North Coastal Diversity Stratum

This stratum includes populations or parts of populations of "short-run" Chinook salmon spawn in watersheds that are most strongly affected by climate conditions typical of the coast. Lower reaches and tributaries of Redwood Creek (e.g., Prairie Creek), Mad River, and lower Eel River experience these sorts of conditions; however, conditions in these watersheds–especially flow patterns–are also affected by higher, inland areas so that the contribution of Chinook populations to this aspect of ESU diversity may be limited. The South Fork Eel River is in this diversity stratum based on its environmental similarity to coastal basins.

The populations that have been selected for the recovery scenario are listed in the table below and their profiles, maps, results, and recovery actions are in the pages following. Populations are listed by alphabetical order within the diversity stratum.

CC Chinook Salmon North Coastal Diversity Stratum, Populations, Historical Status, Population's Role in Recovery, Current IP-km, and Spawner Density and Abundance Targets for Delisting. The Diversity Stratum recovery targets are only comprised of the essential populations because these are the populations that are expected to be viable (See Vol. 1 Chapter 5). The Chinook salmon Lower Eel River is one population divided between two diversity strata. *The Lower Eel River Chinook population is divided between two diversity strata, and as a result has one recovery target for the North Mountain Interior DS (Van Duzen and Larabee) and one for the North Coastal DS (Lower and South Fork Eel River).

Diversity Stratum	CC Chinook salmon Populations	Historical Population Status	Population's Role In Recovery	Current Weighted IP-km	Spawner Density	Spawner Abundance
North Coastal	Bear River	I	Essential	39.4	37.8	1,500
	Humboldt Bay Tributaries	I	Essential	76.0	33.7	2,600
	Little River (Humboldt County)	I	Essential	17.4	40.0	700
	Lower Eel River ~ *Lower Mainstem/ South Fork Eel River**	I	Essential	364.8	20	7,400
	Mad River	I	Essential	94.0	31.8	3,000
	Mattole River	I	Essential	177.5	22.5	4,000
	Redwood Creek (Humboldt Co)	I	Essential	116.1	29.3	3,400
	North Coastal Diversity Stratum Recovery Target					22,600

CC Chinook salmon North Coastal Diversity Stratum Populations selected for the recovery scenario. There are no Supporting populations within this Diversity Stratum.

Bear River Population

Bear River CC Chinook salmon

- Functionally Independent Population
- North Coastal Diversity Stratum
- Spawner Density Target: 1500 adults
- Current Intrinsic Potential: 39.4 IP-km

For information regarding NC steelhead and SONCC coho salmon for this watershed, please see the NC steelhead volume of this recovery plan and the SONCC coho salmon recovery plan (http://www.westcoast.fisheries.noaa.gov/).

Chinook Salmon Abundance and Distribution

Information on the abundance and distribution of Chinook salmon are limited in the Bear River, however they are considered "few in number" and primarily distributed from the mouth of Bear River to the mouth of West Side Creek, including larger tributaries such as the South Fork Bear River (HRC 2008). An outmigrant monitoring effort collected 172 Chinook salmon smolts in the spring of 2001, indicating a successful spawning population (Ricker 2002). Following the 2007 replacement of a culvert road crossing with a bridge in the Happy Valley area, barriers to fish passage on HRC lands are limited to natural waterfalls and high gradient channel conditions (HRC 2008).

History of Land Use

Bear River is a fourth order, coastal stream draining approximately 151.5 square kilometers (53,287 acres) to the Pacific Ocean. 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 (HRC 2008). Since settlement, the two primary land uses in the basin have consisted of grazing and timber harvest. The Humboldt Redwood Company (HRC), formerly Pacific Lumber Company (PALCO), owns 16,537 acres of land in the upper third of the watershed. The remainder of the watershed is in private ownership (36,839 acres), with a small portion (161 acres) owned and managed by the California Department of Parks and Recreation.

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 save for the retention of small Douglas fir groves. 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 (HRC 2008).

Land use in the lower watershed has remained predominately rangeland and is grazed primarily by cattle and sheep. 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).

Since 1998, the California Department of Fish and Wildlife (through the Fisheries Restoration Grants Program-SB 271) has funded ten projects in the Bear River watershed. These have included projects for landowner education, road assessments, water temperature monitoring, riparian enhancement and planting, installation of log structures, installation of fencing for livestock exclusion, and gully erosion and stream bank stabilization.

Current Resources and Land Management

As noted above, the upper third of the Bear River watershed is managed for timber harvest while the lower two-thirds are largely managed primarily as private grazing/ranching lands.

PALCO-HRC Habitat Conservation Plan

The PALCO's Habitat Conservation Plan (HCP) was finalized in 1999 and its associated Incidental Take Permit remains effective through 2049. The HCP was adopted by the HRC upon acquisition of the PALCO lands in 2008. Although the goal of the HCP is to maintain or achieve, over time, a properly functioning aquatic habitat condition, the HCP acknowledges that not all essential habitat elements (*e.g.,* large wood recruitment) will be attainable within the 50-year life of the plan (PALCO 1999). Site-specific prescriptions, which are designed to promote a properly functioning aquatic habitat condition, are contained in the Bear River watershed analysis (HRC 2008).

The Bear River Watershed Analysis was completed in October 2006, and the Hillslope Management and Riparian Management Prescriptions were completed in April, 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 timber 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. In addition, all streams will have a Riparian Management Zone (RMZ). The RMZ for Class I (fish-bearing) streams is 150 feet wide, with no timber harvest permitted within the first 50 feet.

Salmonid Viability and Watershed Conditions

The following habitat indicators were rated Poor through the CAP process: habitat complexity, sediment, estuary/lagoon, sediment transport and water quality. Recovery strategies will typically focus on ameliorating these habitat indicators, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions within the watershed.

Current Conditions

The following discussion focuses on those conditions that rated Fair or Poor as a result of our CAP viability analysis. The Bear River CAP Viability Table results are provided below. Recovery strategies will focus on improving these conditions.

Population and Habitat Conditions

Habitat Complexity: Large Wood & Shelter

Large woody debris (LWD) volume within the mainstem Bear River is generally poor due to the inherently wide bank-full channel width and the high winter flows common to the basin (HRC 2008). Upstream of the Brushy Creek confluence, LWD volume increases as channel dynamics change. Generally speaking, large wood recruitment within the majority of Class I streams is problematic and will continue to be so for at least the next few decades.

Sediment: Gravel Quality & Distribution of Spawning Gravels

Suitable reaches of the mainstem Bear River, South Fork Bear River, and much of the upper watershed suffer from a high degree of fine sediment embedded within available spawning gravel, which likely reduces salmonid egg and fry survival, impairs invertebrate prey production, and ultimately limits juvenile fish production within the watershed. Both the substrate embeddedness and shallow pool depths common to most low gradient stream reaches are likely caused by upslope erosion from past/current logging practices, failing roads, and poor grazing practices. Juvenile salmonids and eggs are the life stages most impacted by poor gravel quality and excess fine sediment.

Water Quality: Turbidity or Toxicity

The high levels of fine sediment entering the Bear River stream system suggests that elevated turbidity may be an issue following storm events. Highly turbid water can suppress juvenile feeding success and, when severe, physically harm basic physiological processes (*e.g.*, gill respiration).

Habitat Complexity: Percent Primary Pools & Pool/Riffle/Flatwater Ratios

Pool depths in the Bear River mainstem average 3.3 feet or greater. However, in the South Fork Bear River and Nelson and Harmonica Creeks, pool depths are 2 feet or less, which is considered a Poor condition for salmonid habitat function. Pool frequency throughout the watershed is Poor at less than 35 percent by length, caused largely by the lack of instream wood accumulation throughout the mainstem and most larger tributaries. Adults are most impacted by the poor channel complexity because of the lost deep pool holding habitat during spawning migration.

Riparian Vegetation: Composition, Cover & Tree Diameter

Riparian forest condition has an overall Poor rating. High IP-km habitat in lower Bear River, South Fork Bear River, as well as the upper watershed and its tributaries, generally lacks canopy cover, and available riparian habitat is largely dominated by hardwood species that provide poor shading and little channel-forming function. 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 groups of large trees in excess of 24" diameter at breast height (dbh) are scattered throughout the Bear River watershed, most stands consist of trees ranging from 11 to 24" dbh. Very little of the HRC owned property meets established targets indicating high LWD recruitment potential (HRC 2008).

Viability: Density, Abundance & Spatial Structure

Chinook salmon abundance is likely low, and their distribution limited to low-gradient mainstem and tributary reaches. The majority of Chinook salmon spawning likely occurs with the lower 9.5 mile reach between the estuary and West Side Creek (HRC 2008).

Threats

The following discussion focuses on those threats that rank as High or Very High. Recovery strategies will likely focus on ameliorating High ranking threats; however, some strategies may address Medium and Low threats when the strategy is essential to recovery efforts. The figures and tables that display data used in this analysis are provided in Bear River CAP Results.

Roads and Railroads

High road density (greater than 3 miles of road per square mile of watershed) occurs throughout the majority of the watershed, and ranked as a High threat to all Chinook salmon life stages. Roads accelerate sediment delivery to riparian and aquatic habitat, while also altering stream hydrography by accelerating storm runoff patterns. The majority of the roads in the watershed are associated with industrial timber land and managed under the HRC HCP; as required under their HCP, HRC is required to stormproof roads on their land to minimize erosional processes.

Livestock Farming and Ranching

Grazing in the middle and lower watershed represents an overall High threat to pre-smolt, smolt, and adult Chinook salmon. Poor livestock grazing practices can denude the riparian corridor, increase upslope erosion, and facilitate nutrient loading of receiving waters through animal waste entering the stream channel. The extent to which current Bear River ranch owners have fenced cattle out of riparian areas is unknown, but analysis of aerial photos suggests little riparian fencing has occurred within the watershed.

Low or Moderate Ranked Threats

Logging is ranked as a Medium threat to all Chinook salmon life stages. Legacy effects of past harvest practices within the upper third of the watershed (HRC property), such as accelerated sediment transport, poor wood recruitment, and impaired riparian function, reduce salmonid habitat quality throughout much of Bear River watershed. Industrial timber harvest impacts may be reduced under the HCP prescriptions, but several decades may pass before riparian and stream habitat recovers. The lower two-thirds of the watershed is privately owned and primarily used for grazing and ranching: appreciable timber harvest does not appear to occur outside of HRC land.

Fire is identified as a Medium threat because of its potential significance if a fire were to occur. No road-crossing barriers have been identified in the Bear River watershed, resulting in a Low threat ranking. 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 Chinook salmon. Finally, 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.

Limiting Stresses, Life Stages, and Habitats

The egg and pre-smolt lifestages are the most limiting to population viability within Bear River, given the high susceptibility to the effects of elevated fine sediment and poor rearing conditions. Poor riparian habitat function likely lowers water quality throughout much of the lower and middle mainstem river and within accessible tributaries.

General Recovery Strategy

In general, recovery strategies focus on improving conditions and ameliorating stresses and threats discussed above, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions within the watershed. The general recovery strategy for the Bear River Chinook salmon population is discussed below with more detailed and site-specific recovery actions provided in the Implementation Schedule for this population.

Reduce Grazing and Road-related Erosion

Failing or improperly maintained roads are significant sources of fine sediment accumulation that is impairing Bear River habitat function. Many tributaries in the upper watershed have high fine sediment concentrations, and recent analysis suggests roads are the primary management-associated source of this type of sediment delivery (141 tons/mi2/yr) (HRC 2008). Although undocumented in the Bear River watershed, poor grazing management could be accelerating streambank erosion within the lower river where cattle grazing is most intensive.

Improve Instream LWD Volume

LWD volume is generally poor within most of the Bear River watershed, especially within the mainstem Bear River reach and the Brushy Creek sub-watershed. Intense historical timber harvesting (pre-1965) effectively depressed natural wood recruitment, while the devastating floods of 1955 and 1964 flushed much of the existing LWD out of the watershed (HRC 2008).

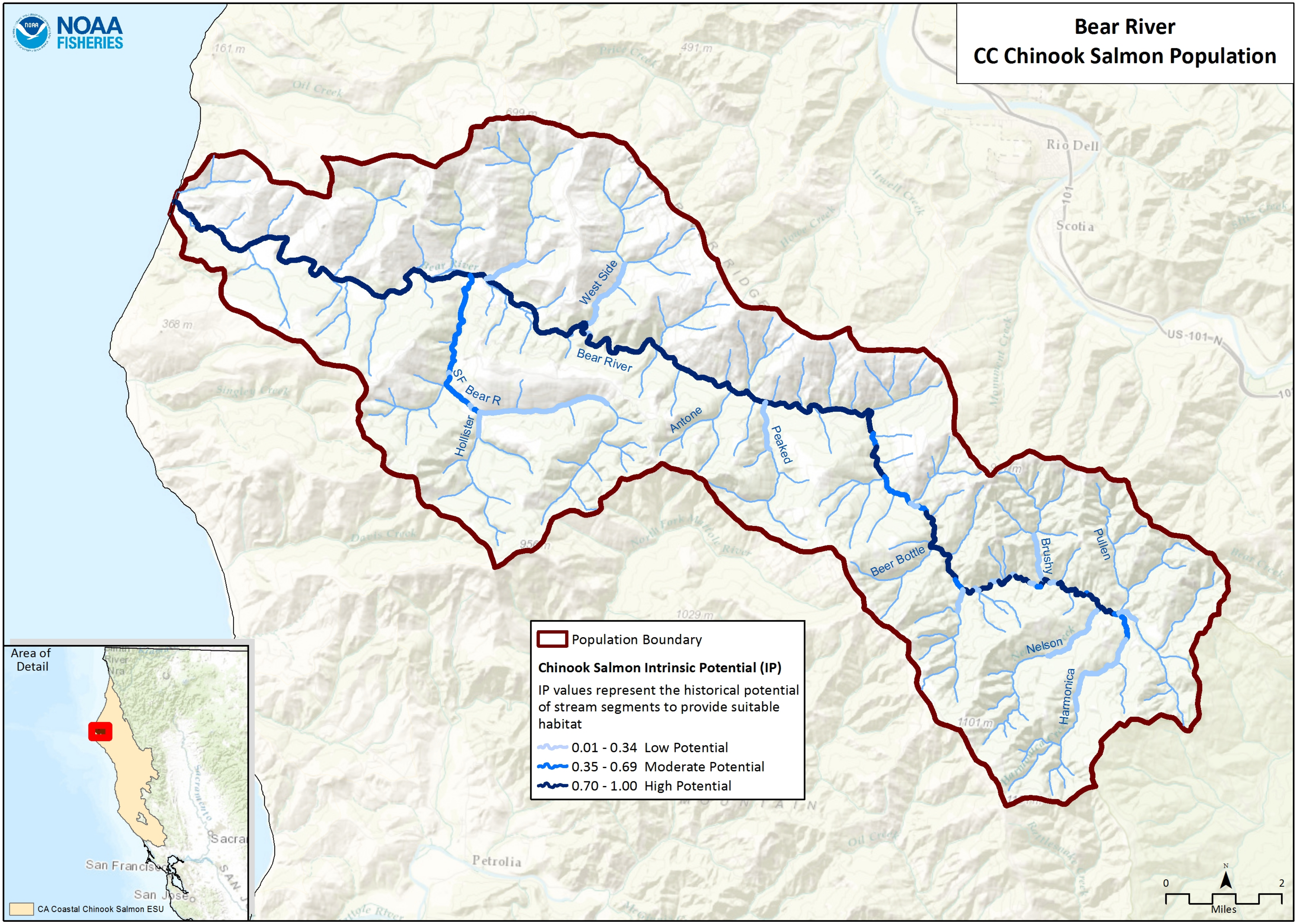
Improve Estuary Habitat

Restore the physical and biological attributes of the estuary. Improve juvenile Chinook salmon rearing habitat by increasing in-water structure and overwater cover.

Literature Cited

Humboldt Redwood Company. 2008. Bear River Watershed Analysis, Cumulative Watershed Effects. Public Review Draft. December 2008. Humboldt Redwood Company LLC.

Pacific Lumber Company. 1999. Habitat conservation plan for the properties of the Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation.



NOAA FISHERIES
Bear River
CC Chinook Salmon Population
Population Boundary
Chinook Salmon Intrinsic Potential (IP)
IP values represent the historical potential of stream segments to provide suitable habitat
0.01 - 0.34 Low Potential
0.35 - 0.69 Moderate Potential
0.70 - 1.00 High Potential
Bear River
West Side
SF Bear R
Hollister
Antone
Peaked
Beer Bottle
Brushy
Pullen
Nelson
Harmonica
Rio Dell
Scotia
US-101-N
Petrolia
Area of Detail
San Francisco
San Jose
CA Coastal Chinook Salmon ESU
0
2
Miles

Bear River CAP Viability Results

#	Conservation Target	Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Measurement	Current Rating
1	Adults	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Large Wood Frequency (BFW 0-10 meters)	<50% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>6 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>6 Key Pieces/100 meters)	>90% of streams/ IP-Km (>6 Key Pieces/100 meters)	<50% of streams/ IP-km (>6 Key Pieces/100 meters)	Poor
			Habitat Complexity	Large Wood Frequency (BFW 10-100 meters)	<50% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	>90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	<50% of streams/ IP-km (>1.3 Key Pieces/100 meters)	Poor
			Habitat Complexity	Percent Staging Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	50% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	<50% of streams/ IP-km (>49% average primary pool frequency)	Poor
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	<50% of streams/ IP-km (>30% Pools; >20% Riffles)	Poor
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	>90% of IP-km	Very Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	100% of IP-km	Very Good

			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	35.05% Class 5 & 6 across IP-km	Fair
			Sediment	Quantity & Distribution of Spawning Gravels	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	<50% of IP-km or <16 IP-km accessible*	Poor
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	50-80% Response Reach Connectivity	Fair
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-km maintains severity score of 3 or lower	Fair
		Size	Viability	Density	<1 spawners per IP-Km	1-20 Spawners per IP-km: low risk spawner density per Spence (2008)	20-40 Spawners per IP-Km (e.g., Low Risk Extinction Criteria)		1-20 Spawners per IP-km	Fair
			Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	100% of Historical Range	Very Good
2	Eggs	Condition	Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Hydrology	Redd Scour	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Sediment	Gravel Quality (Bulk)	>17% (0.85mm) and >30% (6.4mm)	15-17% (0.85mm) and <30% (6.4mm)	12-14% (0.85mm) and <30% (6.4mm)	<12% (0.85mm) and <30% (6.4mm)	14.07% (0.85mm) and <30% (6.4mm)	Fair

			Sediment	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
3	Pre Smolt	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Percent Primary Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	50% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-km (>49% average primary pool frequency)	Good
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	<50% of streams/ IP-km (>30% Pools; >20% Riffles)	Poor
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	<50% of streams/ IP-km (>80 stream average)	Poor
			Hydrology	Flow Conditions (Baseflow)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	0.01 - 1 Diversions/10 IP-km	Good
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	>90% of IP-km	Very Good

			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	35.05% Class 5 & 6 across IP-km	Poor
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined		
			Water Quality	Temperature (MWMT)	<50% IP km (<20 C MWMT; <16 C MWMT where coho IP overlaps)	50 to 74% IP km (<20 C MWMT; <16 C MWMT where coho IP overlaps)	75 to 89% IP km (<20 C MWMT; <16 C MWMT where coho IP overlaps)	>90% IP km (<20 C MWMT; <16 C MWMT where coho IP overlaps)	50 to 74% IP-km (<20 C MWMT; <16 C MWMT where coho IP overlaps)	Fair
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-km maintains severity score of 3 or lower	Fair
		Size	Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	100% of Historical Range	Very Good
5	Smolts	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	<50% of streams/ IP-km (>80 stream average)	Poor
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35		

			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	0.01 - 1 Diversions/10 IP-km	Good
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	>90% of IP-km	Very Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	100% of IP-km	Very Good
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
			Smoltification	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	50-74% IP-km (>6 and <14 C)	Fair
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	50-80% Response Reach Connectivity	Fair
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-km maintains severity score of 3 or lower	Fair
		Size	Viability	Abundance	Smolt abundance which produces high risk spawner density per Spence (2008)	Smolt abundance which produces moderate risk spawner density per Spence (2008)	Smolt abundance to produce low risk spawner density per Spence (2008)			

6	Watershed Processes	Landscape Context	Hydrology	Impervious Surfaces	>10% of Watershed in Impervious Surfaces	7-10% of Watershed in Impervious Surfaces	3-6% of Watershed in Impervious Surfaces	<3% of Watershed in Impervious Surfaces	0.08% of Watershed in Impervious Surfaces	Very Good
			Landscape Patterns	Agriculture	>30% of Watershed in Agriculture	20-30% of Watershed in Agriculture	10-19% of Watershed in Agriculture	<10% of Watershed in Agriculture	0% of Watershed in Agriculture	Very Good
			Landscape Patterns	Timber Harvest	>35% of Watershed in Timber Harvest	26-35% of Watershed in Timber Harvest	25-15% of Watershed in Timber Harvest	<15% of Watershed in Timber Harvest	18.12% of Watershed in Timber Harvest	Good
			Landscape Patterns	Urbanization	>20% of watershed >1 unit/20 acres	12-20% of watershed >1 unit/20 acres	8-11% of watershed >1 unit/20 acres	<8% of watershed >1 unit/20 acres	<8% of watershed >1 unit/20 acres	Very Good
			Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition	<25% Intact Historical Species Composition	Poor
			Sediment Transport	Road Density	>3 Miles/Square Mile	2.5 to 3 Miles/Square Mile	1.6 to 2.4 Miles/Square Mile	<1.6 Miles/Square Mile	4.73 Miles/Square Mile	Poor
			Sediment Transport	Streamside Road Density (100 m)	>1 Miles/Square Mile	0.5 to 1 Miles/Square Mile	0.1 to 0.4 Miles/Square Mile	<0.1 Miles/Square Mile	2.79 Miles/Square Mile	Poor

Bear River CAP Threats Results

	Threats Across Targets	Adults	Eggs	Pre Smolt	Smolts	Watershed Processes	Overall Threat Rank
	Project-specific-threats	1	2	3	5	6	
1	Agriculture	Medium	Low	Medium	Medium	Low	Medium
2	Channel Modification	Medium	Medium	Medium	Medium	Medium	Medium
3	Disease, Predation and Competition	Medium	Low	Medium	Medium	Low	Medium
4	Hatcheries and Aquaculture	Medium	Low	Medium	Medium	Low	Medium
5	Fire, Fuel Management and Fire Suppression	Medium	Medium	Medium	Medium	Medium	Medium
6	Fishing and Collecting	Medium	Low	Medium	Medium	Low	Medium
7	Livestock Farming and Ranching	High	Medium	High	High	Medium	High
8	Logging and Wood Harvesting	Medium	Medium	Medium	High	High	High
9	Mining	Medium	Low	Medium	Medium	Low	Medium
10	Recreational Areas and Activities	Medium	Low	Medium	Medium	Low	Medium
11	Residential and Commercial Development	Medium	Low	Medium	Medium	Low	Medium
12	Roads and Railroads	High	High	High	High	Medium	High
13	Severe Weather Patterns	Medium	Medium	Low	Medium	Medium	Medium
14	Water Diversion and Impoundments	Medium	Low	Low	Medium	Low	Medium
	Threat Status for Targets and Project	High	High	High	High	High	Very High

Bear River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
BeaR-CCCh-1.1	**Objective**	**Estuary**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
BeaR-CCCh-1.1.1	Recovery Action	Estuary	Increase quality and extent of estuarine habitat										
BeaR-CCCh-1.1.1.1	Action Step	Estuary	Study estuarine habitat suitability and utilization for rearing salmonids.	2	5	CDFW							Cost accounted for in Monitoring Chapter
BeaR-CCCh-2.1	**Objective**	**Floodplain Connectivity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
BeaR-CCCh-2.1.1	Recovery Action	Floodplain Connectivity	Rehabilitate and enhance floodplain connectivity										
BeaR-CCCh-2.1.1.1	Action Step	Floodplain Connectivity	Assess habitat to determine beneficial locations and amount of instream structure needed.	3	5	CDFW	115.00					115	Cost for fish/habitat restoration assessment at a rate of $114,861/project.
BeaR-CCCh-2.1.1.2	Action Step	Floodplain Connectivity	Implement actions recommended by assessment that improve floodplain connectivity and function.	3	10	CDFW, NMFS						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
BeaR-CCCh-6.1	**Objective**	**Habitat Complexity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
BeaR-CCCh-6.1.1	Recovery Action	Habitat Complexity	Increase large wood frequency										
BeaR-CCCh-6.1.1.1	Action Step	Habitat Complexity	Assess habitat to determine beneficial locations and amount of instream structure needed.	3	5	Humboldt Redwood Company, NRCS, Private Landowners						115	Cost for fish/habitat restoration assessment at a rate of $114,861/project.
BeaR-CCCh-6.1.1.2	Action Step	Habitat Complexity	Place instream structures, guided by assessment results.	3	5	CDFW, NRCS, Private Landowners						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
BeaR-CCCh-6.1.3	Recovery Action	Habitat Complexity	Improve shelter										
BeaR-CCCh-6.1.3.1	Action Step	Habitat Complexity	Develop tributary pool and shelter projects with cooperative landowners to enhance presmolt and smolt survival	3	5	CDFW, Mendocino County RCD, Private Landowners						0	Action is considered In-Kind
BeaR-CCCh-7.1	**Objective**	**Riparian**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
BeaR-CCCh-7.1.1	Recovery Action	Riparian	Improve riparian conditions										
BeaR-CCCh-7.1.1.1	Action Step	Riparian	Review General Plan and City Ordinances to ensure salmonid habitat needs are accounted for and revise, if necessary.	3	5	CDFW, County, NMFS						0	Existing programs and outreach are considered In-Kind.
BeaR-CCCh-8.1	**Objective**	**Sediment**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
BeaR-CCCh-8.1.1	Recovery Action	Sediment	Improve instream gravel quality										
BeaR-CCCh-8.1.1.1	Action Step	Sediment	Inventory sediment sources, and prioritize for treatment.	2	5	California Conservations Corps						0	Existing programs and outreach are considered In-Kind.

Bear River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
BeaR-CCCh-8.1.1.2	Action Step	Sediment	Treat priority sediment source sites, guided by plan.	2	5	California Conservations Corps						0	Existing programs and outreach are considered In-Kind.
BeaR-CCCh-11.1	**Objective**	**Viability**	**Address other natural or manmade factors affecting the species' continued existence**										
BeaR-CCCh-11.1.1	Recovery Action	Viability	Increase density, abundance, spatial structure, and diversity										
BeaR-CCCh-11.1.1.1	Action Step	Viability	Conduct comprehensive monitoring to measure indicators for spawning and rearing habitat.	3	25	CDFW							Cost accounted for in Monitoring Chapter
BeaR-CCCh-16.1	**Objective**	**Fishing/Collecting**	**Address the overutilization for commercial, recreational, scientific or educational purposes**										
BeaR-CCCh-16.1.1	Recovery Action	Fishing/Collecting	Prevent or minimize reduced density, abundance and diversity based on the biological viability criteria										
BeaR-CCCh-16.1.1.1	Action Step	Fishing/Collecting	Determine impacts of fisheries management on salmonids in terms of VSP parameters.	3	5	NMFS						0	Action is considered In-Kind
BeaR-CCCh-16.1.1.2	Action Step	Fishing/Collecting	If actual fishing impacts exceed levels consistent with recovery, modify management so that levels are consistent with recovery.	2	25	NMFS						0	Action is considered In-Kind
BeaR-CCCh-16.1.1.3	Action Step	Fishing/Collecting	Determine impacts of scientific collection on salmonids in terms of VSP parameters and incorporate delisting criteria when formulating scientific collection authorizations.	3	5	NMFS						0	Action is considered In-Kind
BeaR-CCCh-18.1	**Objective**	**Livestock**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
BeaR-CCCh-18.1.1	Recovery Action	Livestock	Prevent or minimize impairment to instream substrate/food productivity (impaired gravel quality and quantity)										
BeaR-CCCh-18.1.1.1	Action Step	Livestock	Assess grazing impact on sediment delivery and identify opportunities for improvement.	1	5	NRCS, RCD						0	Action is considered In-Kind
BeaR-CCCh-18.1.2	Recovery Action	Livestock	Prevent or minimize adverse alterations to riparian species composition and structure										
BeaR-CCCh-18.1.2.1	Action Step	Livestock	Plant vegetation to stabilize streambank.	1	5	NRCS, RCD						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
BeaR-CCCh-18.1.2.2	Action Step	Livestock	Fence livestock out of riparian zones.	1	5	NRCS, RCD						TBD	TBD, based on amount of linear feet of fencing to exclude livestock from riparian zones. Cost estimated at a rate of $3.63/ft..
BeaR-CCCh-18.1.3	Recovery Action	Livestock	Prevent or minimize impairment to water quality (e.g. turbidity, suspended sediment and/or toxicity)										
BeaR-CCCh-18.1.3.1	Action Step	Livestock	Remove instream livestock watering sources.	3	5	NRCS, RCD	0.61					TBD	TBD, based on number of livestock watering sources and feasible alternatives. Cost estimated at a rate of $858/tank with a 500 ft of piping at a rate of $0.84/ft.
BeaR-CCCh-18.2	**Objective**	**Livestock**	**Address the inadequacy of existing regulatory mechanisms**										
BeaR-CCCh-18.2.1	Recovery Action	Livestock	Prevent or minimize impairment to instream habitat complexity (reduced large wood and/or shelter)										
BeaR-CCCh-18.2.1.1	Action Step	Livestock	Develop grazing management plan to meet objective.	2	5	NRCS, RCD						0	Action is considered In-Kind

Bear River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
BeaR-CCCh-19.1	**Objective**	**Logging**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
BeaR-CCCh-19.1.1	Recovery Action	Logging	Prevent or minimize impairment to habitat complexity										
BeaR-CCCh-19.1.1.1	Action Step	Logging	Encourage coordination of LWD placement projects in streams (as necessary) as part of logging operations.	2	40	CDFW, Humboldt Redwood Company, NMFS						0	Operations conducted normally or with minor modifications are considered In-Kind.
BeaR-CCCh-19.1.1.2	Action Step	Logging	Encourage low impact timber harvest techniques such as full-suspension cable yarding (to improve canopy cover; reduce sediment input, etc.).	3	40	CDFW, Humboldt Redwood Company, NMFS						0	Operations conducted normally or with minor modifications are considered In-Kind.
BeaR-CCCh-19.1.1.3	Action Step	Logging	Work with California BOF, CalFire, CDFW, professional organizations and landowners to protect forest lands from conversion, promote sustainable forestry practices and provide landowner incentives for growing late seral forests in riparian areas and conducting restoration actions.	3	40	NMFS						0	Operations conducted normally or with minor modifications are considered In-Kind.
BeaR-CCCh-19.1.1.4	Action Step	Logging	All roads, landings, and skid trails associated with timber operations should, to the maximum extent practicable, be hydrologically disconnected to prevent sediment runoff and delivery to streams.	3	25	CDFW, Humboldt Redwood Company, NRCS						0	Operations conducted normally or with minor modifications are considered In-Kind.
BeaR-CCCh-23.1	**Objective**	**Roads/Railroads**	**Address the present or threatened destruction, modification, or curtailment of habitat or range**										
BeaR-CCCh-23.1.1	Recovery Action	Roads/Railroads	Prevent or minimize alterations to sediment transport (road condition/density, dams, etc.)										
BeaR-CCCh-23.1.1.1	Action Step	Roads/Railroads	Assess and prioritize road-stream connection, and identify appropriate treatment to reduce delivery of sediment to streams.	3	5	CDFW, Humboldt Redwood Company						79	Cost based on road inventory for 82 miles of road at a rate of $957/mile.
BeaR-CCCh-23.1.1.2	Action Step	Roads/Railroads	Decommission roads, guided by assessment.	3	25	CDFW, Humboldt Redwood Company						TBD	TBD, based on amount of road network to decommission. Cost estimated at a rate of $12,000/mile.
BeaR-CCCh-23.1.1.3	Action Step	Roads/Railroads	Upgrade roads, guided by assessment.	3	25	CDFW, Humboldt Redwood Company						TBD	TBD, cost based on amount of road network to upgrade. Cost estimated at a rate of $21,000/mile.
BeaR-CCCh-23.1.1.4	Action Step	Roads/Railroads	Maintain roads, guided by assessment.	3	25	CDFW, Humboldt Redwood Company						0	Action is considered In-Kind
BeaR-CCCh-23.2	**Objective**	**Roads/Railroads**	**Address the inadequacy of existing regulatory mechanisms**										
BeaR-CCCh-23.2.1	Recovery Action	Roads/Railroads	Prevent or minimize alterations to sediment transport (road condition/density, dams, etc.)										
BeaR-CCCh-23.2.1.1	Action Step	Roads/Railroads	Develop grading ordinance for maintenance and building of private roads that minimizes the effects to salmonids.	3	5	CDFW, County						0	Action is considered In-Kind
BeaR-CCCh-25.1	**Objective**	**Water Diversion/ Impoundment**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										

Bear River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
BeaR-CCCh-25.1.1	Recovery Action	Water Diversion/ Impoundment	Improve flow conditions										
BeaR-CCCh-25.1.1.1	Action Step	Water Diversion/ Impoundment	Identify alternative water sources, storage means, or seasonal withdrawal restrictions to increase streamflow during low flow periods.	2	5	CDFW, County, NMFS						0	Existing programs and outreach are considered In-Kind.
BeaR-CCCh-25.1.1.2	Action Step	Water Diversion/ Impoundment	Reduce diversions.	2	5	NCRWQB						0	Existing programs and outreach are considered In-Kind.
BeaR-CCCh-25.1.1.3	Action Step	Water Diversion/ Impoundment	Provide education and training on conserving water while diverting.	3	10	NCRWQB						0	Existing programs and outreach are considered In-Kind.
BeaR-CCCh-25.1.1.4	Action Step	Water Diversion/ Impoundment	Provide incentives to landowners to reduce water consumption during low flow periods.	3	15	NCRWQB						0	Existing programs and outreach are considered In-Kind.

Humboldt Bay Tributaries Population

Chinook Salmon Fall-Run

- Role within ESU: Potentially Independent Population
- Diversity Stratum: North Coastal
- Spawner Abundance Target: 2,600 adults
- Current Intrinsic Potential: 76.0 IP-km

For information regarding NC steelhead and SONCC coho salmon for this watershed, please see the NC steelhead volume of this recovery plan and the SONCC coho salmon recovery plan (http://www.westcoast.fisheries.noaa.gov/).

Chinook Salmon Abundance and Distribution

The Humboldt Bay watershed drains approximately 433 square kilometers, with a majority of this occurring in the major spawning tributaries of Jacoby Creek, Freshwater Creek, Salmon Creek, and Elk River. Because population data collection in the Humboldt Bay watershed is limited, abundance of the Chinook salmon population is inferred from the trends observed in Freshwater Creek.

Although Chinook salmon have been counted at the Freshwater Creek weir since 1994; these counts are partial counts, as fish can fish pass over the weir during high flows and smaller jacks may pass through the weir. Counts of adults at the Freshwater Creek weir from 1994 through 2014 indicate the wild population has declined (Ricker and Anderson 2014). Ricker and Anderson (2014) characterized the decline in Chinook salmon in Freshwater Creek as dramatic, and raised concerns over depensatory population effects. Once the augmentation of hatchery reared Chinook salmon ceased in 2004, weir captures declined rapidly into the single digits and ultimately reaching an all-time low of no returning adults in 2013 (Ricker and Anderson 2014).

History of 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 instreams. 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 salmon habitat in the population area was largely unaffected by anthropogenic land use. After 1800, European settlement, land use, and resource extraction influenced landscape processes, which resulted in decreased quality, quantity, and accessibility of habitat for salmon adult spawning and juvenile rearing (Beechie *et al*. 2003).

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) 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 or bridges, continued into the 1970s and created a persistent source of sediment delivery to watercourses (HBWAC 2005).

Current Resources and Land Management

Numerous community-based organizations are engaged in salmonid, watershed, and ecosystem restoration activities, which are distributed across public, private and tribal lands in the Humboldt Bay watershed. The local history of restoration, existing patterns of land ownership and settlement, the presence and engagement of numerous Federal and state public lands management agencies as well as regulatory agencies, and the robust civic culture and community relationships is vital for recovery of salmonid populations (Baker and Quinn-Davidson 2011).

Humboldt Bay is an important commercial and recreational shellfish growing area, as well as deep-water port. 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 the 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). The HBHRCD was established in 1970 to manage Humboldt Bay for the promotion of commerce, navigation, fisheries, recreation, the protection of natural resources, and to acquire, construct, maintain, operate, develop, and regulate harbor activities. In addition to the HBHRCD, numerous districts, city, county, state and Federal entities have ownership and regulatory jurisdiction over land use activities in the coastal zone (HBHRCD 2007).

Currently in the upper tributary watersheds of Humboldt Bay, the dominant land use is timber production and harvest. The majority of land in the upper Humboldt Bay watershed is privately owned by two commercial timber companies, Humboldt Redwood Company (Freshwater Creek, Elk River) and Green Diamond Resource Company (Jacoby Creek, Freshwater Creek, Salmon Creek). 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). The dominant land use in the middle and lower portions of the Humboldt Bay watershed are agriculture, urban, residential, and industrial development. Agricultural land is used primarily for livestock grazing and hay production. Urban, residential, and industrial land use are 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 Jacoby Creek and Freshwater Creek watersheds than in the Elk River or Salmon Creek watersheds.

Outside of incorporated municipalities, there is limited public ownership of land within the Humboldt Bay watershed. The few exceptions include: the City of Arcata owns and manages a 2,100 acre community forest which includes a demonstration forest in the Jacoby Creek watershed; the California Department of Fish and Wildlife (CDFW) manages five wildlife areas (Mad River Slough 587 acres; Fay Slough 484 acres; Elk River 2,131 acres; and South Spit 598 acres); the U.S. Fish and Wildlife Service manages the approximately 4,000 acres Humboldt Bay National Wildlife Refuge, with holdings in both the north and south bay areas; Humboldt County manages a small park which includes a seasonal impoundment and associated fish ladder in Freshwater Creek; the Headwaters Forest Reserve, public land managed jointly by the Bureau of Land management and CDFW, includes nearly 7,500 ac of redwood and Douglas-fir forests and protects stream systems that provide habitat for Chinook salmon in South Fork Elk River and Salmon Creek.

Numerous water quality, land use, resource management, and habitat conservation related planning documents specific to Humboldt Bay and its watershed have been prepared (see list below). Local community land use plans (Arcata, Eureka, and Humboldt County) provide direction for future growth and development, express community values and goals, and portray the community's vision of the future. These plans contain measures (*e.g.,* zoning ordinances) designed to protect aquatic habitat by controlling watershed erosion, maintaining instream flows and enhancing riparian habitat, and strive to integrate the incorporated and unincorporated areas within the Humboldt Bay watershed:

- U.S. Bureau of Land Management and California Department of Fish and Game, Headwaters Forest Reserve Resource Management Plan (USBLM and CDFG 2004);
- U.S Fish and Wildlife Service Humboldt Bay National Wildlife Refuge Comprehensive Conservation Plan (USFWS 2009);
- Humboldt Bay Harbor, Recreation and Conservation District Humboldt Bay Management Plan (HBHRCD 2007);
- Humboldt County General Plan Update (ongoing);
- City of Eureka General Land Use Plan (City of Eureka 1997); and
- City of Arcata General Plan 2020 (City of Arcata 2008).

Aside from Federal land management agency and HBHRCD plans, numerous regulatory mechanisms are designed to protect aquatic habitat in the Humboldt Bay watershed. The National Marine Fisheries Service has issued long-term (50-year) section 10(a)(1)(B) Incidental Take Permits for the activities and associated habitat conservation plans for two commercial timber companies in the Humboldt Bay watersheds. Within the State of California, the California Department of Forestry and Fire Protection, the State Board of Forestry and Fire Protection, and the California Environmental Protection Agency have regulatory mechanisms in place or in development to reduce sediment impairment to aquatic habitat from land-based activities in the Humboldt Bay watershed. The North Coast Regional Water Quality Control Board (Regional Water Board) and the U.S. Environmental Protection Agency (EPA) have listed the Freshwater Creek watershed and Elk River watershed under the Clean Water Act Section 303(d) as sediment impaired waterbodies. A program has been developed to recover 303(d) List waterbodies via the establishment of Total Maximum Daily Loads (TMDL). The Regional Water Board staff is in the process of establishing a TMDLs for sediment in the Freshwater Creek and Elk River watersheds. The goal of the TMDL program is to restore and maintain the sediment impaired beneficial uses of water of Freshwater Creek and Elk River and their tributaries. Regulatory mechanisms affecting private lands in the Humboldt Bay watershed include:

- Humboldt Redwood Company Habitat Conservation Plan (HRC 2012);
- Green Diamond Resource Company Habitat Conservation Plan (GDRC 2006);
- California Department of Forestry and Fire Protection and California Department of Fish and Game Anadromous Salmonid Protection Rules (CDFFP and CDFG 2010);
- North Coast Integrated Regional Water Management Plan (NCRP 2007); and
- California State Water Resources Control Board and California Environmental Protection Agency. Water Quality Control Plan for Enclosed Bays and Estuaries. Part 1. Sediment Quality (CSWRCB and CEPA 2009).

Local stakeholders have been proactive in both developing salmonid conservation and habitat restoration plans, strategically coordinating funding and implementation of projects and taking an ecosystem approach to potential effects of sea level rise and climate change:

- Humboldt Bay Watershed Salmon and Steelhead Conservation Plan (HBWAC 2005) (2005);
- North Coast Anadromous Salmonid Conservation Assessment (Tussing and Wingo-Tussing 2005);
- Humboldt Bay Ecosystem-Based Management Program (2007);
- Humboldt Bay Initiative: Adaptive Management in a Changing World (Schlosser *et al.* 2009);
- California Pacific Coast Joint Venture Coastal Northern California Component Strategic Plan (CPCJV 2004); and
- The Humboldt Bay and Eel River Estuary Benthic Habitat Project (Schlosser and Eicher 2012).

Many completed restoration projects have leveraged opportunities on public lands, as well as provided incentives for participation by private landowners. For example, the City of Arcata Baylands and McDaniel Slough Restoration and Enhancement Projects restored and enhanced wetland, riparian and stream habitat adjacent to the Humboldt Bay National Wildlife Refuge, the Arcata Marsh and Wildlife Sanctuary, the Mad River Slough Wildlife Area and Jacoby Creek Land Trust holdings, thereby establishing a continuous, protected habitat area of over 1,300 acres. The Humboldt Bay Initiative (Schlosser *et al.* 2009) identified the need for: (1) a non-profit Coastal Ecosystem Institute of Northern California (CEINC), now established; and (2) a proactive, coordinated response to shoreline and hydrologic changes, and the resulting shifts in land use, human communities, species and habitats due to climate change. In 2013, the CEINC along with the HBHRCD, convened an Adaptation Planning Working Group to begin preparation of a sea level rise adaptation plan for Humboldt Bay.

Salmonid Viability and Watershed Conditions

The following indicators rate as Poor for the Humboldt Bay Chinook salmon population: numbers of spawners and spatial structure; habitat complexity (percent of staging pools; shelter rating); velocity refuge (floodplain connectivity), water quality (turbidity), quality and extent of the estuary, landscape level natural hydrology (redd scour) and patterns of land use (timber harvest, urbanization, road density) that alter sediment transport and population density and distribution.

Current Conditions

The following discussion focuses on those conditions that rated Fair or Poor as a result of our CAP viability analysis. The Humboldt Bay CAP Viability Table results ae provided below. Recovery strategies will focus on improving these conditions.

Population and Habitat Conditions

Viability: Density, Abundance, and Spatial Structure

Relative to historic numbers and recovery targets, the numbers of spawning adults are alarmingly low in the Humboldt Bay population. Low numbers of juveniles suggest that the watershed is not functioning properly. The current spatial distribution of juvenile steelhead is believed to be less than 50 percent of historic distribution. Expression of known diverse life history outmigration and rearing strategies of juvenile salmonids are limited by the quantity and quality of both freshwater and estuarine habitat.

Estuary: Quality and Extent

This condition rates Fair for Chinook salmon adults, pre-smolts, and smolts. Chinook salmon adults use estuarine habitat as a staging area prior to their migration to freshwater, and pre-smolts and smolts use estuarine habitat for rearing, as a transitional habitat between the freshwater and marine environments, and velocity refugia. Chinook salmon pre-smolts rearing in the estuary are almost always found in tidally influenced freshwater habitat while smolts utilize brackish water habitat in the estuary (Wallace, CDFW, personal communication 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 pre-smolts 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 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 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 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 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 in 1971 and Woodley Island 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).

Landscape Patterns: Agriculture, Timber Harvest and Urbanization

This condition has an overall Poor rating for watershed processes. 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 future potential large wood. 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 sediment and other pollutants present in the water 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 juveniles.

Altered Sediment Transport: Road Condition and Density

This condition has an overall Poor rating for watershed processes. 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, 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, transporting considerable volumes of sediment downstream.

Increased sediment delivery has filled pools, widened channels, and simplified stream habitat throughout the Humboldt Bay watershed, including the tidally influenced habitats and the estuary.

Hydrology: Redd Scour Events

This condition has an overall Poor rating for eggs due to increased flows from peak runoff events.

Habitat Complexity: Percent Primary Pools and Pool/Riffle Ratios/Flatwater Ratios

The Percent Primary/Staging Pools condition has a Poor rating for adults. Jacoby Creek, Freshwater Creek, and Elk River have been listed by the North Coast Regional Water Quality Control Board (NCRWQCB) and the U.S. Environmental Protection Agency (EPA), under the Clean Water Act Section 303(d), as sediment impaired. Excessive fine sediment can result in poor spawning habitat for adults.

Velocity Refuge: Floodplain Connectivity

This condition has a Poor rating for pre-smolts and smolts. The primary indicator for this habitat attribute is availability and abundance of velocity refuge during high flows. Velocity refugia are provided by physical features (*e.g.*, pools, large wood) discussed previously, as well as access to and quality of floodplain. Levees and dikes limit connectivity between mainstem slough channels and potential floodplain habitat in valley floor and stream-estuary ecotone sections of most Humboldt Bay tributaries. Tide gates in dikes block fish passage into formerly accessible estuarine rearing habitat and spawning tributaries in the Humboldt Bay watershed (USFWS 2007).

Riparian Vegetation: Composition, Cover & Tree Diameter

This condition has a Fair rating for pre-smolts. 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 salmon were present where the system was heterotrophic, relying on riparian inputs of energy.

Sediment: Gravel Quality and Distribution of Spawning Gravels

This condition has a Fair rating for adults. Embedded channel gravels reduce permeability of redds, which reduces the amount of oxygen available to salmon eggs, thereby potentially reducing growth and survival of eggs. Further, the success of salmon fry emergence from spawning gravels decreases as channel embeddedness increases. 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.

Water Quality: Turbidity or Toxicity

This condition has an overall Fair rating for adults, pre-smolts, and smolts. 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. Nutrient loading from septic tank overflow, runoff from grazing lands, and reduced riparian vegetation, contribute to impaired water quality.

Very or Good Current Conditions

Water Quality: Temperature

This condition has a Good rating for smolts. Water temperatures in Freshwater/Eureka Slough between Fay and Ryan sloughs become high (>22 C) during the summer and potentially act as a thermal barrier between Freshwater Creek and Humboldt Bay for Chinook smolts. This likely occurs in other sloughs in the Humboldt Bay watershed.

Passage/Migration: Mouth or Confluence and Physical Barriers

This condition has an overall Good rating for adults, pre-smolts, and smolts.

Hydrology: Impervious Surfaces

This condition has an overall Very Good rating for watershed processes.

Hydrology: Baseflow and Passage Flows

This condition has an overall Good rating for adults, pre-smolts, eggs and smolts.

Threats

The following discussion focuses on those threats that rate as High or Very High (see Humboldt Bay CAP results). Recovery strategies will likely focus on ameliorating High rating threats; however, some strategies may address Medium and Low threats when the strategy is essential to recovery efforts. The figures and tables that display data used in this analysis are provided in Humboldt Bay CAP results.

Population and Habitat Threats

Roads and Railroads

Forest roads are a primary causative factor for both altered sediment supply and altered hydrologic function. The density of roads in the Humboldt Bay watershed is generally high (>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).

Channel Modification

This threat rates High for adults, pre-smolts, smolts, and watershed processes. The extent of channelization and diking in the lower portion of 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.

Logging and Wood Harvesting

This threat rates as a High for pre-smolts, smolts and watershed processes. Timber harvest activities in both Freshwater Creek and Elk River have resulted in cumulative watershed effects. 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 potential large wood recruitment to stream channels, and the current age of trees limits shade provided by canopy. Interim prescriptions in the PALCO HCP (PALCO 1999) have been modified and are intended to restore, protect or maintain water quality objectives and beneficial uses in Clean Water Act section 303(d)-listed waterbodies.

Severe Weather Patterns

This threat rates as High for adults and for watershed processes. Although current water temperatures in the Humboldt Bay watershed are a relatively Low stress, modeled regional average temperature shows a moderate increase over the next 50 years. 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.

Tidally influenced rearing and migratory habitat for pre-smolts, and smolts are most susceptible to sea level rise. 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 for the extent of existing levees and dikes.

The tidally influenced habitat of the Humboldt Bay watershed is highly vulnerable to sea-level rise due to 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.

Adults will be negatively impacted by ocean acidification and changes in ocean conditions and prey availability (see ISAB 2007; Portner and Knust 2007; Feely *et al.* 2008).

Low or Moderate Rated Threats

Logging and Wood Harvesting
This threat rates as Medium for adults and eggs. See previous discussion.

Residential and Commercial Development
Overall, this threat rates as Medium for Chinook salmon. 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 salmon migratory corridor and rearing habitat), for port related activities. 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.

Agriculture

Agriculture rates as a Medium threat for pre-smolt, smolt, and watershed processes, and a Low threat for adults and eggs. Grazing and haying occurs throughout the lower watersheds and likely contributes to increased sediment mobilization 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.

Disease, Predation and Competition

Overall, this threat rates as Medium. 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. CDFW'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. CDFW 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.

Because Humboldt Bay is used as a port, numerous, non-native invertebrate species, which often appear as fouling organisms on piers and pilings , have been introduced in ballast water, or from vessel hulls (Boyd *et al.* 2002). Culture of the non-native oyster, *Crassostrea japonica*, also introduced a number of non-native invertebrate species into Humboldt Bay. The non-native dwarf eelgrass (Z*ostera japonica*) and denseflower cordgrass (*Spartina densiflora*), are present, and were also likely introduced in ballast water and as deposited ballast, respectively. Monitoring of non-native invertebrates and intertidal and salt marsh vegetation in Humboldt Bay, as well as eradication programs, are ongoing.

Water Diversion and Impoundments

Overall, this threat is Medium. Diversions pose a Medium threat to juveniles, smolts and adults. There are no large dams in the Humboldt Bay watershed. 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 1920s through 2001, a flashboard dam was 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 (HCDPW 2010; 2011).

According to the Department of Water Resources data base (http://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.shtml), 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 may need to notify CDFW and obtain a lake or streambed alteration agreement before diverting water, 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 salmon. Consequently, the combination of reduced natural flow and anthropogenic withdrawals further reduces water quality (*i.e.*, lowered dissolved oxygen) in the remaining habitat.

Mining, Hatcheries and Aquaculture, Fishing and Collecting, Recreational Areas and Activities
Overall rating of these threats is Low.

Limiting Stresses, Lifestages, and Habitats

The pre-smolt and smolt lifestage is most limiting, primarily due to reductions in quality and quantity of summer 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 regulate sediment transport or induce scour, significantly reduces the complexity of the instream habitat. Furthermore, Chinook salmon historically depended on the rich tidally influenced habitat for rearing, and the impaired state of the estuary has further limited rearing opportunities.

General Recovery Strategy

In general, recovery strategies focus on improving conditions and ameliorating stresses and threats, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions within the watershed. The general recovery strategy for the Humboldt Bay Chinook salmon population is discussed below with more detailed and site-specific recovery actions provided in Humboldt Bay CAP results, which provides the Implementation Schedule for these populations.

Recovery actions to reduce the stresses of the Humboldt Bay Chinook salmon population should focus on restoring the natural watershed processes (*i.e.*, the fluvial transport of wood, water, sediment, nutrients, and energy) within Jacoby Creek, Freshwater Creek, Salmon Creek and Elk River. 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) in all of the tributaries to Humboldt Bay will allow for increased growth and survival of individuals. 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 help restore natural landscape processes. Increasing abundance, as well as increasing 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 likelihood of viability of these populations. Because the potential for non-native vegetation to establish in estuarine restoration sites is high due to the disturbance of the substrate and proximity of existing seed sources, estuarine restoration projects should employ measures to enhance colonization by native species.

Population monitoring, as well as implementation of recovery actions in the Elk River watershed, are especially important for recovery.

Improve Estuary Habitat

Restore the physical and biological attributes of the estuary. Improve rearing habitat by increasing in-water structure and overwater cover, restoring access to the tidal slough habitats, and creation of off-channel velocity refugia for winter rearing.

Improve Floodplain Connectivity

Prevent further loss of riparian vegetation and rehabilitate riparian areas that are currently in poor condition. As discussed below the recovery of riparian function will improve LWD recruitment, but also is expected to increase prey availability through terrestrial insect subsidies. Create off-channel freshwater rearing habitat.

Improve Instream Habitat Complexity

Improve large woody frequency across the Humboldt Bay watershed. Riparian areas are in the process of recovery with stands of smaller diameter conifers that currently buffer stream areas. Addition of large wood will provide much needed stream channel complexity until riparian areas reach maturity and begin to recruit large wood naturally to channels. Large wood will improve instream habitat attributes (*e.g.*, pool and riffle frequency, habitat complexity) provide refuge from high flows; and provide for increased growth and survival of juveniles during winter and summer. Information from existing plans and assessments should be utilized in determining high priority streams for large wood restoration projects.

Improve Instream Habitat and Substrate Quality

Continue efforts to reduce sediment delivery from past management caused sources of roads, timber harvest, grazing, and agriculture. Funding must be continued for the implementation of the remaining road and other sediment reduction projects.

Continue efforts to improve water quality by reducing erosion of streambanks from livestock grazing, and off-road vehicle recreational activities.

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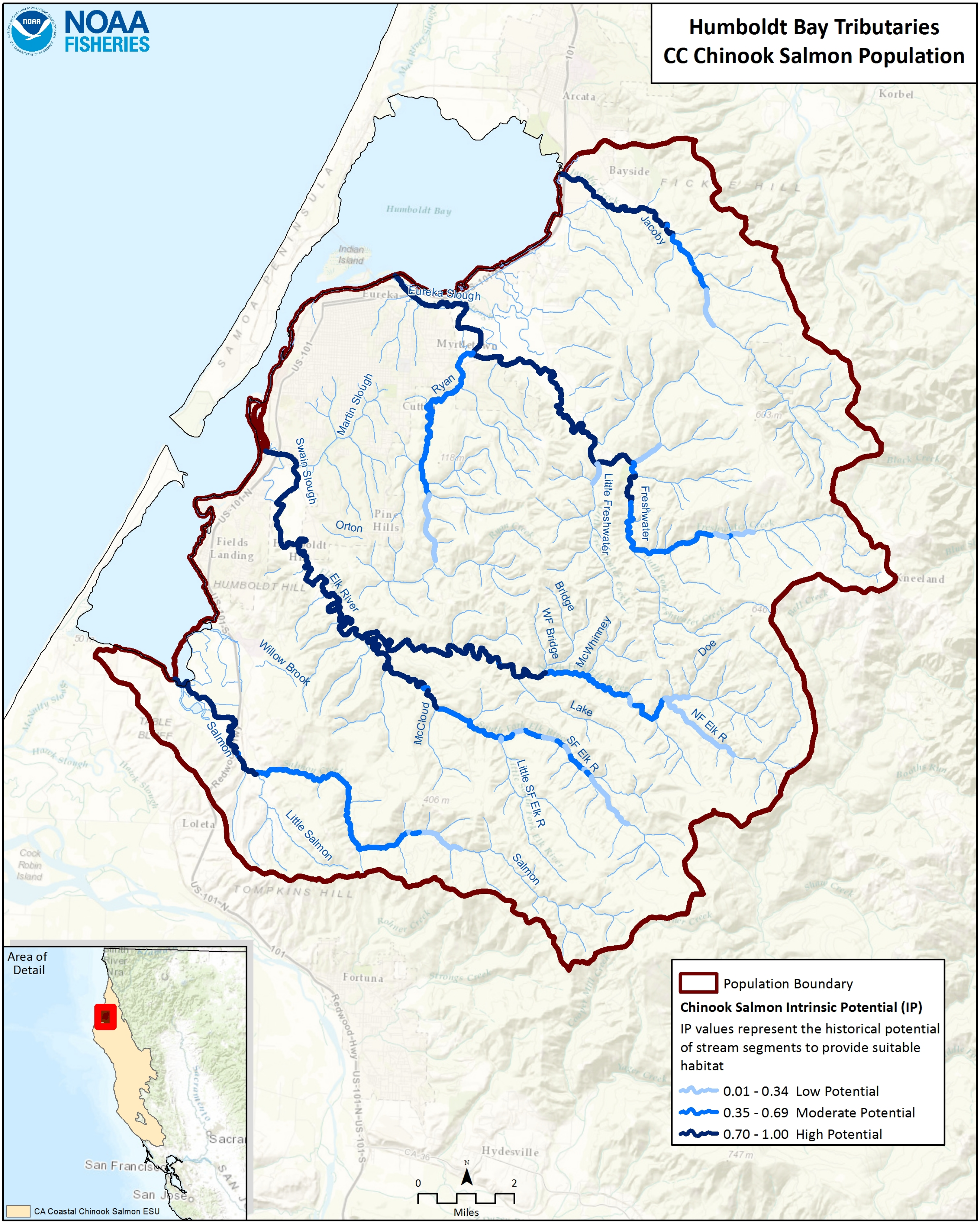

Humboldt Bay Tributaries
CC Chinook Salmon Population
NOAA FISHERIES
Population Boundary
Chinook Salmon Intrinsic Potential (IP)
IP values represent the historical potential of stream segments to provide suitable habitat
0.01 - 0.34 Low Potential
0.35 - 0.69 Moderate Potential
0.70 - 1.00 High Potential
Area of Detail
CA Coastal Chinook Salmon ESU
Miles
Humboldt Bay
Eureka Slough
Jacoby
Ryan
Martin Slough
Swain Slough
Orton
Elk River
Little Freshwater
Freshwater
Bridge
WF Bridge
McWhinney
Doe
Lake
NF Elk R
SF Elk R
Little SF Elk R
McCloud
Willow Brook
Salmon
Little Salmon
Arcata
Bayside
Eureka
Fields Landing
Loleta
Fortuna
Hydesville
Kneeland
Korbel

#	Conservation Target	Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Measurement	Current Rating
1	Adults	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Properly Functioning Condition	Fair
			Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	<50% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>6 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>6 Key Pieces/100 meters)	>90% of streams/ IP-Km (>6 Key Pieces/100 meters)	21.94 Key Pieces/100m	Very Good
			Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	<50% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	>90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	<1 to 1.3Key Pieces/100 meters	Fair
			Habitat Complexity	Percent Staging Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	0% of streams/ IP-km (>49% average primary pool frequency)	Poor
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	99% of streams/ IP-km (>30% Pools; >20% Riffles)	Very Good
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.31	Fair
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	54.56% Class 5 & 6 across IP-km	Fair

			Sediment	Quantity & Distribution of Spawning Gravels	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	50% of IP-km to 74% of IP-km	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	41	Fair
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	<50% Response Reach Connectivity	Poor
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Density	<1 spawners per IP-Km	1-20 Spawners per IP-Km	20-40 Spawners per IP-Km (e.g., Low Risk Extinction Criteria)		<1 spawners per IP-km	Poor
			Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	<50% of Historical Range	Poor
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	76.67	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	17.71	Fair
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	32.3	Good
2	Eggs	Condition	Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Very Good
			Hydrology	Redd Scour	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score >75	Poor

			Sediment	Gravel Quality (Bulk)	>17% (0.85mm) and >30% (6.4mm)	15-17% (0.85mm) and <30% (6.4mm)	12-14% (0.85mm) and <30% (6.4mm)	<12% (0.85mm) and <30% (6.4mm)	81% (0.85mm) and <30% (6.4mm)	Good
			Sediment	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	81% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	41	Fair
3	Pre Smolt	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Fair
			Habitat Complexity	Percent Primary Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	92% of streams/ IP-km (>49% average primary pool frequency)	Very Good
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	99% of streams/ IP-Km (>30% Pools; >20% Riffles)	Very Good
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	13% of streams/ IP-km (>80 stream average)	Poor
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.31	Fair
			Hydrology	Flow Conditions (Baseflow)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Very Good
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	1.1 - 5 Diversions/10 IP-km	Fair

			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Very Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	54.56% Class 5 & 6 across IP-km	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	41	Fair
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	81% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined		
			Water Quality	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	Good
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	<50% of Historical Range	Poor
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	76.67	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	17.71	Fair

			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	32.3	Good
5	Smolts	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Fair
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	13% of streams/ IP-km (>80 stream average)	Poor
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35		
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	1.1 - 5 Diversions/10 IP km	Fair
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Very Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-Km to 90% of IP-km	Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	>90% of IP-km	Very Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	41	Fair
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	81% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
			Smoltification	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	75-90% IP-km (>6 and <14 C)	Good
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	<50% Response Reach Connectivity	Poor

			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-km maintains severity score of 3 or lower	Fair
		Size	Viability	Abundance	Smolt abundance which produces high risk spawner density per Spence (2008)	Smolt abundance which produces moderate risk spawner density per Spence (2008)	Smolt abundance to produce low risk spawner density per Spence (2008)			
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	76.67	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	17.71	Fair
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	32.3	Good
6	Watershed Processes	Landscape Context	Hydrology	Impervious Surfaces	>10% of Watershed in Impervious Surfaces	7-10% of Watershed in Impervious Surfaces	3-6% of Watershed in Impervious Surfaces	<3% of Watershed in Impervious Surfaces	2.97% of Watershed in Impervious Surfaces	Very Good
			Landscape Patterns	Agriculture	>30% of Watershed in Agriculture	20-30% of Watershed in Agriculture	10-19% of Watershed in Agriculture	<10% of Watershed in Agriculture	6.25% of Watershed in Agriculture	Very Good
			Landscape Patterns	Timber Harvest	>35% of Watershed in Timber Harvest	26-35% of Watershed in Timber Harvest	25-15% of Watershed in Timber Harvest	<15% of Watershed in Timber Harvest	55.51% of Watershed in Timber Harvest	Poor
			Landscape Patterns	Urbanization	>20% of watershed >1 unit/20 acres	12-20% of watershed >1 unit/20 acres	8-11% of watershed >1 unit/20 acres	<8% of watershed >1 unit/20 acres	22% of Watershed >1 unit/20 acres	Poor
			Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition	51-74% Intact Historical Species Composition	Good

			Sediment Transport	Road Density	>3 Miles/Square Mile	2.5 to 3 Miles/Square Mile	1.6 to 2.4 Miles/Square Mile	<1.6 Miles/Square Mile	12.59 Miles/Square Mile	Poor
			Sediment Transport	Streamside Road Density (100 m)	>1 Miles/Square Mile	0.5 to 1 Miles/Square Mile	0.1 to 0.4 Miles/Square Mile	<0.1 Miles/Square Mile	10.43 Miles/Square Mile	Poor

Humboldt Bay Tributaries CAP Threat Results

Threats Across Targets		Adults	Eggs	Pre Smolt	Smolts	Watershed Processes	Overall Threat Rank
Project-specific-threats		1	2	3	5	6	
1	Agriculture	Low	Low	Medium	Medium	Medium	Medium
2	Channel Modification	High	Low	High	High	High	High
3	Disease, Predation and Competition	Medium		Medium	Medium	Low	Medium
4	Hatcheries and Aquaculture	Medium		Medium	Medium		Medium
5	Fire, Fuel Management and Fire Suppression	Low	Low	Medium	Low	Low	Low
6	Fishing and Collecting	Medium		Medium	Medium		Medium
7	Livestock Farming and Ranching	Medium	Low	Low	Medium	Low	Medium
8	Logging and Wood Harvesting	Medium	Medium	High	High	High	High
9	Mining	Low	Low	Medium	Low	Low	Low
10	Recreational Areas and Activities	Low	Low	Medium	Low	Low	Low
11	Residential and Commercial Development	Low	Low	Medium	Low	High	Medium
12	Roads and Railroads	Medium	Low	Medium	Medium	High	Medium
13	Severe Weather Patterns	High	Medium	Medium	Medium	High	High
14	Water Diversion and Impoundments	Medium	Low	Medium	Medium	Low	Medium
	Threat Status for Targets and Project	High	Medium	High	High	High	Very High

Humboldt Bay Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
HumB-CCCh-1.1	**Objective**	**Estuary**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-1.1.1	Recovery Action	Estuary	Increase quality and extent of estuarine habitat										
HumB-CCCh-1.1.1.1	Action Step	Estuary	Increase connectivity and salmonid access to watersheds entering Humboldt Bay.	2	25	CDFW, NGO						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
HumB-CCCh-1.1.1.2	Action Step	Estuary	Assess tidally influenced habitat and develop plan to restore tidal channels.	3	5	California Coastal Conservancy, CDFW, NGO						TBD	Costs vary with assessment methods and level of detail.
HumB-CCCh-1.1.1.3	Action Step	Estuary	Restore tidal wetlands and tidal channels, guided by plan.	3	10	California Coastal Conservancy, CDFW, NGO, NMFS						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
HumB-CCCh-2.1	**Objective**	**Floodplain Connectivity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-2.1.1	Recovery Action	Floodplain Connectivity	Rehabilitate and enhance floodplain connectivity										
HumB-CCCh-2.1.1.1	Action Step	Floodplain Connectivity	Develop plan to create off-channel ponds, alcoves, and backwater habitat.	3	5	CDFW, NGO, NMFS, NRCS	115					115	Cost based on fish/habitat restoration assessment at a rate of $114,861/project.
HumB-CCCh-2.1.1.2	Action Step	Floodplain Connectivity	Create habitat guided by plan.	3		CDFW, NGO, NMFS, NRCS						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
HumB-CCCh-6.1	**Objective**	**Habitat Complexity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-6.1.1	Recovery Action	Habitat Complexity	Improve large wood frequency										
HumB-CCCh-6.1.1.1	Action Step	Habitat Complexity	Assess habitat to determine location and amount of instream structure needed	3	5	CDFW	115					115	Cost based on fish/habitat restoration assessment at a rate of $114,861/project.
HumB-CCCh-6.1.1.2	Action Step	Habitat Complexity	Increase LWD, boulders, or other instream structure, guided by assessment.	3	10	CDFW, NGO, NMFS, Private Landowners						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
HumB-CCCh-7.1	**Objective**	**Riparian**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-7.1.1	Recovery Action	Riparian	Improve canopy cover										
HumB-CCCh-7.1.1.1	Action Step	Riparian	Plant native riparian species in open areas	3	10	CDFW, NGO						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
HumB-CCCh-7.1.1.2	Action Step	Riparian	Remove non-native species that inhibit establishment of native riparian vegetation	3	10	NRCS, Private Landowners, RCD						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
HumB-CCCh-8.1	**Objective**	**Sediment**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-8.1.1	Recovery Action	Sediment	Improve instream gravel quality to reduce embeddedness										

Humboldt Bay Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
HumB-CCCh-8.1.1.1	Action Step	Sediment	Assess existing riparian buffers to ensure that capturing the majority of fine sediments before entering watershed.	2	5	NRCS, RCD						0	Action is considered In-Kind
HumB-CCCh-8.1.1.2	Action Step	Sediment	Identify areas that are currently not functioning as sediment traps.	3	5	CDFW, NGO, NRCS						TBD	Cost will vary with assessment methods and level of detail.
HumB-CCCh-8.1.1.3	Action Step	Sediment	Plant riparian species to augment riparian vegetation.	2	5	NGO, NRCS, RCD						TBD	Cost will vary with assessment methods and level of detail.
HumB-CCCh-8.1.1.4	Action Step	Sediment	Assess potentially large inputs of fine sediments (e.g., landslides, failed culvert).	3	5	CDFW, NGO, NRCS						TBD	Cost will vary with assessment methods and level of detail.
HumB-CCCh-8.1.1.5	Action Step	Sediment	Develop and implement plan to reduce large inputs of fine sediments.	3	5	CalFire, CDFW, NCRWQB, NGO						TBD	Cost will vary with assessment methods and level of detail.
HumB-CCCh-12.1	**Objective**	**Agriculture**	**Address the present of threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-12.1.1	Recovery Action	Agriculture	Prevent or minimize impairment to water quality (increased turbidity, suspended sediment, and/or toxicity)										
HumB-CCCh-12.1.1.1	Action Step	Agriculture	Reduce intensity of nutrient and chemical inputs from remote outdoor agriculture and improve practices to minimize pollutants reaching watercourses.	3	25	CDFW, County, NCRWQB						TBD	Costs will vary depending on methods implemented.
HumB-CCCh-18.1	**Objective**	**Livestock**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-18.1.1	Recovery Action	Livestock	Prevent or minimize adverse alterations to riparian species composition and structure										
HumB-CCCh-18.1.1.1	Action Step	Livestock	Assess grazing impact on riparian condition, identifying opportunities for improvement.	3	5	NRCS, RCD							Cost likely accounted for in above action step for fish/habitat restoration assessment.
HumB-CCCh-18.1.1.2	Action Step	Livestock	Develop grazing management plan to meet objective.	3	5	NRCS, RCD						0	Action is considered In-Kind
HumB-CCCh-18.1.1.3	Action Step	Livestock	Fence livestock out of riparian zones.	3	5	NRCS, Private Landowners, RCD						TBD	Cost based on the amount of linear feet to fence. Cost estimated at a rate of $3.63/ft.
HumB-CCCh-18.1.1.4	Action Step	Livestock	Plant vegetation to stabilize stream bank.	2	10	NGO, NRCS, Private Landowners, RCD						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
HumB-CCCh-19.1	**Objective**	**Logging**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-19.1.1	Recovery Action	Logging	Prevent or minimize impairment to instream habitat complexity (reduced large wood and/or shelter)										
HumB-CCCh-19.1.1.1	Action Step	Logging	Determine appropriate silvicultural prescription to improve size and density of conifers	2	5	CDFW, NMFS						0	Action is considered In-Kind
HumB-CCCh-19.1.1.2	Action Step	Logging	Plant conifers as guided by prescription	3	5	CDFW, Private Landowners						TBD	Cost will be based on amount of acres to be planted. Estimate for riparian planting is $20,719/acre.
HumB-CCCh-19.1.1.3	Action Step	Logging	Thin, or release conifers guided by prescription	3	5	CDFW, Private Landowners						TBD	Cost will be based on amount of acres to be treated identified in plan. Estimate for conifer release is $1,468/acre.
HumB-CCCh-19.2	**Objective**	**Logging**	**Address the inadequacy of existing regulatory mechanisms**										

Humboldt Bay Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
HumB-CCCh-19.2.1	Recovery Action	Logging	Prevent or minimize impairment to instream habitat complexity (reduced large wood and/or shelter)										
HumB-CCCh-19.2.1.1	Action Step	Logging	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.	2	5	CalFire						0	Action is considered In-Kind
HumB-CCCh-19.2.1.2	Action Step	Logging	Apply BMPs for timber harvest.	2	25	CDFW, Private Landowners						0	Operations conducted normally or with minor modifications are considered In-Kind.
HumB-CCCh-23.1	**Objective**	**Roads/Railroads**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
HumB-CCCh-23.1.1	Recovery Action	Roads/Railroads	Prevent or minimize alterations to sediment transport (road condition/density, dams, etc.)										
HumB-CCCh-23.1.1.1	Action Step	Roads/Railroads	Assess and prioritize road-stream hydrologic connection and identify appropriate treatment.	3	5	CDFW, NGO, Private Landowners	1,642					1,642	Cost based on amount of road network not identified in tributary streams to Humboldt Bay.
HumB-CCCh-23.1.1.2	Action Step	Roads/Railroads	Assess road network for roads that are currently unnecessary for silvicultural operations to minimize mass wasting.	3	5	CDFW, NGO, Private Landowners						TBD	Cost accounted for in above action step
HumB-CCCh-23.1.1.3	Action Step	Roads/Railroads	Decommission roads, guided by assessment	3	25	CDFW, NGO, Private Landowners						TBD	Cost based on number of miles of road network identified to be decommissioned from assessment. Estimate for road decommissioning is $12,000/mile.
HumB-CCCh-23.1.1.4	Action Step	Roads/Railroads	Maintain roads, guided by assessment	3	25	CDFW, Private Landowners						TBD	
HumB-CCCh-23.1.1.5	Action Step	Roads/Railroads	Upgrade roads, guided by assessment	3	5	CDFW, Private Landowners						TBD	
HumB-CCCh-23.1.1.6	Action Step	Roads/Railroads	Develop grading ordinance for maintenance and building of private roads that minimizes the effects to Chinook salmon.	2	5	County						0	Action is considered In-Kind
HumB-CCCh-23.1.1.7	Action Step	Roads/Railroads	Develop and implement a plan to stabilize hill slopes and other unstable features.	2	5	CDFW, NGO, Private Landowners						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.

Little River Population

Chinook Salmon Fall-Run

- Role within ESU: Potentially Independent Population
- Diversity Stratum: Northern Coastal
- Spawner Abundance Target: 700 adults
- Current Intrinsic Potential: 17.4 IP-km

For information regarding NC steelhead and SONCC coho salmon for this watershed, please see the NC steelhead volume of this recovery plan and the SONCC coho salmon recovery plan (http://www.westcoast.fisheries.noaa.gov/).

Chinook Salmon Abundance and Distribution

Since 1998, outmigrant trapping, summer juvenile, and adult spawning have been conducted throughout the watershed on an annual basis and currently provide the best indication of fish abundance and distribution (GDRC 2009, 2010, 2011). Habitat sampling occurs approximately every eight years (GDRC 2006). Habitat and outmigration monitoring data is available from the early 1990s for inferring longer term trends (Shaw and Jackson, 1994; Vogel 1992; Vogel 1994). Little River watershed fishery potential was determined in the late 1960s to evaluate potential effects of a proposed dam in the upper watershed, which ultimately was never completed (Hurt 1969).

After being commercially fished for a couple of decades, Chinook salmon were hypothesized to be intermittently present in Little River (Hurt 1969). A small hatchery operated from 1985-1992 that augmented Chinook salmon in the watershed, releasing a maximum of 47,000 smolt a year (CDFG 1991). Shaw and Jackson (1994) captured 100 Chinook salmon smolts in 1994. Juvenile Chinook salmon data between 1999-2012 fluctuated widely between approximately 100 and 10,000 individuals (GDRC 2012, Figure 1).

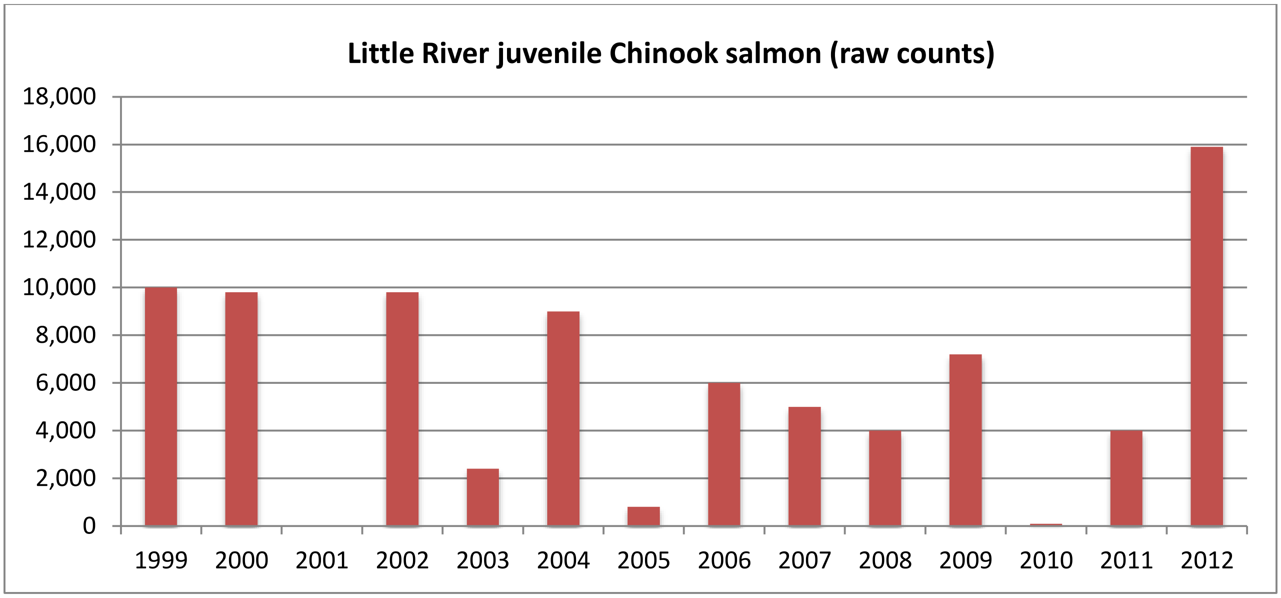

Figure 1. Out-migrant juvenile Chinook salmon raw counts from Little River tributaries, 1998-2012 (GDRC 2009, 2011, 2012).

History of Land Use

Timber harvest, commercial fishing, and livestock grazing all historically occurred in the Little River basin. The first sawmill opened on the Little River in 1907 by the Hammond Lumber Company (Hurt 1969) and the basin was intensely harvested throughout the early 1900s. The logging town of Crannell was built on the coastal plain near the Little River mouth. The river was modified for logging operations, with the main channel flowing through a lumber mill. Logging trucks and roads replaced railroad logging after a fire burned the majority of the watershed in 1945 (Hurt 1969). Large-scale clear cuts, road construction, skid trails, and landings occurred on highly erodible Franciscan soils that are dominant throughout the basin. Highly erosive geology in combination with extensive timber harvest and road building over the years has led to mass wasting events, landslides, and chronic sediment delivery into Little River. Trees were cut in the riparian zone, removing the potential for instream wood recruitment and increasing solar radiation. In the 1930s, a dam was constructed just above the town of Crannell and a commercial fishery for Chinook salmon was established, which largely destroyed the population (Hurt 1969). Dairy cow operations have been conducted on the Little River floodplain between Crannell and the river mouth. Some stream restoration work has taken place; in 1989, the lower 2.5 kms of Little River were fenced to prevent cows from entering the riparian.

Current Resource and Land Management

Today, the majority of the basin is owned by Green Diamond Resource Company (GDRC), and managed for timber production under the guidelines of current state timber harvest regulations and an aquatic habitat conservation plan (HCP, GDRC 2006). Management under the HCP helps protect the watershed from many of the destructive practices that took place historically. An extensive road system (at a density of approximately 7 mi./sq. mi.) winds through the basin, contributing sediment delivery to Little River and tributaries. The flat coastal plain near the mouth of the Little River continues to support livestock grazing. While some of the riparian areas have been fenced to prevent livestock from disturbing them, areas that are not fenced may experience degradation of sensitive vegetation and contribute to bank instability and erosion.

Salmonid Viability and Watershed Conditions

The following indicators were rated Poor through the CAP process for Little River Chinook salmon populations: smolt abundance, spawner density, gravel quality (embeddedness), pool/riffle/flatwater ratio, road density, streamside road density, timber harvest, turbidity, large wood frequency, and V* (see Little River CAP results).

Current Conditions

The following discussion focuses on those conditions that rated Fair or Poor as a result of our CAP viability analysis. The Little River CAP Viability Table results are provided below. Recovery strategies will focus on improving these conditions.

Population and Habitat Conditions

Habitat Complexity: Large Wood and Shelter

Large woody debris associated with riparian corridors provides structure for shade, cover, bank stabilization, and breeding sites for invertebrates (Moseley *et al.* 1998). The Habitat Complexity condition has an overall Poor rating for adult, pre-smolt and smolt lifestages. Large wood debris increases habitat complexity by creating pools, velocity refuge, and cover. Large wood debris surveys conducted throughout the watershed in the 1990s revealed that large wood debris throughout Little River is on average less than 4 pieces/100 m (Vogel 1992, LP 1994). Green Diamond completed large wood surveys for the Little River Basin in 2009; survey results 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). Current practices under the GDRC HCP provide a riparian buffer, and promote recruitment of LWD by allowing 99 percent of riparian conifers to be older than 60 years, and 70 percent older than 80 years.

Viability: Density, Abundance, and Spatial Structure

A population with diverse genetics and behaviors exhibits variation in life history parameters such as age at smolting, age at maturity, spawning time, and fecundity. If a population is genetically diverse, it is more likely to be resilient to variation in environmental habitat fluctuations such as productivity, spawning run timing, and egg incubation time. Viability conditions, such as density, abundance, and special structure, have an overall Poor rating for adults, pre-smolts, and smolts. Reduced smolt density, abundance, and diversity may signify decreased adaptions to environmental stochastic events such as marine survival and spawning success. Populations that remain low in abundance have an increased likelihood of becoming extirpated.

Sediment: Gravel Quality and Distribution of Spawning Gravels

Imapired gravel quality and quantity is a High stress for Chinook salmon eggs and smolts. Salmon egg survival is inversely related to fine sediment, which has the potential to suffocate eggs (Koski 1966; Greig *et al.*, 2005). A streambed substrate survey revealed that fine sediment concentrations are greatest in Lower South Fork Little River, ranging from 7.5- 15.7 percent of sampled sediment particles (Vogel 1994). Increased sediment delivery is primarily a result of high road density and timber harvest activities in Little River. Embedded gravels prevent pre-smolt Chinook salmon from seeking velocity refuge during high winter flows. Embedded gravels also reduce stream productivity, and thus decrease foraging success for pre-smolt Chinook salmon.

Habitat Complexity: Percent Primary Pools and Pool/Riffle/Flatwater Ratios

Complex pools provide rearing habitat for juvenile Chinook salmon. Reduced pool complexity results in decreased vegetative cover and prey availability, and thus juvenile growth rates. Historical logging process resulted in large sediment input into Little River, resulting in pool aggradation. Lack of complex pools, and also fewer deep pools, creates flatwater habitats (neither pool or riffle), which has drastically reduced pool complexity leading to a condition of an overall Poor rating for pre-smolt and smolt lifestages. Less than half of the watershed contains greater than 30 percent pool habitat (Vogel 1992), which is a stress for adults and pre-smolts

Estuary: Quality and Extent

Estuaries provide important juvenile rearing areas for steelhead and Chinook salmon, often fostering faster growth than upper watershed areas due to a high abundance of prey items (Hayes *et al.*, 2008). The lower estuary remains unaltered, currently comprising approximately 0.75 river miles of mud flat, wetland, and sandbar habitat in Moonstone Beach County Park and Little River State Park. Upstream of Highway 101, the estuary and many associated tidal channels have been diked, filled, and channelized for agricultural purposes. Estuarine function is severely hampered by loss of tidal wetland and tidal channels. The reduction in estuarine function is considered a High stress for the smolt lifestage because of the lack of rearing and foraging habitat.

Water Quality: Turbidity or Toxicity

Clean and cool well-oxygenated water remains one of the most important ecological requirements for salmonids. Water quality conditions in the Little River have an overall Poor rating for pre-smolts. High road density, riparian vegetation reduction, livestock grazing, and components of timber management contribute to increased turbidity levels. Effects of increased sediment and turbidity loads range from lethal to sublethal (Newcombe and McDonald 1991), with early life history phases being most sensitive (Sigler *et al.*, 1984). Salmonids rely on visual feeding cues, and increased turbidity may reduce visibility and thus feeding efficiency (Berg and Northcote 1985, Sweka and Hartman 2001).

Riparian Vegetation: Composition, Cover & Tree Diameter

Riparian vegetation provides important habitat functions including shading, habitat complexity for foraging and holding, and channel function. Eliminating or decreasing riparian vegetation may result instream channelizing and straightening, channel widening, channel aggradation, and lowering of the water table (Belsky *et al.* 1999). Riparian forest condition has an overall Poor rating for pre-smolts and watershed processes due to reduced pool frequency, and thus decreased upstream rearing habitat. Historic logging practices removed the majority of large, old trees from riparian zones throughout watershed; shrubs and young to mature deciduous and conifers dominate the upper watershed and dense shrubs such as willow and blackberry occupy the lower watershed (GDRC 2006, Vogel 1992). Livestock grazing has removed components of riparian vegetation; historic timber management reduced canopy cover structure and diversity. The reduction of large trees in riparian areas results in decreased potential for large wood recruitment, which consequently reduces habitat complexity.

Sediment Transport: Road Density

Little River contains a high density of roads in silvicultural areas (an average of 7.1 miles of road per square mile of land). Processes initiated or affected by roads include landslides, surface erosion, secondary surface erosion, and gullying. Existing road networks are a chronic source of sediment to streams (Swanson 1975) and often are the main cause of accelerated surface erosion in forests across the western United States (Harr and Nichols 1993). Important factors that affect road surface erosion include road surface condition, use during wet periods, location relative to watercourses, and steepness. The Sediment Transport, High Road Density, condition has an overall Poor rating for all life history stages, especially early life history phases that are more sensitive to elevated turbidity levels.

Very Good or Good Current Conditions

Velocity Refuge: Floodplain Connectivity

Floodplain habitat provides better rearing and migration habitat for juvenile Chinook salmon than adjacent river channel habitat (Sommer *et al.*, 2001). Juvenile salmonid prey availability remains higher in side channels than the main river channel, with a carrying capacity as much as 260 percent higher (Bellmore *et al.*, in press). Floodplain in lower Little River has been decreased by channel modification, historic timber operations, and the construction of levees for agricultural purposes. All life history phases are exposed to decreased availability of floodplain habitat, and thus rich foraging areas are unavailable. As a result, salmonids may be subject to areas of lower food availability and thus slower growth rates.

Threats

The following discussion focuses on those threats that rate as High or Very High (see Little River CAP results). Recovery strategies will likely focus on ameliorating High rating threats; however, some strategies may address Medium and Low threats when the strategy is essential to recovery efforts. The figures and tables that display data used in this analysis are provided in Little River CAP results.

Logging and Wood Harvesting

Logging and wood harvesting was rated as a High stress for all life history phases of Chinook salmon and watershed processes. Historic logging practices in Little River resulted in large-scale clear cuts, road construction, skid trails, and landings on highly erodible soils. Highly erosive geology in combination with extensive timber harvest has led to mass wasting events, deep-seated landslides, and chronic sediment delivery into Little River. During the years of intense harvest, the river likely had high turbidity, severely affecting development and behavior of all fish species. Decreased habitat complexity, channel aggregation and decreased water quality are all results of intensive silvicultural practices. Management practices have significantly changed, and it is expected that practices such as riparian buffers and sediment management may improve habitat conditions and population abundance.

Roads and Railroads

Roads and railroads were rated as a High stress for all life history phases of Chinook salmon and watershed processes. Little River contains a high density of roads in silvicultural areas (an average of 7.1 miles of road per square mile of land). Processes initiated or affected by roads include landslides, surface erosion, secondary surface erosion (landslide scars exposed to rain splash), and gullying. Existing road networks are a chronic source of sediment to streams (Swanson 1975) and often are the main cause of accelerated surface erosion in forests across the western United States (Harr and Nichols 1993). Elevated turbidity levels may results in decreased growth rates of juveniles, reduced survival of eggs, and reduced feeding success due to turbid conditions. GDRC has begun the process of hydrologically disconnecting roads from the Little River watershed.

Channel Modification

Channel modification was rated as a High stress for pre-smolt and smolts. The lower Little River mainstem has been channelized by dikes and levees for agricultural and livestock purposes. The function of the upper estuary (*e.g.,* rearing, refugia, ocean transition) has been degraded, and juveniles and smolts rearing in or transitioning through mainstem and estuarine habitat will continue to be threatened by the lack of intertidal brackish and salt marsh. Both juveniles and smolts suffer from the lost opportunity for increased growth, which would improve their size at time of ocean entry and marine survival.

Severe Weather Patterns

Severe weather patterns related to climate change such as increased temperature, reduced cold-water refugia, and increased incidences of atmospheric river events are currently rated as Medium to all life history phases. Severe weather combined with a landscape of fragile soils, high road density, and timber operations may cause significant amounts of fine sediment input to Little River. In order to reduce this threat, decommissioning roads and ensuring that adequate stream buffers are in place may offset the deleterious effects of severe weather.

Limiting Stresses, Lifestages, and Habitat

The threats and stress analysis within the CAP workbook process suggest that all life history phases of Chinook salmon and water processes are all potentially limiting population abundance and diversity in Little River. Timber harvest and high road density are the primary threats to Chinook salmon. Historic timber harvest activities reduced large wood abundance and riparian vegetation complexity, consequently reducing habitat complexity. Runoff from the high density roads increase turbidity levels and contribute to decreased water quality, streambed aggradation. Channel modification creates a High threat for pre-smolts and smolts. The unavailability of complex estuarine rearing and foraging habitat subjects pre-smolts and smolts to reduced growth, and thus potentially decreased marine survival and size at maturity.

General Recovery Strategy

In general, recovery strategies focus on improving conditions and ameliorating stresses and threats discussed above, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions within the watershed. The general recovery strategy for the Little River populations is discussed below with more detailed and site-specific recovery actions provided in Little River CAP results, which provides the Implementation Schedule for this population.

Estuarine Restoration

The estuary provides critical rearing habitat for juvenile Chinook salmon and steelhead. A management plan should be developed for the Little River estuary to restore tidal salt and brackish marshes in order to allow fish to have access to high quality foraging and rearing habitat. Riparian areas currently being used for livestock grazing should be fenced in order to allow native vegetation to recover and become reestablished. Riparian buffer areas should be established to create space for the reestablishment of tidal marshes. Dikes and levees should be removed or set back to restore natural habitat-forming processes. Tidegates should be inventoried and removed in order to create tidal fluctuation. The recreation of complex tidal channels may be necessary east of Highway 101 in areas where the main channel has been straightened and simplified.

Road Decommissioning

Little River contains a high density of dirt logging roads; sediment loading from roads contributes to poor salmonid habitat conditions including elevated turbidity levels, stream aggredgation, and impaired gravel quality. Existing road-stream connections should be assessed and upgraded or decommissioned to the maximum extent practical.

Stream Restoration

Little River currently lacks habitat complexity in many areas due to reduced large woody debris, channel aggredgation, and altered riparian vegetation. Large wood, boulders, or other instream structure should be added in order to increase complexity and sort sediment. Off-channel ponds, alcoves, and backwater habitat should be re-created.

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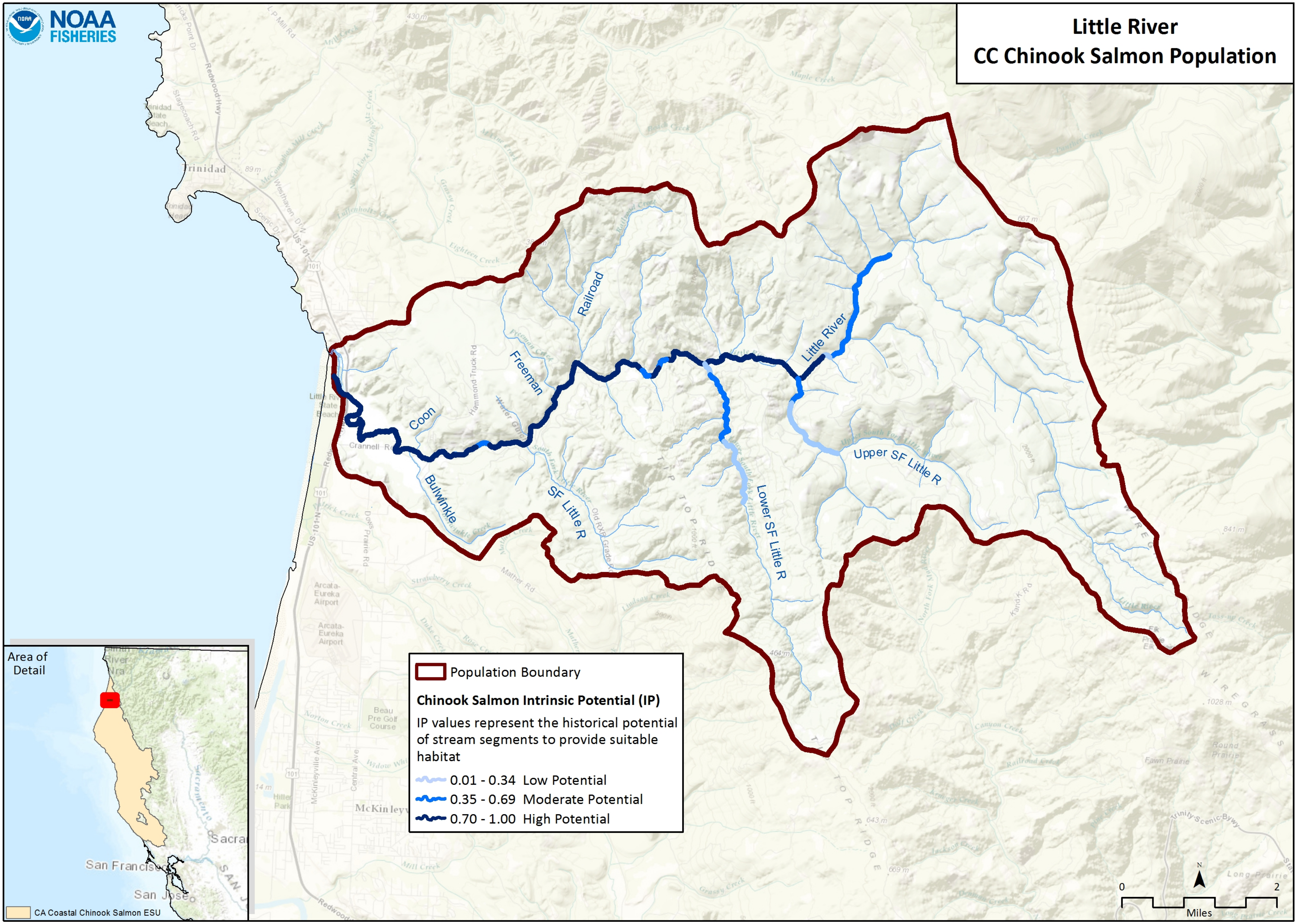

NOAA FISHERIES
Little River
CC Chinook Salmon Population
Railroad
Freeman
Coon
Bulwinkle
SF Little R
Little River
Lower SF Little R
Upper SF Little R
Area of Detail
CA Coastal Chinook Salmon ESU
Population Boundary
Chinook Salmon Intrinsic Potential (IP)
IP values represent the historical potential of stream segments to provide suitable habitat
0.01 - 0.34 Low Potential
0.35 - 0.69 Moderate Potential
0.70 - 1.00 High Potential
0
2
Miles

#	Conservation Target	Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Measurement	Current Rating
1	Adults	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	<50% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>6 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>6 Key Pieces/100 meters)	>90% of streams/ IP-Km (>6 Key Pieces/100 meters)	<50% of streams/ IP-km (>6 Key Pieces/100 meters)	Poor
			Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	<50% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	>90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	<50% of streams/ IP-km (>1.3 Key Pieces/100 meters)	Poor
			Habitat Complexity	Percent Staging Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-km (>49% average primary pool frequency)	Fair
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	<50% of streams/ IP-km (>30% Pools; >20% Riffles)	Poor
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.46	Poor
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Very Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	>90% of IP-km	Very Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	42.76% Class 5 & 6 across IP-km	Fair

			Sediment	Quantity & Distribution of Spawning Gravels	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	50% of IP-km to 74% of IP-km	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	<38	Fair
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	>80% Response Reach Connectivity	Good
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Density	<1 spawners per IP-Km	1-20 Spawners per IP-Km	20-40 Spawners per IP-Km (e.g., Low Risk Extinction Criteria)		<1 spawners per IP-km	Poor
			Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	50-74% of Historical Range	Fair
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	40-60	Fair
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	12.1-17.9	Fair
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	12.1-17.9	Fair
2	Eggs	Condition	Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Good
			Hydrology	Redd Scour	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Very Good

			Sediment	Gravel Quality (Bulk)	>17% (0.85mm) and >30% (6.4mm)	15-17% (0.85mm) and <30% (6.4mm)	12-14% (0.85mm) and <30% (6.4mm)	<12% (0.85mm) and <30% (6.4mm)	15-17% (0.85mm) and <30% (6.4mm)	Fair
			Sediment	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-km (>50% stream average scores of 1 & 2)	Poor
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	<38	Fair
3	Pre Smolt	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Percent Primary Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-km (>49% average primary pool frequency)	Fair
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	<50% of streams/ IP-km (>30% Pools; >20% Riffles)	Poor
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-km (>80 stream average)	Fair
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.46	Poor
			Hydrology	Flow Conditions (Baseflow)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Good
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Good
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	0.01 - 1 Diversions/10 IP-km	Good

			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Very Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	42.76% Class 5 & 6 across IP-km	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	<38	Fair
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-km (>50% stream average scores of 1 & 2)	Poor
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined		
			Water Quality	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	>90% IP-km (>6 and <14 C)	Very Good
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	50-74% of Historical Range	Fair
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	40-60	Fair
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	12.1-17.9	Fair

			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	25-30	Fair
5	Smolts	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-km (>80 stream average)	Fair
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35		
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	0.01 - 1 Diversions/10 IP-km	Good
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score <35	Very Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	>90% of IP-km	Very Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	<38	Fair
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-km (>50% stream average scores of 1 & 2)	Poor
			Smoltification	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	>90% IP-km (>6 and <14 C)	Very Good
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	>80% Response Reach Connectivity	Good

			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Abundance	Smolt abundance which produces high risk spawner density per Spence (2008)	Smolt abundance which produces moderate risk spawner density per Spence (2008)	Smolt abundance to produce low risk spawner density per Spence (2008)			
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	40-60	Fair
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	12.1-17.9	Fair
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	25-30	Fair
6	Watershed Processes	Landscape Context	Hydrology	Impervious Surfaces	>10% of Watershed in Impervious Surfaces	7-10% of Watershed in Impervious Surfaces	3-6% of Watershed in Impervious Surfaces	<3% of Watershed in Impervious Surfaces	<3% of Watershed in Impervious Surfaces	Very Good
			Landscape Patterns	Agriculture	>30% of Watershed in Agriculture	20-30% of Watershed in Agriculture	10-19% of Watershed in Agriculture	<10% of Watershed in Agriculture	2.51% of Watershed in Agriculture	Very Good
			Landscape Patterns	Timber Harvest	>35% of Watershed in Timber Harvest	26-35% of Watershed in Timber Harvest	25-15% of Watershed in Timber Harvest	<15% of Watershed in Timber Harvest	44.77% of Watershed in Timber Harvest	Poor
			Landscape Patterns	Urbanization	>20% of watershed >1 unit/20 acres	12-20% of watershed >1 unit/20 acres	8-11% of watershed >1 unit/20 acres	<8% of watershed >1 unit/20 acres	7% of Watershed >1 unit/20 acres	Very Good
			Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition	25-50% Intact Historical Species Composition	Fair

			Sediment Transport	Road Density	>3 Miles/Square Mile	2.5 to 3 Miles/Square Mile	1.6 to 2.4 Miles/Square Mile	<1.6 Miles/Square Mile	>3 Miles/Square Mile	Poor
			Sediment Transport	Streamside Road Density (100 m)	>1 Miles/Square Mile	0.5 to 1 Miles/Square Mile	0.1 to 0.4 Miles/Square Mile	<0.1 Miles/Square Mile	8.9 Miles/Square Mile	Poor

Little River CAP Threat Results

	Threats Across Targets	Adults	Eggs	Pre Smolt	Smolts	Watershed Processes	Overall Threat Rank
	Project-specific-threats	1	2	3	5	6	
1	Agriculture	Medium	Low	Medium	Medium	Low	Medium
2	Channel Modification	Medium	Medium	High	High	Low	High
3	Disease, Predation and Competition	Medium		Medium	Medium	Low	Medium
4	Hatcheries and Aquaculture	Low		Low	Low		Low
5	Fire, Fuel Management and Fire Suppression	Medium	Low	Medium	Medium	Low	Medium
6	Fishing and Collecting	Low					Low
7	Livestock Farming and Ranching	Medium	Low	Medium	Medium	Low	Medium
8	Logging and Wood Harvesting	High	High	High	High	High	High
9	Mining						
10	Recreational Areas and Activities	Medium	Low	Medium	Medium	Low	Medium
11	Residential and Commercial Development	Medium	Low	Medium	Medium	Low	Medium
12	Roads and Railroads	High	High	High	High	High	High
13	Severe Weather Patterns	Medium	Medium	Medium	Medium	Medium	Medium
14	Water Diversion and Impoundments	Medium	Low	Medium	Medium	Low	Medium
	Threat Status for Targets and Project	High	High	High	High	High	Very High

Little River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K)						Comment
							FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	
LR-CCCh-1.1	**Objective**	**Estuary**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
LR-CCCh-1.1.1	Recovery Action	Estuary	Increase extent of estuarine habitat										
LR-CCCh-1.1.1.1	Action Step	Estuary	Assess tidally influenced habitat and develop plan to restore tidal channels.	1	1	Private	34.11					34	
LR-CCCh-1.1.1.2	Action Step	Estuary	Restore tidal wetlands and tidal channels, guided by plan.	1	5	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
LR-CCCh-1.1.1.3	Action Step	Estuary	Assess and prioritize tidegates and levees for removal or replacement.	1	1	Private	34.11					34	
LR-CCCh-1.1.1.4	Action Step	Estuary	Remove or replace tidegates and levees, guided by assessment.	1	5	CDFW						TBD	Cost based on number of tidegates to be removed.
LR-CCCh-1.1.1.5	Action Step	Estuary	Initiate a study to determine if the Highway 101 bridge crossing the Little River is constricting the river channel and impeding river or tidal circulation in the estuary.	3	1	CDFW						TBD	
LR-CCCh-6.1	**Objective**	**Habitat Complexity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
LR-CCCh-6.1.1	Recovery Action	Habitat Complexity	Improve pool/riffle/flatwater ratios (hydraulic diversity)										
LR-CCCh-6.1.1.2	Action Step	Habitat Complexity	Develop plan to restore habitat complexity by recreating off-channel ponds, alcoves, and backwater habitat.	2	1	Private	115					115	Cost based on fish/habitat restoration assessment at a rate of $114,861/project.
LR-CCCh-6.1.1.3	Action Step	Habitat Complexity	Restore habitat complexity in identified areas by implementing actions to increase the frequency of pool habitats.	2	10	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
LR-CCCh-6.1.2	Recovery Action	Habitat Complexity	Increase large wood frequency										
LR-CCCh-6.1.2.2	Action Step	Habitat Complexity	Develop plan to add large wood, boulders, or other instream structure to specific areas in specific quantities.	2	1	Private	115					115	Cost based on fish/habitat restoration assessment at a rate of $114,861/project.
LR-CCCh-6.1.2.3	Action Step	Habitat Complexity	Place instream structures, guided by assessment.	2	5	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
LR-CCCh-7.1	**Objective**	**Riparian**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
LR-CCCh-7.1.1	Recovery Action	Riparian	Improve canopy cover										
LR-CCCh-7.1.1.1	Action Step	Riparian	Plant native riparian species in denuded areas.	2	2	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
LR-CCCh-7.1.1.2	Action Step	Riparian	Remove invasive species that inhibit establishment of native riparian vegetation.	3	5	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
LR-CCCh-8.1	**Objective**	**Sediment**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
LR-CCCh-8.1.1	Recovery Action	Sediment	Improve instream gravel quality to reduce embeddedness										
LR-CCCh-8.1.1.1	Action Step	Sediment	Assess existing riparian buffers to ensure that capturing the majority of fine sediments before entering watershed.	2	1	Private							Cost accounted for in Monitoring Chapter
LR-CCCh-8.1.1.2	Action Step	Sediment	Identify areas that are currently not functioning as sediment traps.	3	1	Private	115					115	Cost based on fish/habitat restoration monitoring at a rate of $114,861/project.
LR-CCCh-8.1.1.3	Action Step	Sediment	Plant riparian species to augment riparian vegetation.	3	3	Private						TBD	Cost accounted for in above action step.
LR-CCCh-8.1.1.4	Action Step	Sediment	Assess potentially large inputs of fine sediments (e.g., landslides, failed culvert).	2	1	Private	91.00					91	Cost based on erosion assessment for 25% of total watershed acres at a rate of $12.62/acre.
LR-CCCh-8.1.1.5	Action Step	Sediment	Develop plan to remove large inputs of fine sediments.	2	1	Private						TBD	

Little River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
LR-CCCh-8.1.1.6	Action Step	Sediment	Remove large inputs of fine sediments.	3	10	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
LR-CCCh-19.1	**Objective**	**Logging**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
LR-CCCh-19.1.1	Recovery Action	Logging	Prevent or minimize adverse alterations to riparian species composition and structure										
LR-CCCh-19.1.1.1	Action Step	Logging	Increase conifer density and diameter at breast height by determining appropriate silvicultural prescription for benefits to listed salmonids.	2	1	Private						In-Kind	
LR-CCCh-19.1.1.2	Action Step	Logging	Plant conifers, guided by prescription.	2	2	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
LR-CCCh-19.1.1.3	Action Step	Logging	Thin, or release conifers, guided by prescription.	2	5	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
LR-CCCh-19.1.2	Recovery Action	Logging	Prevent or minimize alterations to sediment transport (road condition/density, etc.)										
LR-CCCh-19.1.2.1	Action Step	Logging	Identify and prioritize existing roads that are no longer necessary for silvicultural operations.	2	1	Private	791					791	
LR-CCCh-19.1.2.2	Action Step	Logging	Develop plan to decommission roads.	2	1	Private						TBD	Cost accounted for in above action step.
LR-CCCh-19.1.2.3	Action Step	Logging	Decommission roads throughout watershed.	2	10	Private						TBD	Cost based on number of miles of road network identified to be decommissioned from assessment. Estimate for road decommissioning is $12,000/mile.
LR-CCCh-23.1	**Objective**	**Roads/Railroads**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
LR-CCCh-23.1.1	Recovery Action	Roads/Railroads	Prevent or minimize alterations to sediment transport (road condition/density, dams, etc.)										
LR-CCCh-23.1.1.1	Action Step	Roads/Railroads	Assess streamside roads and prioritize decommissioning to minimize mass wasting.	3	1	Private							Cost accounted for in above action step.
LR-CCCh-23.1.1.2	Action Step	Roads/Railroads	Develop plan to decommission or maintain roads.	3	1	Private							Cost accounted for in above actions step.
LR-CCCh-23.1.1.3	Action Step	Roads/Railroads	Decommission or upgrade roads throughout watershed.	3	20	CDFW, Private							Cost accounted for in above action step.

Lower Eel and South Fork Eel River Subsets of the Lower Eel River Population

CC Chinook Salmon Fall-Run

- Role within ESU: A subset with the Lower Eel River Functionally Independent Population
- Diversity Stratum: North Coastal
- Spawner Abundance Target: 7,300 adults
- Current Intrinsic Potential: 364.8 IP-km

For information regarding NC steelhead and SONCC coho salmon for this watershed, please see the NC steelhead volume of this recovery plan and the SONCC coho salmon recovery plan (http://www.westcoast.fisheries.noaa.gov/).

Chinook Salmon Abundance and Distribution

Quantitative abundance and distribution estimates of South Fork Eel River Chinook salmon are sparse. Yoshiyama and Moyle (2010) reviewed available information and concluded the Eel River basin historic runs of Chinook salmon likely ranged between 300,000 and 800,000 fish per year, and declined to approximately 50,000-100,000 fish per year in the first half of the 20th century. Chinook salmon spawners were counted in the South Fork Eel River at the Benbow Dam from 1938 through 1975, with a high of 21,011 counted in 1941 and a low of 473 in 1959. It should be noted that Benbow Dam occurs approximately halfway up the South Fork Eel River, and therefore the number of fish counted underestimates the true run size.

Recent survey efforts in both the Lower Eel and South Fork Eel have indicated that Chinook salmon spawner abundance is low compared to their estimated historic run-size. In 2010, the California Department of Fish and Wildlife (CDFW) began conducting surveys focused on adults throughout the South Fork Eel River sub-basin.   CDFW (2014) estimated 1,128 redds in 2010-11, 563 redds in 2011-12, and 1445 redds in 2012-13. In 2011, citizen volunteers with the Eel River Recovery Project (ERRP) began conducting dive counts of adult Chinook salmon in the lower Eel River and have documented several thousand each year, although it is uncertain as to how many of these fish spawned in the Lower/South Fork Eel population area.

History of Land Use

Settlement of the region began in the 1850s and the first 100 years of activity had lasting effects on the forests, rivers, and fish populations of the region. Settlement of the South Fork Eel did not experience rapid growth until the 1900s due its remoteness. Canneries were located along the Eel River, and during the 1860s to 1900s it was common to have a commercial salmon catch numbering in the hundreds of thousands of fish in the lower Eel River. In 1904, 345,800 salmon and steelhead were harvested by fishing in the lower portions of the river (Lufkin 1996).

Early timber operations attempted to convert natural timber lands to grazing lands, with little success because the landscape and climate favored the natural vegetation regime. Only when accessibility was well established in the 1900s to 1910s did large-scale timber operations develop to a significant extent (PALCO 2006). The use of log trucks and ground-based tractor yarding began in the 1940s and initiated a period of extensive road building and skid trail use. Railroad and early truck haul routes were commonly located near, or sometimes even within the stream channels. The combination of the early railroad and pre-1970s logging practices had a profound impact on the watercourses in the area (PALCO 2006).

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 (USEPA 1999). Levees were built along the lower Eel River to prevent flooding of urban areas, which significantly reduced the size of the estuary and disconnected the floodplain from the main channel.

Sacramento pikeminnow were introduced to Lake Pillsbury in 1980 (CDFG 1997) and have since colonized all accessible reaches of the Eel River watershed. This predator thrives in the warmer waters of the South Fork Eel River resulting from channel aggradation and degraded riparian forests.

Current Resources and Land Management

Most of the South Fork Eel population area is privately owned and is predominantly in timber production. Marijuana cultivation is another land use as well as rural development in some locales. The Humboldt Redwood Company (HRC) Habitat Conservation Plan (HCP) covers approximately 200,000 acres of forestland along the Lower Eel River. The goals of the HRC HCP include trending towards properly functioning aquatic conditions and reducing sediment input by upgrading 1,500 miles of roads (HRC 2012). The Mendocino Redwood Company

(MRC) currently has a draft HCP which covers two of the key western tributaries to the South Fork Eel: Hollow Tree Creek and Jack of Hearts Creek. There are several active watershed groups in the area: the Eel River Watershed Improvement Group, Friends of the Eel River, and the Eel River Restoration Project. The following are pertinent reports or plans for the Lower Eel and South Fork Eel Rivers:

- South Fork Eel River Basin Report (CWPAP 2014)
- Recovery Strategy for California Coho Salmon (CDFG 2004);
- Eel River Salmon and Steelhead Restoration Action Plan (CDFG 1997);
- Lower Eel River Watershed Assessment (CDFG 2010);
- South Fork Eel Watershed Analysis (USBLM, USFS, and USFWS 1996);
- Humboldt Redwood Company HCP (HRC 2012);
- Mendocino Redwood Company HCP (MRC 2012);
- HRC Watershed Analyses for: Lower Eel/Eel Delta and Upper Eel (PALCO 2006); and
- South Fork Eel and Lower Eel Total Maximum Daily Loads (USEPA 1999; 2007).

Salmonid Viability and Watershed Conditions

The following indicators were rated Poor through the CAP process for Chinook salmon (see Lower Eel and South Fork Eel CAP results): estuary quality and extent, LWD frequency, staging pools, passage at mouth or confluence, tree diameter, turbidity, gravel quality, shelter rating, baseflow conditions, diversions, floodplain connectivity, temperature, road density, and stream-side road density. Recovery strategies and actions will focus on ameliorating these habitat indicators, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions with the population area.

Current Conditions

The following discussion focuses on those conditions that rated Fair or Poor as a result of our CAP viability analysis. The South Fork and Lower Eel CAP Viability Table results are provided below. Recovery strategies will focus on improving these conditions.

Population and Habitat Conditions

Estuary: Quality and Extent

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 salmon populations. The Eel River estuary is severely impaired because of past diking, and filling of tidal wetlands for agriculture and flood protection. Please see the CC Chinook salmon Eel River Overview for a complete discussion and recovery actions.

Water Quality: Temperature

High water temperature is a significant problem throughout most of the population area, especially in the mainstem Eel River and South Fork Eel River. These impaired water temperature conditions are most stressful for lifestages rearing in the mainstem rivers during the summer. Water Quality, temperature conditions have a Poor rating for pre-smolts, and smolts.

Water Quality: Turbidity and Toxicity

Extended periods of high turbidity after rain events were documented in Cummings Creek, Grizzly Creek, Wolverton Gulch, and other areas of the Van Duzen basin, which is a nearby tributary of the Eel River with a similar land use history (CDFG 2012). Turbidity levels high enough to affect SONCC coho salmon health (>25 NTU) were documented in several tributaries of the Van Duzen River from 2000 to 2003 (Harkins 2004). Turbidity is rated Poor for pre-smolts, smolts, and adults, likely reflecting high sediment loads in the basin. Toxicity is rated Fair for pre-smolts, smolts, and adults. Wastewater treatment facilities affect the Lower Eel downstream of the Van Duzen (CDFG 2010). The Loleta wastewater treatment facility accepts both municipal wastewater and wastewater from the Humboldt Creamery and the Loleta Cheese Factory. This facility discharges into percolation/evaporation ponds on the Eel River; these ponds overflow into the Eel River in the winter (CDFG 2010). Marijuana cultivators use rodenticides and herbicides, and these toxic materials can enter the river.

Habitat Complexity: Large Wood, Shelter, and Pools

Surveys conducted by CDFW (SEC 2012) indicate that shelter ratings are poor throughout the population area, with only 11 percent of the IP-km habitat having met desired levels for shelter (primary pools) and LWD. Large wood and shelter conditions have a rating of Poor for pre-smolt and smolt lifestages. Pool indicators (% primary pools and pool/riffle/flatwater ratio) are fair for pre-smolts. The combination of a large sediment supply and lack of riparian function has led to a preponderance of flatwater habitats (neither pool or riffle), which has greatly reduced pool complexity for pre-smolt and smolt lifestages. The 1955 and 1964 floods deposited large amounts of sediment, which reduced pool depths and simplified channels.

Sediment Transport: Road Density

High road densities within the population area are primarily associated with past timber harvest and rural residences. Sediment transport conditions from road densities have a rating of Poor for watershed processes, because for every square mile of land there are 3.9 miles of road. Although significant efforts upgrade or decommission roads to reduce their sediment generating potential are ongoing, road density remains high.

Viability: Density, Abundance, and Spatial Structure

Population density is rated Fair for adults. Although recent trends indicate improved abundance (density) of Chinook salmon, longer term data sets suggest that the reduced abundance is acting as a stress to the population. Spatial structure and diversity are generally at acceptable levels, however, the number of spawners remains depressed as compared to those levels needed for the population to be at low risk of extinction.

Passage/Migration: Mouth or Confluence & Physical Barriers

Adult Chinook salmon tend to enter the Eel River in early September and stage in the lower river until flows become high enough for them to navigate shallow riffles. Due to these impediments to migration early in the season, adults tend to gather in the lower river. These large schools unable to migrate upstream are susceptible to poaching and poor water quality. Furthermore, due to shallow and un-passable riffles in the Van Duzen River, the CDFW installs culverts at the mouth of the Van Duzen River to prevent adults from migrating upstream. The culverts remain in place until flows are high enough to allow for passage. For these reasons, Passage and Migration conditions have a rating of Poor for adults.

Riparian Vegetation: Composition, Cover & Tree Diameter and Habitat Complexity: Percent Primary/Staging Pools, Pool/Riffle/Flatwater Ratios, Large Wood Frequency, V Star

NMFS rated riparian species composition conditions as Fair for watershed processes and Poor for pre-smolts, and rated tree diameter as poor for adults. Due to past harvest of coniferous trees and insufficient replanting, the species composition has been altered and become less conifer-dominant. As such, the trees in the riparian area are dominated by young conifers and species which lack the ability to provide for functional pieces of wood to enter the stream. Riparian Vegetation conditions and Habitat Complexity conditions have an overall rating of Fair, as reflected by the indicators frequency of large wood, percent staging pools, and pool/riffle/flatwater ratio.

Sediment Transport: Road Density and Streamside Road Density

Road density is high, leading to numerous effects including sediment bleeding into streams and increased peak flows as reflected in the Poor rating for these indicators for watershed processes.

Hydrology: Baseflow, Passage Flows, and Instantaneous Flow Condition

Hydrologic conditions have a rating of Fair to Poor across lifestages. Eggs are rated fair for the risk of redd scour from winter flows. Because Chinook salmon are typically in the ocean or rearing in the estuary prior to the onset of lower summer flow conditions. the pre-smolt, smolt, and adult lifestages are primarily exposed to the flow regimes in the fall (adult), winter (adult, pre-smolt), and spring (pre-smolt and smolt). Shallow riffles limit upstream migration of adults during early fall, likely due to both low flows and habitat quality. Erosion and subsequent deposition during larger storm events may be the primary cause for the shallow pools (as reflected by poor Vstar ratings) and simple habitat conditions, rather than the flow conditions present during early fall (CDFG 2010). However, the high number, condition, and magnitude of diversions signal impacts to hydrology, and these diversions typically occur in late summer and early fall when adults are present. Further, the instantaneous flow reduction is rated fair, which likely reflects immediate impacts of diversions.

Threats

The following discussion focuses on those threats that rate as High or Very High (see Lower Eel and South Fork Eel CAP results). Recovery strategies focus on ameliorating High or Very High rating threats; however, some strategies may address Medium and Low threats when the strategy is essential to recovery efforts. The figures and tables that display data used in this analysis are provided in Lower Eel and South Fork Eel CAP results.

Population and Habitat Threats

Water Diversion and Impoundments

Water diversion and impoundments were rated as a Very High threat to pre-smolts and a High threat to adults and watershed processes. Marijuana cultivation and associated water diversion is placing a higher demand on a limited supply of water (S. Bauer, CDFW, personal communication, 1/17/13). Based on an estimate from the medical marijuana industry, each marijuana plant may consume 900 gallons of water per season (Downie 2012). Summer and fall flows measured at the gage in Scotia have been low even in years following wet springs. Future land uses and increasing diversions could increase water demand, further reducing summer and early fall flow conditions.

Channel Modification

Channel modification is rated as a High stress for pre-smolt and smolt lifestages. The Eel River estuary and mainstem has been significantly channelized by dikes and levees and subsequent filling for ranching or livestock purposes. Approximately 60 percent of the estuary has been lost through the construction of levees and dikes and CDFG (2010) estimates that only 10 percent 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) 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 and smolts rearing in or transitioning through mainstem and estuarine habitat will continue to be threatened by the degraded conditions in these habitats. Both pre-smolts and smolts suffer from the lost opportunity for increased growth, which would improve their survival at ocean entry.

Disease, Predation and Competition

Disease, predation, and competition is rated as a High threat to pre-smolts primarily due to the presence of the Sacramento pikeminnow. Pikeminnow have become ubiquitous throughout the Eel River and its tributaries and are a known predator of salmonids. This invasive species has large impacts in areas with impaired habitat conditions, because the altered conditions favor production of the pikeminnow over indigenous salmonids. Pre-smolts and smolts are most vulnerable as they are present when conditions are most favorable to pikeminnow. In addition, pikeminnow prey on pre-smolts and compete with smolts for food and territory.

Fishing and Collecting

Fishing and collecting is rated a High threat to adults. Chinook salmon can be harmed and killed during the catch-and-release fishery in the Lower Eel, which attracts hundreds, if not thousands, of anglers every season to target salmonids. Regulations do not currently protect these fish during the entire period of lower flow conditions that occur coincident with their spawning migration. Currently, sport fishing in the mainstem Eel River is subject to a low flow fishing closure whenever the gage at Scotia is recording flows less than 350 cubic feet per second. However, the low flow season does not begin until October 1st of each year, which allows anglers to target Chinook salmon staging in low flow conditions throughout September. Adult Chinook salmon are easy targets for both fisherman and poachers in these extremely low flows. Poor water quality in September contributes to the stress and likely results in increased hook-and-release mortality (Clark and Gibbons 1991).

Bycatch of Chinook salmon occurs in ocean fisheries targeting Chinook salmon stocks that are not protected under the Endangered Species Act. In a biological opinion on the effects of ocean fisheries managed under the Pacific Coast Salmon Plan, NMFS determined the bycatch impacts of these fisheries are likely to jeopardize the continued existence of CC Chinook salmon, and NMFS provided a Reasonable and Prudent Alternative under which the fisheries are managed to avoid the likelihood of jeopardizing the continued existence of CC Chinook salmon. (NMFS 2000).

Low or Medium Threats

Roads and Railroads

Road density is high throughout the South Fork and Lower Eel River drainages. Many of these roads are unpaved and leach sediment into these rivers and their tributaries. This fact, combined with the substantial rise in marijuana cultivation and future rural residential development in the South Fork Eel River leads to a Medium threat rating for roads for adults, eggs, smolts, and watershed processes.

Severe Weather Patterns

With future climate change, the frequency, intensity and duration of droughts in the region could all increase which could have a considerable negative affect on the distribution and abundance of steelhead in the South Fork and Lower Eel River drainages. This threat is Medium for pre-smolts, smolts, which are already subjected to warm summer water temperatures and reduced habitat availability (low flow) through July. This threat is also Medium for summer adults, and lower flows from droughts will lead to high water temperatures and may make it passage difficult.

Limiting Stresses, Lifestages, and Habitats

The threat and stress analysis within the CAP workbook suggests that the diminished abundance of adult, pre-smolt, and smolt lifestages of Chinook salmon are all likely limiting the the population. The primary issues with adult Chinook salmon are water diversions, impoundments, and fishing pressure. These contribute to poor water quality, impediments to migration, and increased stress and mortality while staging in the lower river during the early fall months.

General Recovery Strategy

In general, recovery strategies focus on improving conditions and ameliorating stresses and threats discussed above, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions. The recovery strategy for the Lower Eel and South Fork Eel populations are discussed below with more detailed and site-specific recovery actions provided in the Implementation Schedule (see Lower Eel and South Fork Eel CAP results).

Enhance and Rehabilitate the Quality and Extent of the Eel River Estuary

Efforts should be implemented to restore the quality and size of the estuary including: levee setbacks, tidal slough reclamation, tide gate replacement, increased connectivity between estuary and tributaries entering estuary (e.g., Salt River, Francis, Russ, Williams Creeks), and enhance cover and complexity by adding structures. CDFG (2010) suggests that over 50 percent of the estuary has been reclaimed for other purposes. All of the salmonid species present in the Eel River watershed highly depend on the estuary, and its restoration would benefit several lifestages and contribute to improvements in the diversity of life history traits present.

Improve Habitat Complexity and LWD Recruitment
Take actions to increase shelter ratings, improve pool depths, increase pool volume, increase LWD abundance, and decrease the extent of flatwater habitats (which are considered to be neither riffles nor pools, and are the result of habitat simplification). Shelter ratings, pool depths, and habitat complexity are lacking throughout the population area and are a major stress for most lifestages. Actions should be taken immediately to bolster the simplified habitat conditions common throughout the population area.

Investigate and Address Water Diversion and Groundwater Extraction
Flows during late summer and early fall are getting lower each year, even following rather wet springs in recent years. The demand and use of water is contributing to lower summer flows which is exacerbating stagnancy in the mainstem reaches. This lack of flow combined with an increased input of nutrients is resulting in more prolific algae growth throughout the area, which is reducing the dissolved oxygen content of the water and exacerbating the stress of poor water quality conditions.

Improve Canopy Cover and Reduce Water Temperature
Water temperatures throughout the majority of the larger segments of mainstem rivers are approaching lethal levels making juvenile summer rearing problematic and stressful. Increasing the amount of instream shade over the water will help in reducing high summer water temperatures. Improvements in riparian vegetation should also contribute to proper riparian function and assist in filtering and preventing sediment from reaching the waterways from upslope.

Reduce Abundance of Sacramento Pikeminnow
Explore how best to reduce the abundance of the Sacramento pikeminnow population. Provide increased refugia habitat for salmonids through the creation of cool and complex habitats, and make habitat less suitable for pikeminnow by managing to reduce water temperature.

Improve Fishing Regulations
The low flow season on the Eel River does not start until October 1st, which allows anglers to target adult Chinook salmon during stressful conditions in September. The low flow closures

should begin at the onset of Chinook arrival in the Eel River (e.g. September 1st as regulated in the Mad River). Due its rural setting, poaching is widespread throughout the Eel River and its tributaries and should be more closely monitored.

Focus Initial Efforts on Restoring Key Tributaries

There are several key tributaries to the Lower Eel and South Fork Eel populations that provide excellent spawning and rearing conditions. Efforts should be focused on these key tributaries in the early phases of recovery plan implementation, to ensure that conditions are improved in areas that are occupied and functional. Tributaries such as Hollow Tree Creek, Indian Creek, Sproul Creek, Salmon Creek, and Redwood Creek should be targeted for implementation of recovery actions as soon as feasible to ensure that key areas are bolstered.

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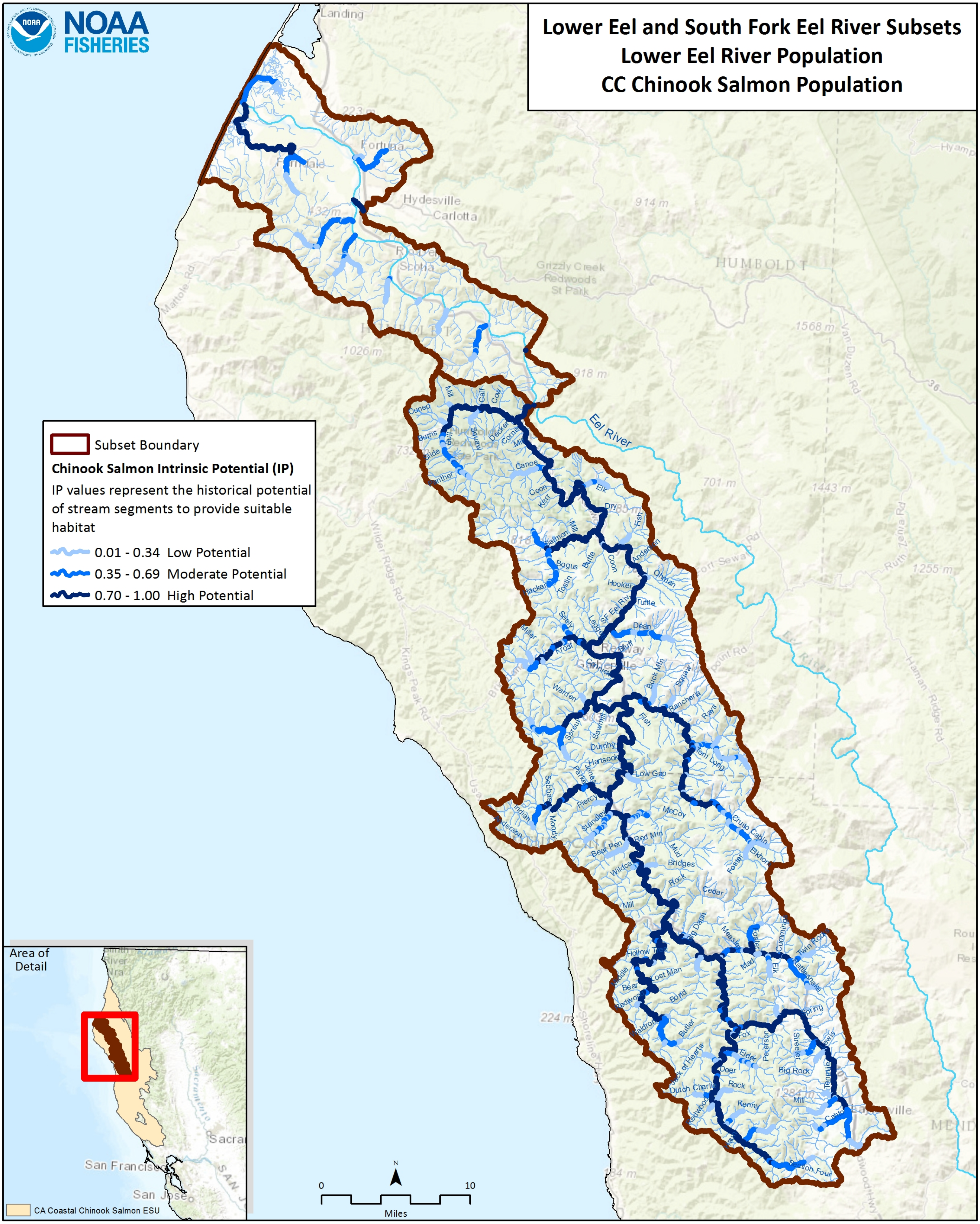

Lower Eel and South Fork Eel River Subsets
Lower Eel River Population
CC Chinook Salmon Population
NOAA FISHERIES
Subset Boundary
Chinook Salmon Intrinsic Potential (IP)
IP values represent the historical potential of stream segments to provide suitable habitat
0.01 - 0.34 Low Potential
0.35 - 0.69 Moderate Potential
0.70 - 1.00 High Potential
Area of Detail
CA Coastal Chinook Salmon ESU
0
10
Miles
N
Eel River
Fortuna
Hydesville
Carlotta
HUMBOLDT
Grizzly Creek Redwoods St Park

#	Conservation Target	Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Measurement	Current Rating
1	Adults	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Poor
			Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	<50% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>6 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>6 Key Pieces/100 meters)	>90% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-km (>6 Key Pieces/100 meters)	Fair
			Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	<50% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	>90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	<50% of streams/ IP-km (>1.3 Key Pieces/100 meters)	Poor
			Habitat Complexity	Percent Staging Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	50% of streams/ IP-km (>49% average primary pool frequency)	Poor
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	67% of streams/ IP-km (>30% Pools; >20% Riffles)	Fair
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.27	Fair
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 51-75	Fair
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	<50% of IP-km or <16 IP-km accessible*	Poor
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	99.9 of IP-km	Very Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	38.07% Class 5 & 6 across IP-km	Poor

			Sediment	Quantity & Distribution of Spawning Gravels	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	67.75	Very Good
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	50-80% Response Reach Connectivity	Fair
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Density	<1 spawners per IP-Km	1-20 Spawners per IP-Km	20-40 Spawners per IP-Km (e.g., Low Risk Extinction Criteria)		1-20 Spawners per IP-km	Fair
			Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	75-90% of Historical Range	Good
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	69.42	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	18.5	Good
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	31.91	Good
2	Eggs	Condition	Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Hydrology	Redd Scour	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 51-75	Fair

			Sediment	Gravel Quality (Bulk)	>17% (0.85mm) and >30% (6.4mm)	15-17% (0.85mm) and <30% (6.4mm)	12-14% (0.85mm) and <30% (6.4mm)	<12% (0.85mm) and <30% (6.4mm)	24.85% (0.85mm) and >30% (6.4mm)	Poor
			Sediment	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	53% of streams/ IP-km (>50% stream average scores of 1 & 2)	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	67.75	Very Good
3	Pre Smolt	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Poor
			Habitat Complexity	Percent Primary Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	64% of streams/ IP-km (>49% average primary pool frequency)	Fair
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	67% of streams/ IP-km (>30% Pools; >20% Riffles)	Fair
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	11% of streams/ IP-km (>80 stream average)	Poor
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.27	Fair
			Hydrology	Flow Conditions (Baseflow)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score >75	Poor
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 51-75	Fair
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	>5 Diversions/10 IP-km	Poor
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk	NMFS Flow Protocol: Risk	NMFS Flow Protocol: Risk	NMFS Flow Protocol: Risk	NMFS Flow Protocol: Risk	Fair

					Factor Score >75	Factor Score 51-75	Factor Score 35-50	Factor Score <35	Factor Score 51-75	
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	50% of IP-km to 74% of IP-km	Fair
			Riparian Vegetation	Species Composition	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	38.07% Class 5 & 6 across IP-km	Poor
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	67.75	Very Good
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	53% of streams/ IP-km (>50% stream average scores of 1 & 2)	Fair
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined		
			Water Quality	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	<50% IP-km (>6 and <14 C)	Poor
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Fair
		Size	Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	75-90% of Historical Range	Good
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	69.42	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	18.5	Good
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	31.91	Good

5	Smolts	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Poor
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	11% of streams/ IP-km (>80 stream average)	Poor
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35		
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	>5 Diversions/10 IP-km	Poor
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 51-75	Fair
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	50% of IP-km to 74% of IP-km	Fair
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	99.9 of IP-km	Very Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	67.75	Very Good
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	53% of streams/ IP-km (>50% stream average scores of 1 & 2)	Fair
			Smoltification	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	<50% IP-km (>6 and <14 C)	Fair
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	<50% Response Reach Connectivity	Poor
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair

			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Fair
		Size	Viability	Abundance	Smolt abundance which produces high risk spawner density per Spence (2008)	Smolt abundance which produces moderate risk spawner density per Spence (2008)	Smolt abundance to produce low risk spawner density per Spence (2008)			
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	69.42	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	18.5	Good
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	31.91	Good
6	Watershed Processes	Landscape Context	Hydrology	Impervious Surfaces	>10% of Watershed in Impervious Surfaces	7-10% of Watershed in Impervious Surfaces	3-6% of Watershed in Impervious Surfaces	<3% of Watershed in Impervious Surfaces	0.45% of Watershed in Impervious Surfaces	Very Good
			Landscape Patterns	Agriculture	>30% of Watershed in Agriculture	20-30% of Watershed in Agriculture	10-19% of Watershed in Agriculture	<10% of Watershed in Agriculture	3.98% of Watershed in Agriculture	Very Good
			Landscape Patterns	Timber Harvest	>35% of Watershed in Timber Harvest	26-35% of Watershed in Timber Harvest	25-15% of Watershed in Timber Harvest	<15% of Watershed in Timber Harvest	22.31% of Watershed in Timber Harvest	Good
			Landscape Patterns	Urbanization	>20% of watershed >1 unit/20 acres	12-20% of watershed >1 unit/20 acres	8-11% of watershed >1 unit/20 acres	<8% of watershed >1 unit/20 acres	4% of Watershed >1 unit/20 acres	Very Good
			Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition	25-50% Intact Historical Species Composition	Fair
			Sediment Transport	Road Density	>3 Miles/Square Mile	2.5 to 3 Miles/Square Mile	1.6 to 2.4 Miles/Square Mile	<1.6 Miles/Square Mile	5.08 Miles/Square Mile	Poor

				Sediment Transport	Streamside Road Density (100 m)	>1 Miles/Square Mile	0.5 to 1 Miles/Square Mile	0.1 to 0.4 Miles/Square Mile	<0.1 Miles/Square Mile	4.17 Miles/Square Mile	Poor

Lower Eel River CAP Threat Results

	Threats Across Targets	Adults	Eggs	Pre Smolt	Smolts	Watershed Processes	Overall Threat Rank
	Project-specific-threats	1	2	3	5	6	
1	Agriculture	Medium	Low	Medium	Medium	Medium	Medium
2	Channel Modification	Medium	Low	High	High	Medium	High
3	Disease, Predation and Competition	Medium	Medium	Medium	Medium	Low	Medium
4	Hatcheries and Aquaculture	Low					Low
5	Fire, Fuel Management and Fire Suppression	Medium	Low	Medium	Medium	Medium	Medium
6	Fishing and Collecting	High		Low	Medium		Medium
7	Livestock Farming and Ranching	Medium	Low	Medium	Medium	Medium	Medium
8	Logging and Wood Harvesting	Medium	Low	Medium	Medium	Medium	Medium
9	Mining	Medium	Low	Medium	Medium	Medium	Medium
10	Recreational Areas and Activities	Low	Low	Medium	Medium	Medium	Medium
11	Residential and Commercial Development	Medium	Low	Medium	Medium	Medium	Medium
12	Roads and Railroads	High	Medium	High	High	High	High
13	Severe Weather Patterns	Medium	Low	High	High	Medium	High
14	Water Diversion and Impoundments	High	Medium	Very High	Medium	High	High
	Threat Status for Targets and Project	High	Medium	Very High	High	High	Very High

South Fork and Lower Eel River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
SFER-CCCh-1.1	**Objective**	**Estuary**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-1.1.1	Recovery Action	Estuary	Increase quality and extent of estuarine habitat										
SFER-CCCh-1.1.1.1	Action Step	Estuary	Implement conservation easements or land acquisitions that would allow for the removal or modification of tide gates and levees in order to restore the tidal prism and tidal wetlands.	2	25	CDFW, Corps, NOAA RC, Private Landowners, RWQCB						TBD	Cost based on amount of habitat to acquire to restore estuarine conditions. Cost based on fair market value and landowner participation.
SFER-CCCh-1.1.1.2	Action Step	Estuary	The impact of property subdivision on streams of Lower Eel River Basin should be minimized through the use of better land management practices. (CDFW-CWPAP 2013).	2	10	CDFW, Humboldt County, Private Landowners						0	Action is considered In-Kind
SFER-CCCh-1.1.1.3	Action Step	Estuary	Where necessary, identify barriers to fish migration in the form of large debris accumulations, culverts, etc. and modify them.	1	5	CDFW, Humboldt County, NMFS							Cost accounted for below in PASSAGE.
SFER-CCCh-1.1.1.4	Action Step	Estuary	Improve educational outreach to community (CDFW-CWPAP, 2013).	2	10	CDFW, Humboldt County, NMFS, NOAA RC						0	Action is considered In-Kind
SFER-CCCh-1.1.1.5	Action Step	Estuary	Encourage and partner with Fortuna Creeks Project's urban stream clean-up, habitat restoration and monitoring (CDFW-CWPAP, 2013).	2		Fortuna Creek Project						0	Action is considered In-Kind
SFER-CCCh-1.1.1.6	Action Step	Estuary	Conduct habitat and fish inventories on urban streams of the Middle Subbasin, including Palmer, Jameson, and Rohner Creeks and unnamed tributaries to Strongs Creek (CDFW-CWPAP, 2013).	2	5	CDFW, Humboldt County, Local Agencies							Cost accounted for in the monitoring chapter.
SFER-CCCh-1.1.2	Recovery Action	Estuary	Reduce turbidity and suspended sediment										
SFER-CCCh-1.1.2.1	Action Step	Estuary	Work to restore natural functioning tidal and drainage patterns within McNulty Slough and the Salt river.	2	10	CDFW, Corps, Farm Bureau, Humboldt County, NOAA RC, Private Landowners, RWQCB						TBD	Costs will vary depending on methods implemented and extent of rehabilitation
SFER-CCCh-1.1.2.2	Action Step	Estuary	Increase the tidal prism to help to maintain existing channels and help remove excessive fine sediment accumulation (CDFW-CWPAP, 2013).	2	25							TBD	Costs will vary depending on methods implemented and extent of rehabilitation and partially in the above action step.
SFER-CCCh-1.1.2.4	Action Step	Estuary	Conduct an upslope erosion inventory on streams in the Middle and Upper Subbasins in order to identify and map stream bank and road-related sediment sources. Sites should be prioritized and improved in order to decrease sediment contributions within the basin (CDFW-CWPAP, 2013).	2	10	CDFW, Humboldt County	1,220	1,220				2,439	Cost based on erosion assessment of 10% of total watershed acres. Combined acreage of Middle and Upper Subbasins equals 1,932,960 acres.
SFER-CCCh-1.1.2.5	Action Step	Estuary	In streams where spawning area is limited, projects should be designed to trap and sort spawning gravels in order to expand and enhance redd distribution (CDFW-CWPAP, 2013).	2	25	CDFW						0	Action is considered In-Kind

South Fork and Lower Eel River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K)						Comment
							FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	
SFER-CCCh-1.1.2.6	Action Step	Estuary	Water quality data, including temperature and dissolved oxygen, should be consistently collected throughout the year, for several years, in order to accurately characterize conditions in the streams. Salinities should be collected in the estuary and upstream to determine the extent of brackish conditions (CDFW-CWPAP, 2013).	2	5	CDFW	20.00					20	Cost based on installing continuous water quality monitoring stations at a rate of $5,000/station. Cost does not account for data management or maintenance. May be considered an In-Kind action
SFER-CCCh-1.1.3	Recovery Action	Estuary	Reduce toxicity and pollutants										
SFER-CCCh-1.1.3.1	Action Step	Estuary	Livestock management fencing should be placed in areas where cattle have unrestricted access to streams (CDFW-CWPAP 2013).	2	10	CDFW, Humboldt County, NMFS, NOAA RC, Private Landowners						TBD	Cost based on amount of area to be treated at a rate of 3.63/ft.
SFER-CCCh-1.1.4	Recovery Action	Estuary	Improve the quality of the estuarine habitat zones										
SFER-CCCh-1.1.4.1	Action Step	Estuary	Identify and prioritize locations within the delta where vegetation can be returned to salt tolerant species, thus increasing salt marsh around slough channels and providing a buffer to adjacent lands during inundation (CDFW-CWPAP, 2013).	2	5	CDFW, Humboldt County, NOAA RC	214.00					214	Cost based on wetland restoration at a rate of $213,307/project.
SFER-CCCh-1.1.4.2	Action Step	Estuary	Programs to increase riparian vegetation should be implemented in streams where shade canopy is below target values of 80% coverage. Additionally, where vegetated with exotic species, it should be considered for native plant restoration (CDFW-CWPAP, 2013).	2	20	CDFW, Humboldt County						0	Action is considered In-Kind
SFER-CCCh-1.1.5	Recovery Action	Estuary	Increase and enhance habitat complexity features										
SFER-CCCh-1.1.5.1	Action Step	Estuary	In creeks where fish spawning and rearing habitat is limited, pool enhancement and instream structures should be added to increase complexity (CDFW-CWPAP, 2013).	2	10	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
SFER-CCCh-2.1	**Objective**	**Floodplain Connectivity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-2.1.1	Recovery Action	Floodplain Connectivity	Rehabilitate and enhance floodplain connectivity										
SFER-CCCh-2.1.1.1	Action Step	Floodplain Connectivity	Assess watershed and prioritize potential refugia habitat sites.	3	5	CDFW	288.00					288	Cost based on riparian and wetland restoration model at a rate of $73,793 and $213,307/project, respectively.
SFER-CCCh-2.1.1.2	Action Step	Floodplain Connectivity	Construct off channel ponds, alcoves, backwater habitat, and old stream oxbows, guided by assessment.	2	20	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
SFER-CCCh-5.1	**Objective**	**Passage**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-5.1.1	Recovery Action	Passage	Modify or remove physical passage barriers										
SFER-CCCh-5.1.1.1	Action Step	Passage	Inventory migration and flow barriers and develop plan to restore passage.	1	5	CDFW	7,863					7,863	Cost based on assessing 35 barriers for adult escapement and juvenile migration model at a rate of $36,379 and $188,264/project, respectively.

South Fork and Lower Eel River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
SFER-CCCh-5.1.1.2	Action Step	Passage	Restore passage, guided by plan.	2	10	CDFW						TBD	Actual cost will be based on what barrier are restored and the actual costs. Some costs may be In-Kind
SFER-CCCh-6.1	**Objective**	**Habitat Complexity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-6.1.1	Recovery Action	Habitat Complexity	Increase large wood frequency										
SFER-CCCh-6.1.1.1	Action Step	Habitat Complexity	Develop plan to add large wood, boulders, or other instream structure to specific areas in specific quantities.	2	5	CDFW	115.00					115	Cost based on fish/habitat restoration model at a rate of $114,861/project.
SFER-CCCh-6.1.1.2	Action Step	Habitat Complexity	Add structure, guided by plan.	2	10	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
SFER-CCCh-6.1.2	Recovery Action	Habitat Complexity	Improve pool/riffle/flatwater ratios (hydraulic diversity)										
SFER-CCCh-6.1.2.1	Action Step	Habitat Complexity	Implement actions to increase the frequency of pool habitats.	3	20								Cost accounted for in above action step.
SFER-CCCh-7.1	**Objective**	**Riparian**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-7.1.1	Recovery Action	Riparian	Improve canopy cover										
SFER-CCCh-7.1.1.1	Action Step	Riparian	Remove invasive species that inhibit establishment of native riparian vegetation.	3	5	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
SFER-CCCh-7.1.1.2	Action Step	Riparian	Plant native riparian species in denuded areas.	2	5	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
SFER-CCCh-10.1	**Objective**	**Water Quality**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-10.1.1	Recovery Action	Water Quality	Reduce toxicity and pollutants										
SFER-CCCh-10.1.1.1	Action Step	Water Quality	Reduce intensity of remote outdoor agriculture's nutrient and chemical inputs and improve practices to prevent pollutants from reaching watercourses.	2	5	CDFW	150.00					150	Cost based on installing a minimum of 3 continuous water quality stations at a rate of $5,000/station. Cost does not account for data management or maintenance.
SFER-CCCh-14.1	**Objective**	**Disease/ Predation /Competition**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-14.1.1	Recovery Action	Disease/ Predation /Competition	Prevent or minimize reduced density, abundance, and diversity based on based on the biological recovery criteria										
SFER-CCCh-14.1.1.1	Action Step	Disease/ Predation /Competition	Assess feasibility and benefits of various methods to eradicate or suppress Sacramento pikeminnow, including genetic technology methods (e.g., deleterious genes).	2	5	CDFW						0	Action is considered In-Kind
SFER-CCCh-14.1.1.2	Action Step	Disease/ Predation /Competition	Take measures to eradicate or suppress fish species using genetic technology or other methods identified as feasible.	2	25	CDFW						0	Action is considered In-Kind
SFER-CCCh-16.1	**Objective**	**Fishing/Collecting**	**Address the inadequacy of existing regulatory mechanisms**										
SFER-CCCh-16.1.1	Recovery Action	Fishing/Collecting	Prevent or minimize reduced density, abundance, and diversity based on based on the biological recovery criteria										

South Fork and Lower Eel River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K)						Comment
							FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	
SFER-CCCh-16.1.1.1	Action Step	Fishing/Collecting	Change the low flow season for the main stem Eel River to start on September 1.	3	5	CDFW						0	Action is considered In-Kind
SFER-CCCh-19.1	**Objective**	**Logging**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-19.1.1	Recovery Action	Logging	Prevent or minimize adverse alterations to riparian species composition and structure										
SFER-CCCh-19.1.1.1	Action Step	Logging	Determine appropriate silvicultural prescription to improve size and density of conifers.	3	5	CalFire						0	Action is considered In-Kind
SFER-CCCh-19.1.1.2	Action Step	Logging	Plant, thin, or release conifers guided by prescription.	3	115	CalFire, CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
SFER-CCCh-23.1	**Objective**	**Roads/Railroads**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-23.1.1	Recovery Action	Roads/Railroads	Prevent or minimize alterations to sediment transport (road condition/density, dams, etc.)										
SFER-CCCh-23.1.1.1	Action Step	Roads/Railroads	Reduce road-stream hydrologic connection.	2	10		768	768				1,535	Cost based on conducting a road inventory of 1,604 miles of road network at a rate of $957/mile.
SFER-CCCh-23.1.1.2	Action Step	Roads/Railroads	Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective.	3	5	CDFW						TBD	Cost based on road inventory identified in above action step.
SFER-CCCh-23.1.1.3	Action Step	Roads/Railroads	Assess streamside roads and prioritize sites for relocation to minimize mass wasting.	3	5	CDFW						TBD	Cost based on amount of road network to relocate.
SFER-CCCh-23.1.1.4	Action Step	Roads/Railroads	Decommission or relocate roads away from streamsides and unstable land features, guided by assessment.	3	15	CDFW						TBD	Cost will be based on the amount of road decommissioned at a rate of $12,000/mile.
SFER-CCCh-23.1.1.5	Action Step	Roads/Railroads	Upgrade roads, guided by assessment.	2	15	CDFW						TBD	Cost based on the amount of road network to be treated at a rate of $21,000/mile
SFER-CCCh-23.1.1.6	Action Step	Roads/Railroads	Maintain roads, guided by assessment.	3	50	CDFW						0	Action is considered In-Kind
SFER-CCCh-25.1	**Objective**	**Water Diversion /Impoundment**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
SFER-CCCh-25.1.1	Recovery Action	Water Diversion /Impoundment	Prevent or minimize impairment to stream hydrology (impaired water flow)										
SFER-CCCh-25.1.1.1	Action Step	Water Diversion /Impoundment	Establish a forbearance program, using water storage tanks to decrease diversion during periods of low flow.	2	25	RWQCB						TBD	Cost based on amount of forbearance program to decrease diversion during low-flow periods. Cost for forbearance program estimated at $70,000/landowner.
SFER-CCCh-25.1.1.2	Action Step	Water Diversion /Impoundment	Monitor forbearance compliance and flow.	3	25	RWQCB						0	Action is considered In-Kind
SFER-CCCh-25.1.2	Recovery Action	Water Diversion /Impoundment	Prevent or minimize reduced density, abundance, and diversity based on based on the biological recovery criteria										
SFER-CCCh-25.1.2.1	Action Step	Water Diversion /Impoundment	Screen all diversions to prevent juvenile mortality.	2	25	CDFW						TBD	Cost based on amount of fish screens needed to be screened. Cost for fish screen on large tributary estimated at $53,465/screen.

Mad River Population

CC Chinook Salmon Fall-Run

- Role within ESU: Functionally Independent Population
- Diversity Stratum: North Coastal
- Spawner Abundance Target: 3,000 adults
- Current Intrinsic Potential: 94 IP-km

For information regarding NC steelhead and SONCC coho salmon for this watershed, please see the NC steelhead volume of this recovery plan and the SONCC coho salmon recovery plan (http://www.westcoast.fisheries.noaa.gov/).

Chinook Salmon and Steelhead Abundance and Distribution

There are no known systematic adult or juvenile population surveys for CC Chinook salmon on the Mad River. Fall-run Chinook salmon spawner surveys and rotary screw trapping have been conducted in recent years but the level of effort has varied within and between years, making statistical inferences impossible. CDFW operated a fish ladder from 1938 through 1964 at Sweasey Dam (built in 1938 and removed in 1970), producing the only known reliable population time series for Chinook salmon, coho salmon, and steelhead in the Mad River.

Fall-run Chinook salmon are documented within the Mad River basin up to the boulder roughs reach (rkm 80) located near Bug Creek (Spence *et al.* 2008; Stillwater Sciences 2010). Chinook salmon utilize both the mainstem Mad River and several tributaries for spawning including Lindsey Creek, North Fork Mad River, Cañon Creek, Maple Creek, and Blue Slide Creek (Stillwater Sciences 2010).

In 1905, an estimated 200,000 pounds of Chinook salmon were harvested commercially in the Mad River, leading to an estimated run of 10,000 fish, not including escapement and recreational catch (Ridenhour et al. 1961). By the middle of the 20th century, runs of Chinook salmon had declined substantially. The largest Chinook salmon return to Sweasey Dam was 3,139 in 1941, with the population declining significantly to less than 100 by the 1960s. In the fall of 2003 and 2004, sporadic, incomplete redd counts on the Mad River during spawner surveys were 457 and 281, indicating there were at least a few hundred spawners in those years. Therefore, it is likely that the population of adult fall-run Chinook salmon in the Mad River is greater than the high risk threshold identified by Spence *et al.* (2008) of 94 adult spawners, but substantially less than low risk threshold of 3,000. Sparkman (2002b) estimated that 954,027 (854,178 –1,053,876) 0+ fall Chinook salmon emigrated past the trap site, located near the hatchery, from March 30 – July 14, 2001. Spence *et al.* (2008) wrote that they did not have enough data available on Mad River fall-run Chinook salmon to determine the current population viability. Spring-run Chinook salmon in the Mad River are thought to be extinct (Spence *et al.* 2008), though their historical prevalence relative to that of fall Chinook salmon has not been documented. The CDFW will be using DIDSON sonar in the Mad River to estimate abundances of Chinook salmon beginning in 2014, which could help future long-term salmonid monitoring.

History of Land Use

Historically, bands of the Wiyot Tribe inhabited the lower portion of the Mad River and fished for salmon and steelhead in the watershed (Sturtevant 1978). After whites settled in the area in the mid-1800s, logging and ranching became the primary land uses. Today, logging, road building, gravel mining, grazing, agriculture and water diversion and impoundment are the human activities that have the most pronounced effect on salmonid habitat in the Mad River basin. Mad River Hatchery currently produces approximately 150,000 steelhead smolts annually, supporting a recreational fishery with economic importance to the region.

These land uses have reduced available habitat throughout the basin. The watershed has been heavily logged, some areas more than once, since the early 1900s (Stillwater Sciences 2010). Increased erosion from logged hillslopes and roads, especially during the 1955 and 1964 flood events, has filled the Mad River with sediment and created chronically high turbidity levels (Stillwater Sciences 2008). 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 (USEPA) estimated that 64 percent of all sediment delivered to streams was attributed to human and land management-related activities, with roads being the dominant source (USEPA 2007). In the lower Mad River and North Fork areas, sediment loading is currently five times greater than natural background loading levels (USEPA 2007). Compounding the increase in sediment delivery, riparian vegetation loss has reduced shading and lowered instream large wood abundance. Most forest stands within the basin are now comprised of smaller diameter trees with a greater percentage of hardwoods, which provide different ecological function than redwood and conifer species that occurred historically (GDRC 2006).

Current Resources and Land Management

Much of the North Fork Mad River watershed and the lower and middle portions of the Mad River basin are owned by Green Diamond Resource Company (GDRC) and managed for timber production under an Aquatic Habitat Conservation Plan. 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 (FEMAT 1993). The largest communities in the watershed, Arcata, Blue Lake and McKinleyville, are situated along the lowermost reach near the mouth of the Mad River. Extensive instream gravel mining occurs throughout the lower Mad River. Instream gravel mining is focused in the 7-mile reach of the lower Mad River between Blue Lake and Arcata. 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 U.S. 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, and particle size, which could impact aquatic invertebrates and juvenile feeding in the lower Mad River (NMFS 2004; 2010).

The following list highlights important groups or documents that are pertinent to the Mad River:

- Mad River Stakeholders Group: http://www.naturalresourcesservices.org;
- Lindsay Creek Watershed Group: http://www.naturalresourcesservices.org/lindsay-creek.html;
- Mad River Watershed Assessment: http://www.naturalresourcesservices.org/mad-river-watershed-management-plan.html;
- Green Diamond Resource Company: http://www.greendiamond.com;
- Mad River Sediment Source Analysis: http://www.epa.gov/region9/water/tmdl/mad/GMA-Mad-River-SSA-final-report-Dec2007-no-plates.pdf;
- Mad River TMDL: http://www.epa.gov/region9/water/tmdl/mad/Mad-TMDL-122107-signed.pdf; and
- Mad River Alliance: http://www.facebook.com/pages/Mad-River-Alliance/481159968568471.

Salmonid Viability and Watershed Conditions

The following indicators are rated Poor through the CAP process for CC Chinook salmon: aquatic invertebrates (EPT), percent of primary and staging pools, pool/rifle/flatwater ratio, road density, shelter, and turbidity. Other indicators that are identified as impaired include the following: LWD frequency, number and magnitude of diversions, estuary quality, redd scour, and tree diameter. Recovery strategies will focus on improving these poor conditions as well as those needed to ensure population viability and functioning watershed processes (see Mad River CAP results).

Current Conditions

The following discussion focuses on those conditions that rated Fair or Poor as a result of our CAP viability analysis. The Mad River CAP Viability Table results are provided below. Recovery strategies will focus on improving these conditions.

Population and Habitat Conditions

Sediment Transport: Road Density

Overall, the sediment load allocations reflect a total 57 percent reduction over the 1976-2006 time period, or an 89 percent reduction in human-and management-related sediment (USEPA 2007). However, because existing management-related sediment loading is so high in the watershed, dramatic cuts in sediment are necessary for habitat improvement (USEPA 2007). Cañon Creek, the North Fork Mad River, Maple Creek, Boulder Creek, Lindsay Creek, the Lower Mad River, and the Lower Middle Mad River all have 50 percent or more of their watershed area in Franciscan Melange, a very erosive geology type. Road building and logging have accelerated erosion rates within this naturally erosive geology. In the lower Mad River and North Fork areas, total sediment loading is currently five times greater than natural sediment loading (USEPA 2007). Most of the hydrologic units within hydrologic sub-areas HSAs in the lower portion of the Mad River watershed, including Little River, Blue Lake, North Fork Mad River, and Butler Valley, have very high road densities of greater than 3 road miles per square mile area. The Lower Middle Mad River has the largest area underlain by Franciscan Melange (40.4 mi2). Road-related landslides contribute 622,942 tons of sediment per year in the Mad River watershed, making sediment transport a substantial stress to this population (Mad River CAP Results). Sediment accumulation at the mouths of tributaries, such as Cañon Creek, may inhibit juvenile and adult access (Halligan, Stillwater Sciences, personal communication, 2011). Excess sediment in the Mad River affects all lifestages and all populations of listed salmonids in the basin. High gravel embeddedness likely causes poor survival of eggs and fry in watersheds such as the North Fork Mad River. Elevated turbidity also makes feeding and respiration difficult for fry and juvenile salmonids.

Estuary: Quality and Extent

Estuary conditions in the Mad River has a rating of Fair for juveniles. The estuary was once connected to many sloughs and other off-channel rearing habitat, such as overflow channels and cut-off meanders. Natural slough channels were blocked in the 1900s, and the mainstem river channel was straightened and channelized in an attempt to minimize overbank flooding (Stillwater Sciences 2010). Channel banks in the estuary were stabilized by the construction of gravel berms, rip rap, and riparian vegetation planted in the 1980s (Stillwater Sciences 2010) and, as a result, active channel area in the reach has declined by 32 percent since 1941 (Stillwater Sciences 2008). Overall, 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 highly altered estuarine function.

Habitat Complexity: Altered Pool Complexity and/or Pool/Riffle Ratios

Sediment loading in the Mad River watershed has aggraded stream reaches, particularly in the lower and middle Mad River watershed. Downstream of the Bug Creek confluence, landslide sediment input exceeds the transport capacity of the river, resulting in a locally aggraded mainstem channel (USEPA 2007). This has caused pools to fill in and become shallow, altering the pool: riffle ratio in several stream reaches. Low LWD volume has also reduced the number and quality of pools instreams in the Mad River watershed. Some short sections of the lower North Fork and lower Mad River mainstem are confined by flood control levees on the right side of the river around the town of Blue Lake and in the Mad River bottoms, downstream of Highway 101. These levees disconnect the channel from its floodplain and limit the formation of off-channel habitat, which is critical for juvenile winter rearing success.

Habitat Complexity: Large Wood and Shelter

Stillwater Sciences (2010) identified several stream reaches as suffering from low LWD volume. Industrial timber removal of trees, ages 40-80 years, will likely substantially reduce LWD recruitment in the future. However, there is evidence that LWD recruitment is improving in some areas, such as Dry Creek and Cañon Creek (Stillwater Sciences 2010). Areas that are lacking LWD include the Lower Mad River sub-basin, North Fork Mad River sub-basin, Maple Creek, and Powers Creek sub-basin. Surveys conducted by CDFW on Black Creek (a.k.a. Black Dog Creek), located along the west side of the Mad River just upstream of Maple Creek at approximately RM 28.3, identified a relatively low level of LWD and recommended installing wood structures to improve pool habitat quality and instream cover levels (Stillwater Science 2010).

Viability: Density, Abundance and Spatial Structure

Information provided above in the *Fish and Distribution* section shows that Chinook salmon are likely far below the low risk spawner thresholds but above the depensation thresholds.

Although Chinook salmon have access to most of their historical spawning habitat, poor habitat complexity within the estuary likely limits the expression of life history diversity.

Water Quality: Turbidity or Toxicity

Analyses detailed in USEPA (2007) indicate there are hundreds of active landslides in the Mad River watershed, which during winter and spring storms create turbid water conditions that stress Chinook salmon fry. Sediment input directly into streams by landslides can also smother available spawning gravel, lowering survival from the egg to fry lifestage. Turbidity is problematic throughout the Middle and Lower Mad River watersheds and in the North Fork Mad River.

Hydrology: Redd Scour

Fall-run Chinook salmon in the Mad River spawn in the lower reaches of the drainage, often in the mainstem Mad River. This spawning strategy makes Chinook salmon particularly susceptible to activities or events that increase gravel scouring frequency or severity. Fall-run Chinook salmon spawn timing (November and December) also makes them particularly vulnerable to redd scouring precipitation events. Logged hillsides with high road densities in the basin promote faster runoff from rain storms that would occur in the absence of logging. Gravel mining destabilizes gravels, making them more mobile at a lower flow than they would be otherwise.

Very Good or Good Current Conditions

Very Good or Good rated conditions include altered riparian species composition and structure, floodplain connectivity: quality and extent, hydrology: water flow, passage and migration, watershed hydrology, and landscape disturbance.

Threats

The following discussion focuses on those threats that rate as High or Very High (Mad River CAP Results). Recovery strategies will likely focus on ameliorating High rating threats; however, some strategies may address Medium and Low threats when the strategy is essential to recovery efforts. The figures and tables that display data used in this analysis are provided in Mad River CAP Results.

Population and Habitat Threats

Channel Modification

Channel modification is a significant threat for juveniles in the Mad River (Mad River CAP Results). The draining of estuary wetlands and construction of high levees for pasture lands has reduced the volume of winter rearing habitat in the lower portions of the watershed, while constructed levees have effectively cut off access to valuable off-channel and slough habitat.

Water Diversion and Impoundments

Water diversions and impoundments affect the function of watershed processes by changing the timing and magnitude of flow events. Matthews Dam, which forms Ruth Reservoir, stores rainfall during the first several rainstorms of the winter season annually spilling after the reservoir is full. This unnaturally attenuates flow in the Mad River, altering the normal hydrologic signal in the Mad River. In years of below average precipitation, flow increases resulting from fall rainstorms are more limited in magnitude, which likely creates barriers to migration at the mouths of some tributaries. Out of basin water diversions or transfer of water from the Humboldt Bay Municipal Water District (HBMWD) could pose a significant threat to Chinook salmon in the Mad River by reducing habitat during certain times of year, decreasing flow variability, and elevating stream temperatures.

Roads and Railroads

Roads are a High threat across all lifestages, and one of the primary threats for these populations. Most of the hydrologic units within HSAs in the lower portion of the Mad River watershed, including Little River, Blue Lake, North Fork Mad River, and Butler Valley, have very high road densities of greater than 3 mi/sq. mi. Overall, the sediment load allocations reflect a total 57 percent reduction over the 1976-2006 time period, or an 89 percent reduction in human-and management-related sediment, suggesting the threat from roads is decreasing. However, roads remain a significant threat even though the volume of sediment due to human activities has been decreasing (USEPA 2007). This threat will remain high in the future for Mad River steelhead populations until a plan is developed that systematically prioritizes and treats landslides and roads that contribute sediment to the aquatic environment.

Mining

Mining/gravel extraction is rated as a High threat to the juvenile. 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 numerous minimization measures to reduce the effects of gravel extraction on fish habitat, such as a head-of-bar buffer to provide for channel steering around 10 skimmed gravel bars, provisions to provide low to moderate flow channel confinement, mining volumes that are scaled to annual water yield) 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; 15 low levels of instream wood), gravel extraction is a high threat to rearing juveniles and a moderate threat to adults who require resting habitat in pools during upstream migration.

Logging and Wood Harvesting

Timber harvest is rated as a High threat to Chinook salmon 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 timber harvest from previous decades. The majority of private timber land in the Mad River basin is owned by the Green Diamond Resource Company (Green Diamond), and will continue as timberland into the future. The HCP lays out goals and objectives to minimize and mitigate timber harvest effects through measures related to road and riparian management, slope stability, and harvesting activities. Although the private timber land is managed under an aquatic HCP that reduces the effects of timber harvest, elevated sediment yields, impaired LWD recruitment, and decreased stream shading are still expected to occur in the future.

Low or Medium Rated Threats

Low or Medium rated threats include agriculture, disease, predation and competition, fire, fuel management and fire suppression, fishing and collecting, recreational areas and activities, residential and commercial development, severe weather patterns, and livestock farming and ranching.

Limiting Stresses, Lifestages, and Habitats

The threat and stress analysis within the CAP workbook suggest that pre-smolt and smolt productivity is likely limiting subsequent adult Chinook salmon abundance within the Mad River watershed. In addition, gravel scouring events likely play a role in poor spawner success during years of high precipitation. Excessive turbidity during the winter and spring months, reduced habitat complexity, and a smaller, simplified estuary have reduced the quality and extent of rearing habitat for Chinook salmon in the Mad River.

General Recovery Strategy

In general, recovery strategies focus on improving conditions and ameliorating stresses and threats discussed above, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions within the watershed. The general recovery strategy for the Mad River populations is discussed below with more detailed and site-specific recovery actions provided in Mad River CAP results, which provides the Implementation Schedule for this population.

Address Upslope Sediment Sources

Existing problem roads (gullied, rutted, with inadequate drainage) and active erosion sites should be prioritized and addressed as part of a comprehensive sediment reduction plan for the Middle and Lower Mad River subwatersheds, which are the areas with the greatest volume of sediment input (Stillwater Sciences 2010). While Green Diamond Resource Company has been prioritizing their roads for treatment, the work needs to be performed across multiple private ownership boundaries. Because roads are the dominant source of sediment in the watershed, improving road condition and maintenance may be the most cost-effective approach to address elevated turbidity within the watershed (USEPA 2007). The main fish-producing tributaries to the Mad River (Lindsay Creek, North Fork Mad River, Canon Creek, and Maple Creek) should be treated first (USEPA 2007).

Increase Instream Shelter Ratings and Pool volume

Availability of shelter habitat should be improved within reaches of the Middle and Lower Mad River subwatersheds with currently low pool availability and quality. Adding LWD will improve habitat complexity in existing pool habitats where shelter components are currently comprised of undercut banks and emergent aquatic vegetation. In other reaches, restoration efforts should implement wood/boulder structures into degraded reaches to increase pool frequency and volume. Additions of large wood have occurred in NF Mad, mainstem Mad, Lindsay Creek and Leggit Creek. These efforts have been for the most part successful at improving habitat. Beneficial uses of water from Ruth Reservoir by the Humboldt Bay Municipal Water District should be explored including elevating fall flows during rainstorms, and providing additional habitat for fisheries restoration. A new Habitat Conservation Plan for HBMWD would be a valuable step to outline how water no longer needed for industrial uses could be used to benefit salmonids.

Increase Mainstem and Estuary Habitat Complexity

The lower portions of the mainstem Mad River (downstream from Mad River hatchery) suffer from a lack of LWD and, in certain areas, disconnection with the floodplain (near Blue and downstream from Highway 299). Priority should be placed on expanding rearing areas, such as creation of off-channel ponds, wetlands, sloughs, and backwaters, to the lower Mad River, its tributaries and the Mad River estuary. Where possible, land should be purchased from willing landowners in order to expand floodplain habitat availability. Gravel mining effects to Chinook salmon, permit minimization measures, and gravel mining techniques and annual extraction volumes should be re-evaluated.

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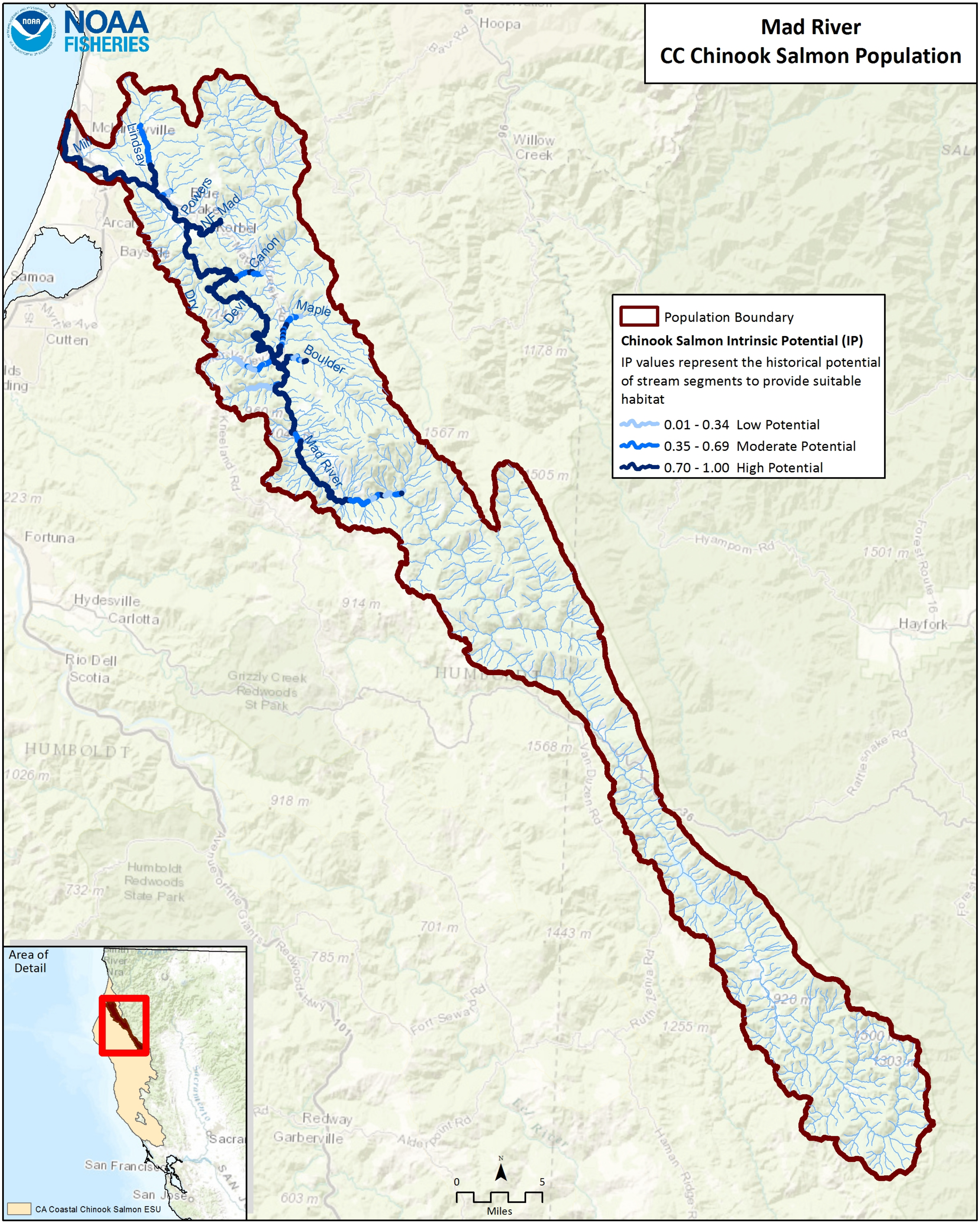
NOAA FISHERIES
Mad River
CC Chinook Salmon Population
Population Boundary
Chinook Salmon Intrinsic Potential (IP)
IP values represent the historical potential of stream segments to provide suitable habitat
0.01 - 0.34 Low Potential
0.35 - 0.69 Moderate Potential
0.70 - 1.00 High Potential
Lindsay
Powers
NF Mad
Canon
Dry
Maple
Boulder
Mad River
Hoopa
Willow Creek
Arcata
Samoa
Cutten
Fortuna
Hydesville
Carlotta
Rio Dell
Scotia
HUMBOLDT
Grizzly Creek Redwoods St Park
Humboldt Redwoods State Park
Redway
Garberville
Hayfork
Area of Detail
CA Coastal Chinook Salmon ESU
San Francisco
San Jose
0
5
Miles

#	Conservation Target	Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Measurement	Current Rating
1	Adults	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Properly Functioning Condition	Good
			Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	<50% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>6 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>6 Key Pieces/100 meters)	>90% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-km (>6 Key Pieces/100 meters)	Fair
			Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	<50% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	>90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	50% to 74% of streams/ IP-km (>1.3 Key Pieces/100 meters)	Fair
			Habitat Complexity	Percent Staging Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	0% of streams/ IP-Km (>49% average primary pool frequency)	Poor
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	48% of streams/ IP-Km (>30% Pools; >20% Riffles)	Poor
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.15	Good
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 42	Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	80% IP-km	Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	100% of IP-km	Very Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	44.52% Class 5 & 6 across IP-km	Fair

			Sediment	Quantity & Distribution of Spawning Gravels	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	80% of IP-km	Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	84	Very Good
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	>80% Response Reach Connectivity	Good
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	70% of streams/ IP-km maintains severity score of 3 or lower	Fair
		Size	Viability	Density	<1 spawners per IP-Km	1-20 Spawners per IP-Km	20-40 Spawners per IP-Km (e.g., Low Risk Extinction Criteria)		5 Spawners per IP-km	Fair
			Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	91% of Historical Range	Very Good
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	57.5	Fair
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	10	Poor
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	28	Fair
2	Eggs	Condition	Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 33	Very Good
			Hydrology	Redd Scour	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 42	Good

			Sediment	Gravel Quality (Bulk)	>17% (0.85mm) and >30% (6.4mm)	15-17% (0.85mm) and <30% (6.4mm)	12-14% (0.85mm) and <30% (6.4mm)	<12% (0.85mm) and <30% (6.4mm)	11% (0.85mm) and <30% (6.4mm)	Very Good
			Sediment	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	100% of streams/ IP-km (>50% stream average scores of 1 & 2)	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	84	Very Good
3	Pre Smolt	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Percent Primary Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	27% of streams/ IP-km (>49% average primary pool frequency)	Poor
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	48% of streams/ IP-Km (>30% Pools; >20% Riffles)	Poor
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	0% of streams/ IP-km (>80 stream average)	Poor
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.15	Good
			Hydrology	Flow Conditions (Baseflow)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 42	Good
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 33	Very Good
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	1.3 Diversions/10 IP-km	Fair

			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 33	Very Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	80% IP-km	Good
			Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition	50% Intact Historical Species Composition	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	84	Very Good
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	100% of streams/ IP-km (>50% stream average scores of 1 & 2)	Very Good
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined		
			Water Quality	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	60% IP-km (>6 and <14 C)	Fair
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	49% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	91% of Historical Range	Very Good
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	57.5	Fair
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	10	Poor

			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	28	Fair
5	Smolts	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	0% of streams/ IP-km (>80 stream average)	Poor
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35		
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	1.3 Diversions/10 IP-km	Fair
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 33	Very Good
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	80% IP-km	Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	100% of IP-km	Very Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	84	Very Good
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	100% of streams/ IP-km (>50% stream average scores of 1 & 2)	Very Good
			Smoltification	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	60% IP-km (>6 and <14 C)	Fair
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	>80% Response Reach Connectivity	Good

			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	70% of streams/ IP-km maintains severity score of 3 or lower	Fair
		Size	Viability	Abundance	Smolt abundance which produces high risk spawner density per Spence et al (2012)	Smolt abundance which produces moderate risk spawner density per Spence et al (2012)	Smolt abundance to produce low risk spawner density per Spence et al (2012)	not applicable		
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	57.5	Fair
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	10	Poor
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	28	Fair
6	Watershed Processes	Landscape Context	Hydrology	Impervious Surfaces	>10% of Watershed in Impervious Surfaces	7-10% of Watershed in Impervious Surfaces	3-6% of Watershed in Impervious Surfaces	<3% of Watershed in Impervious Surfaces	0.29% of Watershed in Impervious Surfaces	Very Good
			Landscape Patterns	Agriculture	>30% of Watershed in Agriculture	20-30% of Watershed in Agriculture	10-19% of Watershed in Agriculture	<10% of Watershed in Agriculture	0.4% of Watershed in Agriculture	Very Good
			Landscape Patterns	Timber Harvest	>35% of Watershed in Timber Harvest	26-35% of Watershed in Timber Harvest	25-15% of Watershed in Timber Harvest	<15% of Watershed in Timber Harvest	19.12% of Watershed in Timber Harvest	Good
			Landscape Patterns	Urbanization	>20% of watershed >1 unit/20 acres	12-20% of watershed >1 unit/20 acres	8-11% of watershed >1 unit/20 acres	<8% of watershed >1 unit/20 acres	4% of watershed >1 unit/20 acres	Very Good
			Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition	50% Intact Historical Species Composition	Fair

			Sediment Transport	Road Density	>3 Miles/Square Mile	2.5 to 3 Miles/Square Mile	1.6 to 2.4 Miles/Square Mile	<1.6 Miles/Square Mile	5.15 Miles/Square Mile	Poor
			Sediment Transport	Streamside Road Density (100 m)	>1 Miles/Square Mile	0.5 to 1 Miles/Square Mile	0.1 to 0.4 Miles/Square Mile	<0.1 Miles/Square Mile	4.02 Miles/Square Mile	Poor

Mad River CAP Threat Results

	Threats Across Targets	Adults	Eggs	Pre Smolt	Smolts	Watershed Processes	Overall Threat Rank
	Project-specific-threats	1	2	3	5	6	
1	Agriculture	Medium	Low	Medium	Medium	Medium	Medium
2	Channel Modification	Medium	Low	High	High	Low	High
3	Disease, Predation and Competition	Medium	Low	Low	Medium		Medium
4	Hatcheries and Aquaculture	Low	Low	Low	Low		Low
5	Fire, Fuel Management and Fire Suppression	Medium	Low	Medium	Medium	Medium	Medium
6	Fishing and Collecting	Medium	Low	Low	Low		Low
7	Livestock Farming and Ranching	Medium	Medium	Medium	Medium	Medium	Medium
8	Logging and Wood Harvesting	Medium	Medium	Medium	Medium	Medium	Medium
9	Mining	Medium	Medium	Medium	Medium	Medium	Medium
10	Recreational Areas and Activities	Medium	Low	Medium	Medium	Low	Medium
11	Residential and Commercial Development	Medium	Medium	Medium	Medium	Medium	Medium
12	Roads and Railroads	Medium	High	High	High	High	High
13	Severe Weather Patterns	Medium	Low	Medium	Medium	Medium	Medium
14	Water Diversion and Impoundments	Medium	Medium	Medium	Medium	High	Medium
	Threat Status for Targets and Project	High	High	High	High	High	Very High

Mad River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
MdR-CCCh-1.1	**Objective**	**Estuary**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MdR-CCCh-1.1.1	Recovery Action	Estuary	Increase extent of estuarine habitat										
MdR-CCCh-1.1.1.1	Action Step	Estuary	Assess and prioritize levees for setback or removal.	3	2	County	283					283	Cost based on estuary use/residence time model at a rate of $282,233/project.
MdR-CCCh-1.1.1.2	Action Step	Estuary	Remove or set back levees, guided by assessment.	3	8	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MdR-CCCh-1.1.1.3	Action Step	Estuary	Assess tidally influenced habitat and develop plan to restore tidal channels.	2	2	CDFW							Cost accounted for in above action step.
MdR-CCCh-1.1.1.4	Action Step	Estuary	Restore tidal wetlands and tidal channels, guided by plan.	2	8	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation. Cost should be coordinated with other action steps above to reduce cost and redundancy.
MdR-CCCh-2.1	**Objective**	**Floodplain Connectivity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MdR-CCCh-2.1.1	Recovery Action	Floodplain Connectivity	Rehabilitate and enhance floodplain connectivity										
MdR-CCCh-2.1.1.2	Action Step	Floodplain Connectivity	Assess watershed and prioritize potential refugia habitat sites.	3	2	CDFW	74.00					74	Cost based on riparian restoration model at a rate of $73,793/project.
MdR-CCCh-2.1.1.3	Action Step	Floodplain Connectivity	Implement projects that create refugia habitats, guided by assessment.	3	8	CDFW							Costs will vary depending on methods implemented and extent of rehabilitation.
MdR-CCCh-5.1	**Objective**	**Passage**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MdR-CCCh-5.1.1	Recovery Action	Passage	Modify or remove physical passage barriers										
MdR-CCCh-5.1.1.1	Action Step	Passage	Develop plan to restore passage of all life stages.	3	2	County	44.54					45	
MdR-CCCh-5.1.1.2	Action Step	Passage	Implement plan.	3	8	County						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MdR-CCCh-6.1	**Objective**	**Habitat Complexity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MdR-CCCh-6.1.1	Recovery Action	Habitat Complexity	Increase large wood frequency										
MdR-CCCh-6.1.1.2	Action Step	Habitat Complexity	Develop plan to add large wood, boulders, or other instream structure to specific areas in specific quantities.	2	2	CDFW	34.11					34	
MdR-CCCh-6.1.1.3	Action Step	Habitat Complexity	Place instream structures, guided by assessment.	2	8	CDFW						TBD	Cost for providing passage based on amount of barriers and methods to improve passage conditions. Cost range between $85,232 to $992,479/project.
MdR-CCCh-7.1	**Objective**	**Riparian**	**Address the inadequacy of existing regulatory mechanisms**										
MdR-CCCh-7.1.1	Recovery Action	Riparian	Improve canopy cover										

Mad River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
MdR-CCCh-7.1.1.1	Action Step	Riparian	Determine appropriate silvicultural prescription for benefits to listed salmonids.	3	5	CDFW						0	Action is considered In-Kind
MdR-CCCh-7.1.1.2	Action Step	Riparian	Plant conifers, guided by prescription.	3	5	CDFW						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MdR-CCCh-8.1	**Objective**	**Sediment**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MdR-CCCh-8.1.1	Recovery Action	Sediment	Improve instream gravel quality and quantity										
MdR-CCCh-8.1.1.1	Action Step	Sediment	Develop study to analyze the frequency and effect of gravel scouring events.	3	2	NMFS	115.00					115	Cost based on fish/habitat restoration monitoring at a rate of $114,861/project.
MdR-CCCh-14.1	**Objective**	**Disease/Predation/Competition**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MdR-CCCh-14.1.1	Recovery Action	Disease/Predation/Competition	Reduce the threat of invasive species to aquatic habitats										
MdR-CCCh-14.1.1.1	Action Step	Disease/Predation/Competition	Eradicate reed canary grass.	3	5	CDFW						TBD	Cost depends on the amount of reed grass that needs to be removed from the channel.
MdR-CCCh-16.1	**Objective**	**Fishing/Collecting**	**Address the overutilization for commercial, recreational, scientific or educational purposes**										
MdR-CCCh-16.1.1	Recovery Action	Fishing/Collecting	Prevent or minimize reduced density, abundance, and diversity based on based on the biological recovery criteria										
MdR-CCCh-16.1.1.1	Action Step	Fishing/Collecting	Re-evaluate fishery management plan.	3	2	CDFW, NMFS						0	Action is considered In-Kind
MdR-CCCh-16.1.1.2	Action Step	Fishing/Collecting	Limit fishing impacts to levels consistent with recovery.	3	25	CDFW, NMFS						0	Action is considered In-Kind
MdR-CCCh-18.1	**Objective**	**Livestock**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MdR-CCCh-18.1.1	Recovery Action	Livestock	Improve watershed conditions										
MdR-CCCh-18.1.1.1	Action Step	Livestock	Assess grazing impact on riparian condition, identifying opportunities for improvement.	3	2	CDFW	74.00					74	Cost based on riparian restoration model at a rate of $73,793/project.
MdR-CCCh-18.1.1.2	Action Step	Livestock	Develop grazing management plan to meet objective.	3	2	CDFW							Cost accounted for in previous action step
MdR-CCCh-18.1.1.3	Action Step	Livestock	Fence livestock out of riparian zones.	3	5	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MdR-CCCh-18.1.1.4	Action Step	Livestock	Plant vegetation to stabilize stream bank.	3	5	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MdR-CCCh-18.1.1.5	Action Step	Livestock	Relocate instream livestock watering sources.	3	2	Private						TBD	Cost based on number of in-stream watering sources to relocate. Cost estimated at $5,000/site.
MdR-CCCh-19.1	**Objective**	**Logging**	**Address the inadequacy of existing regulatory mechanisms**										
MdR-CCCh-19.1.1	Recovery Action	Logging	Prevent or minimize impairment to watershed processes										

Mad River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
MdR-CCCh-19.1.1.1	Action Step	Logging	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).	3	3	CalFire						0	Action is considered In-Kind
MdR-CCCh-19.1.1.2	Action Step	Logging	Apply BMPs for timber harvest.	3	20	CalFire						0	Action is considered In-Kind
MdR-CCCh-23.1	**Objective**	**Roads/Railroads**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MdR-CCCh-23.1.1	Recovery Action	Roads/Railroads	Prevent or minimize impairment to instream substrate/food productivity (gravel quality and quantity)										
MdR-CCCh-23.1.1.1	Action Step	Roads/Railroads	Assess and prioritize road-stream connection, and identify appropriate treatment to meet objective.	3	2	RWQCB	2,107					2,107	
MdR-CCCh-23.1.1.2	Action Step	Roads/Railroads	Decommission roads, guided by assessment.	3	10	Private						TBD	Cost based on amount of road network to decommission based on road inventory.
MdR-CCCh-23.1.1.3	Action Step	Roads/Railroads	Upgrade roads, guided by assessment.	3	10	Private						TBD	Cost based on amount of road network to upgrade. Cost to upgrade estimate at $21,000/mile.
MdR-CCCh-23.1.1.4	Action Step	Roads/Railroads	Maintain roads, guided by assessment.	3	2	Private						0	Action is considered In-Kind
MdR-CCCh-23.2	**Objective**	**Roads/Railroads**	**Address the inadequacy of existing regulatory mechanisms**										
MdR-CCCh-23.2.1	Recovery Action	Roads/Railroads	Prevent or minimize alterations to sediment transport (road condition/density, dams, etc.)										
MdR-CCCh-23.2.1.1	Action Step	Roads/Railroads	Develop grading ordinance for maintenance and building of private roads that minimizes the effects to Chinook.	3	3	CDFW						0	Action is considered In-Kind

Mattole River Population

CC Chinook Salmon Fall-Run

- Role within ESU: Functionally Independent Population
- Diversity Stratum: North Coastal
- Spawner Abundance Target: 4,000 adults
- Current Intrinsic Potential: 177.5 IP-km

For information regarding NC steelhead and SONCC coho salmon for this watershed, please see the NC steelhead volume of this recovery plan and the SONCC coho salmon recovery plan (http://www.westcoast.fisheries.noaa.gov/).

Chinook Salmon Abundance and Distribution

In the mid-to late 1950s and in 1960, the average run size adult Chinook salmon was estimated at 5,000 Chinook salmon (1965). The Mattole Restoration Council (1995) stated, "For Mattole Chinook salmon, the data suggest that the number of spawners dropped from about 3,000 in 1981-82 to around 100 in the 1990-91 season." Based on the number of live fish and redds seen on spawning grounds in recent survey years, the spawning population likely numbers in the hundreds. The number of redds per survey mile (escapement index) observed since the mid-1990s range from 0.13 redds/mile in 2011-12 to 1.68 redds/mile in 1996-97 (MSG 2015).

The age of Chinook salmon adults spawning in the Mattole River is uncertain. The reported age of returning Chinook salmon was primarily 3 to 4 years, with few 5 years old (Myers *et al.* 1998). Based on scale samples of adults captured at a weir in the lower Mattole River (Thompson 2006), the spawning run of Chinook salmon in 2005 was composed of a high proportion (44 percent) of age 2 fish likely reflecting a high percentage of jacks, with the remainder of the run consisting of age 3 (11 percent); age 4 (39 percent) and age 5 (2 percent) fish.

As summarized by Myers *et al.* (1998), an alternative reproductive strategy for Chinook salmon is for males to mature at an early age. Jack Chinook salmon males mature in their first or second ocean years, and offer a reduced risk of mortality, but younger (smaller) males may be at a competitive disadvantage in securing a mate. The incidence of jack males has underlying genetic determinants and appears to be, in part, a response to favorable growing conditions. Although overall the number of live fish observed was low in 2011-12, the relative number of Chinook salmon jacks observed in the Mattole River in the 2011-2012 spawning season was the highest since 1994 (Thompson 2012).

The majority of juvenile Chinook salmon migrate during the spring, and emigrate through the mouth of the Mattole River to the ocean. Prior to downstream migration, juvenile Chinook salmon have been observed rearing in the mainstem and larger tributaries (Baier 2011). During the summer when the river becomes disconnected, small numbers of juvenile Chinook salmon have been observed in large pool habitats in the upper mainstem river (Mattole River and Range Partnership 2009a). Outmigrant trapping data at river kilometer 6.28 in the lower mainstem Mattole River is generally conducted from April into July, with gear deployment and removal contingent on a river flow of 300 to 400 cfs, and closure of river mouth, respectively. Recent population estimates of juvenile Chinook salmon for 2009, 2010, and 2011, were 123,874, 170,823, and 461,832, respectively (Piscitelli 2012).

In 2001 through 2004, MSG rescued juvenile Chinook salmon from drying and disconnected upper reaches of the Mattole River and relocated downstream. MSG has also trapped Chinook salmon out-migrants just upstream of the estuary, and held them in rearing ponds at Mill Creek for fall release The relationship of these rearing and relocation programs to the number of returning adults was undetermined and these practices were discontinued in 2005. MSG maintains that the lack of tag recoveries indicates the programs were successful not only in not precluding a wild, self-sustaining run from surviving (as is sometimes feared when hatchery techniques are utilized), but also that the consistent recovery of tags in prior years indicates the programs were helping to preserve the existence of the Chinook salmon run during the period of very low escapement of the 1980s and 1990s (Thompson 2007).

History of Land Use

The watershed encompasses an area of approximately 194,560 acres (304 square miles) and supports a population of over 2,000 people. The main population centers are in Petrolia, Honeydew, and Whitethorn, although rural residences are scattered throughout the watershed. The majority (84 percent) of the land has a housing density of 1 housing unit or less per 160 ac (NMFS GIS). However, residences occupy approximately 16 percent of the land adjacent to the mainstem and tributaries of the Mattole River (NMFS GIS). Both historic and current land uses are agriculture and forestry.

High intensity timber management in the basin (wide-scale road building and tractor logging) occurred during the 1950s and 1960s. From 1947 to 1987 an estimated 82 percent of the timber was harvested. By 1988, over 90 percent of old-growth forests had been harvested; and by 1996, late seral habitats comprised less than 8 percent of the original forest cover. A large part of the remaining late seral stage acreage lies within the USBLM King Range National Conservation Area, and 12 percent of the Mattole River watershed lies within this management area. Failure of logging operations to re-establish Douglas-fir and other conifers 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. However, conifers will return over time.

Tractor and haul roads cut into 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 (Raphael 1974; Bodin *et al.* 1982). The 1955 and 1964 floods choked channels with sediment, filling deep pools (MRC 2005). 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, Humboldt Redwood Company (HRC), in the Mattole River watershed operates under a state and federal Habitat Conservation Plan (HCP) on 18,350 acres in the western and northern basin (PALCO 1999; HRC 2012).

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 instream diversions or shallow wells which may be affecting streamflows during summer low-flow periods. Much of the domestic demand occurs in the southern basin. Many areas in the Mattole watershed have experienced increasing levels of marijuana cultivation. Many of these operations require water sources during the late spring and early summer, which coincides with juvenile Chinook rearing. The energy of the water flowing into unscreened water diversions (pumps) may directly increase mortality of juvenile Chinook salmon, either through entrainment of individuals into the diversion pipe or impingement of individuals across the mouth the diversion pipe by the water flow.

Current Resources and Land Management

The estimated land use pattern in the Mattole River watershed (MRC 2005) is comprised of rural residential (32 percent), ranch (31 percent), industrial timberland (13 percent) and conservation (24 percent). Conservation lands include those managed by the U. S. Bureau of Land Management (USBLM), Sinkyone Wilderness State Park, Sanctuary Forest, and the North Coast Regional Land Trust. In addition to ownership and occupation of the land, human activities on the land directly and indirectly affect the quantity and quality of surface water because of the hydrologic connection of the land to the surface and ground water. The quality and quantity of aquatic habitat in the mainstem of the Mattole River, as well as its main tributaries (North Fork Mattole, Upper North Fork Mattole, Mill Creek, Squaw Creek, Bear

Creek, Thompson Creek, Honeydew Creek, and Bridge Creek) are affected by the varied land use activities.

The Mattole River Basin Assessment (Downie *et al*. 2003) divided the watershed into five sub-basin planning units (Estuary, Northern, Eastern, Southern, and Western) as an assessment scale upon which to conduct analyses of findings, form conclusions, and suggest improvement recommendations, and identified limiting factors for anadromous salmonids including, poor estuarine conditions, lack of habitat complexity, increased sediment levels, high water temperatures, and inadequate summer flows.

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 HRC HCP has a requirement to maintain a minimum of 10 percent late-seral stands on covered lands until 2049 (HRC 2012); 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. The HCP includes mitigation strategies related to timber management, forest road construction and maintenance, and rock quarrying. The HCP includes land in the Mattole River watershed. The goals of the HCP are to achieve and move towards properly functioning aquatic conditions for anadromous salmonids within the management area covered by the HCP. To ensure habitat goals are met, the HCP relies heavily on watershed analysis, monitoring, and adaptive management tools. The Mattole Watershed Analysis Cumulative Effects Public review draft was completed in 2011 (MRC 2011).

The conservation ethic and natural resource protection efforts of Mattole residents has been recognized and financially supported by state and federal resource agencies and grant programs for many decades. Since 1985, the various groups within the Mattole River basin collectively have received over $9 million from the California Department of Fish and Wildlife's (CDFW) Fisheries Restoration Grants Program, and NOAA's Pacific Coast Salmon Recovery Fund, NOAA Restoration Center, and other sources. In addition, the State Water Resources Control Board has contributed significant funding to address water quality problems (*i.e.*, sediment and temperature impairments) in the watershed. In total, more than $15 million has been spent on restoration efforts within the Mattole River basin. Projects include barrier removal, road upgrade and removal, fisheries science, water quality monitoring, and stream bank stabilization.

The Mattole River and Range Partnership (MRRP), formed in 2002, is an unincorporated association of five local nonprofit organizations including the Mattole Restoration Council

(MRC), the Mattole Salmon Group (MSG), the Middle Mattole Conservancy, the Mattole Fire Safe Council, and Sanctuary Forest, Inc., working together to develop an enhancement program for the watershed. The MRRP takes responsibility for different aspects of watershed management and recovery, working closely with county, state and Federal government partners.

The following plans and assessments have identified restoration opportunities and facilitated needed changes in land use practices to reduce impacts on aquatic habitat and yet maintain a working landscape:

- Mattole Estuary Restoration 5-Year Plan (USBLM 2012)
- Mattole Headwaters Streamflow Improvement Plan (Trout Unlimited *et al.* 2012);
- The Mattole Forest Futures Project (BBW Associates 2011);
- Mattole Coho Recovery Strategy (MRRP 2011)
- Mattole Integrated Coastal Watershed Management Plan (MRRP 2009b);
- The Mattole Watershed Plan (MRC 2005);
- King Range National Conservation Area Resource Management Plan (USBLM and EDAW 2004);
- Mattole River Watershed Assessment Report (Downie *et al.* 2003);
- Mattole River Total Maximum Daily Loads for Sediment and Temperature (USEPA 2003);
- Mill Creek Watershed Analysis (USBLM 2001);
- Honeydew Creek Watershed Analysis (USBLM 1996);
- Dynamics of recovery: a plan to enhance the Mattole estuary (MRC 1995);
- Bear Creek Watershed Analysis (USBLM 1995); and
- Elements of Recovery (MRC 1989).

Salmonid Viability and Watershed Conditions

Although viability attributes of density and spatial structure for Chinook salmon adults were rated Fair based on the recent spawner surveys, smolt outmigration was rated as Poor (MSG 2009; 2012). During years when the estuary closes early due to reduced river flow, survival of juvenile Chinook salmon can be low because of the reduced carrying capacity of the estuary in the summer (MSG 2012).

The following indicators were rated Poor through the CAP process for Chinook salmon adults: large wood frequency, percentage of staging pools, floodplain connectivity, and water quality (turbidity). For eggs; the spawning gravel quality indicator rated as Poor.

The following indicators were rated Poor through the CAP process for Chinook salmon pre-smolts: shelter rating, floodplain connectivity, water quality (turbidity), low flows and diversions, estuary condition, and water temperature.

The following indicators were rated Poor through the CAP process for smolts: shelter rating, water quality (turbidity and temperature), quality and extent of estuary, floodplain connectivity, gravel quality, and water flow.

Recovery strategies will typically focus on improving these habitat indicators, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions within the Mattole River watershed.

Current Conditions

The following discussion focuses on those conditions that rated Fair or Poor as a result of our CAP viability analysis. The Mattole River CAP Viability Table results are provided below. Recovery strategies will focus on improving these conditions.

Population and Habitat Conditions

Viability: Density, Abundance, and Spatial Structure

Relative to historic numbers and recovery targets, the numbers of spawning adults are low. The current spatial distribution of juvenile Chinook salmon is believed to be less than 50 percent of historic distribution. Expression of diverse life history outmigration and rearing strategies of juvenile Chinook salmon is limited by the quantity and quality of both freshwater and estuarine habitat.

Hydrology: Baseflow and Passage Flows

The Hydrology has a Poor rating for pre-smolts and smolts due to impaired water flow in the spring and summer in the Mattole River tributaries and mainstem. 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 and migration habitat availability. The effect of this stress on these lifestages is most acute when natural low flow conditions of little or no rainfall during summer and fall months are exacerbated by high rural and residential water use during the same period. Low flows can result in stranding of individuals in disconnected pools, where high water temperature and low dissolved oxygen may become lethal. Isolation of individuals in shallow pools may result in increased risk of exposure to terrestrial predators. Reaches in the southern basin are particularly prone to seasonal drying.

Sediment Transport: Road Density

Sediment transport is rated poor for watershed processes. High road densities within the Mattole River watershed are primarily associated with rural residences and timber harvest. The high density (2.26 miles/square mile) of roads within 100-meters of stream channels are of particular concern. Although significant efforts to decommission and upgrade roads have occurred on federal, county, and some private lands, road density on private lands remains high. 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 and channel braiding.

Habitat Complexity: Percent Primary Pools and Pool/Riffle/Flatwater Ratios and Habitat Complexity: Large Wood and Shelter

Habitat Complexity conditions have Poor ratings. Available data indicate that there are not enough adult holding pools in the population area. 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. Accelerated delivery of sediment to Mattole River channels from roads and historic timber harvest activities have resulted in aggraded channels and shallow pools. This lack of complex overwintering habitat throughout much of the system may be a major factor in the population decline of Chinook salmon.

Sediment: Gravel Quality and Distribution of Spawning Gravels

The Mattole River is listed as sediment-impaired under section 303(d) of the Clean Water Act (USEPA 2003). Excessive fine sediment can result in poor spawning habitat for adults, suffocate eggs, reduce velocity refugia for winter rearing juveniles, and reduce the productivity of food organisms for pre-smolts and smolts. Sediment condition has a rating of Fair.

Velocity Refuge: Floodplain Connectivity

The condition of Velocity Refuge has an overall rating of Fair for adults and pre-smolts. The primary indicator for this habitat attribute is availability and abundance of velocity refuge during periods of high flow. Velocity refugia are provided by physical features (*e.g.*, pools, large wood) discussed previously, as well as access to quality floodplain habitat.

Water Quality: Temperature

Water temperature has an overall rating of Fair for pre-smolts and smolts. The Mattole River is listed as temperature-impaired under section 303(d) of the Clean Water Act (USEPA 2003). Elevated stream temperatures in the summer and early fall are the result of multiple site-specific factors including reduction of riparian canopy and associated shade, low pool volumes due to excessive sedimentation, and low summer flows due to water diversions. The coolest water temperatures are found in the southern basin, near the community of Whitethorn, where headwater tributaries (Thompson, Mill, Bridge, and Buck creeks) consistently provide cold water discharge to the mainstem Mattole. In the lower seven miles of the Mattole River, three primary tributaries provide cold water inflow: Lower Mill Creek, which enters the Mattole at River Mile 2.8; Stansberry Creek at River Mile 1.3; and Lower Bear Creek at River Mile 1.0. 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. However, these tributaries may be sources of subsurface cold water to the mainstem providing some isolated pockets of cool water refugia.

Estuary: Quality and Extent

The pre-smolt and smolt lifestages are vulnerable to degraded estuarine habitat. Prior to major land disturbances which increased the volume of sediment delivered to the estuary, the Mattole River 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, stored sediment in the mainstem and slough channels of the lower river has reduced both volume and complexity of habitat in the Mattole River estuary, and riparian cover is lacking. Although formation of a sand bar across the mouth of the Mattole River is a natural phenomenon, the timing and duration of bar closure is also affected by legacy and current anthropogenic factors which influence the hydrology and streamflow into the estuary. The lack of access of the ocean can be a major stressor for outmigrating smolts, and lack of access to the river can be a stressor for spawning adults. High water temperatures in the estuary can occur during late summer. The lack of complex habitat for smolt rearing and holding, as well as poor water quality in the estuary, may make Chinook salmon smolts more susceptible to predation.

Water Quality: Increased Turbidity

The condition of Water Quality: Turbidity has an overall Fair ranking for adults, pre-smolts, and smolts. As described earlier, increased turbidity can result in behavioral responses to suspension of sediments that may limit distribution, growth, and survival. Chronic high concentration of fine sediment in the water column, as well as degree of embeddedness of the substrate, can limit availability of epibenthic grazer and predator taxa of benthic macroinvertebrates, an important food source for salmonids.

Riparian Species Composition and Structure

Degraded riparian forest conditions exist across the basin and were given a Fair rating for pre-smolts. 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. Widespread conversion of forests from conifer- to hardwood- dominant (*e.g.*, tanoak and madrone) has likely led to increased fire hazards throughout the basin as dense hardwoods are prone to high intensity and rapid burns. However, larger and more intense wildfires that remove the hardwoods may, over the long-term, may enhance development of conifer-dominated stands in riparian zones.

Very Good or Good Current Conditions

Passage/Migration: Physical Barriers

Passage/Migration: Physical Barriers have an overall rating of Very Good for adults, juveniles and smolts. Numerous culverts in the Mattole River watershed have been upgraded or replaced with bridges, and numerous projects are planned. Few man-made physical barriers (*e.g.*, culverts, dams) remain that restrict habitat; however, passage associated with water diversions remains a concern.

Landscape Patterns: Agriculture, Timber Harvest and Urbanization; Hydrology: Impervious Surfaces; Hydrology: Redd Scour

Percent of watershed utilized for Agriculture, Timber Harvest, and Urbanization conditions have an overall rating of Very Good, and Hydrology: Impervious Surfaces conditions has a rating of Very Good. For watershed processes, the ratings were a result of overall low density of residences, the percent of the watershed with impervious surfaces associated with urbanization, and relatively low percentage of the watershed harvested for timber in the past 10 years.

Gravel-scouring conditions rated as Fair for eggs, which is a function of watershed hydrology processes as described above.

Threats

The following discussion focuses on those threats that rate as High or Very High (see Mattole River CAP Results). Recovery strategies will likely focus on ameliorating High rating threats;

however, some strategies may address Medium and Low threats when the strategy is essential to recovery efforts. The figures and tables that display data used in this analysis are provided in Mattole River CAP Results.

Population and Habitat Threats

Severe Weather Patterns

This threat is rated High for eggs, pre-smolts, smolts, and adults. This threat rated as Medium for watershed processes. The likely increased frequency of severe weather patterns relative to the past patterns (more frequent storms and increased rainfall in the winter, longer dry periods without rain in the spring, summer, and fall) pose a High threat to the Mattole River Chinook. Meteorological drought happens when dry weather patterns dominate an area. Hydrological drought occurs when low water supply becomes evident, especially in streams, reservoirs, and groundwater levels, usually after many months of meteorological drought[12]. Altered freshwater systems, due to increased air temperatures and changes in the timing, amount and type (*i.e.*, rain vs. snow) of precipitation, are a major climate induced ecosystem concern (Osgood 2008). The primary concerns center on altered streamflows and warmer temperatures affecting survival and passage through tributaries by reducing the available habitat, life history diversity and freshwater survival rates for juvenile salmonids.

Increased frequency and magnitude of flows from storms and flooding in the winter are likely to increase red scour and may affect the quantity and quality of spawning gravels, and the amount and quality of pool habitat in many watersheds. Growth and survival of winter rearing juveniles without access to both instream and off-channel velocity refugia are likely decreased due to potential flushing from the system during flood flows. In addition, lack of access to the floodplain during high flows limits the opportunity for feeding on riparian invertebrates.

In the summer, stream reaches currently experiencing temperatures near the thermal maxima for juvenile salmonids may become uninhabitable, and currently habitable reaches may become thermally marginal. Rainfall patterns may or may not exacerbate water temperature problems. Areas subject to low summer flows may experience further summer flow decreases. Water withdrawals that are currently of limited impact on salmonids may increase in impact as streamflows diminish.

[1] http://www.ncdc.noaa.gov/climate-monitoring/dyk/drought-definition

Water Diversions and Impoundments

This threat is rated Very High for pre-smolts, and High for smolts. Currently, there are no large long standing dams within the Mattole River watershed. However, concerns regarding irrigated agriculture and subdevelopment of parcels could increase water demand and further reduce spring and summer streamflows. Additionally, future streamflow alterations could alter the hydrodynamics of the estuary during the summer months. Existing and future residential and agricultural development should be prevented from reducing summer and spring baseflows or groundwater recharge to the extent that rearing habitat functions are impaired. 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 (Sanctuary Forest Inc. 2014). An ongoing Sanctuary Forest forbearance program, where water is stored in tanks during the winter for spring and summer use, will continue to reduce the number of summer and spring water diversions. However, this program alone is likely not sufficient to eliminate this threat.

Roads and Railroads

Roads and railroads are rated as a High threat for Chinook salmon eggs. Unpaved roads, unlike paved surfaces, serve as both conduits for water and sources of sediment. Because roads are a component of the human transportation system, standards for road construction and maintenance are under various jurisdictions depending on ownership and level of service. A 1993 inventory estimated 3,350 miles of active and abandoned roads in the Mattole basin, with 115 miles maintained by the county, 25 miles maintained by BLM, leaving 425 miles of active and 2,800 miles of abandoned roads that are not managed or maintained (NCRWQCB 2005). In addition to roads that account for approximately 76 percent of human-induced erosion, logging, conversion of forestland to pasture, and over grazing contribute to erosion and sedimentation of the streams in the watershed (NCRWQCB 2005). Fine sediment inputs from poorly built, improperly maintained, and abandoned roads will continue. Even with current logging road improvements and standards (rolling dips, rock surfaces, and road widths), legacy logging roads remain a threat to salmonid habitat quantity and quality throughout the Mattole River watershed. More efficient private and public road networks, and decommissioning efforts on problem roads where feasible can prevent further Chinook salmon habitat degradation within the watershed.

Low or Medium Rated Threats

Logging and Wood Harvesting

Logging and wood harvesting are rated as Medium threat to Chinook salmon adults, eggs, pre-smolts, smolts, and watershed processes. Future management and recovery actions need to protect all salmoind habitat from degraded water quality conditions (turbidity and increased temperature) associated with timber harvest, and ensure the continuation of watershed rehabilitation efforts.

Roads and Railroads

This threat is rated as Medium for Chinook salmon adults, pre-smolts, smolts, and watershed processes. Because of the previously discussed relationship among road networks, accelerated transport of sediment and water to stream networks and subsequent habitat degradation, decommissioning efforts on problem roads where feasible, as well creation of more efficient transportation networks, will prevent further salmonid habitat degradation within the watershed.

Residential and Commercial Development

Residential and commercial development is rated as a Medium threat for adults, pre-smolts, smolts, and watershed processes, and Low for eggs. Because residences and businesses are connected by roads and will require water, planning and permitting of future development should insure that streamflows are not reduced and sediment delivery to streams is not accelerated.

Agriculture; Livestock Farming and Ranching: Fire, Fuel Management and Fire Suppression: Recreational Areas and Activities

For Chinook salmon, these threats are rated as Medium for adults, pre-smolts, and smolts. Regulation of land use activities under the Humboldt County General Plan, implementation of USDA Natural Resource Conservation Service best management practices, and preparation of updated fire plans, need to continue and include provisions to prevent erosion and maintain water quality.

Limiting Stresses, Lifestages, and Habitats

Limiting factors for Chinook salmon include excessive water extraction during late spring and summer low flows; low stream shade and low large woody debris recruitment to streams; high sediment production levels, high summer water temperatures, shallow channels and simplified habitat (Downie *et al*. 2003). Juvenile Chinook salmon are limited by poor habitat conditions in the estuary during dry years when water flow in the Mattole River is reduced and the period of mouth closure is extended. Lack of channel complexity results in lack of pools and riffles, reduced cover, and reduce velocity refuge for salmonids. In addition, the egg lifestage is likely limited by elevated fine sediment that reduces survival to emergence in many spawning areas of the Mattole River.

General Recovery Strategy

Recovery strategies generally focus on improving instream habitat conditions and ameliorating stresses and threats, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions. The general recovery strategy for the Mattole River Chinook salmon population is discussed below with more detailed and site-specific recovery actions which provides the Implementation Schedule for this population. Implementation of recovery actions may integrate the outcome of past planning efforts (Downie *et al*. 2003; MRC 2005; MRRP 2009), *e.g.*, sub-basin delineation, action prioritization, social capital of existing private/public partnerships, completed and ongoing habitat restoration and streamflow improvement projects. To insure that the recovery actions have the desired outcome of a self-sustaining population of Chinook salmon in the Mattole River, monitoring of the habitat indicators, as well as the fish populations, may be necessary. Creative partnerships will be the key to leveraging funding and habitat benefits.

Improve Estuary Habitat

Restore the physical and biological attributes of the estuary, including the north and south bank slough channels. Improve juvenile Chinook salmon rearing habitat for by increasing in-water structure and overwater cover. During dry years when estuarine lagoon is formed early and high water temperatures and increased predation are likely, consider feasibility of captive rearing of Chinook salmon pre-smolts.

Improve Late Spring and Summer Baseflow

Conduct outreach with landowners and residents to decrease diversion of ground and surface water during the late spring and summer months. Support research (*e.g.*, Mattole River Headwaters SIP) that focuses on improving groundwater recharge in tributary streams. Increase streamflow in the headwater regions using regulatory mechanisms, developing a water budget, encouraging water conservation, and increasing the participation in the forbearance program. Promote water conservation during low-flow periods. Consider feasibility of fish rescue and relocation or rearing. Use the streamflow improvement plans and streamflow thresholds for juvenile salmonid rearing habitat, currently underway in the Mattole Headwaters Southern sub-basin (McBain and Trush 2012; Trout Unlimited *et al.* 2012), as a model for other sub-basins.

Improve Floodplain Connectivity and Stream Temperatures

The approach to improving riparian conditions in the basin should focus on preventing further loss of riparian vegetation and on rehabilitating riparian areas that are currently in poor condition which primarily occur in the inland subbasins of this watershed. As discussed below, the recovery of riparian function will improve LWD recruitment, but also is expected to improve water quality with respect to stream temperatures for salmonid rearing.

Improve Instream Habitat Complexity

Improve large woody frequency across the Mattole River watershed. Riparian areas are in the process of recovery with stands of smaller diameter conifers that currently buffer stream areas. Addition of wood will provide much-needed complexity to stream channel until riparian areas reach maturity and begin to recruit naturally to channels. Large wood will improve instream habitat attributes, *e.g.*, pool and riffle frequency and habitat complexity; provide important refuge from high flow events; and increase growth and survival of juveniles during winter and summer. Information from existing plans and from groups such as the Mattole Salmon Group should be utilized in determining high priority streams for large wood restoration projects.

Improve Substrate Quality

Continue efforts to reduce sediment delivery from past management caused sources of roads, timber harvest, grazing, and agriculture. Over the past few decades the Mattole Restoration Council's Good Roads Clear Creeks Program has been working systematically through the watershed to upgrade and reduce sediment sources (MRC 2012). Implement remaining road and other sediment reduction projects. Continue efforts to improve water quality by reducing erosion of streambanks from livestock grazing, and off-road vehicle recreational activities.

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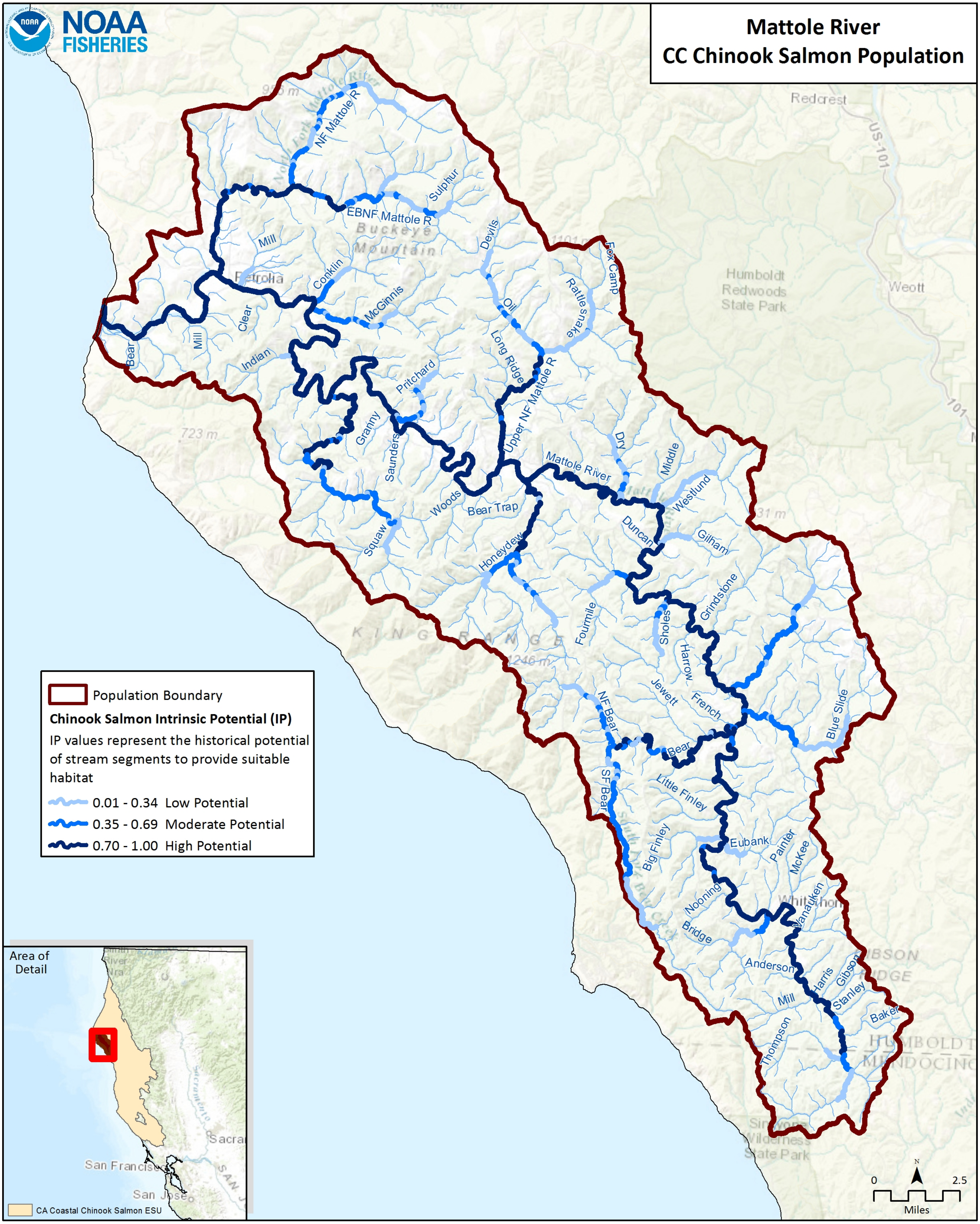

NOAA FISHERIES
Mattole River
CC Chinook Salmon Population
Population Boundary
Chinook Salmon Intrinsic Potential (IP)
IP values represent the historical potential of stream segments to provide suitable habitat
0.01 - 0.34 Low Potential
0.35 - 0.69 Moderate Potential
0.70 - 1.00 High Potential
Area of Detail
CA Coastal Chinook Salmon ESU
Miles
0
2.5
NF Mattole R
EBNF Mattole R
Sulphur
Mill
Petrolia
Conklin
McGinnis
Devils
Oil
Rattlesnake
Fox Camp
Clear
Bear
Indian
Pritchard
Long Ridge
Upper NF Mattole R
Granny
Saunders
Woods
Bear Trap
Squaw
Mattole River
Dry
Middle
Westlund
Duncan
Gilham
Honeydew
Grindstone
Fourmile
Sholes
Harrow
Jewett
French
NF Bear
Blue Slide
SF Bear
Little Finley
Big Finley
Eubank
Painter
McKee
Nooning
Bridge
Vanauken
Anderson
Harris
Gibson
Mill
Stanley
Baker
Thompson
Redcrest
Humboldt Redwoods State Park
Weott
King Range

#	Conservation Target	Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Measurement	Current Rating
1	Adults	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired but functioning	Fair
			Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	<50% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>6 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>6 Key Pieces/100 meters)	>90% of streams/ IP-Km (>6 Key Pieces/100 meters)	<50% of streams/ IP-Km (>6 Key Pieces/100 meters)	Poor
			Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	<50% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	>90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	<50% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	Poor
			Habitat Complexity	Percent Staging Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	0% of streams/ IP-Km (>49% average primary pool frequency)	Poor
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% of streams/ IP-Km (>30% Pools; >20% Riffles)	Fair
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.17	Good
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 51-75	Fair
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	50% of IP-Km to 74% of IP-km	Fair
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	100% of IP-km	Very Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	42.25% Class 5 & 6 across IP-km	Fair

			Sediment	Quantity & Distribution of Spawning Gravels	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	50% of IP-Km to 74% of IP-km	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	45.4	Fair
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	<50% Response Reach Connectivity	Poor
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-Km maintains severity score of 3 or lower	Poor
		Size	Viability	Density	<1 spawners per IP-Km	1-20 Spawners per IP-Km	20-40 Spawners per IP-Km (e.g., Low Risk Extinction Criteria)		1-20 Spawners per IP-Km	Fair
			Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	50-74% of Historical Range	Fair
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	68.12	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	14.71	Fair
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	29.15	Fair
2	Eggs	Condition	Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 35-50	Good
			Hydrology	Redd Scour	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 51-75	Fair

			Sediment	Gravel Quality (Bulk)	>17% (0.85mm) and >30% (6.4mm)	15-17% (0.85mm) and <30% (6.4mm)	12-14% (0.85mm) and <30% (6.4mm)	<12% (0.85mm) and <30% (6.4mm)	19.57% (0.85mm) and >30% (6.4mm)	Poor
			Sediment	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	35% of streams/ IP-Km (>50% stream average scores of 1 & 2)	Poor
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	45.4	Fair
3	Pre Smolt	Landscape Context	Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition		
		Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Poor
			Habitat Complexity	Percent Primary Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	74% of streams/ IP-Km (>49% average primary pool frequency)	Fair
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% of streams/ IP-Km (>30% Pools; >20% Riffles)	Fair
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	25% of streams/ IP-Km (>80 stream average)	Poor
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.17	Good
			Hydrology	Flow Conditions (Baseflow)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score >75	Poor
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score >75	Poor

			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	>5 Diversions/10 IP km	Poor
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score >75	Poor
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	<50% of IP-Km or <16 IP-Km accessible*	Poor
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	45.4	Fair
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	35% of streams/ IP-Km (>50% stream average scores of 1 & 2)	Poor
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined		
			Water Quality	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	<50% IP-Km (>6 and <14 C)	Poor
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-Km maintains severity score of 3 or lower	Poor
		Size	Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	<50% of Historical Range	Poor
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	68.12	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	14.71	Fair

			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	29.15	Fair
5	Smolts	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Poor
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	25% of streams/ IP-Km (>80 stream average)	Poor
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35		
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	>5 Diversions/10 IP km	Poor
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score >75	Poor
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	<50% of IP-Km or <16 IP-Km accessible*	Poor
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	100% of IP-km	Very Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	45.4	Fair
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	35% of streams/ IP-Km (>50% stream average scores of 1 & 2)	Poor
			Smoltification	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	<50% IP-Km (>6 and <14 C)	Poor
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	<50% Response Reach Connectivity	Poor

			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	No Acute or Chronic	Good
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-Km maintains severity score of 3 or lower	Poor
		Size	Viability	Abundance	Smolt abundance which produces high risk spawner density per Spence (2008)	Smolt abundance which produces moderate risk spawner density per Spence (2008)	Smolt abundance to produce low risk spawner density per Spence (2008)			
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	68.12	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	14.71	Fair
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	29.15	Fair
6	Watershed Processes	Landscape Context	Hydrology	Impervious Surfaces	>10% of Watershed in Impervious Surfaces	7-10% of Watershed in Impervious Surfaces	3-6% of Watershed in Impervious Surfaces	<3% of Watershed in Impervious Surfaces	0.07% of Watershed in Impervious Surfaces	Very Good
			Landscape Patterns	Agriculture	>30% of Watershed in Agriculture	20-30% of Watershed in Agriculture	10-19% of Watershed in Agriculture	<10% of Watershed in Agriculture	0% of Watershed in Agriculture	Very Good
			Landscape Patterns	Timber Harvest	>35% of Watershed in Timber Harvest	26-35% of Watershed in Timber Harvest	25-15% of Watershed in Timber Harvest	<15% of Watershed in Timber Harvest	7.35% of Watershed in Timber Harvest	Very Good
			Landscape Patterns	Urbanization	>20% of watershed >1 unit/20 acres	12-20% of watershed >1 unit/20 acres	8-11% of watershed >1 unit/20 acres	<8% of watershed >1 unit/20 acres	1% of watershed >1 unit/20 acres	Very Good
			Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition	25-50% Intact Historical Species Composition	Fair

			Sediment Transport	Road Density	>3 Miles/Square Mile	2.5 to 3 Miles/Square Mile	1.6 to 2.4 Miles/Square Mile	<1.6 Miles/Square Mile	2.96 Miles/Square Mile	Fair
			Sediment Transport	Streamside Road Density (100 m)	>1 Miles/Square Mile	0.5 to 1 Miles/Square Mile	0.1 to 0.4 Miles/Square Mile	<0.1 Miles/Square Mile	2.39 Miles/Square Mile	Poor

Mattole River CAP Threat Results

	Threats Across Targets	Adults	Eggs	Pre Smolt	Smolts	Watershed Processes	Overall Threat Rank
	Project-specific-threats	1	2	3	5	6	
1	Agriculture	Medium	Low	Medium	Medium	Medium	Medium
2	Channel Modification	Medium	Low	Medium	Medium	Low	Medium
3	Disease, Predation and Competition	Medium		Medium	Medium	Medium	Medium
4	Hatcheries and Aquaculture	Low		Low	Low		Low
5	Fire, Fuel Management and Fire Suppression	Medium	Medium	Medium	Medium	Low	Medium
6	Fishing and Collecting	Low		Low	Low		Low
7	Livestock Farming and Ranching	Medium	Low	Medium	Medium	Low	Medium
8	Logging and Wood Harvesting	Medium	Medium	Medium	Medium	Medium	Medium
9	Mining	Medium	Low	Medium	Medium	Low	Medium
10	Recreational Areas and Activities	Medium	Low	Medium	Medium	Low	Medium
11	Residential and Commercial Development	Medium	Low	Medium	Medium	Medium	Medium
12	Roads and Railroads	Medium	High	Medium	Medium	Medium	Medium
13	Severe Weather Patterns	High	High	High	High	Medium	High
14	Water Diversion and Impoundments	Medium	Low	Very High	High	Medium	High
	Threat Status for Targets and Project	High	High	Very High	High	Medium	Very High

Mattole River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
MtR-CCCh-1.1	**Objective**	**Estuary**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-1.1.1	Recovery Action	Estuary	Increase extent of estuarine habitat										
MtR-CCCh-1.1.1.1	Action Step	Estuary	Develop a plan to restore freshwater wetlands to brackish wetlands.	3	2	BLM	214					214	Cost based wetland restoration at a rate of $213,307/project.
MtR-CCCh-1.1.1.2	Action Step	Estuary	Convert areas identified in plan to functioning tidal habitat.	3	5	BLM						TBD	Cost based on amount of habitat to be restored. Cost estimated at $37,200/acre.
MtR-CCCh-2.1	**Objective**	**Floodplain Connectivity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-2.1.1	Recovery Action	Floodplain Connectivity	Rehabilitate and enhance floodplain connectivity										
MtR-CCCh-2.1.1.1	Action Step	Floodplain Connectivity	Develop plan to recreate off-channel ponds, alcoves, and backwater habitat.	3	5	BLM	115.00					115	Cost based on fish/habitat restoration at a rate of $114,861/project.
MtR-CCCh-2.1.1.2	Action Step	Floodplain Connectivity	Recreate habitat guided by plan.	2	5	Private						TBD	Cost based on amount of habitat. Cost estimated at $41,000/acre.
MtR-CCCh-2.1.1.5	Action Step	Floodplain Connectivity	Assess watershed for areas to reconnect the floodplain.	3	5	NGO						TBD	Cost accounted for in above action step.
MtR-CCCh-2.1.1.6	Action Step	Floodplain Connectivity	Re-connect the floodplain, guided by assessment.	3	20	BLM						TBD	Cost accounted for in above action step.
MtR-CCCh-3.1	**Objective**	**Hydrology**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-3.1.1	Recovery Action	Hydrology	Improve flow conditions (baseflow conditions)										
MtR-CCCh-3.1.1.1	Action Step	Hydrology	Ensure sub-division of existing parcels does not result in increased water demand during low-flow season.	2	10	Counties						0	Action is considered In-Kind
MtR-CCCh-5.1	**Objective**	**Passage**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-5.1.1	Recovery Action	Passage	Modify or remove physical passage barriers										
MtR-CCCh-5.1.1.1	Action Step	Passage	Investigate alternatives and provide fish passage at the Bear Creek/Lighthouse Road crossing.	2	5	County						TBD	
MtR-CCCh-6.1	**Objective**	**Habitat Complexity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-6.1.1	Recovery Action	Habitat Complexity	Increase large wood frequency										
MtR-CCCh-6.1.1.1	Action Step	Habitat Complexity	Assess habitat to determine location and amount of instream structure needed.	3	5	NGO	115.00					115	Cost based on fish/habitat restoration. Cost estimated at $114,861/project..
MtR-CCCh-6.1.1.3	Action Step	Habitat Complexity	Add structure, guided by plan.	2	10	NGO						TBD	Cost determined by amount of habitat. Cost estimated at a rate of $26,000/mile.
MtR-CCCh-6.1.2	Recovery Action	Habitat Complexity	Improve pool/riffle/flatwater ratios (hydraulic diversity)										
MtR-CCCh-6.1.2.1	Action Step	Habitat Complexity	Implement actions to increase the frequency of pool habitats.	2	10	NGO						TBD	Cost accounted for in above action step.
MtR-CCCh-12.1	**Objective**	**Agriculture**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-12.1.1	Recovery Action	Agriculture	Prevent or minimize reduced density, abundance, and diversity based on based on the biological recovery criteria										
MtR-CCCh-12.1.1.1	Action Step	Agriculture	Determine effects of marijuana cultivation.	2	20	NMFS						TBD	
MtR-CCCh-12.1.1.2	Action Step	Agriculture	Assess cumulative effects (e.g., flow, water quality) of marijuana cultivation.	2	20	NMFS						TBD	

Mattole River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K)						Comment
							FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	
MtR-CCCh-12.1.1.3	Action Step	Agriculture	If needed, develop plan to reduce effects of marijuana cultivation.	2	20	NMFS						TBD	
MtR-CCCh-12.1.1.4	Action Step	Agriculture	Implement plan.	2	20	NMFS						TBD	
MtR-CCCh-14.1	**Objective**	**Disease/Predation/Competition**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-14.1.1	Recovery Action	Disease/Predation/Competition	Prevent or minimize reduced density, abundance, and diversity based on based on the biological recovery criteria										
MtR-CCCh-14.1.1.1	Action Step	Disease/Predation/Competition	Remove invasive species that inhibit establishment of native riparian vegetation.	3	20	NGO						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MtR-CCCh-14.1.1.2	Action Step	Disease/Predation/Competition	Plant native riparian species in open areas.	3	25	NGO						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MtR-CCCh-18.1	**Objective**	**Livestock**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-18.1.1	Recovery Action	Livestock	Prevent or minimize impairment to water quality (instream water temperature)										
MtR-CCCh-18.1.1.1	Action Step	Livestock	Identify areas where livestock have access to riparian vegetation, develop plan to fence livestock from areas.	3	10	NRCS, RCD	60.00	60.00				120	Cost based erosion assessment of 5% of total acres at a rate of $12.62/acre.
MtR-CCCh-18.1.1.2	Action Step	Livestock	Install fence, guided by plan.	3	5	Private						TBD	Cost based on amount of area to be fenced identified from assessment. Cost estimated at $3.63/ft.
MtR-CCCh-19.1	**Objective**	**Logging**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-19.1.1	Recovery Action	Logging	Prevent or minimize impairment to habitat complexity										
MtR-CCCh-19.1.1.1	Action Step	Logging	Determine appropriate silvicultural prescription to increase DBH of conifers.	3	50	NGO						0	Action is considered In-Kind
MtR-CCCh-19.1.1.2	Action Step	Logging	Plant conifers as guided by prescription.	2	20	NGO						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MtR-CCCh-19.1.1.3	Action Step	Logging	Thin, or release conifers guided by prescription.	3	10	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MtR-CCCh-19.1.2	Recovery Action	Logging	Prevent or minimize impairment to water quality (instream water temperature)										
MtR-CCCh-19.1.2.1	Action Step	Logging	Develop plan that identifies areas in need of more shade that currently support Chinook salmon and describes timber management methods that will increase shade over time.	2	5	CDFW						0	Action is considered In-Kind
MtR-CCCh-19.1.2.2	Action Step	Logging	Manage forests in identified areas to increase shade, guided by plan.	2	50	Private						0	Action is considered In-Kind
MtR-CCCh-23.1	**Objective**	**Roads/Railroads**	**Address the present or threatened destruction, modification, or curtailment of habitat or range**										
MtR-CCCh-23.1.1	Recovery Action	Roads/Railroads	Prevent or minimize alterations to sediment transport (road condition/density, dams, etc.)										
MtR-CCCh-23.1.1.1	Action Step	Roads/Railroads	Identify and prioritize existing roads that are no longer necessary for silvicultural operations.	3	10	NGO	364.76	364.76				730	
MtR-CCCh-23.1.1.2	Action Step	Roads/Railroads	Assess streamside roads and prioritize sites for relocation.	2	10	NGO							Cost accounted for in above action step.
MtR-CCCh-23.1.1.3	Action Step	Roads/Railroads	Maintain roads, guided by assessment.	3	25	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MtR-CCCh-23.1.1.4	Action Step	Roads/Railroads	Upgrade roads, guided by assessment.	3	5	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
MtR-CCCh-23.1.1.5	Action Step	Roads/Railroads	Develop plan to decommission roads.	3	10	NGO							Cost accounted for in above action step.
MtR-CCCh-23.1.1.6	Action Step	Roads/Railroads	Decommission roads throughout watershed.	3	5	Private						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.

Mattole River Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
MtR-CCCh-23.1.1.7	Action Step	Roads/Railroads	Relocate roads away from unstable land features.	3	20	Private							Cost accounted for in above action step.
MtR-CCCh-23.2	**Objective**	**Roads/Railroads**	**Address the inadequacy of existing regulatory mechanisms**										
MtR-CCCh-23.2.1	Recovery Action	Roads/Railroads	Prevent or minimize alterations to sediment transport (road condition/density, dams, etc.)										
MtR-CCCh-23.2.1.1	Action Step	Roads/Railroads	Develop grading ordinance for maintenance and building of private roads that minimizes the effects to Chinook.	3	25	County						0	Action is considered In-Kind
MtR-CCCh-25.1	**Objective**	**Water Diversion/Impoundment**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
MtR-CCCh-25.1.1	Recovery Action	Water Diversion/Impoundment	Prevent or minimize impairment to stream hydrology (stream flow)										
MtR-CCCh-25.1.1.1	Action Step	Water Diversion/Impoundment	Provide incentives to reduce diversions during the summer.	3	25	State						TBD	Cost based on amount of incentives to provide to reduce diversions. Currently, incentive programs exist and should be explored and expanded.
MtR-CCCh-25.1.1.2	Action Step	Water Diversion/Impoundment	Review authorized diversions for opportunities to increase instream flow during summer low flow period.	3	50	State						0	Action is considered In-Kind
MtR-CCCh-25.1.1.3	Action Step	Water Diversion/Impoundment	Identify unauthorized diversions.	3	20	State						0	Action is considered In-Kind
MtR-CCCh-25.1.1.4	Action Step	Water Diversion/Impoundment	Create water budgets to avoid over-allocating water diversions.	3	20	State						0	Action is considered In-Kind
MtR-CCCh-25.1.1.5	Action Step	Water Diversion/Impoundment	Implement forbearance program.	3	20	State						TBD	Cost based will based of forbearance program at a rate $7,716/landowner/year.
MtR-CCCh-25.2	**Objective**	**Water Diversion/Impoundment**	**Address the inadequacy of existing regulatory mechanisms**										
MtR-CCCh-25.2.1	Recovery Action	Water Diversion/Impoundment	Prevent or minimize impairment to stream hydrology (stream flow)										
MtR-CCCh-25.2.1.1	Action Step	Water Diversion/Impoundment	Establish a forbearance program, using water storage tanks to decrease diversion during periods of low flow.	3	20	State						TBD	Cost accounted in above action.
MtR-CCCh-25.2.1.2	Action Step	Water Diversion/Impoundment	Monitor forbearance compliance and flow.	3	20	State	3					3	Cost based on a minimum of 3 gauges at a rate of $1,000/gauge. Cost does not account for data management or maintenance.

Redwood Creek Population

CC Chinook Salmon Fall-Run

- Role within ESU: Functionally Independent Population
- Diversity Stratum: North Coastal
- Spawner Abundance Target: 3,400 adults
- Current Intrinsic Potential: 116.1 IP-km

For information regarding NC steelhead and SONCC coho salmon for this watershed, please see the NC steelhead volume of this recovery plan and the SONCC coho salmon recovery plan (http://www.westcoast.fisheries.noaa.gov/).

Chinook Salmon Abundance and Distribution

Various monitoring programs are used to estimate Chinook salmon abundance and distribution within the Redwood Creek watershed. Since 2000, CDFW has operated a juvenile out-migrant trap in the middle portion of mainstem Redwood Creek at river mile 34 (known as the upper trap), and since 2004 CDFW has also operated a juvenile outmigrant trap in the lower portion of mainstem Redwood Creek at river mile 4 (known as the lower trap). A juvenile outmigrant trap has also been in operation since 2011 in Prairie Creek, near its confluence with mainstem Redwood Creek, previously (years 1998 to 2001) the trap was located near the middle of Prairie Creek. Seining also occurs in the estuary from June to October each year to estimate population abundance. Spawner surveys have been conducted in Prairie Creek since 1999, and in the entire basin since 2009. A Dual frequency Identification SON (DIDSON) unit has also been in mainstem Redwood Creek from 2009 to the present to help determine adult abundance.

Monitoring results vary annually and by program. Ricker (2011a, 2011b) conducted spawning surveys and carcass counts in the Redwood Creek basin in 2009-2010 (November to March) and 2010-2011 (November to April). In the 2009-2010 field season they observed no live Chinook salmon (but 35 unidentified live fish), 23 Chinook salmon carcasses, and 158 identified or predicted Chinook salmon redds. In the 2010-2011 field season they observed 234 live Chinook salmon spawners, 36 Chinook salmon carcasses, and 334 identified or predicted Chinook salmon redds (Ricker 2011b; Ricker 2011a). Multiplying each redd by the common conversion factor of 2.5 adults would give a population estimate of 395 to 835 adults, respectively. However, since Chinook salmon are mainstem spawners, water may be too turbid to survey accurately, redds can be covered with sediments in between redd surveys, and redd counts can underestimate the total population of Chinook salmon adults. In addition, the Chinook salmon redd surveys were conducted under the GRTS coho salmon frame, and did not cover all spawning areas used by Chinook salmon.

DIDSON has been used since 2009 to the present 2014-2015 season to estimate escapement of adult salmonids entering Redwood Creek to spawn (Metheny 2012). Although numerous issues still need to be addressed with using DIDSON to estimate escapement, including differentiating between migrating adults of different species with overlapping run timing, Metheny (2012) estimated that in the 2009 to 2010 season between 2,318 and 2,444 adult Chinook salmon entered Redwood Creek (includes Prairie Creek) to spawn, considerably higher than estimates of the adult population derived from redd counts. During the 2013 to 2014 fall and winter season, Sparkman (M. Sparkman, pers. comm. 2015) estimated that 3,487 adult Chinook salmon entered lower Redwood Creek to spawn in the basin.

Population abundance estimates for age 0+ Chinook salmon in lower Redwood Creek vary by year, from a high in 2013 of 566,859 to a low of 85,149 in 2006 (percentage of smolts ranged from 66 to 100 percent). The average abundance of 0+ Chinook salmon in lower Redwood Creek from 2004 to 2014 is 232,866. Abundance at all outmigrant traps in the basin peaked in 2013, with an estimated population abundance of 663,373 total 0+ Chinook salmon, of which an estimated 497,698 were smolts. The abundance of 1+ Chinook salmon in year 2012 equaled 64 individuals, and indicated for the fourth consecutive year that yearling Chinook salmon are relatively rare in Redwood Creek (Sparkman 2013). Average abundance for 1+ Chinook salmon over years 2009 – 2012 equaled 103 individuals (Sparkman 2013). Based on outmigrant monitoring in lower Redwood Creek, the mean population estimate for 0+ Chinook salmon from 2005 to 2012 was 145,772, and most of these age 0+ juveniles were smolts (81 percent).

Sparkman has also trapped outmigrants at the mouth of Prairie Creek from 2011 to 2014, with population estimates for 0+ Chinook salmon from Prairie Creek ranging from 15,148 in 2011 to 96,817 in 2013 (Sparkman pers. comm. 2015). The trap on lower Redwood Creek is located at approximately river mile 4, upstream of the confluence with Prairie Creek, which is located at approximately river mile 3, therefore, we combine information from both traps to derive a smolt estimate for Chinook salmon for the entire population. Combining the recent smolt estimates for lower Redwood and Prairie creeks, we estimate that the total smolt population in 2011 was 133, 901; in 2012 was 210,483; in 2013 was 497,698; and in 2014 was 146,539 (Sparkman pers. comm. 2015). Using a common but approximate estimate of ocean survival of 1 percent, would give an adult population estimate ranging from 1,335 adult Chinook salmon to 4976 adults, which is greater than the estimate based on redd counts, and closer to the recent DIDSON derived estimates of adult abundance (i.e., between 2,218 to 3,487 adult Chinook salmon).

Estimates of the historical abundance of Redwood Creek Chinook salmon range from 5,000 (CDFG 1965 cited in Good *et al.* 2005) to 1,000 adults (Wahle and Pearson 1987). These are estimates based on professional opinion and evaluation of habitat conditions, not on rigorous field sampling (Good *et al.* 2005), but are presented here for comparison with more recent abundance estimates.

Chinook salmon are distributed throughout the Redwood Creek basin and occupy most of their historic habitat throughout the basin. Chinook salmon spawn in upper, middle, and lower Redwood Creek mainstem, Redwood Creek tributaries, and Prairie Creek and its tributaries, primarily between November and February (Ricker 2011a, 2011b).

History of Land Use

The Redwood Creek basin reflects a long legacy of watershed disturbance, primarily through intensive timber harvest and associated road building, the construction of flood control levees and through conversion of wetlands and bottom lands to agricultural production. Timber harvest cleared the majority of floodplain and valley bottom areas within the basin by the latter half of the nineteenth century. Commercial timber harvest within the greater watershed started in the 1930s. Several upper slopes and ridge tops were logged by 1936, and by 1948 approximately 6 percent of the watershed had been harvested (Best 1995). From 1949 to 1954, approximately 27 percent of the original forested land and 22 percent of the watershed was harvested with the majority of harvest occurring in the upper and middle watershed. From 1955 to 1962, approximately 15 percent of the watershed was logged with a larger portion from within the lower watershed. The 1966 aerial photos showed that approximately 55 percent of the original coniferous forests were logged from 45 percent of the drainage (Best 1995). Unfortunately, the majority of the 1963 to 1966 harvest within the upper watershed occurred within the Redwood Creek inner gorge and its steeper tributaries. This required the construction of numerous roads and tractor yarding trails that significantly increased the frequency and magnitude of landslides during the December 1964 flood. The sediment mobilized from the 1964 flood significantly aggraded much of Redwood Creek and its tributaries, resulting in wide and shallow, simplified stream habitat with a lack of pools and instream structure.

From 1966 to 1970, logging continued at a similar rate, with tractor logging the primary yarding method. By 1970, nearly 65 percent of the original coniferous forest or 53 percent of the watershed was logged. As old-growth forests declined in the 1970s, commercial companies began re-entering previously harvested areas to remove residual old-growth from previously logged areas. At the end of Best's (1995) study period in 1978, over 80 percent of the original forests were logged, or 66 percent of the watershed. The aerial photos show that nearly 69 percent of the original forests in the lower watershed, 92 percent in the middle watershed, and 81 percent in the upper watershed, or 66, 73, and 59 percent of the respective watershed areas were logged in a 42 year period, coinciding with the five largest floods in Redwood Creek.

In 1978, Redwood National Park was expanded from the narrow strip of old growth redwood along the lower one-third of mainstem Redwood Creek that was the original Park dating from 1968, and logging ended within the lower watershed that is protected as National and State Park lands (*i.e.*, the lower one-third of the watershed, and most of the Prairie Creek subwatershed are park lands, approximately 44 percent of the basin is Federal or state land). The expanded National Park contains much of the land that was extensively logged, and the Park is actively restoring its landscape by removing roads and engaging in restoration of its second growth forests.

Approximately 56 percent of the basin is private land, and commercial timber companies and small ranch and timber land owners continue to harvest timber on a rotational basis throughout the upper and middle watershed areas (approximately the upper two-thirds of the watershed are privately owned). Timber harvest practices of today are regulated by the California State Forest Practice Rules in general, and since 2006, lands owned by Green Diamond Resource Company have been managed under an Aquatic Habitat Conservation Plan (AHCP) (GDRC 2006). The AHCP contains many elements that will improve aquatic habitat over time, including an intensive geologic review program for unstable lands and a road decommissioning and upgrading program, both designed to reduce sediment inputs. However, many of the effects of intensive, historic timber harvest practices, such as reduced riparian shading, reduced large wood inputs to the streams and increased sediment inputs, continue to influence the habitat found today in the Redwood Creek basin.

Following post-European human settlement into the Redwood Creek floodplain and subsequent flooding in the town of Orick during the 1953, 1955, and 1964 high flows, the Corps constructed two earthen embankment flood control levees with riprap slope protection and associated infrastructure (*e.g.*, relief wells, flap gates, drains) on either side of the lower mainstem channel of Redwood Creek. The levees were constructed from 1966 to 1968, and confined Redwood Creek for 3.4 miles from the estuary upstream past the confluence of Prairie Creek. Prior to levee construction the Corps sent a report on their plans for construction of a flood control project in Redwood Creek and a request for comments from various Federal and state agencies. Both the U.S. Fish and Wildlife Service (USFWS) and California Department of Water Resources (DWR) expressed numerous concerns regarding the impacts of the proposed flood control project on fish (CDWR 1961; USFWS 1961), including effects on riparian vegetation and pool habitat.

The constructed flood control channel followed the existing Redwood Creek channel alignment, except sections were straightened and the last meander was cut-off and now forms the South Slough. The levees were extended into the estuary, approximately 2,000 feet beyond the preliminary designs (Ricks 1995), in a mostly theoretical attempt to flush sediment to the ocean during high flows, which has not worked, as sediment deposits in the estuary (NHE 2010b). Recent analysis (NHE 2010b) has determined that design flaws (*e.g.*, channel bed elevation set below grade and without enough channel gradient) of the original flood control project encourage sediment deposition rather than sediment transport. In addition, the design flow of 77,000 cfs, which was at the time of construction thought to be a return interval flood of 250 years, is now known to be a flood return interval flood of approximately 2,000 to 4,000 years. Considering the design flaws, the sediment transport rates in Redwood Creek, and habitat needs within the flood control project, the original flood control project design did not consider the geomorphic and ecological effects of the trapezoidal channel or the long-term maintenance (*i.e.*, riparian vegetation and gravel removal) needs. Levee construction has disconnected the channel from its floodplain, tributaries, sloughs and off-channel winter rearing habitat, prevents channel migration and creation of new habitat, and has greatly impacted estuarine function (Cannata *et al.* 2006) for rearing Chinook salmon and steelhead.

In summary, these historic land uses have combined to produce simple instream habitat in much of the mainstem of Redwood Creek and its tributaries and estuary, with reduced availability of shelter, cover, shade, off-channel low velocity areas, pools, and an estuary that is much reduced in size, complexity and function from historic conditions. In contrast, much of the Prairie Creek subwatershed contains habitat in good condition, and provides valuable refugia habitat for listed salmonids.

Current Resources and Land Management

As noted above, about 44 percent of the basin is Federal or state land, with most of that being managed by Redwood National and State Parks (RNSP) with the goals of restoring and preserving the natural landscape. The remaining 56 percent of the basin is privately held, with most of the private land owned by commercial timber companies. The Green Diamond Resource Company is the largest private landowner in the basin and manages approximately 33,038 acres in the Redwood Creek watershed under their AHCP. The Redwood Creek Watershed Group (RCWG) has been active for about 10 years, has authored an integrated watershed strategy, promotes partnerships for habitat restoration and grant funding, and continues to meet quarterly to bring together various partners and efforts within the basin. The following are pertinent reports or plans for the Redwood Creek basin:

- NMFS Recovery Plan for SONCC Coho Salmon, Final (NMFS 2014);
- Redwood Creek Integrative Watershed Strategy (RCWG 2006);
- Redwood Creek Watershed Assessment (Cannata *et al*. 2006);
- Redwood National Park Land and Resource Management Plan (NPS 2000);
- Green Diamond Resource Company AHCP (GDRC 2006); and
- Recovery Strategy for California Coho Salmon (CDFG 2004).

Salmonid Viability and Watershed Conditions

The following indicators are rated as Poor through the CAP process for Chinook salmon (see Redwood Creek CAP results for more details): LWD frequency, pool/riffle/flatwater ratio, shelter rating, tree diameter, mean sediment size, floodplain connectivity, turbidity, food productivity, estuary quality and extent, temperature, road density, streamside road density and staging pools.

Current Conditions

The following discussion focuses on those conditions that rated Fair or Poor as a result of our CAP viability analysis. The Redwood Creek CAP Viability Table results are provided below. Recovery strategies will focus on improving these conditions.

Population and Habitat Conditions

Velocity Refuge: Floodplain Connectivity

Lower Redwood Creek has been disconnected from its floodplain by the construction of flood control levees, which limit access to low gradient, off-channel rearing habitat (including tributaries, sloughs and wetlands) in the depositional area of mainstem Redwood Creek. In addition, roads limit floodplain connectivity in other low gradient stream sections, and much of the mainstem of Redwood Creek flows through a relatively narrow canyon. The quality of floodplain habitat has also been reduced by conversion to agriculture adjacent to lower and middle sections of Redwood Creek. Velocity Refuge: Floodplain connectivity condition has a rating of Poor for pre-smolts and smolts.

Estuary: Quality and Extent

The Redwood Creek estuary was once a large and diverse habitat area that was essential for diversity and productivity of all Redwood Creek salmonid populations. Since 1968, flood control levees have bisected the estuary, which has disconnected the channel from sloughs, wetlands, tributaries and secondary channels, and has reduced the spatial area of the Redwood Creek estuary by over 50 percent (Anderson 2006). Currently, rearing habitat within the estuary and transition zone is simplified, with little cover, shelter, or access to off-channel areas. In addition, diversion culverts in the south levee limit access during most of the year to the South Slough and Strawberry Creek, the two remaining off-channel habitats in the estuarine area. Specifically, the diversion culverts are closed during winter and spring, limiting access to habitat that provides shelter from high water velocities. Low dissolved oxygen and warm water temperatures are also an issue in the estuary and South Slough, and the operation of the diversion culverts may aggravate already poor water quality. Since Chinook salmon juveniles are dependent on extended estuarine rearing to provide growth that maximizes ocean survival, and to provide a diversity of out-migration timing which also increases ocean survival, the reductions in the quality and spatial area of the estuary results in a condition rated as Poor for smolts and for pre-smolts.

Water Quality: Temperature

High summer water temperature is a significant problem throughout most of the population area, especially in the middle and upper sections of mainstem Redwood Creek. Impaired water temperatures are rated as a Poor condition for smolts, and pre-smolts. Redwood Creek is listed as temperature impaired under section 303d of the Clean Water Act. High summer water temperatures in mainstem Redwood Creek, including the estuary, is one of the factors limiting salmonid production in the basin (Cannata *et al.* 2006; Sparkman 2006). Summer water temperature increases from the headwaters of Redwood Creek to the lower-middle section within Redwood National Park, then water temperatures gradually decrease as the river approaches the Pacific Ocean. The middle section of the Redwood Creek basin contains summer water temperatures where the maximum weekly maximum temperatures (MWMT) ranged from 23 to 27°C, as measured during thermal infrared imaging during the summer of 2003. Madej *et al.* (2006) describes this section of Redwood Creek as the "hot zone", and notes that channel aggradation and widening, combined with the removal of large riparian conifers has played a role in increasing summer water temperatures. Sparkman (2012) has also monitored water temperatures at the upper smolt trap in the middle section of Redwood Creek since 2000. The average daily (24 hour period) stream temperature from March 25, 2014 to August 7, 2014 was 15.6 degrees C (or 60.1 degrees F) (95% CI = 14.9 – 16.3 degrees C), with daily averages ranging from 7.8 to 22.3 degrees C (46.0 – 72.1 degrees F). Median daily stream temperature during this time frame equaled 15.4 degrees C (or 59.7 degrees F). The maximum stream temperature for 2014 occurred on July 31, and equaled 26.3 degrees C (79.3 degrees F). Average stream temperature for the 2014 study year (truncated for equal comparisons with pervious study years) equaled 15.5 degrees C (59.9 degrees F). Average daily stream temperatures during the trapping periods did not statistically change over time (years).

Madej *et al.* (2006) also reports that the greatest thermal complexity occurs in lower Redwood Creek upstream of the leveed reach, within the canyon of Redwood National Park. In this reach, Madej *et al.* (2006) measured with thermal infrared imaging many cool springs, seeps, side channels and tributaries. Lower Prairie Creek and lower Redwood Creek, close to the ocean and within the temperate, summer fog belt, have lower temperatures relative to middle and upper Redwood Creek, but lower Redwood Creek is still warmer than the preferred temperature range of salmon and steelhead, causing stressful conditions for rearing juvenile salmonids, including Chinook salmon that mostly outmigrate as 0+ juveniles and are dependent upon the estuary and lower river to gain size needed for ocean survival. Water temperatures in Redwood Creek were monitored by Sparkman (2009) at the lower out migrant trap (river mile 4) during April through July for the period 2004 through 2008. During that time, the maximum weekly average temperature (MWAT) and MWMT ranged from 18.2 to 19.3°C and 21.1 to 22.7°C, respectively. In contrast, the optimum temperature range for rearing Chinook salmon is 10 – 15.6°C (US EPA 1999).

Viability: Density, Abundance, and Spatial Structure

Viability conditions have an overall rating of Fair for adults, pre-smolts and smolts. Although information from out-migrant monitoring in 2013 indicates improved abundance of presmolt and smolt Chinook salmon lifestages, longer term data show that reduced abundance and diversity of Chinook salmon are acting as a stress to the population (Sparkman pers. comm. 2015). Based on out-migrant monitoring in lower Redwood Creek, the average population estimate for age 0+ Chinook salmon from 2005 to 2012 is 145,772 juveniles, and most of these age 0+ juveniles were smolts (81 percent). Estimates of adult abundance range from 395 spawners, which is based on spawning surveys (Ricker 2011a, 2011b) to 2,444 spawners, based on DIDSON estimates (Metheny 2012), to a more recent DIDSON estimate of 3,487 (Sparkman pers. comm. 2015), to a low and high of 1,339 to 4,976 adults using smolt abundances estimates with an estimated ocean survival of 1 percent . However, as already described, since Chinook salmon are mainstem spawners, redds can be covered with sediments in between redd surveys and redd counts can underestimate the total population of Chinook salmon adults. In addition, smolt estimates vary greatly by year, and ocean survival is estimated. Thus, Chinook salmon population abundance is above the depensation level of 114 spawners, but most likely below the spawner target level of 3,400 for this population, on average. The spatial structure of the Chinook salmon population is mostly intact and passage and migration are rated as Very Good for this population, but expression of juvenile life history diversity is negatively influenced by the poor condition of the estuary. In addition, loss of a Chinook salmon spring-run in Redwood Creek contributes to decreased diversity (Sparkman, pers. comm., 2015).

Sediment: Gravel Quality and Distribution of Spawning Gravels

Sediment conditions have an overall rating of Fair for adult, eggs, pre-smolt, and smolt lifestages. Redwood Creek has naturally high sediment loads, which have been increased by past logging, landslides, and road building (Best 1995). Due to instream gravel mining for flood control in lower Redwood Creek and timber harvest activities in the rest of the basin, stream particle size has decreased in parts of the basin. Smaller particle sizes do not offer presmolt Chinook salmon the velocity refuge that is needed for shelter during higher winter flows. In addition, the increase in fine sediment decreases the productivity of food for presmolt Chinook salmon and also make redds more prone to scour during flood flows, negatively affecting eggs of both populations.

Water Quality: Turbidity or Toxicity

Water Quality: Turbidity conditions have an overall Poor rating for adults, pre-smolts and smolts. However, this stress has been declining in recent years as the watershed heals from past logging and road building. Klein and Anderson (2011) documented shifts in the fine and course sediment budgets of Redwood Creek at the Orick gage. There is a decrease in annual bedload and suspended sediment loads when comparing the time period 1954 to 1974 to time period 1975 to 2009. The higher sediment loads during the 1954 to 1974 period were caused by extensive logging and road building in a watershed with steep terrain and highly sheared and fractured rocks during a period of large storms and floods. Several researchers (Harden 1995; Kelsey *et al.* 1995; Madej and Curren 2009; Madej and Ozaki 2009) documented the substantial increase in hillslope sediment erosion and stream channel sediment deposition following the extensive legacy logging and road building during the 1950s to 1970s. Other researchers (Madej and Ozaki 1996) have also documented the extensive sediment deposition and its long-term migration through Redwood Creek's channel. In addition to increased turbidity levels, recent monitoring conducted in summer of 2010 by the USFWS shows low dissolved oxygen levels in the Redwood Creek estuary and South Slough.

Riparian Vegetation: Composition, Cover & Tree Diameter and Habitat Complexity: Percent Primary Pools and/or Pool/Riffle/Flatwater Ratios, and Large Wood and Shelter

Riperian Vegetation: Composition and conditions have a Poor rating for pre-smolt. Due to conversion of riparian areas to agriculture, construction of flood control levees, and riparian vegetation removal for flood control in the leveed reach of Redwood Creek, as well as past harvest of coniferous trees within the riparian zone during logging, the riparian species composition has been altered, contains far fewer coniferous trees, and in the case of lower

Redwood Creek, most of the riparian vegetation has been removed. Throughout much of the watershed riparian vegetation is dominated by hardwood species and young conifers, which will take many years to grow in order to provide functional, large pieces of instream wood. The combination of an aggraded and widened channel, and lack of large wood supply has led to flatwater habitat (neither pool nor riffle), which has drastically reduced pool complexity leading to a Poor rating for adults, pre-smolt, and smolt lifestages. In addition, Habitat Complexity: Large wood and Shelter conditions have a Poor rating for adults, pre-smolts and smolts. The increase in sediment yields and reductions in large wood inputs from streamside logging have reduced shelter habitat throughout the watershed, and removal of riparian vegetation for flood control purposes has decreased shelter and cover in lower Redwood Creek. However, Prairie Creek, which is mostly protected by park lands, contains more complex habitat with greater amounts of large wood and pools.

Sediment Transport: Road Density

High road densities within the population area are primarily associated with past timber harvest and rural residences. Road densities range from 2 to 8 miles of road per square mile of land, with an average road density of 4.8 miles of road per square mile of area (Cannata *et al.* 2006). Although significant efforts have been, and continue to be made, to upgrade and remove roads to reduce their sediment generating potential, road density remains high, but is decreasing and recent estimates of suspended sediment and bedload passing the gage at Orick show reduced sediment transport in Redwood Creek (Klein and Anderson 2011). Sediment Transport: Road density conditions have an overall Poor rating.

Hydrology: Redd Scour

Redd Scour conditions are rated as poor for eggs. Sparkman (2012) describes that population abundances estimated for the lower out-migrant trap on Redwood Creek (river mile 4) are influenced by flood flows in the middle portion of the basin. Flood flows and extreme weather have a large influence on Chinook salmon smolt abundance in Redwood Creek (Sparkman 2013), and is considered a high threat to the egg, pre-smolt and smolt life stages. Sparkman (2011c; 2011b; 2012) found a declining trend in populations of age 0+ and age 1+ Chinook salmon over the past several years from the upper (river mile 34) and lower traps in Redwood Creek. This trend was significantly negative over time for age 0+ Chinook salmon in upper Redwood Creek and was not significantly negative in lower Redwood Creek until flood type flows were added to the model, indicating that Chinook salmon populations passing through the lower basin were influenced by population abundance and flood type flows in the upper basin (Sparkman 2012). Increased sediment yield and channel aggradation have likely increased the chances of redds being scoured by flood flows.

Very Good or Good Current Conditions

Very Good or Good rated conditions include passage and migration, and watershed hydrology. In addition, many aspects of landscape patterns (i.e., percent of watershed in timber harvest, agriculture and urbanized) were rated as very good currently, but based on past timber harvest practices (i.e., legacy timber harvest), landscape disturbance and watershed processes were rated as a high stress for this population. High road densities, past logging that has removed large conifers from riparian areas, and landslides that have been exacerbated by roads and timber harvest activities are the leading contributing factors to the stressful watershed processes condition. Large sediment inputs to Redwood Creek have caused channel aggradation, widening and a lack of deep pools within many channels. However, impervious surfaces and the extent of urban development within the population are favorably rated.

Threats

The following discussion focuses on those threats that rate as High or Very High (see Redwood Creek CAP Results). Recovery strategies will likely focus on ameliorating Very High and High rating threats; however, some strategies may address Medium and Low threats when the strategy is essential to recovery efforts. The figures and tables that display data used in this analysis are provided in Redwood Creek CAP Results.

Population and Habitat Threats

Channel Modification

Channel modification is rated as a Very High threat for presmolt and smolt lifestages. Channel modification is also rated as a High threat for watershed processes and adults (summer and winter). The Redwood Creek estuary and lower mainstem river has been channelized and confined by levees for 3.4 miles, from the river mouth to the beginning of the steeper stream channel that is contained in a canyon. As previously discussed, over 50 percent of the estuary has been lost through the construction of levees (Anderson 2006), and levees prevent access to important sloughs, wetlands and low gradient tributaries. The estuary, transition zone and lower river once contained complex summer and winter rearing habitat (Cannata *et al.* 2006) that was critical to successful completion of the freshwater juvenile lifestage, but very little of that historic function still exists. The potential function of the estuary (*e.g.*, growth, diversity, shelter, and ocean transition) becomes even more critical given the degraded rearing conditions found upstream in mainstem Redwood Creek and most of its tributaries. Both populations suffer from the decreased opportunity for increased juvenile growth and out-migration timing diversity that the current estuary and low gradient habitat provides.

Roads and Railroads

Roads are rated as a High threat for adult and presmolt Chinook salmon lifestages. Roads are also rated as a High threat for watershed processes. As of 2006, Cannata *et al.* (2006) 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. Fine sediment availability increases in basins with more than three miles of road per square mile of area (Cederholm *et al.* 1981). Considering the Very High road density, sediment yields from roads is currently a High threat, and Redwood Creek is listed as sediment impaired under section 303d of the Clean Water Act. NMFS expects that with ongoing upgrading and removal of roads by private landowners in the middle and upper basin, as well as the continuation of road removal in RNSP, that this threat will decrease over time.

Disease, Predation and Competition

This threat is rated as Very High for smolts primarily due to the degraded habitat conditions, lack of cover and high rates of juvenile predation found in the estuary. Monitoring indicates that juveniles continue to enter the estuary during the summer months (Anderson 2005; Sparkman 2010). Chinook salmon that remained in the estuary were larger than those that emigrated to the ocean (Anderson 2005; Sparkman 2011d) prior to the river mouth closure. This larger size can increase the probability of survival in the ocean (Reimers 1973; Bilton 1984; Beamer and Larsen 2004; Bond *et al.* 2008) provided these larger juveniles are able to survive summer and fall-rearing conditions and out-migrate to the ocean after the creek mouth re-opens in the fall. However, Anderson's data (Anderson 2011a; 2011b) show consistent and large declines in numbers of seined individuals and decreased juvenile population estimates within the estuary during summer and early fall sampling when the creek mouth is closed. Researchers believe that the dramatic decline in juveniles abundance within the closed estuary is due to predation rather than juveniles migrating back upstream (Anderson, D. G. Redwood National and State Parks, personal communication 11/30/2011; Sparkman, M. D. CDFW, personal communication, 2011).

Logging and Wood Harvesting

Logging is rated as a High threat to most lifestages of CC Chinook salmon. Although current timber harvest practices are more protective of salmonid habitat than previous practices, timber harvest continues to threaten salmonids in Redwood Creek by increasing sediment yield and by reducing streamside shading and potential large wood recruitment, affecting the quality and quantity of rearing and spawning habitat. Approximately half of the basin is in private ownership as industrial timberland, and commercial timber harvest continues in the middle and upper portions of Redwood Creek. Sediment yields have decreased in recent years (Klein and Anderson 2011), but poor instream habitat and riparian conditions persist throughout much of the basin (Madej *et al*. 2006), making Redwood Creek sensitive to ongoing threats from reductions in riparian shading and large wood recruitment that stem from timber harvest activities. In addition, large wood is often removed from lower and middle Redwood Creek during the winter when it is transported downstream by high flows and used for redwood carvings, sculptures, and for firewood. Removal of large wood from the channel exacerbates the problem of low levels of large wood recruitment from logged riparian areas.

Water Diversion and Impoundments

Aerial photographs of the Redwood Creek basin show numerous and large marijuana plantations, particularly in the Redwood Valley area in the middle portion of the basin. Marijuana cultivation and associated water diversion is placing a higher demand on a limited supply of water (S. Bauer, CDFW, personal communication, 1/17/13). Based on an estimate from the medical marijuana industry, each marijuana plant may consume 900 gallons of water per season (Downie 2012). In addition, rural development in the Redwood Valley area also is consuming more water, both for domestic and agricultural uses (M. Sparkman, CDFW, personal communication, 12/2012), further reducing spring and summer flow conditions.

Mining

Mining, which for Redwood Creek, is instream gravel mining mostly for flood control purposes, is rated as a High threat for presmolts and smolts. The leveed reach of Redwood Creek began aggrading with gravel immediately following levee construction. In an effort to combat this natural process and maintain the flood control project as designed, Humboldt County extracted gravel sporadically between 1968 and 2000, and annually between 2004 and 2010. Gravel removal results in simplified habitat, with reductions in pool availability, coarse surface particles and riparian vegetation that are all important for shelter and cover habitat. Currently, Humboldt County is proposing to mine large quantities of gravel due to the ongoing deposition of gravel in the flood control project reach. Studies (NHE 2010b; 2010a) have shown that the flood control project was not designed to transport gravel through the leveed reach, but rather design deficiencies lead to gravel accumulation and the subsequent need to remove gravel to increase flood water conveyance capacity.

Severe Weather Patterns

Sparkman (2012) describes that population abundances estimated for the lower out-migrant trap on Redwood Creek (river mile 4) are influenced by flood flows in the middle portion of the basin, that is that population abundance is influenced by redd scour and lack of shelter from high water velocities. Flood flows and extreme weather have a large influence on Chinook salmon smolt abundance in Redwood Creek (Sparkman 2013), and is considered a high threat to the egg, pre-smolt and smolt life stages. Flood flows occur during the late fall, winter and spring in Redwood Creek, and habitat conditions throughout much of Redwood Creek, but especially the estuary, make pre-smolts and smolts vulnerable to being washed downstream due to lack of shelter from high water velocities.

Low or Medium Rated Threats

Low and Medium rated threats for Chinook salmon include: residential and commercial development, livestock farming and ranching, agriculture, recreational areas and activities, fire, fuel management and fire suppression, and hatcheries and aquaculture.

Limiting Stresses, Lifestages, and Habitats

The threat and stress analysis within the CAP workbooks indicates that the Chinook salmon presmolt and smolt lifestages are limiting the viability of the Chinook salmon population. The degraded condition of the estuary, including lack of cover and increased predation risk, impaired floodplain connectivity, high summer water temperatures, and general lack of habitat complexity are all limiting factors for this population.

General Recovery Strategy

In general, recovery strategies focus on improving conditions and ameliorating stresses and threats discussed above, although strategies that address other indicators may also be developed where their implementation is critical to restoring properly functioning habitat conditions within the watershed. The general recovery strategy for the Redwood Creek populations is discussed below with more detailed and site-specific recovery actions provided in Redwood Creek CAP results, which provides the Implementation Schedule for these populations.

Enhance and Rehabilitate the Quality and Extent of the Redwood Creek Estuary and Improve Floodplain Connectivity

Efforts should be implemented to restore the quality and size of the estuary and to improve connection with the floodplain. Methods include: levee modification, reconnection and improvement of slough, wetland and tributary habitats, and enhancing cover and complexity by improving riparian vegetation quality and extent, and by adding structural elements to the channel. All of the salmonid species present in the Redwood Creek watershed are highly dependent on the estuary and on low gradient tributaries and off-channel habitats. The restoration of the estuary and re-connection of the floodplain would benefit several lifestages of

Chinook salmon and contribute to improvements in life history diversity, ocean survival and adult abundance.

Habitat Complexity: Large Wood and Shelter

Take actions to increase shelter ratings, improve pool frequency and depths, increase pool volume, increase LWD abundance, and decrease the extent of flatwater habitats. Shelter ratings, pool depths, and habitat complexity are lacking throughout the watershed and are a major stress for most lifestages. Actions include retaining conifers in riparian zones, adding LWD to channels, allowing riparian vegetation to grow in the leveed reach, reducing sediment inputs by continuing to remove and upgrade roads, reducing instream gravel removal, and preventing removal of LWD from stream channels.

Protect and Restore Habitat in Prairie Creek

Within the Redwood Creek watershed, the Prairie Creek subwatershed is unique in that it contains higher quality habitat than the rest of the basin. Prairie Creek is mostly contained within National and State Park land, but does contain some private land and roadways. It is critical to continue to protect (and restore where necessary) the higher quality habitat in Prairie Creek for all salmonid species within the basin.

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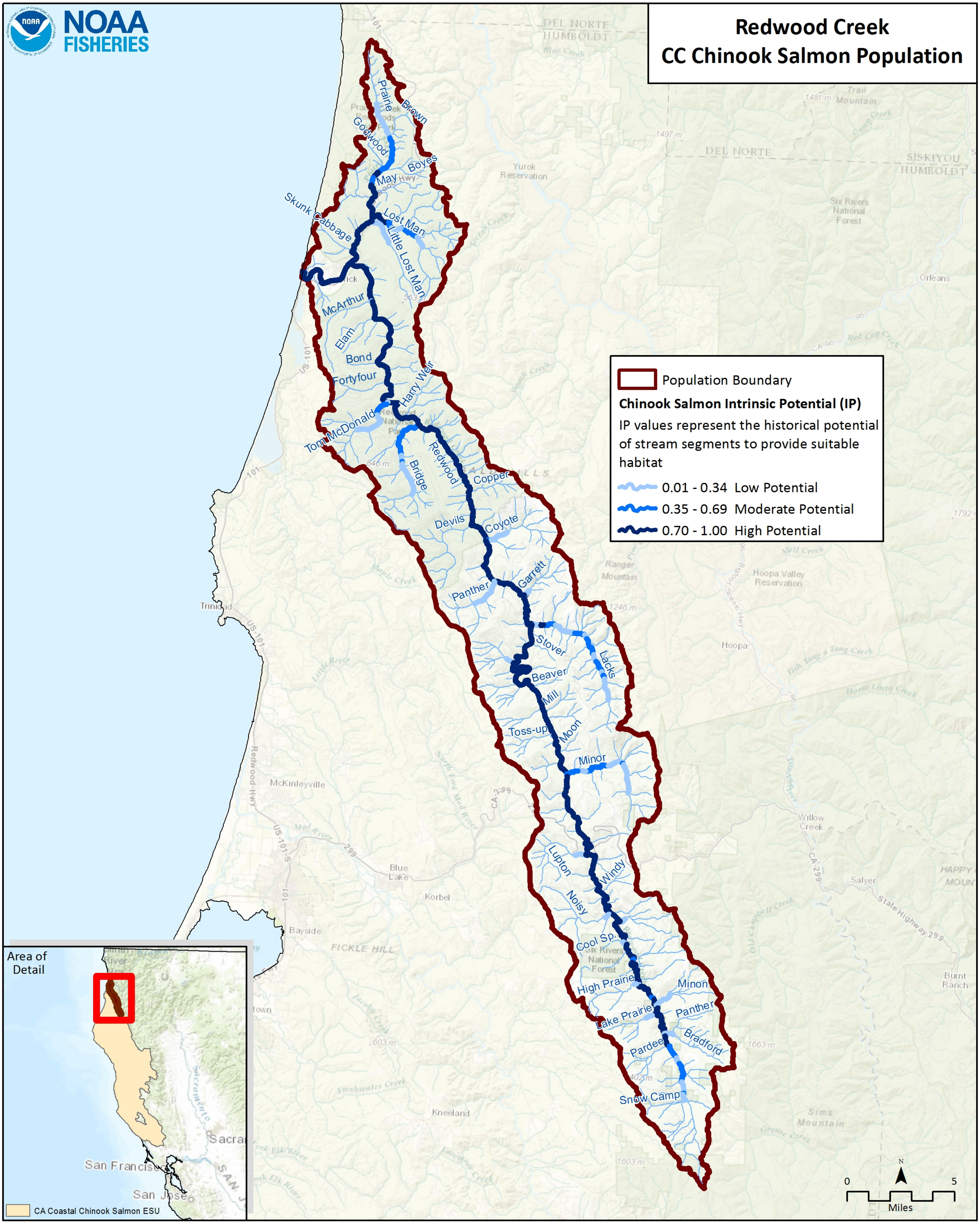
NOAA FISHERIES
Redwood Creek
CC Chinook Salmon Population
Population Boundary
Chinook Salmon Intrinsic Potential (IP)
IP values represent the historical potential of stream segments to provide suitable habitat
0.01 - 0.34 Low Potential
0.35 - 0.69 Moderate Potential
0.70 - 1.00 High Potential
Prairie
Brown
Godwood
Boyes
May
Skunk Cabbage
Lost Man
Little Lost Man
McArthur
Elam
Bond
Fortyfour
Harry Weir
Tom McDonald
Redwood
Bridge
Copper
Devils
Coyote
Panther
Garrett
Stover
Lacks
Beaver
Mill
Toss-up
Moon
Minor
Lupton
Windy
Noisy
Cool Sp.
High Prairie
Minon
Lake Prairie
Panther
Bradford
Pardee
Snow Camp
DEL NORTE
HUMBOLDT
SISKIYOU
Yurok Reservation
Six Rivers National Forest
Orleans
Hoopa Valley Reservation
Hoopa
Willow Creek
Salyer
Burnt Ranch
McKinleyville
Blue Lake
Korbel
Bayside
FICKLE HILL
Kneeland
Sims Mountain
Trinidad
Area of Detail
San Francisco
San Jose
CA Coastal Chinook Salmon ESU
0
5
Miles

#	Conservation Target	Category	Key Attribute	Indicator	Poor	Fair	Good	Very Good	Current Indicator Measurement	Current Rating
1	Adults	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Poor
			Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	<50% of streams/ IP-Km (>6 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>6 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>6 Key Pieces/100 meters)	>90% of streams/ IP-Km (>6 Key Pieces/100 meters)	<4% of streams/ IP-km (>6 Key Pieces/100 meters)	Poor
			Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	<50% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	50% to 74% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	75% to 90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	>90% of streams/ IP-Km (>1.3 Key Pieces/100 meters)	<1% of streams/ IP-km (>6 Key Pieces/100 meters)	Poor
			Habitat Complexity	Percent Staging Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	0% of streams/ IP-km (>49% average primary pool frequency)	Poor
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	7% of streams/ IP-km (>30% Pools; >20% Riffles)	Poor
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.19	Good
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score = 58	Fair
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	50% of IP-Km to 74% of IP-km	Fair
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	100% of IP-km	Very Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	39.41% Class 5 & 6 across IP-km	Fair

			Sediment	Quantity & Distribution of Spawning Gravels	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	50% of IP-km to 74% of IP-km	Fair
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	28.69	Poor
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	<50% Response Reach Connectivity	Poor
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Density	<1 spawners per IP-Km	1-20 Spawners per IP-Km	20-40 Spawners per IP-Km (e.g., Low Risk Extinction Criteria)		1-20 Spawners per IP-km	Fair
			Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	75-90% of Historical Range	Good
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	75	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	12.1-17.9	Fair
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	30-40	Good
2	Eggs	Condition	Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score = 50	Good
			Hydrology	Redd Scour	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score 51-75	Poor

			Sediment	Gravel Quality (Bulk)	>17% (0.85mm) and >30% (6.4mm)	15-17% (0.85mm) and <30% (6.4mm)	12-14% (0.85mm) and <30% (6.4mm)	<12% (0.85mm) and <30% (6.4mm)	16.04% (0.85mm) and <30% (6.4mm)	Fair
			Sediment	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	89% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	28.69	Poor
3	Pre Smolt	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Poor
			Habitat Complexity	Percent Primary Pools	<50% of streams/ IP-Km (>49% average primary pool frequency)	51% to 74% of streams/ IP-Km (>49% average primary pool frequency)	75% to 89% of streams/ IP-Km (>49% average primary pool frequency)	>90% of streams/ IP-Km (>49% average primary pool frequency)	88% of streams/ IP-km (>49% average primary pool frequency)	Good
			Habitat Complexity	Pool/Riffle/Flatwater Ratio	<50% of streams/ IP-Km (>30% Pools; >20% Riffles)	50% to 74% of streams/ IP-Km (>30% Pools; >20% Riffles)	75% to 90% of streams/ IP-Km (>30% Pools; >20% Riffles)	>90% of streams/ IP-Km (>30% Pools; >20% Riffles)	7% of streams/ IP-km (>30% Pools; >20% Riffles)	Poor
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	0% of streams/ IP-km (>80 stream average)	Poor
			Habitat Complexity	VStar	>0.35	0.22-0.35	0.15 - 0.21	<0.15	0.19	Good
			Hydrology	Flow Conditions (Baseflow)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score = 75	Fair
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score = 58	Fair
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	1.1 - 5 Diversions/10 IP-km	Fair

			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score = 58	Fair
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Riparian Vegetation	Tree Diameter (North of SF Bay)	≤39% Class 5 & 6 across IP-km	40 - 54% Class 5 & 6 across IP-km	55 - 69% Class 5 & 6 across IP-km	>69% Class 5 & 6 across IP-km	Impaired/non-functional	Poor
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	28.69	Poor
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	89% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined		
			Water Quality	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	<50% IP-km (>6 and <14 C)	Poor
			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Spatial Structure	<50% of Historical Range	50-74% of Historical Range	75-90% of Historical Range	>90% of Historical Range	75-90% of Historical Range	Good
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	75	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	12.1-17.9	Fair

			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	30-40	Good
5	Smolts	Condition	Estuary/Lagoon	Quality & Extent	Impaired/non-functional	Impaired but functioning	Properly Functioning Condition	Unimpaired Condition	Impaired/non-functional	Poor
			Habitat Complexity	Shelter Rating	<50% of streams/ IP-Km (>80 stream average)	50% to 74% of streams/ IP-Km (>80 stream average)	75% to 90% of streams/ IP-Km (>80 stream average)	>90% of streams/ IP-Km (>80 stream average)	0% of streams/ IP-km (>80 stream average)	Poor
			Hydrology	Flow Conditions (Instantaneous Condition)	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35		
			Hydrology	Number, Condition and/or Magnitude of Diversions	>5 Diversions/10 IP km	1.1 - 5 Diversions/10 IP km	0.01 - 1 Diversions/10 IP km	0 Diversions	1.1 - 5 Diversions/10 IP-km	Fair
			Hydrology	Passage Flows	NMFS Flow Protocol: Risk Factor Score >75	NMFS Flow Protocol: Risk Factor Score 51-75	NMFS Flow Protocol: Risk Factor Score 35-50	NMFS Flow Protocol: Risk Factor Score <35	NMFS Flow Protocol: Risk Factor Score = 58	Fair
			Passage/Migration	Passage at Mouth or Confluence	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	75% of IP-km to 90% of IP-km	Good
			Passage/Migration	Physical Barriers	<50% of IP-Km or <16 IP-Km accessible*	50% of IP-Km to 74% of IP-km	75% of IP-Km to 90% of IP-km	>90% of IP-km	100% of IP-km	Very Good
			Sediment (Food Productivity)	D50 (mm)	<38 >128	38-50 & 110-128	50-60 & 95-110	60-95	28.69	Poor
			Sediment (Food Productivity)	Gravel Quality (Embeddedness)	<50% of streams/ IP-Km (>50% stream average scores of 1 & 2)	50% to 74% of streams/ IP-Km (>50% stream average scores of 1 & 2)	75% to 90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	>90% of streams/ IP-Km (>50% stream average scores of 1 & 2)	89% of streams/ IP-km (>50% stream average scores of 1 & 2)	Good
			Smoltification	Temperature	<50% IP-Km (>6 and <14 C)	50-74% IP-Km (>6 and <14 C)	75-90% IP-Km (>6 and <14 C)	>90% IP-Km (>6 and <14 C)	<50% IP-km (>6 and <14 C)	Poor
			Velocity Refuge	Floodplain Connectivity	<50% Response Reach Connectivity	50-80% Response Reach Connectivity	>80% Response Reach Connectivity	Not Defined	<50% Response Reach Connectivity	Poor

			Water Quality	Toxicity	Acute	Sublethal or Chronic	No Acute or Chronic	No Evidence of Toxins or Contaminants	Sublethal or Chronic	Fair
			Water Quality	Turbidity	<50% of streams/ IP-Km maintains severity score of 3 or lower	50% to 74% of streams/ IP-Km maintains severity score of 3 or lower	75% to 90% of streams/ IP-Km maintains severity score of 3 or lower	>90% of streams/ IP-Km maintains severity score of 3 or lower	<50% of streams/ IP-km maintains severity score of 3 or lower	Poor
		Size	Viability	Abundance	Smolt abundance which produces high risk spawner density per Spence (2008)	Smolt abundance which produces moderate risk spawner density per Spence (2008)	Smolt abundance to produce low risk spawner density per Spence (2008)			
			Water Quality	Aquatic Invertebrates (B-IBI NorCal)	0-40	40-60	60-80	80-100	75	Good
			Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-22.9	>=23	12.1-17.9	Fair
			Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40	30-40	Good
6	Watershed Processes	Landscape Context	Hydrology	Impervious Surfaces	>10% of Watershed in Impervious Surfaces	7-10% of Watershed in Impervious Surfaces	3-6% of Watershed in Impervious Surfaces	<3% of Watershed in Impervious Surfaces	0.09% of Watershed in Impervious Surfaces	Very Good
			Landscape Patterns	Agriculture	>30% of Watershed in Agriculture	20-30% of Watershed in Agriculture	10-19% of Watershed in Agriculture	<10% of Watershed in Agriculture	0.46% of Watershed in Agriculture	Very Good
			Landscape Patterns	Timber Harvest	>35% of Watershed in Timber Harvest	26-35% of Watershed in Timber Harvest	25-15% of Watershed in Timber Harvest	<15% of Watershed in Timber Harvest	13.4% of Watershed in Timber Harvest	Very Good
			Landscape Patterns	Urbanization	>20% of watershed >1 unit/20 acres	12-20% of watershed >1 unit/20 acres	8-11% of watershed >1 unit/20 acres	<8% of watershed >1 unit/20 acres	1% of Watershed >1 unit/20 acres	Very Good
			Riparian Vegetation	Species Composition	<25% Intact Historical Species Composition	25-50% Intact Historical Species Composition	51-74% Intact Historical Species Composition	>75% Intact Historical Species Composition	25-50% Intact Historical Species Composition	Fair

			Sediment Transport	Road Density	>3 Miles/Square Mile	2.5 to 3 Miles/Square Mile	1.6 to 2.4 Miles/Square Mile	<1.6 Miles/Square Mile	8.26 Miles/Square Mile	Poor
			Sediment Transport	Streamside Road Density (100 m)	>1 Miles/Square Mile	0.5 to 1 Miles/Square Mile	0.1 to 0.4 Miles/Square Mile	<0.1 Miles/Square Mile	7.62 Miles/Square Mile	Poor

Redwood Creek CAP Threat Results

Threats Across Targets		Adults	Eggs	Pre Smolt	Smolts	Watershed Processes	Overall Threat Rank
Project-specific-threats		1	2	3	5	6	
1	Agriculture	Medium	Low	Medium	Medium	Low	Medium
2	Channel Modification	High	Medium	Very High	Very High	High	Very High
3	Disease, Predation and Competition	Medium		High	Very High	Low	High
4	Hatcheries and Aquaculture	Low		Low	Medium		Low
5	Fire, Fuel Management and Fire Suppression	Medium	Low	Medium	Medium	Low	Medium
6	Fishing and Collecting	Medium		Low	Low		Low
7	Livestock Farming and Ranching	Medium	Medium	Medium	Medium	Medium	Medium
8	Logging and Wood Harvesting	High	High	High	High	High	High
9	Mining	Medium	Low	High	High	Medium	High
10	Recreational Areas and Activities	Medium	Low	Medium	Medium	Low	Medium
11	Residential and Commercial Development	Medium	Medium	Medium	Medium	Medium	Medium
12	Roads and Railroads	High	Medium	High	High	High	High
13	Severe Weather Patterns	Medium	High	High	High	Medium	High
14	Water Diversion and Impoundments	Medium	Medium	Medium	Medium	Medium	Medium
	Threat Status for Targets and Project	High	High	Very High	Very High	High	Very High

Redwood Creek Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
RC-CCCh-1.1	**Objective**	**Estuary**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-1.1.1	Recovery Action	Estuary	Increase quality and extent of estuarine habitat										
RC-CCCh-1.1.1.1	Action Step	Estuary	Assess feasibility of modifying levees by working with landowners and stakeholders, and prioritize sections of levees for setback or removal.	1	2	USACE	115.00					115	Cost based on fish/habitat restoration monitoring at a rate of $114,861/project.
RC-CCCh-1.1.1.2	Action Step	Estuary	Remove setbacks and levees, guided by assessment.	1	10	USACE						TBD	Cost based on amount of habitat to treat. Cost for floodplain connectivity estimated at $37,200/acre.
RC-CCCh-1.1.2	Recovery Action	Estuary	Rehabilitate inner estuarine hydrodynamics										
RC-CCCh-1.1.2.1	Action Step	Estuary	Assess tidally influenced habitat and develop plan to restore tidal channels.	1	2	USACE	283					283	Cost based on estuary use/residence time monitoring at a rate of $282,233/project.
RC-CCCh-1.1.2.2	Action Step	Estuary	Restore tidal wetlands and tidal channels, guided by plan.	1	10	USACE						TBD	Cost based on amount of tidal estuary to restore. Cost for estuary restoration projects estimated at $41,000/acre.
RC-CCCh-1.2	**Objective**	**Estuary**	**Address the inadequacy of existing regulatory mechanisms**										
RC-CCCh-1.2.1	Recovery Action	Estuary	Increase quality and extent of estuarine habitat										
RC-CCCh-1.2.1.1	Action Step	Estuary	Assess design flaws of the Redwood Creek Flood Control Project that encourage sediment deposition and amend criteria used to assess flood control project.	1	2	USACE	115.00					115	Cost based on fish/habitat restoration monitoring at $114,861/project.
RC-CCCh-1.2.1.2	Action Step	Estuary	Modify flood control project to address design flaws and amend criteria.	1	10	USACE						TBD	Cost based on practices and projects to address design flaws.
RC-CCCh-2.1	**Objective**	**Floodplain Connectivity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-2.1.1	Recovery Action	Floodplain Connectivity	Increase and enhance velocity refuge										
RC-CCCh-2.1.1.1	Action Step	Floodplain Connectivity	Assess watershed and prioritize potential refugia habitat sites.	2	3		115					115	Cost based on fish/habitat restoration monitoring at a rate of $114,861/project. This action step should coordinate with other action steps.
RC-CCCh-2.1.1.2	Action Step	Floodplain Connectivity	Implement projects that create refugia habitats, guided by assessment.	2	10								Costs will vary depending on methods implemented and extent of rehabilitation.
RC-CCCh-5.1	**Objective**	**Passage**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-5.1.1	Recovery Action	Passage	Modify or remove physical passage barriers										
RC-CCCh-5.1.1.1	Action Step	Passage	Modify operation of diversion culverts in South Slough.	1	1	NPS	213					213	Cost based on providing passage at 5 stream crossings at a rate of $42,616.
RC-CCCh-5.1.1.2	Action Step	Passage	Increase passage into Strawberry Creek.	1	2	NPS	43.00					43	Cost based on improving passage at a rate of $42,616/project.
RC-CCCh-6.1	**Objective**	**Habitat Complexity**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-6.1.1	Recovery Action	Habitat Complexity	Improve frequency of primary pools and shelters										
RC-CCCh-6.1.1.1	Action Step	Habitat Complexity	Develop a plan to restore habitat complexity, reduce water temperatures and provide shelter and cover.	2	4	NPS	115.00					115	Cost based on fish/habitat restoration monitoring at a rate of $114,861/project. This recommendation should be coordinated with other action steps to reduce redundancy.
RC-CCCh-6.1.1.2	Action Step	Habitat Complexity	Restore habitat complexity in identified areas.	2	5	NPS						TBD	Cost based on amount of habitat needed to be restored. Cost estimated at $26,000/mile with in project/mile in 50% high IP.

Redwood Creek Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K)						Comment
							FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	
RC-CCCh-6.1.1.3	Action Step	Habitat Complexity	Implement actions to increase the frequency of pool habitats.	2	5	NPS						TBD	Cost accounted for in action steps above.
RC-CCCh-6.1.2	Recovery Action	Habitat Complexity	Increase large wood frequency										
RC-CCCh-6.1.2.1	Action Step	Habitat Complexity	Thin, or release conifers guided by prescription.	2	10	NPS						TBD	Cost based on area to be treated. Cost for riparian thinning estimated at $1,468/acre.
RC-CCCh-6.1.2.2	Action Step	Habitat Complexity	Assess habitat to determine locations and amount of instream structure needed.	2	2	NPS						TBD	Cost accounted for in above action step.
RC-CCCh-6.1.2.3	Action Step	Habitat Complexity	Place instream structures, guided by assessment.	2	3	NPS						TBD	Cost based on amount of habitat to be treated. Cost for instream complexity estimated at $26,000/mile with 1 project/mile in 50% high IP.
RC-CCCh-7.1	**Objective**	**Riparian**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-7.1.1	Recovery Action	Riparian	Improve riparian condition										
RC-CCCh-7.1.1.1	Action Step	Riparian	Remove non-native species that inhibit establishment of native riparian vegetation.	2	3	NPS						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
RC-CCCh-7.1.1.2	Action Step	Riparian	Plant native riparian species in open areas.	2	4	NPS						TBD	Costs will vary depending on methods implemented and extent of rehabilitation.
RC-CCCh-8.1	**Objective**	**Sediment**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-8.1.1	Recovery Action	Sediment	Improve quantity and distribution of spawning gravels										
RC-CCCh-8.1.1.1	Action Step	Sediment	Reduce instream gravel mining.	1	1	USACE						0	This recommendation is based on permitting and management actions and no direct cost of implementation are accounted for. Action is considered In-Kind
RC-CCCh-10.1	**Objective**	**Water Quality**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-10.1.1	Recovery Action	Water Quality	Reduce turbidity and suspended sediment										
RC-CCCh-10.1.1.1	Action Step	Water Quality	Address potentially large inputs of fine sediments (e.g., landslides, failed culverts).	3	3	NPS	229.00					229	Cost based on erosion assessment of 10% of total watershed acres at a rate of $12.62/acre.
RC-CCCh-10.1.1.2	Action Step	Water Quality	Restore large inputs of fine sediments.	3	6	NPS						TBD	Cost based on amount of large inputs needing to be restored. Methods, and cost, vary depending upon type and location of sediment inputs.
RC-CCCh-10.1.2	Recovery Action	Water Quality	Improve stream temperature conditions										
RC-CCCh-10.1.2.1	Action Step	Water Quality	Develop plan that identified areas in need of more shade that currently support steelhead and describes timber management methods that will increase shade over time.	2	1	CalFire	74.00					74	Cost based on riparian restoration monitoring at a rate of $$73,793/project.
RC-CCCh-10.1.2.2	Action Step	Water Quality	Manage forests in identified areas to increase shade, guided by plan.	2	2	CalFire						0	Action is considered In-Kind
RC-CCCh-14.1	**Objective**	**Disease/Predation/Competition**	**Address disease or predation**										
RC-CCCh-14.1.1	Recovery Action	Disease/Predation/Competition	Prevent or minimize reduced density, abundance, and diversity based on based on the biological recovery criteria										
RC-CCCh-14.1.1.1	Action Step	Disease/Predation/Competition	Retain riparian vegetation within flood control project.	1	10	USACE						0	Cost should be minimal as this recommendation is a management decision. Action is considered In-Kind
RC-CCCh-18.1	**Objective**	**Livestock**	**Address the inadequacy of existing regulatory mechanisms**										
RC-CCCh-18.1.1	Recovery Action	Livestock	Prevent or minimize alterations to riparian species composition and structure										

Redwood Creek Chinook Salmon (North Coastal) Recovery Actions

Action ID	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partner	Costs ($K) FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	Comment
RC-CCCh-18.1.1.1	Action Step	Livestock	Identify areas where livestock have access to riparian vegetation, develop plan to fence livestock from area.	3	2	Private	74.00					74	Cost based on riparian restoration monitoring at a rate of $73,793/project.
RC-CCCh-18.1.1.2	Action Step	Livestock	Install fence, guided by plan.	3	2	AC Alliance, Private						TBD	Cost based on amount of fencing needed to exclude livestock from riparian areas. Cost estimated at $3.63/ft.
RC-CCCh-19.1	**Objective**	**Logging**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-19.1.1	Recovery Action	Logging	Prevent or minimize impairment to instream habitat complexity (reduced large wood and/or shelter)										
RC-CCCh-19.1.1.1	Action Step	Logging	Determine appropriate silvicultural prescription to improve size and density of conifers	2	2	NPS						0	Action is considered In-Kind
RC-CCCh-19.1.1.2	Action Step	Logging	Thin, or release conifers guided by prescription.	2	10	NPS						TBD	
RC-CCCh-19.2	**Objective**	**Logging**	**Address the inadequacy of existing regulatory mechanisms**										
RC-CCCh-19.2.1	Recovery Action	Logging	Prevent or minimize adverse alterations to riparian species composition and structure										
RC-CCCh-19.2.1.1	Action Step	Logging	Develop plan that identifies areas in need of more shade that currently support steelhead and describes timber management methods that will increase shade overtime.	2	2	CalFire							Cost accounted for in WATER QUALITY
RC-CCCh-19.2.1.2	Action Step	Logging	Manage forests in identified areas to increase shade, guided by plan.	2	10	CalFire						0	This recommendation should be standard practice. Action is considered In-Kind
RC-CCCh-23.1	**Objective**	**Roads/Railroads**	**Address the present or threatened destruction, modification, or curtailment of the species habitat or range**										
RC-CCCh-23.1.1	Recovery Action	Roads/Railroads	Prevent or minimize impairment to instream substrate/food productivity (impaired gravel quality and quantity)										
RC-CCCh-23.1.1.1	Action Step	Roads/Railroads	Decommission roads, guided by assessment.	2	10	NPS						TBD	Cost based on miles of road identified to be decommissioned. Cost to decommission estimated at $12,000/mile.
RC-CCCh-23.1.1.2	Action Step	Roads/Railroads	Maintain roads, guided by assessment.	2	10	NPS, Private Landowners						0	Action is considered In-Kind
RC-CCCh-23.1.1.3	Action Step	Roads/Railroads	Upgrade roads, guided by assessment.	2	10	NPS, Private Landowners						TBD	Cost based on amount of road network to be upgraded. Cost to upgrade roads estimated at $21,000/mile.