25. Humboldt Bay Tributaries Population

Southern Coastal Diversity Stratum

Core, Functionally Independent Population

Moderate Extinction Risk

Population likely above depensation threshold

5,700 Spawners Required for ESU Viability

157 mi^2 (9% Federally owned)

191 IP-km (118 IP-mi) (62% High)

Dominant Land Uses are Timber Harvest and Agriculture

Key Limiting Stresses are ‘Impaired Estuary/Mainstem Function’ and ‘Lack of Floodplain and Channel Structure’

Key Limiting Threats are ‘Channelization/Diking’ and ‘Roads’

Highest Priority Recovery Actions

• Increase large woody debris (LWD), boulders, or other instream structure • Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows • Remove or replace tidegates	• Remove, set back, or reconfigure levees and dikes • Improve grazing practices • Restore tidally influenced zones

25.1 History of Habitat and Land Use

Vegetation in the upper watershed of the Humboldt Bay Tributaries population area was historically (pre-Euro-American settlement) coniferous forest, dominated by coast redwood. Historic riparian canopy cover was likely high and large wood 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. Euro-American settlement and resource extraction influenced landscape processes, which resulted in decreased quality, quantity, and accessibility of habitat for coho salmon spawning and rearing (Beechie et al. 2003).

Harvest of old growth trees began in the 1860s with associated 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 were 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)].

Currently, the dominant land use in the population area is timber production and harvest in the upper portions of tributary watersheds. Agriculture and 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 (HRC) and Green Diamond Resource Company (GDRC). 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 cities of Arcata (population 16,651) and Eureka (population 26,128), and 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 Creek, and Freshwater Creek watersheds than in the Elk River or Salmon Creek watersheds.

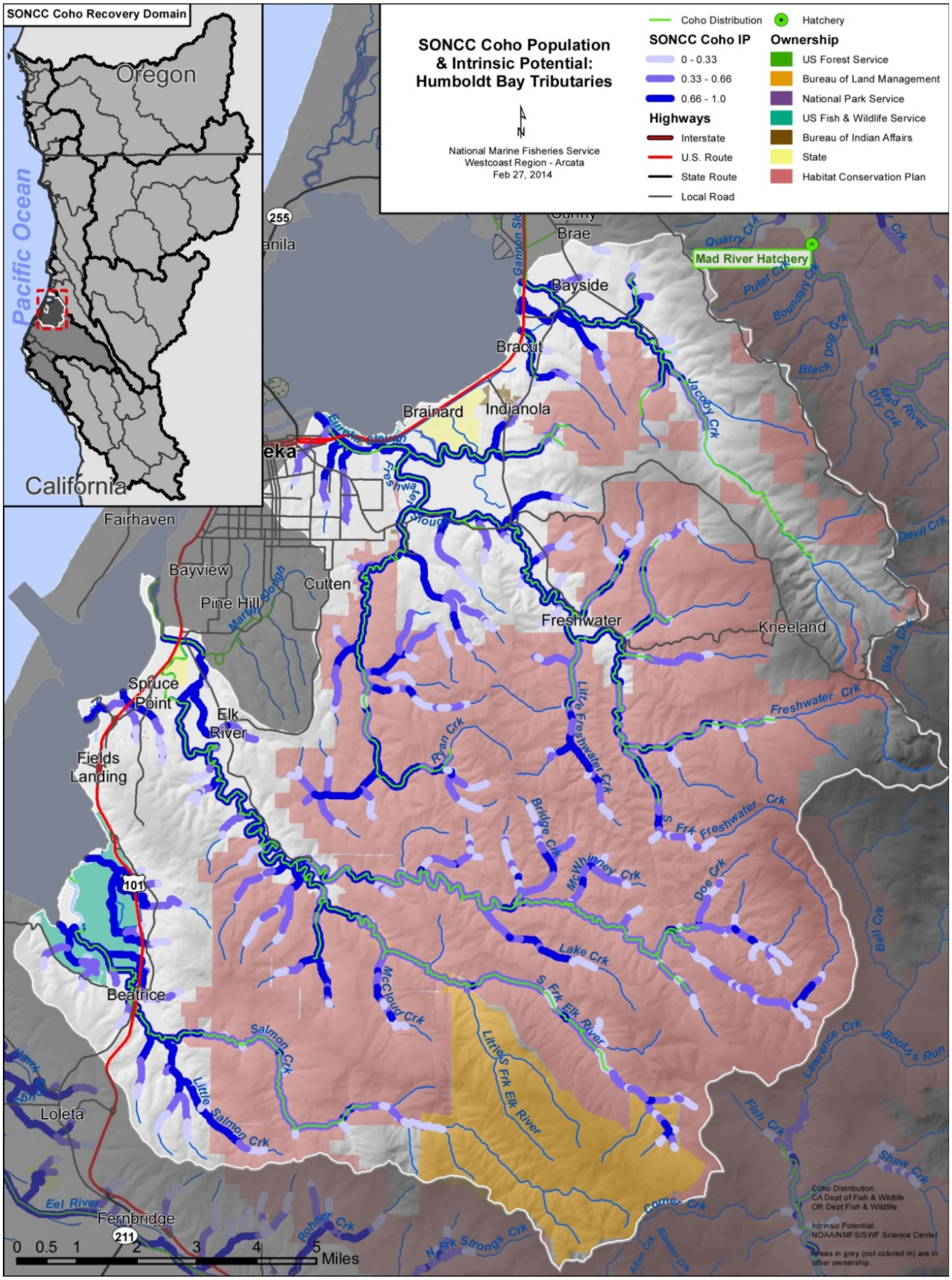

Figure 25-1. The geographic boundaries of the Humboldt Bay Tributaries coho salmon population. Figure shows modeled Intrinsic Potential of habitat (Williams et al. 2006), land ownership, coho salmon distribution (CDFG 2012a), and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Southern Coastal diversity stratum (Williams et al. 2006). Grey areas indicate private ownership.

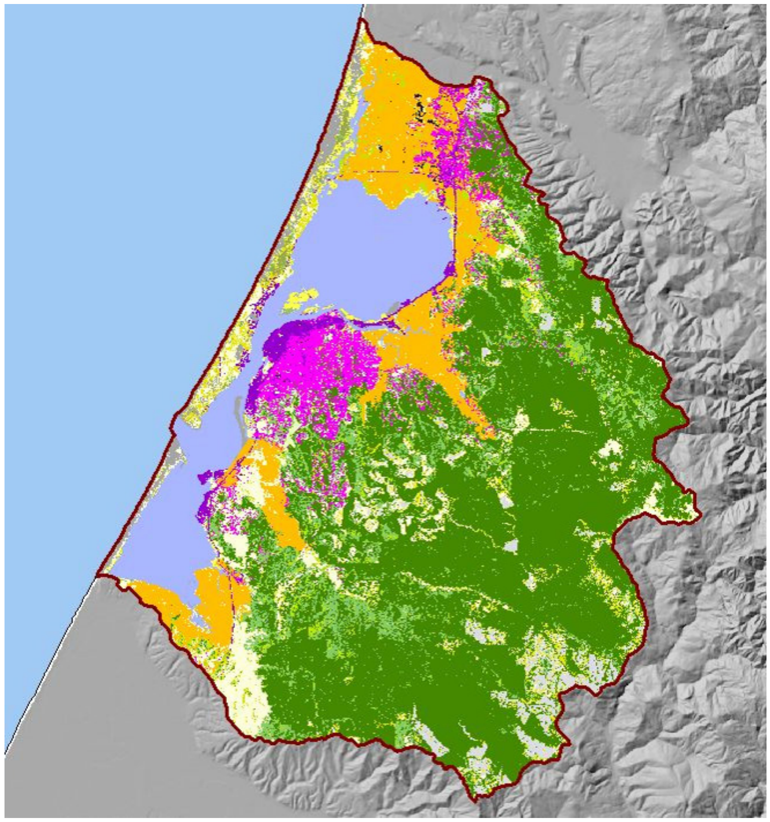

Figure 25-2. Major land use in the Eureka Plain HU. Key: (green = commercial timber; orange = agricultural, and pink = urban/residential/industrial; KRIS 2006).

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).

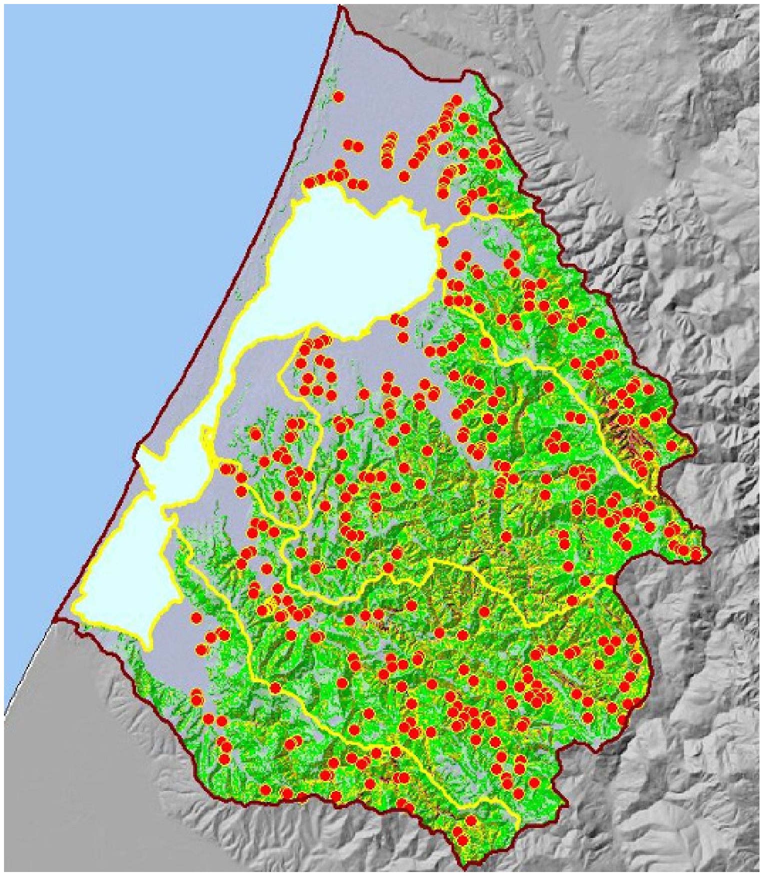

Figure 25-3. Road-stream crossings in the Eureka Plain HU.(KRIS 2006)

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 continental U.S. Pacific Coast (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. However, recent restoration efforts in areas such as McDaniel Slough (City of Arcata), Rocky Gulch, Wood Creek, and Salmon Creek have expanded the amount of slough habitat available to coho salmon. 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 areas of the main spawning tributaries in the population area from north to south are as follows: Jacoby Creek (17 mi^2); Freshwater Creek, including Ryan Creek and Fay Slough (58 mi^2); Elk River, including Martin Slough (58.2 mi^2) and Salmon Creek (17 mi^2). 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 demonstrates the importance of these tributaries to the population (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. 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 juvenile coho salmon 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 documented in Wood Creek (Wallace 2008d), Rocky Gulch, Gannon Slough, and Martin Slough (Wallace 2008b, Wallace 2010a, Wallace 2010b) during the winter, presumably where they were escaping higher velocity flows in the main channels of Freshwater Creek, Jacoby 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 2008a). 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.

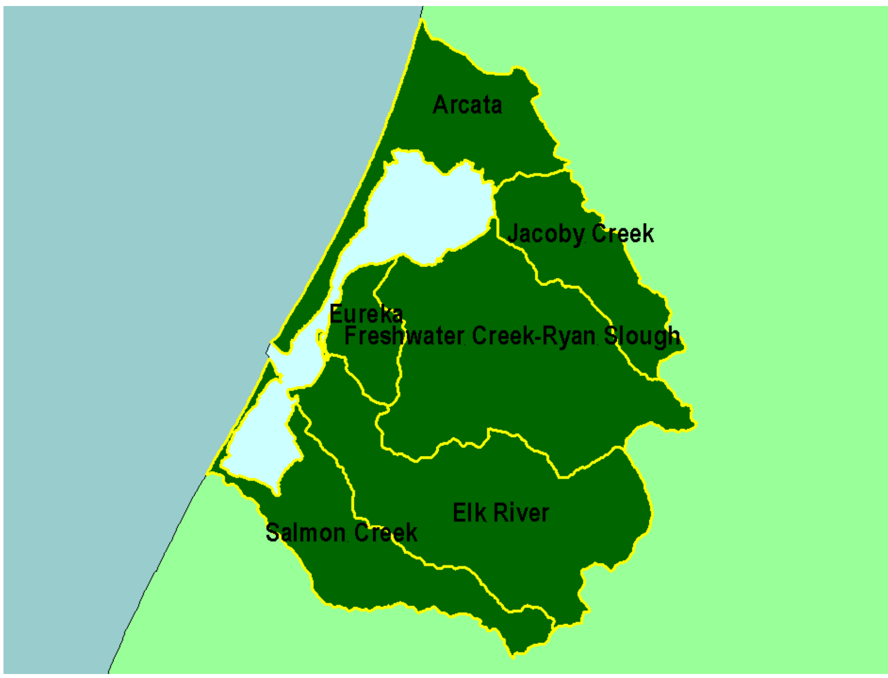

Figure 25-4. Watersheds within the Eureka Plain. Map from KRIS Humboldt Bay June 2006

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 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 25-1. 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.

25.3 Status of Humboldt Bay Tributaries Coho Salmon

Spatial Structure and Diversity

The diversity and complexity of the environmental conditions within the Humboldt Bay Tributaries population area have contributed to the evolutionary legacy of coho salmon. The Humboldt Bay Tributaries population is considered functionally independent within the ESU (Williams et al. 2008). As a functionally independent population, the Humboldt Bay Tributaries 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). The population is unique in the SONCC coho salmon ESU in that it is comprised of several tributaries that share a large bay.

Redd surveys in recent years have documented coho salmon spawning in all major Humboldt Bay sub-watersheds (Elk River, Jacoby, Salmon, and Freshwater creeks), indicating a relatively well-distributed spawner population. However, recent distribution of redds likely reflects current habitat suitability rather than historic distribution due to degradation of spawning habitat. In addition, individual fish have been found to spawn both in tributaries and in the mainstem of Freshwater Creek, or in more than one tributary, which may represent a life history strategy to increase egg survival in the relatively small, dynamic stream (Goin 2009).

Based on data from Freshwater Creek, juvenile coho salmon residing in upstream, 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 2008, Wallace 2008a). Juvenile coho salmon utilize non-natal sloughs and marshes while rearing or migrating through Humboldt Bay. For example, individuals marked in Freshwater Creek have been recaptured in Elk River Slough.

Population Size and Productivity

Williams et al. (2008) determined at least 191 coho salmon must spawn in the Humboldt Bay tributaries each year to avoid effects of extremely low population sizes. The population size of the Humboldt Bay tributaries population is unknown, but the most recent redd abundance estimates for the population were 194 redds in 2009-10 and 2,002 redds in 2010-11 (Ricker, S., pers. comm. 2011a). The trend in Freshwater Creek adult abundance estimates (Figure 25-5) indicates adult escapement has declined since 2002-03, ranging from a high of 1,807 in 2002-03 to a low of 89 in 2009-10 (Moore and Ricker 2012). However, all three cohorts have experienced slight increases in abundance over the past three years. 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 emigrating from Freshwater Creek tributaries has remained relatively constant over 8 years, and is estimated at 3,000 individuals (Ricker 2008), 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 catch per unit effort of young-of-the-year coho salmon caught by CDFG declined between 2005 and 2008.

Although annual spawner escapement in Jacoby Creek is unknown, monitoring in Morrison Gulch following the removal of a fish passage barrier indicates 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 was downward (Taylor and Associates 2009). 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.

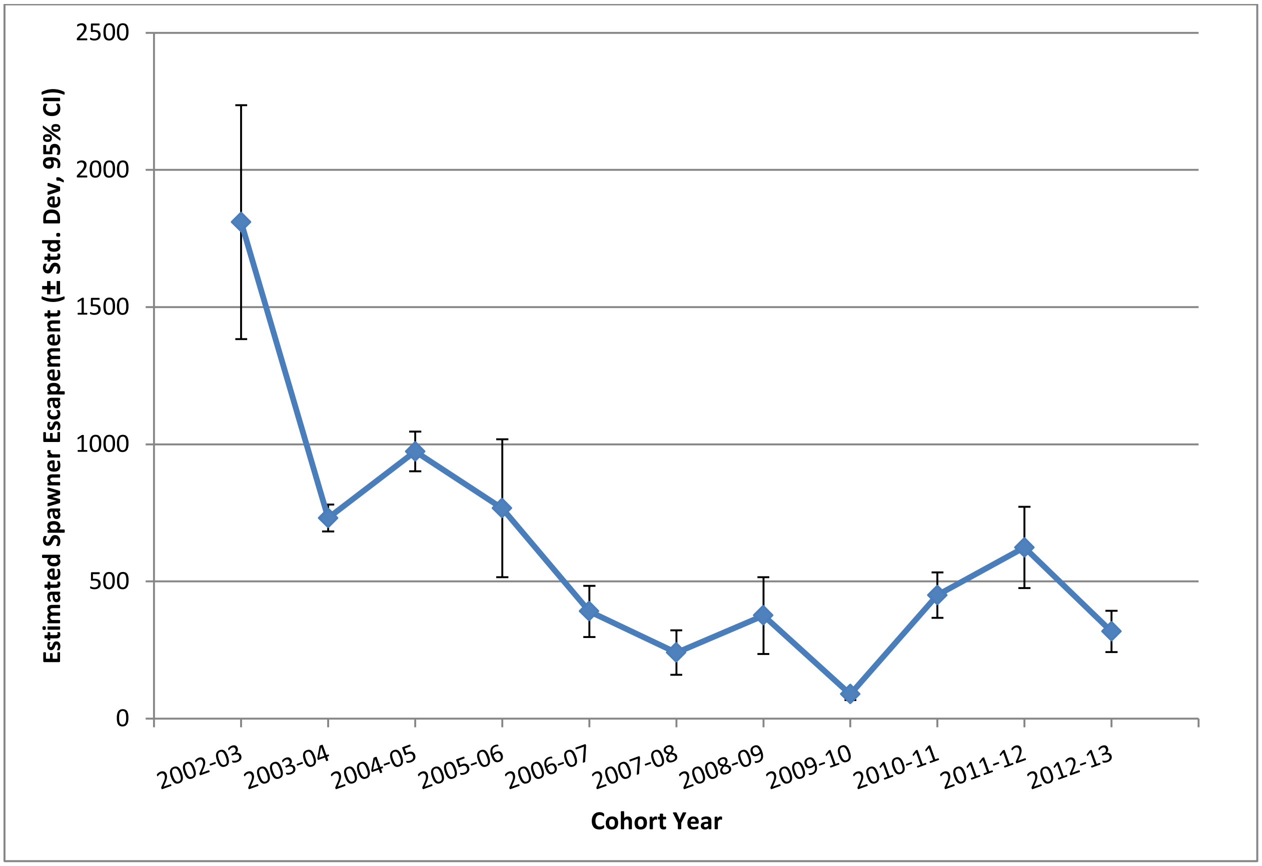

Figure 25-5. Escapement estimates for adult coho salmon in Freshwater Creek (data from Moore and Ricker 2012, Moore, T., pers. comm. 2013).

Extinction Risk

The Humboldt Bay Tributaries population is at moderate risk of extinction because NMFS estimates the ratio of the three consecutive years of lowest abundance within the last twelve years to the amount of IP-km in a watershed is greater than one, but the ratio is less than the minimum required spawner density (both criteria described in Williams et al. 2008).= NMFS' determination of population extinction risk is based on the viability criteria provided by Williams et al. 2008 (Table 3, p. 17). These viability criteria reflect population size and rate of decline. As Williams et al. (2008) provided no viability criteria for assessing moderate and high risk based on spatial structure and diversity, spatial structure and diversity were not considered in NMFS' determination of population extinction risk.

Role in SONCC Coho Salmon ESU Viability

The Humboldt Bay Tributaries population is a core, Functionally Independent population within the Southern Coastal diversity stratum; historically having had a high likelihood of persisting in isolation over 100-year time scales, and with population dynamics or extinction risk over a 100-year time period that are not substantially altered by exchanges of individuals with other populations (Williams et al. 2006). To contribute to stratum and ESU viability, the Humboldt Bay Tributaries core population needs to have at least 5,700 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. Besides its role in achieving demographic goals and objectives for recovery, as a core population the Humboldt Bay Tributaries population fulfills other needs within the Southern Coastal stratum. The Humboldt Bay Tributaries population may serve as a source of spawner strays, including for the extremely depressed Mattole River population to the south and the Mad River to the north.

25.4 Plans and Assessments

Humboldt Redwood Company

Humboldt Redwood Company Habitat Conservation Plan

Humboldt Redwood Company (HRC) (formerly Pacific Lumber Company (PALCO)) owns land in the upper Freshwater Creek and Elk River watersheds in the population area. The 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). More information about HCPs in the Humboldt Bay Tributaries can be found in Section 3.2.5.

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 the 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 the 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 and Stokes 2003, BLM and CDFG 2004) calls for the removal of 50 miles of abandoned timber management 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 2007 and is valid through 2057. The plan has a number of provisions designed to protect coho salmon and aquatic habitat on their land within 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 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 management plan 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 (USFWS 2009b)

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 (HBWAC 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 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.

Humboldt Bay Harbor, Recreation and Conservation District (HBHRCD)

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 (HBHRCD 2007) 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.

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 strategy includes actions to improve coho salmon habitat in the Humboldt Bay Tributaries population area.

Water Quality Control Plan for the North Coast Region
http://www.swrcb.ca.gov/northcoast/water_issues/programs/basin_plan/

This plan, mandated by both the Federal Clean Water Act (CWA) and the State Porter-Cologne Water Quality Act (Porter-Cologne), identifies actions to preserve and enhance water quality and to protect beneficial uses of water in the North Coast Region, and is used as a regulatory tool by the Regional Water Board.

Enclosed Bays and Estuaries of California Water Quality Control Plan
http://water.epa.gov/scitech/swguidance/standards/wqslibrary/upload/2009_12_15_standards_wqslibrary_ca_ca_9_74_43.pdf

This plan provides guidance and regulatory standards for sediment in Humboldt Bay.

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

The North Coast Integrated Regional Water Management Plan (NCIRWMP) is a stakeholder-driven collaboration among seven counties, local government, watershed groups, tribes and interested partners in the North Coast region of California. The NCIRWMP integrates long term planning and project implementation in an adaptive management framework. It focuses on salmonid recovery, enhancement of the beneficial uses of water, and the synchronization of state and federal priorities with local priorities, knowledge and leadership.

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

The Pacific Coast Joint Venture (PCJV) is a public-private partnership which was created to implement the North American Waterfowl Management Plan and has since been expanded to include all native flora and fauna and the full range of habitats associated with the region's wetland ecosystems. PCJV focuses on identification, protection, and restoration of the most important wetlands and associated upland and riparian habitats. Numerous restoration and acquisition priorities have been identified in the Eureka Plain HU.

University of California Subtidal & Intertidal Habitat Goals Project

> *Subtidal Habitat Goals Project for Humboldt Bay and the Eel River Estuary*

The objectives of the project are to evaluate and define benthic habitat in order to provide management recommendations and identify restoration opportunities and research needs.

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. The Humboldt Bay Tributaries population was identified as a priority basin, due to the historically large population sizes and current numbers of returning adults that would aid both short and long-term viability of the ESU.

25.5 Stresses

Table 25-2. Severity of stresses affecting each life stage of coho salmon in the Humboldt Bay Tributaries. Stress rank categories, assessment methods, and data used to assess stresses are described in Appendix B.

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

Key Limiting Stresses, Life Stages, and Habitat

The key limiting stresses for the Humboldt Bay Tributaries population are lack of floodplain and channel structure and impaired estuary/mainstem function, as they have the greatest impact on the population's ability to produce sufficient spawners to support recovery. The juvenile life stage is most limited, primarily due to reductions in quality and quantity of summer and winter rearing habitat. The lack of instream structure significantly reduces sorting of gravels and pool formation, and high flow refugia habitat is severely lacking for winter rearing juveniles due to disconnected floodplains. Furthermore, the population historically depended on the rich tidally influenced habitat for rearing, and the current impaired state of the estuary has limited the population's life history diversity and growth opportunities.

Lack of Floodplain and Channel Structure

Altered floodplain and channel structure (e.g., pool frequency and depth, large woody structures) is a very high stress to the fry and juvenile 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.

Given the extensive timber harvesting that has occurred in the population area and the changes in riparian vegetation characteristics, lack of large wood likely limits the sorting of gravels, formation of pool habitat, and instream cover throughout much of the watershed.

Impaired Estuary/Mainstem Function

Since this population is inherently dependent on the estuary for rearing, 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, M., pers. comm. 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 are 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).

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, likely increasing their survival once they enter the ocean. For example, Wood Creek, and likely Ryan Slough, provide winter habitat refugia from high flows for age 0+ and 1+ juvenile coho salmon in the Freshwater Creek watershed (Wallace, M., pers. comm. 2011).

Altered Sediment Supply

Altered (increased) sediment supply is a very high stress to the egg life stage, and a high stress to the fry and juvenile life stages. The excessive amount of instream sediment is exacerbated by the lack of instream structure to sort gravels and provide scour mechanisms for pool formation. The severity of sediment as a stress is reflected in the listing under Clean Water Act Section 303(d) for 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 in the water column, 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 previous section on impaired function of tidally influenced habitat.

The Humboldt Bay watersheds are comprised of moderately unstable geologic composition. As a result of a poorly constructed road network and a recent intensification in timber harvest operations, the large storms between 1993 and 1997 routed stored sediment from lower order tributary watersheds to the low gradient storage reaches and caused significant amounts of landsliding to occur, resulting in a considerable volume of sediment to route downstream.

Degraded Riparian Forest Conditions

Degraded riparian forest conditions exist across the watershed and present high stresses for the fry, juvenile, and smolt 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, and 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

Impaired water quality is a high stress to the fry, juvenile, and smolt life stages. 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 stresses in lower Salmon Creek, lower Freshwater Creek, and in the lower South Fork of Elk River (Wallace and Allan 2007). Nutrient loading from septic tank overflow, runoff from grazing lands, and reduced riparian vegetation, contribute to these conditions. Water quality is also likely impaired by pollutants contained in urban runoff.

Barriers

Barriers to passage in the tidally influenced portions of the population area are a high stress to the juvenile and smolt fish life stages. 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 hydrologic unit watersheds (USFWS 2007) and constitute the most problematic barriers to the population overall.

Altered Hydrologic Function

Altered hydrologic function is an overall medium stress to coho salmon in the population area. Clearing of vegetation and replacing with impervious surfaces has increased surface runoff. 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, and displacing over-wintering coho salmon juveniles.

Adverse Fishery- and Collection-Related Effects

Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any scientific collection (Appendix B), these activities pose a low stress to juveniles, smolts, and adults.

Adverse Hatchery-Related Effects

A small egg collecting station operated on Freshwater Creek from 1978 to 1995. However, there are no operating hatcheries in the Humboldt Bay Tributaries population area at this time. 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. Hatchery-origin coho salmon may stray into Humboldt Bay; however, the proportion of adults that are of hatchery origin is likely less than five percent and there are no hatcheries in the basin. Therefore, adverse hatchery-related effects pose a low risk to all life stages (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 eradication effort began (Wallace, M., pers. comm. 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, assessment methods, and data used to assess threats are described in Appendix B.

	Threats[2]	Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Threat Rank
1	Roads[1]	Very High	Very High	Very High[1]	Very High	Medium	Very High
2	Channelization/Diking[1]	Medium	High	Very High[1]	Very High	Medium	Very High
3	Agricultural Practices	Medium	Medium	High	High	Medium	High
4	Urban/Residential/Industrial Dev.	Medium	High	High	High	Medium	High
5	Timber Harvest	High	High	High	High	Medium	High
6	Climate Change (sea level rise)	Low	Low	High	High	Medium	High
8	Invasive Non-Native/Alien Species	Low	Low	Medium	Medium	Low	Medium
7	Dams/Diversions	Low	Low	Medium	Medium	Medium	Medium
9	Fishing and Collecting	-	-	Low	Low	Low	Low
10	Road-Stream Crossing Barriers	-	Low	Low	Low	Low	Low
11	Hatcheries	Low	Low	Low	Low	Low	Low
12	High Severity Fire	Low	Low	Low	Low	Low	Low

[1]Key limiting threats and limited life stage
[2]Mining/Gravel Extraction is not considered a threat to this population.

Key Limiting Threats

The two key limiting threats, those which most affect recovery of the population by influencing stresses, are roads and channelization/diking.

Roads

Roads pose a very high threat to all life stages of coho salmon, except adults. Forest roads are a primary causative factor for both altered sediment supply and altered hydrologic function. The density of roads in the Eureka Plain hydrologic unit 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. 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 (PWA 2006). 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). The future effect of roads under lands managed under an HCP is described in Chapter 3.

Channelization/Diking

Existing stream channelization and diking poses a very high threat to the juvenile and smolt life stages. Diking of tidelands and installation of tidegates to create land for agriculture has eliminated the majority of the intertidal rearing habitat around Humboldt Bay. The continued existence of diked tidelands will continue to limit the population's ability to recover by restricting life history strategies and diminishing growth opportunities in the productive estuarine nursery habitat.

Agricultural Practices

Agricultural practices pose a high threat to the juvenile and smolt 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 likely limited by increased turbidity and nutrient loading from feces.

Urban/Residential/Industrial Development

Development in the population area poses a high threat to coho salmon fry, juveniles, and smolts. 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, W., pers. comm. 2008). Future development may degrade existing tidally influenced habitat and limit the value of existing or planned restoration projects. Of particular concern is the potential subdivision of timberlands for residential use, which would result in an expanded network of roads and impervious surfaces. 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).

Timber Harvest

Timber harvest poses a high threat to all life stages of coho salmon, except adults. Many of the changes that have occurred to instream and riparian conditions in the Humboldt Bay tributaries 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 have the potential to affect coho salmon habitat by contributing to sediment deposition and reducing sources of large wood. HCP holders in the population area (e.g., HRC and GDRC) are expected to help reduce the threat of timber harvest through those conservation measures and mitigations developed for each plan.

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 °C in the summer and by approximately 1.0 °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). Stresses 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, Portner and Knust 2007, Feely et al. 2008).

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 continues to monitor Martin Slough and is working with NMFS 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, CDFG found a pit-tagged coho smolt in the stomach of an adult bullfrog at the weir site in Freshwater Creek (Garwood et al. 2010).

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.

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.

Invasive reed canary grass has been documented in many locations within the population area (e.g., Janes Creek). In-channel reed canary grass can cause excessive sediment deposition leading to loss of channel connectivity and capacity, and can also deplete dissolved oxygen levels for juvenile coho during the summer and fall.

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 City of Arcata and State Water Board recently upgraded the structure with a new standpipe and spillway that reduces the amount of sediment from mobilizing downstream.

From the 1920s 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 the juvenile life stage. According to the Department of Water Resources (DWR) data base, 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. 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 (e.g., lowered dissolved oxygen) in the remaining habitat.

Fishing and Collecting

Based on estimates of the fishing exploitation rate, as well as the status of the population relative to depensation and the status of NMFS approval for any scientific collection (Appendix B), these activities pose a low threat to juveniles, smolts, and adults.

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	Campton 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 Severity Fire

The threat of High severity 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 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) 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. The effects of fishing on this population's ability to meet its viability criteria should be evaluated.

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 Tributaries population. Recovery actions for monitoring and research are listed in tables at the end of Chapter 5.

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.1.1.5	Estuary	Yes	Improve connectivity of tidally-influenced habitat	Remove, set back, or reconfigure levees and dikes	Tidally influenced habitat in the lower portions of tributaries where coho salmon would benefit immediately	2c
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 or dikes have been removed or set back*					
SONCC-HBT.1.1.5.2	*Remove or set back levees and dikes and restore channel form and floodplain connectivity, guided by the plan*					
SONCC-HBT.1.2.40	Estuary	Yes	Improve estuarine habitat	Assess and improve estuary and tidal wetland habitat	Estuary	2c
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 and develop a plan for restoration*					
SONCC-HBT.1.2.40.3	*Restore estuary and tidal wetland habitat guided by the plan*					
SONCC-HBT.1.2.45	Estuary	Yes	Improve estuarine habitat	Restore tidally influenced habitats	Former tidelands where coho salmon would benefit immediately	2c
SONCC-HBT.1.2.45.1	*Pursue land conservation tools (e.g., easements) within historic extent of Humboldt Bay in order to increase extent of functioning tidal habitat*					
SONCC-HBT.1.2.62	Estuary	Yes	Improve estuarine habitat	Restore tidally influenced habitats	Population wide	2d
SONCC-HBT.1.2.62.1	*Pursue land conservation tools (e.g., easements) within historic extent of Humboldt Bay in order to increase extent of functioning tidal habitat*					
SONCC-HBT.2.1.1	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	All streams where coho salmon would benefit immediately	2c
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.1.3.4	Estuary	Yes	Increase tidal exchange of water	Remove or replace tidegates	Tidally influenced habitat in the lower portions of tributaries where coho salmon would benefit immediately	2c
SONCC-HBT.1.3.4.2	*Remove or replace tidegates, guided by the USFWS's Humboldt Bay National Wildlife Refuge Comprehensive Conservation Plan (2009)*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.2.2.2	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	All streams where coho salmon would benefit immediately	2c
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 to create refugia habitat, as guided by assessment results*					
SONCC-HBT.3.1.21	Hydrology	No	Improve flow timing or volume	Increase instream flows	All streams where coho salmon would benefit immediately	2c
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 acquisition or easement of water rights from willing sellers/owners*					
SONCC-HBT.3.1.21.2	*Reduce diversions as described in the plan*					
SONCC-HBT.3.1.66	Hydrology	No	Improve flow timing or volume	Increase instream flows	Population wide	2d
SONCC-HBT.3.1.66.1	*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 acquisition or easement of water rights from willing sellers/owners*					
SONCC-HBT.3.1.66.2	*Reduce diversions as described in the plan*					
SONCC-HBT.7.1.46	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Restore riparian vegetation in tidal zones	Tidally influenced lands, particularly Elk River estuary, Fay Slough, Freshwater Slough, and Eureka Slough	2c
SONCC-HBT.7.1.46.1	*Assess tidal marshlands, shrublands, and forestlands and develop a plan for restoration*					
SONCC-HBT.7.1.46.2	*Restore tidal marshlands, shrublands, and forestlands, guided by the plan*					
SONCC-HBT.26.1.56	Low Population Dynamics	No	Increase population abundance	Rescue and relocate stranded juveniles	Population wide	2c
SONCC-HBT.26.1.56.1	*Survey coho-bearing tributaries and relocate juveniles stranded in drying pools*					
SONCC-HBT.8.1.11	Sediment	No	Reduce delivery of sediment to streams	Improve grazing practices	Low gradient stream reaches in pasture lands where coho salmon would benefit immediately	2c
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	*If problems are identified, develop and implement grazing management strategy that decreases delivery of sediment and pollutants to streams and improves riparian condition, based on assessment*					
SONCC-HBT.8.1.11.3	*Monitor effectiveness of grazing management to ensure grazing does not limit recovery of SONCC coho salmon*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.8.1.68	Sediment	No	Reduce delivery of sediment to streams	Improve grazing practices	Population wide	2d
SONCC-HBT.8.1.68.1	*Assess grazing impact on sediment delivery and riparian condition, identifying opportunities for improvement*					
SONCC-HBT.8.1.68.2	*If problems are identified, develop and implement grazing management strategy that decreases delivery of sediment and pollutants to streams and improves riparian condition, based on assessment*					
SONCC-HBT.8.1.68.3	*Monitor effectiveness of grazing management to ensure grazing does not limit recovery of SONCC coho salmon*					
SONCC-HBT.8.1.12	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	All streams where coho salmon would benefit immediately	2c
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 based on assessment*					
SONCC-HBT.1.1.57	Estuary	Yes	Improve connectivity of tidally-influenced habitat	Remove, set back, or reconfigure levees and dikes	Population wide	2d
SONCC-HBT.1.1.57.1	*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 or dikes have been removed or set back*					
SONCC-HBT.1.1.57.2	*Remove or set back levees and dikes and restore channel form and floodplain connectivity, guided by the plan*					
SONCC-HBT.2.1.59	Floodplain and Channel Structure	Yes	Increase channel complexity	Increase LWD, boulders, or other instream structure	Population wide	2d
SONCC-HBT.2.1.59.1	*Assess habitat to determine beneficial location and amount of instream structure needed*					
SONCC-HBT.2.1.59.2	*Place instream structures, guided by assessment results*					
SONCC-HBT.1.3.58	Estuary	Yes	Increase tidal exchange of water	Remove or replace tidegates	Population wide	2d
SONCC-HBT.1.3.58.2	*Remove or replace tidegates, guided by the USFWS's Humboldt Bay National Wildlife Refuge Comprehensive Conservation Plan (2009)*					
SONCC-HBT.2.2.60	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Construct off channel habitats, alcoves, backwater habitat, and old stream oxbows	Population wide	2d
SONCC-HBT.2.2.60.1	*Identify potential sites to create refugia habitats. Prioritize sites and determine best means to create rearing habitat*					
SONCC-HBT.2.2.60.2	*Implement restoration projects that improve off channel habitats to create refugia habitat, as guided by assessment results*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.8.1.61	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	2d
SONCC-HBT.8.1.61.1	*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.8.1.61.2	*Implement plan to stabilize slopes and revegetate areas based on assessment*					
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 where coho salmon would benefit immediately	3c
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*					
SONCC-HBT.2.2.65	Floodplain and Channel Structure	Yes	Reconnect the channel to the floodplain	Improve channel function by redirecting urban streams into above-ground channels ('daylighting')	Population wide	3d
SONCC-HBT.2.2.65.1	*Assess feasibility of daylighting urban streams. Prioritize sites, develop daylight plans*					
SONCC-HBT.2.2.65.2	*Daylight streams, guided by assessment results*					
SONCC-HBT.5.1.43	Passage	No	Improve access	Reduce invasive species	All streams where coho salmon would benefit immediately	3c
SONCC-HBT.5.1.43.1	*Eradicate reed canary grass*					
SONCC-HBT.5.1.67	Passage	No	Improve access	Reduce invasive species	Population wide	3d
SONCC-HBT.5.1.67.1	*Eradicate reed canary grass*					
SONCC-HBT.5.1.10	Passage	No	Improve access	Remove barriers	All streams where coho salmon would benefit immediately	3c
SONCC-HBT.5.1.10.1	*Inventory and prioritize barriers*					
SONCC-HBT.5.1.10.2	*Remove barriers, based on evaluation*					
SONCC-HBT.8.1.55	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	All streams where coho salmon would benefit immediately	3c
SONCC-HBT.8.1.55.1	*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.8.1.55.2	*Implement plan to stabilize slopes and revegetate areas based on assessment*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.8.1.70	Sediment	No	Reduce delivery of sediment to streams	Minimize mass wasting	Population wide	3d
SONCC-HBT.8.1.70.1	*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.8.1.70.2	*Implement plan to stabilize slopes and revegetate areas based on assessment*					
SONCC-HBT.8.1.13	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	All areas where coho salmon would benefit immediately	3c
SONCC-HBT.8.1.13.1	*Assess and prioritize road-stream connection, and identify appropriate treatments*					
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.8.1.69	Sediment	No	Reduce delivery of sediment to streams	Reduce road-stream hydrologic connection	Population wide	3d
SONCC-HBT.8.1.69.1	*Assess and prioritize road-stream connection, and identify appropriate treatments*					
SONCC-HBT.8.1.69.2	*Decommission roads, guided by assessment*					
SONCC-HBT.8.1.69.3	*Upgrade roads, guided by assessment*					
SONCC-HBT.8.1.69.4	*Maintain roads, guided by assessment*					
SONCC-HBT.10.2.16	Water Quality	No	Reduce pollutants	Reduce point- and non-point source pollution	All areas where coho salmon would benefit immediately	3c
SONCC-HBT.10.2.16.1	*Identify pollution sources, and develop a strategy to minimize runoff to streams*					
SONCC-HBT.10.2.16.2	*Implement strategy to minimize pollution runoff to streams*					
SONCC-HBT.10.2.63	Water Quality	No	Reduce pollutants	Reduce point- and non-point source pollution	Population wide	3d
SONCC-HBT.10.2.63.1	*Identify pollution sources, and develop a strategy to minimize runoff to streams*					
SONCC-HBT.10.2.63.2	*Implement strategy to minimize pollution runoff to streams*					
SONCC-HBT.10.7.54	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	All streams where coho salmon would benefit immediately	3c
SONCC-HBT.10.7.54.1	*Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)*					
SONCC-HBT.10.7.54.2	*Supply marine-derived nutrients to streams guided by the plan*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.10.7.64	Water Quality	No	Restore nutrients	Add marine-derived nutrients to streams	Population wide	3d
SONCC-HBT.10.7.64.1	*Develop a plan to supply appropriate amounts of marine-derived nutrients to streams (e.g. carcass placement, pellet dispersal)*					
SONCC-HBT.10.7.64.2	*Supply marine-derived nutrients to streams guided by the plan*					
SONCC-HBT.3.1.47	Hydrology	No	Improve flow timing or volume	Determine effects of marijuana cultivation	Population wide	3d
SONCC-HBT.3.1.47.1	*Assess cumulative effects (e.g., flow, water quality) of marijuana cultivation*					
SONCC-HBT.3.1.47.2	*If needed, develop plan to reduce effects of marijuana cultivation based on assessment*					
SONCC-HBT.3.1.47.3	*Implement plan*					
SONCC-HBT.7.1.7	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve long-range planning	Population wide	3d
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.7.1.9	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Improve timber harvest practices	Population wide	3d
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)*					
SONCC-HBT.7.1.8	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Increase conifer riparian vegetation	Population wide	3d
SONCC-HBT.7.1.8.1	*Develop an appropriate timber harvest management plan for benefits to coho salmon habitat*					
SONCC-HBT.7.1.8.2	*Thin, or release conifers, guided by the plan*					
SONCC-HBT.7.1.8.3	*Plant conifers, guided by the plan*					
SONCC-HBT.3.2.22	Hydrology	No	Increase water storage	Improve long-range planning	Population wide	3d
SONCC-HBT.3.2.22.1	*Develop ordinance, permit requirements, and guidance to maintain open space*					
SONCC-HBT.3.2.22.2	*Provide tax and permit incentives for protection of coho salmon and their habitat*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
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	3d
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 level of fishing impacts that does not limit attainment of population-specific viability criteria*					
SONCC-HBT.16.1.25	Fishing/Collecting	No	Manage fisheries consistent with recovery of SONCC coho salmon	Reduce fishing impacts to levels that do not limit recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-HBT.16.1.25.1	*Determine actual fishing impacts*					
SONCC-HBT.16.1.25.2	*If actual fishing impacts limit attainment of population-specific viability criteria, modify management so that fishing does not limit attainment of population-specific viability criteria*					
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	3d
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 level of scientific collection impact that does not limit attainment of population-specific viability criteria*					
SONCC-HBT.16.2.27	Fishing/Collecting	No	Manage scientific collection consistent with recovery of SONCC coho salmon	Reduce impacts of scientific collection to levels that do not limit recovery	SONCC recovery domain plus ocean; from shore to 200 miles off coasts of California and Oregon	3d
SONCC-HBT.16.2.27.1	*Determine actual impacts of scientific collection*					
SONCC-HBT.16.2.27.2	*If actual scientific collection impacts limit attainment of population-specific viability criteria, modify collection so that impacts do not limit attainment of population-specific viability criteria*					
SONCC-HBT.8.1.14	Sediment	No	Reduce delivery of sediment to streams	Improve regulatory mechanisms	Population wide	3d
SONCC-HBT.8.1.14.1	*Develop grading ordinance for maintenance and building of private roads that minimizes effects to coho*					

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-HBT.10.2.18	Water Quality	No	Reduce pollutants	Set standard	Elk River, Freshwater Creek, Jacoby Creek	3d
SONCC-HBT.10.2.18.1	*Complete TMDLs for water bodies listed under Clean Water Act Section 303(d)*					
SONCC-HBT.3.1.19	Hydrology	No	Improve flow timing or volume	Educate stakeholders	Population wide	BR
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.7.1.6	Riparian	No	Improve wood recruitment, bank stability, shading, and food subsidies	Educate stakeholders	Population wide	BR
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.3.2.23	Hydrology	No	Increase water storage	Educate stakeholders	Population wide	BR
SONCC-HBT.3.2.23.2	*Develop an outreach and education program about preservation of open spaces*					

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