population wide	3
SONCC-LTR.3.1.28.1	*Develop plan to manage stream flows and water temperature during periods of drought*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LTR.3.1.29	Hydrology	Yes	Improve flow timing or volume	Improve water management techniques	Population wide	3
SONCC-LTR.3.1.29.1	*Develop plan to protect coho salmon from effects of climate change*					
SONCC-LTR.3.1.29.2	*Implement plan based on findings*					
SONCC-LTR.5.1.31	Passage	Yes	Improve access	Remove barrier	Hostler Creek	3
SONCC-LTR.5.1.31.1	*Remove barrier from old water supply system*					
SONCC-LTR.5.1.32	Passage	Yes	Improve access	Remove barriers	Population wide, particularly tributaries	3
SONCC-LTR.5.1.32.1	*Evaluate and prioritize barriers for removal*					
SONCC-LTR.5.1.32.2	*Remove barriers, guided by the assessment*					
SONCC-LTR.14.2.14	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of invasive species	Population wide	2
SONCC-LTR.14.2.14.1	*Adopt fishing regulations and educational programs that encourage and allow for the take of an unlimited number of brown trout*					
SONCC-LTR.14.2.14.2	*Euthanize all brown trout captured at CDFG weirs*					
SONCC-LTR.1.2.33	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3
SONCC-LTR.1.2.33.1	*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*					
SONCC-LTR.16.1.16	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LTR.16.1.16.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-LTR.16.1.16.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-LTR.16.1.17	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-LTR.16.1.17.1	*Determine actual fishing impacts*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LTR.16.1.17.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-LTR.16.2.18	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LTR.16.2.18.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-LTR.16.2.18.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-LTR.16.2.19	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-LTR.16.2.19.1	*Determine actual impacts of scientific collection*					
SONCC-LTR.16.2.19.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-LTR.27.1.20	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-LTR.27.1.20.1	*Perform annual spawning surveys*					
SONCC-LTR.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Develop survival estimates	Site to be determined	3
SONCC-LTR.27.1.21.1	*Install and annually operate a life cycle monitoring (LCM) station*					
SONCC-LTR.27.1.22	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-LTR.27.1.22.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-LTR.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-LTR.27.1.23.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-LTR.27.1.23.2	*Annually estimate the in-river tribal harvest of wild/natural SONCC coho salmon*					
SONCC-LTR.27.2.24	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-LTR.27.2.24.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-LTR.27.2.24.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-LTR.27.2.25	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-LTR.27.2.25.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-LTR.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-LTR.27.2.26.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-LTR.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-LTR.27.2.27.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-LTR.27.1.34	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-LTR.27.1.34.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-LTR.27.1.34.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-LTR.8.1.13	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Bull, Limb Camp, Soctish, Lower Mill, Hostler, Lower Tish Tang, Lower Cedar, Campbell Ridge, Hospital, Supply, Horse Range, Summit, E.F. Willow, Ruby, Bunchgrass, Mill (Burnt Ranch HSA), Trinity Village, Hawkins, Quinby, and Sharber creeks	3
SONCC-LTR.8.1.13.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-LTR.8.1.13.2	*Decommission roads, guided by assessment*					
SONCC-LTR.8.1.13.3	*Upgrade roads, guided by assessment*					
SONCC-LTR.8.1.13.4	*Maintain roads, guided by assessment*					
SONCC-LTR.10.2.30	Water Quality	No	Reduce pollutants	Educate stakeholders	Population wide	BR
SONCC-LTR.10.2.30.1	*Develop an educational program that promotes Salmon Safe methods for agricultural operations and Integrated Pest Management for rural residents*					

39. Upper Trinity River Population

- Interior Trinity Diversity Stratum
- Core Population
- Moderate Extinction Risk
- 6,700 Spawners Required for ESU Viability
- 1,183 mi^2
- 365 IP km (227 mi) (0% High)
- Dominant Land Uses are Recreation and Timber Harvest
- Principle Stresses are 'Altered Hydrologic Function', 'Barriers' and 'Adverse Hatchery Related Effects'
- Principal Threats are 'Dams/Diversions' and 'Hatcheries'

39.1 History of Habitat and Land Use

Land use activities in the Trinity include mining, timber harvesting, road construction, recreation and a limited degree of residential development in certain locations (U.S. Environmental Protection Agency (EPA) 2001). The construction of Trinity and Lewiston dams in the early 1960s had and continues to have a major impact on the flow, function and use of the Trinity River (EPA 2001). The dams block access to 109 miles of habitat. Problems facing the Upper Trinity River coho salmon population include degradation of spawning and rearing habitat, sparse spawning gravel recruitment, lack of deep pools, stressful late summer water temperatures, water diversions, channelization and confinement, irregular timing of flows, fragmentation of populations, genetic and ecological interactions with hatchery salmonids, migration barriers, water quality problems, and unscreened diversions.

Historically, the upper Trinity River functioned as a dynamic river reach that effectively created and maintained quality spawning and rearing habitat for anadromous fish. In 1957, construction began on the Trinity River Division (TRD) of Bureau of Reclamation's Central Valley Project (CVP), which transfers water from the Trinity River portion of the Klamath Basin to the Sacramento Basin. The division consists of a series of dams, lakes, power plants, a tunnel, and other related facilities. Lewiston Dam, part of the CVP, was constructed in 1963 near Lewiston, California, and is now the upper limit of anadromous fish migration on the Trinity River. At times, 90 percent of the Trinity River flow was diverted to the Sacramento Basin, contributing to the decline of Chinook salmon, coho salmon, and steelhead.

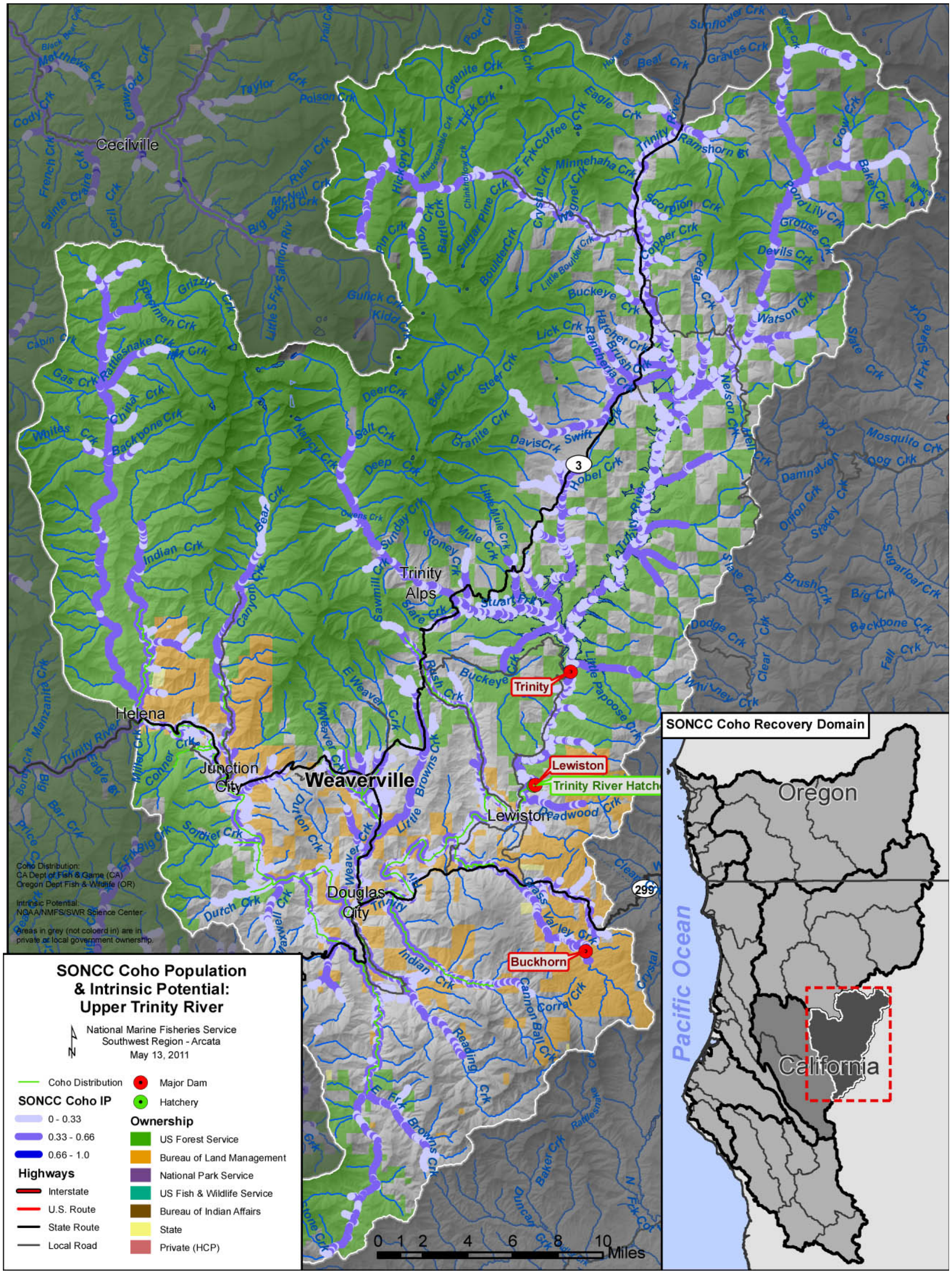

Figure 39-1. The geographic boundaries of the Upper Trinity River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

These water withdrawals, which extracted a large portion of Trinity River water, also caused severe degradation of fish habitat of the Trinity River (US Fish and Wildlife Service (USFWS) and Hoopa Valley Tribe (HVT) 1999). Located at the base of Lewiston Dam, Trinity River Hatchery (TRH) began production of salmon and steelhead in 1958 to mitigate for the loss of 109 miles of anadromous fish habitat upstream of the dam (USFWS and HVT 1999).

Out of concern for declines in anadromous fish populations, Congress enacted the Trinity River Fish and Wildlife Restoration Act (P.L. 98-541) in 1984. This Act directed the Secretary of the Interior to take actions necessary to restore the fisheries resources of the Trinity River Basin. The Central Valley Project Improvement Act (CVPIA) of 1992 (P.L. 102-575) legislated alterations in the operation of the CVP for the improvement of fish and wildlife habitat and resources.

In December 2000, Interior Secretary Bruce Babbitt signed the Record of Decision for the Trinity River Mainstem Fishery Restoration Environmental Impact Statement and Environmental Impact Report (EIS/EIR) (hereafter referred to as the ROD; DOI 2000, USFWS et al. 2000). The ROD adopted the preferred alternative, a suite of actions that included a variable annual flow regime, mechanical channel rehabilitation, sediment management, watershed restoration, and adaptive management. After a court case, the Ninth Circuit Court ruled that the Bureau of Reclamation (Reclamation) did not need to prepare a supplemental environmental document. (Westlands Water District, et al. v. United States Dept. of the Interior) (376 F.3d 853). Consequently, Reclamation has been and continues to implement the flows described in the Trinity ROD.

The minimal static flow levels released since the completion of Lewiston Dam in 1964 were insufficient to maintain the alluvial nature of the upper river and, as a consequence, much of the river channel between Lewiston and the North Fork Trinity River confluence became confined within a narrow channel bordered by a dense riparian corridor. Logging practices, road construction, and floodplain development within the Trinity River watershed have also contributed significantly to habitat degradation (USFWS and HVT 1999). Clearcutting has promoted increased sediment loading; removal of streamside vegetation has increased water temperatures; logjams at the mouths of tributary streams have blocked access for fish spawning and rearing (USFWS and HVT 1999). Logging within the subbasin has necessitated the construction of hundreds of miles of unpaved logging roads and skid trails (USFWS and HVT 1999). The resulting increased yield of sediment in the mainstem Trinity River and its tributaries has reduced the biological productivity and fish carrying capacity of the river (USFWS and HVT 1999). Much of the mainstem Trinity River and virtually all its tributaries have been subjected to hydraulic mining activities (USFWS and HVT 1999; EPA 2001).

Many tributaries downstream of Lewiston Dam presently or historically contained salmonid habitat, particularly in the lower gradient reaches. These tributaries, such as Rush, Reading, Brown’s and Canyon creeks have been subjected to some form of habitat modification, including historic hydraulic mining, current water diversions, road construction and timber harvesting (EPA 2001). De la Fuente et al. 2000, EPA 2001 determined that Weaver and Rush creeks are impaired based on an analysis of the stream and watershed condition indicators. The water quality and channel conditions in Weaver and Rush creeks were rated as functioning at risk and the watershed hazard condition was high (EPA 2001). The same assessment determined that

Brown's Creek was in a moderate condition (De la Fuente et al. 2000, EPA 2001). In other words, physical and biological conditions suggest that aquatic and riparian systems ability to support dependent species and retain beneficial uses of water are at risk.

Numerous studies have identified and evaluated sediment sources and delivery from Grass Valley Creek, which is considered to be the primary producer of sand-size sediment to the mainstem Trinity River (EPA 2001). As a result, the Trinity River Restoration Program (TRRP) supported the development of an extensive erosion control program. Based on a survey initiated by Pacific Watershed Associates (PWA 2000, EPA 2001) in 1992, stream channel conditions in Grass Valley Creek appeared to be improving (pools were more common, larger and deeper; substrate was more coarse; and channel complexity increased). Because Grass Valley Creek is a transport-dominated system (PWA 2000, EPA 2001), most of the sediment is transported to the mainstem Trinity River, aside from what is trapped in the sediment retention basins. Even though sediment production has decreased, the creek continues to discharge sand-size sediment in quantities that are affecting the mainstem (EPA 2001).

The North Fork Trinity, East Fork North Fork Trinity and Stuart Fork Trinity rivers and Coffee Creek watersheds are presently considered "properly functioning" with regard to aquatic habitat and watershed conditions (De la Fuente et al. 2000, EPA 2001). These streams have a large portion of their watersheds in the Trinity Alps Wilderness and remain in a relatively undisturbed state. Of these, the North Fork Trinity and East Fork North Fork Trinity rivers remain accessible to coho salmon; Lewiston and Trinity dams block the others. However, the accessible streams are higher gradient rivers that currently support populations of anadromous steelhead and minimal coho salmon production (Everest 2008), and may not have historically supported robust populations of coho salmon.

39.2 Historic Fish Distribution and Abundance

Approximately 5,000 wild adult coho salmon migrated past the town of Lewiston annually prior to the construction of the Trinity River Division (USFWS and CDFG 1956; USFWS and HVT 1999). Accurate estimates of coho salmon production below Lewiston prior to dam construction are not readily available. Although limited high quality coho salmon habitat exists throughout the Upper Trinity River recovery area (e.g., Weaver Creek), the IP data show the greatest amount of high value IP (IP > 0.66) habitat is upstream of Trinity Dam. Coho salmon are thought to have inhabited many of the smaller creeks and tributaries to the Trinity River in the area upstream of where Trinity Dam now lies (USFWS and HVT 1999). In the late 1940s and early 1950s, juvenile coho salmon were rescued from an irrigation diversion near Ramshorn Creek, which enters the Trinity River approximately 42 miles upstream from Lewiston (USFWS and CDFG 1956, USFWS and HVT 1999). Between the time when the TRD was completed and 1977, only two coho salmon escapements were estimated for the area upstream of the North Fork. Between 1970 and 1999, coho spawner escapement ranged from 558 to 32,373 with an average of 10,192. Based on population estimates from 1991 to 1995, 1998, and 1999 the average in-river escapement of naturally produced fish was approximately 400 fish. During this seven year period of sampling the Trinity coho salmon population experienced two years of no natural production and one additional year of extremely low production, whereas run sizes during the other three years were about 1,000 coho or less (USFWS and HVT 1999). Salmon spawner surveys in 1995 indicate substantial usage in many of the tributaries from the North

Fork upstream to Deadwood Creek. Surveys in the 1980's (USFS 1988) revealed coho salmon in some tributaries. The USFS (2000d) reported that coho salmon are rarely found in the New River.

From this information, NMFS infers that coho salmon once were well distributed throughout the Upper Trinity River subbasin with the highest concentrations in lower gradient tributaries. Table 39-1 lists those tributaries with high IP values. The tributary below Lewiston Dam with the most incidences of high IP reaches is Weaver Creek and its tributaries (Figure 39-1). The close proximity of Deadwood and Rush creeks to Trinity River Hatchery has led to a high degree of straying by hatchery coho salmon into these streams (Yurok Tribe, unpublished data), which may limit the effectiveness of recovery efforts.

Table 39-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006). Access to most of the streams in the Upper Trinity River subarea is blocked by Lewiston Dam.

Subarea[1]	**Stream Name**
Upper Trinity River	Hobel Creek
	Mule Creek
	Stewart Fork Trinity River
	Trinity River
	East Fork Trinity River
Douglas City	Deadwood Creek
	Rush Creek
	Browns Creek
	Little Browns Creek
	Indian Creek
	Grass Valley Creek
	Little Grass Valley Creek
Weaver Creek	Weaver Creek and tributaries
Helena	Trinity River

[1]Subarea refers to hydrologic subarea (HSA) in the CALWATER classification system.

39.3 Status of Upper Trinity River Coho Salmon

Spatial Structure and Diversity

Coho salmon are found in only a fraction of their historic habitat areas in the upper Trinity River subbasin, due mainly to loss of habitat resulting from the erection of Lewiston and Trinity Dams. Thirty-six percent of the historic IP-km has been lost (Williams et al. 2008). The presence of coho salmon has been confirmed in a variety of streams in the Upper Trinity River subbasin such as Grass Valley Creek, Sydney Gulch, Deadwood Creek, Rush Creek, Weaver Creek, East Weaver Creek, West Weaver Creek, Little Browns Creek, Sidney Gulch, Dutch Creek, Indian Creek, Canadian Creek, Soldier Creek, Canyon Creek, North Fork Trinity River, East Fork North

Fork Trinity River, Manzanita Creek, Big French Creek, New River and East Fork New River (Hill 2008; Everest 2008). Coho salmon also likely occur in Reading, Browns, and Indian creeks. However, most of these streams do not have a substantial amount of high IP reaches (IP > 0.66) when compared to the Trinity River upstream of Lewiston Dam. In the mainstem Trinity River, rearing juvenile coho salmon occur in highest densities within the first 12 km downstream of Lewiston Dam (CDFG 2008c). None were found downstream of river kilometer 163 (CDFG 2008c), which is approximately 5 km upstream of Steel Bridge. CDFG (2008c) documented the majority of observations of juvenile coho salmon were at water temperatures of 48.2 to 53°F. The highest water temperature observed for a juvenile coho salmon was 60.8°F. It is likely that within the mainstem Trinity River, the distribution of coho salmon can be explained, at least in part, by water temperature.

Hatchery influences are substantial in the Upper Trinity River subbasin. Each year, Trinity River Hatchery releases approximately 500,000 coho salmon smolts, 800,000 steelhead, and 4.3 million Chinook salmon. Currently, hatchery fish dominate coho salmon returns to the Trinity River (USFWS and HVT 1999). From 2003 to 2005, over 75 percent of adults returning to the Trinity River, as estimated at Willow Creek, were of hatchery origin (Table 39-2). A population of native fish is at least at moderate risk of extinction if the fraction of naturally spawning hatchery fish exceeds five percent (Williams et al. 2008). Hatchery fish may negatively affect wild fish or mixed populations of wild and hatchery fish through genetic interactions (Reisenbichler and Rubin 1999; Mclean et al. 2003; Araki et al. 2007). Straying of hatchery fish into tributaries of the Trinity presents a particular threat to the population's diversity, as the hatchery fish may reduce the reproductive success of the overall population (Mclean et al. 2003).

Although not well documented, there appears to be some diversity of life history strategies in the Upper Trinity River. Data on run timing and outmigration indicate that there is some variation in the life history characteristics of the population. Coho salmon enter the Trinity River between September and November and spawning in the river continues into January (CDFG 2009b). Also, both young-of-the-year and yearling coho salmon are captured at downstream migrant traps located in the Trinity River near Willow Creek (Pinnix et al. 2007). Dispersing of age 0+ coho occurs over a several months between March and September as does outmigration of age 1+ (CDFG 2009b). Outmigration of subyearling coho may be an expression of a life history type that rears in non-natal streams prior to emigrating to the ocean. Some of the dispersion of subyearling coho salmon is likely due to competition for rearing habitat and resources.

In summary, because the current distribution of spawning adults is limited to just a few tributaries with suitable habitat, and the current run is comprised mainly of hatchery fish, the Upper Trinity River coho salmon population is at a high risk of extinction based on its spatial structure and diversity compared to historic conditions.

Population Size and Productivity

The NMFS recovery team made adjustments to the low risk spawner threshold number for the Upper Trinity River population unit proposed by Williams et al. 2008. The amount of available IP habitat was determined to be 365 IP km and a spawner density of 20 fish/IP km. This resulted in a low risk spawner threshold of 6,700 adult coho salmon spawners.

Population estimates for individual tributaries are not available. Limited presence/absence data are available from the U.S. Forest Service Weaverville Office. Given land use changes and activities such as logging and mining, coho salmon abundance in smaller tributaries like Weaver and Reading creeks is probably much less than it was historically. Although there may be robust numbers of spawners occasionally in some years, the overall number of naturally produced coho salmon in the Upper Trinity River watershed is low compared to historic conditions, and hatchery fish dominate the run (Table 39-2). In some years, it appears that naturally produced spawners returned to the Trinity River in sufficient numbers to meet the low population threshold specified by Williams et al. (2008). However, a small proportion of the coho salmon that are judged to be of natural origin are non-clipped hatchery fish (generally less than 1%).

Table 39-2. Estimates of run sizes of coho salmon at the Trinity River's Willow Creek weir. Data are for 1997 – 2008. Hatchery-origin fish were identified by a mark (right maxillary clip). From CDFG (2009).

Year	Number Unmarked	Number Marked	% Hatchery	% Natural
1997	651	7,284	92%	8%
1998	1,232	11,348	90%	10%
1999	586	4,959	89%	11%
2000	539	14,993	97%	3%
2001	3,373	28,768	90%	10%
2002	596	15,420	96%	4%
2003	4,093	24,059	86%	14%
2004	9,055	29,827	77%	23%
2005	2,740	28,679	92%	8%
2006	1,624	18,454	92%	8%
2007	1,199	4,551	79%	21%
2008	1,312	8,671	87%	13%

Table 39-3 shows the number of spawners, and the estimated number of recruits, in the Upper Trinity River. Counts occur at Willow Creek, but most of the fish are thought to spawn in the Upper Trinity River. These data indicate that the amount of recruits produced per female spawner in the Upper Trinity River is substantially less than two, meaning the population is failing to replace itself. Chilcote et al. (2010) found that the recruits produced per coho salmon spawner decreases as the mean proportion of hatchery fish in the spawning population increases, a finding similar to that of Buhle et al. (2009). This is particularly important given that a high percentage (~80 percent) of coho salmon spawners in the upper Trinity River is of hatchery origin. The population growth rate for the Upper Trinity is therefore negative, and the population relies on the heavy influence of hatchery fish to maintain current abundance levels. Due to the low natural population abundance and a negative population growth rate, the Upper Trinity River population does not meet the minimum standards of a viable salmonid population.

Table 39-3. The estimated number of recruits per female spawner in the Upper Trinity River. Adult return data provided by W. Sinnen, CDFG.

Run Year	Marked and Unmarked natural adult female spawners (S)	Estimated total adult unmarked recruits (R)*	Estimated adult unmarked recruits (year+3)	R/S	LN (R/S)
1997	531	271	386	0.727	-0.318
1998	2,945	1,297	3,386	1.150	0.140
1999	843	629	519	0.616	-0.485
2000	3,158	386	4,352	1.378	0.321
2001	8,666	3,386	10,081	1.163	0.151
2002	3,356	519	2,853	0.850	-0.162
2003	7,235	4,352	1,734	0.240	-1.429
2004	11,356	10,081	1,257	0.111	-2.201
2005	5,630	2,853	1,302	0.231	-1.464
2006	4,964	1,734			
2007	1,222	1,257			
2008	1,709	1,302			

*Data on recruits accounts for harvest by the Yurok and Hoopa tribes as well as incidental mortality in ocean Chinook salmon fisheries.

Extinction Risk

Based on the criteria set forth by Williams et al. (2008) the Upper Trinity River population is at a moderate risk of extinction because the number of spawners exceeds the depensation threshold.

Role in SONCC Coho Salmon ESU Viability

The Upper Trinity population is a core "Functionally Independent" population within the Trinity diversity stratum meaning that it was sufficiently large to be historically viable-in-isolation and historically had demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005; Williams et al. 2006). As a core population, the recovery target for the Upper Trinity population is for the population to be viable and to have a low risk of extinction according to population viability criteria (see Chapter 2). Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU.

39.4 Plans and Assessments

U.S. Forest Service, Shasta Trinity National Forest

http://www.fs.usda.gov/main/stnf/landmanagement/planning

The Shasta Trinity National Forest has a variety of documents pertinent to the Upper Trinity River including road and watershed analyses.

State of California

CDFG Recovery Strategy for California Coho Salmon http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The California coho recovery plan includes analyses and recommendations regarding coho salmon recovery in the Trinity River.

Trinity River TMDL
http://www.epa.gov/region9/water/tmdl/trinity/finaltrinitytmdl.pdf

The North Coast Regional Water Quality Control Board published a TMDL for the Trinity River that contains guidelines for the amount of sediment and actions to help reduce sediment.

Trinity River Restoration Program (TRRP)

The Trinity River Restoration Program focuses substantial resources on restoration of the upper Trinity River, particularly the mainstem Trinity River between Lewiston Dam and the North Fork Trinity River. The TRRP also has an active watershed program that performs restoration work in tributaries. A variety plans and assessments are available from www.trrp.net.

39.5 Stresses

Table 39-4. Severity of stresses affecting each life stage of coho salmon in the Upper Trinity River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg[1]	Fry[1]	Juvenile[1]	Smolt[1]	Adult[1]	Overall Stress Rank
1	Adverse Hatchery-Related Effects[1]	Very High[1]	Very High[1]	Very High[1]	Very High[1]	Very High[1]	Very High
2	Altered Hydrologic Function[1]	Low	Very High	Very High[1]	High	Medium	High
3	Barriers[1]	Low	High	High[1]	High	Very High	High
4	Lack of Floodplain and Channel Structure	Medium	High	High	Low	High	High
5	Increased Disease/Predation/Competition	Low	High	High	Medium	Low	High
6	Impaired Water Quality	Low	Medium	High	Low	Medium	Medium
7	Impaired Estuary/Mainstem Function	Low	Low	Medium	Medium	Medium	Medium
8	Degraded Riparian Forest Conditions	Low	Medium	Medium	Medium	Low	Medium
9	Altered Sediment Supply	Medium	Medium	Medium	Low	Medium	Medium
10	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Several factors limit the viability of the Upper Trinity population. The most dominant of these factors stem from the effects of the large-scale dams, reservoirs, and diversion on hydrologic function. In addition, the negative impacts of Trinity River Hatchery, altered floodplain and channel structure, and the lack of habitat access upstream of Lewiston Dam create substantial stresses to the Upper Trinity River coho salmon population. Heating of water in Lewiston Reservoir during the summer months contributes to limiting the amount of habitat available to rearing juvenile coho salmon in the mainstem Trinity River. Barriers, adverse hatchery-related impacts, altered hydrologic function, and lack of floodplain and channel structure are the most likely stresses limiting productivity of the Upper Trinity population. Juveniles and adults are the most likely limited life stages.

Lewiston and Trinity dam block a majority of the high IP habitat in the subbasin. The loss of this habitat has led to a restricted spatial structure and the reliance on a limiting amount of spawning and rearing habitat downstream. The lack of available spawning and rearing habitat downstream of Lewiston Dam is a limiting stress for the population and limits the productivity of the population. Trinity River Hatchery was built to mitigate for the impacts of the dams on the population, but the negative consequences of genetic and ecological interactions under current management goals is likely to be suppressing the productivity of the population (e.g., Chilcote et al. 2010).

Trinity River Hatchery plays a critical role in limiting the productivity (recruits produced per spawner) of the Upper Trinity River population through negative genetic and ecological interactions. Looking at the overall productivity of the population, the hatchery has a major negative impact on population growth and habitat capacity. Competition with and predation by hatchery fish released from Trinity River Hatchery limits rearing and spawning capacity in the Upper Trinity. Competition of hatchery fish with naturally produced fish almost always has the potential to displace wild fish from portions of their habitat (Flagg et al. 2000). Both intra- and inter-specific redd superimposition on the spawning grounds can substantially affect salmon reproductive success (Essington et al. 2000) and the spawning areas downstream of Lewiston Dam are likely near carrying capacity. Also important is predation on wild coho salmon fry by hatchery-reared salmonids (Naman 2008). Cumulatively and in concert with other habitat-related stresses, adverse hatchery-related impacts are a key stressor for the population.

Altered hydrologic function and lack of floodplain and channel structure also have a major impact on the productivity of this population. Rearing opportunities and capacity are low due to a reduced and dampened flow regime. Habitat has been simplified by disconnection of the floodplain, a lack of LWD inputs, poor riparian conditions, and sediment accretion. Loss of flow variability and reduced rearing habitat during the fall and winter months is expected to reduce the ability of the habitat in the Upper Trinity River to support winter rearing of juvenile coho salmon. Water withdrawals from important tributaries like Weaver and Rush creeks reduce baseflows in the summer and fall months, contributing to low flows and high water temperatures. Variability of the natural flow regime is inherently critical to ecosystem function and native biodiversity (Poff et al. 1997; Puckridge et al. 1998; Bunn and Arthington 2002; Beechie et al. 2006). In the summer, flow regimes and the lack of LWD and off-channel habitat leads to poor hydrologic function, disconnection and diminishment of thermal refugia and off-channel habitat, and poor water quality in tributaries and the mainstem during dry years. There exist very few remaining areas downstream of Lewiston Dam with the potential and opportunity for summer and winter rearing. Floodplain disconnection and poor riparian function as a result of reduced flow and variability is being addressed through restoration efforts but will continue to be a limiting factor for the population.

In order to improve the viability of this population it will be imperative to address the issues related to the hatchery and to improve habitat conditions for juveniles and adults. Addressing other stresses and threats and improving habitat for all life stages and life history strategies will also be an important component of recovery for this population.

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. The Upper Trinity River population area contains the Trinity River Hatchery, which currently releases 4.3 million juvenile and yearling Chinook salmon, 500,000 yearling coho salmon, and 800,000 yearling steelhead. Hatchery-origin coho salmon make up most of the spawning run to the Trinity River each year. On average, only three percent of in-river spawners were not reared in a hatchery (USFWS and HVT 1999). Between 1997 and 2002, hatchery fish constituted between 85 percent and 97 percent of the fish (adults plus grilse) returning to the Willow Creek weir in the Lower Trinity River (CDFG 2009b). Most of these fish likely migrate upstream and interact with naturally-produced coho salmon in the Upper Trinity River.

Recent studies have shown that steelhead released from TRH suppress wild salmon populations via predation (Naman 2008). Currently, spawners of natural origin are making very little genetic contribution, and the amount of natural influence in the hatchery population is extremely low (median PNI = 0.045). It is important to note that TRH protects the Upper Trinity River coho salmon population from catastrophic losses, and could take on a very important role in the protection and recovery of this population. Available data indicate that substantial straying of TRH fish occurs into tributaries and mainstem habitat throughout the Upper Trinity (Yurok Tribal Fisheries Program 1999), negatively affecting the genetic and life history diversity of the population via outbreeding depression and competition. Adverse hatchery-related effects pose a very high risk to all life stages, because more than thirty percent of adults are of hatchery origin (Appendix B) and there is significant potential for ecological interactions.

Altered Hydrologic Function

Hydrologic function is a high stress for coho salmon in the Upper Trinity River. Roughly half of the mainstem Trinity River flow is diverted to the Sacramento River Valley and remaining flows and variability are reduced downstream of the Trinity dam. Fry, juvenile, and smolt life stages are all negatively affected by changes in flow. Available fry and juvenile rearing habitat is reduced during certain times of the year, particularly winter months, by reduced flow volumes. Habitat complexity and food supply are likely limited by reduced flow variability. The reduction of dam controlled scouring flows in the mainstem has contributed to fine sediment infiltration into spawning gravels. This impact is greatest just below the confluence of Grass Valley Creek. Deposition of sediment on exposed cobble bars and lack of flushing flows has created “fossilized” berms or sediment accumulation around riparian vegetation. This contributes to loss of open, shallow, low-velocity gravel bar habitats for rearing salmonid fry. In the mainstem Trinity River, regulated flows from Lewiston Dam create static flow releases of 300 CFS for the fall and winter months. Arthington et al. (2004) stated that simplistic, static, environmental flow rules are misguided and will ultimately contribute to further degradation of river ecosystems. Flow variability is an important component of river ecosystems which can promote the overall health and vitality of both rivers and the aquatic organisms that inhabit them (Poff et al. 1997; Puckridge et al. 1998; Bunn and Arthington 2002; Arthington et al. 2004). Variable flows trigger longitudinal dispersal of migratory aquatic organisms and other large events allow access to otherwise disconnected floodplain habitats (Bunn and Arthington 2002), which can increase the growth and survival of juvenile salmon (Jeffres et al. 2008). Lack of flow variability in the mainstem Trinity River in the winter months is likely limiting the growth and survival of rearing coho salmon. In some stream such as Weaver and Rush creeks where water is utilized for residential purposes, summer and fall baseflows are likely impacted from the water withdrawals.

Seaward migration of juveniles is often triggered by the incremental increases in flow (Tripp and McCart 1983; Annear et al. 2002). Elevated flows occur only once during the year and there is little flow variability to trigger or aid in fish migration. The current physical and hydrologic conditions in the Upper Trinity River reach likely impair adult migration. Upstream migration is often triggered by flow variability in the fall; however in the Upper Trinity River flows are stable throughout the summer and fall (Groot and Margolis 1991). Winter flows are particularly low in the mainstem Trinity River and overwintering habitat for juvenile coho salmon is limited. Channel and floodplain-forming flows are absent from the system, leaving simplified rearing habitat. Additional impacts on water quality likely result from flow alteration.

Barriers

The stress table shows that barriers cause a high stress across all life stages except the egg life stage. Lewiston and Trinity dams block access to the vast majority of high quality coho salmon habitat. Additionally, many road-related barriers preclude access to potential coho salmon habitat. The California Fish Passage Assessment Database (CalFish 2009) lists 17 sites on county roads where barriers exist in the Upper Trinity subbasin. Additional barriers on private land may also exist. In certain instances, these road-related barriers block access to stream reaches where the potential for coho salmon habitat and refugia exists. At least seven total barriers block habitat on the North Fork Trinity, Canyon Creek, Browns Creek, and Reading Creek, Weaver Creek, and Middle Weaver Creek (CalFish 2009). Other high priority total barriers exist on tributaries with the potential for providing coho salmon habitat. In addition, four partial barriers exist within the range of coho salmon on Weaver Creek, Browns Creek, and Canyon Creek. Thermal barriers are also a potential stress for the population. Because thermal refugia appear to be decreasing due to climate change and other factors, migratory habitat in some tributaries may be limited and thermal barriers may prevent movement between habitats.

Lack of Floodplain and Channel Structure

Floodplain and channel structure is a high stress for the population and particularly affects fry, juveniles, and adults. Poor floodplain and channel structure is attributed to changes in the hydrology of the subbasin. Changes in sediment supply, storage, and transport, in combination with altered mainstem flow following construction of the TRD, altered the channel geomorphology. Riffle-pool sequences associated with point bars were replaced with monotypic runs after dam construction, which reduced the quantity, quality, and diversity of aquatic habitats. Important habitat types affected by the change in floodplain and channel structure include pools that provide cover from predators and refugia for juveniles and adults; gravel riffles for spawning; open gravel/cobble bars that create shallow, low-velocity zones important for emerging fry; and slack water habitats for rearing juveniles (USFWS and HVT 1999). The Trinity River does not approach a pre-dam channel geomorphology until the confluence with the North Fork (USFWS and HVT 1999). Mainstem reaches are generally disconnected from floodplain habitat and many tributaries experience simplified instream structure and habitat diversity. Pool depths and frequencies are thought to be poor to fair throughout the population area, but data are limited. Data on instream LWD are also limited; however, given the timber harvesting that has occurred in the watershed and the changes in riparian vegetation characteristics, LWD is likely limiting the development of complex stream habitat throughout much of the population area.

There is a direct link between the filling of pools and thermal impacts on water quality. The deepest pools prior to the TRD, were as much as 7 degrees Fahrenheit cooler than the shallow pools and provided important thermal refugia for juveniles (Moffett and Smith 1950). The change in channel geomorphology has eliminated much of the temperature stratification in pools, particularly in the summer and early fall months. In addition, changes in channel structure and substrate quality have reduced benthic macroinvertebrate production. Production of benthic macroinvertebrates takes place on the submerged portions of a streambed (Frederiksen, Kamine, and Associates 1980). Substrate quality and particle size within the streambed can greatly influence the production of benthic macroinvertebrates. Boles (1980) documented an increase in productivity, biomass, and diversity of benthic organisms following the “flushing” of granitic sand from a riffle in the Junction City reach of the Trinity River. However, the EIS noted that based on investigations of macroinvertebrate production in the Trinity compared with other basins, benthic food production does not appear to be a major factor in limiting fish production in the mainstem Trinity at the current time (USFWS and HVT 1999, App. B-13)

Increased Disease/Predation/Competition

Roughly 30 percent of hatchery yearling smolts have been found to die within 10 km of the TRH (Beeman et al. 2009). Disease and predation are possible explanations for this smolt mortality (Beeman et al. 2009), as are tagging and handling and naivety of hatchery coho salmon. Coho salmon smolts may be exposed to diseases like Ceratomyxsis once they reach the Klamath River. Since the zones with the highest rates of infection in the Klamath Basin are in the Klamath River upstream of the Trinity and Klamath rivers confluence (Bartholomew 2008), the level of stress for Trinity smolts is likely lower than for the populations located further upstream in the Klamath Basin. Bacterial kidney disease infection rates at Trinity River Hatchery may be substantial.

Competition and predation by non-native brown trout and hatchery-released salmon and steelhead is also a source of stress and mortality for coho salmon fry, juvenile, and smolts. Coho salmon eggs are consumed by juvenile hatchery steelhead and returning adult hatchery steelhead (Naman 2008). Naman (2008) also found that residualized steelhead can consume large quantities of coho salmon fry.

Impaired Water Quality

Water quality in the Upper Trinity is primarily impacted on a localized basis by fine sediment loading and temperature impairments. No coho salmon were found downstream of river kilometer 163 (CDFG 2008c), which is approximately 5 km upstream of Steel Bridge. CDFG (2008c) documented the majority of observations of juvenile coho salmon were at water temperatures of 48.2 to 53°F. The highest water temperature observed for a juvenile coho salmon was 60.8°F. It is likely that within the mainstem Trinity River, the distribution of coho salmon can be explained, at least in part, by water temperature. Although mainstem water temperatures during the summer months in the Upper Trinity River are generally cool downstream to roughly Douglas City, temperatures can be problematic during years when storage in Trinity Reservoir is low, tributary runoff is low, or air temperatures are high for long durations. Violations of NCRWQCB temperature criteria in the mainstem Trinity River occur often enough to warrant concern. Downstream of Douglas City, daily average mainstem water temperatures during the summer months are higher than the published range for juvenile coho salmon rearing. In some smaller tributary streams, water temperatures can increase to levels stressful for rearing coho salmon in the summer months. Juvenile coho are unlikely to have a sufficient amount of thermal refugia during the summer due to competition and the effects of climate change. Stress from water quality ranges from low to high across life history stages.

Impaired Estuary/Mainstem Function

All salmon and steelhead that originate from the Upper Trinity River migrate to and from the ocean through the mainstem Trinity, the mainstem Klamath River and the Klamath River estuary. The Klamath River estuary plays an important role in providing holding habitat and foraging and refuge opportunities for outmigrating juvenile coho salmon from the Upper Trinity River, especially since there is a significant number of subyearling coho salmon that leave the Upper Trinity and presumably rear downstream in non-natal habitat. Although the estuary is short and small compared to the large size of the watershed, it does provide the opportunity for juvenile and smolt growth and refugia prior to entering the ocean. The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of wetland habitat, and disconnection from tributary streams and the floodplain. Levees along the Lower Klamath and development on the floodplain have led to the loss and degradation of habitat in the estuary. Mainstem conditions contribute to this stress because of the issues with water quality, sedimentation and accretion, and degraded habitat in the Lower Trinity and the Lower Klamath River. Juveniles, smolts, and adults transitioning through mainstem habitat are stressed by the poor water quality, degraded habitat, and increased rates of disease in these migratory habitats.

Degraded Riparian Forest Conditions

Riparian forest conditions present medium to low stresses across all life history stages. Where data exist, the assessment of streamside canopy cover ranges from fair to very good throughout the watershed. The Weaver and Helena areas appear to have fair riparian conditions, while portions of the Helena and Upper Trinity areas have very good riparian conditions. The dynamics of the Trinity River riparian forest have changed dramatically as a result of flow regulation. Whereas natural flow regimes would historically have naturally produced diverse riparian forests with the ability to provide large wood and in-stream structure for coho salmon, the current flow regime favors simplified riparian forests with little habitat diversity. In addition, the removal of riparian canopy cover in some tributaries has resulted in increased solar radiation on the stream, and consequent elevated water temperatures.

Altered Sediment Supply

Altered sediment supply presents Low to Medium stress across all life history stages. The mainstem has an oversupply of sediments because of hydraulic mining, dredging, logging, and road building. Specifically, the substrates that coho salmon require for particular life stages are limited. Below Lewiston Dam, the already coarse channel bed coarsened even more without significant channel down-cutting (USFWS and HVT 1999). Larger particles that were commonly transported during pre-dam floods were no longer mobilized, such that only finer gravels and sands were transported downstream (USFWS and HVT 1999). This caused the riverbed to become armored, which inhibited redd construction. Despite flow re-regulation to produce a scaled-down natural hydrograph, anthropogenic boundary controls have severely altered processes associated with geomorphic self-sustainability and instream habitat availability (Brown and Pasternack 2008). Inadequate spawning gravel has likely led to density dependent reductions in salmon populations and effects to the wild genome that have progressed through time (Ligon et al. 1995). Spawning gravel augmentation under the TRRP takes place below TRH and at the cableway site near Lewiston. This augmentation has helped supplement some of the loss of spawning gravels in the mainstem river and will likely continue to do so in the future.

Fine sediment input was high in the Upper Trinity River and consequently the Trinity River watershed in Trinity County was listed as sediment impaired in California's 1995 CWA 303(d) list, adopted by the State of California North Coast Regional Water Quality Control Board (NCRWQCB). Excessive fine sediment in tributaries and the mainstem have limited coho salmon habitat by infiltrating spawning gravel and increasing egg and alevin mortality, depositing on exposed cobble bars and impacting coho salmon fry and over-wintering rearing habitat, and filling pools and off-channel habitat and limiting juvenile summer rearing habitat (Graham Matthews and Associates (GMA) 2001). Downstream of the first tributaries, salmon egg survival to emergence appears to drop and is lowest below Grass Valley Creek (Poker Bar site), likely due to increased tributary derived fine sediment (GMA 2001). Permeability levels in several other tributaries are low as well. Studies have found that permeability levels in several of the tributaries can be quite low (98cm/hr in Reading Creek; 258 cm/hr in Indian Creek; 363 cm/hr in Rush Creek; 521 cm/hr in Canyon Creek) and could be indicative of low survival rates of salmonids (GMA 2001). The majority of fine sediment in the Trinity River originates from roads, timber harvest, and natural sediment loading from landslides and erosion (EPA 2001).

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

39.6 Threats

Table 39-5. Severity of threats affecting each life stage of coho salmon in the Upper Trinity River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Hatcheries	Very High	Very High	Very High	Very High	Very High	Very High
2	Dams/Diversion	Medium	High	Very High	High	Very High	High
3	Road-Stream Crossing Barriers	Low	High	High	Low	High	High
4	Climate Change	Medium	Medium	Very High	High	Medium	High
5	Invasive Non-Native Alien Species	Medium	High	High	Medium	Low	Medium
6	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
7	Roads	High	High	High	Medium	Medium	High
8	Agricultural Practices	Low	Medium	Medium	Medium	Medium	Medium
9	Channelization/Diking	Low	Low	Medium	Medium	Medium	Medium
10	Urban/Residential/Industrial	Low	Low	Medium	Medium	Low	Medium
11	Fishing and Collecting	-	-	-	-	Medium	Medium
12	Timber Harvest	Low	Low	Medium	Low	Low	Low
13	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low

Hatcheries

Hatcheries pose a very high threat to all life stages of coho salmon in the Upper Trinity sub-basin. The rationale for these ratings is described under the Adverse Hatchery-Related Effects stress.

Dams/Diversions

Dams and diversions are a significant threat across all life history stages. Lewiston and Trinity dams block access to the vast majority of high quality coho salmon habitat. Using the IP model, Lewiston Dam blocks access to 46 percent of the habitat in the Upper Trinity River population. The Trinity River downstream from Lewiston now must mimic and take on the functional role of the mainstem lost beneath the reservoirs and the smaller tributary streams, now cut off by the dams. The Trinity River below Lewiston Dam now has to provide for year-round rearing for fry and juvenile coho salmon, as well as suitable habitat for adult salmonid holding, spawning, and egg incubation and spawning. Based on the limited spawning and rearing conditions downstream of the dams this threat will likely continue to have a negative effect on all life stages of the population in the future.

Based on an average inflow to Trinity Reservoir, the Bureau of Reclamation diverts approximately 57 percent of Trinity River flows to the Central Valley Project (CVP). Remaining flows downstream of the diversion are managed according to water-year type under the Trinity River Record of Decision (DOI 2000). The continuing impacts of diversion and storage are numerous and include reduced water quality during dry years, altered hydrologic function, and reduced rearing habitat availability and access. As mentioned above, loss of flow variability in the winter months resulting from static flows from Lewiston Dam is likely to result in reduced growth and survival of juvenile coho salmon.

Numerous small-scale wells and diversions for domestic uses, stock watering, and small agricultural operations occur throughout the watershed and reduce stream flows during critical low-flow periods in the late summer and fall. The Fish Passage Assessment Database list 154 diversions in the upper Trinity River population, many of which are unscreened (CalFish 2009). A ten-foot defunct concrete diversion dam on Garden Gulch prevents access to high quality low gradient habitat. East Weaver Creek supplies the town of Weaverville with its water. The town's municipal diversion dam creates a barrier to salmon migration and to gravel movement in the creek, which degrades habitat below the dam in addition to blocking fish passage. Developments, like the housing development along Rush Creek, as well as the town of Weaverville (Weaver Creek), draw water from important tributaries used by coho salmon. Water use along these and other small creeks during the summer and fall months likely reduces baseflow in some areas, which reduces the amount of habitat available and contributes to elevated water temperatures.

Road-Stream Crossing Barriers

Although much work has been done to remove barriers in the watershed, road-stream crossing barriers remain that prevent access to several stream reaches. Numerous road-stream crossing barriers exist in the Upper Trinity River population unit. These present a high threat to several life stages of coho salmon because they inhibit fish passage and cause erosion-related effects in downstream reaches. The Fish Passage Assessment database lists 112 road stream crossing barriers in the Upper Trinity River. There are 30 road stream crossing structures that are total barriers to migration in the Upper Trinity River watershed and 25 partial barriers. Two-road stream crossing barriers have been prioritized for removal and 21 prioritized for assessment (CalFish 2009). Important road-stream crossing barriers within the range of the Upper Trinity population are listed below (Table 39-6). Impacts may result when juveniles are unable to pass these culverts during summer low flows and access to potential rearing habitat is restricted. No information exists on the occurrence of road-related barriers on private lands.

Table 39-6. List of road-stream crossing barriers.

Priority*	Stream Name	Road Name	County	Barrier Status*
High	Conner Creek	Conner Creek Rd	Trinity	Total
High	Oregon Gulch	Sky Ranch Rd	Trinity	Total
High	Middle Weaver Creek	Easter Ave	Trinity	Total
High	Weaver Creek	Highway 299	Trinity	Partial
High	Sidney Gulch	Highway 299	Trinity	Partial
High	Sidney Gulch	Weaver Bally Drive	Trinity	Partial
High	Sidney Gulch	Weaver Bally Loop Road	Trinity	Total
High	Ash Hollow	Highway 299	Trinity	Total
High	Five Cent Gulch	Highway 299	Trinity	Partial
High	Ten Cent Gulch	Highway 299	Trinity	Partial
High	Ten Cent Gulch	Highway 3	Trinity	Partial
Medium	Unnamed Tributary	Goose Ranch Rd	Trinity	Total
Low	McKinney Gulch	Conner Creek Rd	Trinity	Total
Low	Trinity House Gulch	Browns Mountain Rd	Trinity	Total

*From Taylor (2002 and USFS, Weaverville office)

Climate Change

The Trinity River is a snowmelt-based river system. This has important implications in terms of climate change because snow pack has been decreasing in the western U.S. (Knowles and Cayan 2004; Mote 2006), and is expected to continue to decrease in the future as a result of the warming trend (Zhu et al. 2005; Vicuna et al. 2007), despite increases in precipitation (Hamlet et al. 2005). This may limit summer base flows in small tributary streams, increase stream temperatures, and cause earlier onsets of peak runoff. Mainstem Trinity River flows could also decrease if the hydrologic yield of Trinity Reservoir decreases over time, which could limit habitat availability for rearing juvenile salmonids. Summertime heating of Lewiston Reservoir poses a substantial threat both to Trinity Reservoir storage flexibility and to water temperatures in the Trinity River, impacting most life stages, but juveniles in particular.

Climate change poses a high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is warmer than the past and modeled regional average temperature predicts a large increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 3° C in the summer and by 1° C in the winter. Changes in flow and air temperature will influence water quality in the Trinity River. During drought years, temperatures will likely rise above levels that are stressful for coho salmon.

Annual precipitation is predicted to change little over the next century. Snowpack in upper elevations of the Trinity River basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009). The vulnerability of the Klamath estuary to sea level rise is low to moderate and therefore does not pose a significant threat to estuarine rearing habitat downstream. Juvenile and smolt rearing and migratory habitat are most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, with all populations in the ESU adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see Independent Science Advisory Board 2007, Feely et al. 2008, Portner and Knust 2007).

Invasive Non-Native/Alien Species

Competition and predation from brown trout, a non-native species, poses a substantial threat to coho salmon (Glova and Field-Dodgson 1995) in the Upper Trinity. Brown trout eat other fish species, and compete with them at all life stages for food, rearing habitat and spawning habitat (Waters 1983; Dewald and Wilzbach 1992; Wang and White 1994; McHugh and Budy 2006). Coho are absent were brown trout where present, and preferred habitats were left unoccupied by coho salmon (CDFG 2009b). Data from weirs operated by CDFG indicate several hundred brown trout pass through the Junction City area annually. Brown trout are abundant enough in the Trinity River to make up a substantial proportion of observations by biologists collecting juvenile salmonid habitat utilization data (Martin 2009).

High Intensity Fire

Fires have swept through regions of the Upper Trinity River in the recent past. The altered vegetation characteristics throughout the watershed present a moderate threat for future high intensity fires, which could alter sedimentation processes as well as riparian vegetation characteristics. Fire risks will continue to increase in the future as conditions become drier and hotter as a result of climate change. Higher temperatures, reduced snowpack, and earlier spring snowmelt all contribute to the frequency, intensity, and extent of fires. Elevated fire frequency and intensity will continue to degrade spawning and rearing habitat through sedimentation and loss of riparian vegetation. Areas prone to fire risk are spread throughout the Trinity Basin.

Roads

Roads are a moderate to high threat across most life history stages. Data indicate road density varies from Very High to Low across the watershed. Most of the habitat with the greatest potential to support coho salmon in this area occurs in areas with road densities greater than 2.5 miles/sq. mile, and much of that habitat is in areas with greater than 3 miles/sq. mile. Given the sedimentation problems seen in the watershed, roads should be considered for removal or upgrade to reduce sediment delivery. Of particular importance are the many roads in the Weaverville and Douglas City areas, where small tributary streams containing reaches with high or medium IP value are accessible to coho salmon.

In total, 636 high and high/moderate priority sites have been identified for treatment on Trinity Country Roads including 149 high priority road-stream crossing sites (Trinity County 2000). In addition, Two County roads, Trinity Dam Boulevard and East Side Road, account for 57.8 percent of the total (708,583 yd^3) stream crossing related volume of potential sediment delivery. This potential volume is the result of roads built on highly erodible decomposed granitic soils. Numerous studies have identified and evaluated decomposed granite sediment sources and delivery from Grass Valley Creek. This creek has been determined to be the largest source of decomposed granite sediment in the reach. Portions of Trinity Dam Boulevard, Lewiston Turnpike, Old Lewiston and other roads in the Lewiston area cross through decomposed granite soils and act as sediment sources. Some sites have already been treated and the County and its partners will continue to target road-related sediment issues to reduce sediment inputs into the river.

Agricultural Practices

Limited agricultural activities exist in the upper Trinity River subbasin. There are small-scale agricultural operations, such as small farms, vineyards and cattle grazing operations. Agriculture is a minor factor affecting coho salmon in this population and is therefore considered a low threat. One associated impact of agricultural practices that is addressed under the threat of dams and diversions (see above) is the diversion of water.

Channelization/Diking

Channelization and diking was ranked a low to medium threat in the threats table. Although channelization and diking is not widespread throughout the watershed, localized restrictions occur if roads run parallel to streams where they reduce floodplain connectivity and function. Other localized instances of channelization near tributary confluences should be identified and evaluated for potential restoration to improve floodplain function and provide off-channel habitat.

Urban/Residential/Industrial Development

Rural population growth will continue to present a moderate threat to coho salmon in the Upper Trinity River. The population of Trinity County increased 9.9 percent from 2000 to 2006 according to the U.S. Census Bureau (U.S. Census Bureau 2008), equating to an annual increase of 1.7 percent. The five principal communities in the area (Trinity Center, Weaverville, Lewiston, Douglas City, and Junction City) are home to approximately half of the people in Trinity County. In the future, demand for water for public use is expected to increase as more people move to the area. Towns will divert more surface flow from streams and waterways in order to provide the public with clean water near towns, and the number of rural residential groundwater wells will likely increase as well. However, the extent of that demand is likely limited due to the relatively small number of people expected to occupy the area. Such growth also results in removal of vegetation, increased sediment generation and delivery and introduction of exotic species. Subdivision of existing parcels will exacerbate this threat.

Fishing and Collecting

California manages fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath/Trinity basin. The effects of the fisheries managed by the State of California and the Yurok and Hoopa Tribes, on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS.

Timber Harvest

Although historically this area was highly impacted by timber harvest, a low amount of timber harvest presently occurs in the population area. Much of the population area is in public ownership (U.S. Forest Service and Bureau of Land Management), including a substantial portion of federally-designated Wilderness. Under current management practices and the financial, administrative and legal restrictions on timber harvest on public land, the USFS and BLM are unlikely to implement large timber sales. Additionally, timber practices are governed by the rigorous protective measures for water quality that are required for actions on public lands under the Northwest Forest Plan Aquatic Conservation Strategy and Standards and Guidelines. Timber harvest in the Upper Trinity has been on the decline over the past 50 years (GMA 2001).

Almost all recently harvested land in the Trinity watershed is privately owned and the extent of its environmental impacts are unknown (EPA 2001). Approximately 15 percent of the Trinity Basin is under private industrial timber management (EPA 2001). Based on data from CalFire (2009) on approved private land timber harvest plans (THPs) in the Trinity River, the majority of timber harvest occurs as large timber sales on industrial timberlands. Most timber harvest on private land will occur in the Douglas City, Weaver Creek, and Upper Trinity HSAs of the Trinity River. Based on the extent and restrictions on future timber harvest it is considered a low to moderate threat to the Upper Trinity population.

Mining/Gravel Extraction

Gravel extraction and mining is a low threat for the population. Very little in-stream gravel mining occurs in the Upper Trinity River. The bedrock underlying the Trinity River supports natural pool and riffle formation and maintenance, providing a buffer against detrimental effects of mining on coho salmon habitat (Wolff 2009). Suction dredge mining for gold probably presents a low threat to coho salmon because of the small number and scale of these operations, and the current moratorium on suction dredge mining. NMFS expects the effects of this activity to remain the same or decrease in the future.

39.7 Recovery Strategy

Naturally-produced coho salmon in the Upper Trinity River are depressed in abundance and have a restricted distribution. Recovery activities in the watershed should promote increased spatial distribution as well as increased productivity and abundance. Curtailing the effects of hatchery fish on this population are of utmost importance. Returns of hatchery fish are several times greater than historical runs and several times greater than the low risk threshold presented by Williams et al. (2008). Activities that increase streamflows, reduce summertime stream temperatures, increase fish distribution through barrier removal, and promote increased floodplain and channel structure and improve long-term prospects for LWD recruitment, should be a priority in the watershed. Specific goals for each stressor are listed below and in the table of recovery actions that follows. These goals identify activities that are expected to reduce the stresses currently affecting the Upper Trinity River coho salmon population.

The presence of coho salmon has been confirmed in a variety of streams in the Upper Trinity River Subbasin such as Grass Valley Creek, Sydney Gulch, Deadwood Creek, Rush Creek, Weaver Creek, East Weaver Creek, West Weaver Creek, Little Browns Creek, Sidney Gulch, Dutch Creek, Soldier Creek, Canyon Creek, North Fork Trinity River, East Fork North Fork Trinity River, Manzanita Creek, Big French Creek, New River and East Fork New River (Hill 2008; Everest 2008). Coho salmon are also likely to be found in Reading, Browns, and Indian creeks. The following actions are essential for the coho salmon population in the Upper Trinity River coho salmon population to recover to the extent necessary for recovery of the SONCC coho salmon ESU. Streams considered a high priority of recovery actions include those streams listed in Table 39-1.

Several steps will be necessary to recover the Upper Trinity population of coho salmon. The hatchery reforms discussed in above, including a Hatchery and Genetic Management Plan, need to be implemented to align hatchery production with recovery standards for hatcheries. Road stream crossing barriers discussed above should be addressed and ameliorated. Areas that contain high road densities, particularly with areas of decomposed granite should be targeted for road decommissioning. A new, more variable and dynamic flow regime to replace static 300 cfs baseflows, which occur from October to May in the mainstem Trinity River, is critical for rearing coho salmon. Adequate protections for the cold water pool in Trinity Reservoir and a strategy to compensate for thermal heating in Lewiston Reservoir are necessary to buffer coho salmon production in the mainstem Trinity River from drought and climate change.

Table 39-7 on the following page lists the recovery actions for the Upper Trinity River population.

Table 39-7. Recovery action implementation schedule for the Upper Trinity River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UTR.14.2.22	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of brown trout	Population wide	2
SONCC-UTR.14.2.22.1	*Adopt fishing regulations and educational programs that encourage and allow for the take of an unlimited number of brown trout*					
SONCC-UTR.14.2.22.2	*Euthanize all brown trout captured at CDFG weirs*					
SONCC-UTR.1.2.41	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3
SONCC-UTR.1.2.41.1	*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*					
SONCC-UTR.16.1.23	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UTR.16.1.23.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-UTR.16.1.23.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-UTR.16.1.24	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-UTR.16.1.24.1	*Determine actual fishing impacts*					
SONCC-UTR.16.1.24.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-UTR.16.2.25	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UTR.16.2.25.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-UTR.16.2.25.2	*Identify scientific collection impacts expected to be consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UTR.16.2.26	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UTR.16.2.26.1	*Determine actual impacts of scientific collection*					
SONCC-UTR.16.2.26.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-UTR.2.2.7	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Mainstem, Grass Valley, Indian, Hayfork, Reading, Weaver, East Fork Weaver Creek	2
SONCC-UTR.2.2.7.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-UTR.2.2.7.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-UTR.2.2.8	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Increase beaver abundance	Grass Valley, Indian, Hayfork, Reading, Weaver, East Fork Weaver Creek	3
SONCC-UTR.2.2.8.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-UTR.2.2.8.2	*Implement beaver program (may include reintroduction)*					
SONCC-UTR.2.2.8.3	*Limit hunting or removal of beaver*					
SONCC-UTR.2.1.9	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Mainstem above Douglas City, Grass Valley, Indian, Hayfork, Reading, Weaver, East Fork Weaver Creek	3
SONCC-UTR.2.1.9.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-UTR.2.1.9.2	*Place instream structures, guided by assessment results*					
SONCC-UTR.17.2.1	Hatcheries	No	Reduce adverse hatchery impacts	Identify and reduce impacts of hatchery on SONCC coho salmon	Trinity River Hatchery	3
SONCC-UTR.17.2.1.1	*Complete California Hatchery Scientific Review*					
SONCC-UTR.17.2.1.2	*Develop Hatchery and Genetic Management Plans*					
SONCC-UTR.17.1.2	Hatcheries	No	Reduce adverse genetic impacts	Increase proportion of natural influence	Trinity River Hatchery	2
SONCC-UTR.17.1.2.1	*Reduce production of coho salmon smolts as guided by Hatchery and Genetic Management Plan*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UTR.17.1.2.2	*Adopt naturally-produced (unmarked) broodstock target guided by Hatchery and Genetic Management Plan*					
SONCC-UTR.17.1.2.3	*Trap and cull excess hatchery broodstock*					
SONCC-UTR.17.1.2.4	*Encourage a terminal recreational fishery to help decrease the number of hatchery fish on the spawning grounds*					
SONCC-UTR.17.1.3	Hatcheries	No	Reduce adverse genetic impacts	Monitor genetic diversity	Trinity River Hatchery	3
SONCC-UTR.17.1.3.1	*Collect tissue samples from all fish returning to the hatchery*					
SONCC-UTR.17.1.4	Hatcheries	No	Reduce adverse genetic impacts	Reduce genetic impacts of hatchery on wild fish	Population wide	2
SONCC-UTR.17.1.4.1	*Adopt a 1:1 mating protocol*					
SONCC-UTR.17.1.5	Hatcheries	No	Reduce adverse genetic impacts	Reduce steelhead ecological interactions	Trinity River Hatchery	2
SONCC-UTR.17.1.5.1	*Reduce hatchery steelhead production as guided by Hatchery and Genetic Management Plan*					
SONCC-UTR.17.1.6	Hatcheries	No	Reduce adverse genetic impacts	Reduce redd superimposition	Population wide	3
SONCC-UTR.17.1.6.1	*Provide geographic segregation of spawning to runs of Chinook salmon, coho salmon, and steelhead by operating weirs or other systems aimed at limiting redd superimposition*					
SONCC-UTR.3.1.16	Hydrology	No	Improve flow timing or volume	Manage flows	Population wide	3
SONCC-UTR.3.1.16.1	*Assess how climate change and likely reduced snowpack might influence water availability*					
SONCC-UTR.3.1.16.3	*Update Trinity River allocations, if needed, based on assessments of ROD flows*					
SONCC-UTR.3.1.17	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Coldwater mainstem tributaries, Grass Valley, Indian, Reading, Weaver, East Fork Weaver Creek	BR
SONCC-UTR.3.1.17.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-UTR.3.1.18	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-UTR.3.1.18.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-UTR.3.1.19	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UTR.3.1.19.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-UTR.3.1.20	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-UTR.3.1.20.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-UTR.3.1.21	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	3
SONCC-UTR.3.1.21.1	*Reduce diversions*					
SONCC-UTR.3.1.36	Hydrology	No	Improve flow timing or volume	Increase instream flows	Mainstem above Douglas City, Grass Valley, Indian, Hayfork, Reading, Weaver, East Fork Weaver creeks	3
SONCC-UTR.3.1.36.1	*Establish a forbearance program, using water storage tanks to decrease diversion during periods of low flow*					
SONCC-UTR.3.1.36.2	*Monitor forbearance compliance and flow*					
SONCC-UTR.3.1.37	Hydrology	No	Improve flow timing or volume	Increase instream flows	Weaver and East Weaver creeks	3
SONCC-UTR.3.1.37.1	*Pump water from mainstem Trinity River for Weaverville municipal water supply during periods of low flow*					
SONCC-UTR.3.1.38	Hydrology	No	Improve flow timing or volume	Improve water management techniques	Population wide	3
SONCC-UTR.3.1.38.1	*Develop plan to protect coho salmon from effects of climate change*					
SONCC-UTR.3.1.38.2	*Implement plan based on findings*					
SONCC-UTR.3.1.39	Hydrology	No	Improve flow timing or volume	Improve water management techniques	Population wide	3
SONCC-UTR.3.1.39.1	*Develop plan to manage stream flows and water temperature during periods of drought*					
SONCC-UTR.27.1.27	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-UTR.27.1.27.1	*Perform annual spawning surveys*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UTR.27.1.28	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-UTR.27.1.28.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-UTR.27.1.29	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track surrogate for genetic diversity	Trinity River Hatchery	3
SONCC-UTR.27.1.29.1	*Describe annual ratio of naturally-produced fish to hatchery-produced fish spawned for hatchery production*					
SONCC-UTR.27.1.30	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-UTR.27.1.30.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-UTR.27.1.31	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Hatchery Management'	Population wide	3
SONCC-UTR.27.1.31.1	*Annually determine the percent of hatchery origin spawners (PHOS), percent of natural origin spawners (PNOS), and the proportion of natural influence (PNI)*					
SONCC-UTR.27.2.32	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-UTR.27.2.32.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-UTR.27.2.32.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-UTR.27.2.33	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-UTR.27.2.33.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-UTR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-UTR.27.2.34.1	*Annually measure the hydrograph and identify instream flow needs*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UTR.27.1.40	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-UTR.27.1.40.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-UTR.27.1.42	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-UTR.27.1.42.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-UTR.27.1.42.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-UTR.5.1.10	Passage	No	Improve access	Remove barriers	North Fork Trinity and Canyon, Browns, Reading, Weaver, Middle Weaver Creeks	3
SONCC-UTR.5.1.10.1	*Assess highest priority road-stream and diversion related barriers. Develop a plan for removal*					
SONCC-UTR.5.1.10.2	*Remove barriers*					
SONCC-UTR.5.1.11	Passage	No	Improve access	Reduce sediment barriers	Tributary confluences	3
SONCC-UTR.5.1.11.1	*Inventory and prioritize barriers formed by alluvial deposits*					
SONCC-UTR.5.1.11.2	*Remove alluvial deposits, construct low flow channels, or reduce stream gradient to provide fish passage at all life stages*					
SONCC-UTR.5.1.35	Passage	No	Improve access	Provide artificial passage	Upstream of Lewiston Dam	3
SONCC-UTR.5.1.35.1	*Study feasibility of fish passage at Lewiston and Trinity dams*					
SONCC-UTR.5.1.35.2	*Provide passage for all life stages, guided by plan*					
SONCC-UTR.10.1.13	Water Quality	No	Reduce water temperature, increase disssolved oxygen	Reduce warm water inputs	Lewiston Dam on mainstem Trinity	3
SONCC-UTR.10.1.13.1	*Study and evaluate methods to reduce thermal heating in Lewiston Reservoir*					
SONCC-UTR.10.1.13.2	*Implement plan to reduce thermal heating based on findings*					
SONCC-UTR.10.1.14	Water Quality	No	Reduce water temperature, increase disssolved oxygen	Increase flow	Weaver, Reading, Grass Valley, and Indian creeks	3
SONCC-UTR.10.1.14.1	*Develop a plan to address water quality and quantity*					
SONCC-UTR.10.1.14.2	*Implement plan to address water quality and quantity*					

40. South Fork Trinity River Population

- Interior-Trinity Diversity Stratum
- Non-Core -1, Functionally Independent Population
- High Extinction Risk
- 970 Spawners Required for ESU Viability
- 932 mi^2
- 242 IP km (150 mi) (26% High)
- Dominant Land Uses are Agriculture and Timber Harvest
- Principal Stresses are ‘Altered Hydrologic Function’ and ‘Impaired Water Quality’
- Principal Threats are ‘Water Diversions’ and ‘Roads’

40.1 History of Habitat and Land Use

The South Fork Trinity River is the largest undammed river in California. Past and present land use practices in the South Fork Trinity River basin have led to a decreased ability to support salmon and steelhead, as evidenced by significantly decreased runs of spawning salmonids (Pacific Watershed Associates (PWA) 1994). Activities such as mining, road construction, fire suppression, stream diversion, and timber harvest have modified streamflow and natural erosion processes and altered stream channels in the South Fork Trinity River basin (U.S. Forest Service (USFS) 2008). These disturbances have been widely distributed and have caused sustained alteration of ecosystem structure and function, particularly in riparian areas (USFS 2008).

Overgrazing in the late 1800s and early 1900s damaged riparian vegetation and led to significant erosion (Tetra Tech 2000). By 1977, 52 percent of forested areas within the basin had been logged. An additional 4 percent of the old growth had been lost to fire. At the time, total road length was 3,456 miles, 92 percent of which were associated with timber harvests (California Department of Water Resources (DWR) 1979, PWA 1994). Since that time, an undetermined, but substantial, amount of additional acreage has been affected by logging, road construction and wildfires. Industrial pollution from lumber mills, domestic pollution from poorly functioning septic systems, and pollution from agricultural non-point sources have also contributed to the declines of salmonids in the South Fork Trinity River (PWA 1994).

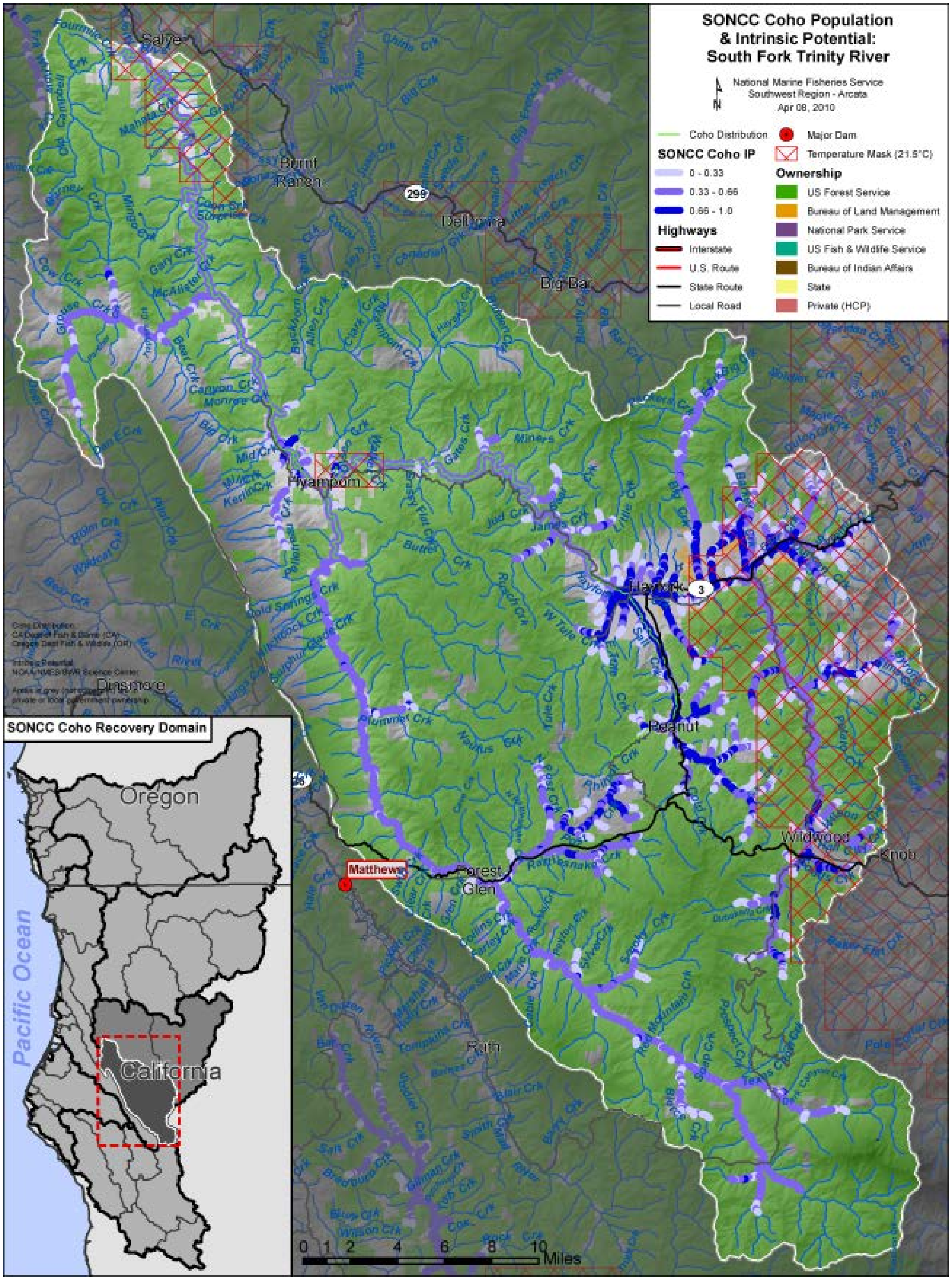

Figure 40-1. The geographic boundaries of the South Fork Trinity River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

The mid-1850s saw the beginning of placer mining on several tributaries of the South Fork Trinity, followed later by dragline mining and hardrock mining. The timber industry developed concurrently and became economically important in the area. The 1905 formation of the Trinity Forest Reserves (later the Trinity National Forest) led to changes in forest management practices, particularly in grazing and fire suppression (USFS 1999c). Changes in land use led to accelerated natural erosion processes in the South Fork Trinity River basin, resulting in increased sedimentation in the river channels. Smaller tributaries generally have been affected less severely than mainstem lower gradient reaches. Sedimentation is most notable in the Hyampom Valley, with most of the sediment being delivered from South Fork Mountain tributaries, particularly downstream of Hyampom Valley and the Pelletreau Creek subwatershed, both of which have been heavily logged since the 1940s (PWA 1994).

Fire is a significant disturbance factor within the South Fork Trinity River basin (USFS 2008). Prior to the initiation of organized fire suppression in the early 1900s, low intensity, surface fires of relatively short intervals of 5 to 30 years were typical in the basin (USFS 2008). The suppression of fire, along with unnatural fuel loading, has initiated a transition to a fire regime characterized by more frequent, high intensity fires and vegetative community changes such as greater abundance of white fir (USFS 2008). Several intense wildland fires have burned in the South Fork Trinity basin since fire suppression commenced. Continued accelerated sediment production is found in many of the areas where large-scale forest fires have burned (U.S. Environmental Protection Agency (EPA) 1998).

Salmon in the South Fork Trinity River have also been affected by a number of large floods over the past several decades, especially by the flood of December 1964 (EPA 1998). The 1964 flood caused tremendous soil loss in tributaries, especially those that had been logged (MacCleery 1974). Sedimentation from road failures and mass wasting associated with roads and clearcut logged areas choked the channels of many of these tributaries. As these tributary streams delivered sediment into the South Fork Trinity River, additional streamside landslides were triggered (PWA 1994). “Unstable geology, along with erosion-producing land use practices have been blamed for the many mass wasting events triggered by the 1964 flood, which resulted in dramatic instream changes, including channel widening, aggradation, and loss of pool depth, all of which adversely affected salmonids” (EPA 1998). The Salyer reach (river mile 1.5 to 6.2) showed about 20 feet of aggradation after the 1964 flood (Dresser et al. 2001). Hyampom Valley (as of 1982) still had 25 feet of aggradation and the channel has widened 66 feet due to the 1964 flood (PWA 1994). Since that time, further changes suggest improvements in some locations, while continued, chronic sediment inputs may be hindering a more complete or faster recovery (EPA 1998).

Recently, Van Kirk and Naman (2008) found that river discharge of the South Fork Trinity River was significantly lower in the period from 1977 to 2005 than the period from 1966 to 1976. This decrease in flow is likely due to a combination of increasing water utilization, land use changes, and climate change, which has resulted in a decrease in snowpack in the region (Van Kirk and Naman 2008). Water utilization and the resulting reduction in the water table also results in longer recharge times for aquifers. This means that the increase in streamflows associated with fall and winter rains is often delayed as groundwater resources recharge.

The Hayfork Creek sub-basin (the largest tributary to the South Fork) includes approximately 191,000 acres of public land and 52,000 acres of private land (South Fork Trinity River Coordinated Resource Management and Planning Group (SFCRMP) 2008). The Hayfork Creek sub-basin is a relatively geologically stable basin in comparison to the rest of the South Fork Trinity River basin. The majority of water diversions and water quality issues (high water temperatures, high nutrient loads, low dissolved oxygen) in the South Fork Trinity River basin occur in the Hayfork sub-basin, where depleted summer flows and lack of riparian shading have adversely affected salmonid production in Hayfork Creek (PWA 1994). The upper reaches of Hayfork Creek are covered by the temperature mask (Figure 40-1), making it uninhabitable to coho salmon without thermal refugia from coldwater springs or groundwater. The loss of riparian canopy (from grazing and timber harvest) contributes significantly to increased water temperatures, which can exceed 80°F in Hayfork Creek (PWA 1994). Flow depletion, lack of riparian cover, and water pollution all affect the ability of Hayfork Creek and its major tributaries to produce salmon and steelhead. Because of its high water temperature, Hayfork Creek increases temperature problems in the main stem South Fork Trinity River in some years, whereas it formerly provided a moderating influence (PWA 1994).

40.2 Historic Fish Distribution and Abundance

It was noted by USFWS and CDFG ((1956) that "Silver [coho] salmon enter most lower Trinity River tributaries to spawn." Similarly, Moffet and Smith (1950) stated that "Silver [coho] salmon enter the lower Trinity River to spawn." Although it is thought that anadromous fish, including coho salmon, were abundant in the middle 20th century but their populations have declined dramatically since the flood of 1964 (Borok and Jong 1997, Dresser et al. 2001). Beyond these few statements, little information is available on the historic distribution and abundance of coho salmon in the South Fork Trinity River basin.

CDFG operated a weir on the South Fork Trinity River at Sandy Bar—about two kilometers upstream of the confluence with the Trinity River—between 1984 to 1990 (Jong and Mills 1992). In 1985 and 1990, years when enough adult and jack coho salmon returned to the river to make escapement estimates possible, it was estimated that 127 [95 percent CI = 109 to 222] and 99 [95 percent CI = 68 to 256] adult and jack coho salmon returned to the river (Jong and Mills 1992). However, 35.8 percent of the adult coho salmon captured in 1985 were of hatchery origin (Jong and Mills 1992). Consistent marking of coho salmon at Trinity River Hatchery did not occur until 1996, but the hatchery fish in 1985 could be identified by marks made in the hatchery as part of a separate experiment (Marshall 2008).

Based on the Intrinsic Potential (IP) of the watershed, Williams et al. (2008) calculated that the low-risk spawner threshold for the South Fork Trinity River population is 6,400 coho salmon. The depensation (high risk) threshold is 242 coho salmon (Williams et al. 2008). Moderate IP reaches exist throughout the South Fork Trinity River basin, both in the mainstem, the East Fork of the South Fork Trinity River, and tributaries such as Butter Creek. There are several streams that contain high IP reaches (IP > 0.66) such as Hayfork Creek and Salt Creek, however, many of these high IP stream reaches are on private land in the low-gradient valley floors of the watershed and experience high temperatures during the summer (Table 40-1). There are no historical accounts of coho salmon presence in the Hayfork Valley, and their prevalence in Hayfork Valley remains in question. There is a section in Hayfork Creek thought to inhibit coho salmon migration into Hayfork Valley because of its high gradient, particularly in dry water years.

Coho salmon in the upper reaches of the South Fork Trinity River were likely dissimilar to those of the coast range and lower Trinity River. In order to access spawning grounds in the Hayfork Valley, Salt Creek, and upper mainstem South Fork Trinity River, they would have begun their spawning migration in late September or October. These “long-run” coho salmon most likely had run timing that was similar to that of coho salmon in the Shasta River. This is unlike coho salmon in the coast range that enter rivers and streams to spawn in November and December following winter rains. The far distance that they travel, distinctive geology and ecology of the Yolla Bolly Mountains, and unregulated flow of the South Fork Trinity River, would have made this population of coho salmon unique among Trinity River coho salmon populations.

Table 40-1. Tributaries with high IP reaches in the South Fork Trinity (IP > 0.66) (Williams et al. 2006).

Subarea[1]	Stream Name
Hayfork Valley	Hayfork Creek
	Salt Creek
	Big Creek
	Barker Creek
Forest Glenn	Butter Creek
	Post Creek
	Rattlesnake Creek
Corral Creek	Corral Creek
Hyampom	Olsen Creek
Grouse Creek	Eltapom Creek

[1]Subarea refers to hydrologic subarea (HSA) in the CALWATER classification system.

40.3 Status of South Fork Trinity River Coho Salmon

Spatial Structure and Diversity

Coho salmon are limited in their distribution in the South Fork Trinity River basin and occur only in the mainstem South Fork Trinity River up to Butter Creek, Butter Creek, Hayfork Creek up to Corral Creek, Eltapom Creek, Olsen Creek, and Madden Creek (Everest 2008; Boberg 2008). There are no know barriers to migration for coho salmon in the South Fork Trinity River upstream of Butter Creek, and Rattlesnake Creek has moderate and high IP reaches. Yet no coho salmon are known to inhabit these stream reaches. Coho salmon have not been found in Hayfork Creek near or upstream of the town of Hayfork. This area has the greatest concentration of high IP values of any stream in the basin. It is not clear if coho salmon are currently able to migrate through Hayfork Creek upstream of Corral Creek, or if they were historically able to migrate past Corral Creek. However, it is likely that habitat conditions, such as high summer water temperatures and low dissolved oxygen, arising from land use, water utilization, climate change and channel aggradation are currently limiting the spatial structure of coho salmon in the South Fork Trinity River basin. The more restricted and fragmented the distribution of individuals within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. For these reasons, coho salmon of the South Fork

Trinity River are spatially restricted in the basin and have an elevated risk of extinction because of their spatial structure.

Each year, Trinity River Hatchery releases approximately 500,000 coho salmon smolts, 800,000 steelhead, and 4.3 million Chinook salmon. Currently, coho salmon returns to the Trinity River are dominated by hatchery fish (US Fish and Wildlife Service (USFWS) and Hoopa Valley Tribe (HVT) 1999; Table 40-2). From 2003 to 2005, over 75 percent of coho salmon adults returning to the Trinity River, as estimated at Willow Creek, were of hatchery origin (Table 40-2). In 1985, Jong and Mills (1992) found that 35.8 percent of adult coho salmon returning to the South Fork Trinity River were of hatchery origin. Straying of hatchery fish into tributaries such as the South Fork Trinity River presents a particular threat to the diversity of the population because the hatchery fish may reduce the reproductive success of the overall population (Mclean et al. 2003) through outbreeding depression (Reisenbichler and Rubin 1999).

Table 40-2 Coho salmon run size estimates for the Trinity River. Based on counts at the Willow Creek counting weir. Data are from CDFG (2008c).

Year	Dates*	Location	Catch	Hatchery proportion of catch	Estimated Run Size
2003	17 Sep-18 Nov	Willow Creek	250	86	28,152
2004	10 Sep-25 Nov	Willow Creek	1,009	77	38,882
2005	3 Sept-4 Nov	Willow Creek	772	92	31,419
2005	24 Sep-2 Dec	Junction City	1,161	92	24,615

**Note that naturally produced coho salmon may return to the Trinity River later than their hatchery counterparts and/or after the weir at Willow Creek is removed from the river.*

Little is known about life history diversity in the South Fork Trinity River such as unique migration timing, redistribution of juveniles, or non-natal rearing. There does appear to be some diversity of life history strategies in the Trinity River based on data on run timing and outmigration. Coho salmon enter the Trinity River between September and November and spawning in the river continues into December (CDFG 2009b). Also, both young-of-the-year and yearling coho salmon are captured at downstream migrant traps located in the Trinity River near Willow Creek (Pinnix et al. 2007). Outmigration of age 0+ coho salmon occurs over a large time period between March and September as does outmigration of Age 1+ (Pinnix et al. 2007). Outmigration of subyearling coho salmon may be due to competition for rearing habitat or sub-optimal rearing conditions or it may be due to a unique life history type that may rear in natal or non-natal streams or both prior to emigrating to the ocean. It is unknown whether the South Fork Trinity population has any of these unique life history characteristics because no juvenile salmonid trapping currently occurs in the basin.

Because of the high numbers of adult hatchery coho salmon migrating past the South Fork Trinity River, and because they are known to stray into non-natal tributaries, the South Fork Trinity River population of coho salmon is, at least, at a moderate risk of extinction with regards to the Diversity viability parameter. Based on current spawning densities and locations, the South Fork Trinity River population is at an elevated risk of extinction because its spatial structure and diversity are very limited compared to modeled IP.

Population Size and Productivity

The only population estimates for the South Fork Trinity River are based on work by Jong and Mills (1992) who estimated that 127 adult and jack coho salmon returned to the South Fork Trinity River in 1985 and 99 returned in 1990. With 35.8 percent (46) of the adult coho salmon captured in 1985 being of hatchery origin, the total wild population was likely under 100 adults during these years (Jong and Mills 1992). In 1985, several hundred coho salmon juveniles were trapped in the South Fork Trinity River below the mouth of Madden Creek (CDFG 1993). More recent data on population sizes, other than that of Jong and Mills (1992) are unavailable. Overall, if a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 242 spawners are needed each year in the South Fork Trinity River to avoid dispensatory effects of extremely low population sizes. If we assume abundances are similar to those found in 1985 and 1990, the South Fork Trinity River population does not meet this depensation threshold and is at high risk of extinction. The population growth rate in South Fork Trinity River basin has not been quantified but is likely negative based on loss of habitat, declining water quality, and detrimental hatchery influences. This downward trend further adds to the extinction risk of the population.

Extinction Risk

The South Fork Trinity River coho salmon population is not viable and at high risk of extinction, because the most recent estimated average spawner abundance was less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The South Fork Trinity River coho salmon population is considered to be a non-core “Functionally Independent” population within the Trinity diversity stratum. This population was likely once sufficiently large to be historically viable-in-isolation and had demographics and extinction risk that were minimally influenced by immigrants from adjacent populations (Bjorkstedt et al. 2005; Williams et al. 2006). As a non-core population, the recovery target for the South Fork Trinity population is for the population to meet the depensation threshold of 242 spawners (Williams et al. 2008).

40.4 Plans and Assessments

Trinity County Resource Conservation District

South Fork Trinity River Coordinated Resource Management Plan Committee

Action Plan for Restoration of the South Fork Trinity River Watershed and Its Fisheries
http://www.krisweb.com/biblio/sft_usbor_pwa_1994_sftplan/pwa1.htm

U.S. Forest Service Watershed Analyses
http://www.fs.fed.us/r5/shastatrinity/publications/watershed-analysis.shtml

State of California

Total Maximum Daily Load
http://www.swrcb.ca.gov/northcoast/

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

40.5 Stresses

Table 40-3. Severity of stresses affecting each life stage of coho salmon in the South Fork Trinity River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult[1]	Overall Stress Rank
1	Adverse Hatchery-Related Effects	Very High	Very High	Very High[1]	Very High	Very High[1]	Very High
2	Altered Sediment Supply[1]	High	High	High[1]	Medium	High	High
3	Impaired Water Quality[1]	Low	Medium	High[1]	High	Medium	High
4	Altered Hydrologic Function[1]	Medium	High	High[1]	Medium	High	High
5	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
6	Lack of Floodplain and Channel Structure	Medium	High	High	High	Medium	High
7	Impaired Estuary/Mainstem Function	-	Low	Medium	Medium	Medium	Medium
8	Barriers	-	Low	High	Low	High	Medium
9	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
10	Increased Disease/Predation/Competition	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Several factors limit the viability of the South Fork Trinity River coho salmon population. The most dominant of these factors stem from the effects of agricultural practices on private land, legacy sediment-related impacts from past floods, fire, and land management. Altered sediment supply, impaired water quality, and altered hydrologic function are the most likely stresses limiting productivity of the South Fork Trinity population. Juveniles are the most likely limited life stage due to the poor summer rearing conditions.

The majority of high IP habitat exists on private land in the Hayfork Valley. This area is characterized by poor water quality, a lack of hydrologic function, sedimentation and high water temperatures. High water temperatures, while affected by high summer air temperatures, are exacerbated by reduction of riparian trees, stream widening due to aggradation, over-grazing of riparian zones, flow depletion and agricultural runoff. The stream bed may remain unstable for a long duration, making recolonization of stream side trees difficult even by invasive species such as willows or alders (e.g., lower reaches of Pelletreau Creek and the South Fork Trinity River at Hyampom; Lisle 1981). Several studies and habitat typing reports have noted stream temperature as a major limiting factor for fisheries in the South Fork Trinity (USFS 1990; PWA 1994). Stream temperatures in the mainstem below Hyampom and in Hayfork Creek often reach lethal levels during the summer and tributaries with the potential for thermal refugia often lack adequate flows during the summer (PWA 1994). Poor water quality leads to reduced survival and growth of juveniles and can contribute to thermal barriers for migrating juveniles and smolts. A limited amount of habitat with adequate temperatures and habitat attributes for juvenile summer rearing exists in the South Fork Trinity. Riparian vegetation is reestablishing in some smaller tributaries and is expected to experience improved water quality in the future (e.g., Sulphur Glade Creek). However many of these streams lack the flow and/or habitat requirements of juveniles coho salmon.

High levels of fine sediment indicate that excessive sediment may also be a major limiting factor in some tributaries and mainstem reaches, for example, the South Fork Trinity River near Hyampom and Hayfork Creek (Gilroy et al. 1992, Dresser et al. 2001). Many streams exhibiting higher channel gradients have flushed substantial amounts of introduced coarse sediment, similar to a pattern of recovery described by Lisle (1981) and Hagans et al. (1986). The mainstem South Fork Trinity River downstream of Hyampom to the confluence with the Trinity River has flushed a substantial portion of the sediment deposited in the 1964 flood. Hyampom Valley transitions from a low gradient, wide alluvial valley to a narrow canyon downstream. The transition area functions as a pinch point that prevents the mobilization of the greater than 25 feet of sediment that filled the Hyampom valley during the 1964 flood. Channel recovery is exacerbated by continued delivery of more sediment than the channel can transport. Headwater streams have also, in some cases, experienced re-growth of riparian zones that has promoted lower stream temperatures. However, reaches of the mainstem South Fork Trinity River upstream of lower Hyampom Valley, and lower Hayfork Creek, seem to be lagging in recovery both in terms of flushing recently introduced sediment and lowering water temperatures (Dale 1990). Water quality and water yield appear to be the main limiting factors to fisheries recovery in the potentially productive Hayfork Creek watershed. In order to improve the viability of this population it will be imperative to improve habitat conditions for juveniles and adults, and address the issues related to straying hatchery adults.

Vital habitat for the South Fork Trinity coho salmon population exists in areas that provide thermal refugia for juveniles in the summer and in areas with relatively intact habitat features such as clean spawning gravel, functional floodplain and channel structure, and established riparian forest. Potential coho salmon refugia areas exist at many stream confluences with the South Fork Trinity River. Madden Creek provides excellent refugia for juvenile and adult coho salmon in the lower South Fork Trinity River (Boberg 2008). It has cool, clean water that originates in the mountains of the Six Rivers National Forest and moderates the high temperature of the South Fork Trinity River in the summer months near the confluence of the two waterways. At times, hundreds of juvenile salmonids congregate in this area. Table 40-4 lists other potential refugia areas.

Table 40-4. Potential coho salmon temperature refugia. Areas in the South Fork Trinity River watershed.

HSA	Stream Name	Ownership
Grouse Creek	Madden Creek	Private/Public
Grouse Creek	Grouse Creek	Private/public
Forest Glenn	Butter Creek	Private
Forest Glenn	Rattle Snake Creek	Private/Public
Hyampom	Olsen Creek	Private
Grouse Creek	Eltapom	Public

Areas with relatively intact spawning and rearing habitat exist is isolated patches of Hayfork Creek and in other, smaller tributaries to the South Fork Trinity. Madden Creek is in the late stages of recovery from the 1964 flood and represents one of the few tributaries flowing off South Fork mountain with good water quality and the potential to accommodate spawning and rearing. The lower part of Hayfork Creek has the greatest extent of high IP habitat and with increased water quality; this section of Hayfork Creek could serve as the major seat of recovery for coho salmon in the South Fork Trinity River basin. Other important tributaries where coho salmon have recently been found include Butter Creek, Eltapom Creek, Olsen Creek, and Madden Creek (Everest 2008; Boberg 2008).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. No hatcheries or artificial propagation occur in the South Fork Trinity River population area, but Trinity River Hatchery is upstream on the Trinity River. Trinity River Hatchery currently releases 4.3 million juvenile and yearling Chinook salmon, 500,000 yearling coho salmon, and 800,000 yearling steelhead. Jong and Mills (1992) found that 35.8 percent of returning adults to the South Fork Trinity River in 1985 were of hatchery origin. Because adult coho salmon returns to Trinity Hatchery have been in excess of 25,000 fish during some years, it is likely that the stray rate of hatchery coho salmon to the South Fork Trinity River has continued to be high (>35 percent). Because hatchery smolts are not likely to migrate from the Trinity River upstream into the South Fork Trinity River, ecological interactions, such as competition and predation, between juveniles are not likely to occur within the South Fork Trinity River. However, juvenile coho salmon from the South Fork Trinity River population may compete with hatchery fish for food and habitat while rearing in the Lower Trinity River and in the Lower Klamath River. Adverse hatchery-related effects pose a very high stress to all life stages in the South Fork Trinity River sub-basin, because more than 30 percent of the spawners are of hatchery origin (Appendix B) and there is significant potential for ecological interactions.

Altered Sediment Supply

Altered sediment supply presents a high stress for most life stages. The 1964 flood resulted in widespread erosion in the mainstem South Fork Trinity River and many tributaries. Adding to these effects was the extensive harvesting of steep inner gorge slopes and widespread land disturbance. Many basins still suffer from chronic erosion and sedimentation as well as thick deposits of stored sediment and resultant wide, shallow streambeds (PWA 1994). Although the 1964 flood delivered substantial sediment to the South Fork Trinity River, there is evidence that some sites affected by the 1964 flood have since downcut to pre-flood levels (Dresser et al. 2001). In areas where sediment loading is still ongoing, sediment has filled pools, widened channels, and simplified stream habitat. In many reaches, aggradation reduced surface flows, potentially limiting access to migrating juveniles. Stream channels with the greatest fine sediment accumulations in pools and with associated low juvenile fish densities include lower Salt Creek, Hayfork Creek above 9-mile bridge, the entire main stem, East Fork South Fork and Grouse Creek (PWA 1994). High turbidity also has negative impacts on respiration and feeding as well as egg incubation. Sediment loading is greatest in the Hyampom Valley, with most of the sediment being delivered from South Fork Mountain tributaries. The Grouse Creek and Pelletreau Creek subwatersheds, both of which have been heavily logged since the 1940s, are both major sediment contributors (PWA 1994). “In the 1964 flood, many debris torrents caused significant aggradation (from 15 to 20 ft in some locations), which probably then triggered many inner gorge landslides” (EPA 1998), along with substantial channel widening, up to 60 feet in areas. Studies have identified landslides as the major source of sediment, followed by streambank erosion, road surface erosion, and hillslope surface erosion. Hillslope sediment inputs seem to have declined dramatically, indicating that upslope conditions are recovering (Raines 1999, Dresser et al. 2001). There has been some indication that fine sediment levels may be limiting for fish, and it is thought that pools are too shallow now for temperature stratification (Gilroy et al. 1992, PWA 1994). Federally managed watersheds in which cumulative erosion and sedimentation effects are likely to be problems include Butter Creek, Rattlesnake Creek, Plummer Creek, South Fork Mountain Tributaries, East Fork South Fork, Upper South Fork, Hidden Valley, Upper Hayfork Creek, Hyampom and Gulch watersheds.

Impaired Water Quality

The stressors from poor water quality are generally high and have the greatest impact on juveniles and smolts due to poor seasonal rearing and migratory conditions. Areas of poor water quality related to accelerated erosion rates, elevated temperature, and contaminant runoff are scattered throughout the basin (PWA 1994). Water quality primarily affects fish and fish habitat in the mainstem South Fork Trinity River and in Hayfork Creek. In Hayfork Creek, water diversion, agricultural practices, residential septic systems, and industrial pollution all contribute to impaired water quality. Water quality has been so bad some years in Hayfork Creek that seasonal fish kills have been documented in the past (PWA 1994). Water temperature in Hayfork Creek and the mainstem South Fork Trinity can reach levels stressful or even lethal (>17 °C) for rearing coho salmon in the summer months (PWA 1994; USFS 1990). Hayfork Creek contributes to poor water temperatures in the mainstem (PWA 1994). In addition to temperature, turbidity effects have been found in the more erodible portions of the basin in the Upper and Lower South Fork sub-basins, particularly west of the mainstem, and in areas where land management practices are most intense (PWA 1994). Other tributaries including, but not limited to Salt Creek, Rattlesnake Creek, Post Creek, Rusch Creek, Tule Creek also suffer from high stream temperatures and associated low dissolved oxygen in the summer months. Many of these streams are adversely affected by illegal water withdrawals, and nutrient and pesticide loading associated with outdoor marijuana cultivation and associated road building and land clearing. Localized areas of non-point source pollution exist and nutrients and toxins from agriculture, roads, and developed areas contribute to poor water quality in the South Fork Trinity basin.

Altered Hydrologic Function

Altered hydrologic function represents a high stress for the population and is especially significant for fry, juveniles, and adults. Flows are naturally low during the summer due to the low elevations in the basin, the bedrock geology and their low water holding capacity. The summers are hot and dry for several months and there is often little water flowing in most creeks during the summer (USFS 1996c). Exacerbating this issue is the substantial water utilization in the South Fork Trinity River, especially Hayfork Creek and its tributaries (PWA 1994), and Rattlesnake Creek (Wiseman 2011) which has caused reductions in the amount of habitat available to rearing juvenile salmon in the summer and restricted access to spawning grounds in the fall. Hayfork Creek below the East Fork has been designated as a critical water shortage area (PWA 1994). Water uses within the Hayfork watershed include numerous withdrawals from Hayfork Creek and East Fork Hayfork Creek for mostly domestic, agricultural and livestock watering purposes. Quantification of the amount diverted is difficult because only an estimated 13 percent of the water diverted from Hayfork Creek is under an appropriated water right (USFS 1996c). Groundwater is also utilized in several portions of the watershed, like Hayfork Valley, and remains undocumented and unregulated. Marijuana cultivation is a serious problem in many areas, such as the Rattlesnake Creek watershed and likely has a significant impact on the hydrologic function of tributary streams during critical low-flow periods in the summer and fall. The South Fork Trinity River basin is also susceptible to rain-on-snow events and intense flooding. Adding to this is the effects grazing and logging have had on the hydrologic function of several streams in the basin by removing trees and vegetation, compacting soils, and widening streams and decreasing pool depth. As a result, flows can be flashy and intense at time, leading to possible reduced survival of eggs and fry.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions present a high to medium stress across all life history stages of the South Fork Trinity River population. Decades of intensive grazing, logging, and intense fire impacted the riparian plant and forest communities throughout the basin (Tetra Tech 2000), impacting stream cover and water temperatures during the summer months. Habitat impairments have been identified in Hayfork Creek and its tributaries related to the lack of riparian vegetation. Loss of riparian vegetation can cause a stream to erode its bed, leading to subsequent streambank erosion problems. In some cases, stream down cutting can cause a drop in the local water table, which leads to reduced floodplain connectivity (PWA 1994). In past surveys, the U.S. Forest Service assessed riparian areas and identified watersheds that have more than 15 percent of their riparian zone acreage with low LWD recruitment potential and low shade. From least (17 percent) to greatest (30 percent) were Butter, Corral, Upper S.F. Trinity, Plummer, Lower Hayfork, Eltapom, Rattlesnake, Hidden Valley, Upper Hayfork, and Salt. Grouse Creek and Eltapom Creek in the Crouse Creek HSA, Naufus, Indian Valley, Dobbins, Rattlesnake, and Salt Creeks also show signs of low LWD recruitment. The Upper South Fork, by comparison, has a riparian forest composed largely of Douglas fir and White fir, with canopy closures ranging between 70 percent and 80 percent. Future LWD recruitment in these stands is excellent, with some of the highest recorded volume measurements in the Trinity Basin (USFS 1999c).

Lack of Floodplain and Channel Structure

Floodplain and channel structure present a high to medium stress across life history stages. Lack of floodplain and channel structure is primarily the result of the 1964 flood, with many stream reaches still not recovered. Past and present activities such as mining, road construction, stream diversion, and timber harvest have also modified streamflow and natural erosion processes and altered the dynamic equilibrium of stream channels in areas of the South Fork watershed such as the Hayfork Valley (USFS 1996c). Piles of mine tailings still line the channels of streams such as Hayfork Creek, constricting flows in places, producing sediment sources, and reducing the proper functioning condition of the stream and associated riparian zone. Recent data on instream LWD is limited but an apparent lack of LWD is likely adding to a lack of channel complexity and floodplain connectivity. Juvenile coho salmon are especially affected by a lack of stream complexity because they rely on instream structure and off-channel habitat for freshwater rearing.

Impaired Estuary/Mainstem Function

All salmon and steelhead that originate from the South Fork Trinity River migrate to and from the ocean through the mainstem Lower Trinity, Lower Klamath River, and the Klamath River estuary. The Klamath River estuary likely plays an important role in providing holding habitat and foraging and refuge opportunities for some juvenile coho salmon from the South Fork Trinity River, given the results of recent research indicating the importance of non-natal rearing in the Lower Klamath River. The degraded conditions that exist throughout the Trinity basin may mean that the estuary plays a very important role by providing the opportunity for juvenile and smolt growth and refugia prior to entering the ocean. The estuary, although relatively intact, suffers from poor water quality, elevated sedimentation and accretion, loss of habitat, and disconnection from tributary streams and the floodplain. Mainstem conditions contribute to this stress because of the issues with water quality, sedimentation and accretion, and degraded habitat in mainstem reaches of both the Lower Trinity and the Lower Klamath rivers. Juveniles, smolts, and adults transitioning through mainstem habitat are exposed to the degraded conditions in these migratory habitats and suffer from the lost opportunity for increased growth and consequently a lower survival rate. The loss and degradation of estuarine and mainstem habitat is considered a medium stress for the population, with the most affected life stages being juveniles, smolts, and adults due to the degradation of rearing and migratory habitat.

Barriers

Barriers are a medium stress across all life stages except the egg life stage. There are no large dams in the South Fork Trinity River drainage; however, numerous small barriers are scattered throughout the sub-basin and could potentially block a significant amount of available habitat. Devastation slide is an adult migration barrier on Grouse Creek and Hyampom (mainstem) and Hayfork (Hayfork Creek) valleys may be temperature barriers to rearing juvenile coho salmon. According to CalFish (2009), there are potentially 4 small dams and 147 road-stream crossing barriers. Of these potential barriers for coho salmon, 11 have been identified as priorities for removal in this database. An assessment on county-owned roads identified 12 low priority stream crossings and four moderate to high priority stream crossings (Trinity County 2000). The number of diversions that act as fish passage barriers to juvenile coho salmon is unknown but presumed to be potentially large given the amount of agriculture in the sub-basin. Unscreened diversions may act to trap juveniles and may prevent upstream or downstream movement.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

Increased Disease/Predation/Competition

Disease is a medium to low stress across life history stages in the South Fork Trinity River. By the time adult coho salmon enter the Lower Klamath River, columnaris (gill rot) is probably not a significant issue. Coho salmon smolts may be exposed to diseases like ceratomyxosis once they reach the Klamath River; however, the rates of infection are likely to be somewhat low given that the zones with the highest rates of infection are upstream of the Trinity-Klamath confluence (Bartholomew 2008). Competition and predation by non-native German Brown trout, which have been found in the South Fork Trinity River (Jong and Mills 1992), may cause stress to fry, juvenile, and smolt coho salmon. However brown trout numbers are not significant enough to cause high mortality rates.

40.6 Threats

Table 40-5. Severity of threats affecting each life stage of coho salmon in the South Fork Trinity River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Hatcheries	Very High	Very High	Very High	Very High	Very High	Very High
2	Roads	High	Very High	Very High	Medium	High	Very High
3	Dams/Diversion	Medium	High	Very High	Medium	High	High
4	Climate Change	Low	Medium	High	Medium	High	High
5	Agricultural Practices	Low	High	Very High	Medium	Low	Medium
6	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
7	Fishing and Collecting	-	-	-	-	Medium	Medium
8	Channelization/Diking	Low	Medium	Low	Low	Low	Low
9	Timber Harvest	Low	Medium	Low	Low	Low	Low
10	Urban/Residential/Industrial	Low	Medium	Low	Low	Low	Low
11	Road-Stream Crossing Barriers	-	Low	Medium	Low	Low	Low
12	Invasive Non-Native/Alien Species	Low	Low	Low	Low	Low	Low
13	Mining/Gravel Extraction	Low	Low	Low	Low	Low	Low

Hatcheries

Hatcheries pose a very high threat to all life stages in the South Fork Trinity River sub-basin. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

Roads

Roads are a high to very high threat across most life history stages. Data indicate road density is very high (>3 miles/square mile) throughout much of the watershed. There are 1,946 miles of roads within the South Fork Trinity River watershed not including skid trails (Tetra Tech 2000). Road density ranges from a high of 5.1 mi/mi2 in Rattlesnake Creek to a low of 1.7 mi/mi2 in Happy Camp and the Upper South Fork Trinity sub-basins (Tetra Tech 2000). The East Fork of Hayfork Creek also has a dense road network on private land in the upper subwatersheds (USFS 1996c). Impacts associated with roads and tractor skid trails include increased peak flows and increased rates of fine sediment production and incidence of mass failures (Tetra Tech 2000). Sedimentation associated with roads continues to alter natural river processes and salmonid habitat by filling in pools and reducing the quality of spawning gravels. High rates of aggradation resulting in decreased channel complexity and decreased pool depth can be found throughout the South Fork Trinity (Dresser et al. 2001).

Dams/Diversions

Dams and diversions present a high threat to the population and affect multiple life stages. Although no major dams exist in this part of the South Fork Trinity River, numerous wells and diversions for domestic and agricultural uses occur throughout the watershed and reduce streamflows during critical low-flow periods. Ewing Reservoir is a small reservoir northeast of Hayfork, but Ewing Gulch, where the dam is located, does not provide habitat for salmon. Numerous vineyards, small farms, and marijuana plantations use water from the South Fork Trinity River and its tributaries including, but not limited to, Rattlesnake and Post creeks. It has been estimated that only 13 percent of water currently diverted from Hayfork Creek and its tributaries have recognized permits (Trinity County 1987, PWA 1994). The effects of diversion are particularly acute in the Hyampom and Hayfork Valleys as well as the Forest Glenn area where summer low flows lead to elevated water temperatures and a constriction of summer rearing habitat. Unscreened diversions can also act as fish passage barriers for juvenile coho salmon and it is likely that many if not all of the illegal diversions in the watershed are unscreened. Although there is a need for more recent assessments, the need for fish screens on diversions in Barker, Big, E. Fork Hayfork, Upper Hayfork, Little, Olsen, Salt, and Tule creeks was identified by PWA (1994). Because of the impacts on summer rearing, diversions pose a very high threat to the juvenile life stage.

Climate Change

Climate change poses a high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 3 °C in the summer and by 1.2 °C in the winter. Bartholow (2005) showed that temperature has already been increasing at a rate of 0.5 °C per decade (1966 to 1979). Annual precipitation amount is predicted to change little over the next century. However, the proportion of precipitation falling as snow is expected to decrease. Snowpack in upper elevations of the basin will decrease with changes in temperature (California Natural Resources Agency 2009). Many of the peaks which now hold snow during the winter months are at elevations that are low enough to be on the cusp of the transition point of snow and rain (<1,800m; Knowles and Cayan 2004; Mote 2006; Regonda et al. 2005). This means that additional warming in the area will immediately impact accumulation of snow, regardless of trends in precipitation. Additionally, the southerly latitude of the basin (Mote 2006) within the SONCC coho salmon ESU puts this basin at a relatively high risk for snowpack loss, which will exacerbate low summer discharge. For the South Fork Trinity River, the trend towards less snowpack, earlier onset of spring snowmelt, and reductions in summertime surface flow are expected to continue into the future (Zhu et al. 2005, Vicuna et al. 2007). Juvenile and smolt rearing and migratory habitat in the South Fork Trinity River and mainstem Klamath River is most at risk to climate change.

Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. McCarthy et al. (2009) ran three climate change scenarios in two representative streams in the South Fork Trinity River basin. Simulated temperature increases ranged from 1.4°C to 5.5°C during the summer and from 1.5°C to 2.9°C during the winter. These temperature increases amplified the weight loss in fish (McCarthy et al. 2009). They concluded that feeding rate and temperature during the summer currently limit the growth and productivity of salmonids (steelhead and rainbow trout) in low-order streams in the South Fork Trinity River basin and predicted that climate change will have detrimental effects on fish growth as well as on macroinvertebrate communities and stream ecosystems in general (McCarthy et al. 2009). Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Also, with all populations in the ESU adult coho salmon will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Agricultural Practices

The effects of water utilization, agricultural runoff, non-point source pollution and sedimentation associated with small farms and wineries is a significant threat to most life stages. Agricultural practices often result in development within floodplain habitat, removal of riparian vegetation, simplification of stream habitat, and degradation of water quality. Substantial portion of low gradient valley reaches in the South Fork Trinity River watershed are used for farming (including marijuana) and ranching. These sub-basins include Hayfork Creek, Rattlesnake Creek, and streams near Hyampom Valley. A survey of parcels owners in the early 1990s who were using water indicated that they can be expected to increase their use of water in the future (PWA 1994). Many survey respondents envisioned expanded water systems, new fences to increase pasture lands, and expanded crops and gardens in the future (PWA 1994). The U.S. Soil Conservation Service reported that groundwater is limited in the Hayfork Valley, so drilling of wells will be of limited utility in meeting future water needs. Illegal marijuana cultivation on public and private land also adds to this threat due to the associated illegal diversion of water and the potential dewatering of tributaries during critical low-flow periods. The juvenile and fry life stages are most affected by agriculture due to the impacts on summer rearing habitat and water quality.

High Intensity Fire

High intensity, widespread fire has swept through regions of the South Fork Trinity River in the recent past, such as the complex of fires in 2008. Fires present a medium to high threat across life stages and particularly affect the fry life stage. Although low-intensity fire is a natural and healthy process in the watershed, fires are now greater in intensity and severity than they were historically (USFS 2008). High intensity, or stand-replacing, fire in the subbasin occurs due to excess fuel loads resulting from decades of fire suppression and timber harvest. Impacts to salmon include altered sedimentation processes as well as degraded riparian vegetation characteristics.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. In addition, tribal salmonid fisheries have the potential to cause injury and death to coho salmon in the Klamath/Trinity basin. The effects of the fisheries managed by the State of California and the Yurok and Hoopa Tribes, on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. As of April 2011, NMS has not authorized future collection of coho salmon for research purposes in the South Fork Trinity River.

Channelization/Diking

Channelization and diking is a low threat to coho salmon in the South Fork Trinity given the large amount of public land in the watershed. Although channelization and diking are not widespread throughout the watershed, localized restrictions of the channel in areas where roads parallel streams reduce floodplain connectivity and function. Other localized instances of channelization near tributary confluences likely occur but the extent of this problem has not been documented. Because the Hayfork Valley does have a substantial amount of private land, this area has the greatest threat from future channelization and diking.

Timber Harvest

Timber harvest is a low to moderate overall threat in the South Fork Trinity River drainage, but certain local factors amplify the level of threat to moderate-high levels. Much of the watershed is in public ownership (U.S. Forest Service). Timber harvest on public land is highly regulated and current and future timber harvesting on Forest Service land is projected to be relatively small in scale and is conducted under strict guidelines designed to protect aquatic resources. However, several extensive vegetation management projects on Forest Service lands in the watershed are planned in the next decade (Rattlesnake, Smoky, East Fork) which will have some effects on hydrologic response despite strict application of BMPs.

Timber resources on private land are limited for the most part, but are concentrated in some highly unstable watersheds south and west of Hyampom. Intensive industrial crop forestry in these areas continues to contribute to cumulative watershed effects that have resulted from legacy timber harvest practices. While impacts from private forestry are largely localized to the upper reaches of these western tributaries, sediment routed from these streams, particularly Pelletreau Creek, enters the South Fork at a critical "pinch point" where the river traverses the Hyampom Valley and aggradation is extreme. Valley confinement downstream of Hyampom has resulted in gravel accumulation that has not recovered from historic sediment pulses associated with the 1955 and 1964 floods. In this regard, the latent effects of past logging practices and ongoing modification of hydrologic response on private industrial timberlands continue to impair the watershed.

Urban/Residential/Industrial Development

Rural population growth will continue to present a moderate to low threat to coho salmon in the South Fork Trinity River. In most areas human population is tempered by the large amount of publicly owned land as well as the steep surrounding terrain. However, some areas such as

Hayfork and Hyampom contain relatively large tracts of level ground. The South Fork Trinity River basin contains 167 mi2 of private land (18 percent of total watershed area). Population trends indicate that in 2050, the population of Trinity County could be upward of 26,479, roughly double current the current population. If this trend holds true for the South Fork Trinity River, demand for water and other resources could increase substantially as the area experiences an increase in the number of housing projects, vacation homes, ranches, vineyards, and small farms. Such growth will likely result in removal of vegetation, increased sediment generation, and the introduction and spread of exotic species. Subdivision of existing parcels will exacerbate this threat. Diversions and groundwater extraction associated with population growth are addressed above under Dams/Diversions.

Road-Stream Crossing Barriers

There are several road-stream crossing barriers in the South Fork Trinity River basin. The California Fish Passage Assessment Database (CalFish 2009) lists 147 road-stream crossing barriers in the South Fork Trinity River basin. Of these, 28 are partial barriers to fish migration, 64 are total barriers, and 42 are unknown. Because of their locations, some above the range of coho salmon, these barriers are considered only a low threat to the population. County surveys by (Trinity County 2000) indicate there are a few total barriers for anadromous fish on county roads (Table 40-6). The crossing on Barker Creek is a barrier to 1.5 miles of fair-to-good habitat. The crossings in Kingsbury Gulch also pose a threat to coho salmon due to the number of crossings (total of four crossings). The habitat upstream of these crossing, however, is of fair quality and of unknown value to coho salmon. On public land, this threat is likely to continue to decrease over time as roads are upgraded and culverts removed or upgraded.

Table 40-6. List of selected moderate to high priority road-stream crossing barriers.

Priority*	Stream Name	Road Name	County	Barrier Status*
High	Kingsbury Gulch #1, Hayfork Creek	Riverview Road	Trinity	Total
High	Kingsbury Gulch #2, Hayfork Creek	Morgan Hill Road	Trinity	Total
High	Little Barker Creek, Barker Creek	Barker Creek Rd	Trinity	Total
*From Trinity County 2000				

Invasive Non-Native/Alien Species

Competition and predation from German brown trout, a non-native species, poses at least a low threat to young coho salmon. Brown trout are a piscivorous species that are known to prey on juvenile coho salmon. Additionally, brown trout may compete with coho salmon at all life stages for food and rearing habitat. Green sunfish and other exotic species have also established breeding populations in drought years, however, the impacts from these populations on coho salmon are unknown (PWA 1994).

Mining/Gravel Extraction

There are few are few current threats to coho salmon from suction dredging in the South Fork Trinity River basin. Currently, mining is regulated by CDFG to ensure safe environmental practices and minimal impacts on salmon and salmon habitat. Regulations include special closed areas, closed seasons, and restrictions on methods and operations (Cal. Code Regs., tit. 14, Sections 228 and 228.5; CDFG 2008c). Mining activities in the region have decreased significantly from historic levels, and suction dredging permits by the state of California were ceased in 2009. Permit issuance will likely resume in 2011 and regulations are expected to be adequate to protect habitat; however, careful monitoring of mining activity must occur to ensure that these regulations are followed and that this threat remains low to moderate. There are no known gravel mining operations in the South Fork Trinity River.

40.7 Recovery Strategy

The threats that pose the biggest risk to coho salmon are water diversions, agricultural practices (including marijuana cultivation) and roads. The stresses that are most acute in this population are altered hydrologic function, poor water quality, and altered sediment supply. Decommissioning of roads that are not utilized, or upgrading of roads, and stabilizing areas prone to mass wasting should be a priority for recovery efforts. This will help reduce sediment yield to the river, which will help make flushing of the current sediment load more likely. Decreasing the amount of water diverted during the summer months by promoting off-channel storage during high winter flows is imperative to recovery of this population. Bolstering water conservation initiatives should also be integral to recovery efforts and should help reduce the threats of water utilization to this population. Educating land owners and individuals about the effects of nutrient rich runoff from fertilizers and other agricultural activities is a necessary step in improving water quality. Minimizing the interactions that naturally-produced coho salmon experience after migrating into the Trinity and Klamath rivers where they encounter millions of hatchery fish could help promote recovery of coho salmon. Reducing adult hatchery coho salmon straying into the South Fork Trinity River will help reduce genetic interactions between hatchery and naturally produced fish.

Coho salmon are currently found in the South Fork Trinity River up to Butter Creek, Butter Creek, Hayfork Creek up to Corral Creek, Eltapom Creek, Olsen Creek, and Madden Creek (Everest 2008; Boberg 2008). These areas should be a priority for recovery. Also, high and moderate IP habitat exists in Pelletreau Creek in the Hyampom HSA and Rattlesnake and Post creeks in the Forest Glenn HSA. These streams should also be considered a high priority for recovery.

Several actions will be required to ensure the South Fork Trinity River population meets recovery the recovery target. In order to make water available for use during low summer flow periods, it will be important to increase water storage and increase and improve water delivery from Ewing Reservoir. Also to reduce water diversions during the summer and fall months, it will be necessary to provide water storage tanks, education programs, and incentives to land owners with a priority on Hayfork, E. F. Hayfork, Summit, Big, Baker, Salt, Carr, Duncan Tule, Olsen, Butter, Corral, Pelletreau, Rattlesnake and Post creeks. Because much of the South Fork Trinity River watershed is comprised of unstable soils, it will be important to decommission unneeded roads and upgrade other roads with a priority on Corral, Butter, and Hyampom subbasins and the Grouse Creek HSA excluding Surprise, Mingo, Hells Half Acre, and Middle Eltapom Creeks and the Forest Glenn HSA. Because the proportion of precipitation falling as snow is expected to decrease, it will be necessary to protect cold water tributary streams to ensure that the maximum amount of water is available as thermal refugia for hot summer periods.

Table 40-7 on the following page lists the recovery actions for the South Fork Trinity River population

Table 40-7. Recovery action implementation schedule for the South Fork Trinity River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFTR.3.1.1	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Hayfork, E. F. Hayfork, Summit, Big, Baker, Salt, Carr, Duncan Tule, Olsen, Butter, Corral, Pelletreau, Rattlesnake and Post Creeks	2
SONCC-SFTR.3.1.1.1	*Determine instream flow needs for coho salmon*					
SONCC-SFTR.3.1.1.2	*Measure stream flow hourly by establishing a USGS gauging station. This station to be operated in addition to USGS station 11528700.*					
SONCC-SFTR.3.1.1.3	*Maintain USGS gauging station*					
SONCC-SFTR.3.1.1.4	*Perform a groundwater study to determine the volume of aquifer storage and the role of aquifers in stream flow*					
SONCC-SFTR.3.1.2	Hydrology	Yes	Improve flow timing or volume	Manage flow	Hayfork, E. F. Hayfork, Summit, Big, Baker, Salt, Carr, Duncan Tule, Olsen, Butter, Corral, Pelletreau, Rattlesnake and Post creeks	2
SONCC-SFTR.3.1.2.1	*Provide consistent (daily) water master service to monitor ground and surface water withdrawals*					
SONCC-SFTR.3.1.3	Hydrology	Yes	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-SFTR.3.1.3.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-SFTR.3.1.4	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-SFTR.3.1.4.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-SFTR.3.1.5	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-SFTR.3.1.5.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-SFTR.3.1.6	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-SFTR.3.1.6.1	*Establish a comprehensive statewide groundwater permit process*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFTR.3.1.7	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Hayfork, E. F. Hayfork, Summit, Big, Baker, Salt, Carr, Duncan Tule, Olsen, Butter, Corral, Pelletreau, Rattlesnake and Post creeks	2
SONCC-SFTR.3.1.7.1	*Assess the utility of water storage tanks for private agricultural and domestic water uses during periods of low flow.*					
SONCC-SFTR.3.1.7.2	*Establish a forbearance program, using water storage tanks to decrease diversion during periods of low flow*					
SONCC-SFTR.3.1.7.3	*Monitor forbearance compliance and flow*					
SONCC-SFTR.3.1.8	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Hayfork, E. F. Hayfork, Summit, Big, Baker, Salt, Carr, Duncan Tule, Olsen, Butter, Corral, Pelletreau, Rattlesnake and Post creeks	2
SONCC-SFTR.3.1.8.1	*Reduce diversions*					
SONCC-SFTR.3.1.9	Hydrology	Yes	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	2
SONCC-SFTR.3.1.9.1	*Re-adjudicate surface water rights and adjudicate groundwater rights based on instream flow needs and groundwater studies*					
SONCC-SFTR.3.1.10	Hydrology	Yes	Improve flow timing or volume	Improve irrigation practices	Agricultural private lands in South Fork Trinity Sub-Basin (likely Hyampom, Hayfork, and Lower South Fork)	2
SONCC-SFTR.3.1.10.1	*Assess agricultural lands and develop a plan for improving water delivery systems*					
SONCC-SFTR.3.1.10.2	*Improve water delivery systems, guided by the assessment*					
SONCC-SFTR.3.1.40	Hydrology	Yes	Improve flow timing or volume	Improve water management techniques	Population wide	3
SONCC-SFTR.3.1.40.1	*Develop plan to manage stream flows and water temperature during periods of drought*					
SONCC-SFTR.3.1.41	Hydrology	Yes	Improve flow timing or volume	Improve water management techniques	Population wide	3
SONCC-SFTR.3.1.41.1	*Develop plan to protect coho salmon from effects of climate change*					
SONCC-SFTR.3.1.41.2	*Implement plan based on findings*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFTR.3.1.42	Hydrology	Yes	Improve flow timing or volume	Increase instream flows	Hayfork Valley	3
SONCC-SFTR.3.1.42.1	*Increase storage capacity or delivery capability for Ewing Reservoir*					
SONCC-SFTR.8.1.16	Sediment	Yes	Reduce delivery of sediment to streams	Improve timber harvest management practices	Private lands, especially Hayfork and Hyampom	3
SONCC-SFTR.8.1.16.1	*Apply best management practices for timber harvest*					
SONCC-SFTR.8.1.17	Sediment	Yes	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3
SONCC-SFTR.8.1.17.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-SFTR.8.1.17.2	*Implement plan to stabilize slopes and revegetate areas*					
SONCC-SFTR.8.1.18	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide, (prioritize Corral, Butter, and Hyampom subbasins and the Grouse Creek HSA excluding Suprise, Mingo, Hells Half Acre, and Middle Eltapom Creeks)	3
SONCC-SFTR.8.1.18.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-SFTR.8.1.18.2	*Decommission roads, guided by assessment*					
SONCC-SFTR.8.1.18.3	*Upgrade roads, guided by assessment*					
SONCC-SFTR.8.1.18.4	*Maintain roads, guided by assessment*					
SONCC-SFTR.8.1.19	Sediment	Yes	Reduce delivery of sediment to streams	Improve grazing practices	Hyampom and Hayfork	3
SONCC-SFTR.8.1.19.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-SFTR.8.1.19.2	*Develop grazing management plan to meet objective*					
SONCC-SFTR.8.1.19.3	*Plant vegetation to stabilize stream bank*					
SONCC-SFTR.8.1.19.4	*Fence livestock out of riparian zones*					
SONCC-SFTR.8.1.19.5	*Remove instream livestock watering sources*					
SONCC-SFTR.10.1.11	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Increase conifer riparian vegetation	South Fork Trinity Sub-Basin	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFTR.10.1.11.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-SFTR.10.1.11.2	*Thin, or release conifers, guided by prescription*					
SONCC-SFTR.10.1.11.3	*Plant conifers, guided by prescription*					
SONCC-SFTR.10.1.12	Water Quality	Yes	Reduce water temperature, increase disssolved oxygen	Increase flow	Downstream of Hyampom (Butter Creek, Hayfork Creek, Eltapom Creek, Olsen Creek, and Madden Creek)	2
SONCC-SFTR.10.1.12.1	*Develop a plan to address water quality and quantity*					
SONCC-SFTR.10.1.12.2	*Implement plan to address water quality and quantity*					
SONCC-SFTR.10.3.13	Water Quality	Yes	Protect cold water	Improve regulatory mechanisms	Madden, Grouse, Butter, Olsen, Eltapom, Rattlesnake Creeks	3
SONCC-SFTR.10.3.13.1	*Identify and prioritize cold water refugia areas currently or potentially supporting coho salmon and develop a plan to improve regulatory oversight*					
SONCC-SFTR.10.3.13.2	*Increase regulatory oversight, guided by the plan*					
SONCC-SFTR.10.3.14	Water Quality	Yes	Protect cold water	Protect existing or potential cold water refugia	Madden, Grouse, Butter, Olsen, Eltapom, Rattlesnake Creeks	3
SONCC-SFTR.10.3.14.1	*Develop emergency plan that will protect thermal refugia during warm periods*					
SONCC-SFTR.1.2.44	Estuary	No	Improve estuarine habitat	Improve estuary condition	Klamath River Estuary	3
SONCC-SFTR.1.2.44.1	*Implement recovery actions to address strategy "Estuary" for Lower Klamath River population*					
SONCC-SFTR.16.1.27	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SFTR.16.1.27.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-SFTR.16.1.27.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-SFTR.16.1.28	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-SFTR.16.1.28.1	*Determine actual fishing impacts*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFTR.16.1.28.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-SFTR.16.2.29	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SFTR.16.2.29.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-SFTR.16.2.29.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-SFTR.16.2.30	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SFTR.16.2.30.1	*Determine actual impacts of scientific collection*					
SONCC-SFTR.16.2.30.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-SFTR.2.2.20	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Mainstem to Butter Cr., Butter Cr., Hayfork Cr. up to Corral Creek, Eltapom Cr., Olsen Cr., and Madden Cr	3
SONCC-SFTR.2.2.20.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-SFTR.2.2.20.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-SFTR.2.2.21	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Increase beaver abundance	Mainstem to Butter Cr., Butter Cr., Hayfork Cr. up to Corral Creek, Eltapom Cr., Olsen Cr., and Madden Cr	BR
SONCC-SFTR.2.2.21.1	*Develop program to educate and provide incentives for landowners to keep beavers on their lands*					
SONCC-SFTR.2.2.21.2	*Implement beaver program (may include reintroduction)*					
SONCC-SFTR.2.2.22	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Improve regulatory mechanisms	Population wide	BR
SONCC-SFTR.2.2.22.1	*Limit hunting or removal of beaver*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFTR.2.1.23	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Mainstem to Butter Cr., Butter Cr., Hayfork Cr. up to Corral Creek, Eltapom Cr., Olsen Cr., and Madden Cr	3
SONCC-SFTR.2.1.23.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-SFTR.2.1.23.2	*Place instream structures, guided by assessment results*					
SONCC-SFTR.2.2.24	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Restore natural channel form and function	Mainstem to Butter Cr., Butter Cr., Hayfork Cr. up to Corral Creek, Eltapom Cr., Olsen Cr., and Madden Cr	3
SONCC-SFTR.2.2.24.1	*Assess habitat to where potential exists to restore channelized or disconnected reaches. Develop a plan to restore prioritized reaches*					
SONCC-SFTR.2.2.24.2	*Restore natural channel form and function to prioritized reaches, guided by the plan*					
SONCC-SFTR.27.1.31	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-SFTR.27.1.31.1	*Perform annual spawning surveys*					
SONCC-SFTR.27.1.32	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-SFTR.27.1.32.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-SFTR.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-SFTR.27.1.33.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-SFTR.27.2.34	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-SFTR.27.2.34.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-SFTR.27.2.34.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFTR.27.2.35	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-SFTR.27.2.35.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-SFTR.27.2.36	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-SFTR.27.2.36.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-SFTR.27.2.37	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-SFTR.27.2.37.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-SFTR.27.2.38	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-SFTR.27.2.38.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-SFTR.27.2.39	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-SFTR.27.2.39.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-SFTR.27.1.43	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-SFTR.27.1.43.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-SFTR.27.1.45	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-SFTR.27.1.45.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-SFTR.27.1.45.2	*If appropriate, modify population types and targets using revised methodology*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFTR.7.1.25	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Educate landowners and develop community programs	Hyampom, Madden Creek, Grouse Creek, Lower S.F. Trinity, Corral Creek, Lower Hayfork, Hidden Valley SubBasins, E.F. S.F. Trinity, Upper South Forkand Happy Camp Creek	BR
SONCC-SFTR.7.1.25.1	*Develop fire hazard reduction educational materials for landowners*					
SONCC-SFTR.7.1.25.2	*Develop a plan for fire break stewardship and defensible space*					
SONCC-SFTR.7.1.25.3	*Implement fire-safe community action plans in identified areas*					
SONCC-SFTR.7.1.26	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce fire hazard	Hyampom, Madden Creek, Grouse Creek, Lower S.F. Trinity, Corral Creek, Lower Hayfork, Hidden Valley SubBasins, E.F. S.F. Trinity, Upper South Forkand Happy Camp Creek	BR
SONCC-SFTR.7.1.26.1	*Identify forested stands for fire hazard reduction*					
SONCC-SFTR.7.1.26.2	*Apply appropriate management techniques (e.g., thinning, burning) to reduce risk of high intensity fire*					

41. South Fork Eel River Population

- Interior Eel River Diversity Stratum
- Core, Functionally Independent Population
- Moderate Extinction Risk
- 9,600 Spawners Required for ESU Viability
- 689 mi^2
- 482 IP km (299 IP mi) (29% High)
- Dominant Land Uses are Timber Production and Agriculture
- Principal Stresses are 'Lack of Floodplain and Channel Structure' and 'Altered Sediment Supply'
- Principal Threats are 'Roads' and 'Timber Harvest'

41.1 History of Habitat and Land Use

Starting in the late 1850s, the South Fork Eel River became populated by homesteaders and ranchers. Because of the remoteness of the area, the South Fork Eel River watershed did not experience rapid growth until the 1900s. The tanbark industry between 1900 and 1920 provided an economic stimulus to the region. However, harvesting tanbark killed many tanoak trees, and resulted in significant environmental impacts in the harvested areas. When synthetic tannin was developed, the industry collapsed around 1920.

After World War II, timber harvesting significantly increased in the watershed. Logging has had a large impact on the physical nature of the South Fork Eel River, as has development and clearing of land for ranches and urbanization. Many riparian areas have been cleared for roads or timber production. Erosion from poorly constructed roads in the highly erosive Franciscan geology has contributed to increased sediment loads in the region's rivers, leaving streams shallower, warmer, and more prone to flooding (Raphael 1974; Bodin et al. 1982). Sediment mobilized from the 1955 and 1964 floods choked the channels with sediment. As a result, many streams have become wider and shallower (U.S. Environmental Protection Agency (EPA) 1999).

With the establishment of rural residences and smaller ranches, the need for water supplies has increased. Currently most of this demand is accommodated through in-stream diversions or shallow wells which have influenced stream flows during summer low-flow periods.

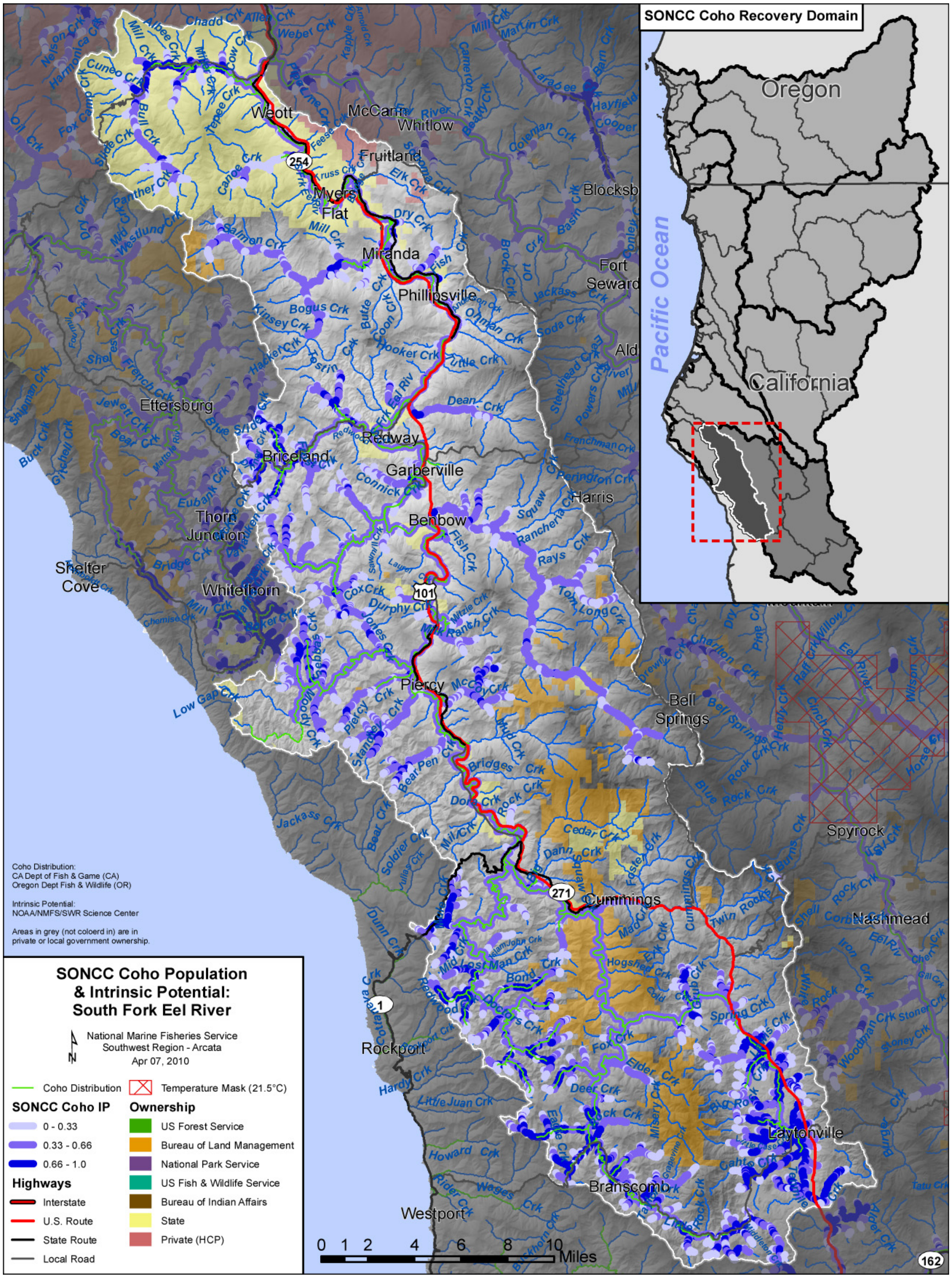

Figure 41-1. The geographic boundaries of the South Fork Eel River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

41.2 Historic Fish Distribution and Abundance

The South Fork Eel River watershed has been the largest producer of coho salmon in the Eel River basin, and perhaps one of the largest producers in all of California. An estimated 15,000 to 17,000 coho salmon spawners annually passed Benbow Dam in the 1930s (U.S. Bureau of Land Management (BLM) et al. 1996). By 1975, the last year fish were counted at the Benbow fish station; only 509 adult coho salmon were counted (Figure 41-2). Since then, coho salmon abundance has remained low, with an estimate of 1,320 in 1991 for the entire South Fork Eel River (Brown and Moyle 1991). Since 1975, coho salmon abundance has only been surveyed sparingly in the South Fork Eel River watershed. Presence-absence surveys have been conducted more frequently, and show that coho salmon are fairly well distributed in the western tributaries of the watershed. A majority of the eastern tributaries are not found to be used by coho salmon.

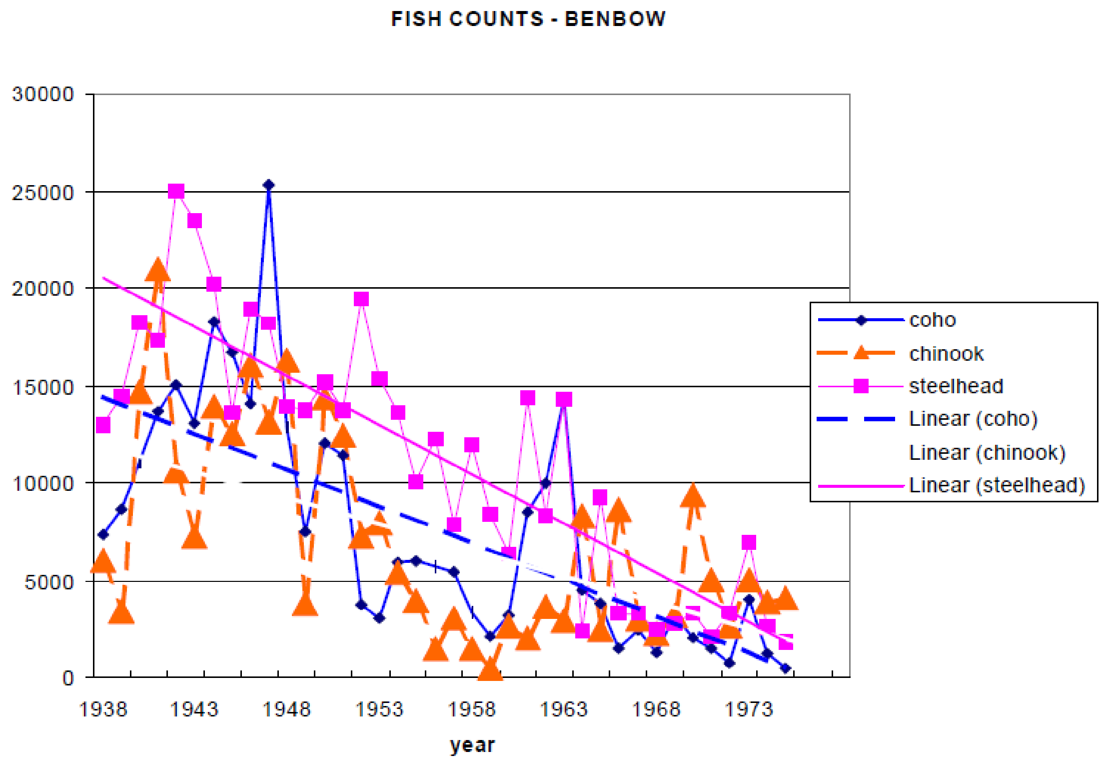

Figure 41-2. Fish counts at Benbow Fish Station from 1938 to 1975. Graph from EPA 1999.

Table 41-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Watershed	Stream Name	Watershed	Stream Name
Benbow	Anderson Creek[1]	**Benbow**	Seely Creek[1]
	Bear Creek[1]		Sommerville Creek
	Bear Pen Creek[1]		Sproul Creek[1] (all forks and tribs included)
	Bear Wallow Creek[1]		Waldron Creek[1]
	Bond Creek[1]	**Laytonville**	Big Rock Creek
	Buck Mountain Creek		Cahto Creek
	Butler Creek[1]		Deer Creek
	China Creek[1]		Dutch Charlie Creek[1]
	Connick Creek		Eagle Creek
	Couborn Creek		Grub Creek[1]
	Cox Creek		Jack of Hearts Creek
	Dean Creek		Kenny Creek[1]
	Durphy Creek		Lewis Creek
	E. Br. South Fork Eel River		Little Charlie Creek
	Fish Creek		Middleton Creek
	Hartsook Creek		Mill Creek
	Hollow Tree Creek[1]		Mud Creek
	Huckleberry [1]		Muddy Gulch Creek
	Indian Creek[1]		Mud Springs Creek
	Jones Creek		Redwood Creek[1]
	Low Gap Creek[1]		Rock Creek[1]
	McCoy Creek[1]		Section Four Creek
	Michaels Creek		Streeter Creek
	Middle Creek		Taylor Creek
	Miller Creek[1]		Tenmile Creek[1]
	Moody Creek[1]		Wilson Creek
	Mule Creek[1]	**Weott**	Bull Creek[1]
	Parker Creek		Canoe Creek[1]
	Piercy Creek[1]		Salmon Creek[1]
	Redwood Creek[1]		
	Sebbas Creek[1]		
[1] Denotes a "Key Stream" as identified in the State of California's Coho Recovery Strategy			

41.3 Status of South Fork Eel River Coho Salmon

Spatial Structure and Diversity

.Williams et al. (2008) determined that at least 20 coho salmon per-IP km of habitat are needed (9,600 spawners total) to approximate the historical distribution of South Fork Eel River coho salmon and habitat. The current distribution of spawners is mostly in western tributaries of the South Fork Eel River. The South Fork Eel population represents a unique life history adaptation which utilizes a 'long run' strategy. Both adults and smolts must migrate great distances from the ocean to their natal spawning grounds, or vice versa.

Population Size and Productivity

Williams et al. (2008) determined at least 481 coho salmon must spawn in the South Fork Eel River each year to avoid depensation.

The South Fork Eel River coho salmon population size is unknown, but is likely extremely reduced compared to historic levels. Surveys in the South Fork Eel River are limited, but indicate that coho salmon spawner abundance may be able to reach at least the 481 depensation threshold. In 2009, 357 adult coho salmon were counted at Hollow Tree Creek (Downie 2010). Because numerous other tributaries in the South Fork Eel River provide suitable spawning and rearing habitat for coho salmon, the potential is high for the entire South Fork Eel River population to produce at least 481 spawners. Some cohorts have been lost or severely depressed in some South Fork Eel River streams and the population growth rate is unknown, but expected to be negative in most years. Therefore, the South Fork Eel River coho salmon population is at moderate risk of extinction given the moderate population size and probable negative population growth rate.

Nine years (1999 to 2007) of juvenile capture data from the west and south forks of Sproul Creek (Trees Foundation 2007) indicate that both forks have the potential to produce thousands of juvenile coho salmon, and the highest combined population estimate of 5,218 occurred in the last year of the study. In addition, a three-year (2000 to 2002) out-migrant population monitoring study in Hollow Tree Creek (Mendocino Redwood Company 2002) reported an estimated smolt population size of 35,178, 35,976, and 9,785, respectively.

Extinction Risk

The South Fork Eel River coho salmon population is not viable and at moderate risk of extinction. The estimated number of spawners exceeds the depensation threshold, but does not meet the low-risk threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The South Fork Eel population is a "Functionally Independent" population in the Interior Eel River diversity stratum, meaning that it is sufficiently large to be historically viable-in-isolation and its demographics and extinction risk are minimally influenced by immigrants from adjacent populations (Williams et al. 2006). As a core population, the recovery target for the South Fork Eel population is for the population to be viable, meaning that it must have a low risk of extinction according to population viability criteria (see Chapter 4). The South Fork Eel population is the largest and most stable in the stratum, and will therefore play a major role in the re-colonization of other populations in the stratum by providing strays.

41.4 Plans and Assessments

State of California

Total Maximum Daily Loads
http://www.swrcb.ca.gov/northcoast/

In December 1999, the EPA published the final Total Maximum Daily Loads (TMDL) for temperature and sediment for the South Fork Eel River. The North Coast Regional Water Quality Control Board (NCRWQCB) is required to develop measures that will result in the implementation of the TMDLs in accordance with the requirements of 40CFR 130.6. Water quality standards are identified in the Action Plan for the North Coast Region, which the NCRWQCB uses to regulate various sources of pollution.

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004.

Eel River Salmon and Steelhead Restoration Action Plan

In 1997, the California Department of Fish and Game completed their assessment of the Eel River watershed and provided recommendations for restoration of salmonid stocks. Primary recommendations include removing barriers, reducing sediment inputs, improving riparian forest conditions, reducing water withdrawals, enhancing habitat, and controlling Sacramento pikeminnow.

Mendocino Redwood Company

Habitat Conservation Plan/Natural Communities Conservation Plan
http://www.mrc.com/Key-Policies-HCP.aspx

The Mendocino Redwood Company Habitat Conservation Plan (HCP) and Natural Communities Conservation Plan (NCCP) have been in the developmental stages since 1999 and are approaching completion. The goals of the HCP/NCCP are to maintain viable populations of covered salmonids and improve and enhance aquatic habitat conditions throughout MRC's forestlands.

Watershed Analysis for Hollow Tree Creek

MRC completed a Watershed Analysis in 2004 for their ownership in the South Fork Eel River which occurs primarily in Hollow Tree Creek, a tributary to the South Fork Eel River. It presents results of fish habitat assessments, fish distribution surveys, out-migrant population estimates, stream channel conditions, road inventory, and mass wasting inventories. Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service

Watershed Analysis for the South Fork Eel River

In 1996, the Bureau of Land Management, Six Rivers National Forest, and the U.S. Fish and Wildlife Service finalized a watershed analysis for the South Fork Eel River. This watershed analysis focused on areas where information was available, such as lands managed by BLM and State Parks, and actions that federal agencies could implement to improve habitat.

Pacific Coast Federation of Fishermen's Associations

Eel River Salmon Restoration Project

As an affiliate organization of the Pacific Coast Federation of Fishermen's Associations, the Eel River Salmon Restoration Project was established in 1983 to enhance salmonid runs in the South Fork Eel River to benefit the sport and commercial fishery. The Eel River Salmon Restoration Project has operated a cooperative rearing facility on Redwood Creek, installed habitat improvement structures, improved fish passage, controlled erosion, monitored salmonids populations with surveys and downstream migrant traps, and educated students about salmonids.

41.5 Stresses

Table 41-2. Severity of stresses affecting each life stage of coho salmon in the South Fork Eel River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Lack of Floodplain and Channel Structure[1]	High	Very High	Very High[1]	Very High	Very High	Very High
2	Altered Sediment Supply[1]	Very High	Very High	Very High[1]	High	Very High	Very HIgh
3	Degraded Riparian Forest Conditions	-	High	High	High	Medium	High
4	Impaired Water Quality	Medium	High	High	High	Medium	High
4	Altered Hydrologic Function	Medium	High	High	High	Medium	High
6	Barriers	-	High	High	Medium	High	High
7	Increased Disease/Predation/Competition	Low	High	High	High	Low	High
8	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	Medium
9	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
10	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The South Fork Eel River is a diverse watershed, where limiting stressors cannot be broadly applied to the entire watershed. Although the South Fork Eel River has been listed as water quality impaired because of elevated water temperature, the upper part of the watershed generally has water temperatures suitable for coho salmon. Elevated water temperature is a concern in the lower half of the South Fork Eel River, from approximately Benbow to the mouth (Downie 2010). Other limiting factors include water quantity where agricultural and domestic use reduces the availability and quality of habitat. This is especially the case in more urbanized areas, such as in the Salmon Creek watershed. Predation by Sacramento pikeminnow is a significant concern in the South Fork Eel River population area, as well as throughout the Eel River watershed. All of these limiting stressors affect fry, juveniles, and smolts the most, so reducing these stressors would increase successful emigration of juveniles and smolts to the ocean.

Because the juvenile life stages are the most limiting in this watershed, protecting quality rearing habitat is essential for the viability of this population. Tributaries that have cold water, instream cover, and deep pools are vital for juvenile survival. Tributaries, such as Indian, Hollow Tree, Jack of Hearts, Redwood, and Sproul Creeks still provide excellent rearing habitat for coho salmon.

Floodplain and Channel Structure

This stress was rated as very high for nearly all life stages. Lack of floodplain and channel structure in the South Fork Eel River is primarily due to excessive sediment loads occurring in the watershed, coupled with paucity of large woody and riparian vegetation. Roads constrict the channel where they occur parallel to the stream.

Sediment Supply

Sediment was rated as a high to very high stress to coho salmon in this population. The EPA recognized this by listing the South Fork Eel River as impaired by sediment. The Eel River has the highest natural sediment load in the United States due to the highly erodible soils in the area, and anthropogenic impacts in the South Fork Eel River have exacerbated these high loads such that pools have filled and substrate quality is poor. . High sediment loads result in shallower and less diverse habitat, reduce growth, and reduce reproductive success.

Riparian Forest Conditions

Degraded riparian forest conditions were rated as a high threat for the juvenile life stages. Riparian stands are currently dominated by willow, alder, and hardwood. Riparian habitat has somewhat rebounded from past large flood events. Riparian forests shade streams, provide terrestrial subsidies, increase habitat complexity, and influence sediment storage and transport.

Sudden oak death (SOD) is an exotic pathogen affecting almost all native species of plants, shrubs, and trees. SOD is in epidemic stages in the population area and in adjacent population areas. Because the SOD pathogen is water borne and can travel downstream in watercourses, the likelihood of SOD outbreaks in the population area and those mainstems in which coho salmon must migrate through are high. One of the largest areas infected by SOD occurs near Redway and is growing at a very fast rate.

Water Quality

Although water quality was rated as an overall high stress to the population, the extent of the temperature problem warranted that the South Fork Eel River is 303(d) listed for temperature. Water temperature in the South Fork Eel River approaches lethal levels in a number of stream reaches, is stressful in most others, and severely limits the amount of habitat available to coho salmon. High temperatures also favor Sacramento pikeminnow productivity. High temperatures are caused by reduced stream flow, lack of riparian canopy, and broader, shallower streams.

Hydrologic Function

This stressor was rated as a medium threat overall. Summer base flows in tributaries to the South Fork Eel River are also affected by rural and urban water withdrawals. Low summer flows reduce habitat and contribute to higher water temperatures. Altered hydrology from roads results in higher peak flows and lower base flows.

Barriers

Barriers to fish passage present a significant impediment to restoration and recovery of the South Fork Eel River coho salmon population, resulting in a high stress ranking. Numerous stream-road crossings exist throughout the population area, and at least 58 crossings partially impede fish migration. The list of road crossing barriers is provided later in the threats section. The Benbow Dam is a seasonal barrier to juveniles, and is currently being evaluated for removal. There are currently no dams in the South Fork Eel River watershed other than unpermitted temporary summer dams on tributaries (Downie 2010).

Disease, Competition and Predation

The non-native Sacramento pikeminnow poses a high threat to coho salmon fry, juveniles, and smolts. Pikeminnow prey on all coho salmon life stages except adults, and also compete with juveniles for limited food and habitat. The pikeminnow is successful in the South Fork Eel River because it thrives in severely impacted habitat that is less favorable for salmonids.

Impaired Estuary/Mainstem Function

All salmon and steelhead that originate from the South Fork Eel River migrate to and from the ocean through the mainstem Eel River and the Eel River estuary. The Eel River estuary was once a highly complex and extensive habitat area that played a vital role in the health and productivity of all Eel River coho salmon. The degraded function of the Eel River estuary and mainstem migratory corridor is a high stress for this population. The Eel River estuary is severely impaired because of diking and filling of wetlands for agriculture and flood protection. Approximately 60 percent of the estuary has been lost through the construction of levees and dikes (CDFG 2010b). There is evidence that the estuary once supported a high degree of estuarine habitat and rearing potential, but very little of that function still exists due to the loss of tidal wetlands and simplification of habitats. Mainstem conditions contribute to this stress because of the issues with reduced flow from diversions, such as the Potter Valley Project, water quality, predation, and degraded habitat in mainstem reaches. Juveniles, smolts, and adults transitioning through estuarine and mainstem habitat are stressed by the degraded conditions in these migratory habitats and suffer from lost opportunity for increased growth and survival. Loss and degradation of the formally-extensive and complex estuarine and mainstem habitat is considered a high stress for the population, with the most affected life stages being juveniles, smolts, and adults due to degradation of rearing and migratory habitat.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the South Fork Eel River population area. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin.

41.6 Threats

Table 41-3. Severity of threats affecting each life stage of coho salmon in the South Fork Eel River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	Very High	Very High
2	Timber Harvest	High	High	High	High	High	High
3	Dams/Diversion	High	High	High	Medium	High	High
4	High Intensity Fire	High	High	High	Medium	High	High
5	Road-Stream Crossing Barriers	-	High	High	High	High	High
6	Urban/Residential/Industrial	Medium	High	High	High	Medium	High
7	Invasive Non-Native/Alien Species	Low	Medium	High	High	Low	High
8	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
9	Channelization/Diking	Medium	Medium	Medium	Medium	Medium	Medium
10	Climate Change	Medium	Medium	Medium	Medium	Medium	Medium
11	Mining/Gravel Extraction	Medium	Medium	Medium	Medium	Medium	Medium
12	Fishing and Collecting	-	-	-	-	Medium	Medium
13	Hatcheries	Low	Low	Low	Low	Low	Low

Roads

Dirt and gravel roads are the primary threat to coho salmon and habitat restoration. Roads constitute a very high threat across all life stages. Road density is very high in most of the population area. Given the sedimentation problems throughout the watershed, roads should be considered for removal or upgrade treatments to reduce sediment delivery.

Timber Harvest

Timber harvest was ranked as a high threat because, given the percentage of the watershed that is privately owned, future timber harvest activities will continue to exacerbate the stresses caused by legacy logging activities. Only a fraction of the land base which is zoned as Timber Production Zones in this watershed is covered by a draft HCP.

Dams/Diversions

Benbow Dam is a seasonal barrier to juveniles, and is currently being studied for removal. Localized water diversion for rural residential and agricultural use reduces stream flow during critical juvenile rearing periods and in the early periods of adult migration.

Fire

Fire constitutes a high threat to most life stages of coho salmon. The altered vegetation characteristics throughout the watershed increase the risk of high intensity fires which alter sedimentation processes, as well as riparian vegetation characteristics. Historically, Native American vegetation management and natural fire cycles created a mosaic of fire resistant vegetation that lessened catastrophic fires.

Road-stream Crossing Barriers

Numerous road-stream crossings continue to block fish passage within the South Fork Eel River watershed, and contribute to a high threat to almost all life stages of coho salmon. The California Fish Passage Assessment Database (CalFish 2009) shows that there are 76 total road crossings that may block fish passage, of which 29 are total barriers, 29 are partial or temporal, and 18 are unknown.

Urban/Residential/Industrial Development

Although Urban/Residential/Industrial Development poses a moderate threat, much of the watershed with high IP value is located in and around the city of Laytonville. Future growth of this area is likely as transportation infrastructure improves and there is further northerly migration from southern metropolitan areas due to declining water supplies and other mandatory amenities in more southerly locations. In addition, further rural residential development is likely as large agricultural holdings are subdivided into smaller ranches. Higher population densities will combine to further increase road building, land clearing, well drilling, septic system construction, and other development with the consequent increase in stressors.

Invasive Non-Native/Alien Species

Agricultural and residential water withdrawals significantly influence the hydrology of the South Fork Eel River. In addition, high water temperatures severely limit the available habitat for summer rearing of juvenile coho salmon. These degraded habitat conditions favor production of the non-native Sacramento pikeminnow, resulting in significant levels of competition and predation on coho salmon. The non-native Sacramento pikeminnow is a high threat to fry, juveniles, and smolts because they compete with and prey on the young coho salmon. Sacramento pikeminnow was introduced in Lake Pillsbury in 1979 (Brown and Moyle 1997), and has spread throughout the entire Eel River watershed. The warm water temperatures in the Eel River and Lake Pillsbury make this voracious predator thrive in this system. The presence of the Sacramento pikeminnow in Lake Pillsbury makes eradication of this species extremely difficult. Any effort to remove this species in the Eel River without treating the lake will only be temporary because the lake will continue to be the source population for the rest of the Eel River watershed.

Agricultural Practices

Grazing occurs throughout the watershed and may contribute to increased sediment generation and delivery. However, specific information on the magnitude of the threat is limited. In addition, remote outdoor agricultural cultivation likely results in riparian vegetation impacts, water withdrawals, diesel spills, and pesticide leaching into streams and groundwater. Water withdrawals for agricultural uses were considered in the “Dams/Diversions” threat.

Channelization/Diking

Channelization and diking poses a moderate threat to coho salmon in the population area, and is primarily associated with road building.

Climate Change

Climate change poses a high threat to this population. The impacts of climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperature shows a large increase over the next 50 years (see Appendix B for modeling methods). Average temperature could increase by up to 2^{o} C in the summer and by up to 1^{o} C the winter. Annual precipitation is predicted to trend downward over the next century (Feely et al. 2008). The vulnerability of the Eel River estuary to sea level rise is very high. Juvenile and smolt rearing and migratory habitat in the South Fork Eel River and mainstem Eel River is most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Rising sea level may also impact the quality and extent of wetland rearing habitat). Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. Adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007; Portner and Knust 2007; Feely et al. 2008).

Mining/Gravel Extraction

Gravel extraction occurs in the South Fork Eel River, but is relatively isolated and conducted with state and federal oversight. The medium ranking for this threat reflects to sensitivity of the channel to additional disturbances (i.e., lack of floodplain and channel structure).

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of coho salmon for research purposes in the South Fork Eel River. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the South Fork Eel River population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

41.7 Recovery Strategy

The severely degraded condition of the South Fork Eel River habitat, combined with the depressed coho salmon population size and distribution, significantly increases the risk of extinction of this important, inland coho salmon population. This combined with the facts that most of the watershed is in private ownership, much of the high IP areas are in developed areas, and predation and competition from non-native Sacramento pikeminnow severely limit juvenile survival, indicates that immediate measures may be necessary to sustain the South Fork Eel River population.

By addressing the major threats to the population – sediment from roads, timber harvest, and restoring the natural hydrograph, many of the major stresses affecting coho salmon will be addressed. Restoration activities that reduce sediment inputs, increase connectivity to floodplains, enhance estuarine habitats, increase riparian vegetation, increase summer instream flows, and reduce the abundance of Sacramento pikeminnow should be immediately implemented.

Coho salmon are found in relatively high numbers in several tributaries in the western region of the population area. Tributaries such as Hollow Tree Creek should be top priority to ensure that areas with extant sub-populations of coho salmon receive priority over those areas with little or no coho salmon. Focusing on areas where coho salmon are currently present ensures that recovery actions implemented will have maximum benefit over shorter periods of time. However, the most limiting life stages are juveniles and smolts predominantly because of poor migratory habitats in the mainstem and estuary of the Eel River. Addressing Sacramento pikeminnow and the quality of the Eel River estuary as well as other actions to improve the migratory corridors for the South Fork Eel population are top priority.

Table 41-4 on the following page lists the recovery actions for the South Fork Eel River population.

Table 41-4. Recovery action implementation schedule for the South Fork Eel River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide, prioritize Redwood, Sproul, Cedar, and Hollow Tree creeks	3
SONCC-SFER.2.1.1.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-SFER.2.1.1.2	*Place instream structures, guided by assessment results*					
SONCC-SFER.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Restore natural channel form and function	Population wide	3
SONCC-SFER.2.2.2.1	*Conduct assessment to identify and prioritize reaches which are confined and/or channelized by man-made structures such as roads, dikes, and levees*					
SONCC-SFER.2.2.2.2	*Implement priority actions to address confinement and channelization, guided by the assessment*					
SONCC-SFER.2.2.3	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide, prioritize key tributaries such as Redowood, Sproul, Cedar, and Hollow Tree creeks	2
SONCC-SFER.2.2.3.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-SFER.2.2.3.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-SFER.8.1.15	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide, priortize Red Mountain Management Area, Redwood, Sproul, and Cedar Creeks	3
SONCC-SFER.8.1.15.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-SFER.8.1.15.2	*Decommission roads, guided by assessment*					
SONCC-SFER.8.1.15.3	*Upgrade roads, guided by assessment*					
SONCC-SFER.8.1.15.4	*Maintain roads, guided by assessment*					
SONCC-SFER.8.1.16	Sediment	Yes	Reduce delivery of sediment to streams	Reduce erosion	Hermitage Road	3
SONCC-SFER.8.1.16.1	*Install gates to control vehicle access*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.8.1.17	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-SFER.8.1.17.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-SFER.8.1.18	Sediment	Yes	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3
SONCC-SFER.8.1.18.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-SFER.8.1.18.2	*Implement plan to stabilize slopes and revegetate areas*					
SONCC-SFER.14.2.14	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of Sacramento pikeminnow	Population wide	2
SONCC-SFER.14.2.14.1	*Determine the effectiveness of various pikeminnow suppression techniques and develop experimental control methods. Develop a plan that identifies watersheds suitable for experimental pikeminnow control*					
SONCC-SFER.14.2.14.2	*Control Sacramento pikeminnow, guided by the control plan*					
SONCC-SFER.1.2.43	Estuary	No	Improve estuarine habitat	Improve estuary condition	Eel River Estuary	3
SONCC-SFER.1.2.43.1	*Implement recovery actions to address strategy "Estuary" for Lower Eel/Van Duzen River population*					
SONCC-SFER.16.1.28	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SFER.16.1.28.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-SFER.16.1.28.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-SFER.16.1.29	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-SFER.16.1.29.1	*Determine actual fishing impacts*					
SONCC-SFER.16.1.29.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.16.2.30	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SFER.16.2.30.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-SFER.16.2.30.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-SFER.16.2.31	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-SFER.16.2.31.1	*Determine actual impacts of scientific collection*					
SONCC-SFER.16.2.31.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-SFER.3.1.4	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-SFER.3.1.4.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-SFER.3.1.5	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-SFER.3.1.5.1	*Create water budgets that avoid over allocating water diversions*					
SONCC-SFER.3.1.6	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide, especially Redwood, Sproul, and Cedar creeks	2
SONCC-SFER.3.1.6.1	*Provide incentives to reduce water use*					
SONCC-SFER.3.1.7	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide, especially Redwood, Sproul, and Cedar creeks	2
SONCC-SFER.3.1.7.1	*Establish a forbearance program modeled after the Mattole watershed*					
SONCC-SFER.3.1.7.2	*Monitor forbearance compliance and flow*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.3.1.8	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide, especially Redwood, Sproul, and Cedar creeks	BR
SONCC-SFER.3.1.8.1	*Provide educational materials describing how to most efficiently use water*					
SONCC-SFER.3.1.9	Hydrology	No	Improve flow timing or volume	Remove dam	South Fork Eel River at Benbow	3
SONCC-SFER.3.1.9.1	*Identify a plan to remove Benbow Dam*					
SONCC-SFER.3.1.9.2	*Remove Benbow Dam*					
SONCC-SFER.3.1.10	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-SFER.3.1.10.1	*Develop an educational program about water conservation programs and instream leasing programs*					
SONCC-SFER.3.1.11	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-SFER.3.1.11.1	*Prioritize and provide incentives for use of CA Water Code Section 1707*					
SONCC-SFER.3.1.12	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-SFER.3.1.12.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-SFER.3.1.13	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-SFER.3.1.13.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-SFER.27.1.32	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-SFER.27.1.32.1	*Perform annual spawning surveys*					
SONCC-SFER.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Develop survival estimates	Site to be determined	3
SONCC-SFER.27.1.33.1	*Install and annually operate a life cycle monitoring (LCM) station*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.27.1.34	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-SFER.27.1.34.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-SFER.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-SFER.27.1.35.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-SFER.27.1.36	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the threat 'Invasive Species'	Population wide	3
SONCC-SFER.27.1.36.1	*Annually estimate the density of non-native predators, such as the Sacramento pikeminnow in the Eel River basin*					
SONCC-SFER.27.1.36.2	*Identify the status and trend of invasive species*					
SONCC-SFER.27.2.37	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-SFER.27.2.37.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-SFER.27.2.37.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-SFER.27.2.38	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-SFER.27.2.38.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-SFER.27.2.39	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-SFER.27.2.39.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-SFER.27.2.40	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-SFER.27.2.40.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-SFER.27.2.41	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-SFER.27.2.41.1		*Measure the indicators, pH, D.O., temperature, and aquatic insects*				
SONCC-SFER.27.2.42	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-SFER.27.2.42.1		*Annually measure the hydrograph and identify instream flow needs*				
SONCC-SFER.27.1.44	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-SFER.27.1.44.1		*Develop supplemental or alternate means to set population types and targets*				
SONCC-SFER.27.1.44.2		*If appropriate, modify population types and targets using revised methodology*				
SONCC-SFER.5.1.25	Passage	No	Improve access	Remove barriers	Population wide	3
SONCC-SFER.5.1.25.1		*Evaluate and prioritize barriers for removal*				
SONCC-SFER.5.1.25.2		*Remove barriers*				
SONCC-SFER.7.1.21	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	3
SONCC-SFER.7.1.21.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-SFER.7.1.21.2		*Thin, or release conifers, guided by prescription*				
SONCC-SFER.7.1.21.3		*Plant conifers, guided by prescription*				
SONCC-SFER.7.1.22	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce fire hazard	Tributaries	3
SONCC-SFER.7.1.22.1		*Identify forested stands for fire hazard reduction*				
SONCC-SFER.7.1.22.2		*Apply appropriate management techniques (e.g. thinning, burning) to reduce risks of high intensity fire*				

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-SFER.7.1.23	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve regulatory mechanisms	Population wide	3
SONCC-SFER.7.1.23.1	*Develop planning guidelines or ordinances that protect riparian stands*					
SONCC-SFER.7.1.24	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-SFER.7.1.24.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					
SONCC-SFER.10.2.19	Water Quality	No	Reduce pollutants	Remove pollutants	Population wide	3
SONCC-SFER.10.2.19.1	*Remove hazardous materials from streams*					

42. Mainstem Eel River Population

- Interior Eel River Stratum
- Core, Potentially Independent Population
- High Extinction Risk
- 4,800 Spawners Required for ESU Viability
- 521 mi^2
- 144 IP km (89 mi) (8.5% High)
- Dominant Land Uses are Timber Production and Agriculture
- Principal Stresses are ‘Altered Sediment Supply’ and ‘Lack of Floodplain and Channel Structure’
- Principal Threats are ‘Roads’ and ‘Dams/Diversions’

42.1 History of Habitat and Land Use

Historically, timber harvest was the dominant land-use in the Mainstem Eel River and timber harvest has had a large impact on the landscape. Late-seral stands of conifers are largely absent and historic logging and fire suppression caused the change from conifer-dominated stands to stands with high proportions of oak and shrub species. Erosion from poorly constructed roads in the highly erosive Franciscan geology has contributed to increased sediment loads in the region’s rivers, leaving streams shallower, warmer, and more prone to flooding (Bodin et al. 1982; Raphael 1974). Sediment production from the 1955 and 1964 floods choked the channels with sediment and most channels are still recovering from these large flood events. Many areas which were cleared by logging have since been farmed or grazed.

U.S. Forest Service (USFS) land occurs in the headwaters of tributaries in the northeast portion of the population - primarily the Dobbyn Creek and Kekawaka Creek watersheds. USFS land in the Mainstem Eel River is currently used for grazing and recreation. BLM land occurs in a number of areas throughout the Mainstem Eel River, including several smaller watersheds that contain high IP reaches. These include Woodman, White Rock, Drewry, Charlton, Bell Springs, and Chamise Creeks. The dominant land uses on BLM land are primarily recreation and timber production.

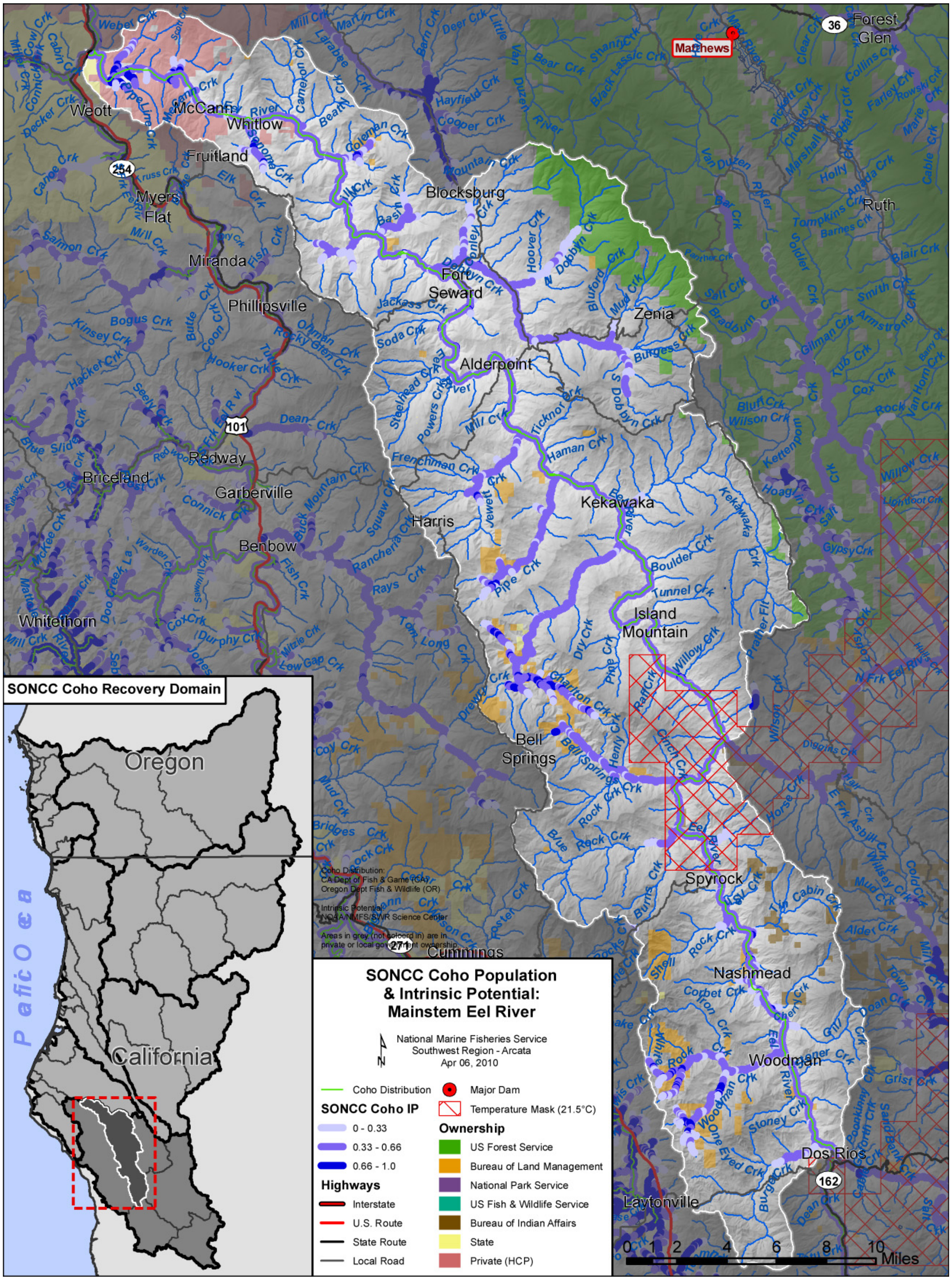

Figure 42-1. The geographic boundaries of the Mainstem Eel River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

The Mainstem Eel River is isolated and predominantly rural. Small population centers of less than 200 to 500 residents occur throughout the Mainstem Eel River drainage, primarily along the Eel River itself. With the establishment of rural residences and smaller ranches, the need for water has increased. In addition, agriculture results in significant water demands in Mainstem Eel River tributaries. Currently, much of this demand is accommodated through in-stream diversions or shallow wells, which have influenced stream flows during summer low-flow periods.

42.2 Historic Fish Distribution and Abundance

No estimates of the size of the historical (or current) coho salmon population in the Mainstem Eel River are available. Brown and Moyle (1991) documented historical coho salmon presence in Jewett and Kekawaka Creeks, but recent surveys have not documented coho salmon presence in these Mainstem Eel River tributaries (California Department of Fish and Game (CDFG) 2002a).

Table 42-1. Tributaries in the Mainstem Eel population with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Subbasin	Stream Name	Subbasin	Stream Name
Sequoia	Coleman Creek	**Spy Rock**	Bell Springs Creek
	Drewry Creek		Chamise Creek
	Jewett Creek		Charlton Creek
	Pipeline Creek		Pipe Creek
	Poison Oak Creek		Pipe Creek
	Sonoma Creek		White Rock Creek
	Thompson Creek		Woodman Creek

42.3 Status of Mainstem Eel River Coho Salmon

Spatial Structure and Diversity

The more restricted and fragmented the distribution of individuals are within a population, and the more spatial distribution and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 33 coho salmon per-IP km of habitat are needed (4,800 spawners total) to approximate the historical distribution of Mainstem Eel River coho salmon and habitat. The current distribution of spawners is unknown and observations are few, but expected to be very limited because most of the habitat is extremely degraded. The Mainstem Eel River coho salmon population is at high risk of extinction, in part, because its spatial structure and diversity is limited.

Population Size and Productivity

Williams et al. (2008) determined at least 144 coho salmon must spawn in the Mainstem Eel River each year to avoid depensation effects of extremely low population size.

The Mainstem Eel River coho salmon population size is likely to be extremely reduced compared to historic levels. Breeding groups may have been lost or severely depressed in some Mainstem Eel River streams. The population growth rate is unknown, but expected to be negative in most years given the low numbers of fish observed at Van Arsdale and the degraded habitat conditions available. Therefore, the Mainstem Eel River coho salmon population is at high risk of extinction.

Extinction Risk

The Mainstem Eel River coho salmon population is not viable and at high risk of extinction, because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008). Observations of coho salmon in the Mainstem Eel River and its tributaries have been steadily declining, and no coho salmon have been observed in some years.

Role in SONCC Coho Salmon ESU Viability

The Mainstem Eel River population is a Functionally Independent core population in the Interior Eel River Diversity stratum, meaning that it is sufficiently large to be historically viable-in-isolation and its demographics and extinction risk are minimally influenced by immigrants from adjacent populations (Williams et al. 2006). Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU. As a core population, the recovery target for the Mainstem Eel population is for the population to be viable meaning that it has a low risk of extinction according to population viability criteria (see Chapter 2).

42.4 Plans and Assessments

Environmental Protection Agency

Total Maximum Daily Loads for the Eel River

In January 2006, the EPA published the final Total Maximum Daily Loads (TMDLs) for temperature and sediment for the Middle Main Eel River and tributaries. The North Coast Regional Water Quality Control Board is required to develop measures which will result in implementation of the TMDLs in accordance with the requirements of 40 CFR 130.6.

State of California

Eel River Salmon and Steelhead Restoration Action Plan

In 1997, the California Department of Fish and Game completed their assessment of the Eel River watershed and provided recommendations for restoration of salmonid stocks. Primary recommendations include removing barriers, reducing sediment inputs, improving riparian forest conditions, reducing water withdrawals, enhancing habitat, and controlling Sacramento pikeminnow.

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004

42.5 Stresses

Table 42-2. Severity of stresses affecting each life stage of coho salmon in the Mainstem Eel River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

Stresses (Limiting Factors)		Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Sediment Supply[1]	Very High	Very High	Very High[1]	High	Very High	Very High
2	Lack of Floodplain and Channel Structure[1]	Medium	High	Very High[1]	Very High	Very High	High
3	Degraded Riparian Forest Conditions	-	High	High	High	High	High
4	Increased Disease/Predation/Competition	Low	High	High	High	Low	High
5	Impaired Water Quality	Low	High	High	High	Medium	Medium
6	Altered Hydrologic Function	Medium	High	Very High	High	Medium	Medium
7	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	Medium
8	Barriers	-	Medium	Medium	Medium	Medium	Medium
9	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
10	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Based on the type and extent of stresses and threats affecting the population as well as the limiting factors influencing productivity, it is likely that the juvenile life stage is the most limited and that quality summer and winter rearing habitat is lacking. Juvenile summer and winter rearing success is most limited by unsuitable habitat resulting from high water temperatures and excessive sedimentation. Low summer flows resulting from Scott Dam serve to support the non-native Sacramento pikeminnow by providing ideal low-flow warm conditions for this predator. In addition, channel complexity and a diverse estuary are important to juvenile coho salmon, increasing their size and fitness prior to ocean entry, and overall marine survival success.

Complex stream channels with deep pools and woody structure as well as tidally influenced wetlands with off channel ponds are important refuge areas for juvenile coho. Properly functioning rearing habitat would provide buffers against some of the other stresses affecting the population. Juvenile coho salmon would be more protected against predation, competition, and warm mainstem water temperatures if there were additional refugia areas. Available information regarding habitat conditions in the Mainstem Eel River indicates that none of the streams accessible to coho salmon currently are able to function as refugia. Small reaches in streams that could provide a combination of suitable habitat and water temperatures may exist, but these have not been identified and likely possess lower IP values.

Altered Sediment Supply

Excessive sediment was rated as a very high stress to nearly all life stages of coho salmon. The EPA recognized this by listing the Mainstem Eel River as sediment-impaired. The Eel River has the highest natural sediment load in the United States due to the highly erodible soils in the area, and anthropogenic impacts in the Mainstem Eel River have exacerbated these high loads such that pools have filled and substrate quality is poor. High sediment loads, especially fine sediment, have the potential to decrease the amount of suitable habitat by filling in pools, decrease food availability and impair feeding, increase physiological stress, and ultimately reduce the reproductive success and viability of coho salmon.

Lack of Floodplain and Channel Structure

Floodplain and channel structure relates to the depth, substrate, riparian vegetation, and large wood structures found in the floodplain and channels, which create functioning adult and juvenile coho salmon habitat. Where data are available, pool depths, pool frequencies, and substrate embeddedness measurements indicate poor channel structure. The lack of floodplain and channel structure in the Mainstem Eel River is primarily due to the excessive sediment loads, coupled with the paucity of large wood and riparian vegetation. Roads and the railroad constrict the channel where they occur parallel to the stream.

Riparian Forest Conditions

Late-seral conifer stands no longer occur along most of the riparian zone of the Mainstem Eel River. Their absence causes a loss of shade, decreased wood delivery to streams, and reduced sediment filtration and retention, all of which affect the quality of habitat for coho salmon. Riparian stands are currently dominated by willows, alders, and hardwoods. Large flood events which occurred in the 1950’s and 1960’s have significantly impacted riparian areas due to sedimentation and damage to riparian trees. Riparian habitat has somewhat rebounded from past large flood events as channels are narrowing and trees are recovering.

Sudden oak death (SOD) is an exotic pathogen affecting almost all native species of plants, shrubs, and trees. SOD is in epidemic stages in the population area and upstream of the population area. Because the SOD pathogen is water borne and can travel downstream in watercourses, the likelihood of SOD outbreaks in the population area are high. One of the largest areas infected by SOD occurs near Redway and is growing at a very fast rate.

Increased Disease/Predation/Competition

The non-native Sacramento pikeminnow preys upon all coho life stages except adults, and also competes with juveniles for limited food and habitat. Sacramento pikeminnow are successful in the Eel River because the severely impacted habitat which is less favorable for salmonids, is suitable for the Sacramento pikeminnow, and as such confers a competitive advantage to this species.

Water Quality

Water temperature is rated as a high stress to fry, juveniles, and smolts. Where water temperature has been measured, many of the moderate to high IP reaches throughout the watershed exceed 17 ºC. Water temperature is affected by lack of riparian vegetation, a high width to depth ratio, and flow quantity. Water temperature in the Mainstem Eel River approaches lethal levels in a number of stream reaches and is stressful in most others, and severely limits the amount of habitat available to juvenile coho salmon. Other water quality issues, including toxins and nutrients, are not known to be a widespread problem.

Altered Hydrologic Function

The amount of water available and the altered flow regime reduce the amount of available habitat for fry and juveniles as well as the migration timing of adults. Scott Dam on the Upper Mainstem Eel River alters the amount and timing of water available to the Mainstem Eel River which decreases instream habitat availability, decreases riparian vegetation, affects adult upstream migration and may influence juvenile migration. Summer base flows in tributaries to the Mainstem Eel River are further affected by rural and urban water withdrawals. Altered hydrology due to impervious areas and changes to the drainage network results in higher peak flows and lower base flows.

Table 42-3. List of complete barriers.

Stream Name	Road Name	Subbasin
Bloyd Creek	Dyerville Loop Rd	Sequoia
Jackass Creek	Railroad	Sequoia
Line Gulch	Alderpoint Rd	Sequoia
McCann Creek	Dyerville Loop Rd	Sequoia
Sequoia Creek	Whitlow Rd	Sequoia
Soda Creek	Railroad	Sequoia
Unnamed tributary	McCann Rd	Sequoia

Impaired Estuary/Mainstem Function

All salmon and steelhead that originate from the Mainstem Eel River population migrate to and from the ocean through the Eel River estuary. The Eel River estuary was once a highly complex and extensive habitat area that played a vital role in the health and productivity of all Eel River coho salmon. The degraded function of the Eel River estuary and mainstem migratory corridor is a high stress for this population. The Eel River estuary is severely impaired because of past diking and filling of wetlands for agriculture and flood protection. Approximately 60 percent of the estuary has been lost through the construction of levees and dikes (CDFG 2010b). There is evidence that the estuary once supported a high degree of estuarine habitat and rearing potential, but very little of that historic function still exists. The estuary provides rearing, refugia, and ocean transition habitat for coho salmon that originate in the Mainstem Eel River population. This habitat is very important given the degraded habitat conditions and predation and competition with Sacramento pikeminnow in the Mainstem Eel River subbasin. Juveniles, smolts, and adults occupying estuarine habitat are stressed by the degraded conditions in these habitats and suffer from the lost opportunity for increased growth and survival.

Barriers

Barriers to fish passage are not a significant impediment to restoration and viability of the Mainstem Eel River coho salmon population. Barriers known to impede access to all life stages of coho salmon in the Mainstem Eel River population are described in Table 42-3. Most of the barriers will not greatly influence the ability of the population to achieve viability because of the minimal habitat present upstream of the barriers.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Mainstem Eel River population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin.

42.6 Threats

Table 42-4. Severity of threats affecting each life stage of coho salmon in the Mainstem Eel River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	Very High	Very High
2	Timber Harvest	High	High	High	High	High	High
3	Dams/Diversion	High	High	High	Medium	High	High
4	High Intensity Fire	High	High	High	Medium	High	High
5	Invasive Non-Native/Alien Species	Low	Medium	High	High	-	High
6	Climate Change	Low	Low	High	High	Medium	High
7	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
8	Channelization/Diking	Medium	Medium	Medium	Medium	Medium	Medium
9	Mining/Gravel Extraction	Medium	Medium	Medium	Medium	Medium	Medium
10	Urban/Residential/Industrial	Medium	Medium	Medium	Medium	Medium	Medium
11	Road-Stream Crossing Barriers	-	Medium	Medium	Medium	Medium	Medium
12	Fishing and Collecting	-	-	-	-	Medium	Medium
13	Hatcheries	Low	Low	Low	Low	Low	Low

Roads

Roads constitute a very high threat across all life stages in most parts of the watershed due to the abundance of roads in the population. Road density is high in the limited area containing high IP habitat. Most roads in the watershed are dirt or gravel, and prone to deliver sediment to waterways, especially given the unstable geologic types in the population area.

Timber Harvest

Timber harvest was ranked as a high threat because, given the percentage of the watershed that is privately owned by timber companies or managed for timber production. Future timber harvest activities will continue to exacerbate the stresses caused by legacy logging activities. In addition, timber harvest is likely in some of the few areas of high IP located in the western portion of the population area.

Dams/Diversions

Scott Dam and the Potter Valley Project have altered the volume and timing of water discharge and changed the hydrologic regime that Mainstem Eel River coho salmon have evolved with. In addition, localized water diversions for rural residential and agricultural use reduce stream flow during critical juvenile rearing and adult migrating periods.

High Intensity Fire

The altered vegetation characteristics throughout the watershed make high intensity fires more likely than they were historically. Such fires alter sedimentation processes, as well as riparian vegetation characteristics, and ultimately degrade coho salmon habitat. Historically, Native American vegetation management and natural fire cycles created a mosaic of fire resistant vegetation that lessened catastrophic fires. However, vegetation management and prescribed fires are no longer common and thus have contributed to the future threat of high intensity fires.

Invasive Non-Native/Alien Species

The non-native Sacramento pikeminnow competes with and preys on young coho salmon. The warm water temperatures in the Eel River and Lake Pillsbury create ideal conditions for this predator. The presence of the Sacramento pikeminnow in Lake Pillsbury makes eradication of this species extremely difficult. Any effort to remove this species in the Eel River without treating the lake will only be temporary because the lake will continue to be a major source population for the Eel River. Once the volume and timing of instream flows are restored to conditions more favorable to coho salmon, there should be more habitats available for juveniles to seek refuge from predation. Further, to the extent that water becomes cooler due to restoration activities, conditions will become less ideal for the pikeminnow.

Climate Change

Climate change in this region will have the greatest impact on juveniles, smolts, and adults. The current climate is generally warm. The modeled regional average temperature is projected to increase by up to 2.6 °C in the summer and by up to 1.2 °C in the winter over the next 50 years (see Appendix B for modeling methods). Annual precipitation in this area is predicted to change little over the next century. However, snowpack in the upper elevations of the Eel River basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009).

The Eel River estuary is vulnerable to sea level rise (CDFG 2010b). Juvenile rearing and migratory habitat are most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Rising sea level may also impact the quality and extent of freshwater wetland rearing habitat in the estuary. Adults will likely be negatively affected by ocean acidification and changes in ocean conditions and prey availability (Independent Science Advisory Board 2007; Portner and Knust 2007; Feely et al. 2008).

Agricultural Practices

Grazing occurs throughout the watershed and contributes to increased sediment generation and delivery where animals have access to waterways. In addition, agriculture likely results in riparian vegetation impacts, water withdrawals, diesel spills, and pesticide leaching into streams and groundwater. Water withdrawals for agricultural uses, which can be significant, are considered in the "Dams/Diversions" threat above.

Channelization/Diking

Channelization and diking of the Mainstem Eel River and its tributaries is primarily associated with road building and a defunct rail line that parallels the Mainstem Eel River. See the estuarine function section for information on the effects of channelization and diking upon the estuarine environment.

Mining/Gravel Extraction

Gravel extraction occurs in select areas in the Mainstem Eel River and is conducted with state and Federal oversight. The medium ranking for this threat reflects the sensitivity of the channel to additional disturbances (lack of floodplain and channel structure). Although the gravel mining industry is quite regulated, there is potential for adverse impacts as gravel extraction can influence habitat for great distances.

Urban/Residential/Industrial Development

Future rural residential development is likely once large agricultural holdings are subdivided into smaller ranches. However, the isolation of the area and limited infrastructure development may limit population growth. Rural development will lead to more road building, land clearing, well drilling, septic system construction, and other development, with the associated increase in stresses.

Road-Stream Crossing Barriers

The 5 Counties Program identified several barriers in the lower watershed which have not been resolved. Such barriers would prevent coho access to their respective tributaries. Although these barriers preclude fish access to available habitat, they are not likely to pose a significant impediment to recovery because of the limited extent of habitat available upstream of the barriers.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries on the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. As of April 2011, NMFS has not authorized future collection of coho salmon for research purposes in the Mainstem Eel River. However, collections of fish originating from the Mainstem Eel River population could occur in studies being conducted in other Eel River population areas.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Mainstem Eel River population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

42.7 Recovery Strategy

The severely degraded condition of the Mainstem Eel River habitat, combined with the very low coho salmon population size and its restricted distribution, significantly increases the risk of extinction of this inland coho salmon population. One of the strategies which may be necessary to achieve viability would require transfer of coho salmon from nearby populations once sufficient habitat is available to sustain such transferred fish. Identification of long-term restoration actions is also imperative to prevent further habitat degradation and reduce the impacts of past activities. Restoration activities that reduce sediment inputs, increase floodplain connectivity, increase riparian vegetation, increase summer instream flows, and reduce the abundance of Sacramento pikeminnow should be immediately implemented.

Table 42-5 on the following page lists the recovery actions for the Mainstem Eel River population.

Table 42-5. Recovery action implementation schedule for the Mainstem Eel River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MER.2.2.8	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Mainstem Eel	2
SONCC-MER.2.2.8.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MER.2.2.8.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-MER.2.1.9	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2
SONCC-MER.2.1.9.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MER.2.1.9.2	*Place instream structures, guided by assessment results*					
SONCC-MER.8.1.14	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3
SONCC-MER.8.1.14.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MER.8.1.14.2	*Decommission roads, guided by assessment*					
SONCC-MER.8.1.14.3	*Upgrade roads, guided by assessment*					
SONCC-MER.8.1.14.4	*Maintain roads, guided by assessment*					
SONCC-MER.8.1.15	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-MER.8.1.15.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-MER.8.1.16	Sediment	Yes	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3
SONCC-MER.8.1.16.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-MER.8.1.16.2	*Implement plan to stabilize slopes and revegetate areas*					
SONCC-MER.8.1.17	Sediment	Yes	Reduce delivery of sediment to streams	Work with willing landowners to reduce the effects of timber harvesting	Population wide	3
SONCC-MER.8.1.17.1	*Identify landowners with active NTMPs, THPs, and HCPs where there may be opportunities to reduce the effects of timber harvesting*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MER.8.1.17.2	*Offer incentives and technical support to reduce timber harvesting impacts and incorporate recovery objectives utilizing grant funds*					
SONCC-MER.14.2.2	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of Sacramento pikeminnow	Population wide	2
SONCC-MER.14.2.2.1	*Determine the effectiveness of various pikeminnow suppression techniques and develop experimental control methods. Develop a plan that identifies watersheds suitable for experimental pikeminnow control*					
SONCC-MER.14.2.2.2	*Control Sacramento pikeminnow, guided by the control plan*					
SONCC-MER.1.2.31	Estuary	No	Improve estuarine habitat	Improve estuary condition	Eel River Estuary	3
SONCC-MER.1.2.31.1	*Implement recovery actions to address strategy "Estuary" for Lower Eel/Van Duzen River population*					
SONCC-MER.16.1.19	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MER.16.1.19.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MER.16.1.19.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-MER.16.1.20	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MER.16.1.20.1	*Determine actual fishing impacts*					
SONCC-MER.16.1.20.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-MER.16.2.21	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MER.16.2.21.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-MER.16.2.21.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-MER.16.2.22	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MER.16.2.22.1	*Determine actual impacts of scientific collection*					
SONCC-MER.16.2.22.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-MER.3.1.3	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	2
SONCC-MER.3.1.3.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-MER.3.1.4	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	2
SONCC-MER.3.1.4.1	*Create water budgets that avoid over allocating water diversions*					
SONCC-MER.3.1.5	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2
SONCC-MER.3.1.5.1	*Provide incentives to reduce water use by reducing diversion during summer*					
SONCC-MER.3.1.6	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2
SONCC-MER.3.1.6.1	*Establish a forbearance program, using water storage tanks to decrease diversion during periods of low flow*					
SONCC-MER.3.1.6.2	*Monitor forbearance compliance and flow*					
SONCC-MER.3.1.7	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-MER.3.1.7.1	*Provide educational materials describing how to most efficiently use water*					
SONCC-MER.26.1.1	Low Population Dynamics	No	Increase population abundance	Develop a rearing enhancement program to increase population abundance	Population wide	2
SONCC-MER.26.1.1.1	*Assess impacts and benefits associated with different enhancement programs such as captive broodstock, rescue rearing, and conservation hatcheries*					
SONCC-MER.26.1.1.2	*Develop a facility to rear fish*					
SONCC-MER.26.1.1.3	*Operate enhancement program as a temporary strategy to increase population abundance*					
SONCC-MER.26.1.1.4	*Monitor fish populations at all life stages including juvenile snorkel counts, downstream migrant counts, spawning surveys, and PIT tagging*					
SONCC-MER.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-MER.27.1.23.1	*Perform annual spawning surveys*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MER.27.1.24	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-MER.27.1.24.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-MER.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-MER.27.1.25.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-MER.27.1.26	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the threat 'Invasive Species'	Population wide	3
SONCC-MER.27.1.26.1	*Annually estimate the density of non-native predators, such as the Sacramento pikeminnow in the Eel River basin*					
SONCC-MER.27.1.26.2	*Identify the status and trend of invasive species*					
SONCC-MER.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MER.27.2.27.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-MER.27.2.27.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-MER.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-MER.27.2.28.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-MER.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MER.27.2.29.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-MER.27.1.30	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MER.27.1.30.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MER.27.1.32	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-MER.27.1.32.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MER.27.1.32.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-MER.5.1.13	Passage	No	Improve access	Remove barriers	Population wide, especially: Soda, Jackass, Sequoia, McCann, Bloyd, Line Gulch creeks, and unnamed tributary on McCann Road	3
SONCC-MER.5.1.13.1	*Evaluate and prioritize barriers for removal*					
SONCC-MER.5.1.13.2	*Remove barriers*					
SONCC-MER.7.1.10	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	3
SONCC-MER.7.1.10.1	*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*					
SONCC-MER.7.1.10.2	*Thin, or release conifers, guided by prescription*					
SONCC-MER.7.1.10.3	*Plant conifers, guided by prescription*					
SONCC-MER.7.1.11	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reestablish natural fire regime	Tributaries	3
SONCC-MER.7.1.11.1	*Identify areas prone to high intensity fire and develop a plan to reestablish a natural fire regime*					
SONCC-MER.7.1.11.2	*Carry out fuel reduction or modification projects such as thinning, prescribed burning, and piling, guided by the plan*					
SONCC-MER.7.1.12	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-MER.7.1.12.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					

43. Middle Fork Eel River Population

- Interior Eel River Stratum
- Potentially Independent Population
- High Extinction Risk
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 753 mi^2
- 78 IP km (48 mi) (13% High)
- Dominant Land Uses are Agriculture and Recreation
- Principal Stresses are 'Altered Sediment Supply' and 'Degraded Riparian Forest Conditions'
- Principal Threats are 'Roads' and 'High Intensity Fire'

43.1 History of Habitat and Land Use

Historic land use activities in the Middle Fork Eel River include grazing, timber harvest, recreation, and residential development. Overgrazing in the early 1900s precipitated soil erosion and altered vegetation (California Department of Water Resources (DWR) 1982). Currently, grazing is believed to be moderate in scope. In 1862, small-scale logging began near Covelo and continued until after World War II. An estimated 46 percent of the timbered land in the population area, representing 23 percent of the overall land in the population, was logged by either clear cut or partial cut methods from 1950 to 1981 (DWR 1982).

USFS Watershed Analyses for the Middle Fork Eel River and Black Butte River watersheds ("sub-watersheds" in document) concluded that, "human activities contributed to conditions that resulted in increased erosion and sedimentation, direct removal of riparian vegetation, and secondary impacts resulting from bank erosion and decreased vegetation in the watershed." Past timber harvest practices along intermittent and perennial streams contributed to increases in stream temperatures. Floods in 1955 and 1964, as well as high densities of dirt roads, are responsible for excessive sedimentation that is especially apparent in the Round Valley watershed contained within the Middle Fork Eel River population area

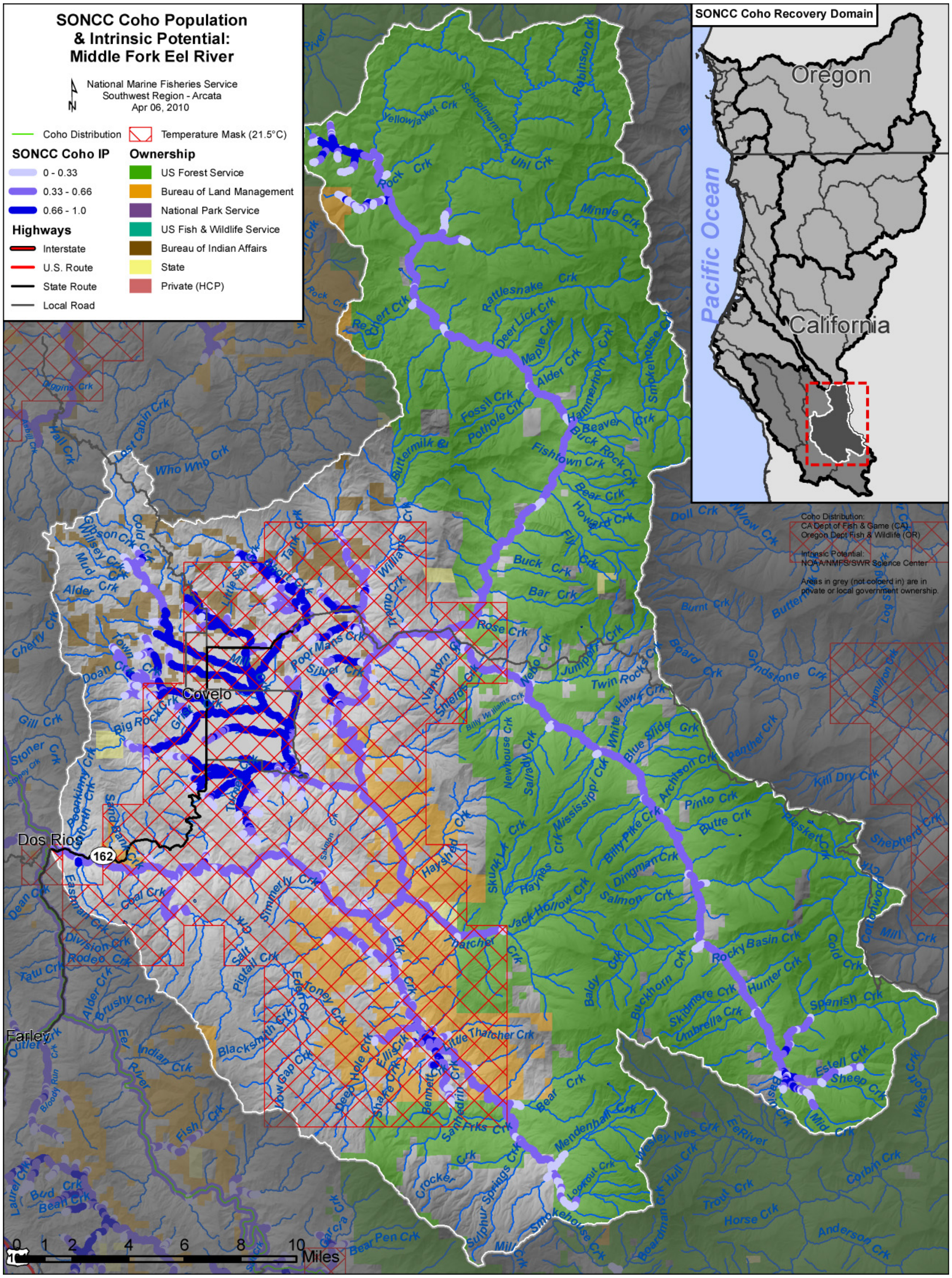

Figure 43-1. The geographic boundaries of the Middle Fork Eel River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

43.2 Historic Fish Distribution and Abundance

Middle Fork Eel River historic coho salmon population size estimates are not available. Coho salmon have not been recorded in the Middle Fork Eel River or its tributaries since 1979, despite numerous surveys by CDFG (Jong et al. 2008).

Table 43-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Subarea	Stream Name	Subbasin	Stream Name
Round Valley	Grist Creek	**Black Butte River**	Basin Creek
	Little Salt Creek		Estell Creek
	Little Valley Creek		Mid Creek
	Mill Creek		Spanish Creek
	Poor Mans Creek	**Eden Valley**	Bennett Creek
	Short Creek		Elk Creek
	Silver Creek		Ellis Creek
	Tank Creek		Sanhedrin Creek
	Town Creek		Shake Creek
	Turner Creek	**Wilderness**	Willow Creek
	Williams Creek		unnamed tributary of the North Fork Middle Fork Eel River

43.3 Status of Middle Fork Eel River Coho Salmon

Spatial Structure and Diversity

Except for occasional strays, the current distribution of spawners is extremely limited if they are present at all. Because of the extremely low number of individuals, diversity is also extremely low. Because its spatial structure and diversity are limited, the Middle Fork Eel River coho salmon population is at high extinction risk. Population Size and Productivity

Williams et al. (2008) determined at least 78 coho salmon must spawn in the Middle Fork Eel River each year to avoid extinction resulting from extremely low population sizes. The Middle Fork Eel River coho salmon population size is unknown and is presumed to be extirpated. Under the current climate, the Middle Fork Eel River may never have supported coho salmon (U.S. Forest Service (USFS) 2009d). Surveys of the Middle Fork Eel River and its tributaries since 1979 have resulted in no observations of coho salmon. Given the extremely low population size and presumed negative population growth rate, the Middle Fork Eel River coho salmon population is at high risk of extinction.

Extinction Risk

The Middle Fork Eel River coho salmon population is presumed to be functionally extinct, not viable, and at high risk of extinction because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al.

2008). Any remnant coho salmon that still use this population area are at high extinction risk. Areas with the highest intrinsic potential are primarily in the Round Valley; however, most of the tributaries in the Round Valley are dry in the summer (U.S. Environmental Protection Agency (EPA) 2003b).

Role in SONCC Coho Salmon ESU Viability

The Middle Fork Eel River population is a Potentially Independent non-core population within the ESU meaning that it has a high likelihood of persisting in isolation over a 100-year time scale but is too strongly influenced by immigration from other populations to exhibit independent dynamics (Williams et al. 2006). Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU. The Middle Fork Eel River population recovery target is for the population to recover to at least a moderate risk of extinction (see Chapter 2).

43.4 Plans and Assessments

Environmental Protection Agency

Total Maximum Daily Loads for the Eel River

In December 2003, the EPA published the final Total Maximum Daily Loads (TMDL) for temperature and sediment for the Middle Fork Eel River. The North Coast Regional Water Quality Control Board is required to develop measures which will result in implementation of the TMDLs in accordance with the requirements of 40 CFR 130.6

State of California

Eel River Salmon and Steelhead Restoration Action Plan

In 1997, the California Department of Fish and Game completed its assessment of the Eel River basin and provided recommendations for restoration of salmonid stocks. Primary recommendations included removing barriers, reducing sediment inputs, improving riparian forest conditions, reducing water withdrawals, enhancing habitat, and controlling Sacramento pikeminnow.

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The specific restoration recommendations developed by the Coho Recovery Team and CDFG for the Middle Fork Eel River (for Subareas Eden Valley, Round Valley, Black Butte River, and Wilderness) have been considered and incorporated into the table of population-specific recovery actions.

U.S. Forest Service

Watershed Analysis

The U.S. Department of Agriculture Forest Service completed watershed analyses for the Upper Middle Fork Eel River and the Black Butte River in 1994 and 1996, respectively.

43.5 Stresses

Table 43-2. Severity of stresses affecting each life stage of coho salmon in the Middle Fork Eel River population. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Sediment Supply[1]	Very High	Very High	Very High[1]	High	Very High	High
2	Degraded Riparian Forest Conditions[1]	Low	High	High[1]	High	High	High
3	Increased Disease/Competition/Predation	Low	High	High	High	Low	High
4	Barriers	-	Medium	Medium	Medium	Medium	Medium
5	Lack of Floodplain and Channel Structure	Low	Low	High	High	High	Medium
6	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	Medium
7	Impaired Water Quality	Low	Medium	High	High	Medium	Medium
8	Altered Hydrologic Function	Medium	Medium	Medium	Medium	Medium	Medium
9	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
10	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Based on the type and extent of stresses and threats affecting the population as well as the limiting factors influencing productivity, the juvenile life stage is likely the most limited, and quality summer and winter rearing habitat is lacking. Juvenile summer and winter rearing success is most limited by unsuitable habitat resulting from high water temperatures and excessive sedimentation. Moreover, channel complexity and estuary diversity are important to juvenile coho salmon, increasing their size and fitness prior to ocean entry and their overall marine survival success.

Complex stream channels with deep pools and woody structure as well as tidally influenced wetlands with off channel ponds are important refuge areas for juvenile coho. Properly functioning rearing habitat would provide buffers against some of the other stresses affecting the population. Juvenile coho salmon would be more protected against predation, competition, and warm mainstem water temperatures if there were additional refugia areas. Although water temperatures in this subbasin are elevated, several pools and tributaries have been identified as potential thermal refugia. Although these refugia are not in reaches with high IP values, they could still provide important rearing habitat for juveniles.

Sediment Supply

Excessive sediment presents a very high stress for most of the life stages of coho salmon. . Increased sediment delivery resulted in a high percentage of embeddedness in the Middle Fork Eel River and a number of its tributaries. Measurements in the upper subbasin show limited sediment deposition in pools, where the median particle size is good to fair. The EPA (2003b) estimated that 95 percent (574 tons/mi^2/year) of the sediment load is due to the natural, highly erosive geology of the upper subbasin, and the remaining 5 percent (29 tons/mi^2/year) of the sediment load is management related. High sediment loads embed spawning gravel, rendering spawning beds less suitable, bury redds, and fill-in pools.

Riparian Forest Conditions

Degraded riparian forest conditions are a high stress for all coho salmon life stages. Riparian shade is generally fair in the valley while the upper subbasin has fair to good shade cover. Streamside areas are dominated by the early seral conditions of either open or hardwood canopies. The lack of mature riparian species and an insufficient forest canopy results in inadequate water temperatures for juvenile rearing.

Sudden oak death (SOD) is an exotic pathogen affecting almost all native species of plants, shrubs, and trees. SOD is in epidemic stages in population areas downstream of the population, in which coho salmon must migrate through. Because the SOD pathogen is water borne and can travel downstream in watercourses, the likelihood of SOD outbreaks in the population area and adjacent populations are high. One of the largest areas infected by SOD occurs near Redway and is growing at a very fast rate.

Increased Disease, Competition, and Predation

The non-native Sacramento pikeminnow poses a high threat to coho salmon fry, juveniles, and smolts and also competes with juveniles for limited food and habitat. The pikeminnow is successful in the Middle Fork Eel River because it thrives in severely impacted habitat that is less favorable for salmonids.

Barriers

Barriers are a medium stress for all life stages from juveniles to adults. Several tributaries of the Middle Fork Eel River have natural and/or unnatural complete barriers as well as partial barriers. Some dams and natural barriers block access to high IP habitats, such as on Cutfinger Creek. A barrier on Willow Creek may also partially or completely block access to this high IP tributary.

Floodplain and Channel Structure

Habitat complexity, including presence of pools, large wood cover, and floodplains, is essential for juvenile coho salmon to optimize forage; avoid predation; and access thermal and velocity refuges. Inadequate floodplain and channel structure presents a high stress for juveniles, smolts and adults. Pool frequency is poor throughout the population area, and pool depth varies from good to poor. In the early 1900s, Round Valley streams were extensively modified and resulted in significant stream incision throughout the valley that disconnected the streams from their floodplains. Derelict cars were commonly used as riprap to stabilize the streambanks.

Impaired Estuary/Mainstem Function

All salmon and steelhead that originate from the Middle Fork Eel River migrate to and from the ocean through the mainstem Eel River and the Eel River estuary. The Eel River estuary was once a highly complex and extensive habitat area that played a vital role in the health and productivity of all Eel River coho salmon populations. The degraded function of the Eel River estuary and mainstem migratory corridor today constitutes a high stress for this population. The Eel River estuary is severely impaired because of past diking and filling of wetlands for agriculture and flood protection. Approximately 60 percent of the estuary has been lost through the construction of levees and dikes (CDFG 2010b). There is evidence that the estuary once supported a high degree of estuarine habitat and rearing potential, but very little of that historic function still exists. Mainstem conditions contribute to this stress because of water quality issues, predation pressure, and degraded habitat. Juveniles, smolts, and adults suffer from lost opportunities for increased growth and survival in formerly extensive and now degraded estuarine and mainstem rearing and migratory habitats.

Impaired Water Quality

Suitable water quality, especially appropriate temperature, is essential for juvenile coho salmon growth and survival. Impaired water quality acts as a high stress for juveniles and smolts and represents a medium stress for fry and adults. Although benthic macroinvertebrate richness and EPT metrics are rated very good (indicating little to no water quality contamination and good dissolved oxygen levels), summer rearing stream temperature is poor throughout most of the population area. Most of the exposed main channels are close to lethal stream temperatures during the hottest part of the summer (EPA 2003b). However, the headwaters of Black Butte Creek may have thermal refugia, and the upper Middle Fork Eel River has many stratified pools that support other salmonids.

Hydrologic Function

Altered hydrologic function is a medium stress for all life stages when summarized across the subbasin. Water quantities in the upper subbasin are believed to be very good. Flow data for the lower subbasin wherein most of the high IP areas occur does not exist. The EPA (2003b) noted that most of the tributaries in the Round Valley and Elk/Thatcher areas are dry except in their uppermost portions. Beginning in the 1850s, the conversion of wetlands to arable lands resulted in a lower water table and reduced summer flows.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries in California are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effects of fisheries managed by the state of California and tribal governments upon the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Middle Fork Eel River population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin.

43.6 Threats

Table 43-3. Severity of threats affecting each life stage of coho salmon in the Middle Fork Eel River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	High	Very High	Very High	High	Very High	Very High
2	High Intensity Fire	High	High	Medium	Medium	High	High
3	Climate Change	Medium	Medium	High	High	High	High
4	Invasive Non-Native/Alien Species	Low	High	High	High	Low	Medium
5	Road-Stream Crossing Barriers	-	Medium	Medium	Medium	Medium	Medium
6	Dams/Diversion	Low	Medium	Medium	Medium	Medium	Medium
7	Agricultural Practices	Medium	Medium	Low	Low	Medium	Medium
8	Urban/Residential/Industrial	Low	Medium	Low	Low	Medium	Medium
9	Fishing and Collecting	-	-	-	-	Medium	Medium
10	Channelization/Diking	Low	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low

[1]Gravel Mining/Gravel Extraction, and Timber Harvest are not considered threats to this population.

Roads

Roads are a significant threat across all life stages and are the most significant, overall threat for coho salmon in this population. Road density is very high in the Round Valley, where high IP reaches are predominately located. Road-related and harvest-related landsliding rates are highest in Black Butte, Elk Creek and Round Valley subareas with rates as high as 9 to 13 tons per square mile per year (EPA 2003b). With few road decommissioning and upgrading projects in the population area and the likelihood of more road building, this threat is likely to continue in the future.

High Intensity Fire

High intensity fire is a high threat to adults, eggs, and fry and a medium threat to juveniles. Past timber harvest practices coupled with decades-long fire-suppression efforts have rendered understory forest fuel loads excessive. High intensity fires regularly result from these excessive forest fuel loads and are likely to continue in this subbasin. Such high intensity fires threaten coho salmon because they remove vegetation and plant litter that protects or minimizes soil erosion, gullying, and mass wasting that contributes to high sediment loads within coho salmon habitats. High sediment loads embed spawning gravel, making it less suitable for spawning or burying redds and alevins. Lastly, high intensity fires remove riparian trees, thus increasing solar radiation in the mainstem and tributaries and resulting in elevated water temperatures.

Climate Change

Climate change will have the greatest impact upon juveniles, smolts, and adults. The current climate is generally warm and regional average temperature models indicate average temperatures could increase by up to 3 °C in the summer and by up to 1 °C in the winter (see Appendix B for modeling methods). Annual precipitation in this area is predicted to change little over the next century. However, snowpack in upper elevations of the Eel River basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009). The vulnerability of the Eel River estuary to sea level rise is very high. Juvenile and smolt rearing and migratory habitats are most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Rising sea level may also impact the quality and extent of wetland rearing habitat in the estuary. Overall, the range and degree of variability in temperature and precipitation is likely to increase in all populations. As with all populations in the ESU, adults will be negatively impacted by ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

Invasive Non-Native/Alien Species

The non-native Sacramento pikeminnow is a high threat to fry, juveniles, and smolts because they compete with and prey upon young coho salmon. Sacramento pikeminnow were introduced in Lake Pillsbury in 1979 (Brown and Moyle 1997) and have spread throughout the entire Eel River basin. The warm water temperatures in the Eel River and Lake Pillsbury allow this voracious predator to thrive in this system. The Sacramento pikeminnow's presence in Lake Pillsbury makes eradication of this species extremely difficult. Any effort to remove this species in the Eel River without treating the lake will only be temporary because the lake will continue to be the source population for the rest of the Eel River basin.

Road-stream Crossing Barriers

Road-related barriers are a low threat to coho salmon. There are six complete and three partial barriers resulting from road culverts in the population area. However, most of these barriers occur outside of high IP reaches.

Dams/Diversions

Diversions pose a medium threat to fry, juveniles, smolts, and adults and a low threat to eggs. Unpermitted agricultural diversions, primarily for remote cultivation practices, significantly reduce or eliminate streamflows during the summer and fall rearing periods and are likely to increase as remote agriculture is expanded in the upper population reaches.

Agricultural Practices

Agricultural practices present a medium threat to adults, eggs, and fry and a low threat to the other life history stages. Grazing occurs throughout the lower subbasin, and where exclusionary fencing has not been installed and maintained, contributes to increased bank erosion and riparian vegetation degradation.

Urban/Residential/Industrial Development

Urban, residential, and industrial development pose medium threats to adults and fry. The largest developed areas within the population area are located in the valley reaches near Covelo. However, this threat is not expected to change significantly because Covelo is not expected to significantly expand in the near future.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The Round Valley Tribe’s salmonid fishery has the potential to cause injury or death to coho salmon in the Middle Fork Eel River. The effects of the fisheries managed by the State of California and by the Round Valley Tribe upon the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. As of April 2011, NMFS has not authorized future collection of coho salmon for research purposes in the Middle Fork Eel River.

Channelization/Diking

On-going, un-permitted stream channel manipulations pose a medium threat to all life stages. Tributaries to the Middle Fork Eel River in the Round Valley area have been channelized for residential and agricultural purposes. Channelization significantly degrades juvenile coho salmon rearing habitat by increasing flow velocities, reducing creek meanders, and impeding the creeks’ abilities to access floodplains during high flows.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Middle Fork Eel River population area. The rationale for these ratings is described under the “Adverse Hatchery-Related Effects” stress.

43.7 Recovery Strategy

Historic logging, agriculture, urbanization, and associated activities in the Middle Fork Eel River have resulted in severely degraded instream and riparian conditions in the population area. Currently, high road density continues to contribute excessive sediment loads. Improperly managed livestock grazing significantly degrades water quality and quantity and negatively impacts water temperatures in the lower subbasin. Excessively high water temperatures severely limit available juvenile coho salmon summer rearing habitat, especially in high IP reaches. Natural and artificial barriers also limit rearing and spawning access. The non-native Sacramento pikeminnow continues to compete with and prey upon juvenile coho salmon. The highest IP areas within the Middle Fork Eel River subbasin occur in areas exhibiting the highest human impacts.

Coho salmon abundance and distribution in the Middle Fork Eel River are practically nonexistent, making population recovery extremely difficult. Recovery activities in the population area should promote increased spatial distribution as well as increased productivity and abundance. Where possible, activities should focus upon those tributaries with high IP values. Activities that reduce sediment delivery and stream temperatures should be a high priority within the population area. Specific goals for each stressor are listed below and identify activities expected to reduce the stresses currently affecting the Middle Fork Eel River coho salmon population.

Table 43-4 on the following page lists the recovery actions for the Middle Fork Eel River population.

Table 43-4. Recovery action implementation schedule for the Middle Fork Eel River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MFER.7.1.4	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	BR
SONCC-MFER.7.1.4.1	*Review General Plan or City Ordinances to ensure coho salmon habitat needs are accounted for. Revise if necessary*					
SONCC-MFER.7.1.4.2	*Develop watershed-specific guidance for managing riparian vegetation*					
SONCC-MFER.7.1.5	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve grazing practices	Population wide	BR
SONCC-MFER.7.1.5.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-MFER.7.1.5.2	*Develop grazing management plan to meet objective*					
SONCC-MFER.7.1.5.3	*Plant vegetation to stabilize stream bank*					
SONCC-MFER.7.1.5.4	*Fence livestock out of riparian zones*					
SONCC-MFER.7.1.5.5	*Remove instream livestock watering sources*					
SONCC-MFER.8.1.7	Sediment	Yes	Reduce delivery of sediment to streams	Reduce risk of catastrophic fire	Population wide	BR
SONCC-MFER.8.1.7.1	*Identify forested stands for fire hazard reduction*					
SONCC-MFER.8.1.7.2	*Apply appropriate management techniques (e.g. thinning, burning) to reduce risks of high intensity fire*					
SONCC-MFER.8.1.8	Sediment	Yes	Reduce delivery of sediment to streams	Reduce stream bank erosion	Round Valley, Eden Valley, wilderness, and Black Butte River HSAs	BR
SONCC-MFER.8.1.8.1	*Inventory sediment sources, and prioritize for treatment*					
SONCC-MFER.8.1.8.2	*Treat priority sediment source sites, guided by assessment*					
SONCC-MFER.8.1.9	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	BR
SONCC-MFER.8.1.9.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MFER.8.1.9.2	*Decommission roads, guided by assessment*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MFER.8.1.9.3	*Upgrade roads, guided by assessment*					
SONCC-MFER.8.1.9.4	*Maintain roads, guided by assessment*					
SONCC-MFER.14.2.1	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of Sacramento pikeminnow	Population wide	2
SONCC-MFER.14.2.1.1	*Determine the effectiveness of various pikeminnow suppression techniques and develop experimental control methods. Develop a plan that identifies watersheds suitable for experimental pikeminnow control*					
SONCC-MFER.14.2.1.2	*Control Sacramento pikeminnow, guided by the control plan*					
SONCC-MFER.1.2.23	Estuary	No	Improve estuarine habitat	Improve estuary condition	Eel River Estuary	3
SONCC-MFER.1.2.23.1	*Implement recovery actions to address strategy "Estuary" for Lower Eel/Van Duzen River population*					
SONCC-MFER.16.1.11	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MFER.16.1.11.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MFER.16.1.11.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-MFER.16.1.12	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MFER.16.1.12.1	*Determine actual fishing impacts*					
SONCC-MFER.16.1.12.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					
SONCC-MFER.16.2.13	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MFER.16.2.13.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-MFER.16.2.13.2	*Identify scientific collection impacts expected to be consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MFER.16.2.14	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MFER.16.2.14.1	*Determine actual impacts of scientific collection*					
SONCC-MFER.16.2.14.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-MFER.2.1.2	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	BR
SONCC-MFER.2.1.2.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-MFER.2.1.2.2	*Place instream structures, guided by assessment results*					
SONCC-MFER.2.2.3	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Remove, set back, or reconfigure levees and dikes	Population wide	BR
SONCC-MFER.2.2.3.1	*Assess feasibility and develop a plan to remove or set back levees and dikes that includes restoring the natural channel form and floodplain connectivity once the levees have been removed*					
SONCC-MFER.2.2.3.2	*Remove levees and restore channel form and floodplain connectivity*					
SONCC-MFER.2.2.22	Floodplain and Channel Structure	No	Reconnect the channel to the floodplain	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows	Population wide	3
SONCC-MFER.2.2.22.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-MFER.2.2.22.2	*Implement restoration projects that improve off channel habitats as guided by assessment results*					
SONCC-MFER.27.1.15	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-MFER.27.1.15.1	*Perform annual spawning surveys*					
SONCC-MFER.27.1.16	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MFER.27.1.16.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MFER.27.1.17	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-MFER.27.1.17.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-MFER.27.1.17.2	*Annually estimate the in-river tribal harvest of wild/natural SONCC coho salmon*					
SONCC-MFER.27.2.18	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MFER.27.2.18.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-MFER.27.2.18.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-MFER.27.2.19	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-MFER.27.2.19.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-MFER.27.2.20	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MFER.27.2.20.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-MFER.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the threat 'Invasive Species'	Population wide	3
SONCC-MFER.27.1.21.1	*Annually estimate the density of non-native predators, such as the Sacramento pikeminnow in the Eel River basin*					
SONCC-MFER.27.1.21.2	*Identify the status and trend of invasive species*					
SONCC-MFER.27.1.24	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-MFER.27.1.24.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MFER.27.1.24.2	*If appropriate, modify population types and targets using revised methodology*					

44. Middle Mainstem Eel River Population

- Interior Eel River Diversity Stratum
- Core, Functionally Independent Population
- High Extinction Risk
- 6,400 Spawners Required for ESU Viability
- 347 mi^2
- 256 IP km (159 mi) (53 % High)
- Dominant Land Uses are Agriculture and Timber Production
- Principal Stresses are ‘Altered Sediment Supply’ and ‘Degraded Riparian Forest Conditions’
- Principal Threats are ‘Roads’ and ‘Dams/Diversions’

44.1 History of Habitat and Land Use

The 1955 and 1964 floods caused significant sedimentation in the Eel River and its tributaries, filled in many pools, destroyed riparian vegetation, and widened channels. Historic timber harvest contributed to significant erosion and sedimentation of stream channels. Unstable landforms, high road densities, and past timber harvest practices all contributed to the population area’s current poor habitat quality.

Ranch and urban land development profoundly affected the Middle Mainstem Eel River’s physical nature. Historically, Little Lake Valley was a large seasonal lake. In 1910, the lake was drained to repurpose the former lakebed for cattle grazing and potato production (LeDoux-Bloom and Downie 2007). During the same timeframe, the thalwegs through Little Lake were connected via dredging to Outlet Creek and the creek and its tributaries underwent channelization. Subsequent Highway 101 construction precipitated Outlet Creek’s realignment. Erosion from poorly constructed roads in the highly erosive Franciscan geology contributed to increased sediment loading within the region’s rivers, leaving streams shallower, warmer, and more prone to flooding (Raphael 1974, Bodin et al. 1982). The current landscape is comprised of hardwood-dominated forest stands and pasture lands. Late seral stands are largely absent from the population area.

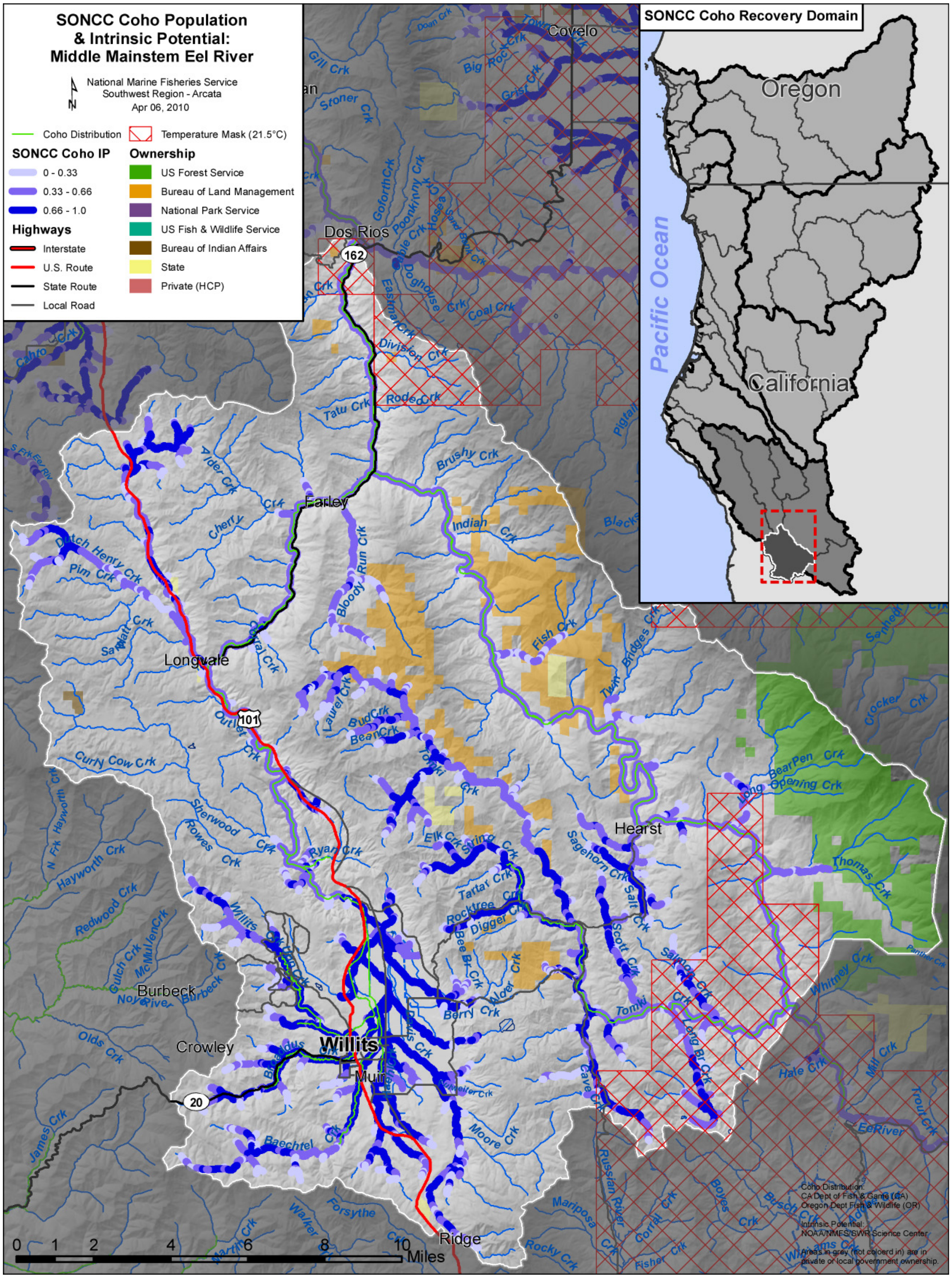

Figure 44-1. The geographic boundaries of the Middle Mainstem Eel River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

Rural residence and small ranch establishment, coupled with early 1990s agricultural intensification, has increased water supply demands. Currently, water users primarily create in-stream diversions or shallow wells to satisfy their water demands; such practices impact streamflows during summer low-flow periods. Prolific remote agriculture within the area requires large quantities of water from the mainstem Eel River and its tributaries to be diverted, which has profoundly impacted the region's hydrology (LeDoux-Bloom and Downie 2007).

The Potter Valley Project's 1908-built Cape Horn and 1922-erected Scott hydropower production dams significantly altered Middle Mainstem Eel River coho salmon habitat.

The Potter Valley Project diverts significant flows from the mainstem Eel River to areas outside of the basin (Russian River). Up to approximately 160,000 acre feet of Eel River flows are annually diverted into the East Fork of the Russian River for hydropower production and agricultural uses in the Russian River. Prior to 2004, summer instream flows recorded downstream of Cape Horn Dam typically measured between 2 and 3 cfs. Summer flow reductions degraded riparian forests, restricted coho salmon rearing habitats, restricted coho salmon tributary access, and made juvenile coho salmon survival nearly impossible.

In 2004, the Federal Energy Regulatory Commission (FERC) required Pacific Gas and Electric (PG&E) to implement an instream flow regime consistent with the Reasonable and Prudent Alternative in the National Marine Fisheries Service's (NMFS) 2002 Biological Opinion. The new flow requirement increased Cape Horn Dam's minimum water release volume, incorporated within-year and between-year variability, and replaced the formerly constant 2 cfs summer instream flow minimum.

In 1980, predatory Sacramento pikeminnow were introduced into Lake Pillsbury (California Department of Fish and Game (CDFG) 1997b), and have since colonized the entire Eel River watershed. This predator thrives in warmer waters like those in the mainstem Eel River. Increased sedimentation, dams, diversions, and degraded riparian forests have decreased the number of high-quality pool refugia that could have provided some protection for juvenile coho salmon.

44.2 Historic Fish Distribution and Abundance

While estimates of past Middle Mainstem Eel River coho salmon population abundance are not available, estimates for a subset of this population are available. Two major tributaries, Outlet and Tomki creeks, both have some data on abundance available. Outlet Creek was historically the largest producer of coho salmon in the population area. In the 1989/1990 season there was an estimated 240 spawning adults in Outlet Creek (Brown and Moyle 1991). No population estimates for Tomki Creek have been made, and brood year surveys since 1979 in the Tomki Creek watershed have not confirmed any presence of coho salmon, except for one observation in Cave Creek. The entire Eel River basin was estimated to have supported 70,000 coho salmon in 1900 (CDFG 1997b). By 1964, less than 500 coho salmon were estimated to return to the Eel River above the South Fork (CDFG 1965). .

Records from the late 1980s found that coho salmon spawned in Long Valley, Reeves Canyon, Ryan, and Haehl creeks and several Outlet Creek tributaries, including Willits, Broaddus, and Baechtel creeks (Brown and Moyle 1991).

Based upon recorded juvenile observations, the Indian, Bloody Run, Reeves, Rowes, Mill, Dutch Henry, Rocktree, String, and Tarter Creek tributaries are believed to have also supported coho salmon (Brown and Moyle 1991, Downie and Gleason 2007). In 1949, approximately 16,815 juveniles were rescued from Tomki Creek and 5,629 juveniles were rescued from Baechtel Creek (Downie and Gleason 2007). Tomki Creek presumably does not currently support coho salmon, and Outlet Creek escapement is in severe decline, ranging from 0 to 25 spawners annually (LeDoux-Bloom and Downie 2007).

Table 44-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Subarea	***Stream Name***	***Subarea***	***Stream Name***
Outlet Creek	Baechtel Creek[1]	**Tomki Creek**	Bean Creek
	Berry Creek		Bud Creek
	Bloody Run Creek[1]		Cave Creek[2]
	Broaddus Creek[1]		Elk Creek
	Davis Creek		Laurel Creek
	Dutch Henry Creek		Long Branch Creek[2]
	Fulweiter Creek		Rocktree Creek
	Haehl Creek		Sagehorn Creek
	Long Valley Creek		Salmon Creek[2]
	Mill Creek[1]		Salt Creek
	Moore Creek		Scott Creek
	Outlet Creek[1]		Shelving Rock Creek
	Upp Creek		String Creek
	Willits Creek[1]		Tarter Creek
			Tomki Creek
			Unnamed tributary to Garcia Creek
			Wheelbarrow Creek

[1] Denotes a "Key Stream" as identified in the State of California's Coho Recovery Strategy
[2] Stream is under the temperature mask, as modeled by Williams et al. (2006)

44.3 Status of Middle Mainstem Eel River Coho Salmon

Spatial Structure and Diversity

Current spawner distribution is unknown but is expected to be limited to Outlet Creek. CDFG conducts annual surveys of Outlet Creek and estimates the escapement ranges from 0 to 25 coho salmon annually (LeDoux-Bloom and Downie 2007). The Middle Mainstem Eel River coho salmon population is at high risk of extinction because its spatial structure and diversity are very limited.

Population Size and Productivity

Although the Middle Mainstem Eel River coho salmon population size is unknown, this population's extinction risk is likely high. In a 2007/2008 survey of Willits and Mill creeks (tributaries of Outlet Creek), over 40 spawners were observed (Harris 2010). However, the two other year classes have been mostly absent. In all Middle Mainstem Eel River streams, breeding groups have been lost or severely depressed. The population growth rate is unknown but is likely negative in most years. Therefore, the Middle Mainstem Eel River coho salmon population is at high risk of extinction given the extremely low population size and negative population growth rate.

Extinction Risk

The Middle Mainstem Eel River coho salmon population is not viable and is at high risk of extinction because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the ESU's evolutionary legacy. . As a core population, the recovery target for the Middle Mainstem Eel River population is for the population to be viable, meaning that it has a low risk of extinction according to population viability criteria (see Chapter 4). Core populations may provide beneficial strays to other populations as abundance improves over time. Middle Mainstem Eel River coho salmon possess "long run" life histories as these fish must migrate long distances within the Eel River to reach their spawning grounds. Their life histories are unique and important to the long term survival and recovery of the SONCC coho salmon ESU as well as to the Interior Eel River Diversity Stratum.

Role of Adjacent Populations

Situated near the upstream extent of anadromy in the Eel River basin, this population's emigrating fish must traverse and interact with several downstream populations of coho salmon. . These downstream populations include (progressing downstream): the Middle Fork Eel River; Mainstem Eel River; South Fork Eel River; and the Lower Eel/Van Duzen River. In addition, migrants from upstream populations influence Middle Mainstem Eel River coho salmon. Adjacent populations benefit the Middle Mainstem Eel River population's recovery by serving as a source of genetic diversity; repopulating suitable tributaries; and schooling in pools, refugia, and the ocean.

44.4 Plans and Assessments

Environmental Protection Agency

Total Maximum Daily Loads
http://www.swrcb.ca.gov/northcoast/

In January 2006, the EPA published the final Total Maximum Daily Loads (TMDLs) for temperature and sediment for the Middle Main Eel River and tributaries. The North Coast Regional Water Quality Control Board is required to develop measures which will result in implementation of the TMDLs in accordance with the requirements of 40 CFR 130.6.

State of California

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004.

Eel River Salmon and Steelhead Restoration Action Plan

In 1997, the California Department of Fish and Game completed its assessment of the Eel River basin and provided recommendations for restoration of salmonid stocks. Primary recommendations included removing barriers, reducing sediment inputs, improving riparian forest conditions, reducing water withdrawals, enhancing habitat, and controlling Sacramento pikeminnow.

44.5 Stresses

Table 44-2. Severity of stresses affecting each life stage of coho salmon in the Middle Mainstem Eel River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Altered Sediment Supply[1]	Very High	Very High	Very High[1]	Very High	Very High	Very High
2	Degraded Riparian Forest Conditions[1]	-	Very High	Very High[1]	Very High	High	Very High
3	Impaired Water Quality[1]	High	Very High	Very High[1]	Very High	Medium	High
4	Lack of Floodplain and Channel Structure	High	Very High	Very High	High	High	High
5	Altered Hydrologic Function	Medium	High	High	High	-	High
6	Increased Disease/Predation/Competition	Low	High	High	High	Low	High
7	Impaired Estuary/Mainstem Function	-	Low	High	High	Medium	Medium
8	Barriers	-	Low	Medium	Low	Medium	Medium
9	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
10	Adverse Hatchery-Related Effects		Low	Low	Low	Low	Low

[1]Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

The juvenile life stage is the most limited and quality summer and winter rearing habitat is lacking. Juvenile summer and winter rearing success are most limited by unsuitable habitat arising from high water temperatures, excessive sedimentation, and a lack of channel complexity. Low summer flows resulting from permitted and unpermitted diversions benefit the non-native Sacramento pikeminnow by providing this predator ideal, low-flow warm conditions. Complex stream channels with deep pools and woody structure as well as tidally influenced wetlands with off channel ponds are important refuge areas for juvenile coho. Properly functioning rearing habitat would provide buffers against some of the other stresses affecting the population. Juvenile coho salmon would be more protected against predation, competition, and warm mainstem water temperatures if there were additional refugia.

Currently, none of the tributaries accessible to coho salmon function as refugia. Recently, spawning adults were observed in Willits and Mill creeks, and these areas should be given high priority restoration actions.

Sediment Supply

High percentages of fine sediment (<1mm) and sand (<6.4mm) are observed in Willits Creek. Except for the lowest reach of Tomki Creek, all surveyed reaches have high or very high embeddedness. Sediment loading can be inferred from road density because the majority of sediment originates from unmaintained and legacy dirt and gravel roads. Road density is very high (>3 mi/sq mi) throughout most of the population area. High road density areas result in higher sediment mobilization into adjacent waterways. Other sources of sedimentation include high intensity fire-exposed soils; the 1964 flood; highly erodible slopes; and historic timber harvest.

Excessive sedimentation reduces habitat diversity, embeds spawning gravel, and reduces channel stability. Such habitat changes hinder successful spawning and emergence; reduce pool frequency and depth; increase competition and predation; and reduce macroinvertebrate densities. Suspended sediment loads and high turbidity can negatively impact juvenile salmon by interfering with gill function as well as feeding and other behaviors.

Riparian Forest Conditions

Although Outlet Creek's upstream reach has good stream canopy cover, all other surveyed reaches of Broaddus, Tomki, and Long Valley creeks have either fair or poor canopy cover. The lack of canopy cover is likely due to a lack of mature riparian zones resulting from past logging, agricultural clearing, , grazing, urbanization, high intensity fires, and the major floods in 1955 and 1964 that obliterated riparian areas' mature conifer trees. Riparian stands are currently dominated by willows, alders, and hardwoods and in general lack conifers. All surveyed reaches of Tomki, Long Valley, Outlet, and Broaddus creeks have at least 40 percent hardwood canopy. Lack of suitable riparian forests results in increased solar radiation that elevates water temperatures to stressful or lethal levels for juvenile coho salmon. Healthy and mature riparian forests stabilize banks, reduce and filter erosion, and contribute large wood to streams which create complex channel and floodplain structure.

Sudden oak death (SOD) is an exotic pathogen affecting almost all native species of plants, shrubs, and trees. SOD is in epidemic stages in the population area and in adjacent population areas. Because the SOD pathogen is water borne and can travel downstream in watercourses, the likelihood of SOD outbreaks in the population area and those mainstem segments in which coho salmon must migrate through are high. One of the largest areas infected by SOD occurs near Redway and is growing at a very fast rate.

Impaired Water Quality

Benthic macroinvertebrate sampling within the population area was limited to one site each in Willits, Broaddus, and Baechtel creeks, and such sampling reveals either fair or poor conditions . Summer rearing stream temperature is poor with values exceeding 17°C for the maximum weekly average temperature (MWAT) throughout most of the population area. Extensive water quality monitoring (Humboldt County Resource Conservation District (HCRCD) 1998) revealed that many Middle Mainstem Eel River tributary water temperatures were marginal, stressful, or lethal (19°C to over 24°C) to coho salmon. Excessively warm water temperatures can occur as early as late May during hot years with low flows; but more commonly occur during late June and early July. Elevated temperature is problematic throughout the population area, thus prompting the 303(d) listing for temperature. High temperature-induced stress can lead to decreased growth and survival of juveniles and increased mortality of adult coho salmon.

Floodplain and Channel Structure

The majority of surveyed reaches and tributaries have fair or poor pool depths (<2.0 ft). The lower half of Tomki Creek has very poor pool frequency (<35 percent by length), whereas Outlet Creek and its tributaries have mostly good and very good pool frequencies (>50 percent by length). Between the mouth of String Creek and Cave Creek, 1952-dated photos indicate maximum channel widths of 200 feet; in 1983, the maximum width expanded to 400 feet, primarily resulting from gravel extraction during that time period (U.S. Environmental Protection Agency (EPA) 2004). Large woody debris data are lacking, but NMFS believes the Middle Mainstem Eel River's large wood volume is inadequate given current conditions and disturbance history.

Hydrologic Function

Potter Valley Project instream flow requirements incorporate within-year and between-year variability. Although in-stream flow remains less than that of an un-impaired flow, the flow regime approximates a natural hydrograph. Eel River minimum in-stream flows have increased and the total water diverted out of the Eel River and into the East Fork Russian River has been reduced from up to160,000 to between 60,000 to 138,000 acre-feet per year based on the water year.

Throughout the Eel River and its tributaries, remote agriculture has prompted numerous water diversions resulting in significant flow reductions that have severely degraded instream and riparian communities. Degradation indicators include benthic macroinvertebrate population reductions, habitat inaccessibility, shallow pools, elevated water temperatures, and poor riparian vegetation. Middle Mainstem Eel River tributary summer base flows are also affected by rural and urban water withdrawals and roads.

Disease/Predation/Competition

Sacramento pikeminnow thrive within the population area's warmer water temperatures, prey upon coho salmon, and displace coho salmon from other available habitats.

Impaired Estuary/Mainstem Function

All Middle Mainstem Eel River coho salmon migrate to and from the ocean through the mainstem Eel River and the Eel River estuary. The Eel River estuary was once a highly complex and extensive habitat area that played a vital role in the health and productivity of all Eel River coho salmon populations. Agriculture and flood protection-induced diking and wetland filling have resulted in severe impairment and a 60 percent reduction in the size of the Eel River estuary (CDFG 2010b). Mainstem conditions contribute to this stress because of the issues with water quality, predation, and degraded habitat. Juveniles, smolts, and adults transitioning through mainstem and estuarine habitat suffer from the lost opportunity for increased growth and survival.

Barriers

CDFG's Passage Assessment Database indicates that at least 15 road crossing barriers and 6 dams within the Middle Mainstem Eel River completely block fish passage. Except for one road crossing, all of these complete barriers are located within the Outlet Creek watershed, and several of these barriers block access to suitable rearing habitats, including high IP reaches.

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Middle Mainstem Eel River population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin.

44.6 Threats

Table 44-3. Severity of threats affecting each life stage of coho salmon in the Middle Mainstem Eel River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Roads	Very High	Very High	Very High	Very High	Very High	Very High
2	Dams/Diversion	Low	High	Very High	High	High	High
3	Climate Change	Low	Low	Very High	Very High	Medium	High
4	High Intensity Fire	High	High	High	High	High	High
5	Agricultural Practices	Medium	High	High	High	Medium	High
6	Invasive Non-Native/Alien Species	Low	High	High	High	Low	High
7	Urban/Residential/Industrial	Medium	Medium	High	Medium	Medium	Medium
8	Channelization/Diking	Medium	Medium	Medium	Medium	Medium	Medium
9	Mining/Gravel Extraction	Medium	Medium	Medium	Medium	Medium	Medium
10	Timber Harvest	Medium	Medium	Medium	Medium	Medium	Medium
11	Fishing and Collecting	-	-	-	-	Medium	Medium
12	Road-Stream Crossing Barriers	-	Low	Medium	Low	Medium	Low
13	Hatcheries	Low	Low	Low	Low	Low	Low

Roads

Throughout most of the population area, paved, gravel, and dirt road densities are very high (>3 mi/mi^2), especially in areas with high IP reaches. If not properly maintained, these extensive road networks can increase erosion and sediment availability and facilitate sediment transport into streams. Excessive stream sedimentation causes substrate embeddedness, smothers eggs, reduces pool depths, and results in habitat simplification. Roads can also influence peak flows and contribute to higher peak flows in areas with high paved road densities.

Dams/Diversions

Within the Outlet Creek watershed, 6 dams completely block coho salmon migration. These dams are all located within 4 miles of the city of Willits. Localized residential and agricultural water diversions within the Tomki Creek and Outlet Creek watersheds, including un-quantified remote agricultural water withdrawals, reduce streamflows during critical juvenile rearing periods and restrict fish passage.

Climate Change

Climate change will have the greatest impact upon coho salmon juveniles, smolts, and adults. The current climate is generally warm and regional average temperature models indicate average temperatures could increase by up to 2.6 °C in the summer and by up to 1.2 °C in the winter over the next 50 years (see Appendix B for modeling methods). Area annual precipitation is already low and is predicted to decrease over the next century. In upper elevations of the Eel River basin, snowpack will decrease with temperature and precipitation changes (California Natural Resources Agency 2009).

Juvenile and smolt rearing and migratory habitat are most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Rising sea level may also impact the quality and extent of wetland rearing habitat for smolts in the estuary. Overall, the range and degree of variability in temperature and precipitation are likely to increase in all populations. As with all populations in the ESU, adults will be negatively impacted by ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

High Intensity Fire

Past timber harvest practices coupled with fire-suppression efforts over the past century have rendered understory forest fuel loads excessive. High intensity fires result from these excessive forest fuel loads and often mobilize sediment downslope into streams. The altered vegetation in the population area increases high intensity fire potential that presents a high threat to all coho salmon life stages. Until the subbasin's upland regions undergo fuel reduction, high intensity fires are expected to occur in the future and will continue to alter sedimentation processes and riparian vegetation characteristics.

Agricultural Practices

Agriculture is predominantly low within this population area with the exception of Little Lake Valley. The gentle slopes of Little Lake Valley accommodate various agricultural uses such as pastures for livestock and growing crops. Unfortunately, several high IP reaches are located in and around Little Lake Valley. Grazing presumably occurs throughout the area and may contribute to increased sediment generation and delivery. Local watershed groups are working with landowners to exclude cattle from riparian areas. Agriculture-induced lack of riparian vegetation exacerbates negative water quality and habitat conditions.

Invasive Non-Native/Alien Species

The warm water in the Eel River and Lake Pillsbury create ideal conditions for the non-native Sacramento pikeminnow, which is a voracious predator. The presence of the Sacramento pikeminnow in Lake Pillsbury makes eradication of this species extremely difficult. Any effort to remove this species from the Eel River without treating the lake will only be temporary because the lake will continue to be a source population for the Eel River basin. As more water is released into the mainstem Eel River, more refuge habitat should become available. Moreover, to the extent that restoration activities restore cooler water temperatures, habitat conditions will become less ideal for the pikeminnow. Urban/Residential/Industrial Development

The majority of high IP habitat reaches are located within or near the city of Willits. Future urbanization is likely as transportation infrastructure improves and northerly migration from San Francisco Bay Area metropolitan areas increases. In addition, increased rural residential development is likely as large agricultural holdings are subdivided into smaller ranches. These land use changes will culminate in increased road building, land clearing, and other development activities.

Channelization/Diking

Channelization is especially prominent in the Little Lake Valley, where many of the Middle Mainstem Eel River tributaries are channelized to maximize agricultural production. Within the city of Willits, tributaries are channelized along roads and other urban infrastructures. Because the city of Willits is expected to expand, channelization and diking are expected to increase.

Mining/Gravel Extraction

Very little gravel mining occurs in the Middle Mainstem Eel River. In the past, four gravel mining operations were permitted to operate near Dos Rios, but these operations have ceased.

Timber Harvest

Between 1972 and 1992, timber harvest activities were limited and only a few isolated watersheds experienced moderate harvest intensities. Many of the changes that have occurred to instream and riparian conditions in the Middle Mainstem Eel River reflect legacy effects of more intensive harvest from previous decades. Although the majority of the effects to habitat were the result of legacy timber harvesting, timber harvest will continue into the future and remain a moderate threat.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries upon the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of Middle Mainstem Eel River coho salmon for research purposes. NMFS has determined these collections are not likely to jeopardize the continued existence of the SONCC coho salmon ESU.

Road-Stream Crossing Barriers

CDFG's CalFish website indicates that there are 15 road crossings that are complete barriers to coho salmon migration. Most of these fish passage barriers are in the Outlet Creek watershed and result from either Hwy 101 or 20. Most of these road crossing barriers block high IP reaches, especially in the Willits area.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Middle Mainstem Eel River population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

44.7 Recovery Strategy

Current Middle Mainstem Eel River habitat conditions, combined with a severely depressed coho salmon population and its restricted distribution, significantly increase the extinction risk of this important, inland coho salmon population. Considering that most of the population is in private ownership, much of the high IP habitat is located within developed areas, and predation and competition from non-native Sacramento pikeminnow severely limits juvenile survival, it is clear that immediate measures may be necessary to sustain the remnant Middle Mainstem Eel River population until restoration actions are identified and implemented. Activities that reduce sediment input, increase connectivity to the floodplain, increase riparian vegetation, increase summer instream flows, and reduce the abundance of Sacramento pikeminnow should be immediately implemented.

Table 44-4 on the following page lists the recovery actions for the Middle Mainstem Eel River population.

Table 44-4. Recovery action implementation schedule for the Middle Mainstem Eel River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MMER.7.1.3	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Revegetate riparian areas	Tomki and Outlet Creek HSAs, Long Valley, Broaddus Creeks	3
SONCC-MMER.7.1.3.1	*Identify and prioritize locations for planting*					
SONCC-MMER.7.1.3.2	*Plant conifers and other native species in riparian areas, guided by assessment results*					
SONCC-MMER.7.1.4	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Increase regulatory oversight	Outlet Creek and Tomki Creek HSA	3
SONCC-MMER.7.1.4.1	*Ensure channel modifications are permitted and reviewed*					
SONCC-MMER.7.1.5	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-MMER.7.1.5.1	*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*					
SONCC-MMER.7.1.6	Riparian	Yes	Improve wood recruitment, bank stability, shading, and food subsidies	Reestablish natural fire regime	Upper Watershed of Outlet Creek	3
SONCC-MMER.7.1.6.1	*Identify areas prone to high intensity fire and develop a plan to reestablish a natural fire regime*					
SONCC-MMER.7.1.6.2	*Carry out fuel reduction or modification projects such as thinning, prescribed burning, and piling, guided by the plan*					
SONCC-MMER.8.1.15	Sediment	Yes	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Tomki and Outlet Creek HSA	3
SONCC-MMER.8.1.15.1	*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*					
SONCC-MMER.8.1.15.2	*Decommission roads, guided by assessment*					
SONCC-MMER.8.1.15.3	*Upgrade roads, guided by assessment*					
SONCC-MMER.8.1.15.4	*Maintain roads, guided by assessment*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MMER.8.1.16	Sediment	Yes	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3
SONCC-MMER.8.1.16.1	*Develop grading ordinance for maintenance and building of private roads that minimizes the effects to coho*					
SONCC-MMER.8.1.17	Sediment	Yes	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3
SONCC-MMER.8.1.17.1	*Assess and map mass wasting hazard, prioritize treatment of sites most susceptible to mass wasting, and determine appropriate actions to deter mass wasting*					
SONCC-MMER.8.1.17.2	*Implement plan to stabilize slopes and revegetate areas*					
SONCC-MMER.14.2.9	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of Sacramento pikeminnow	Population wide	2
SONCC-MMER.14.2.9.1	*Determine the effectiveness of various pikeminnow suppression techniques and develop experimental control methods. Develop a plan that identifies watersheds suitable for experimental pikeminnow control*					
SONCC-MMER.14.2.9.2	*Control Sacramento pikeminnow, guided by the control plan*					
SONCC-MMER.1.2.34	Estuary	No	Improve estuarine habitat	Improve estuary condition	Eel River Estuary	3
SONCC-MMER.1.2.34.1	*Implement recovery actions to address strategy "Estuary" for Lower Eel/Van Duzen River population*					
SONCC-MMER.16.1.19	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MMER.16.1.19.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-MMER.16.1.19.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-MMER.16.1.20	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-MMER.16.1.20.1	*Determine actual fishing impacts*					
SONCC-MMER.16.1.20.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-MMER.16.2.21	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MMER.16.2.21.1		*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*				
SONCC-MMER.16.2.21.2		*Identify scientific collection impacts expected to be consistent with recovery*				
SONCC-MMER.16.2.22	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-MMER.16.2.22.1		*Determine actual impacts of scientific collection*				
SONCC-MMER.16.2.22.2		*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*				
SONCC-MMER.2.1.2	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	Tomki Creek and Outlet Creek HSA	3
SONCC-MMER.2.1.2.1		*Assess habitat to determine beneficial location and amount of instream structure needed*				
SONCC-MMER.2.1.2.2		*Place instream structures, guided by assessment results*				
SONCC-MMER.3.1.10	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2
SONCC-MMER.3.1.10.1		*Provide incentives to reduce water use by reducing diversion during summer*				
SONCC-MMER.3.1.10.2		*Establish a forbearance program to reduce diversions during summer*				
SONCC-MMER.3.1.10.3		*Monitor forbearance compliance and flow*				
SONCC-MMER.3.1.11	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	3
SONCC-MMER.3.1.11.1		*Develop an educational program about water conservation programs and instream leasing programs*				
SONCC-MMER.3.1.12	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MMER.3.1.12.1		*Prioritize and provide incentives for use of CA Water Code Section 1707*				
SONCC-MMER.3.1.13	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MMER.3.1.13.1	*Establish a categorical exemption under CEQA for water leasing*					
SONCC-MMER.3.1.14	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Population wide	3
SONCC-MMER.3.1.14.1	*Establish a comprehensive statewide groundwater permit process*					
SONCC-MMER.26.1.1	Low Population Dynamics	No	Increase population abundance	Develop a rearing enhancement program to increase population abundance	Population wide	2
SONCC-MMER.26.1.1.1	*Assess impacts and benefits associated with different enhancement programs such as captive broodstock, rescue rearing, and conservation hatcheries*					
SONCC-MMER.26.1.1.2	*Develop a facility to rear fish*					
SONCC-MMER.26.1.1.3	*Operate enhancement program as a temporary strategy to 26.1*					
SONCC-MMER.26.1.1.4	*Monitor fish populations at all life stages including juvenile snorkel counts, downstream migrant counts, spawning surveys, and PIT tagging*					
SONCC-MMER.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-MMER.27.1.23.1	*Perform annual spawning surveys*					
SONCC-MMER.27.1.24	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track life history diversity	Population wide	3
SONCC-MMER.27.1.24.1	*Describe annual variation in migration timing, age structure, habitat occupied, and behavior*					
SONCC-MMER.27.1.25	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-MMER.27.1.25.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-MMER.27.1.26	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the threat 'Invasive Species'	Population wide	3
SONCC-MMER.27.1.26.1	*Annually estimate the density of non-native predators, such as the Sacramento pikeminnow in the Eel River basin*					
SONCC-MMER.27.1.26.2	*Identify the status and trend of invasive species*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MMER.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-MMER.27.2.27.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-MMER.27.2.27.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-MMER.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-MMER.27.2.28.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-MMER.27.2.29	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-MMER.27.2.29.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-MMER.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-MMER.27.2.30.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-MMER.27.2.31	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-MMER.27.2.31.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-MMER.27.2.32	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-MMER.27.2.32.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-MMER.27.1.33	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-MMER.27.1.33.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-MMER.27.1.35	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-MMER.27.1.35.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-MMER.27.1.35.2	*If appropriate, modify population types and targets using revised methodology*					
SONCC-MMER.5.1.7	Passage	No	Improve access	Remove barriers	Population wide, especially Willits, Broaddus, Outlet creeks and their tributaries with high IP	3
SONCC-MMER.5.1.7.1	*Evaluate and prioritize barriers for removal*					
SONCC-MMER.5.1.7.2	*Remove barriers*					
SONCC-MMER.5.1.8	Passage	No	Improve access	Remove barriers	Ryan Creek	3
SONCC-MMER.5.1.8.1	*Remediate the one county, one private, and two Caltrans culverts that have been identified as high priority for fish passage*					

45. Upper Mainstem Eel River Population

- Interior Eel Diversity Stratum
- Potentially Independent Population
- High Extinction Risk
- Recovery criteria: 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival
- 361 mi^2
- 54 IP km (34 mi.) (27% High)
- Dominant Land Uses are ‘Recreation’ and ‘Agriculture’
- Principal Stresses are ‘Barriers’ and ‘Water Quality’
- Principal Threats are ‘Dams/Diversions’

45.1 History of Habitat and Land Use

Land use activities in the Upper Mainstem Eel River include timber harvest, hydropower production, recreation, limited livestock operations, and residence construction.

The Potter Valley Project’s 1908-built Cape Horn and 1922-erected Scott hydropower production dams represent the most significant Upper Mainstem Eel River coho salmon habitat alterations and precipitated the loss of most of this population’s historic habitat.

Built without a fish ladder, Scott Dam blocks an estimated 100 to 150 miles of potential anadromous salmonid habitat, and the 1922-built Cape Horn Dam fish ladder has proven ineffective. With an approximate 93,000 acre-feet (AF) capacity, Lake Pillsbury is situated upon most of the high IP reaches present in the population area.

The Potter Valley Project diverts the majority of mainstem Eel River flows out of the basin. From 1992 to 2004, up to approximately 160,000 AF of Eel River water were annually diverted into the East Fork of the Russian River for hydropower production and agricultural uses. Until 2004, flows released downstream of Cape Horn Dam were approximately 3 cubic feet per second (cfs) during most of the summer. In 2004, the Federal Energy Regulatory Commission issued an order requiring Pacific Gas and Electric (PG&E) to implement an instream flow regime consistent with the Reasonable and Prudent Alternative in the NMFS 2002 Biological Opinion.

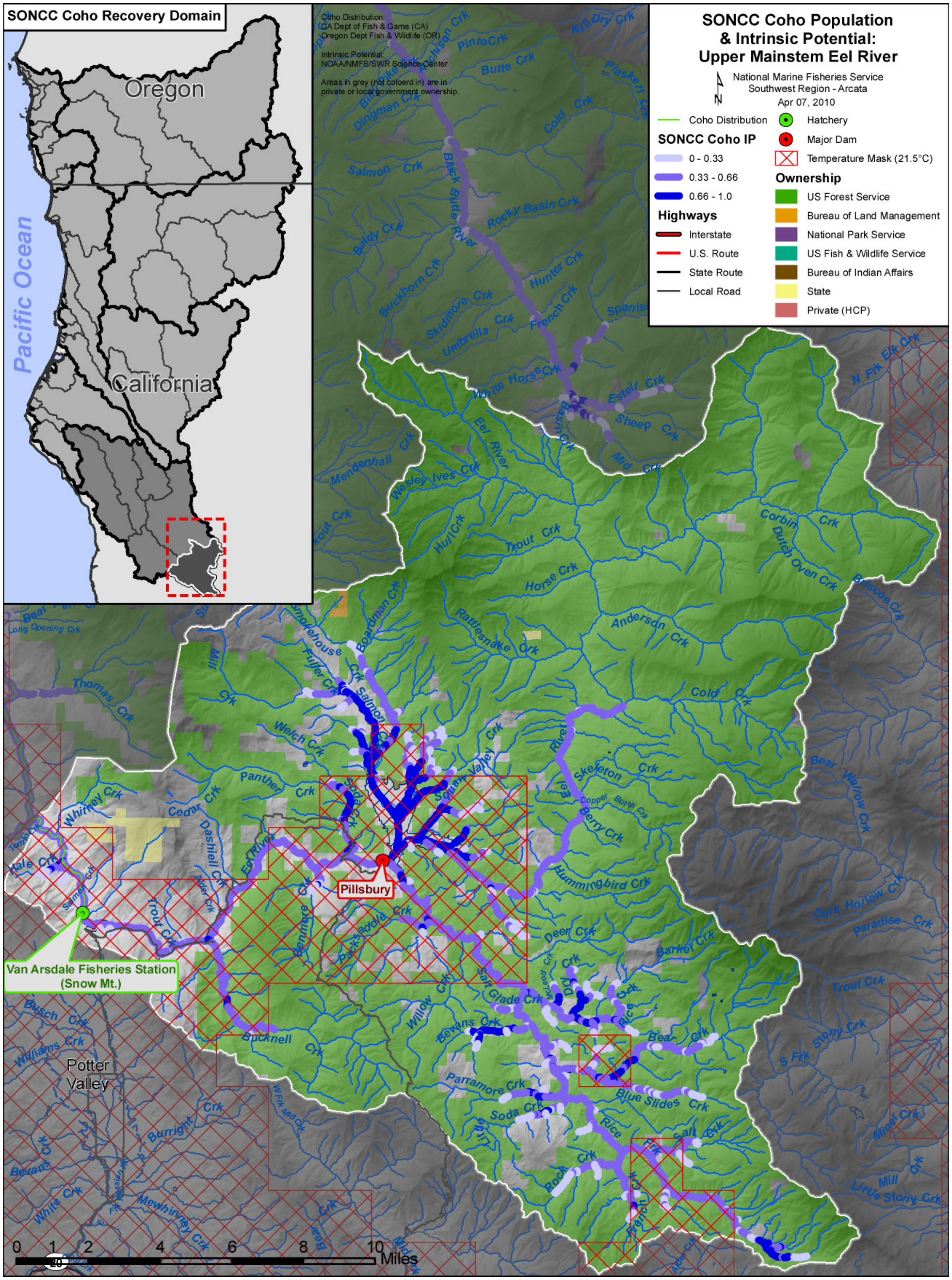

Figure 45-1. The geographic boundaries of the Upper Mainstem Eel River coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2009a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Northern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

The new flow requirement increased the minimum Cape Horn Dam release flows and incorporated within-year and between-year variability.

Minimum flows are dependent on a number of factors and formulas, including cumulative inflow into Lake Pillsbury, current and previous water year, and time periods. Therefore, specifying actual minimum flows that would be expected is not possible as this varies by too many factors. Water gage data for the Eel River below Van Arsdale Reservoir records a 9 day-long duration of 7 cfs as the lowest mean daily flow since March 2007(California Department of Water Resources (DWR) 2010).

The Potter Valley Project has significantly reduced rearing habitat (Week 1992) and restricted access to many tributaries both upstream of the dams by precluding access to fish as well as downstream of the dams by reducing flows. Important Stream flows affect important ecosystem linkages, including food web interactions among salmonids, their predators, and their prey; nutrient cycles; and overall habitat diversity and quantity (National Research Council 1996).

The 1964 flood caused significant sedimentation within the Eel River and its tributaries, by filling in many pools, destroying riparian vegetation, and widening channels. Timber harvest activities were widespread and resulted in sediment transport into creeks. The preponderance of unstable landforms, high road densities, and past timber harvest have contributed to the poor habitat quality evident throughout the population area.

In 1980, predatory Sacramento pikeminnow were introduced into Lake Pillsbury (California Department of Fish and Game (CDFG) 1997b), and now occupy the entirety of the Eel River basin’s accessible habitat. This predator thrives in the warmer waters created by the reservoir, lower instream flows in the mainstem Eel River, and degraded riparian forest conditions. Pools which were formerly high quality refugia which had large woody debris have decreased because of increased sedimentation, dams, and degraded riparian forests. These pools and large woody structures would have provided juveniles some protection from predators.

45.2 Historic Fish Distribution and Abundance

Information on historic coho salmon use of the population area is limited. Over the past half century, coho salmon have been intermittently observed, and surveys were rarely conducted. During the 1946/1947 spawning season, 47 adults were observed at the Cape Horn Dam’s Van Arsdale Fisheries Station and since that time, adults have been observed on only four other occasions, including a 2010/2011 season observation (Jahn 2011). Neither scientific nor anecdotal coho salmon observation information for the areas above Lake Pillsbury has been discovered. Spawning habitat on the 12 mile reach between Scott and Cape Horn dams was and continues to be suitable because cool water flows out of Scott Dam. By 1964, less than 500 coho salmon were estimated to return to the Eel River above the South Fork (CDFG 1965). The current Eel River population above the South Fork is estimated to be less than 100 based upon 1989 to 1999 NMFS estimates.

Downstream of the dams, water temperature further restricts coho salmon distribution within the population area. The temperature mask data contained in Williams et al. (2006) suggests that portions of IP habitat may be too warm during the summer to support coho salmon. Historically, temperature was likely moderated by intact riparian areas and higher unimpaired flows.

Table 45-1. Tributaries with instances of high IP reaches (IP > 0.66). (Williams et al. 2006).

Subarea	Stream Name	Subarea	Stream Name
Lake Pillsbury	Bear Creek*	**Lake Pillsbury**	North Fork Corbin Creek*
	Bevans Creek*		Packsaddle Creek*
	Bucknell Creek[1]		Perramore Creek*
	Dry Creek*		Rice Creek*
	French Creek*		Rice Fork*
	Hale Creek		Salmon Creek (and tribs.)*
	Little Soda Creek*		Salt Spring Creek*
	McLeod Creek*		Soda Creek[1]

[1] Denotes a “special tributary” as identified in the 1995 watershed analysis for this area given their relatively large size and current accessibility to anadromous salmonids.
* Denotes a stream that lies above Lake Pillsbury and is currently inaccessible to coho salmon.

45.3 Status of Upper Mainstem Eel River Coho Salmon

Spatial Structure and Diversity

Williams et al. (2008) determined that at least 39 coho salmon per-IP habitat km are needed (2,100 spawners total) to approximate the historical distribution of Upper Mainstem Eel River coho salmon. Currently, coho salmon are restricted to the lowermost portions downstream of Lake Pillsbury, totaling 12 IP km (7 IP mi) of habitat. It is important to note that all of the 12 IP km of habitat downstream of Lake Pillsbury are covered by the temperature mask identified in Williams et al. (2006). In addition to elevating water temperatures, Scott Dam precludes access to most of the historic IP area. Downstream of Scott Dam, those few observed coho salmon were restricted to tributaries possessing degraded habitat and water quality. Coho salmon genetic and life history diversity is low due to the low number of individuals. Based upon these observations, the Upper Mainstem Eel River coho salmon population is at high extinction risk because its spatial distribution and diversity are limited.

Population Size and Productivity

Few coho salmon have been observed at the Van Arsdale Fisheries Station. As of 2011, coho salmon have been recorded only five times since the 1940s, including a high count of 47 adults in 1947 (Jahn 2011). Of the five occurrences of coho salmon at Van Arsdale, four occurrences were within the most recent decade. Coho salmon abundance within the tributaries below the dams is unknown but is presumed to be low. Williams et al. (2008) estimated at least 54 coho salmon must spawn in the Upper Mainstem Eel River each year to avoid extinction resulting from extremely low population sizes.

Coho salmon are likely present in numbers well below this high risk threshold. Cape Horn and Scott dams limit coho salmon access to much of the population area and are responsible for degraded habitat present within remaining downstream tributaries. As a result, coho salmon productivity has been diminished. Given the extremely low population size and presumed negative population growth rate, the Upper Mainstem Eel River coho salmon population is at high extinction risk and may already be functionally extinct.

Extinction Risk

The Upper Mainstem Eel River coho salmon population is not viable and at high risk of extinction because the estimated average spawner abundance over the past three years has been less than the depensation threshold (Table ES-1 in Williams et al. 2008).

Role in SONCC Coho Salmon ESU Viability

The Upper Mainstem Eel River population historically was a Potentially Independent population within the ESU meaning that it had a high likelihood of persisting in isolation over a 100-year time scale but was too strongly influenced by immigration from other populations to exhibit independent dynamics (Williams et al. 2006). As a non-core population, the recovery target for the Upper Mainstem Eel River population is to ensure that the population is occupied by coho salmon consistently in the future (see Chapter 4). Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU.

45.4 Plans and Assessments

Environmental Protection Agency

Total Maximum Daily Loads for the Eel River

In January 2006, the EPA published the final Total Maximum Daily Loads (TMDLs) for temperature and sediment for the Middle Main Eel River and tributaries. The North Coast Regional Water Quality Control Board is required to develop measures which will result in implementation of the TMDLs in accordance with the requirements of 40 CFR 130.6.

State of California

Eel River Salmon and Steelhead Restoration Action Plan

In 1997, the California Department of Fish and Game completed its assessment of the Eel River basin and provided recommendations for restoration of salmonid stocks. Primary recommendations included removing barriers, reducing sediment inputs, improving riparian forest conditions, reducing water withdrawals, enhancing habitat, and controlling Sacramento pikeminnow.

Recovery Strategy for California Coho Salmon
http://www.dfg.ca.gov/fish/Resources/Coho/SAL_CohoRecoveryRpt.asp

The Recovery Strategy for California Coho Salmon was adopted by the California Fish & Game Commission in February 2004.

The U.S. Forest Service

Watershed Analysis

The U.S. Department of Agriculture Forest Service (USFS) completed a watershed analysis for the Upper Main Eel River in 1995.

45.5 Stresses

Table 45-2. Severity of stresses affecting each life stage of coho salmon in the Upper Mainstem Eel River. Stress rank categories and assessment methods are described in Appendix B, and the data used to assess stresses for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Stresses (Limiting Factors)	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Barriers[1]	-	Very High	Very High[1]	Very High	Very High	Very High
2	Impaired Water Quality[1]	Low	Very High	Very High[1]	Very High	High	High
3	Altered Sediment Supply	Very High	Very High	High	Low	Very High	High
4	Lack of Floodplain and Channel Structure	High	Low	High	High	High	High
5	Degraded Riparian Forest Conditions	-	High	High	High	High	High
6	Increased Disease/Predation/Competition	Low	High	High	High	Low	High
7	Impaired Estuary/Mainstem Function	-	Low	Very High	High	Medium	Medium
8	Altered Hydrologic Function	Low	Medium	High	High	Low	Medium
9	Adverse Fishery-Related Effects		-	-	-	Medium	Medium
10	Adverse Hatchery-Related Effects	Low	Low	Low	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s).

Limiting Stresses, Life Stages, and Habitat

Based upon the type and extent of stresses and threats affecting the population as well as the limiting factors influencing productivity, it is likely that the juvenile life stage is the most limited, and the quality and quantity of summer and winter rearing habitat is lacking. Access to the most suitable juvenile summer and winter rearing habitat is currently blocked by Scott Dam, and habitat downstream of the dam is limited by high water temperatures and excessive sedimentation. Scott Dam also prevents adult passage, resulting in 100 to 150 miles of potential spawning habitat loss. High road densities affect water quality throughout the population area by transporting excess sediment into streams. Low summer flows resulting from the Potter Valley Project Diversion serve to support non-native, predatory Sacramento pikeminnow populations to the detriment of coho salmon. Channel complexity and a diverse estuary are important to juvenile coho salmon, increasing their size and fitness prior to ocean entry, and overall marine survival success.

Complex stream channels with deep pools and woody structure as well as tidally influenced wetlands with off channel ponds are important refuge areas for juvenile coho salmon. Juvenile coho salmon would be more protected against predation, competition, and warm mainstem water temperatures if there were additional refugia areas. Available information regarding habitat conditions in the Upper Mainstem Eel River indicates that none of the streams accessible to coho salmon currently are able to function as refugia. Soda Creek data suggest a number of stressors prevent it from serving as a refugia area. While Bucknell Creek may have refugia potential, such designation would be based upon 1990s-dated measurements. Small reaches in other streams that could provide a combination of suitable habitat and water temperatures may exist, but these have not been identified.

Barriers

Barriers pose a very high stress for all coho salmon life stages. Scott Dam (Lake Pillsbury) precludes access to more than 80 percent of the historic population area, resulting in an estimated loss of 100 to 150 miles of potential anadromous salmonid habitat. Downstream of Scott Dam, habitat areas may become seasonally inaccessible due to a lack of water, channel aggradation, braiding, and high temperatures. Data from Soda Creek quantifying the amount of dry channel length reveal that dry stream reaches are problematic within the lower portion of this subbasin. There are likely numerous road-stream crossing barriers, but because most of the National Forest roads are upstream and upslope of Scott Dam these crossing barriers have not been inventoried thoroughly and likely have no impact on the population.

Impaired Water Quality

Impaired water quality is a high or very high stress for most life stages. Although the benthic macroinvertebrate (IBI) score is rated as good to very good in the upper subbasin (indicating little or no water quality contamination and good dissolved oxygen levels), stream temperature for summer rearing is poor throughout most of the population area. Extensive water quality monitoring by the Humboldt County Resource Conservation District (HCRCD 1998) confirms that many of the tributary water temperatures are marginal, stressful, or lethal (19 °C to >24 °C). Excessively warm water temperatures can occur as early as late May during hot years with low flows but more commonly occur during late June and early July. Elevated temperatures are problematic throughout the population area. High temperature- induced stress can lead to decreased growth and survival of juveniles and also increase the mortality rate of returning adults.

Altered Sediment Supply

Altered sediment supply poses a very high or high stress to all life stages. Adults, eggs, and fry are most affected by fine sediment prevalence in gravel. Sediment data are limited, but given EPA-reported observations (EPA 2004), sediment is likely a key stressor throughout the population area. Increased sediment delivery has resulted in a high embeddedness percentage within Soda Creek, which is where the majority of accessible, high IP habitat exists. Upper

Bucknell Creek measurements reveal limited sediment deposition within pools; however these data are based upon only one sampling point.

Lack of Floodplain and Channel Structure

Floodplain and channel structure evaluations were based upon floodplain connectivity, pool frequency, and pool depth information. Based on this information, the lack of floodplain and channel structure is a high stress for all coho salmon life stages, except for fry. Although it contains approximately 80 percent of the currently accessible historic high IP habitat, Soda Creek lacks adequate pools and pool depths. Immediately below Scott Dam, floodplain connectivity is fair while floodplain connectivity within the upper subbasin is believed to be very good. Although data on large wood is limited, wood recruitment to the mainstem is presumably low because dams block most wood transport. Moreover, low in-stream flows cannot facilitate wood mobilization and transport downstream. Essential to juvenile rearing, pools, large wood cover, and floodplains provide habitat complexity that facilitates forage optimization, predation avoidance, and permits access to thermal and velocity refuges.

Degraded Riparian Forest Conditions

Degraded riparian areas pose a high stress for all coho salmon life stages. Stream corridor vegetation is believed to be very good throughout most of the population area. However, Soda Creek, a tributary containing the majority of accessible, high IP habitat, has poor riparian shade and is dominated by the early seral conditions characteristic of either open or hardwood canopies.

Sudden oak death (SOD) is an exotic pathogen affecting almost all native species of plants, shrubs, and trees. SOD is in epidemic stages in population areas downstream of the population, in which coho salmon from this population must migrate through. Because the SOD pathogen is water borne and can travel downstream in watercourses, the likelihood of SOD outbreaks in the population area and adjacent populations are high. One of the largest areas infected by SOD occurs near Redway and is growing at a very fast rate. It is likely that SOD will continue to infect native species throughout the Eel River watershed into the future.

Increased Disease/Predation/Competition

Increased disease, predation, and competition are high stress upon fry, juveniles, and smolts. Sacramento pikeminnow thrive in the warmer water temperatures. Sacramento pikeminnow prey upon coho salmon and also displace them from potential pool refugia.

Impaired Estuary/Mainstem Function

All coho salmon that originate from the Upper Mainstem Eel River migrate to and from the ocean through the mainstem Eel River and the Eel River estuary. The Eel River estuary was once a highly complex and extensive habitat area that played a vital role in the health and productivity of all Eel River coho salmon populations. The degraded function of the Eel River estuary and mainstem migratory corridor today constitutes a high stress for this population. The Eel River estuary is severely impaired because of diking and filling of wetlands for agriculture and flood protection. Levees and dikes reduced the size of the estuary by over 60 percent

(CDFG 2010b). The estuary once supported a high degree of estuarine habitat and rearing potential but very little of that historic function still exists. Mainstem conditions contribute to coho salmon population stress because of water quality degradation, increased predation, and degraded habitat issues impacting this population area. The long migrations that this population must take through the mainstem Eel River makes the loss of mainstem functions a high to very high stress. Fitness of juveniles, smolts, and adults migrating through estuarine and mainstem habitat is reduced by the degraded conditions.

Hydrologic Function

Altered hydrologic functions pose a high stress for juveniles and smolts, a medium stress for fry, and a low stress for eggs and adults. Above Scott Dam, hydrologic function is very good but is only fair below the dam. Significant reductions in hydrologic function degrade entire instream and riparian communities. Stream flows affect important ecosystem linkages, including food web interactions among salmonids, their predators, and their prey; nutrient cycles; and overall habitat diversity and quantity (National Research Council 1996).

More recent instream flow requirements increase the minimum Cape Horn Dam release flow from the former 3 cfs constant summer rate and incorporate within-year and between-year variability. Although water quantity remains less than that of unimpaired flows, this new flow regime better approximates a more natural hydrograph. As the result of NMFS Biological Opinion, mainstem Eel River minimum instream flows have increased, and the total water diverted out of the Eel River and into the East Fork Russian River was reduced from 160,000 to between 60,000 and 138,000 acre-feet per year (based on the water year).

Adverse Fishery-Related Effects

NMFS has determined that federally-managed fisheries are not likely to jeopardize the continued existence of the SONCC coho salmon ESU (Appendix B). The effect of fisheries managed by the state of California on the continued existence of the SONCC coho salmon ESU has not been formally evaluated by NMFS (Appendix B).

Adverse Hatchery-Related Effects

The effects of hatchery fish on all life stages of coho salmon are described in Chapter 3. There are no operating hatcheries in the Upper Mainstem Eel River population area. Hatchery-origin adults may stray into the population area; however, the proportion of adults that are of hatchery origin is unknown. Adverse hatchery-related effects pose a low risk to all life stages, because less than five percent of adults are presumed to be of hatchery origin (Appendix B) and there are no hatcheries in the basin.

45.6 Threats

Table 45-3. Severity of threats affecting each life stage of coho salmon in the Upper Mainstem Eel River. Threat rank categories and assessment methods are described in Appendix B, and the data used to assess threats for the initial threats assessment (described in Appendix B) is presented in Appendix H.

	Threats[1]	Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Dams/Diversion	Very High	Very High	Very High	Very High	Very High	Very High
2	Roads	Very High	Very High	Very High	Very High	Very High	Very High
3	Invasive Non-Native/Alien Species	Medium	Very High	Very High	Very High	Low	Very High
4	Climate Change	Low	Low	Very High	Very High	Medium	High
5	High Intensity Fire	High	High	Medium	Medium	High	High
6	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
7	Fishing and Collecting	-	-	-	-	Medium	Medium
8	Timber Harvest	Low	Low	Low	Low	Low	Low
9	Urban/Residential/Industrial	Low	Low	Low	Low	Low	Low
10	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low

[1] Mining/Gravel Extraction and Channelization/Diking are not considered threats to this population.

Dams/Diversions

Dams and diversions pose a very high stress to all life history stages. PG&E's Potter Valley Project dams and diversion are the most significant threats to the Upper Mainstem Eel River coho salmon population as well as to other downstream Eel River coho salmon populations. While the Cape Horn Dam possesses a fish ladder, the Scott Dam completely blocks access to over 100 miles of potential habitat. Approximately 80 percent of this population's high IP reaches as identified by Williams et al. (2006) are located upstream of Scott Dam.

During the summer and fall, the Potter Valley Project diverts almost all of the mainstem Eel River water. Near Cape Horn Dam, approximately 60,000 to 138,000 AF of Eel River water has been annually diverted out of the basin and into the East Fork of the Russian River since 2004. Although the NMFS 2002 biological opinion and the 2004 FERC order require PG&E to release more water from both Cape Horn and Scott dams, increased flows in the upper mainstem Eel River are still significantly lower relative to unimpaired flows. Downstream of the dams, a subdivision along the Upper Mainstem Eel River diverts water for domestic use. The quantity of water diverted for the subdivision and whether there is an adequate fish screen is not known at this time. As human populations expand in Sonoma and Mendocino counties, there will be more demands for Eel River water.

Roads

Roads constitute a very high threat to all the population's life history stages. Upstream of Van Arsdale Reservoir, the USFS has noted that some of the roads and trails often function as streams by transporting water and sediment to other drainages (USFS and U.S. Bureau of Land Management (BLM) 1995b). There are over 175 miles of trails (including about 100 miles of designated off-highway vehicle trails), more than 760 miles of road, and approximately 3900 road/stream crossings. Downstream of Scott Dam, road density is mostly very high (>3 mi/sq. mi). . These road and trail networks facilitate sediment transport into streams and increase erosion and sediment availability, especially if the roads and trail networks are not properly maintained. Scott Dam and Lake Pillsbury block most fine particulate matter from traveling into the mainstem Eel River.

Invasive Non-Native/Alien Species

Sacramento pikeminnow are a very high threat to fry, juveniles, and smolts and are a medium threat to eggs because they compete with and prey upon young coho salmon. The warm water temperatures in the Eel River and Lake Pillsbury allow this voracious predator to thrive. The Sacramento pikeminnow's presence in Lake Pillsbury makes eradication of this species extremely difficult. Any effort to remove this species in the Eel River without treating the lake will only be temporary because the lake will continue to be the source population for the rest of the Eel River basin. As more water is released into the mainstem Eel River, there should be more habitats available for juveniles to seek refuge from predation.

Climate Change

Climate change will have the greatest impact upon juveniles, smolts, and adults. The current climate is generally warm and modeled regional average temperature models indicate average temperatures could increase by up to 3 °C in the summer and by up to 1 °C in the winter (see Appendix B for modeling methods). Average annual precipitation is already very low and is predicted to decrease over the next century. Snowpack in upper elevations of the Eel River basin will decrease with changes in temperature and precipitation (California Natural Resources Agency 2009).

The vulnerability of the downstream Eel River estuary to sea level rise is very high. Juvenile and smolt rearing and migratory habitat are most at risk to climate change. Increasing temperatures and changes in the amount and timing of precipitation and snowmelt will impact water quality and hydrologic function in the summer and winter. Rising sea level may also impact the quality and extent of wetland rearing habitat for smolts in the estuary. Overall, the range and degree of variability in temperature and precipitation are likely to increase in all population areas. As with all populations in the ESU, adults will be negatively impacted by ocean acidification, changes in ocean conditions, and prey availability (see Independent Science Advisory Board 2007, Portner and Knust 2007, Feely et al. 2008).

High Intensity Fire

High intensity fire poses a high threat to most of the life history stages, and a medium threat to juveniles and smolts. Past timber harvest practices coupled with decades-long fire-suppression efforts have rendered understory forest fuel loads excessive. High intensity fires regularly result from these excessive forest fuel loads. Such high intensity fires threaten coho salmon populations because they remove vegetation and litter that protect or minimize soil erosion, gullying, and mass wasting that contribute to high sediment loads and degrade coho salmon habitats. High sediment loads embed spawning gravel, making it less suitable for spawning and bury redds and alevins.

Agricultural Practices

Because of the steepness of the headwaters of the Mainstem Eel River, most agricultural activities are uncommon. However, the area's remoteness has facilitated agriculture within the Mendocino National Forest. Agricultural activities divert water away from Lake Pillsbury and the Upper Mainstem Eel River. The Mendocino National Forest currently does not allow grazing on their Lake Pillsbury and Ericson Ridge Management Areas; however, there is a grazing allotment in the Pine Mountain Management Area south of the Mainstem Eel River (Stewardship Council 2007). Grazing effects upon the Upper Mainstem Eel River are currently unknown. Rice and vineyard production is expected to expand within Potter Valley and will require more water diversion from the Eel River.

Fishing and Collecting

California-managed fisheries for species other than coho salmon occur in estuaries, freshwater, and nearshore marine areas. The effects of these fisheries upon the continued existence of the SONCC coho salmon ESU have not been formally evaluated by NMFS. NMFS has authorized future collection of Upper Mainstem Eel River coho salmon for research purposes. NMFS has determined these collections will not jeopardize the continued existence of the SONCC coho salmon ESU.

Timber Harvest

Timber harvest is a low threat to this population. Timber harvest primarily occurs on National Forest land and recently has been minimal. Timber harvest is not expected to intensify in the near future because of current management practices and administrative and court challenges.

Urban/Residential/Industrial Development

Limited small and remote communities exist within the Upper Mainstem Eel River population area. Residential growth is not expected because of the remoteness of this area. The Potter Valley Project's hydropower production completely prevents coho salmon passage to most of the high IP reaches. Depending upon the water year, the Potter Valley Project annual Eel River diversions have been reduced from 160,000 to between 60,000 and 138,000 since 2004. Many of the threats associated with the Potter Valley Project are covered in the Dams/Diversion section above.

Road-Stream Crossing Barriers

Road-stream crossing barriers pose a low threat to all coho salmon life stages. CDFG's CalFish website shows that a National Forest road culvert crossing on the M-3 Road is the only complete road-stream crossing barrier (CalFish2009). However, this culvert is not accessible to coho salmon, even if Scott Dam was not an issue.

Hatcheries

Hatcheries pose a low threat to all life stages of coho salmon in the Upper Mainstem Eel River population area. The rationale for these ratings is described under the "Adverse Hatchery-Related Effects" stress.

45.7 Recovery Strategy

The amount of currently inaccessible IP habitat combined with elevated air and water temperatures present throughout most of the Upper Mainstem Eel River population area will make recovery of this population extremely difficult. The recovery criterion for this population is that 20% of IP habitat must be occupied in years following spawning of brood years with high marine survival. Key habitat in areas downstream of Scott Dam where elevated water temperatures are not limiting coho salmon should be improved to facilitate some level of population persistence. Key components to achieving this population's recovery include: restoring in-stream flows to that which more closely mimic the natural hydrograph; controlling Sacramento pikeminnow abundance and spatial distribution; increasing floodplain connectivity; and enhancing Eel River estuary quality and size.

Table 45-4 on the following page lists the recovery actions for the Upper Mainstem Eel River population.

Table 45-4. Recovery action implementation schedule for the Upper Mainstem Eel River population.

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UMER.5.2.7	Passage	Yes	Decrease mortality	Screen all diversions	Downstream of Scott Dam	BR
SONCC-UMER.5.2.7.1	*Assess diversions and develop a screening program*					
SONCC-UMER.5.2.7.2	*Screen all diversions*					
SONCC-UMER.14.2.8	Disease/Predation/ Competition	No	Reduce predation and competition	Reduce abundance of Sacramento pikeminnow	Population wide	2
SONCC-UMER.14.2.8.1	*Determine the effectiveness of various pikeminnow suppression techniques and develop experimental control methods. Develop a plan that identifies watersheds suitable for experimental pikeminnow control*					
SONCC-UMER.14.2.8.2	*Control Sacramento pikeminnow, guided by the control plan*					
SONCC-UMER.1.2.29	Estuary	No	Improve estuarine habitat	Improve estuary condition	Eel River Estuary	3
SONCC-UMER.1.2.29.1	*Implement recovery actions to address strategy "Estuary" for Lower Eel/Van Duzen River population*					
SONCC-UMER.16.1.16	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating salmonid fishery management plans affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UMER.16.1.16.1	*Determine impacts of fisheries management on SONCC coho salmon in terms of VSP parameters*					
SONCC-UMER.16.1.16.2	*Identify fishing impacts expected to be consistent with recovery*					
SONCC-UMER.16.1.17	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Limit fishing impacts to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	2
SONCC-UMER.16.1.17.1	*Determine actual fishing impacts*					
SONCC-UMER.16.1.17.2	*If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UMER.16.2.18	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Incorporate SONCC coho salmon VSP delisting criteria when formulating scientific collection authorizations affecting SONCC coho salmon	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UMER.16.2.18.1	*Determine impacts of scientific collection on SONCC coho salmon in terms of VSP parameters*					
SONCC-UMER.16.2.18.2	*Identify scientific collection impacts expected to be consistent with recovery*					
SONCC-UMER.16.2.19	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Limit impacts of scientific collection to levels consistent with recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3
SONCC-UMER.16.2.19.1	*Determine actual impacts of scientific collection*					
SONCC-UMER.16.2.19.2	*If actual scientific collection impacts exceed levels consistent with recovery, modify collection so that impacts are consistent with recovery*					
SONCC-UMER.2.1.9	Floodplain and Channel Structure	No	Increase channel complexity	Increase LWD, boulders, or other instream structure	All reaches downstream of Scott Dam	BR
SONCC-UMER.2.1.9.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-UMER.2.1.9.2	*Place instream structures, guided by assessment results*					
SONCC-UMER.2.1.10	Floodplain and Channel Structure	No	Increase channel complexity	Identify and enhance non natal rearing sites	Tributaries and their confluences	BR
SONCC-UMER.2.1.10.1	*Investigate coho salmon non-natal rearing and refugia use in lower reaches of tributaries and mainstem confluences. Develop a plan to enhance identified locations.*					
SONCC-UMER.2.1.10.2	*Improve rearing locations, guided by the plan*					
SONCC-UMER.3.1.1	Hydrology	No	Improve flow timing or volume	Manage flow	Cape Horn and Scott Dams	2
SONCC-UMER.3.1.1.1	*Conduct assessments to identify areas of improvement for water management and diversions*					
SONCC-UMER.3.1.1.2	*Manage and reduce diversions to restore the natural volume and mimic the natural hydrograph*					
SONCC-UMER.3.1.2	Hydrology	No	Improve flow timing or volume	Remove dams	Cape Horn and Scott Dams	BR
SONCC-UMER.3.1.2.1	*Work with PG&E and stakeholders to develop alternatives that would facilitate removal of large dams on the Eel River*					
SONCC-UMER.3.1.2.2	*Remove dams*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UMER.3.1.3	Hydrology	No	Improve flow timing or volume	Improve regulatory mechanisms	Mainstem and tributaries downstream of Scott Dam	BR
SONCC-UMER.3.1.3.1	*Ensure water diversions are within their water rights*					
SONCC-UMER.3.1.4	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-UMER.3.1.4.1	*Complete comprehensive flow study activities, and use them to educate water managers on how to reduce impacts to coho salmon.*					
SONCC-UMER.3.1.5	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-UMER.3.1.5.1	*Provide incentives to landowners to reduce water consumption*					
SONCC-UMER.3.1.6	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
SONCC-UMER.3.1.6.1	*Provide education and training on water diversion practices and facilitate compliance with pertinent regulations (e.g., FGC §1600 et. seq., CFPR 916.9, California water rights law).*					
SONCC-UMER.27.1.20	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate abundance	Population wide	3
SONCC-UMER.27.1.20.1	*Perform annual spawning surveys*					
SONCC-UMER.27.1.21	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Estimate juvenile spatial distribution	Population wide	3
SONCC-UMER.27.1.21.1	*Conduct presence/absence surveys for juveniles (3 years on; 3 years off)*					
SONCC-UMER.27.1.22	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the stress 'Fishing and Collecting'	Population wide	2
SONCC-UMER.27.1.22.1	*Annually estimate the commercial and recreational fisheries bycatch and mortality rate for wild SONCC coho salmon.*					
SONCC-UMER.27.1.23	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Track indicators related to the threat 'Invasive Species'	Population wide	3

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-UMER.27.1.23.1	*Annually estimate the density of non-native predators, such as the Sacramento pikeminnow in the Eel River basin*					
SONCC-UMER.27.1.23.2	*Identify the status and trend of invasive species*					
SONCC-UMER.27.2.24	Monitor	No	Track habitat condition	Track habitat indicators related to spawning, rearing, and migration	Population wide	3
SONCC-UMER.27.2.24.1	*Measure indicators for spawning and rearing habitat. Conduct a comprehensive survey*					
SONCC-UMER.27.2.24.2	*Measure indicators for spawning and rearing habitat once every 10 years, sub-sampling 10% of the original habitat surveyed*					
SONCC-UMER.27.2.25	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Lack of Floodplain and Channel Structure'	All IP habitat	3
SONCC-UMER.27.2.25.1	*Measure the indicators, pool depth, pool frequency, D50, and LWD*					
SONCC-UMER.27.2.26	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Degraded Riparian Forest Condition'	All IP habitat	3
SONCC-UMER.27.2.26.1	*Measure the indicators, canopy cover, canopy type, and riparian condition*					
SONCC-UMER.27.2.27	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Altered Sediment Supply'	All IP habitat	3
SONCC-UMER.27.2.27.1	*Measure the indicators, % sand, % fines, V Star, silt/sand surface, turbidity, embeddedness*					
SONCC-UMER.27.2.28	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Water Quality'	All IP habitat	3
SONCC-UMER.27.2.28.1	*Measure the indicators, pH, D.O., temperature, and aquatic insects*					
SONCC-UMER.27.2.30	Monitor	No	Track habitat condition	Track habitat indicators related to the stress 'Impaired Hydrologic Function'	All IP habitat	3
SONCC-UMER.27.2.30.1	*Annually measure the hydrograph and identify instream flow needs*					
SONCC-UMER.27.1.31	Monitor	No	Track population abundance, spatial structure, productivity, or diversity	Refine methods for setting population types and targets	Population wide	3
SONCC-UMER.27.1.31.1	*Develop supplemental or alternate means to set population types and targets*					
SONCC-UMER.27.1.31.2	*If appropriate, modify population types and targets using revised methodology*					

Action ID	Strategy	Key LF	Objective	Action Description	Area	Priority
Step ID		*Step Description*				
SONCC-UMER.7.1.11	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	All reaches downstream of Scott Dam	BR
SONCC-UMER.7.1.11.1		*Determine appropriate silvicultural prescription for benefits to coho salmon habitat*				
SONCC-UMER.7.1.11.2		*Thin, or release conifers, guided by prescription*				
SONCC-UMER.7.1.11.3		*Plant conifers, guided by prescription*				
SONCC-UMER.7.1.12	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	2
SONCC-UMER.7.1.12.1		*Amend California Forest Practice Rules to include regulations which describe the specific analysis, protective measures, and procedure required by timber owners and CalFire to demonstrate timber operations described in timber harvest plans meet the requirements specified in 14 CCR 898.2(d) prior to approval by the Director (similar to a Spotted Owl Resource Plan).*				
SONCC-UMER.7.1.13	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Reduce fire hazard	Upland areas adjacent to streams	BR
SONCC-UMER.7.1.13.1		*Identify forested stands for fire hazard reduction*				
SONCC-UMER.7.1.13.2		*Apply appropriate management techniques (e.g. thinning, burning) to reduce risks of high intensity fire*				
SONCC-UMER.8.1.14	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	BR
SONCC-UMER.8.1.14.1		*Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective*				
SONCC-UMER.8.1.14.2		*Decommission roads, guided by assessment*				
SONCC-UMER.8.1.14.3		*Upgrade roads, guided by assessment*				
SONCC-UMER.8.1.14.4		*Maintain roads, guided by assessment*				

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