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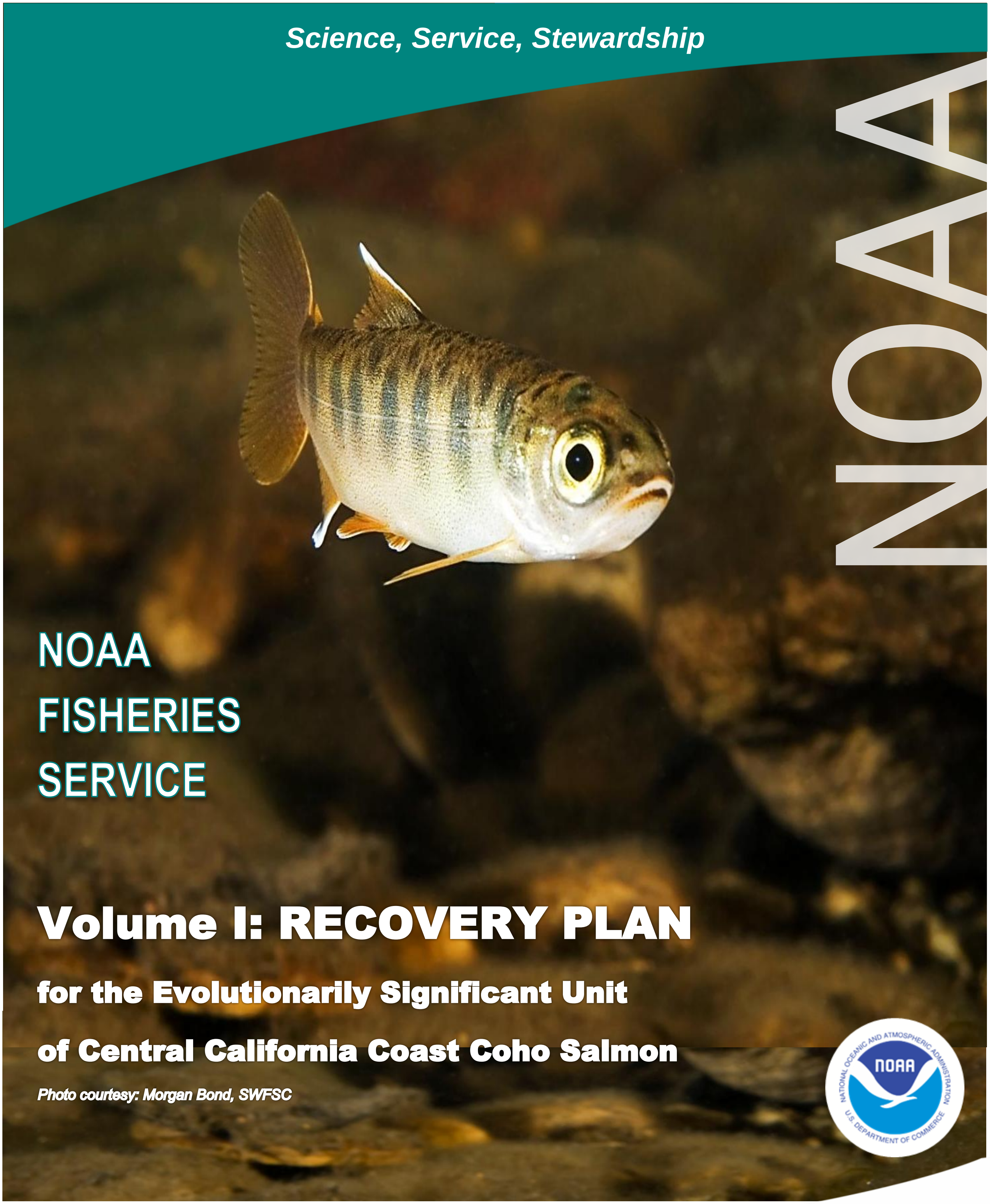

NOAA
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Volume I: RECOVERY PLAN

for the Evolutionarily Significant Unit of Central California Coast Coho Salmon

Photo courtesy: Morgan Bond, SWFSC

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Cover photo courtesy: CCC coho salmon juvenile, Scott Creek, Santa Cruz, Morgan Bond, Southwest Fisheries Science Center

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

COHO SALMON AND RECOVERY

Central California Coast (CCC) Evolutionarily Significant Unit (ESU) coho salmon are listed as an endangered species under the Federal Endangered Species Act (ESA) due to a precipitous and ongoing decline in their population. Since their initial listing in 1996 by NOAA's National Marine Fisheries Service (NMFS), the population has continued to decline and the species is now very close to extinction. Under the ESA, a recovery plan (which is a non-regulatory document) must be developed and implemented for threatened or endangered species. The purpose of recovery plans is to provide a road map that focuses and prioritizes threat abatement and restoration actions necessary to recover, and eventually delist, a species.

BIOLOGICAL FOUNDATION OF THIS RECOVERY PLAN

The CCC coho salmon ESU recovery plan was developed by the NMFS Southwest Region Protected Resources Division, North Central Coast Office (NCCO) recovery team. This plan covers the geographic area associated with the CCC coho salmon ESU on California's central coast which extends from Punta Gorda (southern coastal Humboldt County) south to Aptos Creek in Santa Cruz County; an area of more than 4,100 square miles and approximately 2.6 million acres. The diverse geographic setting includes redwood and oak forestlands, rural working forests and agricultural lands as well as the highly urbanized areas of the San Francisco Bay area. The ESU includes the San Francisco Bay estuary and its tributaries (except for the Sacramento-San Joaquin rivers) where coho salmon historically occurred, but are now extirpated.

The biological setting and foundation for the plan were provided in two technical memoranda prepared by a group of experts and fishery scientists (The Technical Recovery Team or TRT) led by the NMFS Southwest Fisheries Science Center. These memoranda describe the species historical population structure and biological viability and also describe the environmental and biological settings necessary to reduce the risk of extinction. A total of 75 watersheds (*i.e.*, populations) were identified as historically supporting CCC coho salmon by the TRT. These populations were grouped into five Diversity Strata which are geographically distinct areas with similar environmental conditions. Based upon a low extinction risk framework developed by the TRT, a recovery scenario was established by the recovery team that included the following parameters: (1) the populations in four of the five Diversity Strata (the San Francisco Bay Diversity Stratum was excluded) must be viable and (2) low extinction risk spawner targets for individual populations must be achieved and sustained.

Not all populations (watersheds) are needed for, or capable of supporting, recovery in the CCC ESU. The recovery team evaluated quantitative and qualitative information provided by a large suite of stakeholders regarding current presence or prolonged absence of coho salmon, habitat suitability, threats likely affecting habitat suitability and current protective efforts ongoing in the watershed. This assessment led to the selection of 28 focus populations (12 Independent Populations and 16 Dependent Populations) and 11 supplemental populations across four Diversity Strata, as the recovery focus areas. Spawner abundance numeric targets were established for the 28 focus populations, for the four Diversity Strata, and for the CCC ESU.

COHO SALMON LIFE CYCLE

Coho salmon are anadromous (ocean-going) fish and return from the ocean to the streams where they were born to spawn and die. This cycle of life takes them from freshwater to tidal zones to the ocean and back again in just three years. Each transition into a new habitat is associated with a different life stage. Salmon begin as eggs in stream gravels where their parents spawned, they then emerge from the gravels up into the stream flow as juveniles where they will stay for a little over a year before beginning their downstream migration to the ocean as smolts. Their ocean phase as adults usually lasts about two years before they return to the stream where they were born; to spawn and die.

Juvenile coho salmon need cool, clean water that flows unimpaired and unconstrained from the headwaters to the ocean. The suitability of the stream to provide the necessary habitats for coho salmon to survive at each life stage is critical to their persistence in our rivers and streams. This means streams must have: (1) clean loose gravels free of fine sediment; needed for spawning and egg development; (2) adequate pools and natural instream cover for juveniles; (3) connected alcoves and offchannel habitats for juveniles to survive winter flows; (4) clean cool water; and (5) unimpaired passage to and from the ocean.

ASSESSMENT AND PRIORITIZATION

The more impaired a watershed, the less likely juvenile coho salmon will survive to reach the ocean and return as adults to spawn. The suitability of habitats to provide for coho salmon survival across life stages, and ultimately abundant populations, is inexorably linked to factors that impair these habitats or diminish their ability to support coho salmon (*e.g.*, threats). Numerous habitat conditions were evaluated as well as natural and anthropogenic threats to their habitat and survival. The NCCO recovery team evaluated these conditions using best available information for the 28 focus populations using the Nature Conservancy Conservation Action Planning (CAP) analysis.

The evaluation of current habitat conditions and ongoing and future threats led to the conclusion that summer and winter rearing survival are very low due to impaired instream habitats. These impairments were due to a lack of complexity formed by instream wood, high sediment loads, lack of refugia habitats during winter, low summer flows and high instream temperatures. The major sources of these impairments are roads, water diversions and impoundments, residential and commercial development, and severe weather patterns. Comparing results across the ESU, patterns emerged. Conditions and threats worsen from north to south. Populations farthest north in Mendocino County have no very high threats, while populations to the south from northern Sonoma County to Santa Cruz County have high and very high threats.

CURRENT STATUS

The low survival of juveniles in freshwater, in combination with poor ocean conditions, has led to the precipitous declines of CCC coho salmon populations. A recent status review for the CCC coho salmon ESU concluded that the ESU is in danger of extinction (Williams *et. al.* 2011). Estimates by researchers and agencies show a pronounced decline of coho salmon in California over the past 70 years:

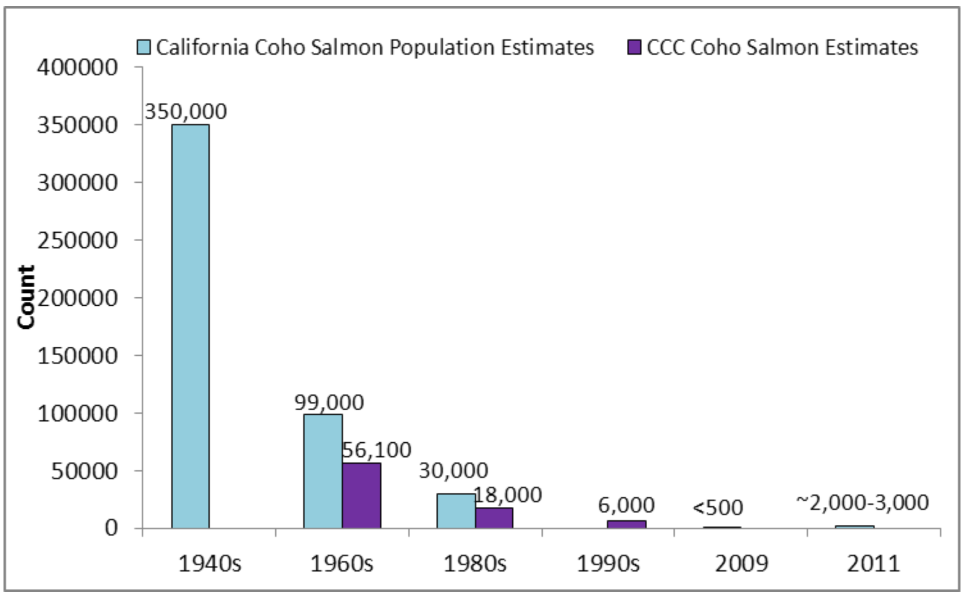

Figure 1: Historical estimates of coho salmon spawners across ESU

TURNING THE PLAN INTO ACTION

The impending extinction of CCC coho salmon necessitated a triage approach for a prioritization of actions to save this species. Recovery actions in the plan are prioritized based on: (1) where coho currently exist (*e.g.*, Core Areas); (2) the likelihood of the action increasing the probability of freshwater survival; and (3) whether it directly improves a condition found poor or a threat found high or very high in the CAP analysis. To prevent their extinction, a phased approach is recommended to focus actions and funding in specific areas called Core Areas and phase restoration work to other areas (Phase I and II). Threat abatement and restoration recommendations were developed site-specifically and for the ESU, Diversity

Stratum, and population (watershed). Taking focused action equitably across the range is essential for ESU viability.

Unlike many other recovery planning efforts in the western United States, little Federal or State lands are available to aid in the recovery this species. The majority of lands in the CCC ESU (approximately 85%) are in private ownership and the majority of extant populations occur on forestlands in Mendocino County. The primary mechanism for coho salmon protection on forestlands is California's Forest Practice Rules, while the primary mechanisms of protection from other land uses are more indirect and associated with State regulations, county ordinances, etc. Developing and nurturing partnerships with private landowners, concerned citizens, various State and Federal agencies, non-governmental organizations will be essential. Furthermore, creating incentives and expanding public/private partnerships for restoration and improving land and water use practices are critical if CCC coho salmon are to be saved. One such option is Conservation Banking.

THE PRICE TAG OF CLEAN WATER AND FLOWING STREAMS

The ESA requires recovery plans to include estimates of the time required and the cost to carry out those measures needed to achieve the plan's goals. This plan estimates CCC coho salmon recovery could take 50 to 100 years with costs for implementing the actions estimated at roughly $1.5 billion. This is a significant amount of money however, it is important to note that this price tag will bring many ancillary benefits because healthy salmon populations provide significant economic benefits. Entire communities, businesses, jobs and even cultures have been built around the salmon of California. Similarly, many communities, businesses and jobs have been lost as wild populations have steadily declined. In other words, unhealthy salmon populations signify lost economic opportunities and an unhealthy environment. Investments in watershed restoration projects can promote the economy through the employment of workers, contractors, and consultants, and the expenditure of wages and restoration dollars for the purchase of goods and services. In addition, viable salmonid populations provide ongoing direct and indirect economic benefits as a resource for fishing, recreation, and tourist-related activities. Every dollar spent on CCC coho salmon recovery will promote local, State, Federal, and tribal economies, and should be viewed as an investment with both societal (*e.g.*, healthy ecosystems and clean rivers where we and our children can swim and play) and economic returns.

<u>YES WE CAN!</u>

The plight of salmon is inexorably tied to the story of the changing landscape. Many naturalists, fishermen and biologists across Europe, Eastern Pacific and North America have monitored salmon and chronicled their decline and extinctions. NMFS alone cannot shift the trajectory of CCC coho salmon from extinction to recovery. Coho salmon recovery will require a united community forming alliances and strategically implementing recovery actions to this single purpose. Salmon survival will depend on us not regarding "…*this inhabitant of the waters with something like annoyance*" (Fearing 1876), but embracing a paradigm that we can live, work and use the land and water compatibly with the needs of the larger ecological community, including fish.

> *"…restoring salmon runs will require reshaping our relationship to the landscape, guided by the humility to admit that we do not know how to manufacture, let alone manage, a natural ecosystem.."*
>
> *David Montgomery 2003*

Their dire status is a call for immediate action to prevent their extinction by, among other things, restoring habitat conditions and watershed processes across their historical range. The situation is daunting, but it is not hopeless. There are few large dams and many areas are not irreversibly lost to urbanization; the CCC coho salmon ESU is represented by coastal communities, redwood forests and people who are connected and care about salmon. To bring CCC coho salmon back from the brink of extinction we must do something uniquely human: contemplate our impact on the environment and shift our actions. Improving and sustaining the human well-being, while sustaining our natural resources (including our wild salmon), are one in the same challenge. By reading the plan and working to implement it, you are placing yourself in a position to save a critically endangered species.

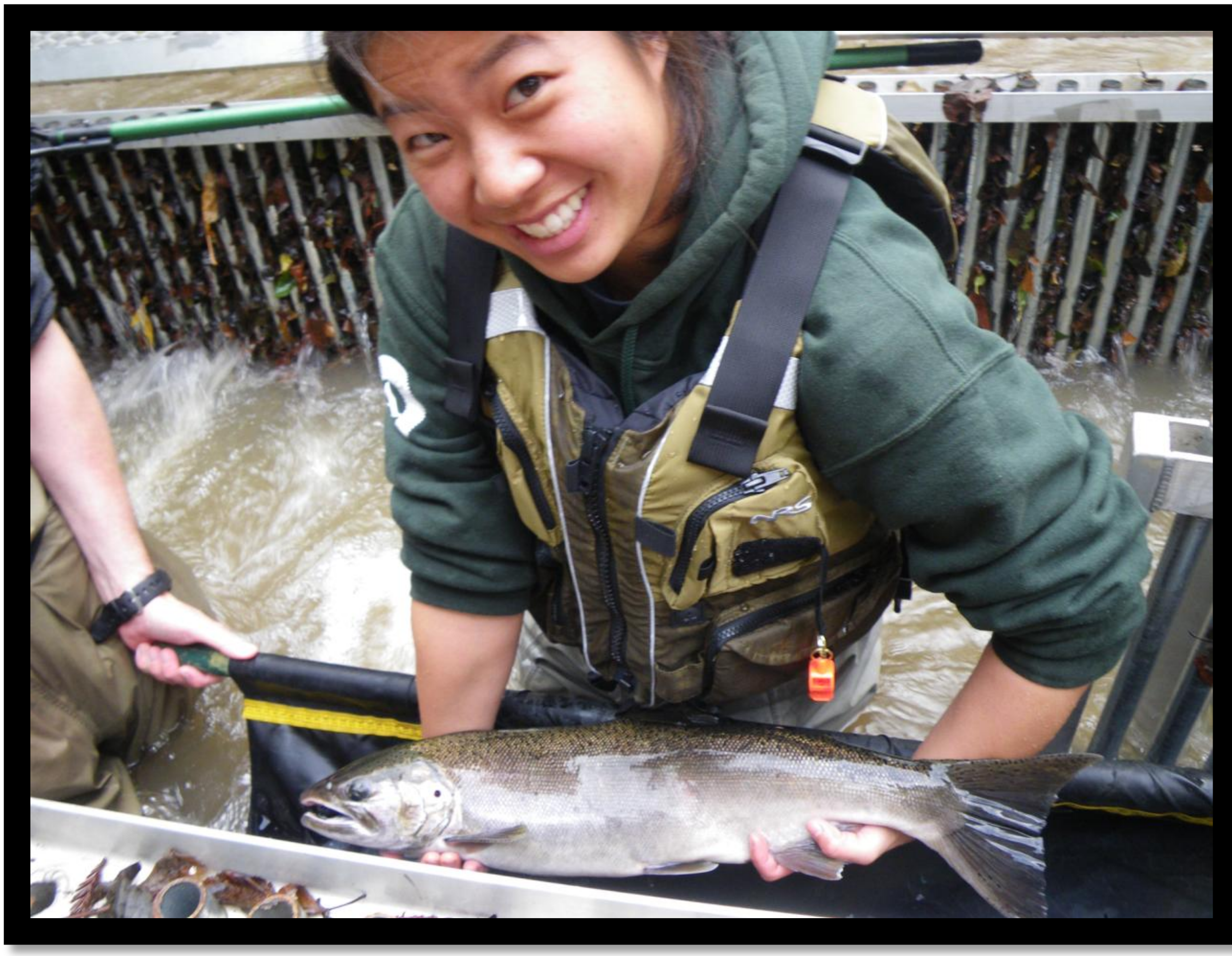

Photo Courtesy 1: CCC coho salmon; Mill Creek, Sonoma County, CA; *Mariska Obedzinski, UC SeaGrant*.

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BACI	Before After Control Impact
BFW	Bankfull Width
BIA	Bureau of Indian Affairs
BiOp	Biological Opinion
BKD	Bacterial kidney disease
BLM	Bureau of Land Management
BMP	Best Management Practices
BOF	California Board of Forestry
BOR	Bureau of Reclamation
BRT	Biological Review Team
C	Celsius
CC	California Coastal
CalFire	California Department of Forestry and Fire Protection

Caltrans	California Department of Transportation
CAP	Conservation Action Planning
CIE	Center for Independent Experts
CCC	Central California Coast
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFPA	California Forest Practices Act
cm	Centimeters
CMP	California Coastal Salmonid Monitoring Plan
CRT	State Coho Recovery Team
CV	Coefficient of Variation
CWA	Clean Water Act
CWPAP	Coastal Watershed Planning and Assessment Program
DBH	Diameter at Breast Height
DNA	Deoxyribonucleic Acid
DP	Dependent Population
DPS	Distinct Populations Segment
ECS	Egg Collection Station
EIR	Environmental Impact Report
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FEMAT	Forest Ecosystem Management Assessment
FERC	Federal Energy Regulatory Commission
FIP	Functionally Independent Population

FMEP	Fisheries Monitoring and Evaluation Plan
FPR	Forest Practice Rules
FR	Federal Register
FRN	Federal Register Notice
FRGP	Fisheries Restoration Grant Program
GIS	Geographic Information System
GRTS	Generalized Random Tessellation Sampling
HCD	Habitat Conservation Division
HCP	Habitat Conservation Plan
HGMP	Hatchery Genetic Management Plan
IP	Intrinsic Potential
IPCC	Intergovernmental Panel on Climate Change
IP-km	Intrinsic Potential per Kilometer
IWRP	Integrated Watershed Restoration Program
kg	Kilograms
Km	kilometers
KRIS	Klamath Resource Information System
LCM	Life Cycle Monitoring
LWD	Large Woody Debris
m	Meter
mg	Milligram
mm	Millimeters
MMWD	Marin Municipal Water District
MOU	Memorandum of Understanding
MRC	Mendocino Redwood Company
MWAT	Mean Weekly Average Temperature
MWMT	Mean Weekly Maximum Temperature
MBSTP	Monterey Bay Salmon and Trout Project
NCCP	Natural Communities Conservation Planning

NCCC	North Central California Coast
NCCO	North Central Coast Office
NC	Northern California
NFIP	National Flood Insurance Program
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA RC	NOAA Restoration Center
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Unit
OLE	Office of Law Enforcement
PACT	Priority Action Coho Team
PCSRF	Pacific Coastal Salmon Recovery Fund
PDO	Pacific Decadal Oscillation
PFMC	Pacific Fishery Management Council
PSMFC	Pacific States Marine fisheries Council
pHOS	Percent of Hatchery Origin Spawners
PIP	Potentially Independent Population
ppm	Parts per Million
PRC	Public Resources Code
PRD	Protected Resources Division
RAMP	Regional Advanced Mitigation Project
RATS	Recovery Action Tracking System
RCD	Resource Conservation District
RWQCB	California Regional Water Quality Control Board
SAMI	Statewide Advanced Mitigation Initiative
SCWA	Sonoma County Water Agency
SEC	Sonoma Ecology Center
SPAWN	Salmon Protection and Watershed Network

SONCC	Southern Oregon Northern California Coast
SWFSC	Southwest Fisheries Science Center
SWR	Southwest Region
SWRCB	California State Water Resources Control Board
SWRO	Southwest Region Office
THP	Timber Harvest Plan
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TRT	Technical Recovery Team
UC	University of California
UCCE	University of California Cooperative Extension
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	US Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VSP	Viable Salmonid Population
WOC	Washington, Oregon, and California
WHR	Wildlife Habitat Relationship

1.0 INTRODUCTION TO RECOVERY PLANNING

"From the most narrow possible point of view, it is in the best interest of mankind to minimize the losses of genetic variations. The reason is simple: they are potential resources. They are the keys to puzzles which we cannot solve, and may provide answers to questions which we have not yet learned to ask."

U.S. House of Representatives, 1973, when enacting the Endangered Species Act

1.1 THE ENDANGERED SPECIES ACT AND RECOVERY PLANS

The Federal Endangered Species Act (ESA) was enacted by Congress and signed into law December 28, 1973, by President Richard Nixon, and has been amended several times (16 U.S.C. 1531 et seq.). The ESA was established to safeguard the Nation's natural heritage by conserving species in danger of extinction for the enjoyment and benefit of current and future generations. The intent of Congress in enacting the ESA, as interpreted by the United States Supreme Court, was "to halt and reverse the trend toward species extinction," "require agencies to afford first priority to the declared national policy of saving endangered species," and "give endangered species priority over the 'primary missions' of Federal agencies" (Tennessee Valley Authority v. Hill, Tennessee Valley Auth. v. Hill 1978).

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) (together referred to as the Services) share responsibility for ESA implementation. Generally, USFWS oversees terrestrial and freshwater species, and NMFS manages marine and anadromous species (species that live their adult lives in the ocean but move into freshwater streams to reproduce or spawn, such as salmon). Either on the initiative of the Services or in response to a petition, the Services make a determination on whether a species is endangered or threatened based on ESA Section 4(a)(1) listing factors (16 U.S.C. 1533 (a)(1)).

These factors are:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

(E) Other natural or manmade factors affecting its continued existence.

The ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range…" (16 U.S.C. 1532(6)). A threatened species is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1532 (20)). A species or subspecies may be listed as threatened or endangered (*e.g.* salmon Evolutionarily Significant Units (ESU) or steelhead (Distinct Population Segment)). Two policies are used for the delineation of these listed units: the "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (56 FR 58612) and the "Policy Regarding the Recognition of Distinct Vertebrate Population Segments" (61 FR 4722).

Legal protections under the ESA are triggered once a species is listed, including Section 4(f)(1) which requires a recovery plan be developed and implemented by the Services unless such plan will not promote the species conservation and recovery. Section 4(f)(1)(B) of the ESA specifies that contents of a recovery plan must include, to the maximum extent practicable:[1]

i. A description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;

ii. Objective, measurable criteria which, when met, would result in the determination that the species be removed from the list; and

[1] In 1988 Congress amended the ESA (S. Rep. No. 240, 100th Cong., 2d. Sess. 111-32 (1988) adding that: "Section 4(f) of

iii. Estimates of the time required and costs to carry out those measures needed to achieve the Plan’s goal (of species recovery) and to achieve the intermediate steps toward that goal.

In addition, recovery plan components and their development are guided by other policies and Acts; some reflecting court interpretations of the ESA. Several of these include: (1) the Interim Endangered and Threatened Species Recovery Planning Guidance Version 1.3 (Interim Recovery Guidance) (NMFS 2010a); (2) the 1994 Interagency Policy on Information Standards; and (3) the Data Quality Act of 2002 directing NMFS to “verify and assure the quality of the science used to establish official positions, decisions and actions” (59 FR 24271).

NMFS (2010a) defines recovery as: “…the process by which listed species and their ecosystems are restored and their future safeguarded to the point that protections under the ESA are no longer needed.”

Plans provide information on: (1) biology, life history and status of the species; (2) threats pertinent to its listing and endangerment; (3) strategies and actions to reverse decline and ameliorate threats; and (4) criteria to measure species responses and threat reductions. They also guide restoration, monitoring and funding activities and can be used by agencies to set priorities for implementation of existing regulations. Federal agencies use recovery plans to fulfill obligations outlined in Section 2(c)(1) and 7(a)(1) of the ESA which require Federal agencies to “utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species.” They guide, for example, other ESA work such as section 7(a)(2) consultations on Federal agency activities or development of section 10(a)(1)(B) Habitat Conservation Plans (HCPs). Recovery plans are used by the Services to determine if downlisting or delisting a species is warranted.

Notwithstanding, for the public recovery plans are guidance documents only and are neither self-implementing nor legally binding.

The Services are required to conduct five-year reviews on the status of the species and its' threats per ESA Section 4(c)(2)) as well as report to Congress every two years on the efforts to develop and implement recovery plans (ESA Section 4(f)(3)). A determination to change the status is made based on the recovery criteria and the same five listing factors that resulted in the initial listing of the species (50 C.F.R. 424.11 (c)).

WHAT'S IN A RECOVERY PLAN?

Site specific actions, objective measurable criteria, and estimates of time and cost designed to provide for long term survival and ultimate delisting of the species.

1.2 RECOVERING PACIFIC SALMON

For millions of years salmon and steelhead (salmonids) thrived in abundance despite natural fluctuations in the marine and freshwater environments, predation, disease, prolonged droughts, flash floods, uncontrolled wildfires, marine oscillations, volcanic eruptions, and climate change – environmental fluctuations that also currently challenge the human setting. Approximately 37 million people live in California, and the human uses of land and water present increasing challenges to the survival and persistence of salmonids. Human population growth and land use have resulted in adverse impacts to California's salmonid habitats. Many streams lack sufficient water or habitat complexity, and are dammed, channelized, or polluted making it more difficult for salmonids to survive. Other factors such as ocean harvest, bycatch and hatchery practices have also had adverse impacts to salmonid survival. Both natural and human factors have contributed to the decline of west coast salmonids. As a result of these declines, 28 Distinct Population Segments (DPS) or Evolutionarily Significant Units (ESU) of salmon and steelhead have been listed by NMFS across the Pacific Northwest.

1.3 CALIFORNIA'S RECOVERY DOMAINS

In 2001, NMFS organized recovery planning for listed salmonids into geographically coherent units called "recovery domains." Of the 28 salmon ESUs and steelhead DPSs listed under the ESA, ten are entirely within, or partially occur in, California. The NMFS Southwest Region (NMFS SWR) organized these ten populations into four Recovery Domains: (1) Southern Oregon/Northern California Coast; (2) North-Central California Coast (NCCC Domain); (3) California Central Valley; and (4) South-Central/Southern California Coast (Figure 2). The NMFS SWR offices responsible for each recovery domain are located in: (1) Arcata; (2) Santa Rosa; (3) Sacramento; and (4) Long Beach. NMFS SWR has a web page to provide ongoing updates and information to the public about the Federal recovery planning process and can be found at: http://swr.nmfs.noaa.gov/recovery/index.htm.

Each recovery domain includes: (1) one or more populations of salmon and steelhead; (2) a Recovery Coordinator responsible for facilitating development of the recovery plan; and (3) a Technical Recovery Team (TRT) led by the NMFS Science Center. While each recovery plan will meet ESA requirements, the process of recovery plan development across the Pacific coast varies based on the unique circumstances of the domain such as species life history, local planning efforts, public interest and coordination, and data availability.

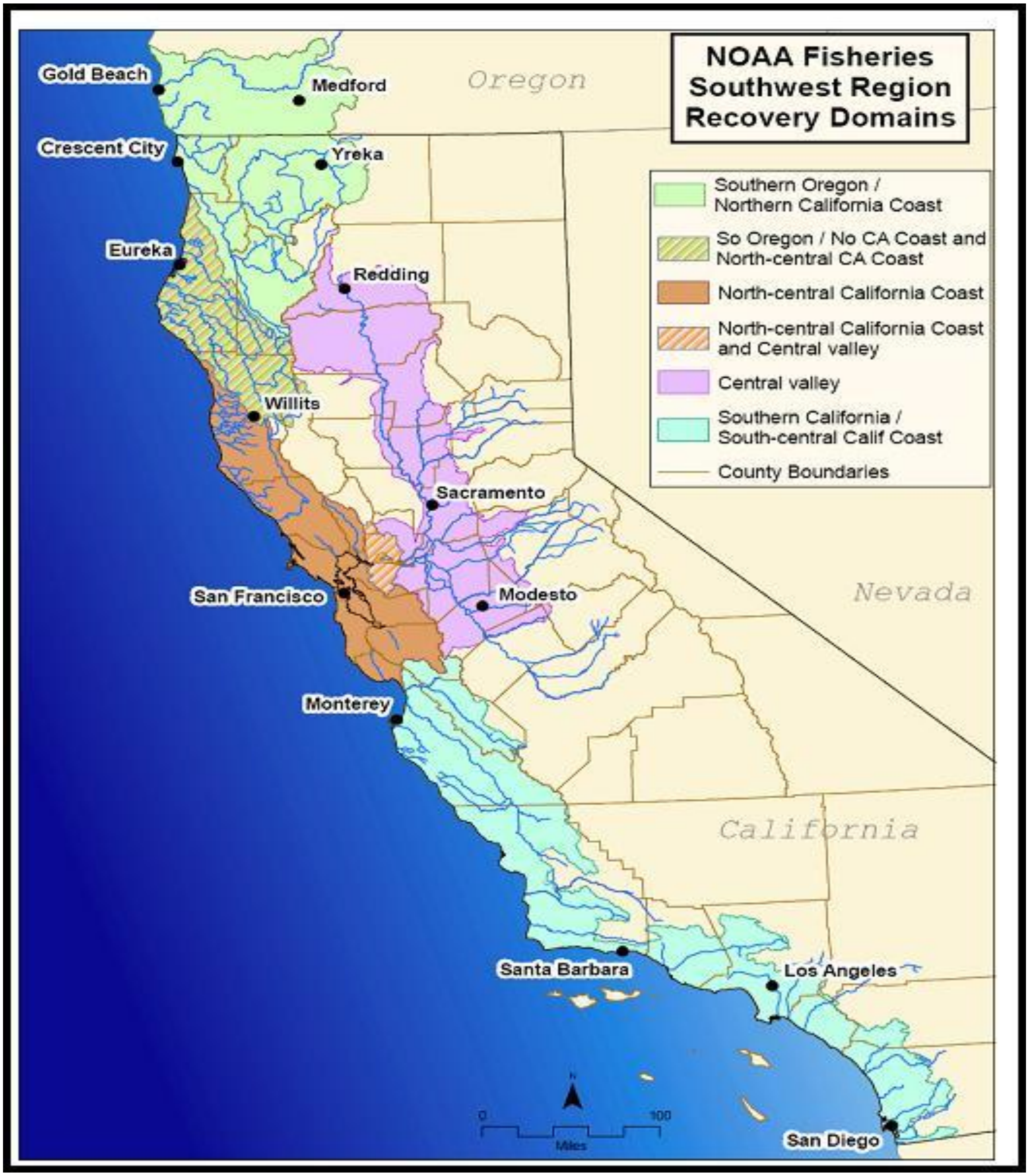

Figure 2: Salmon and Steelhead Recovery Domains in California (with overlapping Domain areas shown with cross-hatching).

The NMFS SWR assembled a team of scientists and experts in 2001, the TRTs, who were tasked to produce technical memoranda outlining the historical population structure (Bjorkstedt *et al.* 2005) and develop biological viability criteria (Spence *et al.* 2008) to be used for the recovery plans. Plan development and finalization is the responsibility of the Protected Resources

Division (PRD) of NMFS SWR and the specific office associated with the recovery domain; a process led by the Recovery Coordinator. Plan development involves a notice of intent to prepare a recovery plan published in the Federal Register, outreach to secure the best available information, coordination work with stakeholders and other entities, application of the TRT criteria and plan creation.

The NCCC Domain includes the following ESUs and DPSs (Figure 3):

1. Threatened Northern California steelhead DPS (NC steelhead DPS);
2. Threatened California Coastal Chinook salmon ESU (CC Chinook salmon ESU);
3. Threatened Central California Coast steelhead DPS (CCC steelhead DPS); and
4. Endangered Central California Coast coho salmon ESU (CCC coho salmon ESU).

The NCCC Domain is preparing two recovery plans: one for CCC coho salmon and one for the remaining three listed salmonids in the Domain. This is the final recovery plan for the CCC coho salmon ESU. The second plan (*i.e.*, Multispecies Plan) is in preparation for co-manager review by state and Federal agencies sometime in early 2013.

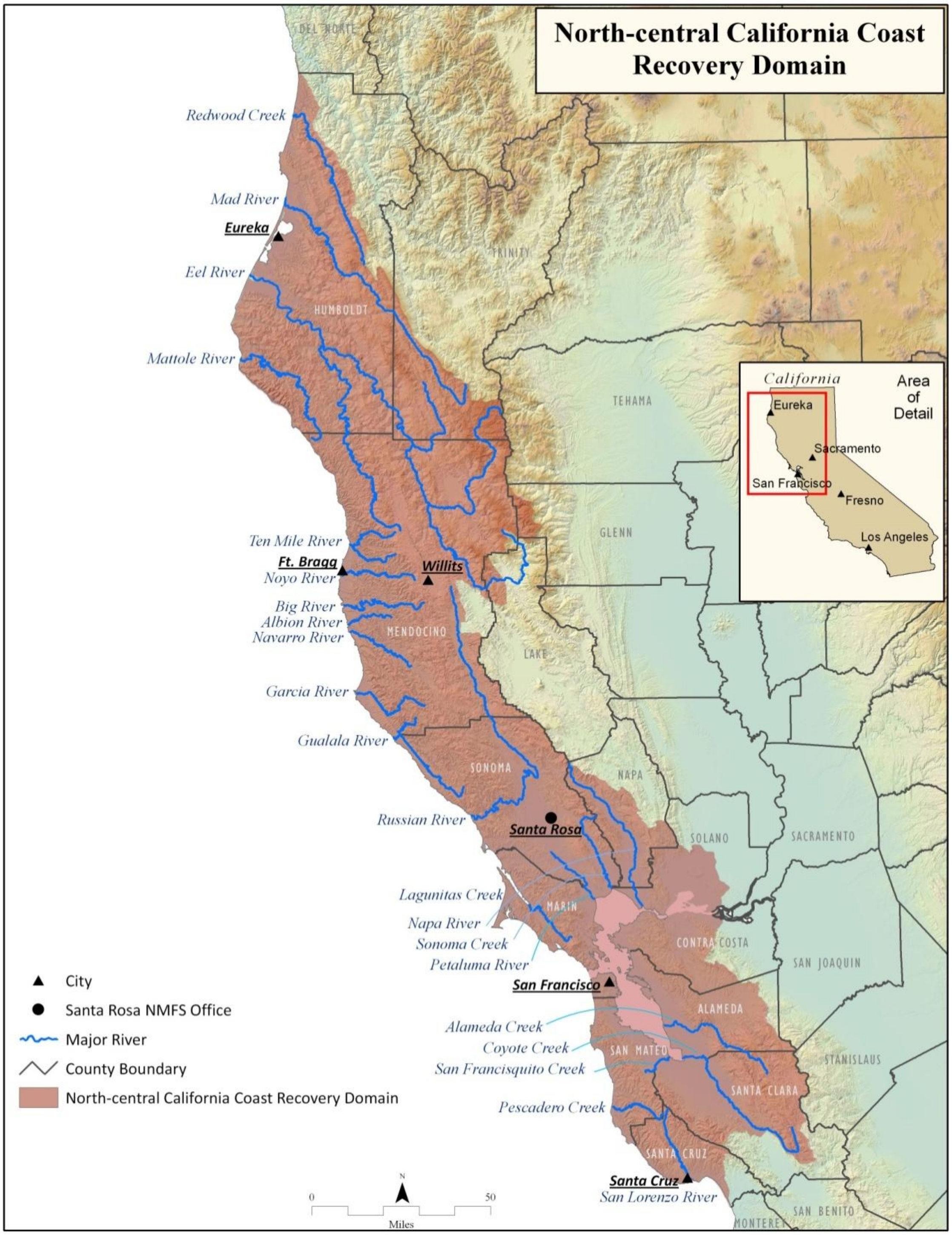

Figure 3: North Central California Coast Recovery Domain

This recovery plan covers the geographic area associated with the CCC coho salmon (*Oncorhynchus kisutch*) ESU; an area of approximately 4,000 square miles across California's central coast extending from the Punta Gorda in Humboldt County, south to Aptos Creek in Santa Cruz County. The geographic setting includes redwood and oak forestlands, agricultural lands as well as highly urbanized areas of the San Francisco Bay area. The CCC coho salmon ESU includes the San Francisco Bay Estuary and its tributaries (except for the Sacramento-San Joaquin rivers) (Figure 4). Historically coho salmon were present in San Francisco Bay but are now extirpated.

There have been several iterations and reviews of the CCC coho salmon ESU recovery plan since 2007, including reviews by: NMFS staff and general counsel, the Center of Independent Experts (CIE peer reviews), co-managers and the public. The public draft was released in March 2010, and the extensive comments received have been reviewed and incorporated where appropriate. We thank all who invested time to review the plan and submitted their recommendations for plan improvements.

1.4 OVERVIEW OF RECOVERY PLAN GOALS

The final CCC coho salmon recovery plan is intended to foster discussion and information/data exchanges regarding the status of CCC coho salmon, habitat conditions and the types of site specific recovery actions that will facilitate coho salmon recovery. The overarching plan goal is to prevent the extinction of CCC coho salmon and ensure their long-term persistence towards a viable, self-sustaining, and eventually harvestable status (*e.g.*, delisting).

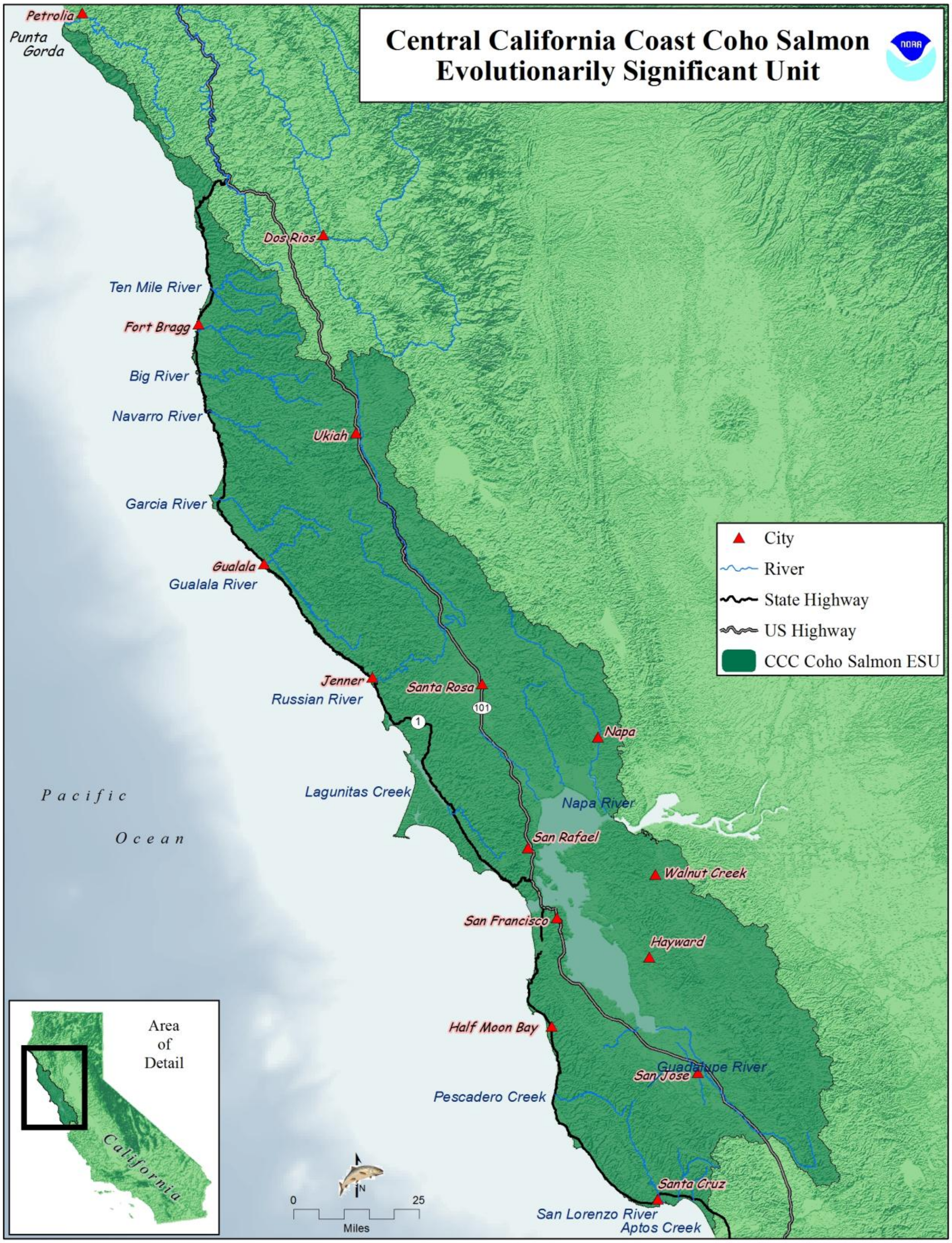

Figure 4: Historical Range of CCC Coho Salmon

To ensure delisting, it is imperative to:

- Prevent extinction by protecting existing populations and their habitats;
- Maintain current distribution of coho salmon and restore their distribution to previously occupied areas essential to their recovery;
- Increase abundance of coho salmon to viable population levels, including the expression of all life history forms and strategies;
- Conserve existing genetic diversity and provide opportunities for interchange of genetic material between and within meta populations;
- Maintain and restore suitable freshwater and estuarine habitat conditions and characteristics for all life history stages so viable populations can be sustained naturally;
- Ensure all factors that led to the listing of the species have been ameliorated; and
- Develop and maintain a program of monitoring, research, and evaluation that advances understanding of the complex array of factors associated with coho salmon survival and recovery and which allows for adaptively managing our approach to recovery over time.

1.5 RECOVERY PARTNERS & LIFE CYCLE CONSERVATION

To prevent extinction of CCC coho salmon and shift their trajectory toward recovery, a few basic requirements must be met: clean water, sufficient stream flows, absence of barriers to their migration, suitable habitats and limited harvest. Accomplishing this goal requires confronting the challenges of the expanding human population and modifying land and water uses to assure a healthy and sustainable environment; it will also require public support and collaboration. Many efforts are already underway with considerable time and money dedicated to the cause of saving salmon. However, changing the trajectory from extinction to recovery will require a shift in status quo. An integrated new conservation strategy termed "Life Cycle Conservation" is needed. Scientists have widely used the life cycle concept, but it is rarely applied to guide conservation, restoration and recovery actions. The marginal successes of efforts to save salmon in California are not totally due to lack of resources, rather they are due to a lack of a grand plan. The implementation strategy is to thus chart a course forward using this plan to connect the societal system of authorities with salmonid life history requirements to ensure coordinated efforts across freshwater, estuaries and ocean environments.

> **"Salmon rely on an interconnected system of forests, oceans, *etc*. Yet human agencies deal with the parts and have subdivided an interconnected system into bureaucracies so separate it all but assures that we're not likely to solve this problem."**
>
> **- David Suzuki.**

1.6 RECOVERY PLAN ORGANIZATION

Recovery is the process of restoring listed species and their ecosystems to the point they no longer require the protections of the ESA. A recovery plan serves as a road map for species recovery—it lays out where to go and how to get there. Without a plan to organize, coordinate and prioritize recovery actions, the efforts of the many agencies, non-profit organizations, tribal entities, stakeholders and citizens may be inefficient, ineffective, or misdirected. Focused implementation can ensure limited resources are used effectively.

The recovery plan is organized into three volumes (Volume 1, Volume II, and Volume III). Volume I provides information on background, methods, results, actions, criteria and implementation. Volume II describes recovery actions for the ESU, Diversity Strata, and populations (*e.g.*, watersheds). For each population information is provided on watershed setting, habitat and threat results, and actions required for the populations' recovery. Volume III contains the appendices which include: (1) the foundational document on population viability developed by the TRT (Spence *et al.* 2008); (2) reports detailing how current conditions and future threats were analyzed; (3) tables used to estimate costs; (4) summary of the habitat data used in the analyses; and (5) a discussion of climate change and marine habitat.

2.0 THE HISTORY OF SALMON

"Dan Jansen looked down from a bluff… "the water was like glass…the [coho] salmon were in rows…they lay there still…every now and then one would wiggle its tail to keep his place in line. They lay there by the thousands as far as the eye could see…"

Thanksgiving on the Garcia River 1930's (Levene et al. 1976)

2.1 LET THE FISH TELL THE STORY

Nearly everyone has a fish story to tell. Some tales talk of a time when "…salmon and steelhead spawning runs were so thick that a person could walk across the stream on their backs" or when the "big one got away"; tales reminding us of a time when coho salmon were abundant and believed "inexhaustible". Even our Roman, French and English ancestors once had fish stories to tell…and they chronicle a species demise.

Photo Courtesy 2: Kelley House Museum, Fort Bragg, California, 1920's

Salmon: Paleolithic Times to Today

Photo Courtesy 3: L'Abri du Poisson, Les Eyzies-De-Tayac; *Charlotte Ambrose, NMFS,*

Twenty five thousand years ago Paleolithic man carved a life-size salmon into the ceiling of a cave in southern France near the Vézère River; *L'Abri du Poisson* is the oldest known artistic representation of a salmon in the world. Evidence of salmon is frequently found in the debris of the French caves and believed to have been a food preference of Paleolithic and Plinian man. Around the world, our ancestors have relied on salmon as a food source for thousands of years. In 200 BC, Celtic France, lore described salmon as keepers of wisdom. Salmon were believed to be the most intelligent of animals for they braved predators, survived in ocean and river waters, and leaped effortlessly through the air in their journey back to their place of birth; when a person touched a salmon they would gain this sacred knowledge. Two depictions of salmon were made on Celtic coins and standing stones a century before Julius Caesar and his soldiers invaded the land. Around 45 BC, "the soldiers of Caesar, when on their victorious march toward Gaul and Britain, they reached the banks of the Garonne, to behold the fish [salmon] cleaving his joyous way upwards as he made his ascent from the sea" (Dickens 1888). Romans prized salmon in their Gallic and British provinces.

Pliny the Elder, a Roman scholar, was the first to write about salmon in 77 AD in his book "*Historia Naturalis*" saying "*…salmon are the most esteemed of fishes…*" and Ausonius in 371 AD in his poem Mosella writes of the beauties and edible qualities "*…Nor will I pass the glistening salmon by with crimson flesh within of sparkling dye…with what colours has Nature painted thee*" (Ausonius 371 AD in Dickens 1888).

Photo Courtesy 4: CCC Coho Salmon Adult, Albion River; *Marilyn Stubbs*

The struggling salmon populations rebounded in England after the first Magna Carta in 1215 AD ordered the dismantling of the King's weirs to confirm the rights of free navigation; giving salmon access to previously restricted habitat. Salmon were of such importance that regulations on salmon fishing go back as early as 1030 AD. Both Scottish and English laws were instituted in the 12th century to remove obstructions, institute fishing restrictions, control pollution and prevent the killing of salmon out of season; some offenders faced a year in the dungeons. King Richard the First, Lionheart, embodied into the English code that for salmon passage there be *"left in all weirs a gap of such size that a 3-year old pig might turn round in it without touching snout nor tail"* (Dickens 1888). In 1406 AD, the King of Scotland set a closed season for salmon in Scottish rivers, an act that remained in place for over 400 years.

Salmon had been in great abundance throughout European countries and so numerous that one hundred pounds of salmon could be bought for an old knife (Dickens 1888) and so common they were cheaper than all other meat.

> *In making comparisons between the supplies of fish and other flesh, we must also recollect that fish, or at least salmon, though higher in money value, cost nothing for their "keep", make bare no pastures, hollow out no turnips, consume no corn but are, as Franklin expressed it, "bits of silver pulled out of the water".*
>
> *Treasures of the Deep, Daniel B. Fearing, 1876*

As the human populations grew, the salmon species declined. New methods of preserving salmon for long periods (*i.e.*, storing salmon in ice) resulted in a boom of large scale commercial trade which fed the masses. Fearing wrote that, "It was no uncommon thing, on some of the upper fisheries of the Tweed, to kill within an hour, a greater number of fish [salmon] than had been killed with the rod during the whole season…butchery, slaughterous and wasteful killing" (Fearing 1876).

The collapse of the salmon continued through the Industrial Revolution with England's increase in factories, dams, pollution, sewage and rampant poaching. Attempts were made to institute new laws to protect salmon and their habitats, but many commercial interests opposed any restriction on fishing and protecting habitats. A rising tide of men started to speak out on behalf of salmon and the need to protect them, one of these men was, J. Cornish who authored a treatise on the state of the salmon fisheries and in 1824 wrote:

> *"The salmon is one of the most valuable fish we have; yet…mankind seem more bent on destroying the whole race of them than that of any other animal, even those that are most obnoxious. Of this there cannot be a stronger and more conclusive proof than their present scarcity, contracted with their former abundance."*
>
> *(J. Cornish 1824 in Montgomery 2003)*

Daniel B. Fearing (1876) in Treasures of the Deep opined:

> *"There is no end to the destructive appliances which man has brought to bear against this lordly fish* [salmon]. *And the public themselves are impatient of legislation. River fisheries are regulated by more than twenty acts and have been the subject of more government inquiries than we care to count…people, who know little of the economy or its' life history, have come to regard this inhabitant of the waters with something like annoyance."*

Charles Dickens, in his weekly magazine "All The Year Round" in 1861 and 1888 wrote:

> *It will doubtless be news to many that, among the silent effects which our present age is producing upon the animal creation – one of those mighty results which silently and slowly grow from day to day, from year to year, till at last they burst upon our view a stupendous fact, a thundering avalanche composed of thousands of minute flakes of snow – is the gradual extinction of the salmon. The cry of "Salmon in Danger!" is now resounding throughout the length and breadth of the land. A few years, a little more over-population, a few more tons of factory poisons, a few fresh poaching devices…and the salmon will be gone…he will be extinct….And are we, active, healthy Englishmen in heart and soul, full of veneration for our ancestors, and thoughtful for the yet unborn…Shall we not step in between wanton destruction…and so ward off the obloquy which will be attached to our age when the historian of 1961 will be forced to record that: "The inhabitants of the last century destroyed the salmon…." (1861)*

"Owing to causes such as drainage, pollution, and the formation of weirs…salmon forsake certain rivers. To see a salmon river in the fullness of its abundance we must cross the Atlantic and visit the waters of the Columbia, Sacramento and other streams which actually swarm with hundreds of thousands of salmon." (1888)

Parliamentary bills escalated from the 1500's to the late 1800's for the protection of salmon:

- 1548 Bill to continue Act against destroying eels and salmon;
- 1562 Bill against using unlawful fishing nets in the Thames;
- 1623 Bill for the preservation and increase of salmon and the fry of salmon;
- 1816 Bill to prevent the destruction of the breed of salmon;
- 1826 Bill for the more effectual preservation and increase of salmon and regulating the salmon fisheries throughout Great Britain and Ireland;
- 1828 Bill to regulate salmon fisheries in Scotland;
- 1842 Bill for the better regulation of the close of time in salmon fisheries in Scotland;
- 1846 Bill to regulate the salmon fisheries in England and Wales;
- 1852 Thoughts on the present scarcity of salmon (Williamson; Rev. Dugald S.)
- 1854 The natural history and habits of the salmon; with reasons for the decline of the fisheries and how they can be improved and again made productive (Andrew Young); and
- 1871 Details regarding the extreme limits beyond which salmon are prevented from ascending rivers due to obstructions.

However, the lack of enforcement, the "old plea of ruin…to undertake such work [salmon protections]" and the "political paralysis over the salmon crisis" (Montgomery 2003) rendered salmon extinct by the end of the 19th century in nearly all English rivers. These catastrophic declines and extinctions were also observed in Scotland, France and many other European counties where salmon had once been in great abundance. Today wild Atlantic salmon in Europe are all but extinct except in only a few countries. In Scotland today, salmon are so rare that commercial fishing is banned, rights to fish for salmon are privately owned and fishing without permission is a criminal offence. To fish for salmon can cost an angler from several hundred to £1,400 per day.

The European story is being recounted today…here on the Pacific Coast for Central California Coast coho salmon with the same warnings of impending extinction; the same calls for action.

> *"Our modern salmon crisis is a strikingly faithful retelling of the fall of Atlantic salmon in Europe..."*
>
> *Montgomery 2003*

Salmon are an integral link between the oceans and our landscapes. They have inspired art, rituals, lore, feasts, literature, poetic expression and have supported humans and their economies for thousands of years. "A salmon crisis is nothing new…if we fail to learn the lessons from history, it will tell us more about ourselves than it will about our salmon" (Montgomery 2003).

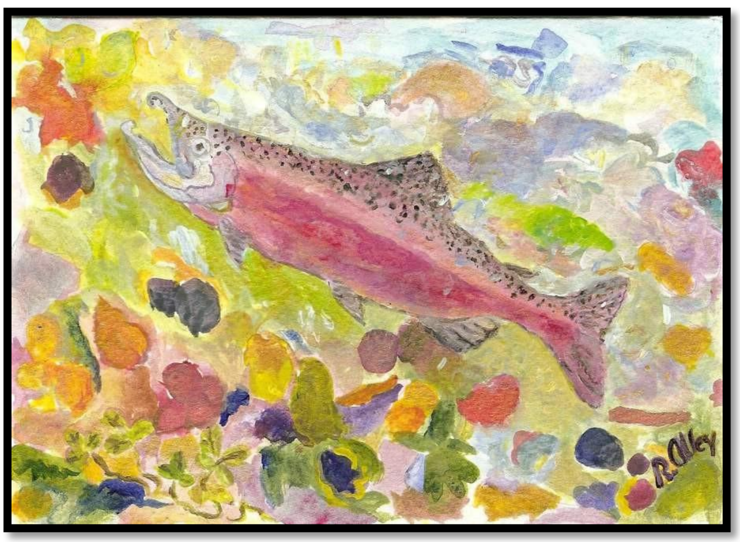

Photo Courtesy 5: A painting of coho salmon by Rosalind Alley, Santa Cruz, CA.

The precipitous decline of coho salmon in California prompted a series of State and Federal listings under the respective Endangered Species Act's in 1995 and 1996 (61 FR 56138). Despite the listings, populations continued to decline resulting in a Federal reclassification of CCC coho salmon from threatened to endangered in 2005 (70 FR 37160). There is no single factor responsible for the decline of CCC coho salmon; however, the destruction and modification of habitat over 150 years has been identified as a primary cause.

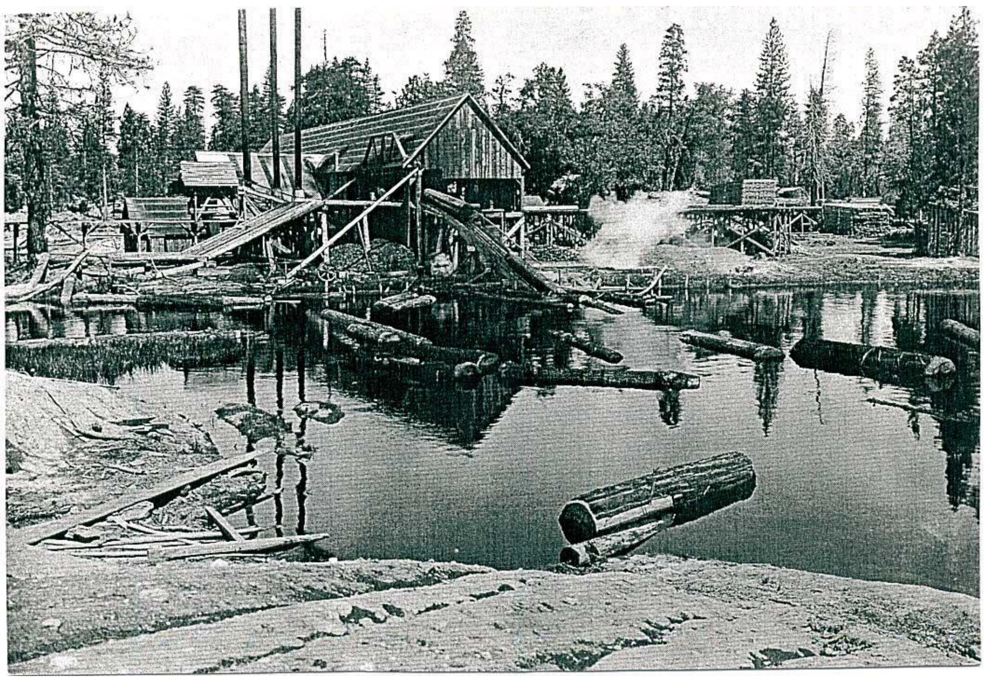

Photo Courtesy 6: Sawmill, Camp Mathers; *Friends of Camp Mathers*

> ***"…[the] sawmill, run by a turbine wheel, having a well-constructed dam, built of hewn logs, well secured across the creek. The dam is twenty feet long and about ten feet high, built in eighteen hundred and sixty-two…no fish have ever passed. Large quantities of sawdust and blocks are deposited in the stream below the dam; fish are found dead, their eyes eaten out by the strong poisonous acids in the water, and their bodies covered beneath the skin with disgusting blisters, like the small pox, whilst the inside is as black as ink. The waters are rendered at times wholly unfit for use…unless some other method be adopted to get rid of it [sawdust], such as burning it or repairing roads with it, there will not be a breed of trout left in a few years."***
>
> ***Wakeman 1880, Pescadero Creek, Santa Cruz County, in Spence et al. (2011)***

Now gone from most streams, their precipitous decline is intimately tied to the human story of the region and the expanding human configured landscape and harvest pressure of the last 200 years. While the fate of coho salmon depends on us, humans have also depended on salmon for hundreds of years. This chapter chronicles the progression of the human influence on California's ecosystem and the slow progression of decline of our natural resources from Spanish settlements, redwood forests clearcutting to urban interfaces threatening the quality of our water, our natural resources and the salmon that have depended on them for over a million years. CCC coho salmon are nearly extinct and some argue nothing can be done to save them; we disagree.

> ***"It is difficult to break old concepts and to think along new lines. But when the evidence points strongly in favor of a change of thought, then it is fair and necessary to do so…"***
>
> ***Shapovalov and Taft 1954***

> ***"The dogmas of the quiet past are inadequate to the stormy present. The occasion is piled high with difficulty, and we must rise with the occasion. As our case is new, so we must think anew, and act anew."***
>
> *Abraham Lincoln, Message to Congress, December 1, 1862*

2.2 THOUSANDS AS FAR AS THE EYE COULD SEE

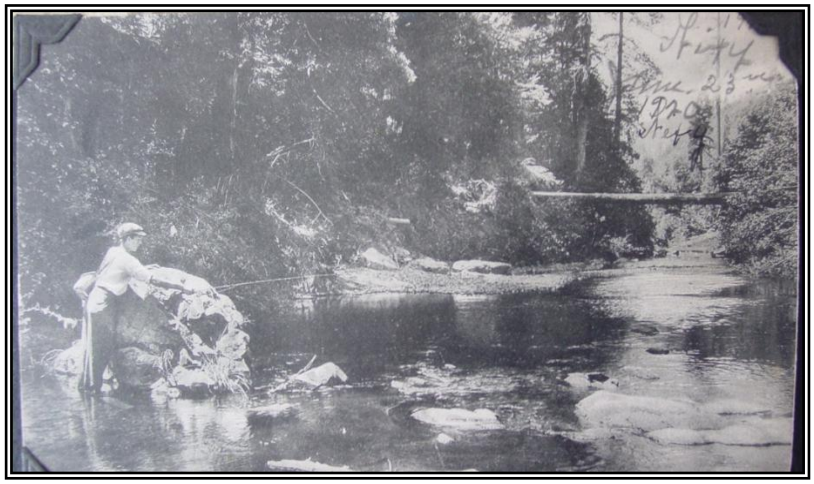

Photo Courtesy 7: Noyo River (1920); *Kelley House, Sheppard Album, Post Cards*

Within the living memories of California's elders are visions of coho salmon in staggering abundance. It was late November in the 1930's when Dan Jansen looked down from a bluff above the Garcia River in Mendocino County and observed thousands of salmon as far as the eye could see; coho salmon on their ascent from the ocean to their natal freshwater stream to spawn and die (Levene *et al.* 1976). Other rivers are remembered for the size of coho salmon their runs such as the Navarro, the Noyo, the Big, the Russian and the San Lorenzo. These runs "were once a mainstay of California's sport and commercial fisheries" (Moyle *et al.* 2008). This species, which had survived millennia of predators, droughts, fluctuating ocean conditions, and other natural hazards, was considered abundant and prolific just fifty years ago (Janssen 2008). Unfortunately, CCC coho salmon would barely persist into the 20th century. By 1991 another lifelong resident of the Garcia River, Lando Franci, reported that "the (c)oho are gone" (Monschke and Caldon 1992).

2.3 COOL, MOIST, AND COASTAL

The distribution of CCC coho salmon at the time of European settlement included most coastal streams from the Santa Cruz County portion of the Pajaro River north to Usal Creek in Mendocino County. Watersheds draining into San Francisco Bay with similar conditions (*e.g.* ample cool water and conifer forests), also supported coho salmon. The first scientific specimens of CCC coho salmon in California were collected from a San Francisco Bay stream, San Mateo Creek in San Mateo County, by Alexander Agassiz in 1860. Historical presence of coho salmon is confirmed for Corte Madera Creek and Arroyo Corte Madera del Presidio in Marin County. Less definitive evidence suggests CCC coho salmon presence in streams further east to include the Napa River, Walnut Creek, San Leandro Creek, Coyote Creek, and the Guadalupe River. A longtime Berkeley resident reported in 1939 that Strawberry Creek, "the one which runs through the University of California Campus . . . [once] supported a run of silver salmon" (Leidy 2007). This observation is supported by archeological evidence predating Spanish settlement (Gobalet *et al.* 2004). While up to a quarter of Bay watersheds may have supported coho salmon, conditions may not have been ideal. The persistence of coho salmon in the San Francisco Bay probably depended on "immigration from coastal populations" (Spence *et al.* 2005). Drier and hotter inland areas probably had intermittent runs, with coho salmon runs likely not surviving during drought conditions. A similar pattern was observed in the Russian River, with coho salmon abundant in the lower watershed, in the cool fog belt near the ocean, but likely did not persist in the middle or upper reaches of the Russian due to a drier hotter climate (Levene *et al.* 1976). In the upper Russian River, when it was wetter and cooler, "occasional migrants were likely present for short periods of time." But in the long run it was "too warm or dry to allow coho to complete their life cycles" (Spence *et al.* 2005). A similar situation existed along the coast south of the Pajaro River, where the presence of coho to at least the Big Sur River (Monterey County) has been hypothesized, but not documented (Anderson 1995). Recently recovered archeological evidence confirmed coho salmon at least as far south as Elkhorn Slough in Monterey County (Gobalet 2008). Evidence suggests that the CCC coho population was likely concentrated near the coast where habitat conditions were ideal. At the edges and interiors of their range, coho

Photo Courtesy 8: Juvenile coho salmon, *Oncorhynchus kisutch*, collected in San Mateo Creek, a tributary of San Francisco Bay, in 1860; *Harvard Museum of Comparative Zoology. Specimen 68471.*

salmon were probably found occasionally, and likely disappeared when conditions became too warm and dry.

Photo Courtesy 9: Early logging operation, Sonoma County c. 1880. *Sonoma County Museum Collection*

2.4 "EN ESPECIAL SALMON"

Salmon, because they represented a significant seasonal food source, have always attracted humans. The settlements near these food sources are reflected in the location of many native villages, and held true when the Spanish began to arrive in California in the late 18th century. Place names like *Pescadero* ("fishing place") illustrate the importance of fish as a food source. At the Carmel Mission (Monterey County), "Father Serra had a lagoon created . . . and they diverted the Rio Carmelo and raised salmon/steelhead in it" (Lydon 2003). Decades later, during the founding of the last California mission, Father Altamira recorded the observation of a native guide, who told him that Sonoma Creek had plenty of fish, "*en especial salmon*" (Altimira 1823). While Spanish and Mexican settlers caught, ate and even raised salmon, it seems unlikely they had much effect on coho salmon populations. The number of settlers was small, the fish abundant, and their habitats relatively unimpaired.

2.5 A CHANGING LANDSCAPE

As the Mission era drew to a close in the 1830s, ownership of land shifted from the Catholic church to private individuals. Land grants of thousands of acres were given out. The mature forests and ample water that coho salmon require were the very resources that attracted the attention of the American settlers; a significant shift in how man would alter the natural resources began. The population of American settlers in Mexican California was slowly increasing, and so was the demand for lumber.

Photo Courtesy 10: *Kelley House Museum*, Mendocino County, CA.

From the earliest mission days, redwoods and other trees had been cut and milled by hand. Two men working a sawpit could produce about 100 board feet of lumber a day (Carranco and Labbe 1975). It could take a year or more to reduce a medium-sized redwood to boards. Several historical coho salmon streams still bear Spanish names which point to early timber harvesting in these watersheds, including Corte Madera Creek, and Arroyo Corte Madera del Presidio. A "*Corte Madera*" is a place to "cut lumber." California's first water-powered sawmill was built in 1834 on a coho stream—Mark West Creek, a tributary of the Russian River. It could process about 500 board feet a day (Carranco and Labbe 1975). A flood washed the mill away before the decade was out, but other mills were soon in operation. General Vallejo built a mill on Sonoma Valley's Asbury Creek in 1839 (Dawson 1998). The Santa Cruz area developed its first mill in 1841, with another built in 1845.

By 1857, there were ten sawmills in the county and by 1864 the number had increased to twenty-eight. This exponential growth of sawmills was not driven by local need, but paralleled the exponential population growth associated with the Gold Rush and developing San Francisco (Figure 5). Santa Cruz County became "one of the major suppliers for the builders" of San Francisco (Lehmann 2000). North of the Golden Gate, mills appeared along the Sonoma coast in the 1840s, and by 1852 on Big River, in Mendocino County (Downie *et al.* 2006). Again, demand from San Francisco drove these mill operations; Mendocino County's population was small enough that its affairs were administered by Sonoma County until 1859.

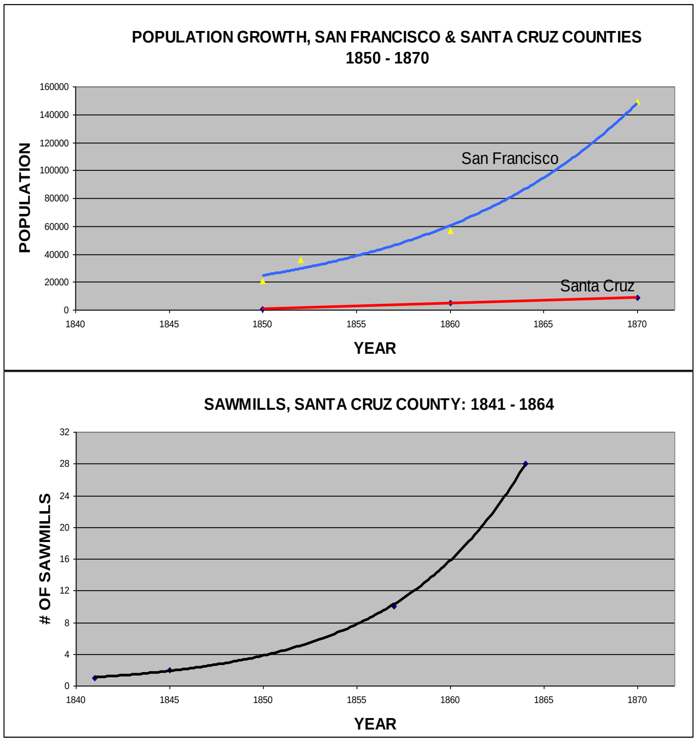

Figure 5: Growth of sawmills and human population

Coho salmon habitat was at the center of this logging boom. Many coho salmon streams were named after their mills or mill owners: Mill Creek in Marin County; Mark West Creek in Sonoma County; and Waddell Creek in Santa Cruz. Usal Creek in Mendocino, is said to be named for the initials of the "United States of America Lumber" Company. Likewise, Duncan's Mill gave its name to the small town on the Russian River where it once stood. How did this first wave of logging affect coho salmon? On Mendocino's Big River, and elsewhere, early logging occurred adjacent to rivers and large trees were cut from the riparian zone, floated downstream to impoundment near a mill (Downie *et al.* 2006). This method resulted in dammed streams, changes in flows and channel features and increased stream temperatures from reduced riparian shade. Coho salmon were now faced with barriers to their migration from the sea, warm summer temperatures for their young and a completely altered stream system for the young to mature and outmigrate to the sea.

South of the Golden Gate, streams did not have the volume of water to carry logs, so they "had to be skidded down using oxen, or processed where they fell. The best the lumbermen could do was fell the redwoods . . . and split them on site, carrying the posts, pickets, or shakes out . . . on mules or wagons." Coho salmon spawning beds and rearing pools were altered as "roads were laid out in stream bottoms or drainage swales, and no attempts were made to control the resulting erosion. Gullies from these early operations are still visible… Landslides and slumps were often precipitated by these logging practices… Many of today's mapped landslide deposits probably date from this period" (County of Santa Cruz 1976).

Photo Courtesy 11: *Kelley House Museum*, Mendocino County, CA.

A variety of products were produced from forests of California's central coast—lumber, shingles, fencing, as well as tan oak bark for tanning leather, a major industry at the time. Redwood was, "the best wood known for railroad ties . . . Sonoma and Mendocino Counties provided ties for the Central Pacific Railroad [the first trans-continental railway]. Every eastern train that crosses the Sierra rolls over the product of the forests of Sonoma . . . ties from the county synchronized to "maximize the flow."

To avoid log jams, men cleared the stream channels in the drier months of "all obstructions and debris." These log drives had severe consequences for coho salmon: they flushed away gravel spawning beds; deposited huge amounts of fine sediment in the estuary; destroyed rearing pools by eroding streambeds, in some cases to bedrock; and created jams which may have acted as migration barriers. This act, called "splash damming" continued into the early 1930s and more than 70 years later, the devastating effects of these log drives are still apparent. The Big River watershed was recently described as being "beat up the worst" of any river on the central coast, due to this practice (Downie *et al.* 2006). Splash dams were also used on the Garcia and Navarro Rivers and other parts of the Mendocino Coast.

2.6 "A MOVING MASS OF TURGID FILTH"

By twentieth century standards, the pace of early logging was modest. About a thousand acres a year were being harvested in Sonoma County during the 1870s (Thompson 1877), a rate that may have been nearly sustainable for both trees and salmon. However, downstream the operations of the mills themselves caused other problems. Sawmills produced tremendous quantities of sawdust. A common practice in the 19th century was to dump the waste into the same stream that powered the mill. As early as 1867, the *Santa Cruz Sentinel* reported that, "the sawmills on the Pescadero have . . . injured the fishing, from the sawdust running down the creek." Four years later, an article in the same newspaper described how the "impact of sawmills on trout fishing was always a matter of contention in the communities along the streams flowing out of the redwood-covered canyons of the Santa Cruz Mountains." For years it had been the practice of lumber companies to remove sawdust from the various mills by sluicing it into the running streams. This system had become universal . . . "until our pure limpid streams were discolored, and the water became, in some instances, as black as tar,--a moving mass of turgid filth" (Santa Cruz Sentinel 1871). The problem was not limited to sawmills, creeks were sees as handy disposal systems. In Santa Cruz, Bausch Beer Gardens lost business on days a nearby winery dumped pungent tailing in the creek and the [San Lorenzo] river ran red when Kron's tannery empties a tanbark vat" (Gibson 1994).

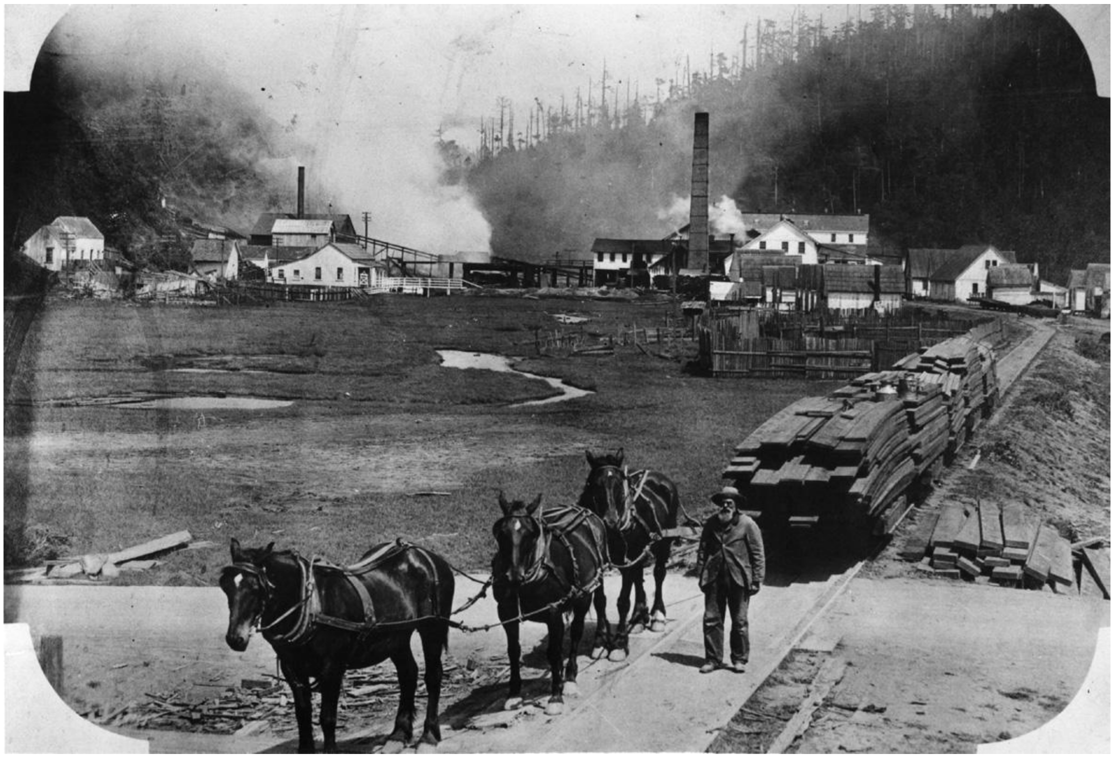

Photo Courtesy 12: Mill, Mendocino County, CA.

Some of the earliest environmental protection laws in California were passed during this era. In Santa Cruz "local laws curbed mill dumping of sawdust." North of the Golden Gate, the Big River Mill, near the town of Mendocino, was temporarily shut down in 1889 to instigate a new sawdust disposal system required by the County Fish Commissioner (Downie *et al.* 2006), and the following year, the *Point Arena Record* reported the mill at Gualala was "constructing a large furnace . . . to burn their sawdust instead of dumping it into the river" (Mendocino Beacon 1890).

Stream and rivers were also used for other purposes besides log transport and waste disposal. In 1873, it was reported that "every dairyman along the many streams which drain the western slope of the Santa Cruz range," was preparing to tap these creeks for irrigation and domestic use. These included waterways like San Vicente Creek (where coho salmon still persist), and most "…streams along the coast south of Waddell's creek, to the Pajaro." Water which flowed into the ocean rather than put to human uses was considered "waste water" (Santa Cruz Sentinel 1873).

2.7 HOOKS, NETS, PITCHFORKS, AND DYNAMITE

Photo Courtesy 13: Fishing Fleet at Noyo, Mendocino County, circa 1930; *H.H Wonacott, Mendocino County Museum.*

The impacts were having a noticeable effect on salmon and trout numbers. In 1878, A.J. LaMotte, who arrived in Sonoma Valley in the early 1860s, lamented, "(s)ome years back great numbers of trout could be taken, but as fishermen increased, the fish rapidly decreased in number" (Munro-Fraser 1880). The same situation was true in at least one tributary of the Russian River. A Russian River local newspaper in the 1870's reported that Santa Rosa Creek, "once a splendid stream for trout" had gotten so bad that "now no one thinks of trying to fish there" (The Sonoma Democrat 1876). Besides steelhead, Santa Rosa Creek also supported coho salmon (Merritt Smith Consulting 1996).

Photo Courtesy 14: Noyo River Post Card 1930's; *Kelley House Museum, Mendocino County, CA.*

In addition to sport fishing, coho salmon were commercially harvested in a few places during the 1860s, including Pescadero and San Gregorio Creeks in San Mateo County (Gobalet *et al.* 2004). Two decades later, over 183,000 pounds of salmon were canned near Duncan's Mills on the Russian River (Sonoma County) in 1888. The size of the fish, 8-20 pounds suggest many were coho salmon. Coincidentally or not, declining numbers of salmon were first noted in the Russian River that same year (Steiner Environmental Consulting 1996).

It is impossible to know exactly how much impact commercial and recreational fishing had on salmon populations in that era. The popularity of fishing is evidenced by this account: "(w)hen the railroad reached Santa Cruz in 1876, it was the river as much as the beach that drew tourists. Santa Cruz promoted itself as a 'sportsmen's paradise,' with most hotels only two blocks from the river. Hotels and downtown campgrounds saw a business boom each year at the start of fishing season" (Gibson 1994). There were no limits or fishing regulations in those days. Fish were caught with hooks, nets, pitchforks, fish wheels, even dynamite. In the San Lorenzo River (Santa Cruz County), "railroad workers . . . while building the South Pacific Coast Railroad in the late 1870s, often used explosives to 'fish.'" (Lydon 2003). Though no longer legal, the same technique was used by at least one individual in Sonoma Valley as late as the 1930s (Dawson 1998). Most historical sources lump several species under the term "salmon," so it is difficult to estimate what impact 19th century fishing had on the coho salmon population. Hard to catch with hook and line (Janssen 2008), spawning runs would have been vulnerable to nets, pitchforks, fish wheels, and dynamite. The coho salmon life cycle makes them especially sensitive to human impacts, suggesting their population followed the general decline of California "salmon" and "trout" recorded during the mid-19th century, perhaps more steeply than other species.

Photo Courtesy 15: Salmon Spear, *Kelley House.*

Declining numbers of salmon and trout prompted action. As mentioned, the dumping of waste into streams was prohibited. The California Fish Commission was created in the 1870s, and established early fishing regulations. The state's first fish hatchery was built on a tributary of the Sacramento in 1872.

Hatcheries soon proliferated, built with both public and private funding (including railroads hoping to attract tourists). While early hatcheries raised steelhead and Chinook salmon, "propagation of coho dates back to at least the 1890s" (CDFG 2002) Beginning around 1906, the San Lorenzo River was stocked with coho salmon and steelhead (Becker and Reining 2007). It was common practice in those days to plant fry (fish a few months old or less), which have a much lower rate of survival than larger, year-old smolts. Hatcheries also used eggs from watersheds as far away as Oregon and Washington, and the young fish were not genetically adapted to the waters into which they were released (Bjorkstedt *et al.* 2005). However, in general, coho salmon planting was "infrequent before 1929" (Spence *et al.* 2005) and for many reasons, planting hatchery fish probably had little to no effect on wild coho before the mid-twentieth century.

2.8 BALES OF SMOKED COHO

Photo Courtesy 16: Coho salmon. "Mouth of Garcia, Oct. 1932. This is what we caught." *Sheppard Album, Kelley House Museum, Mendocino, California*

Initially, the center of California's salmon industry was the Sacramento River, with its abundant runs of Chinook salmon. As that fishery declined, "commercial trollers began harvesting salmon offshore. By 1904, some 175 sail-powered fishing boats were operating out of Monterey Bay" (Lufkin 1991). Coho salmon that had survived more than a year in freshwater and following migration out to sea, faced a new challenge. Human activity was now affecting coho salmon at every life stage. In Mendocino County, commercial fishing began near Fort Bragg, on the Noyo River in the 1890s with "a few men using dories or rowboats on the river," who "netted or seined silver salmon in the winter"

(Stebbins 1986). Elmer Walker, who was born on the Garcia River in 1889, recalled how his father sent fish to San Francisco:

> *"They had what they called a card. [It] had timbers that would float, with slots in there so that the fish couldn't get out. But they'd put them right in there and keep them alive . . . everything was shipped by boat at that time. They towed the cards. From where it was located it wasn't too far down to the mouth of the river . . . and then they had a dip net that they dipped them out with when they got ready to ship them. They were shipped in wooden crates and nailed up and sent to San Francisco. They knocked 'em in the head. Salmon and steelhead: there was no designation as far as marketable fish".*

Photo Courtesy 17: Sheppard Family Photo Album, *Kelley House Museum Mendocino County, CA.*

Roy Bishop, who also grew up on the Garcia River, remembered seeing "bales of smoked coho" that his grandfather sold. This was around 1925 (Levene *et al.* 1976). By the 1920s, California's salmon and steelhead streams had earned worldwide acclaim, and the "economic value of the sport fishery exceeded commercial fishing by two-to-one" (Lufkin 1991). Special trains brought anglers from the San Francisco Bay Area to fish for adult coho salmon in Lagunitas Creek (Brown and Moyle 1991). By one account, "the San Lorenzo River became the number one fishing river in northern California, and remained so for half a century." At the same time, the advent of the automobile granted fishermen ready access to once remote streams. Soon after, the Great Depression saw a resurgence of subsistence fishing as people fell on hard times. Vernon Piver recalled:

> *"Times were really tough. My mother told me, to this day, she don't have a taste for smoked salmon, because they netted fish on the Garcia River and my grandfather smoked salmon and sold them for revenue, to pick up a few nickels and dimes. One of their main staples was that smoked fish" (Russell and Levene 1991).*

While diminished to some degree from their numbers a century before, CCC coho salmon continued to occupy most of their original range. To some extent the land was recovering from the 19th century logging. By 1942, the Big River basin, whose channels had been so badly "beaten up" by the use of splash dams, had "some of the finest redwood second growth in the state"(Downie *et al.* 2006). World War II may have granted coho a temporary reprieve from fishing and planting, because industry focused on building weapons to fight the war. But ultimately, the war had repercussions that reached to the heart of the coho salmon's domain.

2.9 WAR TANKS TO BULLDOZERS: BUILDING A MOONSCAPE

In the late 1940s, "the technologies of World War II . . . spun off the highly mobile track-driven bulldozer," which delivered the large trees of the central coast "for conversion to two-by-fours for a national building boom driven by the affluence of the returning soldiers" (House 1998). In essence, the industrial capacity used to build tanks was retooled into building bulldozers. Transient "gypsy loggers and sawmillers invaded the region with Gold Rush zeal"(Lufkin 1991). The combination of heavy equipment and the way it was used caused significant erosion and sediment delivery to streams. The equipment's size required the use of wide skid roads. Water breaks to curb erosion were rarely installed. To brake going downhill, tractor drivers scraped the ground with their blades. The construction of logging roads on unstable ground was common practice. Even worse, a 1962 Fish and Game survey of the Garcia River (Mendocino County) noted that "numerous roads were constructed in the stream channels," themselves, "oftentimes moving the stream out of its natural channel" (Monschke and Caldon

1992). Trees were harvested "practically to the bottom of small gullies" (Downie *et al.* 2006). Individual "layouts" were created, up to 300 feet long and 20 feet wide, to prevent falling trees from shattering on impact. By the end of 1956 it was estimated over 1000 miles of California streams had been damaged. The 1962 survey of the Garcia found more than 85 percent, of the channels had suffered some damage, and more than a third was "severely damaged" (measured by length). A person who saw it from the air in the late 1960s described the upper Garcia as "…a moonscape. Blue-line creeks were skid roads" (Monschke and Caldon 1992). Even in an average year, such conditions caused serious problems for coho: "These hills are prone to erosion in the first place, so if you build roads and take out the trees, it's going to cause sedimentation" (Craig Bell quoted in Monschke and Caldon 1992)).

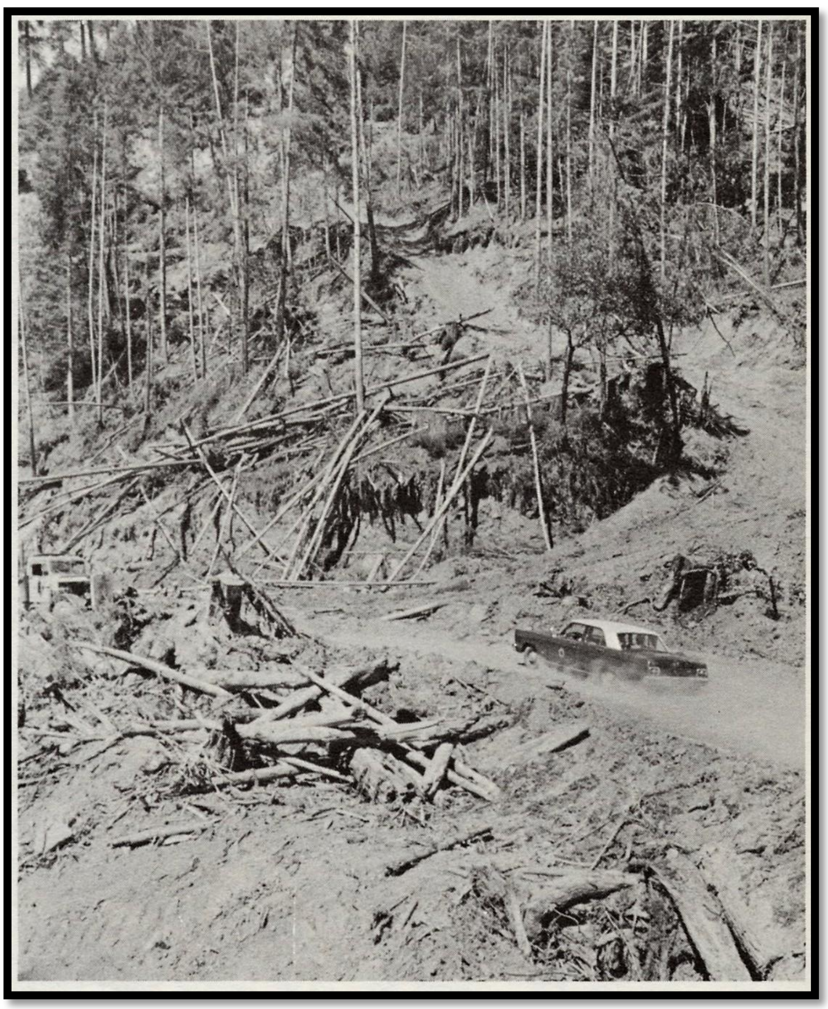

Photo Courtesy 18: Salmon Creek, Mendocino County, CA; *David Wright*.

The intensity of the timber harvest was summed up by a resident of the Butano/Pescadero watershed: "They built a road to every tree they cut down" (Environmental Science Associates *et al.* 2004). By the 1970s, "more than 80 percent of the virgin forests had been cut, milled, and shipped," in most watersheds along the central coast (Lufkin 1991). In an unfortunate coincidence, two of the region's biggest floods on record happened in 1955 and 1964. Several residents of the Butano Creek (San Mateo County) basin reported that "the cause of the first damaging flood in the watershed . . . was due to logging undertaken by the Santa Cruz Lumber Company . . . beginning in 1955." Trout fishermen saw fishing decline rapidly: "(t)he creek silted up so bad . . . that the pool at the bottom of the 'Falls' was completely silted in." A resident who flew over the area at the time reported "hundreds and possibly thousands of landslides in the upper Butano" (Environmental Science Associates *et al.* 2004). Silt from landslides clogged spawning gravel and filled rearing pools, and landslides themselves directly blocked streams, creating migration barriers for coho salmon.

Photo Courtesy 19: Hal Janssen with two coho salmon caught in the San Lorenzo River, 1964. *Alameda Creek Alliance*

Attempts at flood control were made in response to these events. On the lower San Lorenzo River in the City of Santa Cruz, the river was leveed for flood control and "all riverside forests were stripped and the river was straightened by the Army Corps of Engineers." These actions "transformed the river from a tree-lined and very scenic part of town, to a sterile drainage ditch. The siltation of the channel and the lack of deep water pools of water, coupled with low summer flows and a lack of shade . . . decimated fish populations." Where before, "trout and salmon had been routinely caught in the city," now "the river was barren of most wildlife," and "the fish populations declined" (McMahon 1997). Today, although the San

Lorenzo River runs right through the center of the City of Santa Cruz, most building face away from the river, no restaurants over look its banks, and it is generally viewed as more of a nuisance than an attribute.

2.10 THE BABY BOOM

The postwar building boom increased the demand for other building materials besides lumber. In the early part of the twentieth century, gravel mining was conducted by hand in local streams. Elders in Sonoma Valley remember people driving small trucks down to the creek. "A number three scoop [shovel] and a strong back, that was how you did it" (Dawson 2002). Local gravel went to construct nearby buildings, bridges, and roads. The Garcia River saw its first commercial gravel operation in the 1930s (Monschke and Caldon 1992), but it was not until after the war that such operations increased to the point where they were significantly impacting rivers and streams (Dawson 2002).

Population growth drove the postwar boom. The number of people living in the Russian River basin increased 400 percent in the second half of the 20th century. More people brought a corresponding increase in the demand for water. Dams of every size were constructed on coho salmon streams throughout the region. Two large dams were built on the Russian River; Coyote Dam was completed in 1959, and Warm Springs Dam in 1982. While these dams pose a barrier to other salmonids, these migration impediments were probably not significant for coho salmon, as they likely did not spawn in the middle or upper Russian River. Downstream, however, these dams altered the dynamics of the river, reducing peak flows, reducing the magnitude of channel forming winter flows, eliminating replenishment of spawning gravel, and increasing summer flows more than 15 to 20 times above historical levels (Steiner Environmental Consulting 1996). This last effect may be the most significant. During the warm months, coho salmon rely on the cooler water at the bottom of deep pools. Higher summer flows raise the temperature of this cooler layer by mixing it with warmer surface waters.

Medium-sized dams were built in smaller coho salmon watersheds, such as Lagunitas and Nicasio Creeks in Marin County. Nevertheless, the small dams may have had the greatest cumulative effect. Five hundred small dams were counted on key CCC coho salmon tributaries of the Russian River in 1996 (Steiner Environmental Consulting 1996). Besides acting as migration barriers on the lower Russian's coho salmon streams, these dams reduce spawning gravel and summer water supply downstream.

2.11 AN AMAZING TIME TO LIVE

As the second half of the twentieth century progressed, coho salmon faced ever-increasing pressures at every stage of their life history: they were cut off from some of their prime spawning and rearing habitat in many streams, they laid their eggs in silted spawning beds, they lost cool summer refuges at the bottom of deep pools, and faced increasing commercial fishing at sea. It is really no surprise their numbers declined; however, it did not happen at once. During the 1960s and 1970s, commercial and sport fishermen were still seeing and catching coho salmon.

In places, coho salmon were still abundant. Hal Janssen, who grew up on Alameda Creek on San Francisco Bay in the 1950s, has spent a lifetime on the central coast, fishing "300 days a year . . . for thirty-five, forty years." Hal called the fifties "an amazing time to live." Speaking of coho salmon, he recalls the abundance of coho salmon in Big River, Ten Mile River and other coastal streams. "Huge schools and schools of them in California in the fifties and sixties in the San Lorenzo River and Pescadero" he has said (Janssen 2008). As fishing declined on the San Lorenzo in the early 1960s, he moved north, to the Russian and then up into Mendocino County. One September a friend called him up and said, "Come to the Garcia; you can't believe it. It's loaded with silvers (coho); they're jumping everywhere!" Sure enough, when he arrived on the Garcia River, coho salmon "were everywhere."

Of the Navarro River, he said, "(t)he tidewater used to be absolutely packed with salmon. Packed! You'd go down there in September, it was more packed than the Garcia was." Hal witnessed first-hand the decline of coho salmon and other salmonids. For the Navarro River Hal says: "Now there's none! They're gone!" and attributes the decline to a number of things, including: poachers, who take advantage of the lack of game wardens in the field; the flood of 1955, and predation by marine mammals (Janssen 2008). Today Hal concentrates his fishing efforts in stillwater and lakes since the rivers no longer support a suitable experience.

2.12 COMPUTERS, ACCIDENTAL ANGLERS AND MILLIONS OF FRY

Coho salmon numbers are estimated to have plummeted statewide from as many as 500,000 in the 1940s, to as few as 13,000 by 2002 (CDFG 2002) (CCC coho would have represented a fraction of this number). Moreover, while most coho salmon in the 1940s were native to their streams, as few as 500 purely native fish remained. The gene pool of the rest has been diluted by out-of-basin plantings. A troubling development is the disappearance of coho salmon from many parts of their range, the general pattern being from south to north. In Santa Cruz County, the Pajaro River and Soquel Creek lost their native runs around 1968, followed by Aptos Creek in 1973. In 1957, the San Lorenzo River was called "the most important steelhead and salmon fishery " south of the Bay area (Becker and Reining 2007). Just twenty-seven years later, its coho salmon run was gone. Many San Mateo County streams lost their runs in the late 1970s and early 1980s, due to the drought of 1976-1977 coupled with land and water development. By 1995, only Waddell and Scott Creeks were believed to maintain sustained natural runs of coho south of San Francisco (Anderson 1995). Today, the run in Waddell Creek is extirpated and only Scott Creek maintains all three cohorts of coho salmon. Coho salmon persistence in Scott Creek is largely due to the Conservation Hatchery operated by the Monterey Bay Salmon and Trout Project (a volunteer organization) with support from CDFG, NMFS and NOAA Southwest Fisheries Science Center.

Urbanization is a more prominent factor for the future, than logging, and likely a more significant influence on the fate of CCC coho salmon; particularly around the San Francisco Bay area. As late as 1965, runs of coho salmon were reported in Marin's Corte Madera Creek, the declines of coho salmon around the San Francisco Bay were being documented. CDFG reported in 1965, that coho salmon in the Napa River "had been eliminated", had become rare in Walnut Creek, and had been last reported in the South Bay's Guadalupe River (Santa Clara County) in the 1970s (Leidy 2007). The growth of Silicon Valley fueled a sharp rise in development in the upper watershed of San Lorenzo River in Santa Cruz County that peaked in the 1970s (County of Santa Cruz 2001).

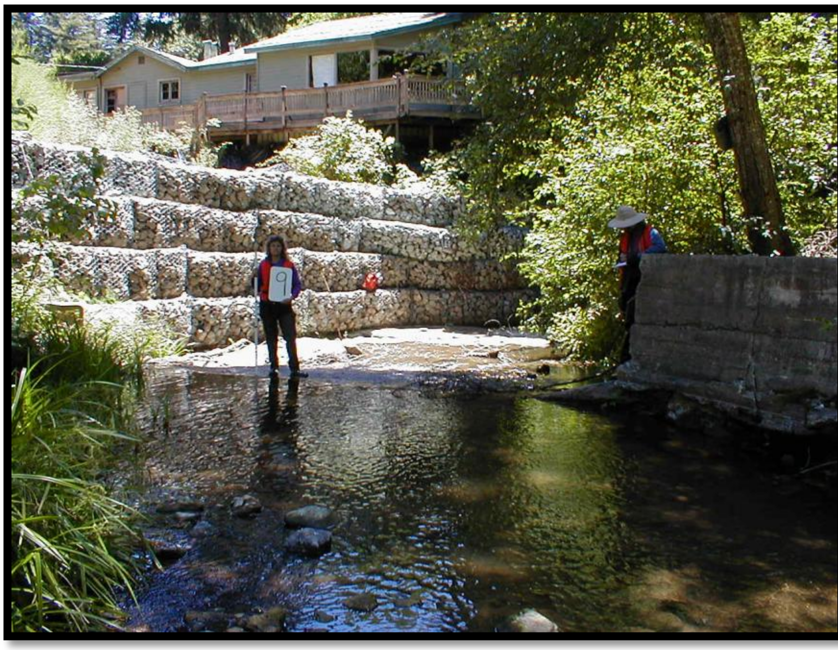

Photo Courtesy 20: Urbanization of stream channels, Santa Cruz County; Kristen *Kittleson, County of Santa Cruz*

> ***"It is sobering to think that salmon could take the worst nature could throw at them for millions of years – from floods to volcanic eruptions – but that little more than a century of exposure to the side effects of Western civilization could drive them to the edge of extinction."***
>
> ***David Montgomery 2003***

The expanding urban footprint resulted in even more significant changes and alterations to rivers and their floodplains. Unlike logging impacts, where the impacts from past practices are healing over time and current practices are regulated according to the California Forest Practice Rules, the impact of urbanization is profound and largely permanent. Of all 78 watersheds that historically had a coho population, many with significant amounts of urban development, have lost abundant populations of coho salmon save one, Lagunitas Creek[2].

In Lagunitas Creek, the 2007/2008 coho run was probably the smallest run observed since annual surveys began in 1995. There was a 70 percent decline in the number of redds (gravel "nests" where eggs are laid) compared the parent generation, which hatched three years earlier. Similar or greater declines were seen in other coastal watersheds in Marin County. This is consistent with a 73 percent decline in counts for returning CCC coho throughout their range. The decline has been attributed to reduced populations and influences of "poor ocean conditions and food supply when these coho salmon migrated to the ocean as smolts in 2006" (Ettlinger *et al.* 2008). Remarkably, as bad as the 2007/2008 spawning run was the 2008/2009 spawning run was worse, with only 40 fish returning from the ocean.

On the Russian River, the number of coho salmon smolts entering to the ocean is estimated to have declined 85 percent in just the sixteen years between 1975 and 1991. By the winter of 2007/2008, Joe Pecharich, a coho salmon researcher who worked at the Warm Springs Dam Fish Hatchery and now works for the NOAA Restoration Center, said, "…we know of only two coho that came back. The year before that we know of only two. The year before that were five." And in the current winter of 2008/2009, the only known coho female to return was caught and, inadvertently, killed by an angler (Norberg 2009).

Along the Mendocino coast, the pattern was more varied, in some cases the opposite of that seen in the southern portion of the species coastal range. On Big River, which had seen intensive logging, only two coho were reported in 1955. Yet by 1978, its coho salmon run had rebounded and was estimated at 2000 spawning adults. Stocking of coho salmon began there in 1956, and a hatchery was built in the early 1960s (Stebbins 1986). A half million eggs and fry

[2] Lagunitas Creek coho are persisting due in large part the dedication and organization of local citizens and the common vision of local agencies and political bodies to implement restoration actions and policies necessary to protect CCC coho salmon.

were planted in Big River between 1956 and 1978 (Downie *et al.* 2006). As with past stocking efforts using fry, the effectiveness of the plants was probably minimal. Current run size is unknown, but juveniles have been consistently found in many tributaries, showing that some adults are still spawning on the Big River. On the Garcia River, Lando Franci recalled that "(s)almon were already starting to dwindle" by the 1940s. Craig Bell remembers seeing "(s)ilvers and Kings . . . rolling in the tidewater" in October 1979. But "by about '(19)85 it was history" (Monschke and Caldon 1992). The fish were gone.

As on Big River, declining numbers of coho salmon inspired vigorous hatchery and planting programs. Unfortunately there was still no effort to plant native streams with native stock. In all, over 11.5 million out-of-basin fry and fingerlings were released in central coast streams, mostly from the 1950s through the mid-1990s (Spence *et al.* 2005). Despite all the planting, commercial catch of coho salmon declined sharply in the late 1970s, believed to be the result of poor conditions in both the ocean and the freshwater habitat. By the early 1990s, ocean stocks of coho salmon were so low commercial and sport fishing were closed (CDFG 2002) and have remained closed ever since.

2.13 RAYS OF HOPE

By the winter 2006/2007, native coho were estimated to have declined more than 99 percent in less than seventy years. Most spawning populations are reduced to less than fifty fish (Moyle *et al.* 2008). California's once abundant central coast coho salmon are now nearly extinct. Only a sustained and vigorous effort by the public, landowners, and decision-makers at every level, will bring them back. While their survival hangs in the balance, a handful of places have seen modest increases in coho salmon in recent years. On a tributary of the Garcia River where coho salmon had not been seen for at least twenty years, schools of juveniles were discovered at ten locations in 2008. One researcher believes that the sustainable forestry now being practiced there, "might be the best way left to preserve woodland ecosystems, watersheds and fish" (Fimrite 2008). Additionally, gravel mines have closed or improved their activities to be more compatible with habitat needs, such as Homer and Steve Canelis from Austin Creek

Aggregates, and extensive restoration efforts on agricultural and forested landscapes have been ongoing for 15 years and are resulting in substantial improvements in habitat quality.

Large wood is being placed into streams to promote gravel sorting and pool development for improved spawning and rearing habitats. One such project on the South Fork Ten Mile River facilitated the restoration of 9.4 miles with 245 logs and 65 rootwads placed across 138 sites. Coho salmon were observed shortly after completion in the mainstem South Fork Ten Mile for the first time in a decade with freshwater conditions improving. Similar projects are being implemented for the North Fork and Clark Fork Ten Mile; projects that are a very high priority for preventing extinction and ensuring survival of coho salmon.

Photo Courtesy 21: Ten Mile wood projects for CCC coho salmon, *David Wright, Campbell Timberlands.*

In Santa Cruz County, San Vicente Creek had apparently lost its coho run by the early 1980s. Yet, in the fall of 2002, several hundred coho were discovered in an agricultural off-channel pond on the Coast Dairies Property by NOAA's Office of Law Enforcement (Environmental Science Associates 2004). Researchers believe the cool, deep water in this pond, which is connected to the creek by an inlet and outlet channel, mimics natural "off channel" conditions preferred by coho for rearing. Recently, when water flow into this pond became disconnected, numerous agencies and concerned citizens joined together and completed a complex restoration effort in record time, solely for the purpose of saving this important southern coho salmon population. In 2010, the California Coastal Conservancy and Santa Cruz Resource Conservation District funded and permitted the construction of a high flow refugia project and in 2011, the first large wood restoration effort in more than a decade to improve juvenile rearing conditions. In 2012, scientists from NOAA's Southwest Fisheries Science Center (SWFSC) documented juvenile coho salmon rearing adjacent to the structures.

The Monterey Bay Salmon and Trout Project (MBSTP) are working with NMFS' Science Center and the California Department of Fish and Game (CDFG) to ensure the King Fisher Flat facility on Scott Creek is managed appropriately. The Sonoma County Water Agency, US Army Corp of Engineers, NMFS, CDFG and others are collaborating on Warm Springs Hatchery operation as part of the Russian River Coho Salmon Captive Broodstock Program to maximize genetic diversity and improve distribution and abundance of coho salmon. In early 2012, after years of effort, coho salmon adults were detected spawning in tributaries of the Russian River basin where they have not been detected for many years.

CDFG, NOAA Restoration Center, Trout Unlimited, The Nature Conservancy, Resource Conservation Districts, private timber companies, State Parks, State Demonstration Forests, and many others have dedicated substantial sums of money to restore passage, install woody debris, and reduce sediment inputs from problem roads in many watersheds. The Marin Municipal Water District and SPAWN, work to ensure Lagunitas Creek maintains a strong population. The National Park Service conducts extensive monitoring for Lagunitas and Olema Creeks

Photo Courtesy 22: Monterey Bay Salmon and Trout Project, CCC coho salmon. *Michelle Leicester, CDFG.*

(Marin County) and water agencies have provided funding to the recovery efforts. Significant improvements have been realized by the Giacomini Wetlands restoration. The Counties have joined together under the FishNet 4C program and meet regularly to pool resources in an effort to streamline permitting, train staff, and obtain additional grant monies for the benefit of coho salmon. Timber companies and conservation organizations have dedicated significant resources, including staff and equipment, to monitor coho salmon populations and their habitat, fix problem roads and stream crossings, and restore instream habitat.

California's redwood forests are now some of the last areas where coho salmon persist. Unlike other land uses such as agriculture or urbanization, timberland management in California is regulated according to Forest Practice Rules. These Rules have standards for road construction and maintenance to reduce sediment to streams, riparian canopy retention along fish-bearing and non-fishbearing watercourses and mechanisms for forest growth and regeneration. Watershed processes that provide for salmon spawning, rearing and sheltering are relatively intact on many forestlands. The future and fate of salmon is inextricable to the future and fate of California's redwood forests.

2.14 YES WE CAN!

The plight of salmon is inexorably tied to the story of the changing landscape. Many naturalists, fishermen and biologists across Europe, Eastern Pacific and North America have monitored salmon and chronicled their decline and extinctions. The story of the salmon crisis is nothing new and their recovery is up to us. For over a century salmon were seldom seen in England or France, that is, until recently. Actions to reduce pollution and improve stream conditions are working and small numbers of salmon have returned in recent years to rivers such as the Thames in England, and the Seine in France. When CCC coho salmon return to their natal streams in California each winter to spawn, it is reason to celebrate and act anew. These few fish represent the past, present and future and the struggling remnants of a once abundant species and a thread back in time (not so very long ago) when our creeks and rivers ran clean, cool, and flowed unimpaired from their headwaters to the sea. Some argue nothing can be done to save them; we disagree. Montgomery (2003) stated, "Success or failure will depend on whether salmon are recognized as equal stakeholders".

Fisheries biologist alone cannot shift a species trajectory from extinction to recovery; it requires a united community forming alliances and strategically implementing recovery actions to this single purpose. Salmon survival will depend on us not regarding "*…this inhabitant of the waters with something like annoyance"* (Fearing 1876), but embracing a paradigm that we can live, work and use the land and water compatibly with the needs of the larger ecological community, including fish. Salmon survival now depends on us as much as our ancestors depended on salmon for their survival nearly 25,000 years ago.

Photo Courtesy 23: Pudding Creek Monitoring, Mendocino County, CA; C*DFG and Campbell Timberlan*d

The situation is daunting, but it is not hopeless. There are few large dams and many areas are not irreversibly lost to urbanization; the CCC coho salmon ESU is represented by coastal communities, redwood forests and people who are connected and care about our CCC coho salmon. To bring CCC coho salmon back from the brink we must do something uniquely human: contemplate our impact on the environment and shift our actions. Improving and sustaining the human well-being, while sustaining our natural resources (including our wild salmon), are one in the same challenge. By reading this plan and working to implement it, you are placing yourself in a position to help save a species. It is our fervent hope that with your help, we can turn the tide, and bring CCC coho salmon back from the brink. Your children and grandchildren will thank you when they can enjoy the benefits of healthy salmon populations and healthy watersheds.

Please join us! If we can do it for the California condor, the bison, the bald eagle, the whooping crane…we can do it for our CCC coho salmon. Yes we can.

Photo Courtesy 24: *Operation Migration, Whooping Cranes*

> *"…a procession of salmon shining in glittering panoply of silver, sweeping onwards like an invading army, swimming as cranes and wild geese fly, in a wedge; some large old salmonids at the apex of the triangle, and young males at the base…"*
>
> *Olaus Magnus 1500 AD in Dickens 1888*

Preventing extinctions of species is possible. The purpose of this plan is to build upon these successes and educate our children so that the spawning runs witnessed on the Garcia River in the 1930's, as well as healthy spawning runs throughout the Central Coast, will be a part of our future.

Photo courtesy 25: *Bob Coey, NMFS*

3.0 OVERVIEW OF THE CCC COHO SALMON ESU

"Pacific salmon matter not only as a delicacy and an economic resource but also as an indicator of the state's environmental health. Wild salmon are to the rivers and the watershed and the ocean what the canary is to the miners in the coal mine."

Congressman Mike Thompson 2008

3.1 SPECIES AT THE BRINK OF EXTINCTION

Central California Coast coho salmon are gravely close to extinction. Despite being listed under the Federal and California Endangered Species Acts, populations of CCC coho salmon continue to decline precipitously. Immediate and focused action is essential to increase the survival of, and provide the highest protection for, remaining populations.

Photo Courtesy 26: Juvenile CCC salmon 1from Scott Creek, Santa Cruz County, California; *Morgan Bond, SWFSC.*

Regrettably, many of our streams are now unsuitable for salmon. For millennia salmon have successfully persisted in abundance under ever shifting, and catastrophic occurrences in their environments. However, human alteration of the landscape over the last two centuries, and human harvesting of salmon, has placed significant pressures on coho salmon's ability to survive in freshwater and marine environments. Landscape alterations such as bank stabilization and development in the floodplains have resulted in significant modification to stream channels, contamination of streams, reductions in stream flows, *etc.* that, cumulatively, have led to detrimental changes to watershed processes and thus corresponding declines in the CCC coho salmon populations. Critical homes for coho salmon, stream habitats, have become more inhospitable; thus, fewer individuals survive and the population declines. With fewer individuals surviving, populations become increasingly vulnerable to predation, shifting ocean environments, and catastrophic natural events leading to even further declines. Overtime these low populations experience genetic bottlenecks due to difficulty finding mates. These small population dynamics are often referred to as an extinction vortex (Gilpin and Soule 1986). The illustration below of an "Extinction vortex" (Figure 6) describes the process declining populations undergo when "a mutual reinforcement occurs among biotic and abiotic processes that drives population size downward to extinction" (Brook *et al.* 2008). Current information on adult escapement in the ESU are limited, however, monitoring data gathered from across the ESU suggest coho salmon populations are in this extinction vortex.

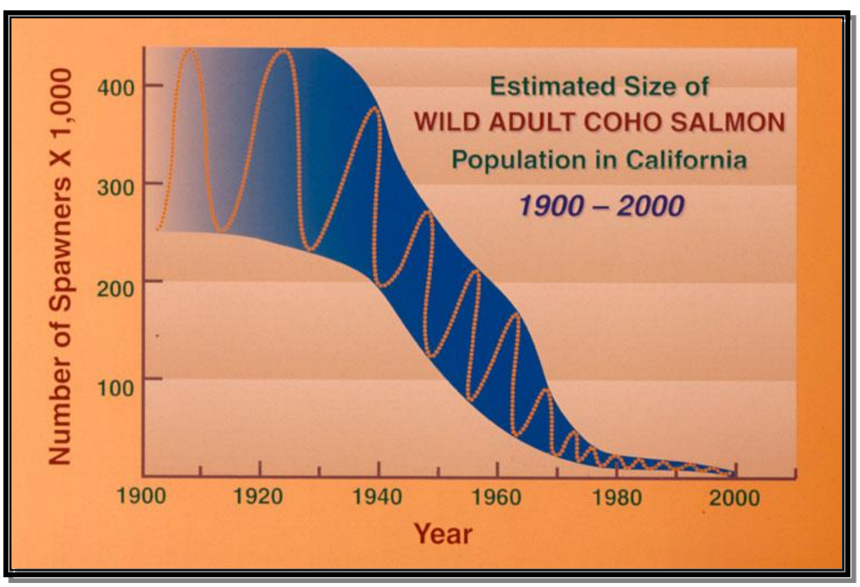

Figure 6: Visual Representation of extinction vortex of coho salmon *(Peter Moyle, personal communication).*

3.2 TAXONOMY, RANGE AND ESA LISTING OF COHO SALMON

3.2.1 TAXONOMY

There are six species of Pacific salmon within the *Oncorhynchus* genus: *O. kitsutch, keta, gorbuscha, tshawytscha, nerka,* and *masou*. Within this group, coho salmon and Chinook (*O. tshawytscha*) salmon are the most closely related. The English translation of the genus name, *Oncorhynchus*, is hooked snout. Coho salmon, the common name accepted by the American Fisheries Society for *O. kisutch*, comes from a Native American name for the species. Other commonly used names include silver salmon, sea trout, blueback, jack salmon, hooknose, and silversides (Hassler 1987).

3.2.2 RANGE

The current North American range of *O. kitsutch* extends from Point Hope, Alaska, south to streams in Santa Cruz County, California. NMFS has designated seven ESUs of coho salmon in Washington, Oregon, and California. The CCC coho salmon ESU is the southern-most extant population and ranges from Punta Gorda in southern coastal Humboldt County, California, south to Aptos Creek in Santa Cruz County, California; an area of approximately 2.6 million acres. Their historical range includes the San Francisco Bay and many of its tributaries (Figure 7). Coho salmon may have occurred as far south as the Big Sur River in Monterey County and east into streams of the Sierra Nevada in the Central Valley (Gustafson *et al.* 2007). According to recently discovered archeological data from Elkhorn Slough, this species once ranged as far south as the Pajaro River in Santa Cruz and Santa Clara counties, and/or possibly the Salinas River in Monterey and San Luis Obispo counties (Gobalet In press). The first scientific collection of CCC coho salmon occurred in 1860. Alexander Agassiz collected the species in San Mateo Creek, San Mateo County. Today, CCC coho salmon are extirpated from all rivers flowing into San Francisco Bay.

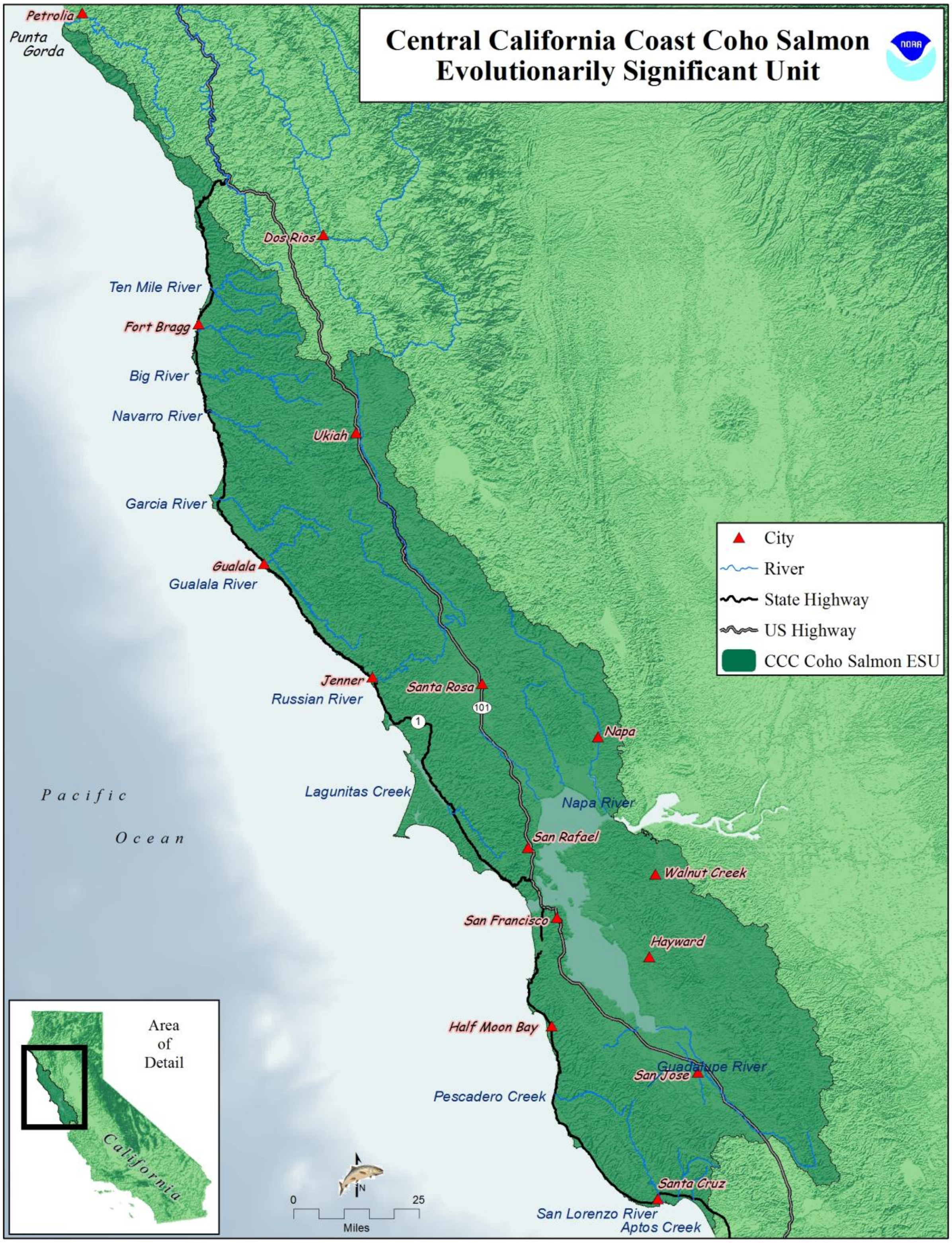

Figure 7: Historical range of CCC coho salmon

3.2.3 State and Federal Listings of CCC Coho Salmon

The State of California listed coho salmon south of San Francisco Bay as a state endangered species in 1995. On August 30, 2002, the California Fish and Game Commission found that coho salmon warranted listing as an endangered species under the California ESA from San Francisco Bay north to Punta Gorda (the remainder of the CCC coho salmon ESU) and as a threatened species from Punta Gorda north to the California-Oregon border (the Southern Oregon Northern California (SONC) coho salmon ESU). The State developed and finalized a recovery strategy for the California ESUs in 2004 (CDFG 2004). NMFS listed the CCC coho salmon ESU on October 31, 1996, as Federally threatened (61 FR 56138). In response to severe population declines between 1996 and 2004, NMFS relisted CCC coho salmon, and changed its status from threatened to endangered (*i.e.,* in danger of extinction throughout all or a significant portion of its range) on June 28, 2005 (70 FR 37160).

On November 12, 2003, NMFS received a petition to redefine the southern extent of the CCC coho salmon ESU by excluding ESA protections from those populations occupying watersheds in Santa Cruz and coastal San Mateo Counties, California. The petitioner's assertions were based on the following:

1. Early scientific species range descriptions and newspaper accounts failing to document coho south of San Francisco prior to artificial introductions in 1906;
2. Coho salmon were introduced into streams south of San Francisco Bay with the delivery of coho salmon eggs from Baker Lake, Washington, to the Brookdale hatchery on the San Lorenzo River in Santa Cruz County in 1906. This introduction was the beginning of an effort to establish a coho salmon fishery in the coastal streams south of San Francisco Bay;
3. Absence of coho salmon remains in the refuse sites (middens) of the native people;
4. That various physical characteristics (*e.g.*, climate, geology, and hydrology) render the streams in the Santa Cruz mountains inhospitable to coho salmon; and
5. Incorrect application of the ESU/DPS policies.

In 2010, NMFS accepted the petition and convened a biological review team (BRT) to specifically address the petitioned action and determine the appropriate southern boundary of the CCC coho salmon ESU. The BRT addressed two key questions pertinent to the petitioned action: (1) Does the available evidence support a southern boundary for CCC coho salmon that excludes streams south of the entrance to San Francisco Bay, and (2) does the available evidence support a boundary different from the current boundary at the San Lorenzo River? The BRT's review and findings are detailed in Spence *et al.* (2011). Based on their review of historical and scientific information, the BRT concluded the available evidence did not support the petitioner's contention that the boundary should exclude coastal streams south of the entrance to San Francisco Bay. The BRT conclusions were supported by the following information:

1. Juvenile CCC coho salmon were collected from four streams in San Mateo and Santa Cruz county streams in 1895, eleven years before a hatchery program was initiated in Santa Cruz County. These specimens are housed at the California Academy of Sciences in San Francisco;
2. Hatchery outplanting efforts would have been unlikely to contribute to the abundance of coho salmon documented by Shapolov and Taft (1954) in the 1930s due to the low survival rates resulting from fry outplanting and the fact the Baker Lake fish stock of coho salmon evolved in a cold, snowmelt-dominated watershed of the northern Cascade Range. The environmental conditions in the northern Cascade Range are vastly different from those found in streams on the central coast of California, which may have limited the success of any released fish. The most notable adaptation of coho salmon to the Baker Lake habitat conditions is the summer run timing (July–August) of returning adult spawners. This pattern contrasts significantly with the winter run timing of coho salmon in central California.
3. After the petition was received, evidence of coho salmon was recovered from two archaeological sites and independently verified osteological identification experts. Based on these findings, the BRT concluded that archaeological evidence established the historical presence of coho salmon south of the entrance to San Francisco Bay,

possibly as far south as northern Monterey County;

4. Genetic analysis consisting of molecular genetic data from coho salmon populations located throughout California, as well as from populations located throughout the rest of the species' range, including Canada, Alaska and Russia show that coho salmon from populations in the southernmost portion of the range of the CCC coho salmon ESU are unambiguously similar to coho salmon populations elsewhere within the range of this ESU and not with populations from other ESUs located further north. This analysis clearly ruled out that the genetic ancestry of coho salmon populations south of the entrance to San Francisco Bay is substantially derived from an out-of-ESU source (*e.g.*, Baker Lake or 1980s imports from Washington and Oregon stocks). The analysis definitively established fish from northern populations are not the primary contributors to the current populations south of San Francisco, nor were they established by out-planting of fish from northern populations within the ESU or outside the ESU, including imports from the Noyo River;
5. Evidence suggesting inhospitable physical conditions for CCC coho salmon in Santa Cruz and San Mateo watersheds (compared to areas north of San Francisco Bay) was not compelling enough to suggest significant conditions that preclude species presence. This is based on information indicating the same conditions are present throughout other watersheds in the CCC ESU still occupied by coho salmon; and
6. NMFS' ESU policy was properly applied to these populations.

The BRT further concluded the CCC coho salmon ESU should be extended southward to include the Soquel and Aptos creek watersheds. Information supporting this boundary change included: (1) recent observations of coho salmon in Soquel Creek; (2) genetic analysis of these fish indicating they are derived from other nearby populations in the ESU; (3) presence of suitable freshwater habitat conditions; and (4) watershed processes in Soquel and Aptos Creeks similar to those found in adjacent watersheds of the ESU supporting coho salmon populations. Based on a review of the best scientific and commercial information available, including the

BRT report (Spence *et al.,* 2011), NMFS concluded the petitioned action was not warranted (76 FR 6383) and extended the range of coho salmon to include Soquel and Aptos creeks (77 FR 19552).

Unfortunately, despite the protections afforded to CCC coho salmon by State and Federal listings, and the development of a State Recovery Plan, the CCC coho salmon population continues to decline.

3.3 THE IMPERILED CCC COHO SALMON

Only rough estimates exist for historical CCC coho salmon adult abundance. There are still no long term data sets for wild coho salmon abundances across individual river systems in the ESU. Despite these limitations, the pronounced decline of CCC coho salmon has been documented over the past 70 years by various researchers and agencies with salmon population abundance estimates showing:

- 200,000 to 500,000 coho salmon statewide in the 1940's (Brown *et al.* 1994);
- 99,000 statewide with approximately 56,100 (56%) in CCC coho salmon ESU streams in the 1963 (CDFG 1965);
- 18,000 wild CCC coho salmon adults in the 1984/1985 spawning season (Wahle and Pearson 1987);
- 6,000 wild CCC coho salmon adults in the 1990's (61 FR 56138); and
- Less than 500 wild adults in 2009 (Spence, pers. comm. 2009).
- Between 2,000 to 3,000 wild adults in 2011(Gallagher and Wright 2012, Spence, pers. comm. 2012).

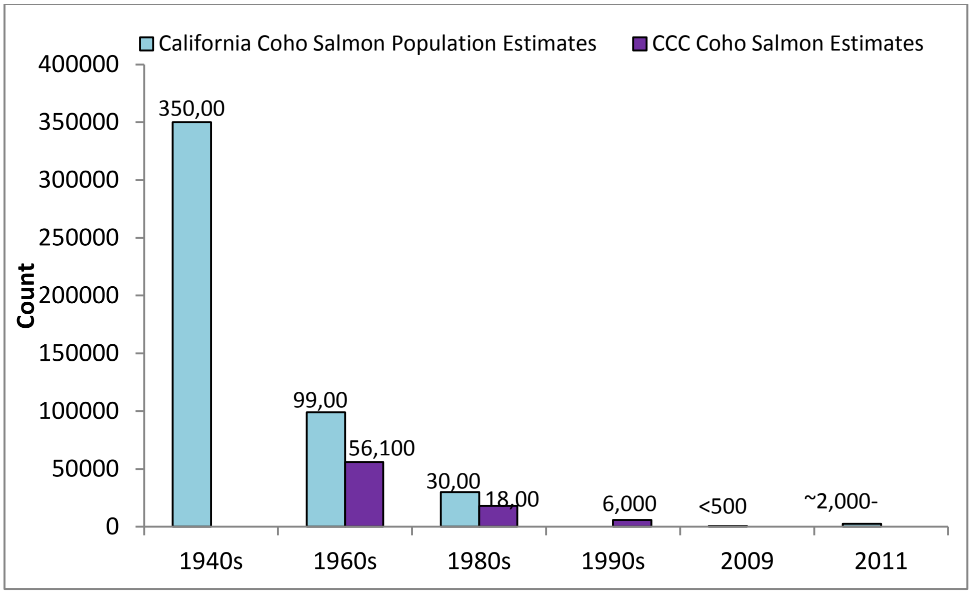

Figure 8: Historical estimates of coho salmon spawners across ESU

Table 1: Historical estimates of coho salmon spawner abundance

	Estimated Escapement			
River/Region	CDFG (1965)[3] 1963	1965	Wahle & Pearson (1987)[4] 1984-1985	Brown *et al.* (1994)[5] 1987-1991
Ten Mile River		6,000	2,000	160[6]
Noyo River		6,000	2,000	3,740
Big River		6,000	2,000	280
Navarro River		7,000	2,000	300
Garcia River		2,000	500	
Other Mendocino County		10,000	7,000[7]	470[8]
Gualala River		4,000	1,000	200
Russian River		5,000	1,000	255
Other Sonoma County		1,000		180
Marin County		5,000		435
San Mateo and Santa Cruz Counties		4,100	550	140
San Mateo County	1,000			
Santa Cruz Co (excl. SLRiver)	1,500		50	
San Lorenzo River	1,600		500	
ESU Total	**56,100**		**18,050**	**6,160**

[3] Values excludes ocean catch
[4] Estimates are for wild or naturalized fish; hatchery returns excluded.
[5] Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.
[6] Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.
[7] Value may include Marin and Sonoma County fish.
[8] Appears to include Garcia River fish.

A recent status review for the CCC coho salmon ESU was conducted (Spence and Williams 2011) whereby new biological information was reviewed, the listing determination assessed, and a range extension was considered. The findings:

- Coho salmon are at a greater risk of extinction than five years ago;
- Populations at extreme risk of extirpation or extinct are Gualala River, Russian River, Walker Creek, Pescadero Creek and San Lorenzo River;
- The Noyo River population was deemed at moderate to high risk of extinction;
- Ten Mile, Big River, Albion River, Navarro River and Lagunitas Creek were considered data deficient.

Spence and Williams (2011) concluded "the lack of demonstrably viable populations in any of the Diversity Strata, the lack of redundancy in viable populations, and substantial gaps in the distribution of coho salmon…conclude that the CCC coho salmon ESU is in danger of extinction."

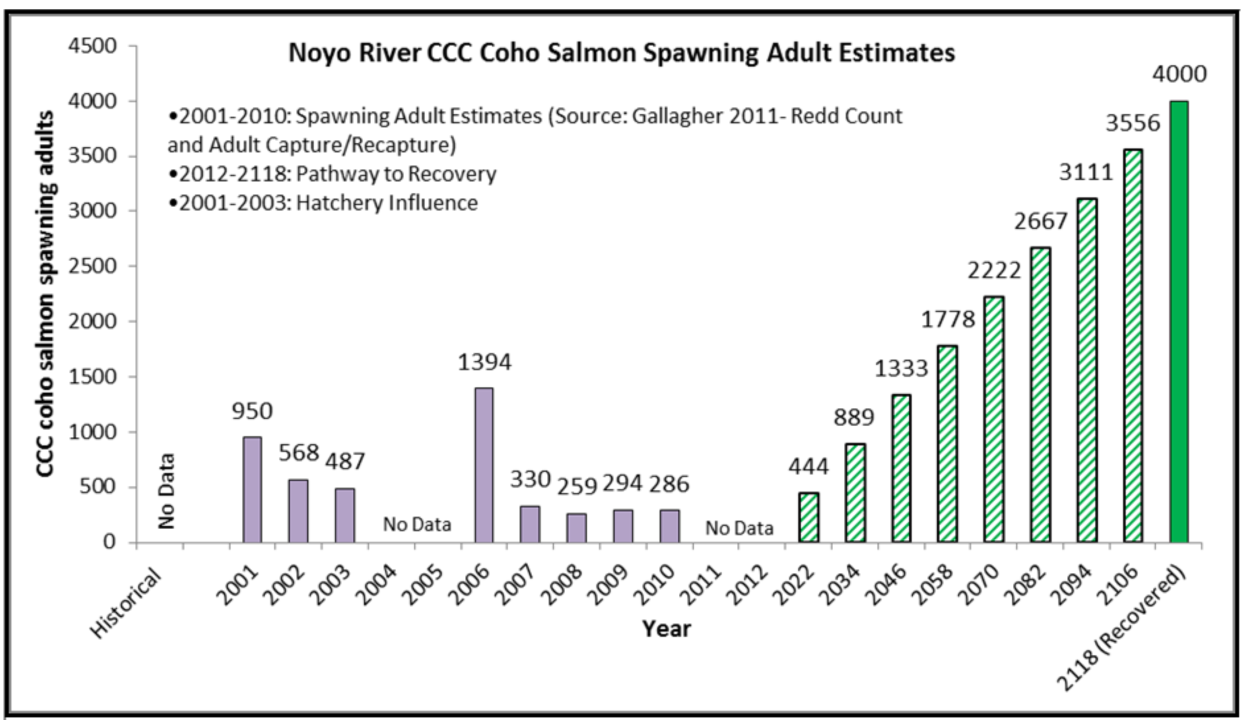

Figure 9: Noyo River, Mendocino County, Coho Salmon Data

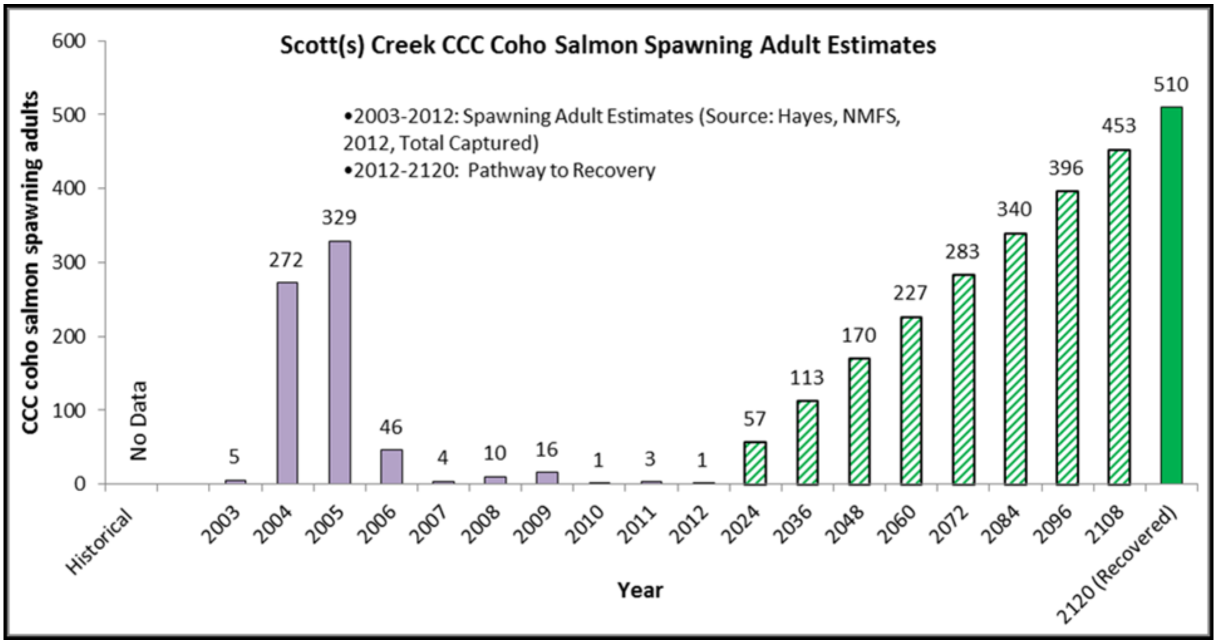

Figure 10: Scott Creek, Santa Cruz County, Coho Salmon Data

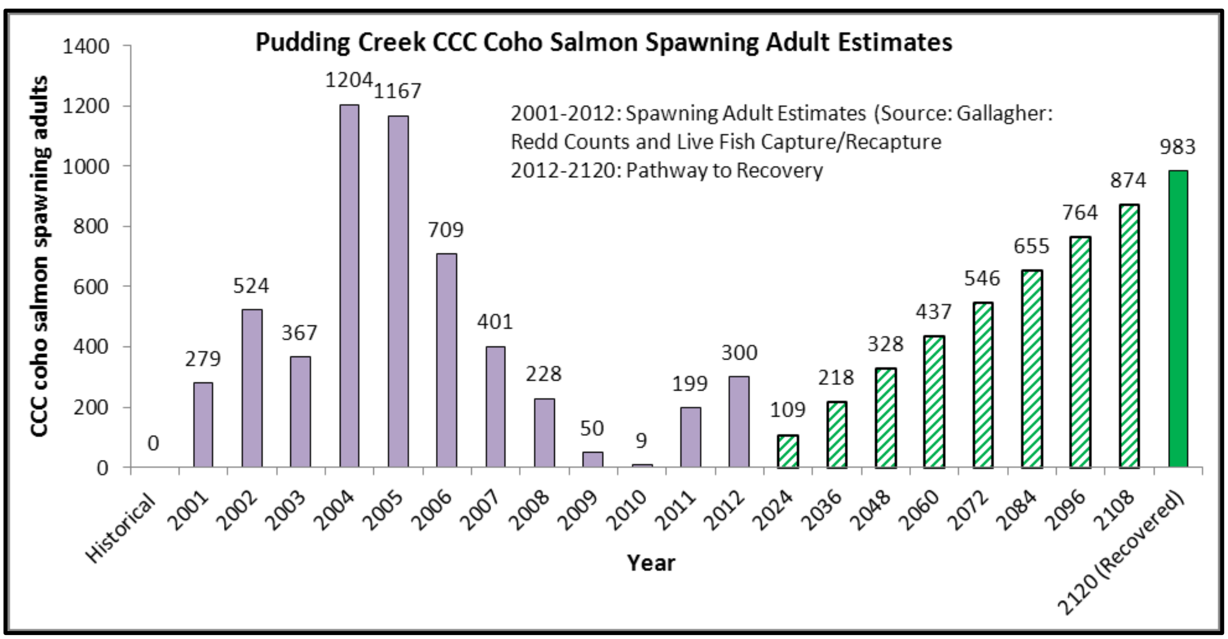

Figure 11: Pudding Creek, Mendocino County, Coho Salmon Data

While the status across the range is concerning, some places are showing signs of hope such as Pudding Creek and, more recently, the Russian River.

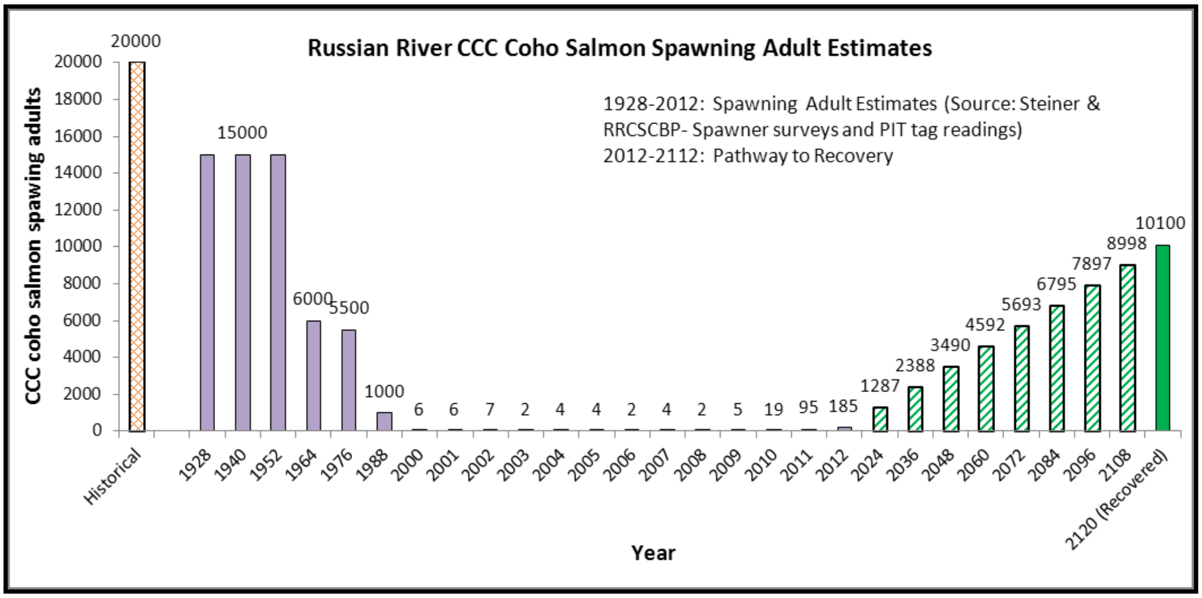

Figure 12: Russian River, Sonoma County, Coho Salmon Data

Photo Courtesy 27: A positive sighting. Three wild juvenile CCC coho salmon, and one juvenile steelhead (bottom left), in the Russian River 2008. *Joe Pecharich, Russian River coho monitoring project, UC Cooperative Extension - Sonoma County.*

3.4 COHO SALMON LIFE HISTORY

Juveniles: Juvenile salmon are blue-green on the back with silver sides and 8-12 parr marks (Hassler 1987). The parr marks are centered along the lateral line and are narrower than the spaces between marks. The adipose fin is finely speckled with uniform pigmentation making it appear dark grey (Moyle 2002). The anal, pectoral, and pelvic fins lack spots and are tinted orange with varying intensity. The anal fin is pigmented between the rays which produces a black banding effect (Hassler 1987).

Characteristics used to identify juvenile coho salmon from other salmonid species are their sickle shaped anal and dorsal fins and large eyes (Pollard *et al.* 1997).

Spawning Adult: Adult coho salmon have a fusiform body shape that is laterally compressed (Hassler 1987). Considered a medium to large salmon, coho salmon typically reach fork lengths of 4–70 cm and weights of 3–6 kg (Shapovalov and Taft 1954; Moyle 2002). Dorsal, anal, pectoral, and pelvic fins range from 9–12, 12–17, 13–16, and 9-11 rays respectively (Moyle 2002). The lateral line is straight with 121–148 single pored scales. The white gum line of coho salmon can be used to distinguish this species from Chinook salmon, which have black gums. Coho salmon can be distinguished from chum and sockeye salmon by the dark spots on the back, dorsal fin, and upper lobe of the tail (Hassler 1987).

Ocean Adult: In the ocean, the coloration of adult coho salmon is steel blue to greenish on the back, silvery on the sides, and white on the belly (Hassler 1987). The coloration of spawning males is dark green on the back, bright red on the sides, and gray to black on the belly (Scott and Crossman 1973). In addition to the red lateral line, spawning males are also characterized by a hooked jaw, enlarged and exposed teeth, and slightly humped backs. Females have duller coloration than males with a pale pink hue on the sides (Moyle 2002). Males and females both have small black spots on the back, upper sides, base of the dorsal fin, and upper lobe of the caudal fin.

Life History Strategy

To ensure recovery of CCC coho salmon, individuals must survive across their life stages and populations must sustain themselves across a large geographic area. Thus, understanding life history is fundamental to building a recovery plan. Coho salmon are anadromous fish, meaning they migrate between the ocean and freshwater environments at different stages of their three-year life span. Coho salmon are also semelparous, meaning they die shortly after spawning. The life history of coho salmon is similar to most Pacific salmonids. They hatch and rear in freshwater, migrate downstream to the ocean where they mature into adults, and then return to their natal freshwater streams and rivers to spawn and die. Coho salmon exhibit less flexibility than other salmonid species, predominantly adhering to a three year life cycle from juvenile to adult. This three-year life span results in strong demographic separation of the three-year classes. The exceptions to the three year life cycle are jack males which return to freshwater at two years of age, and a small percentage of smolts remain in freshwater for two years rather than one year. These exceptions prevent total genetic isolation between temporal (sequential) runs (Moyle 2002). Additionally, there have been documented cases (Jerry Smith pers. comm.) of hatchery produced smolts of larger size than wild, returning as two year female spawners. The life history and habitat requirements of CCC coho salmon have been well documented (Shapovalov and Taft 1954; Hassler 1987; Emmett *et al.* 1991; Sandercock 1991; Pearcy 1992; Moyle 2002).

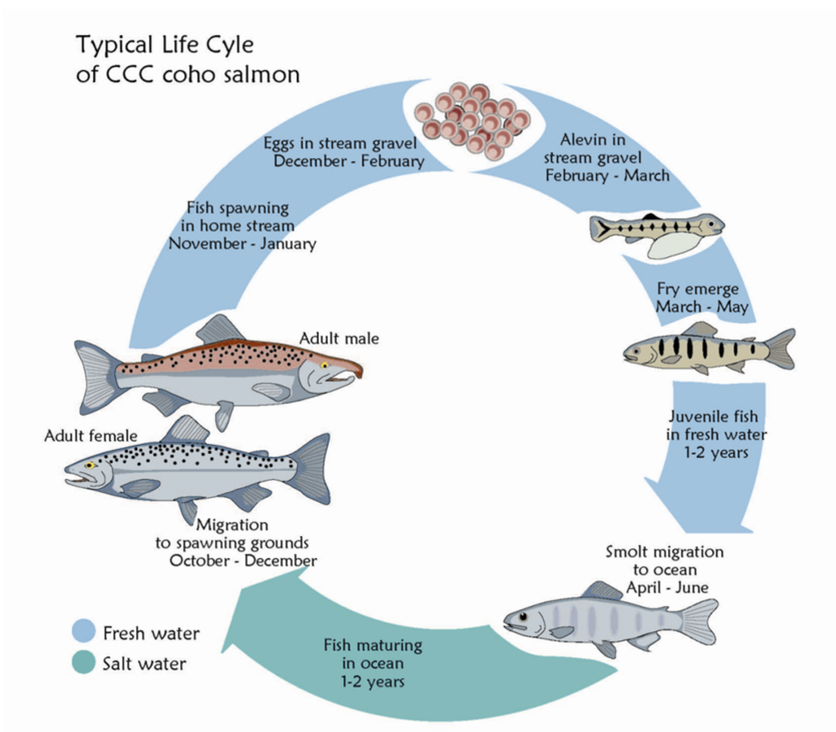

Figure 13: General overview of life stages (modified from *Reeves 2009*)

Photo Courtesy 28: Adult CCC coho salmon, Scott Creek, Santa Cruz County, *SWFSC.*

Photo Courtesy 29: Juvenile CCC coho salmon, Garcia River, Mendocino County, *Jen Carah, TNC*.

Photo Courtesy 30: CCC coho salmon smolt, San Vicente Creek, Santa Cruz County, *Chris Berry.*

Coho salmon's distinct life stages correspond to our seasons (Table 2). Adults migrate from the ocean to natal streams in the fall, generally entering freshwater from September through January, with spawning occurring primarily from November to January (CDFG 2004). Moving south across CCC coho salmon range, the timing of migration occurs later in the winter. Fish will typically enter freshwater in the southern portion of the range from November through January, and spawn into February or early March (Moyle 2002). The upstream migration towards spawning areas coincides with large increases in stream flow (Hassler 1987). Coho salmon often are not able to enter freshwater until heavy rains have caused breaching of sand bars that form at the mouths of many coastal California streams. Spawning occurs in streams with direct flow to the ocean, or in large river tributaries (Moyle 2002). Female coho salmon choose a site to spawn at the head of a riffle, just downstream of a pool where water flow changes from slow to turbulent, and where medium to small size gravel is abundant (Moyle 2002).

Redd location is chosen to allow good aeration between the stream gravels and removal of metabolic waste from the nest. Once suitable habitat is located, the female fans the gravels with her tail to create a nest, or "redd," where eggs are deposited and fertilized by accompanying males. The number of eggs a female produces is directly correlated with her size (the larger the female, the more eggs produced). Typically, female egg counts range from 1,400–3,000. California coho salmon typically have lower fecundities than fish from the more northern populations (Sandercock 1991). Females die after spawning; the female may guard the redd for up to two weeks before dying (Moyle 2002).

Eggs incubate in redds from November through April, and hatch into "alevins" after a period of 35-50 days (Shapovalov and Taft 1954). The period of incubation is inversely related to water temperature (Moyle 2002; CDFG 2004). Alevins remain in the gravel for two to ten weeks then emerge into the water column as young juveniles, known as "fry".

Table 2: Seasonal presence of CCC coho salmon in California. Dark shading indicates months of peak activity for a particular life stage with the lighter shading indicating months of lower activity.

LIFE STAGE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult migration	Light								Light	Light	Dark	Dark
Spawning	Dark	Light								Light	Dark	Dark
Egg Incubation	Dark	Dark	Dark	Light							Light	Dark
Emergence/ Fry		Light	Dark	Dark	Dark	Light						
Juvenile rearing	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Emigration			Light	Dark	Dark	Dark	Light					

Juveniles, or fry, form schools in shallow water along the undercut banks of the stream to avoid predation. The juveniles feed heavily during this time, and as they grow they set up individual territories. The foraging behavior of juvenile coho salmon can be placed into three categories: territorial, floater, and nonterritorial fish (Nielsen 1994; Martel 1996). Territorial coho salmon are typically thalweg juveniles that defend feeding territories in flowing water and are typically the fastest growing of the three categories. Floaters are small, slow growing coho salmon that live in the same areas as territorial fish but either are constantly on the move, avoiding territorial fish, or occupy stream margins. Nonterritorial coho salmon are found mostly in pools individually and in small shoals, often feeding in the upstream end of the water column. During winter, territorial behavior largely disappears when fish aggregate in deep cover, move into side channels, or move up into small clear tributaries (Sandercock 1991).

Juveniles are voracious feeders, ingesting any organism that moves or drifts over their holding area. The juvenile's diet is mainly aquatic insect larvae and terrestrial insects, but small fish are taken when available, and feeding occurs mainly during dawn and dusk (Moyle 2002). The importance of different foods depends on the season and on the individual fish preferences. In winter coho salmon feed on flying insects and mayfly larvae during peak flows, and earthworms when flows lower. In spring and summer food availability increases and juveniles feast on abundant insects as well as the loose eggs and fragments of the decaying carcasses from the spawned out adults (Moyle 2002).

Photo Courtesy 31: CCC coho salmon juveniles, Fay Creek, Marin County, CA; *Joe Pecharich, NOAA RC.*

Juveniles stay in freshwater typically for one year, requiring use of distinct habitats during summer and winter rearing periods. In the summer, when flows are low, juvenile coho salmon concentrate in deep (≥ 1 meter) cool pools with abundant overhead cover (Moyle 2002). Water temperature is critical during this time; juveniles prefer and presumably grow best at temperatures of 12-14° C. Juveniles do not persist in streams where summer temperatures reach 22-25° C for extended periods of time or where there are high fluctuations in temperatures between the extremes of their tolerance (Moyle 2002). In the winter, when stream flows are high, juvenile coho salmon require slower water refuge in areas provided by off channel or backwater pools, formed by large woody debris (LWD) such as fallen trees and root wads. Availability of overwintering habitat is one of the most important and least appreciated factors influencing the survival of juvenile CCC coho salmon in the streams (Moyle 2002). Beaver (*Castor canadensis*) ponds have been shown to provide excellent winter and summer rearing habitat (Reeves *et al.* 1989; Pollock *et al.* 2004). Recent studies in the Lower Klamath, Middle Klamath and Shasta sub-basins confirm that beaver ponds provide high quality summer and winter rearing habitat for coho salmon (Chesney *et al.* 2009; Silloway 2010). The suitability of many coastal streams in the CCC coho salmon ESU to support beavers is unknown due in part to higher gradient redwood dominated riparian areas which may be less suitable than lower gradient stream with deciduous dominated riparian zones.

Photo Courtesy 32: CCC coho salmon smolt, Mill Creek, Russian River, CA; *Joe Pecharich, NMFS.*

After one year in freshwater juvenile coho salmon undergo physiological transformation into "smolts" for outmigration to the ocean. Smoltification is associated with fish age, size, and environmental conditions (Hassler 1987). Smolt outmigration begins in March, and peaks in California from April to early July (Weitkamp *et al.* 1995). Smolts may spend time residing in the estuarine habitat prior to ocean entry, to allow for the transition to the saline environment. Estuarine use by CCC coho salmon is quite variable, ranging from seasonal juvenile rearing, to limited use as a migratory corridor. Estuarine juveniles are scarcer in California as most small estuaries are shallower and warmer than they were historically due to sedimentation and reduced water flow from anthropogenic factors such as urban development and agriculture (Moyle 2002). Smolts emigration is correlated with peak upwelling currents along the coast and entry into the ocean at this time facilitates growth and, therefore, improved marine survival (Holtby *et al.* 1990). At this point, the smolts are about four to five inches in length. After entering the ocean, the immature salmon initially remain in the nearshore waters close to their natal stream. They gradually move northward, generally staying over the continental shelf (Brown *et al.* 1994). In most cases they migrate north of their river of origin; some individuals remain relatively close to their natal river and some migrate southward (Weitkamp *et al.* 1995).

Once at sea, salmon grow significantly larger due to ocean productivity and achieve at least 99% of their final body growth (Quinn 2005). Adults remain in the colder and more productive zone of upwelling along the coast. After approximately two years at sea, adult coho salmon move slowly homeward. Adults begin their freshwater migration upstream after heavy fall or winter rains breach the sandbars at the mouths of coastal streams (Sandercock 1991) and/or flows are sufficient to reach upstream spawning areas. Delays in river entry of over a month are not unusual (Salo and Bayliff 1958; Eames *et al.* 1981). Adult coho salmon undergo a reverse process to osmoregulate in freshwater and may remain in more brackish water areas until their physiological transformation is complete. Migration continues into March, generally peaking in December and January, with spawning occurring shortly after arrival to the spawning ground (Shapovalov and Taft 1954). During migration adult coho salmon stop feeding and are sustained by fat reserves. Considerable energy is required for migration and reproductive behavior such as courtship and nest defense after the migration has ended. Taken together, freshwater migration and reproduction deplete salmon of almost all their fat and about half their protein (Quinn 2005). The female chooses and prepares the redd location and is often attended by one or more males during spawning.

Photo Courtesy 33: Adult male, female and jack CCC coho salmon, Devils Gulch, Marin County, CA; *Eric Ettlinger, NPS*.

After spawning, female coho salmon guard their nests until they become too weak to hold position and eventually drift away and die (Quinn 2005). The males will also die. The carcasses of dead salmon provide a tremendous net influx of biomass from the ocean to relatively unproductive stream ecosystems. Recent research using stable isotope ratios has demonstrated that the marine derived nutrients in the salmon carcasses are an important contribution to the aquatic and terrestrial ecosystems, affecting the growth and density of bears, growth of juvenile salmonids, productivity of lakes, biofilm and insects in streams, and even the growth of trees in the riparian zone (Quinn 2005).

3.4.1 THREE-YEAR FEMALE LIFE SPAN

Coho salmon exhibit an almost completely distinct maternal brood year lineage that is a life history trait of significant influence on overall population viability, management, and recovery (Anderson 1995). Essentially all wild female coho spawn as three-year olds[9] (Shapovalov and Taft 1954). Consequently, of all wild female coho salmon three-year olds at the time of spawning, there are three distinct, separate maternal brood year lineages for each stream in the ESU (Shapovalov and Taft 1954; Anderson 1995). For example, coho salmon males and females spawning in 2012 were the progeny of females who spawned three years earlier in 2009, which in turn were the progeny of females produced three years earlier in 2006, *etc*. The three maternal brood year lineages are shown in Table 3.

Table 3: Maternal Brood Year Lineage

Lineage: I	2000	2003	2006	2009	2012	2015
Lineage: II	2001	2004	2007	2010	2013	2016
Lineage: III	2002	2005	2008	2011	2014	2017

[9] There is genetic exchange between year classes of a particular stream when two year old precocious males (jacks) of one year class spawns with three year old females of the prior year class. Recent information from California has documented juveniles rearing in freshwater for two years (Bell 2001; Smith, personal communication 2010; Hayes, personal communication 2009; Wright, personal communication 2009), and based on documentation of precocious females at the Noyo ECS (CDFG 2008 – comments), it appears as though some genetic exchange in maternal brood years is occurring. Nonetheless, the production of fry (based upon females) shows a strong three year brood pattern (Smith, personal communication 2010).

The lack of overlapping maternal generations places brood year lineages (*i.e.*, year classes) at high long-term risk from the adverse effects of stochastic (random) events (such as floods, droughts, *etc*.). This risk is especially high for small, remnant populations. For example, a chemical spill or catastrophic wildfire adjacent to a coho salmon stream; may eliminate all juveniles in the stream resulting in the complete loss of a year class, followed three years later by a lack of spawning adults. As losses of consecutive year class continues across generations, risk of extirpation increases. Repopulation is possible by improving freshwater conditions to allow the remnant population to gradually rebound, or from spawning pairs that stray into neighboring streams to reproduce.

The loss of year classes appears to have happened to the lineages of populations in the coho salmon streams south of San Francisco Bay. Lineage I and II were virtually eliminated, but Lineage III persisted in many streams, although at a greatly reduced population size. This lineage was generally considered the last strong remaining year class. Unfortunately, poor ocean conditions during 2006/2007 resulted in a catastrophically low rate of adults returning during the winter of 2007/2008. Currently this one strong year class is almost nonexistent (Spence, pers. comm. 2009). The Lockheed fire in August of 2009 further compounded the risk to coho salmon south of San Francisco Bay by burning the headwaters of Scott Creek and affecting riparian canopy, increasing landslide risk and degrading stream conditions.

Luckily these adverse conditions have not fully materialized in Scott Creek and, due to captive breeding efforts of the Monterey Bay Salmon and Trout Project (whose hatchery at Kingfisher Flat almost burned down in the same fire), CDFG, and NOAA Southwest Fisheries Science Center the coho salmon run persists in Scott Creek

3.4.2 LIFE HISTORY HABITAT REQUIREMENTS

Coho salmon must survive conditions across many different environments during their lifecycle spanning freshwater and ocean travel. Coho salmon spend the majority of their lives in the ocean, an unpredictable environment which is largely subject to stochastic events affecting fish that are outside of human control. When ocean conditions are favorable the sub-adult and adult survival rates appear relatively high. Most coho salmon mortality occurs in freshwater, and during the rearing stage when juveniles may be exposed to winter and spring flooding, lack of rearing or winter refugia availability, and summer droughts (Sandercock 1991).

Environmental conditions influence how much energy coho salmon will need to survive, and whether or not they can survive within the range of available conditions. In freshwater, coho salmon must maintain enough energy to migrate, in some cases very long distances, and be able to find and fight for mates (males), build redds (females), and spawn. Coho salmon must avoid predators, obtain food, survive through winter flows, find pools and cool water for summer rearing, and have access to off-channel habitats during outmigration and high winter/spring flows. Coho salmon smolts must have refuge in lagoon/estuary habitats for a successful saltwater transition before entering the ocean environment. Smolt size is now understood as an indicator for marine survival to adulthood. As environmental conditions become less favorable, fewer coho salmon are able to survive (Lichatowich 1989; Beechie *et al.* 1994; Gregory and Bisson 1997). Table 4 summarizes habitat requirements for each life stage.

Table 4: Habitat Requirements and Vulnerability for Each CCC Coho Salmon Life Stage

Eggs: Incubation requires clean water, free of contamination and siltation. Disturbance of a single "redd" (nest of eggs) could result in the death of thousands of salmon embryos.	**Freshwater Streams**
Alevins: After hatching, alevins remain nestled in the small spaces between the gravels, and feed from their attached yolk sacs. They are highly vulnerable to siltation and scour. Once the yolk is absorbed, the young salmon emerge from the gravels.	**Freshwater Streams**
Juveniles: Deep cool pools are critical for the summer rearing juvenile's survival. Riparian vegetation helps support some of the insects consumed by juveniles, provides cover from predators (when recruited to streams can create wood formed pools), and limits solar radiation to streams keeping water temperatures cool. Tree roots stabilize streambanks and create habitat structure. Large woody debris or downed wood creates cover and refugia for the tiny salmon to reside during high velocity flows. Pools and wetlands provide shelter from high flows, predators, and help filter sediments from the water column.	**Freshwater Streams**
Smolts: Juvenile salmon undergo a physiological change known as "smoltification" enabling them to transition, in estuaries or lagoons, for a life adapted to saltwater. Smoltification can occur primarily within the freshwater areas, or in the nearshore environment. Smolts need adequate flow from upstream rearing areas to be able to travel downstream to estuaries. Estuaries should provide cover and adequate feeding habitats to facilitate the transition into the ocean. Estuaries should be deep to provide cool temperatures and buffered with freshwater to dilute seawater (Moyle 2002). The quality of these areas has implications to the survival of smolts entering the ocean environment.	**Freshwater Streams, Estuaries, Lagoons, and Ocean**
Sub-Adults/Adults: Maturation occurs during ocean residency over a two year period leading up to the adult salmon's return to streams of their birth. The patterns of migration in the ocean vary, and shifts in ocean conditions affect food, migration patterns and survival. Fish in the ocean need adequate supplies of food to facilitate rapid growth. As the salmon return to their natal stream to reproduce, they once again undergo change from saltwater to freshwater; they depend on the near shore and estuarine environments for this transition.	**Ocean**
Spawners: Migration begins after heavy late fall or winter rains breach sand bars of coastal streams, allowing fish to move into lagoons (Moyle 2002). Once the adult spawners arrive at their home river or stream they need adequate flows, cool water temperatures, deep pools and cover to rest and hide as they migrate upstream. Females seek clean, loose gravel of a certain size in highly oxygenated riffle type flow water for laying their eggs. The site must remain stable throughout egg incubation and emergence, and allow water to percolate through the gravel to supply oxygen to the developing embryo.	**Ocean, Estuaries, Freshwater Streams**

The key to preventing the decline of coho salmon is to protect their spawning and rearing streams, and to restore damaged habitat (Moyle 2002). While the ocean environment is where coho salmon spends the majority of its life (and productivity fluctuations in this environment significantly impact populations), escapement (returns of adults from the ocean) combined with impaired freshwater habitats can have a significant negative impact on future spawning, rearing and outmigration success. While ocean conditions have fluctuated in the past between poor and excellent for coho salmon, the general trend of freshwater habitat conditions during the 20th, 21st and early 22nd centuries has been one of increasing degradation. Continuing degradation of freshwater habitat impairs the ability of coho salmon to rebound from poor ocean conditions. It is, therefore, important to restore and protect essential freshwater habitat features.

Conditions in the freshwater environment necessary to ensure the highest likelihood of coho salmon survival through spawning, rearing, and outmigration are varied. Coho salmon are found in a broader diversity of habitats than any of the other anadromous salmonids, from small tributaries of coastal streams to lakes to inland tributaries of major rivers (Meehan and Bjorn 1991). Based on the current status of the population this may seem implausible. However, coho salmon were found throughout most of their historical range in California until the mid-1900s. Shapovalov and Taft (1954) reported that coho salmon ascend practically all accessible streams within their range flowing into the Pacific Ocean, from the largest to the very smallest. To emphasize the point they cited Chamberlain (1907) who reported that in southeastern Alaska "(t)he coho is probably less particular (in comparison with the other Pacific salmons) in its requirements. The fry were found, without exception, in every stream and brook examined; even a tiny seepage … which would become dry with the first week of fair summer weather contained its little school of coho fry." Historically, CCC coho salmon inhabited the largest river basins, such as the Russian River, and very small coastal tributaries such as Jackass Creek (Mendocino County).

Unfortunately, the habitat requirements for coho salmon in most streams in the CCC ESU are not at properly functioning conditions and their abundance has decreased, in large part, because the natural rates of critical watershed processes (*e.g.*, sediment delivery, hydrology, wood recruitment, loss of beaver habitat, temperature regulation, *etc.*) have been substantially altered by human activities. This is remarkable considering the historically ubiquitous occurrence of coho salmon in the northern coastal streams of North America. The absence of coho salmon in these freshwater habitats is a strong indication that the majority of the watersheds in the CCC ESU are substantially degraded and watershed processes disrupted.

3.4.3 OPTIMAL COHO FRESHWATER HABITAT AND CURRENT CONDITIONS

When in freshwater, optimal habitats for successful rearing include adequate quantities of; (1) deep complex pools formed by large woody debris, (2) adequate quantities of water, (3) cool water temperatures, (4) unimpeded passage to spawning grounds (adults) and back to the ocean (smolts), (5) adequate quantities of clean spawning gravel, and (6) access to floodplains, side channels and low velocity habitat during high flow events. Numerous other requirements exist (*i.e.*, adequate quantities of food, dissolved oxygen, low turbidity, *etc.*) but in many respects these other needs are generally met when the six freshwater habitat requirements listed above are at a properly functioning conditions.

Deep complex pools formed by wood.

Large woody debris originating from riparian trees is a form of cover in many streams, and its importance is widely recognized (Bisson *et al.* 1987; Holtby 1988). When riparian trees fall into watercourses they create conditions which scour the gravel bottoms of streambeds creating deep pools. These pools are preferred habitats of coho salmon due to slow moving water, pools that provide cover from predators and food for foraging. Slow moving water allows coho to capture food with the minimum expenditure of energy.

Photo Courtesy 34: Lagunitas Creek, Marin County, CA, *Eric Ettlinger.*

Pools also provide an increase in the volume of rearing habitat which allows a greater density of juveniles than does an equivalent length of stream without pool habitats. For example, in British Columbia, juvenile coho salmon abundance was five times higher in streams with large amounts of LWD compared to streams with lower amounts of LWD (Fausch and Northcoat 1992 in Bilby and Bisson 1998). In many streams, these essential pool and complex habitats have been altered or lost due to reduced water flows, large woody debris removal activities, increased rates of sedimentation, and loss, alteration and simplification of riparian forests. Simplification of riparian forests then leads to a lack of future large wood recruitment. Lack of recruitment is due in large part to the younger age of current riparian forests. Younger riparian forests often lack trees of sufficient size and decadence that can act as keystone pieces to create habitat complexity after they fall into a stream.. The absence of large wood in streams, in particular, has had major impacts to coho salmon. This is due to the role wood contributes to physical habitat formation, in sediment and organic-matter storage, and in maintaining a high degree of spatial heterogeneity (habitat complexity) in stream channels ((National Research Council 1996). Decreases in coho abundances following LWD removal or loss have been documented in streams in the Pacific North West and Alaska (Bryant 1983; Dolloff 1986; Reeves *et al.* 1993). The loss of pools formed by large woody debris is indicative of past and present management practices as well as altered natural processes.

Photo Courtesy 35: Cutting instream wood destroys coho salmon habitat, San Lorenzo, Santa Cruz County, *Chris Berry*.

> *"It is hard to overestimate the importance of loss of large woody debris as the result of historical logging practices. The streams in the Santa Cruz Mountains and Mendocino Coast contain little of the low-gradient, wide-valley streams that tend to be the most productive habitat for coho salmon. Thus the role of large wood in these steeper streams was, in all likelihood, absolutely essential for providing refuge during high flow events in winter, because there were fewer opportunities for off-channel habitat refuges. Lack of habitat structure is clearly a major problem facing CCC coho, especially in the winter months when refuges from high flows are needed (e.g., Stillwater Sciences 2008). Even in state parks in the region, which often have 100-year old riparian forests, large in-channel wood remains extremely scarce and is largely present as the result of enhancement projects (e.g., Ferguson 2005)."*
>
> *Moyle 2008*

Maintaining pool habitats, reversing the mechanisms leading to their loss, and actively installing large wood structures is one of the highest priorities in the recovery plan. The status of CCC coho salmon is dire and cannot wait for the natural processes to provide wood inputs to streams through bank erosion, natural recruitment, etc. We need wood in streams now as an interim measure to jump start the restoration and to improve survival of CCC coho salmon.

Beavers are also believed to play an important role in the formation of salmon habitat. The felling of trees by beavers increases woody debris, leading to increased invertebrate diversity and biomass, and the debris cover, provided by the lodge and food cache, has been shown to attract some fish species including salmonids (Collen and Gibson 2001). The presence of beaver dams reduces siltation of spawning gravels below the impoundment (Macdonald *et al.* 1995). The deeper water in beaver ponds provides important juvenile rearing habitat (Scruton *et al.* 1998), as well as important habitat for adults during the winter (Cunjak 1996) and in times of drought (Duncan 1984). With regards to coho salmon specifically, beaver ponds have been shown to provide excellent winter and summer rearing habitat (Reeves *et al.* 1989; Pollock *et al.* 2004). Recent studies in the Lower Klamath, Middle Klamath and Shasta sub-basins confirm that beaver ponds provide high quality summer and winter rearing habitat for coho salmon (Chesney *et al.* 2009; Silloway 2010).

Water

Fish need water, and adequate water quantity and quality are essential for CCC coho salmon survival and recovery. Coho salmon populations need enough aquatic space for large numbers of juveniles to find food and escape from predators. Appropriate flows are needed for migration to and from the ocean, for habitat connectivity during the low flow summer season, for spawning, and for egg and alevin survival.

Lack of water is a severe limiting factor for coho salmon in many watersheds in the CCC ESU. Impacts from ongoing water diversions are most severe in the more urbanized watersheds, and watersheds with a large percentage of agricultural development and diversions. California's Mediterranean climate results in low flow conditions during the summer and late fall rearing periods. Water diversions during the summer rearing period magnify the impact of natural low flows with pronounced impacts to juvenile survival. Frost protection for vineyards can create instantaneous flow reductions that leave salmon stranded on a drying stream bed.

Additionally, the impervious surfaces in urbanized areas cause increased water run-off resulting in higher winter flows, lower summer base flow, (as well as the introduction of hydrocarbons and garbage) into the stream systems. CDFG has documented unauthorized and illegal summer and fall water diversions are a serious concern and many previously perennial streams are now dry in late summer (Harris, S. pers. comm. 2009). Strategies to address this limiting factor are often difficult to implement but will be necessary to begin coho salmon recovery in many of the targeted watersheds in the ESU.

Instream Temperature

Summer rearing coho salmon are sensitive to warm water temperatures. Optimal growth occurs when instream temperatures average 12-14° C. When maximum weekly average temperatures exceed 18° C, coho salmon are absent from otherwise suitable rearing habitat (Welsh *et al.* 2001). Temperatures exceeding 25-26°C are lethal to coho salmon. Altered thermal regimes change many characteristics of stream habitat by changing the structure of plant and invertebrate communities (Bisson and Davis 1976), and adverse interspecific interactions between salmon and non-salmon fishes through increased competition and predation (Reeves *et al.* 1987).

One of the more important factors contributing to optimal stream temperature is intact riparian buffers. Retention of wide riparian buffers with adequate riparian canopy provided by mature native trees, moderates water temperature. Riparian canopy intercepts solar radiation, particularly in the smaller tributary streams where coho salmon juveniles rear, moderating the effects of warm summer temperatures.

Photo Courtesy 36: Russian River, Sonoma County, CA; *Ann Dubay, SCWA*.

<u>Passage</u>

Coho salmon require adequate passage conditions from the ocean to spawning areas for adults, and from rearing areas to the ocean for smolts. Reduced flows, debris jams, plugged or improperly placed or sized culverts, excessive water velocities, closed sandbars, and other conditions impede migrating adults. Unscreened diversions can impede smolt outmigration, particularly during low flow conditions. Typically, adult coho salmon do not migrate to the higher gradient stream reaches that steelhead are able to access. Many of the more significant barriers to adult migration in the CCC ESU have been addressed through past restoration projects. A large proportion of projects implemented have directed efforts at fixing passage problems. In the past, CDFG expended considerable effort in removing large wood formed barriers that impeded salmonid migration to upstream spawning and rearing areas.[10]

[10] Today a lack of wood exists in many streams due to some of the large wood removal activities that were conducted for the purpose of passage improvement and channel improvement. Reduced large wood frequencies in most streams is now recognized as a key habitat limiting factor of for coho habitat across the CCC ESU.

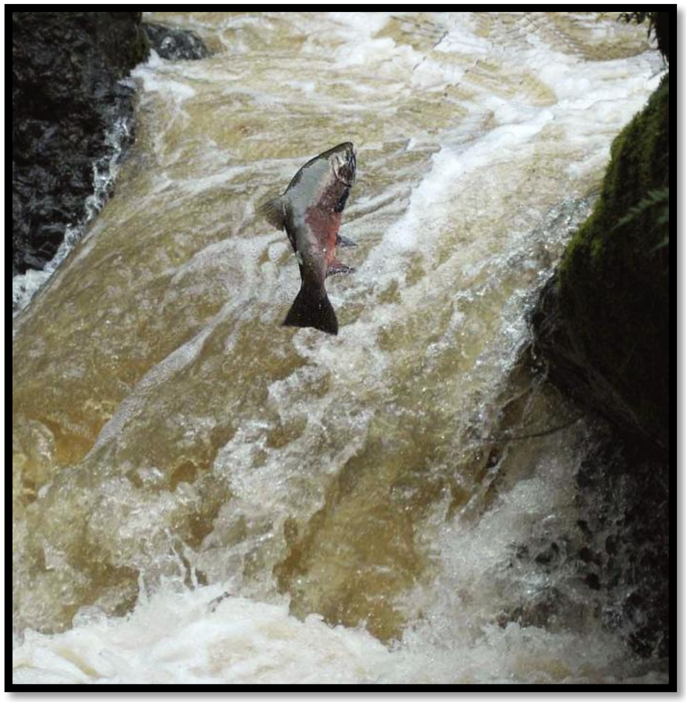

Photo Courtesy 37: Adult CCC coho salmon, San Geronimo, Marin County; *Paola Bouley, SPAWN*.

Spawning Gravel

Adult coho females choose a spawning site near the head of a riffle, just below a pool, where water changes from smooth to turbulent flow, and where there is abundant medium to small gravel. Most females dig at least three to four nests (redds) and deposit eggs in each (Godfrey 1965). The eggs will incubate an average of 38 days at 10.7° C (Shapovalov and Taft 1954), or longer at cooler water temperatures. Depth of egg burial varies substantially within and between salmon populations (Burner 1951; van den Berghe and Gross 1984; Tripp and Poulin 1986). In some cases, larger females deposit eggs at greater depth than their smaller counterparts (van den Berghe and Gross 1984), reducing the probability of egg loss due to streambed scour during high flow conditions. Physical factors such as water velocity, the size of substrate, and compaction of the stream bed also influence the depth of egg burial (Burner 1951). Upon hatching the sac fry (alevins) remain in the gravel from one to five months.

Photo Courtesy 38: Coho salmon redd and spawning gravels in south fork Noyo River; *Rick Macedo, CDFG*

To ensure survival from spawning to emergence, the gravels must be relatively free of fine sediment. Clean gravels facilitate, via intragravel flow, a supply of oxygen rich water to the eggs and newly hatched sac fry and help ensure that metabolic waste is removed.

Gravels with high concentrations of fine sediment can substantially reduce egg survival. Phillips *et al.* (1975) found survival to emergence was only eight percent where gravel/sand mixtures were 70 percent (particle size < 3.3 mm). Fine sediment originates from many anthropogenic activities including agriculture, livestock grazing, urbanization, roads, forestry, mining as well as natural processes such as landslides, streambank erosion, and fire. Minimizing anthropogenic sources of fine sediment is readily achievable when riparian buffers of sufficient size persist along stream channels, culverts are adequately sized and properly located, development or extractive land management practices are avoided on unstable areas, cover crops are left during the winter, roads are properly maintained, *etc*.

Photo Courtesy 40: Headwater landslide leading to sediment delivery downstream to a CCC coho salmon stream making it unsuitable for coho salmon for many years, *Jon Ambrose, NMFS.*

Photo Courtesy 39: Cottaneva Creek, Mendocino County, *Matt Goldsworthy, MRC*

Floodplains

Survival and distribution of juvenile coho salmon are associated with available winter habitat (Bustard and Narver 1975; Peterson 1982; Tschaplinski and Hartman 1983; Nickelson *et al.* 1992; Quinn and Peterson 1996). During winter, juvenile coho salmon select habitats with low velocity water such as alcoves, side-channels, backwaters, riverine ponds, and deep pools formed by rootwads (Bustard and Narver 1975; Peterson 1982; Tschaplinski and Hartman 1983; Nickelson *et al.* 1992). These habitat features provide cover from predators and protection from high winter flow; factors that cause premature emigration and/or mortality of over-wintering salmonids (Bustard and Narver 1975; Erman *et al.* 1988; McMahon and Hartman 1989; Sandercock 1991).

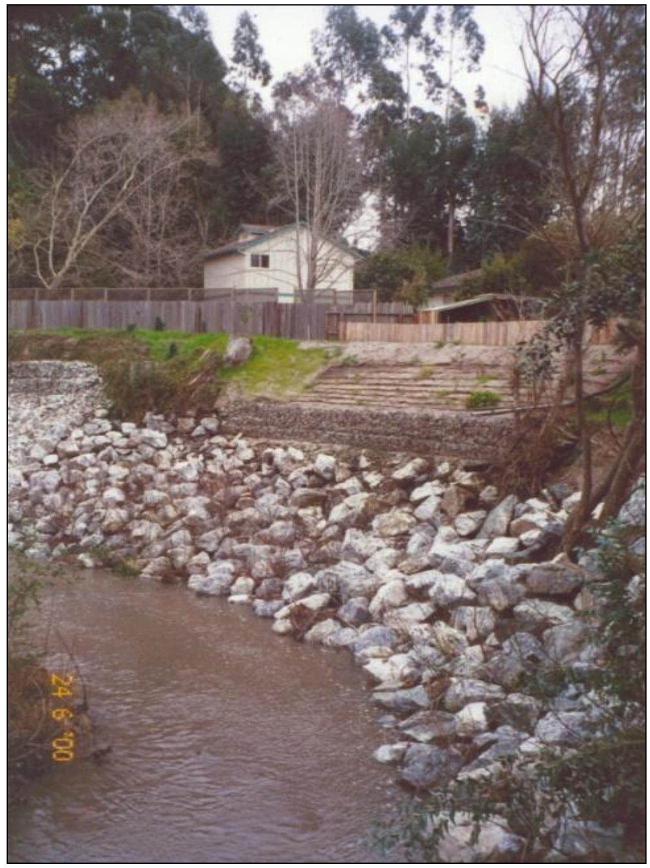

Photo Courtesy 41: Bank stabilization and hardening results in loss of riparian canopy, pool habitats and channel complexity. Branciforte Creek, San Lorenzo River, Santa Cruz County, CA; *Jon Ambrose, NMFS*

These refugia areas are often found at the greatest frequency on floodplains. Survival and growth of CCC coho salmon are higher in floodplain habitats, maintenance and restoration of these areas may be of extraordinary importance for coho salmon recovery. However, floodplains are frequently locations of human development despite also being areas prone to recurrent flooding. Many floodplain habitats in the CCC ESU are altered and channelized (for flood control or routine maintenance) and no longer support alcoves, side-channels, backwaters, *etc*. Restoring floodplain habitats would substantially benefit over-wintering survival of coho salmon.

For more information see Fiedler and Jain (1992), Gentry (1986), Gilpin and Soule (1986), Nicholson (1954), Odum (1971; 1989), Soulè (1986), FEMAT (1993), Gregory and Bisson (1997), Hicks *et al.*, (1991), Murphy (1995), National Research Council (1996), Nehlsen *et al.*, (1991), Spence *et al.*, (1996), Thomas *et al.*, (1993), and The Wilderness Society (1993).

3.4.4 Marine Life Stage

The marine life stage of CCC coho salmon is not well studied. After initial entrance to the ocean, smolts concentrate in schools inshore, gradually moving north along the continental shelf (CDFG 2004). Ocean residence typically lasts for two years, when adult fish return to freshwater to spawn and begin the cycle again. Some precocious males (jacks) return after only six months of ocean residence.

Long-term trends in marine productivity associated with atmospheric conditions in the North Pacific Ocean have a major influence on coho salmon production. Coho salmon have evolved behaviors and life history traits allowing them to survive a variety of environmental conditions. When populations are fragmented or reduced in size and range, however, they are more vulnerable to extinction by natural events.

Poor ocean conditions are believed to have a prominent role in the recent decline of coho salmon populations in California. Unusually warm ocean surface temperatures and associated changes in coastal currents and upwelling, known as El Niño conditions result in ecosystem alterations such as reductions in primary and secondary productivity, and changes in prey and predator species distributions. More significantly, poor ocean conditions that affect the biological productivity are the result of interdecadal climate variability in the northeast Pacific (Hollowed and Wooster 1992; Beamish and Bouillon 1993). Regimes shifts in the ocean have likely significantly adversely affected all CCC coho salmon production.

El Niño is often cited as a cause for the decline of West Coast salmonids. Near-shore conditions during the spring and summer months along California's coast may have dramatically affected year-class strength of salmonids (Kruzic *et al.* 2001). Coho salmon along the California coast may be especially sensitive to upwelling patterns because of the lack of other coastal habitat types (*i.e.*, extensive bays, straits, and estuaries) that normally buffer adverse oceanographic effects. The scarcity of high quality near-shore habitat, coupled with variable ocean conditions, makes freshwater rearing habitat more crucial for the survival and persistence of many coho salmon populations. Of greatest importance is not how salmonids perform during periods of high marine survival, but how prolonged periods of poor marine survival affect population viability. Salmonid populations have persisted through many such cycles. It is less certain how they will fare in periods of poor ocean survival when freshwater, estuary, and nearshore marine habitats are degraded (Good *et al.* 2005). Recovery of coho salmon will depend on robust populations resilient enough to withstand natural changes in ocean productivity.

The interannual variations of El Niño events decrease salmonid prey abundance; however, changes to Pacific Decadal Oscillation (PDO) are more long lasting and more profound to salmonid populations. Synthesis of climate and fishery data from the North Pacific sector highlights the existence of large scale, interdecadal, coherent pattern of environmental and biotic changes. The marine ecological response to the PDO-related environmental changes starts with phytoplankton and zooplankton at the base of the food chain, and works its way up to higher level predators like salmon (Venrick 1992; Roemmich and McGowan 1995; Hare 1996) (Brodeur *et al.* 1996; Francis 1997). This "bottom-up" enhancement of overall productivity appears to be closely related to upper ocean changes characteristic of the positive polarity of the PDO. PDO reversals occurred in 1925, 1947, and 1977 (Mantua *et al.* 1997; Mantua and Hare 2002). These reversals significantly altered harvest patterns between Alaskan fisheries and fisheries in Washington, Oregon, and California (WOC). However, Mantua *et al.* (1997) observed a weaker connection between harvest records for the WOC salmonids than the Alaskan fisheries and indicated that climatic influences on salmon in their southern ranges may also be masked or overwhelmed by anthropogenic impacts. The conclusion: Alaskan stocks are predominantly wild spawners in pristine watersheds, while the WOC coho and Chinook salmon are of hatchery origin, and originate in watersheds significantly altered by human activities. For more information on climate and marine conditions please see Appendix A.

Photo courtesy 42: Hatchery CCC coho salmon Adult from Scott Creek Hatchery Program, Scott Creek Santa Cruz County, *Morgan Bond, NMFS*

4.0 FACTORS LEADING TO FEDERAL LISTING

"Man in his misguidance has powerfully interfered with Nature. He has devastated the forests, and thereby even changed the atmospheric conditions and the climate. Some species of plants and animals have become entirely extinct through man, and the purity of the air is affected by smoke and the like, and the rivers are defiled. These and other things are serious encroachments upon Nature, which men nowadays entirely overlook but which are of the greatest importance, and at once show their evil effect not only upon plants but upon animals as well, the latter not having the endurance and power of resistance of man."

Goethe, 1832

4.1 PURPOSE

ESA Section 2(a) states that:

- *"various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern for ecosystem conservation;*
- *these species are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people;*
- *the United States has pledged itself…to conserve to the extent practicable the various species of fish or wildlife and plants facing extinction…; and*
- *Congress encourages the States and other interested parties…to develop and maintain conservation programs…to better safeguard, for the benefits of all citizens, the Nation's heritage in fish, wildlife, and plants (16 U.S.C. 1531)."*

Furthermore, ESA Section 3 outlines that to conserve species is to use all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the Act (ESA) are no longer necessary (16 U.S.C. 1531 §3). Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulatory taking (16 U.S.C. 1531 §3).

To comply with the ESA, case law and recovery planning policies, an assessment of the Section 4(a)(1) factors (listing factors) identified at the time of listing was conducted. These assessments are required under Section 4(b)(1) of the ESA during the listing process and require that Federal agencies review the species' status using the best scientific and commercial data available and determine whether a species is endangered or threatened from any one or a combination of the following factors:

Section 4(a)(1) Factors:

(A) The present or threatened destruction, modification or curtailment of habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) Inadequacy of existing regulatory mechanisms; and

(E) Other natural or man-made factors affecting its continued existence.

A secondary assessment was performed for this recovery plan to determine if the factors have changed over time. These assessments conform with:

1. Directives by the U. S. Government Accountability Office (USGAO 2006), from an audit of recovery plans, to ensure new recovery plans have criteria evidencing consideration of the Section 4(a)(1) factors identified for the species at time of listing; and
2. Case law outlining that plans must recognize identified threats and recommend appropriate actions to address threats. The administrative record should reflect the agency considered new ESA section 4(a)(1) threats that have arisen since listing, document the existence of new threats or the elimination of a threat since listing, and develop criteria that address these threats (Fund for Animals v Babbitt, 903F. Supp. 96, 111 (D.D.C. 1995); Defenders of Wildlife v. Babbitt, 130 F. Supp. 2d. 121 (D.D.C. 2001).

All pertinent *Federal Register* notices (FRN), including both proposed and final listing determinations for the CCC coho salmon were reviewed (Table 5). The listing factors described in this Chapter are those that were: (1) specified in the FRN at the time of listing and explicitly described in the listing determination notices for which the notice pertained, or (2) specified in earlier proposed FRNs and incorporated into the final FRN by reference. The current status of all listing factors were assessed in context to the recovery plan threats analysis and through consultation with staff from NMFS, CDFG, and other entities. Information has been catalogued into the administrative record, and described here, for use during 5-year status reviews and for downlisting/delisting decisions by NMFS.

Table 5: Federal Register Notices analyzed

Date	Citation	Title	Content Description
July 25, 1995	60 FR 38011	Endangered and Threatened Species; Proposed Threatened Status for Three Contiguous ESUs of Coho Salmon Ranging From Oregon Through Central California	Proposed rule: threatened status for CCC coho salmon.
October 31, 1996	61 FR 56138	Endangered and Threatened Species; Threatened Status for CCC Coho Salmon ESU	Final rule: threatened status for CCC coho.
June 14, 2004	69 FR 33102	Endangered and Threatened Species: Proposed Listing Determinations for 27 ESUs of West Coast Salmonids	Proposed rule: endangered status for CCC coho salmon, threatened status update for CC Chinook, threatened status update for CCC steelhead, threatened status update for NC steelhead.
June 28, 2005	70 FR 37160	Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs	Final rule, endangered status for CCC coho salmon, threatened status update for CC Chinook salmon. Extend final listing for *O. mykiss* DPSs.

4.2 FACTORS AFFECTING CCC COHO SALMON AT, AND SINCE, LISTING

Through the regulatory process, the Secretary of Commerce determined the CCC coho salmon ESU is an endangered species based on a combination of the five factors summarized below. The factors threatening naturally reproducing coho salmon throughout its range are numerous and varied. For CCC coho salmon ESU, the present depressed condition of the population is the result of several long-standing human-induced factors (*e.g.*, habitat degradation, harvest, water diversions, and artificial propagation) that serve to exacerbate the adverse effects of natural environmental variability from such factors as drought and poor ocean conditions (61 FR 56138).

This chapter outlines the factors affecting CCC coho salmon as they were identified in 1996, and re-affirmed in 2005, when CCC coho salmon were relisted to an endangered status. The chapter outlines changes in: (a) the severity of threats and (b) threats that have been reduced or removed since publication of the final listing rule. The discussion of these listing factors at the time of listing consolidates the major identified threats from both 1996 and 2005 and, where appropriate, focuses on the threats as of 2005, since this is the most recent information analyzed in the Federal Register.

4.2.1 FACTOR A: PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF HABITAT OR RANGE

Factor A: At Listing

Logging, agriculture, mining, urbanization, stream channelization, dams, wetland loss, and water withdrawals and unscreened diversions for irrigation contributed to the decline of the CCC coho salmon ESU. Land use activities associated with logging, road construction, urban development, mining, agriculture, and recreation have significantly altered coho salmon habitat quantity and quality (61 FR 56138). Impacts of concern associated with these activities included the following: alteration of streambank and channel morphology, alteration of ambient stream water temperatures, elimination of spawning and rearing habitat, fragmentation of available habitats, elimination of downstream recruitment of spawning gravels and large wood, removal of riparian vegetation resulting in increased stream bank erosion, and degradation of water quality (61 FR 56138). Of particular concern was the increased sediment input into spawning and rearing areas resulting from the loss of channel complexity, pool habitat, suitable gravel substrate, and LWD (61 FR 56138). Decreased large woody material in streams has also reduced habitat complexity and contributed to the loss of cover, shade, and pools which are required by juvenile coho salmon (60 FR 38011).

Agricultural practices had contributed to the degradation of salmonid habitat in the ESU through water diversions for irrigation, inadequate riparian protections, sedimentation, overgrazing in riparian areas, and compaction of soils in upland areas from livestock. Urbanization had degraded coho salmon habitat through stream channelization, changes to the hydrologic regime (including floodplain processes), riparian damage, and inputs of point source and non-point pollution (including sediments with trace metals, pesticides, herbicides, fertilizers, gasoline, and other petroleum products).

Water diversions and storage of natural flows had drastically altered natural hydrologic cycles in many central California rivers and streams. Alteration of stream flows had increased juvenile salmonid mortality for a variety of reasons (61 FR 56138). Reduced flows degrade or diminish fish habitats via increased deposition of fine sediments in spawning gravels, decreased recruitment of new spawning gravels, encroachment of riparian and nonnative vegetation into spawning and rearing areas, and increased water temperatures (60 FR 38011; 61 FR 56138). The destruction or modification of estuarine areas has resulted in the loss of important rearing and transitional habitats necessary for successful migration.

Factor A: Since Listing

Since 1996 and 2005, restoration work has improved habitats and captive rearing activities have prevented CCC coho salmon extinction. Additionally, active habitat rehabilitation has facilitated watershed recovery from legacy effects of logging prior to California's Forest Practice Rules (FPRs) (*e.g.*, many sub-watersheds in the Garcia River, Mendocino County, CA). While some improvements are still needed, in general, the FPRs for logging and forestry activities on private and state lands have advanced from 1996 and 2005, to the present. The continuation of efforts to reduce impacts and restore streams is critical to CCC coho salmon recovery. Nevertheless, land uses causing the destruction, modification or curtailment of habitat or range continue to outpace restoration. Forest conversions, urban growth, water diversion, and agricultural activities continue to detrimentally impact streams and coho salmon habitats, which diminish the ability of coho salmon to survive and reproduce. Noteworthy activities needing to be addressed under this factor are: urban growth, riparian removal for land uses unregulated by counties, stream channelization, floodplain disconnection or encroachment, road building, road/bridge reconstruction work disregarding stream or estuarine needs (*e.g.* U.S. Highway 1 bridge over Scott Creek in Santa Cruz County, CA), impacts of rural residential development, decentralized oversight of agricultural activities, adverse effects of marijuana cultivation, conversion of forestlands to other land uses and authorized/unauthorized water diversions (1,771 existing unauthorized dams have been identified within the North Coast Area (SWRCB, North Coast Instream Flow Policy, Appendix E, Table ES.1)).

4.2.2 Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Factor B: At Listing

Coho salmon historically supported a recreational, commercial and tribal fisheries. Modification and degradation of natural habitats in combination with overfishing led to the depletion of many stocks of salmonids (69 FR 33102). Marine harvest of coho salmon occurred primarily in nearshore waters off British Columbia, Washington, Oregon, and California and exploitation rates were higher than many populations could withstand. Prohibitions on the retention of coho salmon in ocean commercial fisheries were instituted in 1993 and 1994. State sport fishing regulations continued to allow fishing for coho salmon in inland waters. The contribution of coho salmon to the in-river sport catch was unknown, and losses due to injury and mortality from incidental capture in other authorized fisheries, principally steelhead, are also unknown. Funding and personnel were not available to implement monitoring programs to evaluate these impacts.

Illegal harvest occurs on spawning beds and in rearing/holding areas. Recreational fishing is pursued in many streams and recent regulations on river harvest have resulted in the closure or severe curtailment of fishing impacts. During periods of decreased habitat availability (*e.g.*, drought conditions) the impacts of incidental capture from recreational fishing may be increased.

Collection for scientific research and educational programs had likely little or no impact on California coho salmon populations. In California, most scientific collection permits are issued to environmental consultants, Federal resource agencies, and educational institutions by CDFG and NMFS. Regulation of take is controlled by conditioning individual permits. CDFG and NMFS require reporting of any coho salmon incidentally taken by other monitoring activities; however, no comprehensive total or estimate of coho salmon mortalities related to scientific sampling are kept for any watershed in California. CDFG does not believe that indirect mortalities associated with scientific research were detrimental to coho salmon in California (61 FR 56138).

Factor B: Since Listing

The global moratorium on high seas driftnet fishing (via a United Nations resolution implemented by the US in 1992) and ocean commercial fisheries closures in 1994 have reduced this threat to CCC coho salmon. Furthermore, the PFMC instituted no-directed coho fisheries or retention-of-coho salmon in all commercial and recreational fisheries off California. Marine fisheries impacts should be no more than 13.0 percent to protect endangered CCC coho salmon as indicated by projected impacts on Rogue/Klamath hatchery coho salmon. The current degree of impact (mortality resulting from (a) hook-and-release, (b) drop off before being boated, and (c) non-compliance) associated with existing regulations for non-retention and mark-selective coho salmon fisheries to the wild CCC coho salmon fishery, as of 2011, was estimated at 3.8%.

State sport fishing regulations no longer allow retention of CCC coho salmon in California inland or nearshore waters. Impacts associated with incidental capture from freshwater recreational fishing still occur. Freshwater steelhead sport fishing is allowed in many rivers and streams where CCC coho salmon persist, including many of the focus watersheds identified in the plan. There is some overlap in run-timing between CCC coho salmon and adult steelhead (October through late February); adult CCC coho salmon have been misidentified by recreational anglers and have recently been incidentally caught and retained. This is particularly a concern in the Russian River watershed where both conservation hatchery coho salmon and traditional hatchery steelhead are adipose fin-clipped.

The Russian River Coho Salmon Captive Broodstock Program was initiated in 2001, to prevent the extirpation of coho salmon in the watershed. The program propagates coho salmon while adhering to conservation hatchery practices using a genetic matrix and releases fry and smolts into Russian River tributaries; a portion of the young will return two to three years later as adults to spawn. The programs' goal is to re-establish a natural self-sustaining population of CCC coho salmon. Because these coho share a common mark with hatchery steelhead, misidentification has occurred and resulted in the harvest of coho salmon. To address these problems, an outreach campaign has been implemented and is underway to raise angler awareness with informational press releases, fliers, and species identification signs at popular angling access points (Figure 14). Species identification and proper handling and release techniques, when incidental capture of CCC coho salmon occurs, is critical to reduce likelihood of mortality and ensure coho salmon adult survival. Releasing coho salmon unharmed requires specific handling, hook removal, revival efforts and minimal air exposure time (*i.e.*, time out of the water). Due to misidentification, marking techniques of coho salmon in the Russian River are being reassessed.

To compound this problem, some angling resources lack clarity or are inaccurate. For example, current fishing regulations indicate that hatchery steelhead may be caught in streams where there is a very low likelihood of hatchery trout occurring (See Fishing in Appendix B) and the Northern California DeLorme Atlas & Gazette (2003) mistakenly indicates that freshwater fishing is allowed for coho salmon in several streams (*i.e.*, Albion River, Big River, Garcia River, Navarro River, Noyo River, Russian River, San Lorenzo River, and Ten Mile River). Education, outreach, improvements to regulations (*e.g.*, consideration of low flow closures, emergency regulations for CCC coho and other mechanisms) and focused enforcement by Game Wardens would appreciably reduce the risk of this factor to coho salmon.

Figure 14: Attention Anglers signage as part of outreach and education.

Scientific research and educational programs are believed to have little or no impact on coho salmon populations; however, the amount of incidental take associated with these is not being tracked. Therefore, it is relatively unknown how these factors are affecting CCC coho salmon populations. Given the extremely low population and endangered status, any impacts associated with this factor such as angling, research, education, *etc.* may have a significant adverse effect and should be monitored.

4.2.3 FACTOR C: DISEASE OR PREDATION

Factor C: At Listing

Relative to the effects of fishing, habitat degradation, and hatchery practices, disease and predation were not believed to be major factors contributing to the decline of West Coast coho salmon populations. However, disease and predation were believed to have substantial episodic adverse impacts in local areas. Coho salmon are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Specific diseases known to be present in, and affect, salmonids are listed in 69 FR 33102. Very little current or historical information existed to quantify changes in infection levels and mortality rates attributable to these diseases for coho salmon. However, studies have shown native fish tend to be less susceptible to these pathogens than hatchery-reared fish (Buchanan *et al.* 1983; Sanders *et al.* 1992). In California, many natural and hatchery coho salmon populations were tested positive for the bacterium *Renibacterium salmoninarum*, a causative agent of bacterial kidney disease (BKD). Within the CCC coho salmon ESU, the overall incidence of BKD infection in fish at Scott and Waddell Creeks (Santa Cruz County, CA) was believed to be 100 percent (61 FR 56138). Stress, caused by migration or poor water quality (including poor water quality due to increased water temperature) or quantity, may trigger the onset of the disease. CDFG initiated a treatment protocol to attempt to control BKD outbreaks in hatchery fish released into the Russian River and Scott Creek (61 FR 56138).

Piscivorous predators, such Pacific hake (*Merluccius productus*) and pollock (*Theragra chalcogramma*) are known to consume salmon smolts (Holtby *et al*. 1990) and likely affect the abundance and survival of CCC coho salmon. Predation by marine mammals (seals and sealions)and birds (such as gulls, grebes *(Podicipedidae)*; and loons *(Gavia spp.)*, herons, egrets, bitterns *(Ardeidae)*; cormorants *(Phalacrocorax spp.)*, terns (*Sterna* spp.), mergansers *(Mergus spp.)*, pelicans *(Pelecanus spp.)*,was of concern in areas experiencing dwindling run sizes of salmon or low juvenile coho salmon densities. Introductions of non-native species and habitat modifications may have resulted in increased predator populations in numerous rivers and near shore environments. It is important to note that these predators are opportunistic feeders, preying upon the most abundant and easiest to catch. Although predation does occur, it was believed to be a minor factor in the overall decline of coastwide salmonid populations at the time of listing but may have contribute to keeping low populations at low levels. The combination of increased predator populations and large-scale habitat modifications that favor predators may have shifted predator-prey balance in some areas. The accumulating effects of reduced population size, decreases in cover habitat and stream flow likely made coho salmon more vulnerable to predation.

Factor C: Since Listing

Since 1996 and 2005, disease and predation were not found to be major factors contributing to CCC coho salmon decline relative to other effects (*i.e.*, habitat degradation). BKD treatment protocols and the discontinuation of conventional production hatcheries may have addressed one of the main sources of this threat. Habitat conditions such as low water flows and high temperatures can exacerbate susceptibility to both disease and predation through increased physiological stress and physical injury. Additional studies are necessary to determine the effects other diseases, under a range of conditions, may have on the population. The potential of some disease outbreaks, due to introductions and straying of out-of-basin and other non-native fishes, are less likely than at the time of listing due to implementation of policies by CDFG prohibiting interbasin transfers.

Predation by marine mammals is coincidental and watershed specific with some probability of coho salmon depletion occurring in locally areas and where populations are low (NMFS 1997; Quinn 2005). While predation was not found to be a major factor, additional investigations should be conducted to assess the relative impact to depressed populations in the marine and freshwater environments from avian predators and marine mammals and non-native fishes such as smallmouth bass and striped bass.

4.2.4 FACTOR D: INADEQUACY OF EXISTING REGULATORY MECHANISMS

Summary: At the time of listing a variety of state and Federal regulatory mechanisms were in place to protect coho salmon and their habitats. Due to funding and implementation uncertainties, and the voluntary nature of many programs, the regulatory mechanisms that existed at the time of listing were determined as not providing sufficient certainty that combined Federal and non-federal efforts are reducing threats to CCC coho salmon. Since listing, a number of factors outlined in the 1996 Federal Register listing CCC coho salmon persist, have improved or have been identified as not relevant. The primary regulatory mechanisms that protect coho salmon are not comprehensive and are vastly different across the landscape and land use type. Timber operations abide by California's Forest Practice Rules while other land uses have little to no oversight or coho protections rely on State regulations or county ordinances when those mechanisms are triggered. Consistent protection measures in a watershed should be pursued regardless of land use. Activities are outside the ESU, and are henceforth excluded from the listing factor analysis. These programs are PACFISH, Northwest Forest Plan, Redwood National and State Park General Management Plan, Green Diamond Habitat Conservation Plan (HCP), PALCO HCP, and Humboldt Bay Municipal Water District HCP.

Currently, regulatory mechanisms for Factor D needing improvements include:

(1) Lack of coordination between NMFS and other Federal agencies to use their authorities in furtherance of the purposes of the ESA and Section 4 of the ESA to conserve endangered CCC coho salmon according to Sections 2(c) and 7(a)(1) of the ESA;

(2) Need for full implementation of ESA programs to create more efficient and effective public/private partnerships (over 85% of the CCC coho salmon ESU is in privately held ownerships);

(3) Increased collaboration between State agencies and NMFS regarding policies, information sharing, permit streamlining, and coordinated efforts to recover CCC coho salmon;

(4) Improvements to, and implementation of, policies and regulations of the U.S. Army Corp of Engineers, Federal Emergency Management Agency and other Federal/State agencies protective of coho salmon and their habitat; and

(5) Collaboration by NMFS with entities (including RCD's, county governments, private landowners, and others) to provide information on recovery priorities and needs.

4.2.5 FEDERAL EFFORTS

In the ESA, Congress declared it "to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA" (16 U.S.C. § 1531 (c)). The legislative history reveals an explicit congressional decision to require agencies to afford first priority to the declared national policy of saving endangered species and a "conscious decision by Congress to give endangered species priority over the 'primary missions' of the federal agencies" (Tennessee Valley Auth. v. Hill 1978).

To ensure Federal regulatory mechanisms are no longer a threat to CCC coho salmon, Federal agencies should fully embrace the rule of interagency cooperation as outlined in the ESA Section 7(a)(1). ESA Section 7(a)(2) imposes a procedural duty on the "action agency" to consult with the "consultation agency" (*i.e.*, NMFS) if the agency's action "may affect" a listed species (50 C.F.R. § 402.14(a)); Turtle Island Restoration Network, 340 F.3d at 974; Pacific Rivers Council v. Thomas, 30 F.3d 1050, 1054 n.8 (9th Cir. 1994).

U.S. Army Corps of Engineers (USACE) At Listing:

USACE regulates dredging and filling in the waters of the United States through the Federal Clean Water Act (CWA) Section 404 Program. The USACE program is implemented through the issuance of a variety of individual, nation-wide and emergency permits. USACE is obligated to not permit a discharge that would cause or contribute to significant degradation of the waters of the United States. At listing, it was determined implementation of the CWA was not effective in adequately protecting fishery resources, particularly in regard to non-point sources of pollution. One factor that was considered in this determination is cumulative effects. USACE guidelines did not specify a methodology for assessing cumulative impacts or how much weight to assign them in decision-making. Furthermore, there was no USACE process to address the cumulative effects of the continued development of water front, riverine, coastal, and wetland properties. A variety of factors, including inadequate staffing, training, and in some cases policy direction, was found to result in ineffective protection of aquatic habitats important to migrating, spawning, or rearing coho salmon. The deficiencies of the program were found particularly acute during large-scale flooding events, such as those associated with EI Niño conditions, which can put additional strain on the administration of the CWA Section 404 program.

U.S. Army Corp of Engineers Since Listing:

The USACE continues to lack a comprehensive and consistent process to address the cumulative effects of the continued development of water front, riverine, coastal, and wetland properties. USACE need for staffing, training and consistency in application of laws and policies still remains. A new development since listing is the USACE policy on *Compensatory Mitigation for Losses of Aquatic Resources* (73 FR 19594); a policy not being uniformly interpreted nor applied between Districts. The significance of different interpretations and priorities within USACE is currently being demonstrated in the Russian River. The USACE operates a hatchery facility at Warm Springs Dam which is instrumental in the Russian River Coho Salmon Recovery Program (a broad coalition of government agencies, scientists, water agencies, private landowners, and others). The program has been in operation since 2001, to raise young coho salmon from wild broodstock and release them into Russian River tributaries. While rearing coho salmon at the hatchery is successful, there is a critical need for outplanting sites with high quality habitat for these young coho salmon to survive in the impaired Russian River watershed. Nearly all of the Russian River is privately owned and many property owners are reluctant to collaborate with the agencies. Thus, securing properties for the outplanting of coho salmon is critical; yet there are few tools to establish such public/private partnerships. Conservation and Mitigation Banking has been identified by NMFS as a tool to secure land in perpetuity towards that cause. Unfortunately, staff at the District office of the USACE, and unconnected with the Russian River Program, is interpreting the policy on *Compensatory Mitigation for Losses of Aquatic Resources* (73 FRN 19594) in a manner different from other Districts that make Conservation Banks economically non-viable and thus a conservation tool unlikely to be used by public entities for CCC coho salmon recovery. Other USACE Districts are interpreting the policy more broadly and have realized demonstrated benefits to salmonids. To reduce this threat for CCC coho salmon, the USACE should consider working with NMFS to determine a service area for salmonids that is more biologically relevant for Conservation and Mitigation Banks and utilize their authority to fulfill their Section 2 and Section 7(a)(1) responsibility. This alone could widen the market for mitigation credits, provide an incentive for private landowners to manage their land for the recovery of CCC coho salmon, and reduce this threat category.

In addition, there is a lack of oversight or consultation with NMFS by USACE for activities (where navigable waters are impaired and coho salmon habitat degraded) that result from normal farming, silviculture, ranching, agriculture, emergency reconstruction of structures, farm ponds, and construction/maintenance of farm or forest roads. Section 404 of the CWA requires permits for the discharge of dredged or fill material into waters of the United States, but exempts activities as outlined in Section 404(f)(1)(A-E):

A. Normal farming, silviculture, and ranching activities such as plowing, seeding, cultivating, minor drainage, harvesting for the production of food, fiber, and forest products or upland soil and water conservation practices;

B. Maintenance, including emergency reconstruction of recently damaged parts of currently serviceable structures such as dikes, dams, levees, groins, riprap, breakwaters, causeways, and bridge abutments or approaches, and transportation structures;
C. Construction or maintenance of farm or stock ponds or irrigation ditches, or the maintenance of drainage ditches;
D. Construction of temporary sediment basins on a construction site which does not include placement of fill material into the navigable waters; and
E. Construction or maintenance of farm roads or forest roads, or temporary roads for moving mining equipment, where such roads are constructed and maintained, in accordance with best management practices, to assure that flow and circulation patterns and chemical and biological characteristics of the navigable waters are not impaired, that the reach of the navigable waters is not reduced, and that any adverse effect on the aquatic environment will be otherwise minimized.

Some of these activities have been found to impair salmonid streams, but without a clear trigger for Federal oversight many of these activities will continue to degrade habitats. This policy should be amended for activities where significant impacts are likely to occur to salmonid streams.

Federal Emergency Management Agency (FEMA) At Listing:

FEMA administers programs which influence development in waterways and floodplains. Through the Public Assistance, Individual and Households and Hazard Mitigation Grant programs, FEMA provides technical and financial assistance to public and private property owners in preparation, response, and recovery from disasters, including flooding events. In the past, FEMA's actions often result in infrastructure repair that only provided funding for replacement of damaged facilities and structures in their original locations and original configurations (*i.e.*, undersized culverts that cannot pass flood flows). These types of repairs are prone to repeated damage from future flooding and have led to repeated disturbance of riparian and aquatic habitats important to migrating, spawning, or rearing coho salmon.

FEMA administers the National Flood Insurance Program (NFIP) which enables property owners in participating communities to purchase insurance as a protection against flood losses. In exchange, state and community floodplain management regulations are implemented, with the goal of reducing future flood damages. Regulations allow for development in the margins of active waterways (if they are protected against 100-year flood events), and do not raise water surface elevations within the active channel (floodway) more than one foot during such flood events. This standard was found to not adequately reflect the dynamic, mobile nature of watercourses in the CCC coho salmon ESU, and the critical role that margins of active waterways (riparian areas) play in the maintenance of aquatic habitats.

Federal Emergency Management Agency Since Listing:

In 2004, a judge ruled (U.S. District Court, Western District of Washington, Seattle, Order No. C03-2824Z) that "FEMA has violated Section 7(a)(2) of the ESA" and directed FEMA to initiate consultation with NMFS on the impacts of its implementation of the NFIP on Chinook salmon. A NMFS Biological Opinion was completed in 2008 and concluded the NFIP, as currently implemented, caused jeopardy to listed Puget Sound salmonids and Southern Resident Killer Whales and adversely modified critical habitat (NMFS 2008a).

A second lawsuit (Audubon Society of Portland *et al*. v FEMA Case 3:09-cv 00729-HA) alleged FEMA violated Section 7 of the ESA by not consulting with NMFS regarding the potential effects of the NFIP on ESA listed salmonids in Oregon. The lawsuit further asserted that FEMA failed to use its authorities to carry out programs to conserve listed species. On July 9, 2010, FEMA entered into an agreement with the plaintiffs settling the lawsuit (U.S. District Court Case 3:09-cv-00729-HA: Settlement Agreement and [Proposed] Court Order). The settlement agreement required FEMA to initiate formal consultation with NMFS on FEMA's implementation of the NFIP and its associated discretionary components including the mapping of floodplains and revisions thereof, and the implementation of the Community Rating System (CRS) for the 15 salmon and steelhead ESUs/DPSs listed under the ESA in Oregon. Due in part to these lawsuits and the Puget Sound area NFIP biological opinion, a national consultation effort is underway between FEMA and NMFS regarding FEMA's proposed revision of its NFIP. The timing for its finalization is unknown at this time; however, staff in the Northwest Region and SWR are currently providing technical assistance to FEMA for that consultation and have provided comments through the NEPA comment process. Through this process, the inadequacy of the regulatory mechanisms of the FEMA NFIP was outlined by NMFS in a July 12, 2012, letter (NMFS 2012b). The letter highlighted the following issues:

(1) Current mapping protocols fail to accurately recognize and reflect the full range of flood hazards to people and property, and simultaneously fail to recognize and protect natural resource values of the floodplain;
(2) Existing minimum floodplain management criteria promote construction in floodplains rather than discourage development in floodplains, to the detriment of ESA listed species and their critical habitat; and
(3) The community rating system should better incentivize flood damage minimization practices that are compatible with preservation/restoration of natural functions of floodplains.

Currently, work in the SWR is underway on a programmatic biological opinion on implementation of FEMA's programs for disaster preparation response, and recovery, including flooding events. NMFS and FEMA have been engaged in discussions to improve implementation of these programs and include standard conservation measures for the protection of salmonids and their designated critical habitat. Conservation measures will also include regeneration of riparian habitat, improvements to passage, and provisions for restoration of natural and historical channel processes that are necessary to support listed salmonids including CCC coho salmon. If the NFIP and Disaster Relief Program consultations improve these programs for salmon and steelhead, the threat will be reduced.

EPA, Water Quality Control Board and Total Maximum Daily Loads (TMDL) At Listing:

The CWA is administered by the Environmental Protection Agency (EPA), is intended to protect and fully support the beneficial uses of water such as aquatic life, fisheries, drinking water, recreation, industry and agriculture. The State of California inventoried a list of water bodies, known as the 303(d) lists, and characterized water as either; fully supported, impaired, or in some cases threatened, as beneficial uses. Section 303(d)(1)(C) and (D) of the CWA requires states to prepare Total Maximum Daily Loads (TMDLs) for all water bodies failing to meet water quality standards. TMDLs are a method for quantitative assessment of environmental problems in a watershed and identifying pollution reductions necessary to protect drinking water, aquatic life, recreation, and other use of rivers, lakes, and streams. The states either develop a numeric criteria or a narrative description for the maximum amount of a pollutant that a water body can receive while still meeting water quality standards.

EPA delegated its authority to each state to enact the CWA. In California, both EPA and the California Regional Water Quality Control Boards (RWQCB) establish TMDLs for impaired rivers and streams on the 303(d) list. In the late 1990's, the state of California committed to, and completed, the development of TMDLs for 18 basins in California by 2007. EPA outlined a plan to develop TMDLs for the remaining impaired basins and agreed to complete all TMDLs if the State failed to meet its commitments in 2007. The North Coast Regional Water Quality Control Board (NCRWQCB) was in the process of updating its north coast basin plan, which would establish water quality standards for all of the northern California rivers and streams (including Ten Mile, Noyo, Navarro, Garcia, Gualala, and Russian rivers). Basin plans are considered living documents and are continually updated and refined.

At the time of listing, NMFS was concerned about the inadequacy of existing regulatory mechanisms to protect and conserve CCC coho salmon ESU through the development and implementation of TMDLs in California (62 FR 43937). NMFS determined implementation of the existing regulatory mechanisms had not been adequate to protect coho habitat.

EPA, Water Quality Control Board and Total Maximum Daily Loads (TMDL) Since Listing:
Since the original listing and the recent 5-year status review for CCC coho salmon, the EPA and State have established a number of TMDL's in watersheds for various constituents (*i.e.*, sediment, temperature, nutrient, *etc*.) to reduce pollutant loads to impaired water bodies. Based on the current 303(d) list with over 1,883 water body/pollutant combinations, the SWRCB has estimated that the total number of TMDLs needed is over 400 projects across the State. The Regional Boards are currently engaged in developing over 120 TMDLs, many addressing multiple pollutants. Schedules have been developed for establishing all required TMDLs over a 13-year period (see web site for more information at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/303dlists2006/epa/r1_06_303d_reqtmdls.pdf). More detailed schedules of work to be undertaken in the 3- and 5-year periods have also been developed.

Approved TMDLs are improving CCC coho salmon habitats in some watersheds (*e.g.* Garcia River, Mendocino County, CA); in other watersheds substantial progress or improvement is needed (*e.g.*, San Lorenzo, Santa Cruz County, CA). These differences are largely the result of staff availability and varying implementation schedules time by the various WQCBs.

In 2011, the NCRWQCB, the Central California Coast RWQCB, and the San Francisco Bay RWQCB updated their basin plans to establish water quality standards for rivers, streams, and tributaries in the CCC ESU. NMFS expects the development and implementation of TMDLs will improve CCC coho salmon ESU habitat; however, their efficacy in protecting coho salmon habitat will be unknown for years to come. Monitoring of the TMDLs process is essential to the recovery CCC coho salmon.

Considerable work has been done to improve water quality in California's streams, rivers, and tributaries; however, there are a number of additional water quality issues that need to be addressed to protect and conserve coho salmon. For example, impacts to fish habitat from agricultural practices have not been closely regulated. The State of California does not have regulations that directly manage agricultural practices, but instead relies on the TMDLs under the CWA to improve water quality from all sources and parties, including agricultural sources. Numerous streams in the CCC coho salmon ESU are currently impacted by agricultural practices, but do not have TMDLs (SWRCB 2010), and many are not scheduled for completion until 2019. The majority of TMDLs focus on sediment and temperature requirements with little focus on pesticide toxicity. Pesticide toxicity is currently believed to be an upcoming issues regarding stream impairment but little is known about its effects to CCC coho salmon.

Many pesticides are applied in CCC coho salmon watersheds to control pests associated with agricultural crops, residential homes, commercial and industrial facilities, transportation corridors, parks, golf courses, and timberlands. Pesticides can be transported to salmon habitats as a result of point source (*e.g.*, discharges from industrial and municipal outfalls) and non-point source (*e.g.*, agricultural and urban runoff) pathways. The direct impact of pesticides (and pesticide mixtures) on salmon health is an emerging research area (Eder *et al.* 2009; Laetz *et al.* 2009) in the context of population recovery (Baldwin *et al.* 2009); however, the indirect impacts of pesticides on salmonids via their supporting aquatic food webs remain poorly understood (MacNeal *et al.* 2010). Results by Baldwin *et al*. (2009) indicated short-term (*i.e.*, four-day) exposures (representative of seasonal pesticide use) may be sufficient to reduce the growth and size at ocean entry of juvenile steelhead. Overall, results indicate exposure to common pesticides may place important constraints on the recovery of ESA listed salmon species, and that simple models can be used to extrapolate toxicological impacts across several scales of biological complexity (Baldwin *et al.* 2009). Despite these gaps, there is considerable evidence pesticides may have toxic effects on the biological communities that support ESA-listed salmon (reviewed in NMFS 2008b; NMFS 2009). Research on this topic for CCC coho salmon is critically needed.

At the Federal level[11], the EPA initiated ESA section 7 consultations with the NMFS' Office of

[11] The California Department of Pesticide Regulations (CDPR) regulates pesticides. The CDPR has a statutory mandate to encourage the development and implementation of pest management systems that stress biological, mechanical and cultural pest control. The CDPR uses "integrated pest management" (IPM) to ensure the least possible harm to non-target organisms, public health and the environment.

Protected Resources for the re-registration of 37 pesticide active ingredients. At present, five biological opinions have been completed with NMFS with the conclusion that numerous[12] insecticides, fungicides, herbicides and insecticides, used in both agricultural and urban settings, likely jeopardize and adversely modify designated critical habitat for CCC coho salmon ESU (NMFS 2008b; NMFS 2009; NMFS 2010b; NMFS 2011; NMFS 2012c). Two biological opinions for the remaining eight active ingredients are scheduled for completion by 30 June 2013.

In summary, some improvements in some watersheds in the CCC ESU are occurring where TMDLs are developed and actively implemented. The State has developed many TMDLs but the list of additional impaired waterbodies remains very large and TMDL development will likely take many more years to fully implement. TMDLs development and implementation has significant potential to provide long term benefits to listed salmonids and their habitat. However, it will take time to develop and implement TMDL standards for all pollutants and to determine the magnitude of the benefits of existing programs.

NMFS Efforts At Listing (ESA Section 7 Consultations):

NMFS conducts ESA section 7 consultations with Federal action agencies that fund, conduct or authorize projects in the range of CCC coho salmon. NMFS evaluates impacts to CCC coho salmon from a wide variety of projects including: irrigation and water diversion, timber harvest, watershed restoration, fish passage, gravel mining, grazing, and transportation projects. From 2000 to 2005, NMFS had conducted approximately 2,300 ESA section 7 consultations with over 20 Federal action agencies in California. Of this total, approximately 1,500 consultations involved projects in coastal watersheds occupied by listed coho salmon, Chinook salmon, and steelhead ESUs/DPSs. NMFS has also provided technical assistance to Federal agencies on hundreds of additional projects throughout the State of California. The

[12] Chlorpyriifos, diazinon, malathion, carbaryl, carbofuran, methomyl, 2,4-D, oryzalin, penditmethalin trifluralin, and pesticide products containing the active ingredient naled, phosmet, ethoprop, phorate and methidathion.

majority of consultations were with BOR, USACE, FHWA, FWS, USFS, BLM, and BIA. In addition to consulting with other Federal agencies, NMFS has also consulted with itself regarding the effects of recreational and commercial fishing on listed salmonid ESUs. These consultations improved, or minimized adverse impacts to, and resulted in more consistent approaches to management of listed salmonid and their habitats throughout coastal watersheds in California. Two consultations the Potter Valley Project (which included the Russian River) and the USACE and the Sonoma County Water Agency (for the Russian River) were expected to improve, or minimize adverse impacts to salmonids and their associated habitat.

NMFS Efforts Since Listing (ESA Section 7 Consultations):

Both the Potter Valley Project and the USACE and Sonoma County Water Agency consultations have been completed. The Potter Valley Project does not directly relate to CCC coho salmon; however the Sonoma County Water Agency consultation is expected to realize significant benefits to CCC coho salmon when fully implemented. A small percentage of the CCC coho salmon ESU falls within the jurisdiction of Section 7 consultations due to the large percentage of privately held land. Nonetheless, Section 7 consultations can provide benefits to CCC coho salmon if recommendations in this plan are fully implemented. Some programmatic biological opinions have been completed with the USACE for restoration and enhancement actions. See Chapter 12 "Implementation by NMFS" for more details.

NMFS Efforts At Listing (ESA Section 10):

Habitat Conservation Planning (HCP) under section 10 of the ESA addresses species protection on non-Federal lands. HCPs are particularly important since much of the habitat in the range of CCC coho salmon is in non-Federal ownership.

NMFS Efforts Since Listing (ESA Section 10):

Section 10 of the ESA involves both the development of HCPs as well as scientific research.

An HCP with Mendocino Redwood Company has been in development since 2000, but has yet to be finalized. Due to the high non-Federal ownership in the CCC coho salmon, the use of HCPs will be critical to recovery.

Scientific research and educational programs are believed to have little or no impact on coho salmon populations; however, the amount of incidental take associated with these is not being tracked. Therefore, it is relatively unknown how these factors are affecting CCC coho salmon populations. Given the extremely low population and endangered status, any impacts associated with this factor such as angling, research, education, *etc.* may have a significant adverse effect and should be monitored.

Other NMFS Efforts Since Listing:

Conservation and advance mitigation planning efforts are being considered or proposed by many agencies and project proponents. An increasing number of conservation banks targeting NMFS species and their habitats are being proposed by bank sponsors. The SWR is currently engaged in a number of conservation banking activities which include the operation of established bank sites, developing new banks, developing regional and state-wide mitigation initiatives with state agencies, and interagency efforts to improve and maintain consistent coordination. In 2011, the SWR issued policy guidance for the review, establishment, use, and operations of conservation banks and in-lieu fee mitigation programs within the Southwest Region. Conservation banks use the free–market enterprise to offer landowners an economic incentive to protect, preserve and restore habitats for species listed under the federal ESA. In exchange, the landowner banks habitat "credits" that may be sold to groups to compensate for adverse impacts to these listed species or their habitats that are caused from projects. Banks are usually held in perpetuity. A summary of ongoing and potential banking efforts in the CCC coho salmon ESU are described below.

- The Austin Creek Conservation Bank was signed in 2010 and is the first NMFS approved Conservation Bank in the CCC coho salmon ESU. The ownership is roughly 400 acres and lies along several stream miles of upper East Austin Creek and Devils Creek in the Russian River watershed and adjacent to Austin Creek State Recreation

Area. The bank agreement is on file at the SWR's North Central California Coast Office. The bank targets Central California Coast coho and steelhead and has credits for riparian and upland habitats that maintain natural stream processes. The service area is a 2-tiered system. The primary service area includes Marin and Sonoma Counties, and may be utilized for mitigation and conservation. The secondary area includes the entire Central California Coast coho and steelhead ESU/DPSs, and may be used for conservation purposes. Phase 1 of the bank involves 144 acres and Phase 2 will bring in the remaining acreage of the property into the bank. The bank owner has initiated restoration and is allowing the Russian River Coho Salmon Captive Broodstock Program staff to outplant juvenile coho salmon on the property. Wild coho salmon adults spawned on the property in 2011 and their young were confirmed by snorkel surveys. To continue the good work, NMFS and other agencies should continue to ask project proponents to consider banks as a way of offsetting impacts.

- The Statewide Advance Mitigation Initiative (SAMI) Memorandum of Understanding (MOU) establishes a mutual framework for developing a coordinated advanced mitigation plan for projects proposed by the California Department of Transportation (Caltrans). The MOU was signed in 2011 by Caltrans, CDFG, Corps, the Environmental Protection Agency (EPA), the US Fish and Wildlife Service (USFWS), and NMFS. The SAMI may include conservation and mitigation banks, in-lieu fee (ILF) programs, or other appropriate mitigation or conservation measures. The MOU addresses unavoidable impacts to aquatic ecosystems resulting from transportation projects and specifically requires Caltrans to first avoid then minimize impacts.
- The Regional Advanced Mitigation Project (RAMP) MOU was signed by in 2009 by Caltrans, the Business Transportation and Housing Agency, the Wildlife Conservation Board, EPA, USACE and the California Department of Water Resources (DWR) to improve project mitigation and streamline the mitigation process for transportation and flood control infrastructure projects. A copy of the MOU is on file at the NMFS SWRO. The RAMP MOU establishes a working group that will develop a regional plan to develop, implement and institutionalize strategies that encourage the use of advanced

regional mitigation planning and projects in the planning, design, and implementation of transportation and flood infrastructure projects. The workgroup is pursuing a pilot project to apply these principles and strategies.

Northwest Forest Plan (NFP) and PACFISH At Listing:

The NFP is a Federal management policy with potential benefits for CCC coho salmon. Under the NFP the US Forest Service (USFS) and the Bureau of Land Management (BLM) made efforts to reduce adverse effects to aquatic and riparian dependent species including salmon in the range of the Northern spotted owl. The most significant element of the NFP for anadromous fish is its Aquatic Conservation Strategy, which includes an objective for salmon habitat conservation. However, Federal lands comprise only about five percent of the CCC coho salmon ESU, a proportion too small to secure recovery even with the strictest of Federal forest management practices.

PACFISH is a cooperative effort between USFS and BLM to develop coordinated Management and Land Use Plans for the Federal lands they manage in eastern Oregon and Washington, Idaho, and portions of Northern California. PACFISH is intended to provide protection of anadromous fish aquatic and riparian habitat conditions while a longer term, basin scale aquatic conservation strategy is developed. PACFISH provides objective standards and guidelines that are applied to all Federal land management activities such as timber harvest, road construction, mining, grazing, and recreation.

Northwest Forest Plan (NFP) and PACFISH Since Listing:

The NFP and PACFISH should not be considered in further status reviews nor listing evaluations as they are not issues affecting the CCC coho salmon ESU.

Pacific Fisheries Management Council (PFMC) At Listing:

Ocean fisheries are managed by the PFMC. Since the listing of Pacific salmon and steelhead under the ESA, substantial harvest reform has been instituted to reduce impacts to listed stocks.

Each year the PFMC develops fishing regulations that are established by NMFS in Section 7 consultations for listed ESUs in California, Oregon, Washington, and Idaho. The ocean fisheries have been implemented consistent with NMFS' requirements and have been effective at reducing harvest impacts.

Pacific Fisheries Management Council Since Listing:

The PFMC continues to institute no directed coho fisheries or retention of coho in all commercial and recreational fisheries off California. The marine fisheries impacts should be no more than 13.0 percent to protect endangered CCC coho salmon.

Pacific Coastal Salmon Recovery Fund (PCSRF) At Listing:

The PCSRF was established in Fiscal Year (FY) 2000 to address a coast-wide need to protect, restore and conserve Pacific Chinook, coho, chum, sockeye, and pink salmon and steelhead, including their habitats. The PCSRF supplements existing state and tribal programs to foster development of federal-state-tribal-local partnerships in salmon recovery and conservation by providing grants for restoration of anadromous salmonids to the eligible states and tribes. States must provide a minimum 33% match as a condition for use of these funds. NMFS oversees the administration of PCSRF and distributes the congressional appropriations to states and tribes in the Pacific Coast Region. CDFG administers the funds through the Fisheries Restoration Grant Program (FRGP). Funded projects include, but are not limited to, fish passage barrier removals, stream bank stabilization, fish habitat improvements that increase the frequency of pools, removal of and/or storm-proofing of roads that contribute sediment to streams, stabilizing eroding hill slope area adjacent to stream channels, revegetation of upslope areas and riparian areas, monitoring programs to provide baseline and/or population trend data, and support of local watershed organizations and education projects. The Federal funds provided to the State and California Tribes have been important in furthering conservation efforts in coastal watersheds. The funds have been successfully used to leverage additional State and local salmon recovery funding sources, and have precipitated a substantial increase in overall funding in the coastal counties of California.

Pacific Coastal Salmon Recovery Fund (PCSRF) Since Listing:

The PCSRF program has been continuous since FY 2000, and many restoration actions have been implemented with meaningful benefits realized for CCC coho salmon and their habitats. The DFG Fisheries Grant Program (FRGP) that uses PCSRF monies has improved since listing. The PCSRF program has also improved the focus to ensure ESA listed species are considered top priorities for PCSRF money. For FY 2012, NMFS initiated a solicitation for the states to seek applications for projects to allocate Federal funds and demonstrate how the money is anticipated to be used according to new NMFS priorities. Specifically, in accordance with the Congressional authorization, that funding is used for projects "*necessary for conservation of salmon and steelhead populations that are listed as threatened or endangered, or identified by a State as at-risk, or for maintaining populations necessary for exercise of tribal treaty fishing rights or native subsistence fishing, or for conservation of Pacific coastal salmon and steelhead habita*t." (Public Law 112-55 in NOAA 2012). New program priorities for FY2012 PCSRF applications are (ranked in order):

(1) Projects that address factors limiting the productivity of ESA-listed Pacific salmonids as specified in approved, interim or proposed Recovery Plans. This includes projects that are a necessary precursor to implementing priority habitat actions for ESA-listed salmonids (*e.g.*, project planning/design);

(2) Projects that restore or protect the habitat of anadromous salmonids that are at-risk of being ESA listed or are necessary for exercise of tribal treaty fishing rights or native subsistence fishing. This includes projects that are a necessary precursor to implementing habitat actions (*e.g.*, project planning/design);

(3) Effectiveness monitoring of habitat restoration actions at the watershed or larger scales for ESA-listed anadromous salmonids, status monitoring projects that directly contribute to population viability assessments for ESA-listed anadromous salmonids, or

monitoring necessary for the exercise of tribal treaty fish rights or native subsistence fishing on anadromous salmonids; and

(4) Other projects consistent with the Congressional authorization with demonstrated need for PCSRF funding. This includes habitat restoration and planning projects not included in the above priorities, as well as outreach, coordination, research, monitoring, and assessment projects that can be justified as directly supporting one of the priorities.

The FRGP program, supported in part by PCSRF funding, is one of the single most important restoration programs in California. Continued PCSRF funding is a critical component to prevent extinction, focus restoration, conduct monitoring and support entities interested in recovery of CCC coho salmon.

Other Federal Efforts Since Listing:

See Chapter 12 "Implementation by NMFS" for more details on actions associated with the ESA.

4.2.6 NON-FEDERAL EFFORTS

State Programs

California Department of Fish and Game At Listing:

Coho salmon were first listed under the CESA in 1995, in coastal streams south of the Golden Gate. The original State listing did not encompass the entire ESU and NMFS determined it is essential to manage the ESU as a population unit. NMFS concluded that CDFG may intend to expand its recovery planning effort to the entire ESU, the protective measures of the State ESA needed to be expanded to encompass the remainder of the ESU. The State of California eventually listed the remainder of the CCC coho salmon ESU as endangered under the State ESA. Freshwater fishing regulations were identified as a threat to coho salmon at the time of listing (see Listing Factor B for further discussion).

California Department of Fish and Game Since Listing:

In 2004, the California Fish and Game Commission finalized the California State Coho Salmon Recovery Strategy (CDFG 2004) which identified and addressed recovery needs of coho salmon and their habitats. The State recovery strategy established six goals:

1. Maintain and improve the number of key populations and increase the number of populations and brood years of coho salmon;
2. Maintain and increase the number of spawning adults;
3. Maintain the range and maintain and increase the distribution of coho salmon;
4. Maintain existing habitat essential for coho salmon;
5. Enhance and restore habitat within the range of coho salmon; and
6. Reach and maintain coho salmon population levels to allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.

To achieve these goals the plan provides recommendations to address stream flow, water rights, fish passage, water temperature, pool habitat structure, riparian habitat, watershed planning, and gravel mining activities. Recovery priorities have been included into the operations of both conservation hatchery programs (Warm Springs and Kingfisher Flat Monterey Bay Salmon and Trout Project in Scott Creek) and the CDFG FRGP, though currently the plan has not been evaluated for its effectiveness due to lack of funding for State monitoring programs.

Many projects have been implemented in the CCC coho salmon ESU under the CDFG FRGP on public and private lands. FRGP funds have been used by watershed groups, non-profit organizations and others to promote important conservation actions. CDFG conducts site specific implementation and effectiveness monitoring to track the success and benefits of these efforts. FRGP has recently been revamped to more effectively coordinate and comport with State and Federal priorities. Furthermore, a more equitable distribution of funds is underway to ensure projects for all federally listed salmonids are represented. The overall benefits of the FRGP have improved significant acres of watersheds and miles of habitat; however effectiveness monitoring has been lacking due to limited funding. It is critical that the FRGP program is funded, and expanded, to ensure continued restoration and monitoring work critical to prevent CCC coho salmon extinction and shift their trajectory towards recovery. Long-term funding is critically needed for the State to expand its monitoring programs that are currently funded by FRGP.

Freshwater fishing regulations no longer allow for fishing of coho salmon (see Listing Factor B for further discussion).

CDFG established the range-wide Coho Salmon Recovery Team (CRT) in December, 2002. The CRT is made up of 21 members from a wide range of interests, professions, and perspectives which represents county, State, and Federal governments, tribes, commercial and recreational fishing, forestry, agriculture, ranching, water management, and environmental interests. The team addressed many significant issues affecting coho salmon range-wide which were incorporated into the California Recovery Strategy for Coho Salmon (CDFG 2004). The CRT continued meeting after completion of the recovery strategy and, in recent years, has convened on average of two times per year to address issues ongoing and recent developments in regard to the continued decline of coho salmon in the State.

Coastal Monitoring Plan (CMP) At Listing:

A major concern in risk assessments for salmonid ESUs in California has been the lack of comprehensive abundance and trend data for coastal salmonids. In 1994, the state's habitat restoration program funded a major coastal salmonid monitoring program development effort that is being carried out by the CDFG and NMFS. The development of a statewide, coastal monitoring program plan is critical to assessing the viability of listed ESUs and their response to extensive habitat restoration efforts and other conservation efforts. While the program was expected to be developed within a year of listing, sufficiency of long-term funding for implementation was an identified as a major uncertainty.

Coastal Monitoring Plan (CMP) Since Listing:

The *California Coastal Salmonid Population Monitoring: Strategy, Design and Methods* (Adams *et al.* 2011) was finalized and is the first iteration of the CMP to guide monitoring of salmonid populations for the State. Joint CDFG-NMFS committees have been formed to oversee program development and implementation to further detail both population and habitat monitoring protocols and analysis techniques. The progress of the CMP and work by the committees is an improvement from the time of listing and a step forward to broaden and intensify monitoring. Unfortunately, the long-term and consistent data collection needed to inform us on status and trends cannot be realized with short-term and uncertain funding. New partners and assured funding for monitoring are critically needed for the CMP to become a viable program. The lack of sustained and secured funding to implement the CMP, and essential to conduct long-term monitoring, remains a concern and threat to CCC coho salmon.

California State Water Resources Control Board (SWRCB) At Listing:

SWRCB administers a water rights permitting system which controls utilization of waters for beneficial uses throughout the State. This permitting system, while it contains provisions (including public trust provisions) for the protection of instream aquatic resources, does not provide an explicit regulatory mechanism to implement CDFG Code Section 5937 requirements to protect fish populations below impoundments. Additionally, SWRCB generally lacks the oversight and regulatory authority over groundwater development comparable to surface water developments for out-of-stream beneficial uses.

California State Water Resources Control Board (SWRCB) Since Listing:

Assembly Bill 2121 (Stats. 2004, ch. 943, §§ 1-3) added sections 1259.2 and 1259.4 to the California Water Code. Water Code section 1259.4 requires the SWRCB to adopt principles and guidelines for maintaining instream flows in northern California coastal streams for the purposes of water right administration. The principles and guidelines were adopted as part of state policy for water quality control pursuant to chapter 3, article 3 (commencing with section 13140) of the Porter-Cologne Water Quality Control Act (Wat. Code, § 13000 *et seq*.).

On May 4, 2010, the State Water Board adopted a policy for water quality control titled "*Policy for Maintaining Instream Flows in Northern California Coastal Streams*." The policy contains principles and guidelines for maintaining instream flows for the purposes of water right administration. The geographic scope of the policy encompasses coastal streams from the Mattole River to San Francisco and coastal streams entering northern San Pablo Bay and extends to five counties: Marin, Sonoma, and portions of Napa, Mendocino, and Humboldt Counties.

Implementation of the Policy for Maintaining Instream Flows in Northern California Coastal Streams should result in major benefits to coho salmon in the northern portions of the CCC ESU if properly implemented and enforced. The policy includes provisions to address seasons of diversions, minimum bypass flows, maximum cumulative diversions, onstream dams, and assessment of cumulative effects for new water diversion applications. The policy does not apply to previously authorized water diversions. Numerous unpermitted and out-of-compliance water diversions are present in the CCC ESU. Resources are lacking to monitor and enforce these diversions to ensure adequate instream flow is available for rearing coho salmon.

California Forest Practice Rules (FPRs) At Listing:

The California Department of Forestry and Fire Protection (CalFire) enforces California's FPRs which are promulgated through the State Board of Forestry (BOF). The FPRs contain provisions that could provide significant protection for salmon if fully implemented. NMFS however believes the FPRs did not provide adequate protection of properly functioning conditions. It is unclear what level of protection would be afforded to coho salmon on private lands and in non-forested areas.

FPRs Since Listing:

Forest practice rules regulate management of non-Federal timberlands in California and are promulgated by a governor-appointed Board of Forestry. Because of the preponderance of private timber land and timber harvest activity in the CCC coho salmon ESU, the FPRs are critically important for the species' conservation. Since listing, NMFS, RWQCB, and CDFG have expended considerable time and effort working with the Board of Forestry to increase protections for listed salmonids and their habitats. These efforts have resulted in varying degrees of success. For example:

1. At the time of listing the Board of Forestry did not adopt CDFG's proposal to designate coho salmon as a sensitive species pursuant to 14 CCR 898.2(d).
2. Efforts between NMFS, CALFIRE, and the BOF to develop guidelines for timber harvest plans which do not result in take of coho salmon or damage to coho habitat were only partially successful. Guidelines to prevent take of coho salmon were never fully developed or adopted. Guidelines to protect habitat have resulted in considerable efforts to address necessary increases in habitat protections while allowing operational flexibility based on site specificity.
3. In 1998, the expected implementation of a NMFS/State of California Memorandum of Agreement (MOA) was a critical factor in NMFS' decision to not list NC steelhead as threatened in 1998 (63 FR 13347). The MOA committed the State to implement measures in the State Strategic Plan for steelhead, implement the California Watershed Protection Program, and review and revise (if found necessary) the State's FPRs. In accordance with the MOA, a scientific review panel was appointed to undertake an independent review of the FPRs. In 1999, the review panel concluded the FPRs, including their implementation through the timber review process, did not ensure protection of anadromous salmonid habitats and populations. To address these shortcomings, and as specified in the MOA, the California Resources Agency and the California Environmental Protection Agency jointly presented the BOF with a proposed rule change package in July 1999.
4. The State's Threatened and Impaired Value Rules (T/I Rules) were developed and intended to minimize impacts to salmonid habitat resulting from timber harvest by requiring management actions in watersheds with State and Federally listed threatened, endangered, and or candidate populations of anadromous salmonids. Following several months of public review, the BOF took no action on the package in October 1999,

thereby precluding any possibility of implementing improvements in California's FPRs by January 1, 2000, as the State had committed in the MOA. The California State Legislature gave special authority to the BOF to adopt new rules twice during the year 2000, for the specific purpose of revising the State's FPRs to meet ESA requirements for salmonids. On March 14, 2000, the BOF adopted only a subset of rule changes. It was determined the full implementation of these provisions was critically important to protecting the habitat of the NC steelhead DPS (and other salmonids as well, including CCC coho salmon). NMFS' decision to list the NC steelhead DPS as a threatened species (65 FR 36074) was largely due to the BOF approving only a portion of the 1999 T/I rule package and not fully implementing critically important conservation measures (*e.g.*, Class II and Class III protections).

5. In July 2000, CDFG began imposing stricter guidelines to protect and restore watersheds with threatened or impaired values (T/I rules). Examples of the special management actions required include constructing watercourse crossings that allow for unrestricted fish passage, increasing large woody debris recruitment, increasing soil stabilization measures, and requiring coordination between CDFG, CalFire, and Regional Water Quality Control Boards to minimize sediment discharge. The T/I rules were never permanently adopted, but instead have been re-authorized numerous times since their inception in 2000. The T/I rules were replaced by the Anadromous Salmonid Protection (ASP) rules in 2010. The BOF's primary objectives in adopting the ASP rules were to: (1) ensure rule adequacy in protecting listed anadromous salmonid species and their habitat, (2) further opportunities for restoring the species‟ habitat, (3) ensure the rules are based on credible science, and (4) meet Public Resources Code (PRC) § 4553 for review and periodic revisions to the FPRs. The coastal watersheds south of San Francisco Bay were specifically excluded from the increased protections provided by the ASP rules, despite the fact coho salmon in these watersheds are critically close to extirpation.
6. A number of items identified as inadequacies of the forest practice rules remain unresolved. These are (1) rate of harvest; (2) winter operations; (3) road planning,

construction, maintenance and decommissioning; (4) loss of riparian function and chronic sediment input from streamside roads; (5) unstable areas; (6) planning, implementation and enforcement; (7) exemptions and conversions and (8) watershed analysis. Until a watershed analysis process is put in place in California the rules will continue to be decoupled from addressing the limiting factors to salmonids.

<u>Other Non-Federal Entities At Listing:</u>

Resource Conservation Districts (RCDs):

An extensive network of RCDs exists within the range of ESA-listed salmonids in northern coastal California. These RCDs represent an important vehicle through which the agricultural community and other private landowners can voluntarily address and correct management practices that impact ESA-listed salmonids and their habitats. Working with individual landowners or through organizations such as the California Farm Bureau and NRCS, these RCDs can assist landowners in developing and implementing best management practices that are protective of salmonids. Active participation of the agriculture community and other private landowners is critical to the conservancy and recovery of ESA-listed ESUs in California. Programmatic biological opinions issued to the Corps for the permitting of instream restoration and enhancement projects were in development for some RCDs.

A voluntary certification program was developed by the Sotoyome Resource Conservation District for agricultural properties in Sonoma and Mendocino counties who implement land management practices that decrease soil erosion and sediment delivery to streams. The development of the Fish Friendly Farming Program resulted in the creation of a workbook of Beneficial Management Practices. The growers participate in a series of workshops to develop and finalize a farm plan that is presented to a certification team comprised of NMFS, CDFG, and the Northern California Regional Water Quality Control Board.

Livestock Ranching and Farming:

The Rangeland Management Advisory Committee developed a management plan for inclusion in the State's Non-point Source Management Plan. The purpose of the plan was to maintain and improve the quality and associated beneficial uses of surface water that passes through rangeland resources.

Gravel Mining:

Long-term sustained gravel mining plans have been, or are being, developed by three northern California counties (Del Norte, Humboldt, and Mendocino), which comprise a substantial portion of the range of several listed ESUs. The intent is for the impacts of all gravel extraction projects to be evaluated at the watershed scale. Approved projects (by the USACE) will require annual monitoring reports on gravel recruitment, river geomorphology, and fisheries impacts. Mendocino County is in the process of obtaining plan approval. NMFS will work with the counties to ensure any approved plans for gravel mining are sufficiently protective of coho salmon.

FishNet 4C & 5 Counties Road Maintenance Program:

FishNet 4C is a multi-county group comprised of representatives from Mendocino, Monterey, Sonoma, Marin, San Mateo, and Santa Cruz Counties. The goals are to facilitate effective local actions that will maintain or improve the region's water quality and riparian habitat, provide increased assistance and education for local government and the private sector, and encourage cooperation and coordination among all levels of regulatory responsibility for fisheries restoration. The program seeks to accomplish these goals through a process of evaluating existing activities, recommending model programs, tracking legislation, soliciting outside funding, and increasing communications among interested agencies and the public. The program has coordinated county efforts such as road maintenance, fish barrier assessment and removal, riparian and grading ordinances, erosion control, implementation of bioengineering projects and the development of guidelines for public works departments that enhance or protect salmonid habitat. Continuation of FishNet 4C is in jeopardy due to a lack of funding from FRGP.

A Memorandum of Understanding between NMFS and five northern California counties (the 5 Counties Salmonid Conservation Program which includes Mendocino County) was developed to create standardized county routine road maintenance manual to assist in the protection of ESA listed species and their habitat. This manual includes best management practices (BMPs) for reducing impacts to listed species and the aquatic environment, a five-county inventorying and prioritization of all fish passage barriers associated with county roads, annual training of road crews and county planners, and a monitoring framework for adaptive management. The 5 Counties Manual was found to adequately conserve salmonids by NMFS and take prohibitions under section 9 and applicable 4(d) rules would not apply. It is unknown the level of implementation of the 5 Counties Manual has been done by Mendocino County. Continuation of 5 Counties Program is in jeopardy due to a lack of funding from FRGP.

Watershed Councils, Groups and others:

Local watershed councils and other groups throughout California successfully developed restoration plans and worked to implement habitat restoration projects expected to contribute to the conservation of listed salmonids. Many watershed groups, landowners, environmental groups, and non-profit organizations throughout the range of CCC coho salmon conduct habitat restoration and planning efforts contributing to species conservation.

Local governments have the most direct responsibility for permitting land uses on non-Federal and non-state owned lands. Local efforts to control development within the floodplains and active channels is, in many cases, limited to the protection of public properties such as county or city roads, bridges, and other infrastructure. Local government regulation of floodplain development depends to a large extent on the standards provided by FEMA's FIP which did not explicitly provide for the protection of natural fluvial processes essential for the maintenance of naturally functioning riverine and riparian habitats important for coho salmon migration, spawning, and rearing.

Other Non-Federal Entities Since Listing:

Improvements in threats since listing include: (1) DFG's development and implementation of a California State Coho Salmon Recovery Strategy; (2) changes to California's Forest Practice Rules; (3) implementation of AB2121 by the SWRCB; (4) ongoing implementation of FRGP for restoration projects on private and public lands; (5) issuance of programmatic biological opinions for enhancement and restoration actions to the Santa Cruz County, Marin County, and Mendocino County RCDs; (6) continuation of Fish Friendly Farming although issues of water use need to be addressed; (7) coordination with gravel mining operations (especially those in the Russian River who are assisting with restoration work); (8) projects implemented under the FishNet 4C program; and the work of many watershed groups or collaborations to monitor, restore and protect CCC coho salmon and their habitats (*i.e.*, Usal Forest, CDFG and Campbell Timberland Pudding Creek monitoring, Mendocino Land Trust, CDFG monitoring on Caspar Creek, Big River Program, TNC work in the Garcia, Gualala Watershed Council, Russian River Broodstock program, Lagunitas Technical Advisory Committee, SPAWN, CalPoly, San Vicente Watershed Group, Trout Unlimited and many others coordinating their activities for the benefit of salmon). See Chapter 5 outlining Protective Efforts for more information.

Photo Courtesy 43: Rootwads for input into Austin Creek; Bob Snyder and Homer Canellis Austin Creek Materials; *David Hines, NMFS.*

4.2.7 FACTOR E: OTHER NATURAL AND MAN-MADE FACTORS AFFECTING THE SPECIES' CONTINUED EXISTENCE

Factor E: At Listing

Long-term trends in rainfall and marine productivity associated with atmospheric conditions in the North Pacific Ocean had a major influence on coho salmon production. Natural climatic conditions may have exacerbated or mitigated the problems associated with degraded and altered riverine and estuarine habitats (69 FR 33102). Coho salmon have evolved behaviors and life history traits allowing them to survive a variety of environmental conditions. When populations are fragmented or reduced in size and range, however, they are more vulnerable to extinction by natural events.

The effects of extended drought on water supplies and water temperatures were a major concern for California populations of coho salmon. Drought conditions reduced the amount of water available, resulting in reductions (or elimination) of flows needed for adult coho salmon passage, egg incubation, and juvenile rearing and migration. Although the decline of many coho salmon populations began prior to numerous years of drought conditions in California, these conditions have further reduced already small populations. Reductions in population size can lead to adverse genetic effects, such as inbreeding and a reduction in future potential for adaption.

Flood events increased sedimentation to streams, particularly in areas with inherent erosion risk, urban encroachment, intensive timber management, and land disturbances resulting from logging, road construction, mining, urbanization, livestock grazing, agriculture, and fire. Sedimentation of stream beds was implicated as a principal cause of declining salmonid populations throughout their range. Central coastal California has some of the most erodible terrain in the world. In this region, catastrophic erosion and subsequent stream sedimentation (such as during the 1955 and 1964 floods) resulted from areas which had been clearcut or had roads constructed on unstable soils (61 FR 56138). These events can reduce flood flow capacity and widening and loss of pool-riffle sequence due to aggradation. Many north coast streams continue to show impacts from large debris flows and some of these streams have remained wide, warm, and unstable. Flooding events can also cause scour and redeposition of spawning gravels which can lead to loss of eggs in redds and filling in of streams and pools with sediment.

Poor ocean conditions were believed to have a prominent role in the decline of coho salmon populations in California. Variables from the Coastal domains which appear to have undergone shifts during the late 1970s and fluctuate out-of-phase include, current transport, sea surface temperature, and upwelling. Variability in the Subarctic Front (the most prominent feature of the North Pacific Transitional Region) is probably characterized by indirect trophic interactions rather than a direct cause-effect relationship (Rogers 1984; Fisher and Pearcy 1988; Pearcy 1992). Associations between salmon survival during the first few months at sea and ocean conditions such as sea surface temperature and salinity have been reported (Vernon 1958; Holtby *et al.* 1989; Holtby *et al.* 1990) and likely significant influence salmonid abundance. Coho salmon along the California coast may be especially sensitive to upwelling patterns because of the lack of other coastal habitat types that normally buffer adverse oceanographic effects (*i.e.*, extensive bays, straits, and estuaries). Additionally, unusually warm ocean surface temperatures and associated changes in coastal currents and upwelling, known as El Niño conditions, resulted in ecosystem alterations such as reductions in primary and secondary productivity and changes in prey and predator species distributions. El Niño was often cited as a cause for the decline of West Coast salmonids. Near-shore conditions during the spring and summer months along the California coast may have dramatically affected year-class strength of salmonids (Kruzic *et al.* 2001). The paucity of high quality near-shore habitat, coupled with variable ocean conditions, makes freshwater rearing habitat more crucial for the survival and persistence of many coho salmon populations.

The use of artificial propagation had a significant impact on the production of West Coast coho salmon. Non-native coho salmon stocks were introduced as broodstock in hatcheries and widely transplanted in many coastal rivers and streams in central California (Bryant 1994;

Weitkamp *et al.* 1995). Potential problems associated with hatchery programs include genetic impacts on indigenous, naturally-reproducing populations (Waples 1991), disease transmission, predation of wild fish, difficulty in determining wild stock status due to incomplete marking of hatchery fish, depletions of wild stock to increase brood stock, and replacement rather than supplementation of wild stocks through competition and continued annual introduction of hatchery fish (61 FR 56138).

Impacts associated from wildfires include impairment to water quality as a result of short-term increases in sedimentation. These increases can lead to pool gravel quality during spawning leading to decreased egg survival and filling of pools which can reduce juvenile carrying capacity. Other impairments to water quality can include degradation from chemical agents (such as fire retardants dropped by aircraft) to control fire.

Many concerns existed regarding the impacts of artificial propagation on wild stocks of salmon. While non-native stocks were introduced in the CCC coho salmon ESU, most of the recent long-term hatchery programs were conducted with minimal inter-ESU import of broodstock. Intra-ESU transfers did occur and negative impacts were likely. Impacts may have included increased competition for resources such as food and spawning sites, displacement of wild cohorts from their usual microhabitats, genetic impacts to indigenous populations, introduction of diseases, increased exploitation and reduction in size of wild populations. These impacts could result in replacement rather than supplementation of wild stocks through competition and annual introduction of hatchery fish. At time of listing, most hatchery programs had modified their practices and hatchery fish releases were conducted based on a determination that the hatchery stocks were considered similar to native runs. Efforts were made to return hatchery fish to their natal streams, and were held for an acclimation period to increase the probability of imprinting.

Factor E: Since Listing

No significant improvements related to climate change, ocean conditions, floods, or droughts have occurred since listing and the threats remain. The best available scientific information indicates that the Earth's climate is warming, driven by the accumulation of greenhouse gasses in the atmosphere (Oreskes 2004; Battin *et al.* 2007; Lindley *et al.* 2007). Because CCC coho salmon depend upon freshwater streams and the ocean during different stages of their life history cycle, the population is likely to be significantly impacted by climate change (See Appendix A for more information on marine and climate conditions). Impacts associated with ocean conditions, floods, and droughts are anticipated to continue into the future.

The Noyo River Fish Station egg-take program began in 1962 and was the only fish culture facility in California that has focused exclusively on coho salmon. The program was discontinued in 2004.

Hatchery management practices in the ESU have improved since listing through the adoption of conservation hatchery practices at the two remaining coho salmon hatcheries in the CCC ESU. These hatchery programs are the Russian River Captive Broodstock Program and the Monterey Bay Salmon and Trout Project Coho Salmon Broodstock Program.

The Russian River Coho Salmon Captive broodstock program was created in 2001, when coho in the Russian River were teetering on the brink of extinction. Remaining Russian River coho were captured by CDFG biologists, in coordination with biologists from other agencies, and brought to the Don Clausen Fish Hatchery at Lake Sonoma, where they were spawned based on a genetic matrix developed to mimics natural spawning. This initial effort to save the last remaining Russian River coho led to the formation of a multi-agency broodstock program. Partnership agencies include the USACE, NMFS, CDFG, University of California Cooperative Extension, and Sonoma County Water Agency. Unlike traditional hatcheries, the broodstock program releases young coho into their historic spawning grounds where, as adults, they return to spawn. The goal of the program is to recover the self-sustaining wild population. In 2004, more than 6,000 young coho raised from the program were released into three tributaries of the Russian River. The program is currently releasing 172,000 juvenile coho annually into 19 tributaries of the Russian River. In winter 2011-2012, 185 adult coho released as juveniles were counted migrating upstream in the Russian River. Other adult coho were found in tributaries. Until now, the program has been located outdoors in net-covered tanks that have been exposed to the elements and predators. A new building has been purchased that provides necessary light and air, while better protecting the tanks and allowing for a higher degree of quality control and fish health. The new structure is also designed to allow for expansion of the broodstock program. Monitoring is also conducted to include downstream smolt trapping, snorkel surveys in the summer and spawner surveys in the winter. Biologist use PIT-tag technology to track program fish.

The Monterey Bay Salmon and Trout Project (MBSTP) maintains a conservation broodstock program at the Kingfisher Flat Fish Facility on Big Creek, a tributary of Scott Creek in Santa Cruz county, California. The program was started with progeny from the 2002 broodyear and is a collaborative effort between CDFG, SWFSC, the MBSTP and others.

Conservation hatchery practices being used by the broodstock programs are designed to prevent extinction and preserve wild genetics. Local wild fish are used in the hatchery broodstock in sufficient numbers such that the genetic composition represents a wild population. The practices are significantly different than augmentation programs designed to simply increase the number of fish available for harvest. While improvements and/or expansion are needed for both facilities each are critical to preventing extinction of CCC coho salmon. Currently there is no hatchery threat to CCC coho salmon; in fact, these captive broodstock programs are likely the lifeboats to save the species.

Table 6: Listing Factors and Status

Listing Factor A: Habitat & Range	Status of Listing Factor
Agriculture	Persisting; Expected to worsen
Estuarine modification	Persisting; Expected to worsen
Forestry	Threat Reduced; Improvements still needed
Freshwater Conditions	Persisting; Improvements due to restoration
Habitat Degradation	Persisting; Expected to worsen
Mining	Persisting; Watershed specific (some improvements)
Removal of Riparian Habitat	Persisting; Expected to worsen
Removal of Wetland Habitat	Persisting; Expected to worsen
Urbanization	Persisting; Expected to worsen
Water Diversions	Persisting; Expected to worsen
Wildfires	Currently Low; Expected to worsen

Listing Factor B: Overutilization	Status of Listing Factor
Collection	Persisting; Assessment needed
Freshwater Harvest	Persisting; Improvements needed
Illegal Harvest	Persisting; Assessments needed
Overfishing	Threat Reduced; Bycatch and freshwater interception persisting; Assessments needed

Listing Factor C: Disease & Predation	Status of Listing Factor
Avian Freshwater Predation	Persisting; Expected to worsen
Predation	Persisting; Watershed specific
Disease and Predation	Disease Threat Reduced; Predation Persisting; Watershed specific
Infectious Disease	Reduced
Marine Mammal Predation	Persisting; Magnitude watershed specific
Marine Predation	Threat Unknown; Assessments needed
Piscivorous Predators	Persisting; Assessments needed
Predation	Persisting; Assessments needed
Predation by non-native species	Persisting; Assessments needed
Predation by seabirds	Persisting; Expected to worsen

Listing Factor D: Inadequate Regulatory Mechanisms	Status of Listing Factor
All Federal, State, local governments, municipalities and others	Some Improvement; Assessments needed

Listing Factor : Other manmade or other factors	Status of Listing Factor
Artificial Propagation	Improved; Conservation practices implemented
Drought	Persisting; Expected to worsen
El Nino conditions	Persisting; Expected to worsen
Floods	Persisting; Expected to worsen
Floods – scour	Persisting; Expected to worsen
Floods – sediment	Persisting; Expected to worsen
Floods – sedimentation	Persisting; Expected to worsen
Floods – erosion	Persisting; Expected to worsen
Forest Fires	Persisting; Expected to worsen
Hatchery Programs	Improved; Conservation practices implemented
Natural Climatic Conditions	Persisting; Expected to worsen
Natural Events	Threat Persisting; Expected to worsen
Ocean Conditions	Threat Persisting; Expected to worsen
Ocean Conditions - El Nino	Threat Persisting; Expected to worsen

5.0 ASSESSMENT OF PROTECTIVE EFFORTS

"Conservation is a state of harmony between men and land."

Aldo Leopold

5.1 FEDERAL REGISTER ASSESSMENT OF PROTECTIVE EFFORTS

Two types of assessments were conducted to assess protective efforts in context to listing and recovery: (1) Protective efforts, as evaluated pursuant to the "Policy for Evaluation of Conservation Efforts When Making Listing Decisions" (68 FR 15100); and (2) the Conservation Assessment pursuant to the Interim Recovery Planning Guidance (NMFS 2010a).

Protective efforts assessed during listing decisions are required under section 4(b)(1)(A) of the ESA and they require an assessment of a species status based solely on the best scientific and commercial data available after taking into account those efforts of a state to protect the species. In determining the efficacy of existing efforts NMFS must consider the following: (1) substantive, protective and conservation elements; (2) degree of certainty efforts will be implemented; and (3) presence of monitoring provisions that determine effectiveness and permit adaptive management.

All pertinent *Federal Register* notices, including both proposed and final listing determinations for the CCC coho salmon were reviewed (Table 5 in Chapter 4) and catalogued. The summary below outlines the described conservation efforts identified at the time of listing and a discussion on the current status of those efforts.

5.2 CONSERVATION EFFORTS AT, AND SINCE, LISTING

Conservation efforts by individuals, private organizations, State and local agencies, or Federal agencies and others for CCC coho salmon have been underway for years. These efforts have collectively improved habitats and prevented the extinction of CCC coho salmon (especially in the Russian River and in the Santa Cruz Mountains Diversity Stratum). At the time of listing, however, it was determined that the efforts still did not reduce the level of extinction risk for coho salmon.

5.2.1 FEDERAL EFFORTS SINCE LISTING

The current status of Federal efforts outlined in the FRNs is:

- The NMFS section 7 consultation for the USACE and SCWA Reservoir Operations project (Russian River), specifically noted in 69 FR 33102, has been finalized.
- The HCP for Mendocino Redwoods Company to improve CCC coho salmon populations and habitat is still in draft. The finalization of this HCP and the development of either a statewide forestry HCP or other forestry landowner HCPs is a very high priority for the recovery of the CCC coho salmon. Fifteen of the 28 focus populations are located in areas of large tracts of forestlands owned either by private small landowners or large timber companies.
- The Pacific Coastal Salmon Recovery Fund continues to benefit CCC coho salmon and the State of California has developed a more equal distribution of the funds across all coastal salmonids and has included a specialized scoring system to ensure projects link more closely to recovery actions.
- NMFS' gravel removal guidelines continue to be utilized and are a useful tool to evaluate and reduce the impacts of gravel mining projects to ESA-listed salmonids in Mendocino and Sonoma counties.
- The NMFS/NRCS MOU was not completed.
- The NMFS and CDFG Coastal Salmonid Monitoring Program is one of the highest priorities designated in this recovery plan. While the scientific and statistical foundation for monitoring population was finalized in 2011, the "program" itself has yet to be funded or implemented on a programmatic level. Thus, consistent funding for monitoring at spatial scales relevant to recovery planning continues to be an essential conservation effort needed for CCC coho salmon.

- Watershed partnerships: Little has developed in regards to NMFS participation in inter-agency and public watershed partnerships due to staff limitations and section 7 workloads. For CCC coho salmon recovery, it will be imperative to begin developing and supporting these partnerships. With a few exceptions, the key CCC coho salmon watersheds occur on private lands and in areas where many land management actions do not trigger ESA section 7 consultations. Use of section 7 towards recovery of CCC coho salmon will have limited benefit, except in cases where impacts are offset through the purchase of bank credits for Conservation Banks that directly benefit CCC coho salmon.
- EPA Wetland Protection Grants: Some grants have been directed towards projects focused on improving critical limiting factors for some focus populations in the ESU.
- Following the October 31, 1996 listing as "threatened" under the ESA (61 FR 56138), NMFS applied ESA section 9(a)(1) take prohibitions on December 30, 1996 (61 FR 56138), designated critical habitat on May 5, 1999 (64 FR 24049), and upgraded the status of coho salmon to "endangered" on June 28, 2005 (70 FR 37160). With the change in listing status to endangered, the take "limits" allowed under ESA section 4(d) for specific authorized activities contributing to the conservation of salmonids were no longer applicable.
- The PFMC, guided by the Reasonable and Prudent Alternatives of the NMFS 1999 Supplemental Biological Opinion and Incidental Take Statement, instituted no-directed coho fisheries or retention of coho salmon in all commercial and recreational fisheries off California to protect endangered CCC coho salmon. This no-directed take or retention, and the standard that marine fisheries impacts be no more than 13.0 percent to protect endangered CCC coho salmon as indicated by projected impacts on Rogue/Klamath hatchery coho salmon, has been instituted by the PFMC every year. The current degree of impact (mortality resulting from (a) hook-and-release, (b) drop off before being boated, and (c) non-compliance) associated with existing regulations for non-retention and mark-selective coho salmon fisheries to the wild CCC coho salmon fishery, as of 2011, was estimated at 3.8%.

5.2.2 STATE EFFORTS SINCE LISTING

Current status of State efforts outlined in the FRNs:

- California ESA Listing: The California Fish and Game Commission listed coho salmon in the coastal streams south of the entrance to San Francisco Bay as endangered on December 31, 1995, under CESA. Protective regulations went into effect on December 2, 1996. On March 30, 1996, coho salmon throughout the CCC ESU were as listed by the California Fish and Game Commission as endangered under CESA. Protective regulations went into effect on August 29, 2005.
- On February 4, 2004, the California Fish and Game Commission adopted the California Recovery Strategy for Coho Salmon as part of the state listing. The State recovery strategy established six goals:
    1) Maintain and improve the number of key populations and increase the number of populations and brood years of coho salmon;
    2) Maintain and increase the number of spawning adults;
    3) Maintain the range and maintain and increase the distribution of coho salmon;
    4) Maintain existing habitat essential for coho salmon;
    5) Enhance and restore habitat within the range of coho salmon; and
    6) Reach and maintain coho salmon population levels to allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.

  To achieve these goals the plan provides a range of recommendations to address factors responsible for the decline of coho salmon including; stream flow, water rights, fish passage, water temperature, pool habitat structure, riparian habitat, watershed planning, and gravel mining activities. Recovery priorities have been included into the operations of both conservation hatchery programs (Warm Springs and Kingfisher Flat, Monterey Bay Salmon and Trout Project, in Scott Creek) and the CDFG FRGP, though currently the plan has not been evaluated for its effectiveness due to lack of funding for State monitoring programs.
- CDFG is responsible for conserving, protecting, and managing California's fish, wildlife, and native plant resources. To meet this responsibility, the Fish and Game Code (Section

1602) requires an entity to notify CDFG of any proposed activity that may substantially modify a river, stream, or lake. CDFG has improved level of project review under the 1603 to comply with revised CEQA standards.

- Development and implementation of EPA TMDL Programs: The State (and EPA) has established a number of TMDL's in watersheds for various constituents (*i.e.*, sediment, temperature, nutrient, *etc.*) in the CCC ESU to reduce pollutant loads to impaired water bodies. Schedules have been developed for establishing all required TMDLs over a 13-year period (see web site for more information at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/303dlists2006/epa/r1_06_303d_reqtmdls.pdf) for the State. Approved TMDLs are improving CCC coho salmon habitats in some watersheds (*e.g.* Garcia River, Mendocino County, CA); in other watersheds substantial progress or improvement is needed (*e.g.*, San Lorenzo, Santa Cruz County, CA). These differences are largely the result of staff availability and varying implementation schedules time by the various Regional Water Quality Control Boards. NMFS expects the development and implementation of TMDLs will improve CCC coho salmon ESU designated critical habitat in the long-term; however, their efficacy in protecting coho salmon habitat will be unknown for years to come. Implementation and monitoring to determine the effectiveness of the TMDLs process is needed. A number of additional water quality issues need to be addressed to protect and conserve CCC coho salmon. For example, impacts to fish habitat from agricultural practices have not been closely regulated. The State of California does not have regulations that directly manage agricultural practices, but instead relies on the TMDLs under the CWA to improve water quality from all sources and parties, including agricultural sources. Numerous streams in the CCC ESU are currently impacted by agricultural practices, but do not have TMDLs (SWRCB 2010), and many are not scheduled for completion until 2019. The majority of TMDLs focus on sediment and temperature requirements with little focus on pesticide toxicity. Pesticide toxicity has been identified as a new cause of stream impairment in California.

- The California Resources Agency development of a state-wide coho salmon conservation program, to serve as a basis for NMFS 4(d) protective regulations, was not completed prior to NMFS reclassifying CCC coho salmon from "threatened" to "endangered" status.
- State sport fishing regulations no longer allow retention of CCC coho salmon in California inland or nearshore waters. Impacts associated with incidental capture from freshwater recreational fishing still occur. Freshwater steelhead sport fishing is allowed in many rivers and streams where CCC coho salmon persist, including many of the focus watersheds identified in the plan. There is some overlap in run-timing between CCC coho salmon and adult steelhead (October through late February); adult CCC coho salmon have been misidentified by recreational anglers and incidentally caught and retained. This is particularly a concern in the Russian River watershed where both conservation hatchery coho salmon and traditional hatchery steelhead are adipose fin-clipped.
- Forestry: NMFS has participated in BOF meetings since 1998 and has encouraged the State of California to adopt State Forest Practice Rules protective of salmonids and pursue development of a section 10(a)(1)(B) permit (*e.g.*, HCP) that authorizes incidental take of listed salmonids under the ESA modeled from the Washington State Forest Practice HCP (including their monitoring and adaptive management process). While revisions and improvements to the Forest Practice Rules have been realized, they do allow operations to occur in salmonid watersheds that are less protective than standards under west coast forestry HCP's that authorize incidental take. At the time of listing the Board of Forestry did not adopt CDFG's proposal to designate coho salmon as a sensitive species pursuant to 14 CCR 898.2(d). Since listing under the ESA, populations of coho salmon continue to decline and this species is still not a BOF designated sensitive species. Provisions for sensitive species designation allow the BOF to adopt special management practices for sensitive species and their habitats. Additionally, the majority of extant CCC coho salmon populations persist on forestlands and sensitive species designation could provide increased protections from potential timber harvest impacts. NMFS, CALFIRE, and the BOF did not fully develop or adopt develop no-take guidelines for timber harvest activities that could impact coho salmon. In 2010, the BOF adopted the Anadromous Salmonid Protection (ASP)

rules. The BOF's primary objectives in adopting the ASP rules were to: (1) ensure rule adequacy in protecting listed anadromous salmonid species and their habitat, (2) further opportunities for restoring the species‟ habitat, (3) ensure the rules are based on credible science, and (4) meet Public Resources Code (PRC) § 4553 for review and periodic revisions to the FPRs. The coastal watersheds south of San Francisco Bay were specifically excluded from the increased protections to salmonids provided by the ASP rules, despite the fact coho salmon in these watersheds are critically close to extirpation. Currently, the inadequacies of the FPRs that remain unresolved are: (1) rate of harvest; (2) winter operations; (3) road planning, construction, maintenance and decommissioning; (4) loss of riparian function and chronic sediment input from streamside roads; (5) unstable areas; (6) planning, implementation and enforcement; (7) exemptions and conversion's and (8) watershed analysis. Until a watershed analysis process is put in place in California the rules will continue to be decoupled from addressing the limiting factors to salmonids. Furthermore, aggressive wood placement programs should be considered in the interim. The primary objective of the FPR core zone is streamside bank protection to promote bank stability, wood recruitment by bank erosion, and canopy retention. The primary objective for the inner zone is to develop a large number of trees for large wood recruitment. Even the outer zone has additional wood recruitment as an objective. Retaining large trees that are most conducive to recruitment are a priority in Class I watercourses with confined channels in the coastal anadromy zone. One weakness of this paradigm is that coho salmon cannot wait for banks to erode, nor wait for large trees to develop, nor rely on chance that a tree conducive to falling into the stream will actually fall into the stream. Coho salmon need large wood in streams now if we are to recover the population.

- FRGP: Many projects have been implemented within the CCC coho salmon ESU under the CDFG FRGP, and CDFG conducts implementation monitoring to track the success and benefits of these efforts. These projects include instream restoration, monitoring, fish passage improvements, upslope sediment remediation, and many other enhancement efforts. FRGP programmatic permit coverage from numerous regulatory agencies expedites regulatory approval, this coverage is a major additional benefit for grantees. FRGP has recently revamped its' program to coordinate more effectively with both the State and Federal priorities. Furthermore, a more equitable distribution of funds is underway to ensure projects for all federally listed salmonids are being represented.

- Coastal Salmon Initiative: The Coastal Salmon Initiative of the California Resources Agency, initiated in July 1995, was a conservation program based on voluntary measures and incentives to protect fish and wildlife habitat while protecting economic interest of communities within the range of coho salmon. The effort ended soon after the 1996 Federal listing of CCC coho salmon as threatened.
- Hatchery Practices: Current conservation hatchery practices are viewed as beneficial and necessary for CCC coho salmon. Monitoring is currently being conducted on these populations, though the numbers of fish released are only recently approaching the level at which significant adult returns could be expected. Disease transmission (including bacterial kidney disease) has been substantially reduced due to strict screening and treatment protocols. Utilization of excess broodstock within the Warm Springs Captive Broodstock Program has resulted in additional recovery efforts in watersheds where coho salmon were extirpated within the ESU. These activities should continue, with appropriate monitoring. The continuation of the Scott Creek/King Fisher Flat Captive Broodstock Program (privately owned and managed by the Monterey Bay Salmon and Trout Project) is a high priority until a regional program or larger facility in Santa Cruz are developed.
- Hatchery Practices: The Noyo River Fish Station egg-take program began in 1962 and was the only fish culture facility in California that has focused exclusively on coho salmon. Eggs collected at Noyo Egg Taking Station were reared to yearlings at Mad River Hatchery (Humboldt County). These yearlings were planted in the Noyo River with the object of maintaining the run to the station. Early in the program operation (1962-1967), stocked coho salmon were from a mix Noyo River, Pudding Creek, Alsea (Oregon), and Klaskanine (Oregon) of egg sources. Subsequent efforts relied almost exclusively on Noyo River coho eggs. Coho salmon from Noyo River broodstock were also occasionally planted in various other locations (Brown *et al*. 1994). The program was discontinued in 2004.

- Watershed Protection Program: Under Proposition 13 (Water Code, Division 25, Chapter 5, Article 2) grants were available to municipalities, local agencies, or nonprofit organizations to develop and implement local watershed management plans to reduce flooding, control erosion, improve water quality, and improve aquatic and terrestrial species habitats. Monies are no longer available and no new applications are being accepted. The last biennial report was in 2003.
- The California Natural Communities Conservation Planning Program was intended to form the basis of protective regulations by NMFS under section 4(d) of the ESA, which is no longer available due to the CCC coho salmon listing as endangered. This program was never realized.
- Water Diversions: On May 4, 2010, the State Water Board adopted a policy for water quality control titled "Policy for Maintaining Instream Flows in Northern California Coastal Streams." The policy contains principles and guidelines for maintaining instream flows for the purposes of water right administration. The geographic scope of the policy encompasses coastal streams from the Mattole River to San Francisco and coastal streams entering northern San Pablo Bay and extends to five counties: Marin, Sonoma, and portions of Napa, Mendocino, and Humboldt Counties. Implementation of the Policy for Maintaining Instream Flows in Northern California Coastal Streams should result in major benefits to coho salmon in the northern portions of the CCC ESU if properly implemented and enforced. The policy includes provisions to address seasons of diversions, minimum bypass flows, maximum cumulative diversions, onstream dams, and assessment of cumulative effects for new water diversion applications. The policy does not apply to previously authorized water diversions. Numerous unpermitted and out-of-compliance water diversions are present in the CCC ESU. Resources are lacking to monitor and enforce these diversions to ensure adequate instream flow is available for rearing coho salmon.

5.2.3 LOCAL GOVERNMENT EFFORTS SINCE LISTING

The status of efforts by local government agencies outlined in the FRNs includes:

- FishNet 4C: This group has been meeting quarterly for the past 12 years and participation includes County Supervisors and staff, RCDs, Special Districts and Federal and State agency representatives. It has conducted extensive training on watershed process, road maintenance, salmon life cycle, biotechnical bank stabilization, sediment reduction efforts, fish migration barrier removal training, *etc*. Coordination between the counties and implementation of projects to remove barriers, upgrade roads, improve policies, develop permit streamlining for projects, *etc*. has benefited coho salmon.
- Five Counties Salmonid Conservation Program: A Memorandum of Understanding between NMFS and five northern California counties (the Five Counties Salmonid Conservation Program which includes Mendocino County) was developed to create standardized county routine road maintenance manual to assist in the protection of ESA listed species and their habitat. This manual includes best management practices (BMPs) for reducing impacts to listed species and the aquatic environment, a five-county inventorying and prioritization of all fish passage barriers associated with county roads, annual training of road crews and county planners, and a monitoring framework for adaptive management. In 2007, ESA authorization of the Five Counties Salmonid Conservation Program's routine road maintenance program was approved. Potential benefits resulting from implementation of this program apply to Mendocino County only and not to the rest of the CCC ESU; however, it is unknown whether Mendocino County consistently uses the manual as part of their road work.

5.2.4 NON-GOVERNMENTAL EFFORTS SINCE LISTING

The status of efforts by non-government agencies outlined in the FRNs includes:

- The effectiveness of conservation efforts of numerous local non-governmental organizations, while likely benefiting CCC coho salmon, is unknown in terms of increasing coho salmon populations. While CDFG conducts project monitoring associated with all PCSRF funded projects, there is no larger oversight body that conducts implementation and effectiveness monitoring for all local, state and federal funding sources to determine whether these actions are successful, or are benefiting the populations of CCC coho salmon as a whole – this is partially related to the lack of a statewide coordinated trend and abundance monitoring program.

- The Fish Friendly Farming Program provides guidance for agricultural properties to manage agricultural land to decrease soil erosion and sediment delivery to streams and improve riparian conditions. This effort has resulted in education, outreach and improvements in agricultural practices. While the program addresses water infrastructure concerns (passage barriers, screening criteria, *etc.*) it has not addressed streamflow impacts to salmon from diversions on participating ownerships and does not necessarily provide standards that achieve a "no take" standard.
- The California Rangeland Management Plan has not been evaluated.
- Habitat restoration and planning efforts are ongoing within many watersheds in the CCC ESU. Many watershed assessments have been completed and information has been used to identify limiting factors for anadromous salmonids and prioritize restoration efforts and threat abatement actions. Habitat restoration has included projects to improve fish passage, remediate sources of upslope sediment, improve carrying capacity, and improve water quality. Many of these projects are carried out by watershed organizations, RCDs, agencies, and private companies including, but not limited to Campbell Timberland Management, California Coastal Conservancy, Committee for Green Foothills, Santa Cruz RCD, Pescadero Conservation Alliance, Peninsula Open Space District, Mill Valley Streamkeepers, Friends of Corte Madera Creek, San Mateo RCD, Sotoyome RCD; Marin County RCD, Mendocino County RCD, Coastal Watershed Counsel, National Park Service – Point Reyes, Garcia River Watershed Advisory Group, Noyo Watershed Alliance, Jackson Demonstration State Forest, County of Santa Cruz, Soquel Demonstration State Forest, Mendocino Redwood Company, Midpeninsula Open Space District, CalPoly – San Luis Obispo, Big Creek Lumber Company, San Mateo County Parks, California Department of State Park – Mendocino County, California Department of State Parks – Santa Cruz County, Goldridge RCD, Trout Unlimited, Gualala Redwoods Watershed Council, Circuit Riders, Occidental Arts and Ecology Center, Lompico Watershed Conservancy, Redwood Forest Foundation, Mendocino Land Trust, Conservation Fund, and The Nature Conservancy.

- Many RCDs provide assistance to voluntary landowners in developing and implementing best management practices to reduce impacts from their activities (*i.e.*, timber harvest, road building, livestock grazing, agriculture, *etc.*) affecting water quality. Continued implementation of these programs should abate some threats to coho salmon and their habitats in many watersheds in the CCC ESU. Many RCDs within the CCC ESU assist local agriculture and local conservation groups to apply for and use State and Federal grants for habitat restoration purposes. Other organizations such as the Garcia River Watershed Advisory Group, SPAWN, Sonoma County Water Agency, and the California Farm Bureau also have provided assistance to landowners in assisting landowners in developing and implementing best management practices.

5.2.5 ADDITIONAL EFFORTS SINCE LISTING

The status of some protective efforts not outlined in FRNs includes:

- In accordance with the California Fish and Game Commission's direction as well as statutory requirements, CDFG established the range-wide Coho Salmon Recovery Team (CRT). CDFG sought innovative and creative ideas in the development of a strategy that balances coho salmon recovery with other interests. The CRT is made up of 21 members from a wide range of interests, professions, and perspectives which represents county, State, and Federal governments, tribes, commercial and recreational fishing, forestry, agriculture, ranching, water management, and environmental interests. The CRT first met and commenced working in December 2002. The team addressed many significant issues affecting coho salmon range-wide which were incorporated into the California Recovery Strategy for Coho Salmon (CDFG 2004). The CRT continued meeting after completion of the recovery strategy and in recent years has convened on average of two times per year to address issues ongoing implementation of the recovery strategy and recent developments regarding the continued decline of coho salmon in the State.
- In 2003, NMFS received a petition to delist those populations of the CCC coho salmon ESU that spawn in coastal streams south of the entrance to San Francisco Bay. The petition was eventually accepted by NMFS (75 FR 16745) on April 2, 2010, which triggered a formal

status review focused on determining whether the populations south of the entrance to San Francisco Bay were part of the ESU, what the appropriate southern boundary of the ESU should be, and the biological status of any revised ESU. NMFS determined the petitioned action was not warranted. In conducting this status review, new information became available indicating that the range of the ESU should be extended southward (Spence *et al.*, 2011). This information included observations of coho salmon in Soquel Creek in 2008, genetic analysis of tissue samples indicating that the fish from Soquel Creek were closely related to nearby coho salmon populations in the ESU, and the ecological similarity of Soquel and Aptos creeks with other nearby creeks that support coho salmon. Based on this information, on April 2, 2012, the southern boundary of the ESU was expanded of the San Lorenzo River to include any coho salmon found in Soquel and Aptos creeks (77 FR 19552).

- ❑ In 2011, the CDFG and NMFS formed the Priority Action Coho Team (PACT). The mission of PACT is for NMFS and DFG, in the context of their authorities and the State and Federal coho salmon recovery plans to: (1) collaborate with other agencies and community entities, (2) seek to identify clear objectives, develop specific priority action plans, and (3) identify new and available resources to expedite immediate actions to prevent imminent extirpation of populations within the CCC coho salmon ESU. PACT recommendations are expected to be completed within a year.
- ❑ The Austin Creek Conservation Bank was signed in 2010 and is the first NMFS approved Conservation Bank in the CCC coho salmon ESU. The property is roughly 400 acres and lies along several stream miles of upper East Austin Creek and Devils Creek in the Russian River watershed and adjacent to Austin Creek State Recreation Area. The bank agreement is on file at the SWR"s North Central California Coast Office. The bank targets Central California Coast coho and steelhead and has credits for riparian and upland habitats that maintain natural stream processes. The service area is a 2-tiered system. The primary service area includes Marin and Sonoma Counties, and may be utilized for mitigation and conservation. The secondary area includes the entire Central California Coast coho and steelhead ESU/DPSs, and may be used for conservation purposes. Phase 1 of the bank has included input of large wood structures and covers 144 acres. Phase 2 of the bank proposes

future addition of the adjacent 296 acres remaining in the parcel. The bank owner has initiated restoration and is allowing the Russian River Coho Salmon Captive Broodstock Program staff to outplant juvenile coho salmon on the property. Wild coho salmon adults spawned on the property in 2011 and their young were confirmed by snorkel surveys. To continue the good work, NMFS and other agencies should continue to ask project proponents to consider banks as a way of offsetting impacts.

- The NOAA Restoration Center (NOAA RC) administers the Community-based Restoration Program. The program's objective is to bring together citizen groups, public and nonprofit organizations, industry, corporations and businesses, youth conservation corps, students, landowners, and local government, State and Federal agencies to restore fishery habitat around the coastal U.S. The program funds projects directly, and through partnerships with national and regional organizations and has provided funding, input, and project review for numerous high priority projects in the CCC coho salmon ESU.
- Trout Unlimited is funding a staff position in the Lost Coast Diversity Stratum to provide grant writing assistance to landowners. This program has been very successful in helping to obtain grants (including FRGP) focused on key restoration projects such as unsecured large woody debris projects in watersheds with focus populations.
- Sonoma-Marin Saving Water Partnership represents 10 water utilities in Sonoma and Marin counties who have joined together to provide a regional approach to water use efficiency. The utilities are the Cities of Santa Rosa, Rohnert Park, Petaluma, Sonoma, Cotati; North Marin, Valley of the Moon and Marin Municipal Water Districts, Town of Windsor and Sonoma County Water Agency. Each of these utilities has water conservation programs to assist homeowners in reducing water use. Effective water conservation programs are essential to reducing impacts associated with water diversions in the CCC ESU.
- Frost Protection: NMFS HCD, Sonoma County District Attorney, and CDFG are actively working to address impacts associated with spring water diversions from the Russian River and tributaries to salmonids associated with the practice for frost protection for vineyards.
- From 1999 through 2006, NOAA OLE, CDFG Game Wardens, and the Sonoma County District Attorney worked together to address unpermitted summer dams in Sonoma

County. Many of these unpermitted dams were located on the Russian River and its tributaries. Working in close coordination, the agencies worked to bring dam owners and operators into ESA and CEQA compliance. NMFS PRD developed a guidance document in 2001, regarding summer impoundment and a series of mitigation measures to minimize impacts for existing and newly proposed impoundments. This effort led to cessation of a number of dam operations, dam removal, or owners/operators bring dams into compliance with applicable laws. Today, far fewer summer dams are installed and habitat quality is anticipated to have significantly improved.

- Critical monitoring efforts are occurring in some focus watersheds in the ESU, including Scott Creek, Lagunitas Creek, Caspar Creek, Pudding Creek, and Noyo River. In the Lost Coast Diversity Stratum, CDFG is evaluating techniques to determine coho salmon and steelhead spawning escapement estimates effective for monitoring population status and trends. Methods used by CDFG include use of annual spawning ground surveys for long term regional monitoring where adult population sizes are estimated annually in a rotating panel design that samples 10% of all spawning habitat using one or a combination of commonly used techniques including live fish or redd counts and or salmon carcass counting. These estimates are calibrated at life cycle monitoring stations where known estimates of returning adults from total counts or capture-recapture experiments are used to calibrate spawning ground escapement estimates. Adoption of these protocols, expansion of the monitoring program, and landowner cooperation is essential for assessing the status of CCC coho salmon in the ESU. CDFG has expanded the program into the Santa Cruz Mountains Diversity Stratum.
- Campbell Timberlands Management, The Nature Conservancy, the Conservation Fund and private foresters and loggers have worked together to implement several extensive restoration projects using unsecured wood to increase instream habitat complexity in key watersheds. This collaboration includes the use of loggers and their equipment for tree falling and wood placement.
- Sustainable Conservation worked with the Corps to develop a programmatic biological assessment for restoration projects within the regulatory jurisdiction of NMFS' PRD NCCO.

A biological opinion was issued in 1996, which authorizes a wide-suite of restoration activities to cover a total of 500 projects for ten years. CDFG wrote a consistency determination of CCC coho salmon and the program is administered by the NOAA RC and the Corps. This program provides and expedited permitting pathway for projects that do not receive FRGP funding (which has numerous programmatic permits) that may incidentally take listed salmonids. To date, an average of only ten projects per year have been are authorized. The underuse of this programmatic permit is likely due to the lack of comprehensive permit coverage from other agencies (such as the California Coastal Commission, USFWS, CDFG's LSAA, *etc*.).

- ❑ Coastal Streamflow Stewardship Project: Trout Unlimited and CEMAR are selecting and assessing four to six coastal watersheds from Northern California down to the Santa Barbara (California) area, and working with landowners in those pilot watersheds to develop water management tools and identify projects to protect and reconnect stream flow – including coordinating diversions and implementing rotation schedules, storing winter water for summer use, and improving irrigation efficiency. Two watersheds with focus populations, San Gregorio Creek and Grape Creek (tributary to Dry Creek, tributary to the Russian River) are included in the project. California's current system of water right administration frequently fails to protect water users as well as salmon and steelhead, and it discourages innovative efforts to restore and protect stream flows. Traditionally, water diverters have been regulated individually, if at all, with little regard to how their actions relate to other diversions in the area or contribute to cumulative impacts on the stream. Insufficient water flows are a key limiting factor to many focus populations, particularly for the summer rearing lifestage. In light of climate change and future population growth, adverse impacts to streamflow will likely increase without major efforts to address this limiting factor. The Coastal Streamflow Stewardship Project offers an opportunity to try to balance human water demand with fisheries life history requirements. If successful, programs such as will provide a much needed tool for CCC coho salmon recovery.
- ❑ Major land purchases by conservation organizations have occurred in watersheds with focus populations since listing. Examples include purchase (1) of much of Big Salmon Creek

and lower portions of Big River by the Conservation Fund, (2) portions of San Gregorio Creek by Midpeninsula Open Space District, (3) large portions of San Vicente Creek by Trust for Public Land, The Nature Conservancy, Peninsula Open Space Trust, Land Trust of Santa Cruz County, Save the Redwoods League, and Sempervirens Fund, (4) Usal Creek by Redwood Forest Foundation and funded in part by the Wildlife Conservation Board, and (5) portions of the Garcia River by The Conservation Fund with support of The Nature Conservancy. These purchases are critical conservation measures to ensure important watersheds with focus populations are protected from parcelization, subdivision, and conversion from forestlands to agriculture (particularly vineyards) or rural residential land uses. Many of the aforementioned conservation organizations are working actively to expedite habitat restoration actions with direct benefits to CCC coho salmon.

- The County of Santa Cruz stopped funding their Public Works Department from routinely removing large woody material from streams in Santa Cruz County in 2010. The County Planning Department is now reviewing all accumulations of large woody material in consultation with a hydrologist and staff from NMFS and CDFG in order to assess potential impacts to infrastructure and passage. This program has reduced the quantity of instream wood removed from key streams with focus populations and significant improvements to habitat and anticipated to accrue overtime.
- The California Coastal Conservancy works with local governments, other public agencies, nonprofit organizations, and private landowners to purchase, protect, restore, and enhance coastal resources, and to provide access to the shore. The California Coastal Conservancy and has been funded primarily by State general obligation bonds and from the State's general fund. The Coastal Conservancy has undertaken numerous projects which include, (a) land acquisition, (b) resource restoration, (c) resource enhancement, (d) funding for watershed assessments, and (e) land use conservation and site reservation. In 2004, the California Coastal Conservancy funded and helped to create the Integrated Watershed Restoration Program (IWRP) to help navigate the complexities of watershed work in Santa Cruz County. IWRP is a voluntary framework for watershed partners to communicate with each other. It is designed to help remove the stumbling blocks for watershed projects. One

of the main objectives of IWRP is to coordinate the relevant State and Federal agencies on the identification, funding, and implementation of watershed restoration projects. IWRP is administered by the Santa Cruz County RCD and has been instrumental in "fast-tracking" the design, permitting, and implementation of important restoration projects benefiting coho salmon in the Santa Cruz County. Project implementation has proven to be quicker than the projects funded through FRGP. The success of IWRP has led to expansion of the program to Monterey and San Mateo Counties.

5.2.6 PRIORITY CONSERVATION EFFORTS

While Federal, State, county and non-governmental efforts are underway, and collectively enhance the potential that populations and habitats of the CCC coho salmon ESU can be protected, they do not provide sufficient certainty of implementation and effectiveness to substantially ameliorate the level of assessed extinction risk for CCC coho salmon. The fact that CCC coho salmon continue to decline is an indication that conservation efforts may need refocusing, expansion, and/or restructuring to align with the highest priorities to, first, prevent this species' extinction and, second, provide for its long-term survival. Given all of the ongoing conservation efforts, the following efforts are considered the highest priority for future continuation:

- Continuation and funding for the two Captive Broodstock Programs;
- Continuation and funding of restoration and monitoring projects by FRGP and PCSRF;
- Funding and implementation of the California Coastal Salmonid Monitoring Program;
- Implementation of Coho Priority Action Coho Team recommendations necessary to prevent the extinction of CCC coho salmon; and
- Development of public/private partnerships to involve private landowners in CCC coho salmon recovery (*e.g.*, Safe Harbor agreements, Conservation Banks, Habitat Conservation Plans, *etc.*).

Conservation efforts of very high priority that were anticipated at the time of listing for implementation but currently remain unrealized, or not fully realized, include:

- Mendocino Redwood Company HCP: The company owns portions of six high priority recovery watersheds (focus populations) in Mendocino and Sonoma counties; watersheds currently supporting extant coho populations. Finalization of the HCP is strongly encouraged.
- Other HCPs: HCPs in development at time of listing (*i.e*., Jackson Demonstration State Forest and Georgia-Pacific Corporation now Hawthorne Timberlands Inc. managed by Campbell Timberland Management) have been discontinued. These should be investigated for possible continuation, in collaboration with the USFWS, to focus on securing these forestlands for the long term due to the high number of watersheds where current populations of CCC coho salmon persist.
- The California Recovery Strategy for Coho Salmon has been finalized and was relied upon in the development of this recovery plan. The priorities described in the Strategy, and this recovery plan should guide implementation of the PCSRF/FRGP funds as discussed above.

Photo Courtesy 44: Large wood input into Ten Mile River, Campbell Timberlands, Mendocino County; *David Wright, Campbell Timberlands Management*.

6.0 POPULATION STRUCTURE & VIABILITY

"In summary, the lack of demonstrably viable populations…and substantial gaps in the distribution of coho salmon throughout the CCC ESU strongly indicate that this ESU is currently in danger of extinction."

Spence et al. 2008

6.1 INTRODUCTION

Salmonid populations have persisted in great abundance for nearly a million years; their persistence contingent on ecological, biological and evolutionary dynamics across both space and time. These historical conditions represent a baseline for population structure and viability with the assumption that as a population departs from its historical baseline, the greater the risk of extinction. For the CCC coho salmon ESU to be removed from the Federal ESA, criteria related to the number, size, trends, structure, *etc.* and the timeframes (*e.g.*, 100 years) to sustain these biological conditions must be met. To inform the recovery or "delisting" criteria, the TRT prepared two NOAA Technical Memoranda characterizing the historical population structure and biological viability criteria for the NCCC Domain salmon and steelhead ESUs/DPSs (Bjorkstedt *et al.*, 2005, Spence *et al.*, 2008). These memoranda provide the fundamental criteria to assess the biological status of populations and their risk of extinction. This chapter provides a summary of these memoranda.

6.2 VIABLE POPULATIONS & HISTORICAL STRUCUTRE

The viable salmonid population (VSP) concept was developed by McElhany *et al.* (2000) and adopted by NMFS as the approach to define viability and determine risk of extinction. This approach evaluates abundance, productivity, spatial structure, and diversity across three levels: ESU or DPS, Diversity Strata, and population. For salmon and steelhead in the NCCC Recovery Domain, the VSP concept was expanded by considering two population characteristics independently: "*…viability, defined in terms of probability of extinction over a specified time frame* *and independence, defined in terms of the influence of immigration on a population's extinction probability"* (CDFG 2004).

6.2.1 HISTORICAL POPULATION STRUCTURE

Understanding viability, probabilities of extinction and the influence of immigration on extinction probabilities required some knowledge of, and accounting for, "*characteristics that contribute to a populations' viability and thus their contribution to the persistence of the ESU*" (Bjorkstedt *et al.* 2005). Understanding the historical role these characteristics played for population viability is the underpinning of VSP. Since "*…historical patterns of population abundance, productivity, spatial structure and diversity form the reference conditions about which we have a high confidence that the ESUs…had a high probability of persisting over long periods of time. As populations depart from these historical conditions, their probability of persistence declines and their functional role with respect to ESU viability may be diminished*" (Spence *et al.* 2008).

The development of the historical structure included:

- ❑ Modeling the historical intrinsic potential of streams to support adult spawning and juvenile rearing;
- ❑ Compilation and review of historical records on population size and distribution;
- ❑ Defining populations and their viability in context to the ESU;
- ❑ Grouping populations into geographical units within an ESU; and
- ❑ Analyzing genetic structure, historical out-of-basin transfers and other information (See Bjorkstedt *et al.* 2005).

6.2.2 MODELING INTRINSIC POTENTIAL OF HISTORICAL HABITATS

Due to a lack of detailed population data, Bjorkstedt *et al.* (2005), used the concept of intrinsic potential (IP) to estimate potential habitat and historical carrying capacity of CCC coho salmon streams. Population size affects a species' viability and extinction risk and size is supported by extent and quality of habitats. Spawning and rearing habitats for adult and juvenile salmon and steelhead are largely determined by the interactions of landform, lithology, and hydrology relatively constant over long time scales which govern movement and deposition of sediment, large wood and other structural elements along a river network (Agrawal *et al.* 2005). To account for these controls and the differences in habitat suitability across a watershed, three habitat parameters were modeled to serve as a predictor of historical habitat attributes: channel gradient, valley width and mean annual discharge. Each of the three attributes were weighted between zero to one as to their potential to provide quality habitat with lower quality habitats scoring low and higher quality habitats scoring near one. For example, narrow valley widths and steep channel gradients are less likely to provide good spawning habitats while wider valley widths and low gradients are more likely to provide higher quality spawning and rearing habitats. The IP score for each reach in a watershed was multiplied by its respective reach length, and the values summed to estimate IP in km within a watershed that support spawning and rearing. These weighted IP-km, which is not a linear measurement, were used to calculate the likely historical carrying capacity of adult salmonids. Depending on watershed size, 20 to 40 spawners per km were calculated against the amount of IP in a watershed to determine a population size that would represent a low risk of extinction.

Discrepancies were observed between the predicted IP for CCC coho salmon and historical record accounts. A summer water temperature component was then included to address discrepancies in the model for coho salmon because water temperature is a strong indicator of presence and survival of summer rearing juveniles. Historical records for distribution of CCC coho salmon were reviewed (Spence *et al.* 2005) and a mean August air temperature that exceeded 21.5° C (following isolines) was applied to the model (*i.e.*, temperature mask) to exclude areas where streams were likely too consistently warm for coho salmon (Figure 15). The resulting outputs were more consistent with historical records. The historical abundances are displayed in Bjorkstedt *et al.* 2005 and Spence *et al.* 2008.

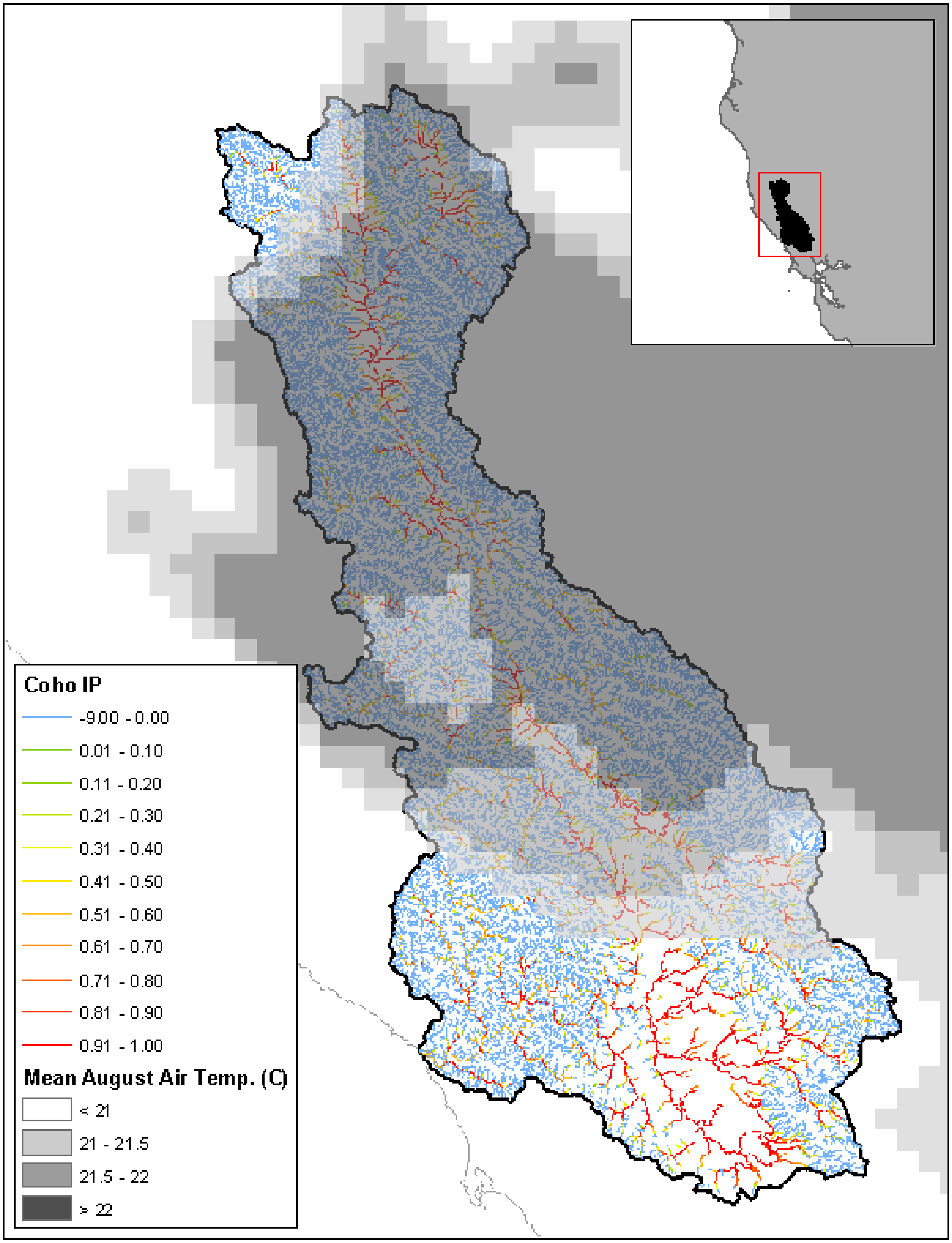

Figure 15: Temperature mask for CCC coho salmon IP in the Russian River. The dark shaded region was excluded due to high mean air temperature.

Uncertainty exists with the IP model outputs, including a likely bias to over or underestimate IP and historical habitat potential. Nonetheless, a benefit of the IP model is that it takes into account differences in intrinsic habitat potential in an objective and transparent manner. This objectivity precluded subjective judgments regarding whether or not habitat historically supported spawning and rearing salmonids, which is often very difficult to determine in light of currently degraded habitat conditions and poor historical records. Comparing modeled IP-based results of spawner abundance to the few historical records of abundance was conducted by Spence (pers. comm. 2008) and indicated, in the majority of cases, that modeled adult abundances were <u>lower</u> than those observed during the 1930s into the 1950s. The conclusion: projected spawner abundance targets did not overestimate natural carrying capacity for most populations within the ESU.

6.2.3 CLASSIFYING POPULATIONS FOR THE CCC COHO SALMON ESU

Population size (*e.g.*, spawner abundance) and genetic exchange of populations determines ESU viability and extinction risk. A population is "…*a group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group*." (Bjorkstedt *et al*., 2005). A "viable" population is "…*a population having a low (<5%) probability of going extinct over a 100-year time frame*" and an "Independent" population "…*as one for which exchanges with other populations have negligible influence on its extinction risk*" (Bjorkstedt *et al*. 2005) or otherwise termed "viable-in-isolation." To distinguish between "viable" and "non-viable" populations the TRT evaluated each populations potential to be "viable-in-isolation" and their measure of "self-recruitment". Self-recruitment "is the proportion of a populations' spawning run that is of native origin" (Bjorkstedt *et al*., 2005). The TRT used the likely historical population abundance as a proxy for assessing viability-in-isolation. The self-recruitment analysis was framed by (1) understanding an individual will attempt to return to its natal watershed and (2) population dynamics are dominated by both internal processes and external dynamics (*e.g.*, straying). This analysis assisted the TRT "…*in identifying the functional role different populations historically played in ESU persistence*" (Bjorkstedt *et al*. 2005 *in* Spence *et al*. 2008).

The TRT determined at least 32 IP-km were required for a population of coho salmon to be viable-in-isolation. This value was selected for consistency with other TRTs in California and Oregon and was based on a simulation analysis of Nickelson and Lawson (1998).

Three types of populations were defined:

- "Functionally Independent Populations" (FIPs): Populations with a high likelihood of persisting over 100-year time scales due to their population size and relatively independent dynamics (*i.e.*, negligible influence of migrants from neighboring populations on extinction risk);
- "Potentially Independent Populations" (PIPs): Populations with a high likelihood of persisting in isolation over 100-year time scales due to large population size, but were likely too strongly influenced by immigration from other populations to exhibit independent dynamics; and
- "Dependent Populations" (DPs): Populations with a substantial likelihood of going extinct within a 100-year time period in isolation due to smaller population size, but receive sufficient immigration to alter their dynamics and reduce extinction risk.

The independence of a population establishes its relative importance to ESU viability. For example, a large population (*e.g.*, Functionally Independent Population) likely functions as a regular source of surplus individuals (through straying) to smaller populations (*e.g.*, Dependent Populations). Straying adds resilience to the ESU when smaller populations are impacted by adverse environmental conditions (*e.g.*, catastrophic wildfire, *etc*.). Surplus individuals from large populations can re-colonize these watersheds overtime. This resilience confers more importance onto large populations for their role in the viability and recovery of the ESU. Notwithstanding, the role of dependent populations are very important in situations where associated historical independent populations are extirpated or at a high risk of extirpation. In these cases, dependent populations can become the vital source of colonizers and genetic diversity to support restoration of the extirpated populations associated with the larger watersheds.

6.2.4 Grouping Populations: ESU Diversity Strata

Diversity Strata, or boundaries that group populations, were delineated for the ESU and are "*geographically proximate populations that reflect the diversity of selective environments, phenotypes and genetic variation across the ESU*" and are "*described in terms of geography and a generally similar set of environmental and ecological conditions*" (Bjorkstedt *et al.*, 2005).

6.2.5 Results from Historical Structure Analysis

The TRT identified 11 "functionally independent", one "potentially independent" (Figure 16) and 64 "dependent" populations in the CCC coho salmon ESU (Bjorkstedt *et al.*, 2005 with modifications described in Spence *et al.* 2008). The 75 populations were grouped into five Diversity Strata (Figure 16, Figure 17). Five thousand one hundred and ninety four (5,194) IP-km were identified across the historical CCC coho salmon ESU[13]. Watershed boundaries delineate each population for CCC coho salmon ESU.

The advised application of the TRT historical structure is outlined in Bjorkstedt *et al.* (2005): *"Increasing divergence from this baseline almost certainly decreases the ability of the ESU to persist. The functional relationship between departure from historical conditions and extinction risk for the ESU is probably non-linear, such that the loss of a few populations–particularly small populations–from an otherwise intact ESU may not greatly reduce ESU viability, whereas the loss of key populations or the loss of populations from an already diminished ESU will have more profound implications for the persistence of the ESU. Uncertainty associated with the form of this relationship must be accounted for in assessing the viability of any proposed ESU configurations that departs from historical conditions. Understanding the historical population structure of an ESU is essential to reducing the consequences of this uncertainty, as information on the historical role of specific populations in the ESU supports a biologically relevant context for recovery planning. **Simply put, populations that were important to ESU persistence in the past, if restored or preserved, are likely to be important to ESU persistence in the future"***(emphasis added). See Bjorkstedt *et al.* (2005) for more information.

[13] The recovery scenario for CCC coho designated 28 focus watersheds and 11 supplemental populations. The total historical IP-km of the 28 watersheds is 1736 km or 33 percent of the historical total.

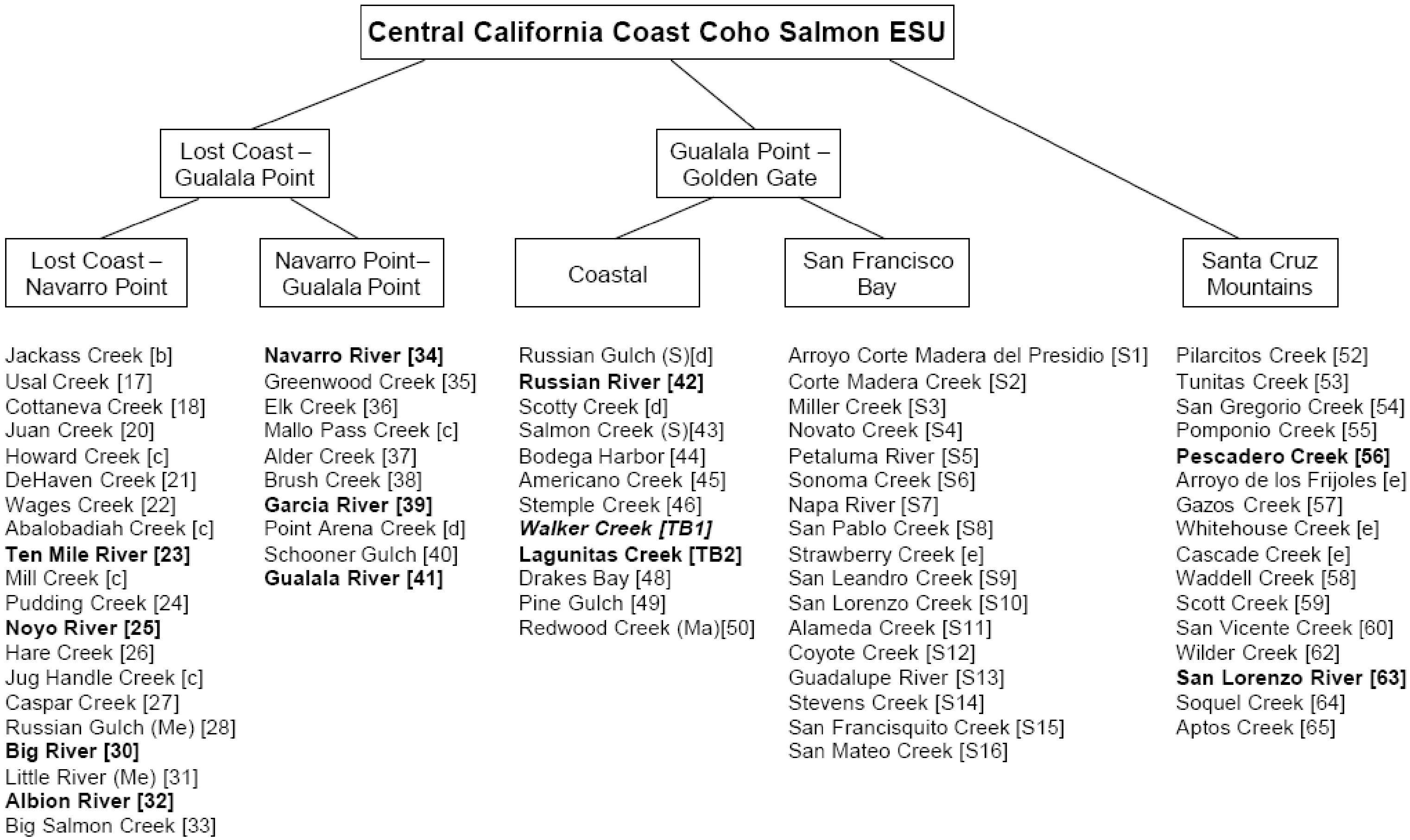

Figure 16: Historical population structure of the CCC coho salmon ESU, arranged by Diversity Strata. Independent population are in bold, potentially independent populations are in italics and dependent populations are all others.

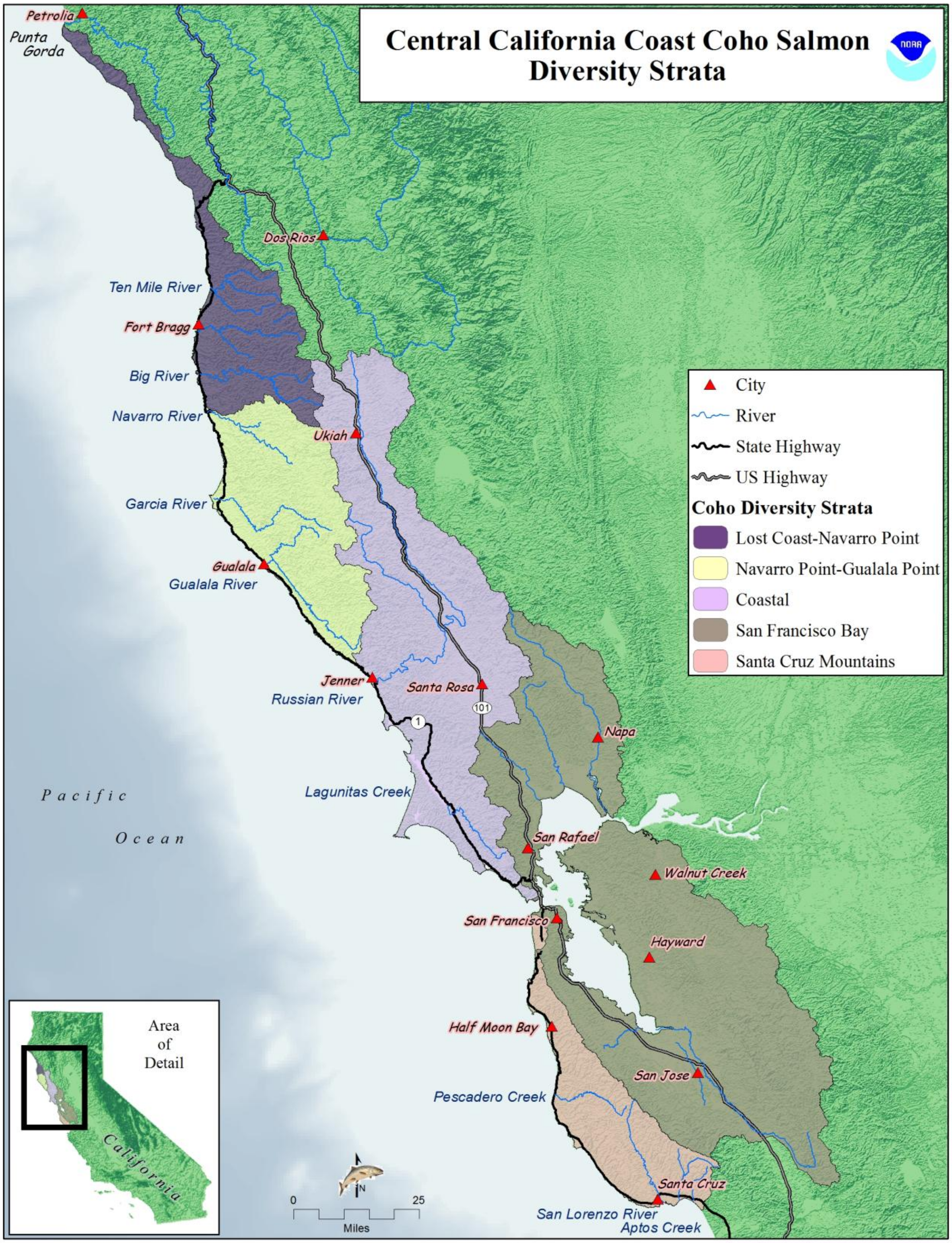

Figure 17: CCC coho salmon Diversity Strata

6.2.6 BIOLOGICAL VIABILITY CRITERIA

Spence *et al.* (2008) developed biological viability criteria for the ESU, Diversity Strata and populations consistent with the three levels of biological organization outlined by Bjorkstedt *et al.* (2005) important for the long term persistence of CCC coho salmon. These criteria are described in the two categories of: "Population Viability Criteria" and "ESU Viability Criteria". The biological viability criteria "*…defines sets of conditions or rules that, if satisfied, would suggest that the ESU is at low risk of extinction*" (Spence *et al.* 2008). These general conditions require: (1) achieving population viability across selected populations and (2) attaining the necessary number and configuration of these viable populations across the landscape. ESU and population viability was considered by (Spence *et al.* 2008) using "*two distinct but equally important perspectives*": (1) population viability in relation to its historical function and (2) minimum population size.

6.2.7 POPULATION VIABILITY CRITERIA

Criteria were developed that constitute a viable population (Table 7) and categorized into extinction risk categories of abundance, population growth rate, population spatial structure and population diversity (McElhany *et al.* 2000):

- Abundance is the number of adult spawners measured over a time based on life history;
- Population growth rate (*i.e.*, productivity) is a measure of a populations' ability to sustain itself overtime (*e.g.*, returns per spawner);
- Population spatial structure describes how populations are arranged geographically based on dispersal factors and quality of habitats; and
- Population diversity is the underlying genetic and life history characteristic providing for population resilience and persistence across space and time.

For a population to be viable it must be large enough to (1) have a high probability of surviving environmental variation, (2) compensate for disturbances, (3) maintain genetic diversity, and (4) functionally contribute to associated ecosystems. The criteria provides information on (1) likelihood of extinction, (2) effective population size or total population size, (3) population decline, (4) catastrophic decline, (5) spawner density, and (6) hatchery influence (Table 7).

Table 7: Population Extinction Risk Criteria (Spence *et al.* 2008)

Population Characteristic	Extinction Risk		
	High	**Moderate**	**Low**
Extinction risk from population viability analysis (PVA)	≥ 20% within 20 yrs	≥ 5% within 100 yrs but < 20% within 20 yrs	< 5% within 100 yrs
	- or any ONE of the following -	- or any ONE of the following -	- or ALL of the following -
Effective population size per generation *-or-* Total population size per generation	$N_e \le 50$ *-or-* $N_g \le 250$	$50 < N_e < 500$ *-or-* $250 < N_g < 2500$	$N_e \ge 500$ *-or-* $N_g \ge 2500$
Population decline	Precipitous decline[a]	Chronic decline or depression[b]	No decline apparent or probable
Catastrophic decline	Order of magnitude decline within one generation	Smaller but significant decline[c]	Not apparent
Spawner density	$N_a/IPkm^d \le 1$	$1 < N_a/IPkm <$ MRD[e]	$N_a/IPkm \ge$ MRD[e]
Hatchery influence[f]	Evidence of adverse genetic, demographic, or ecological effects of hatcheries on wild population		No evidence of adverse genetic, demographic, or ecological effects of hatchery fish on wild population

[a] Population has declined within the last two generations or is projected to decline within the next two generations (if current trends continue) to annual run size $N_a \le 500$ spawners (historically small but stable populations not included) *or* $N_a > 500$ but declining at a rate of ≥10% per year over the last two-to-four generations.
[b] Annual run size N_a has declined to ≤ 500 spawners, but is now stable *or* run size $N_a > 500$ but continued downward trend is evident.
[c] Annual run size decline in one generation < 90% but biologically significant (e.g., loss of year class).
[d] *IPkm* = the estimated aggregate intrinsic habitat potential for a population inhabiting a particular watershed (i.e., total accessible km weighted by reach-level estimates of intrinsic potential; see Bjorkstedt et al. [2005] for greater elaboration).
[e] MRD = minimum required spawner density and is dependent on species and the amount of potential habitat available. Figure 5 summarizes the relationship between spawner density and risk for each species.
[f] Risk from hatchery interactions depends on multiple factors related to the level of hatchery influence, the origin of hatchery fish, and the specific hatchery practices employed.

6.2.8 ESU Viability Criteria

Four criteria were developed that, collectively, constitute a configuration in the number and distribution of viable and non-viable populations likely providing for ESU persistence over 100 year time frame (*i.e.*, viable). There may be several plausible scenarios of population viability that could satisfy ESU-level criteria (Spence *et al.*, 2008). The goals of the ESU criteria are to reduce the risk of extinction by ensuring: (1) connectivity between populations, (2) representation of ecological, morphological, and genetic diversity, and (3) redundancy in populations to minimize risks associated with catastrophic events.

In characterizing a viable ESU the TRT applied the hypothesis that populations, as they functioned in their historical context, were highly likely to persist and that "…*increasing departure from historical characteristics logically requires a greater degree of proof that a population is indeed viable*" (Spence *et al.* 2008). Due to the likely historical roles of functionally independent or potentially independent populations, these populations form the foundation of the ESU viability criteria. Dependent population criteria were also developed to ensure reservoirs of genetic diversity, account for the extirpation of FIPs in the ESU, connectivity between FIPs, reduced risk of ESU extinction, to provide a vital source of colonizers for extirpated populations and to buffer impacts resulting from poor ocean conditions and disturbances to independent populations.

The four ESU viability criteria are:

(1) Representation Criteria;

> 1. a. All identified Diversity Strata that include historical FIPs or PIPs within an ESU should be represented by viable population for the ESU to be considered viable.
>
> -AND-
>
> 1. b. Within each Diversity Stratum, all extant phenotypic diversity (*i.e.*, major life-history types) should be represented by viable populations.

(2) Redundancy and Connectivity;

2.a. At least fifty percent of historically independent populations (FIPs or PIPs) in each Diversity Stratum must be demonstrated to be at low risk of extinction according to population viability criteria. For strata with three or fewer independent populations, at least two populations must be viable.

-AND-

2.b. Within each Diversity Stratum, the total aggregate abundance of independent populations selected to satisfy this criterion must meet or exceed 50% of the aggregate viable population abundance (*i.e.*, meeting density-based criteria for low risk) for all FIPs and PIPs.

(3) Remaining populations, including historically dependent populations or any historical FIPs or PIPs not expected to attain a viable status, must exhibit occupancy patterns consistent with those expected under sufficient immigration subsidy arising from the 'focus' Independent populations selected to satisfy the preceding criterion.

(4) The distribution of extant populations, regardless of historical status, must maintain connectivity within the Diversity Stratum, as well as connectivity to neighboring Diversity Strata.

7.0 METHODS

"The wide-ranging migration patterns and unique life histories of anadromous salmonids take them across ecosystem and management boundaries in an increasingly fragmented world, which creates the need for analyses and strategies at similarly large scales."

- Good et al. 2007. Recovery Planning for Endangered Species Act-listed Pacific Salmon: Using Science to Inform Goals and Strategies

7.1 INTRODUCTION

This chapter summarizes the methods used to: (1) select focus populations essential for recovery using the recovery framework provided by Bjorkstedt *et al.* (2005) and Spence *et al.* (2008); (2) assess current conditions, identify future stresses and threats to these populations and their habitats; and (3) develop site-specific and range-wide recovery actions designed to restore conditions and abate threats. A detailed description of criteria and protocols developed to assess current habitat conditions, stresses and threats are provided in a Viability and Threats Report in Appendix B.

7.2 SELECTING FOCUS POPULATIONS FOR RECOVERY

The biological viability criteria, described in Spence *et al.* (2008) (Volume III; Appendix E), sets the foundation for understanding the long-term biological viability of CCC coho salmon populations. These viability criteria, however, are not synonymous with recovery criteria. The viability criteria define "sets of conditions or rules for viable populations that, if satisfied, would suggest that the ESU or DPS is at low risk of extinction" (Spence *et al.* 2008). These general conditions include: (1) achieving population viability across selected populations; and (2) attaining a number and configuration of viable populations across the landscape to ensure long-term viability of the ESU or DPS as a whole. The criteria, however, "…do not explicitly specify which populations must be viable for the ESU or DPS to be viable…, but rather they establish a framework within which there may be several ways by which ESU or DPS viability can be achieved" (Spence *et al.* 2008). Furthermore, the biological viability criteria do not include specific numeric abundance targets for "Dependent" populations. The viability criteria provide a theoretical foundation and practical basis for recovery planners to select populations for inclusion into the recovery scenario, and to develop criteria for measuring population response to recovery actions. The viability criteria include metrics for population abundance, productivity, spatial structure, and diversity. Populations that are abundant at each life stage, highly productive, widely distributed, and exhibit the full variety of life-history traits available are considered at low risk of extinction.

A total of 75 watersheds (*e.g.*, populations), between Mendocino County and Santa Cruz County (including San Francisco Bay tributaries) were identified by Bjorkstedt *et al.* (2005) to historically support CCC coho salmon. Not all populations are needed for, or capable of supporting, recovery. A subset of the 75 populations was selected for this recovery plan. Working from Bjorkstedt *et al.* 2005 and Spence *et al.* (2008), quantitative and qualitative information were evaluated regarding current presence or prolonged absence of coho salmon, habitat suitability, status (*e.g.*, independent or dependent status), threats and current protective efforts ongoing in the watershed. This assessment led to the selection of 28 populations (12 independent populations and 16 dependent populations) and 11 supplemental populations across four Diversity Strata, to represent the CCC coho salmon ESU recovery strategy. Historical presence of coho salmon in the San Francisco Bay stratum is well documented. However, the degree to which the tributaries of the San Francisco Bay were historically capable of supporting coho salmon populations is uncertain. The general conclusion reached by Bjorkstedt *et al.* (2005) was San Francisco Bay watersheds supported only small and/or ephemeral populations, particularly in the drier and warmer interior watersheds and no independent populations historically existed. Thus, no populations were chosen for the San Francisco Bay Diversity Stratum.

The 28 populations selected are the "focus populations" (Table 8) with 11 supplemental populations designated to fulfill the occupancy and connectivity criteria as outlined in Spence *et al.* 2008 (Figure 18). To provide a contemporary context on extent of potential habitat for these focus populations, we evaluated the historical spawner abundances and associated IP-km calculated by the TRT. The IP-kms were assessed against habitat survey information, local knowledge, Google Earth images, watershed documents, several ground-truthing surveys and outreach to agencies and other entities for information. The exercise yielded changes to the IP-kms for several watersheds where natural barriers, steep gradient changes or stream flow dynamics were undetected by the model or where the temperature mask incorrectly removed potential habitats where coho salmon persist. Revisions to the extent of potential habitat were made and recalculated into potential miles of habitat (Table 8). Associated spawner targets for each population were re-calculated by multiplying the number of spawning adults needed per IP-km based on Spence *et al.* 2008. These new spawner abundances correspond to the biological delisting criteria with downlisting targets set at a moderate risk of extinction and approximately 50% of the delisting criteria (see Chapter 10). These spawner targets individually and collectively meet the population viability criterion (*e.g.*, each population is expected to achieve a density equal to or greater than 640 spawning adults) as well as the Diversity Strata criterion (*e.g.*, total stratum abundances meets or exceeds 50 percent of the aggregate historical abundance for the FIPs and PIPs based on the density criteria Spence *et al.,* 2008). Occupancy targets for dependent populations were derived from abundance estimates from Waddell Creek (Santa Cruz County, CA) data from the 1930's (Shapavolov and Taft 1954). Additional populations were selected to fulfill occupancy patterns criteria (called supplemental populations). The selection of supplement populations was predicated on presence or recent presence of CCC coho salmon. Occupancy delisting goals were developed for supplemental populations. The combined abundance targets and recovery criteria provide a recovery framework to achieve multiple recovery goals that include ecological benefits and commercial, recreational, and tribal harvest. The plan's approach of designating 28 focus populations and 11 supplemental populations provides redundancy, resiliency and representation in the ESU.

Table 8: Diversity Strata, Focus Populations, Status of Population and Miles of Potential Habitat

Diversity Strata	Population	(Independent or Dependent)	Miles of Potential Habitat
Lost Coast	Usal Creek	D	10.9
	Cottaneva Creek	D	14.5
	Wages Creek	D	9.8
	Ten Mile River	I	118.5
	Pudding Creek	D	26.4
	Noyo River	I	127.0
	Caspar Creek	D	12.5
	Big River	I	214.8
	Albion River	I	59.2
	Big Salmon Creek	D	16.8
Navarro-Gualala Point	Navarro River	I	220.4
	Garcia River	I	103.7
	Gualala River	I	266.6
Coastal	Russian River	I	457.5
	Salmon Creek	D	35.9
	Pine Gulch	D	11.4
	Walker Creek	I	67.6
	Lagunitas Creek	I	64.5
	Redwood Creek	D	6.8
Santa Cruz Mountains	San Gregorio	D	36.7
	Pescadero Creek	I	54.9
	Gazos Creek	I	7.1
	Waddell Creek	D	8.0
	Scott Creek	D	13.9
	San Vicente Creek	D	3.4
	San Lorenzo River	I	117.5
	Soquel Creek	D	31.9
	Aptos Creek	D	26.0

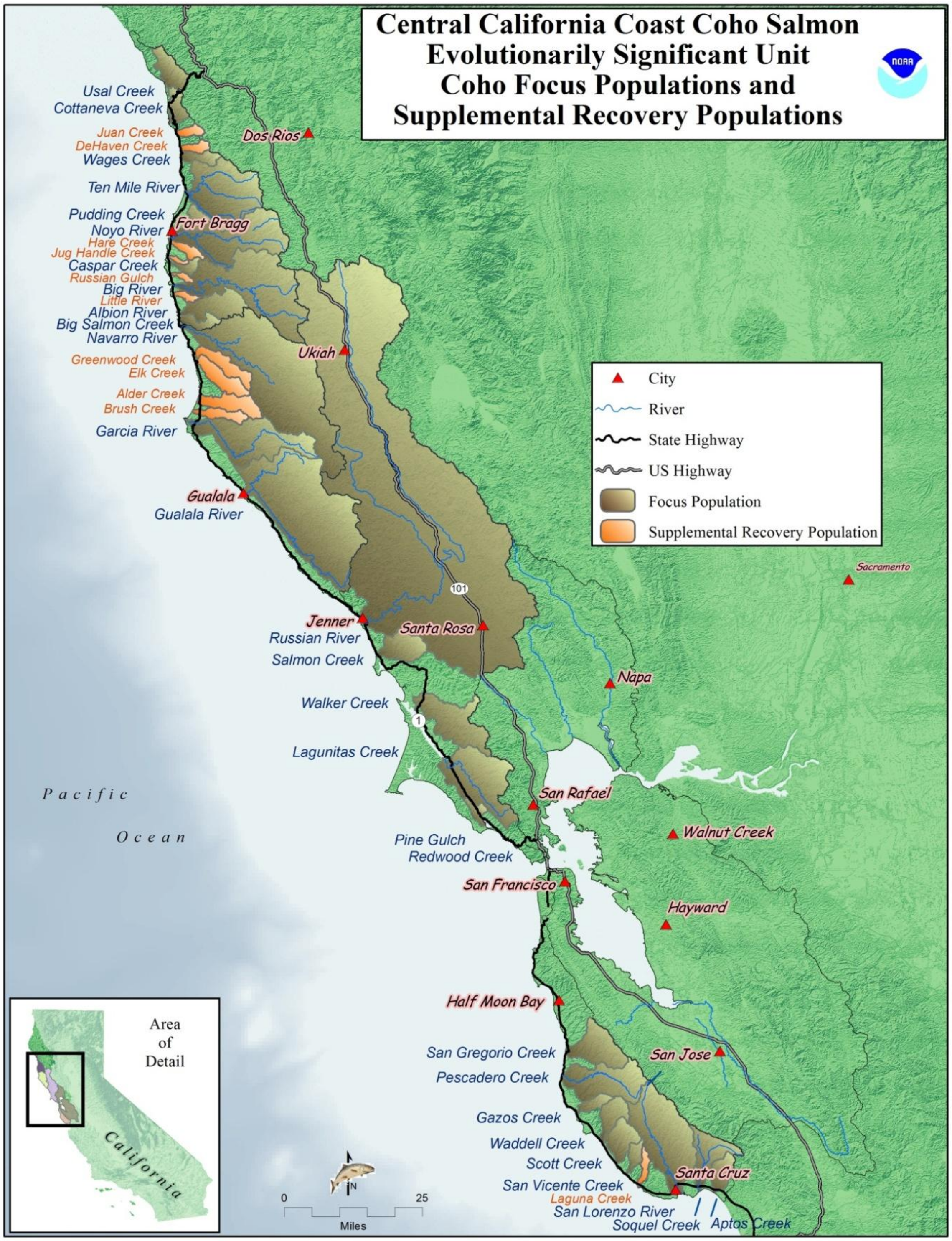

Figure 18: CCC coho salmon ESU Focus Populations & Supplemental Populations

7.3 CURRENT CONDITIONS AND THREATS

Instream and watershed conditions and threats for the 28 focus populations were assessed using The Nature Conservancy's (TNC) Conservation Action Planning (CAP) workbook. The CAP was developed in collaboration with the World Wildlife Fund, Conservation International, Wildlife Conservation Society and others. The CAP protocols and standards were developed by the Conservation Measures Partnership, a partnership of ten different non-governmental biodiversity organizations (www.conservationmeasures.org). The method is a "structured approach to assessing threats, sources of threats, and their relative importance to the species' status" and a method recommended in the Interim Guidance (NMFS 2010a). The CAP process was adopted as the recovery planning assessment tool for the NCCC Domain, and in 2006, we partnered with TNC for assistance, training and support in applying the CAP process for recovery planning. CAP is a Microsoft Excel-based tool adaptable to the needs of the user. The NMFS application of the CAP protocol included; (1) defining current conditions for habitat attributes across freshwater life stages essential for the long term survival, and (2) identifying activities reasonably expected to continue, or occur, into the future that will have a direct, indirect, or negative effect on life stages, populations and the ESU (*e.g.*, threats). Results from this assessment provided an indication of watershed health and likely threats to coho salmon survival and recovery. These results were the basis used to formulate recovery actions designed to improve current conditions (restoration strategies) and abate future threats (threats strategies). The CAP is expected to be used to track recovery criteria overtime since it is both a warehouse to store information and is iterative as this new information becomes available.

7.4 CAP WORKBOOK STRUCTURE

A CAP workbook was developed for each focus population and each component of the analyses includes an assessment of conditions and threats for each key coho salmon life stage (*i.e.*, adults, eggs, summer juveniles, winter juveniles and smolts). CAP facilitates user input of quantitative and qualitative information. Each workbook is organized to input and display data, information and best professional judgments for each specific criterion. Algorithms in the Excel CAP workbook summarize these data into general score cards. Score cards are assembled into spreadsheets, facilitating assessment of conditions and threats across the three levels of biological organization described in Spence *et al.* (2008). These three levels are (1) focus population, (2) Diversity Strata, and (3) overall ESU.

The CAP method provided a number of features to assess the magnitude and extent of threats to CCC coho salmon and their habitats, including:

- Incorporation of both quantitative and qualitative measures of existing and future conditions;
- Objective, consistent tracking for changes in the status of each conservation target (*i.e.*, life history stages) over time;
- Assessment of a watershed's condition or focus population viability and objective comparisons to other watersheds or populations;
- Focusing of recovery actions by identifying past, current and potential future threats to CCC coho salmon and their habitats; and
- Providing a central repository for documenting and updating information and assumptions about existing conditions.

Each CAP workbook has two assessment components: viability for evaluating current conditions (Figure 19) and Threats for evaluating future stresses and source of stress (Figure 20).

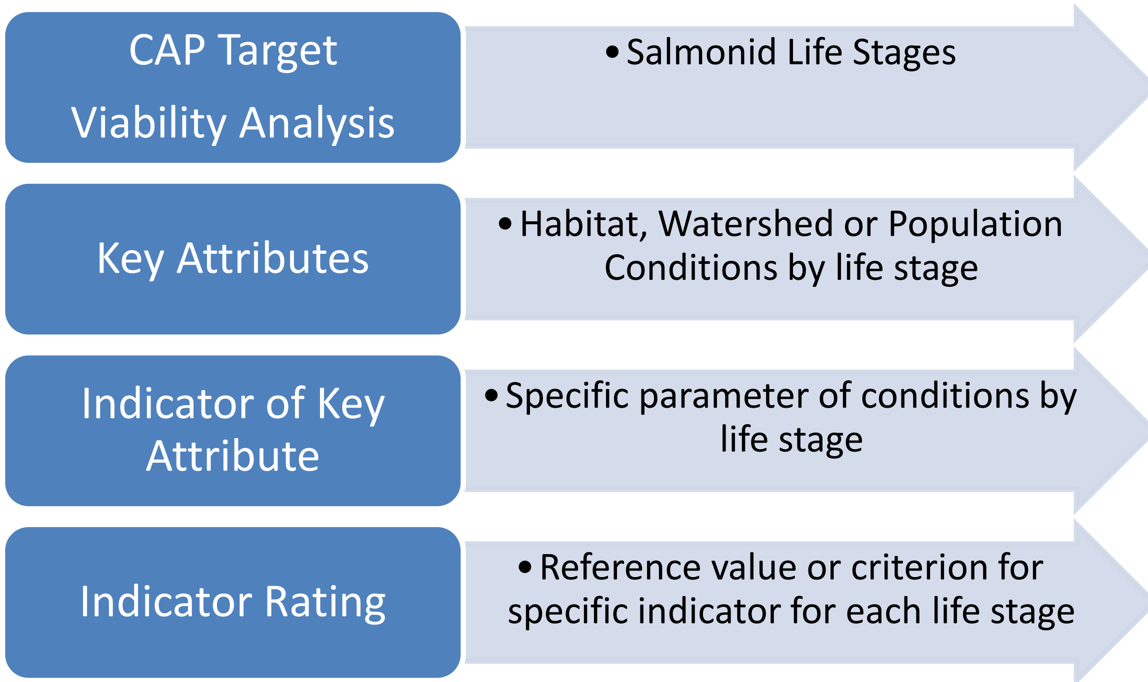

Figure 19: Structure of CAP workbooks for Viability Analysis

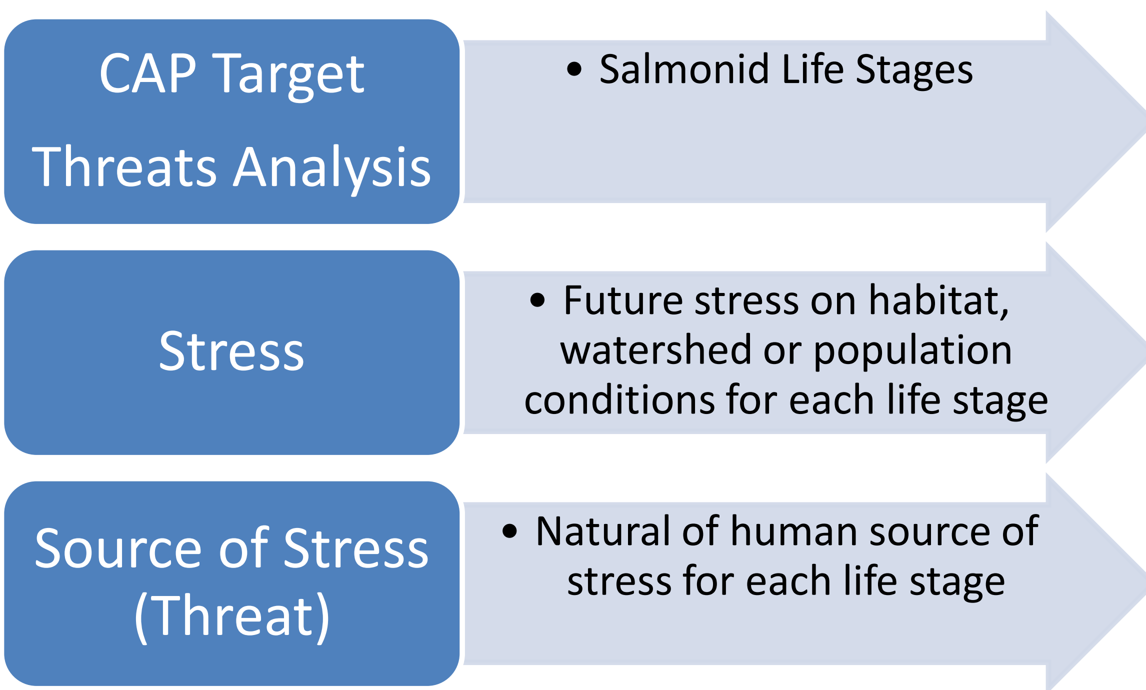

Figure 20: Structure of CAP workbooks for Threats Analysis

7.5 ASSESSING CURRENT CONDITIONS: VIABILITY

The viability table defines the specific life stages for each species as "conservation targets" and provides the structure for an assessment of current conditions supported by data from NMFS, other agencies, recovery partners, and the scientific literature.

CONSERVATION TARGETS

Conservation targets are the five freshwater life stages specific to coho salmon and watershed processes. These life stages are described below and were incorporated in each CAP workbook (Table 9).

- Spawning Adults - Includes adult fish from the time they enter freshwater, hold or migrate to spawning areas, and complete spawning (September 1 to March 1);
- Eggs - Includes fertilized eggs deposited into redds and incubation of through the time of emergence from the gravel (December 1 to April 1);
- Summer Rearing Juveniles - Includes juvenile rearing in streams and estuaries (when applicable) during summer and fall (June-October) prior to the onset of winter rains;
- Winter Rearing Juveniles - Includes rearing of juveniles from onset of winter rains through the winter months up to the initiation of smolt outmigration (November 1 to March 1);
- Smolts - Includes juvenile migration from natal rearing areas until they enter the ocean (March 1 to June 1); and
- Watershed processes - Includes instream habitat, riparian, upslope watershed conditions and landscape scale patterns related to land use.

Table 9: CAP Workbook Homepage showing life stage targets

The Nature Conservancy. Protecting nature. Preserving life.™	Conservation Action Planning Workbook A tool for developing strategies, taking action, and measuring success © 2010 The Nature Conservancy Version: CAP_v6b October 15, 2010			ConserveOnline Help Changes for Excel 2007 Full Version
Welcome	Hide/Zoom Worksheets	Workbook Setup (Establecer libro de trabajo) (Organização do Programa)	Reset Menus and Tables	Switch to Basic Version

To enter, edit or delete data in protected cells (which are shaded or contain entries in black font), double-click on the cell. An entry form will appear.
To change the table format, double-click on the table header. A table format form will appear.

Project and Conservation Targets	
Project	**Central California Coast Coho Salmon ~ Soquel Creek**
Target #1	**Adults**
Target #2	**Eggs**
Target #3	**Summer Rearing Juveniles**
Target #4	**Winter Rearing Juveniles**
Target #5	**Smolts**
Target #6	**Watershed Processes**

KEY ATTRIBUTES

Key attributes are defined as critical components of a conservation target's biology or ecology (TNC 2007). Viable populations result when key attributes function and support transitions between life history stages. By this definition, if attributes are missing, altered, or degraded, survival is adversely affected. Factors with the greatest potential to impair survival across life stages and limit salmonid production at the population scale were defined as key attributes.

There are three general categories of attributes (Table 10):

- Specific elements of aquatic habitats (*e.g.*, site specific conditions of water, wood, sediment);
- Watershed processes; and
- Life stage and population viability.

7.5.1 INDICATORS AND INDICATOR RATINGS

Indicators are a specific habitat, watershed process or population parameter providing a method to assess the status of a key attribute. An attribute may have one or more indicators. Each indicator has a rating which is a reference value describing the conditions of the key attribute as it relates to life stage survival. These conditions are described as poor, fair, good or very good. Reference values or indicator ratings were developed using established values from published scientific literature or the best available information. Measurable quantitative indicators were used for most indicators; however, the formulation of other more qualitative decision making structures were used when data were limited or non-existent. Qualitative decision structures were used to rate three attributes: instream flow conditions, estuary conditions, and toxicity.

Very good values were considered fully functional to allow complete life stage function and life stage transition. Good values were considered functional but slightly impaired, fair values were considered functional but significantly impaired, and poor values were considered inadequate for transition from one life stage to the next life stage. In watersheds where the majority of indicators were rated as good or very good, overall conditions were likely functional and support transitions between life history stages within the historical range of variability.

Based on the quantitative or qualitative data for each indicator, key attributes were rated for each life stage at the population level. Due to natural variability within watersheds and influences of human caused changes to streams and landscapes, habitat conditions vary greatly within and across streams, watersheds, and populations. To capture this variability, rating values and thresholds varied by indicator type and scale of the available data (*e.g.*, site, reach, stream, watershed or population). All final indicator ratings are reported at the population level; however, some rating required additional steps to arrive at a population level rating. For example, landscape pattern data (*e.g.*, percent of urban development) are readily available at the watershed scale, and a single-step rating process can characterize conditions for an entire population. However, habitat condition data (*e.g.*, percent of primary pools), collected at the habitat unit scale, were averaged to obtain reach, then stream, then watershed level values. This multiple step analysis was necessary to evaluate condition at a population (watershed) scale. Stream level rating criteria were based on indicator thresholds developed from the scientific literature values, while population scale rating criteria incorporated a spatial element. To rate current condition of each habitat attribute at the population level, NMFS determined the percentage of streams, or the percentage of IP-km, within a population meeting criteria for a very good, good, fair, or poor rating. Spatializing information enabled scaling up of stream level habitat data to the population level without compromising data protocol or integrity.

Table 10: CCC coho salmon CAP Conditions by Target Life Stage

CCC Coho Population Conditions By Target Life Stage

Target	Attribute	Indicator
Adults	Habitat Complexity	Large Wood Frequency (BFW 0-10 meters)
Adults	Habitat Complexity	Large Wood Frequency (BFW 10-100 meters)
Adults	Habitat Complexity	Pool/Riffle/Flatwater Ratio
Adults	Habitat Complexity	Shelter Rating
Adults	Hydrology	Passage Flows
Adults	Passage/Migration	Passage at Mouth or Confluence
Adults	Passage/Migration	Physical Barriers
Adults	Riparian Vegetation	Tree Diameter (North of SF Bay)
Adults	Riparian Vegetation	Tree Diameter (South of SF Bay)
Adults	Sediment	Quantity & Distribution of Spawning Gravels
Adults	Velocity Refuge	Floodplain Connectivity
Adults	Water Quality	Toxicity
Adults	Water Quality	Turbidity
Adults	Viability	Density
Eggs	Hydrology	Flow Conditions (Instantaneous Condition)
Eggs	Hydrology	Redd Scour
Eggs	Sediment	Gravel Quality (Bulk)
Eggs	Sediment	Gravel Quality (Embeddedness)
Summer Rearing Juveniles	Estuary/Lagoon	Quality & Extent
Summer Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)
Summer Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)
Summer Rearing Juveniles	Habitat Complexity	Percent Primary Pools
Summer Rearing Juveniles	Habitat Complexity	Pool/Riffle/Flatwater Ratio

Summer Rearing Juveniles	Habitat Complexity	Shelter Rating
Summer Rearing Juveniles	Hydrology	Flow Conditions (Baseflow)
Summer Rearing Juveniles	Hydrology	Flow Conditions (Instantaneous Condition)
Summer Rearing Juveniles	Hydrology	Number, Condition and/or Magnitude of Diversions
Summer Rearing Juveniles	Passage/Migration	Passage at Mouth or Confluence
Summer Rearing Juveniles	Passage/Migration	Physical Barriers
Summer Rearing Juveniles	Riparian Vegetation	Canopy Cover
Summer Rearing Juveniles	Riparian Vegetation	Tree Diameter (North of SF Bay)
Summer Rearing Juveniles	Riparian Vegetation	Tree Diameter (South of SF Bay)
Summer Rearing Juveniles	Sediment (Food Productivity)	Gravel Quality (Embeddedness)
Summer Rearing Juveniles	Water Quality	Temperature (MWMT)
Summer Rearing Juveniles	Water Quality	Toxicity
Summer Rearing Juveniles	Water Quality	Turbidity
Summer Rearing Juveniles	Viability	Density
Summer Rearing Juveniles	Viability	Spatial Structure
Winter Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)
Winter Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)
Winter Rearing Juveniles	Habitat Complexity	Pool/Riffle/Flatwater Ratio
Winter Rearing Juveniles	Habitat Complexity	Shelter Rating
Winter Rearing Juveniles	Passage/Migration	Physical Barriers
Winter Rearing Juveniles	Riparian Vegetation	Tree Diameter (North of SF Bay)
Winter Rearing Juveniles	Riparian Vegetation	Tree Diameter (South of SF Bay)
Winter Rearing Juveniles	Sediment (Food Productivity)	Gravel Quality (Embeddedness)
Winter Rearing Juveniles	Velocity Refuge	Floodplain Connectivity
Winter Rearing Juveniles	Water Quality	Toxicity
Winter Rearing Juveniles	Water Quality	Turbidity
Smolts	Estuary/Lagoon	Quality & Extent
Smolts	Habitat Complexity	Shelter Rating
Smolts	Hydrology	Number, Condition and/or Magnitude of Diversions
Smolts	Hydrology	Passage Flows
Smolts	Passage/Migration	Passage at Mouth or Confluence
Smolts	Smoltification	Temperature
Smolts	Water Quality	Toxicity
Smolts	Water Quality	Turbidity
Smolts	Viability	Abundance
Watershed Processes	Hydrology	Impervious Surfaces
Watershed Processes	Landscape Patterns	Agriculture
Watershed Processes	Landscape Patterns	Timber Harvest
Watershed Processes	Landscape Patterns	Urbanization
Watershed Processes	Riparian Vegetation	Species Composition
Watershed Processes	Sediment Transport	Road Density
Watershed Processes	Sediment Transport	Streamside Road Density (100 m)

7.6 FUTURE THREATS: STRESSES & SOURCES OF STRESS

Past, continuing, and newly identified threats are the ultimate cause for a species decline. To accurately address these issues, a threats assessment is required under NMFS' Interim Guidance (NMFS 2010a). The Interim Guidance recommends when "…discussing each threat and its sources, the geographic scope, severity, and frequency of the various threats should be indicated." Using the CAP method, a threats assessment was conducted to determine the severity, frequency, and contribution of a threat to each population.

7.6.1 ASSESSING FUTURE CONDITIONS: STRESSES

Stresses represent altered or impaired key attributes for each population, such as impaired hydrology or reduced habitat complexity. They are the inverse of the key attributes. For example, the attribute for passage becomes the stress of impaired passage. These altered conditions, irrespective of their sources, are expected to reduce population viability. For each population and life stage, stresses were ranked using two metrics, which are combined using algorithms contained in CAP to generate a single rank for each stress identified:

1. Severity of damage: The level of damage to the conservation target that can reasonably be expected to occur into the future under current circumstances (*i.e.*, given the continuation of the existing situation). Stresses ranked as very high for severity are likely to destroy or eliminate the target life stage over time. Stresses ranked as high are likely to seriously degrade the target. Medium ranks are likely to moderately degrade the target, and low ranks are applied to stresses that are likely to slightly impair the target.

2. Scope of damage: The geographic scope of impact on the conservation target at the site that can reasonably be expected into the future under current circumstances (*i.e.*, given the continuation of the existing situation). Stresses ranked as very high for scope are likely widespread or pervasive. Stresses ranked as high are likely to be widespread,

medium ranks are more localized, and low ranks are applied to stresses that are more limited.

Fifteen stresses were evaluated for specific life stages:

1. Altered Riparian Species Composition & Structure;
2. Altered Sediment Transport: Road Condition & Density;
3. Estuary: Impaired Quality & Extent;
4. Floodplain Connectivity: Impaired Quality & Extent;
5. Hydrology: Gravel Scouring Events;
6. Hydrology: Impaired Water Flow;
7. Impaired Passage & Migration;
8. Impaired Watershed Hydrology;
9. Instream Habitat Complexity: Altered Pool Complexity and/or Pool/Riffle Ratios;
10. Instream Habitat Complexity: Reduced Large Wood and/or Shelter;
11. Instream Substrate/Food Productivity: Impaired Gravel Quality & Quantity;
12. Landscape Disturbance;
13. Reduced Density, Abundance & Diversity;
14. Water Quality: Impaired Instream Temperatures; and
15. Water Quality: Increased Turbidity or Toxicity.

Stresses with a high level of severity and/or broad geographic scope are ranked as high or very high. For example, in Table 11 the stress of hydrology – impaired water flow was ranked as very high for its effects to the summer rearing life stage. This stress also ranked as high for smolts, because in low water years, flows are inadequate for out migration. This stress was ranked medium for adults and eggs, indicating it was not as severe and/or more limited in scope and, therefore, not as detrimental to those life stages, since flows during adult migratory periods and egg development periods are typically adequate. Stresses to the population are compiled in a summary table to describe major stresses for each population by target (Table 11).

Table 11: CAP Stress Table for Soquel Creek

Stress Matrix
Central California Coast Coho Salmon ~ Soquel Creek

	Stresses (Altered Key Ecological Attributes) Across Targets	Adults	Eggs	Summer Rearing Juveniles	Winter Rearing Juveniles	Smolts	Watershed Processes
		1	2	3	4	5	6
1	Reduced Density, Abundance & Diversity	Very High		Very High		Very High	
2	Instream Habitat Complexity: Reduced Large Wood and/or Shelter	High		Very High	High	Very High	
3	Hydrology: Impaired Water Flow	Medium	Medium	Very High		High	
4	Instream Substrate/Food Productivity: Impaired Gravel Quality & Quantity	Low	High	Medium	High		
5	Instream Habitat Complexity: Altered Pool Complexity and/or Pool/Riffle Ratios	High		Medium	High		
6	Floodplain Connectivity: Impaired Quality & Extent	Medium			High		
7	Water Quality: Impaired Instream Temperatures			High		Low	
8	Altered Sediment Transport: Road Condition & Density						High
9	Hydrology: Gravel Scouring Events		High				
10	Impaired Watershed Hydrology						High
11	Water Quality: Increased Turbidity or Toxicity	Medium		Medium	Medium	Medium	
12	Impaired Passage & Migration	Medium		Medium	Low	Low	
13	Estuary: Impaired Quality & Extent			Medium		Medium	
14	Landscape Disturbance						Medium
15	Altered Riparian Species Composition & Structure			Low			Low

7.6.2 Assessing Future Conditions: Sources of Stress (Threats)

CAP defines direct threats to the species as the sources of stress likely to limit viability into the future. Threats may result from currently active issues such as ongoing land uses, or from issues likely to occur in the future (usually within ten years), such as increased water diversion or development. Threats are expected to contribute to stresses in ways likely to impair salmonid habitat into the future. Many threats are driven by human activities; however, naturally occurring events such as earthquakes may also threaten the habitat of the species. For each population and life stage, threats were ranked using two metrics, which were combined by CAP algorithms to generate a single rank for each threat identified:

1. Contribution: The expected contribution of the source, acting alone, to the full expression of a stress under current circumstances (*i.e.*, given the continuation of the existing management/conservation situation). Threats ranked as very high for contribution are very large contributors to the particular stress. Threats ranked as high are large contributors, medium ranks are moderate contributors, and low ranks are applied to threats that contribute little to the particular stress; and
2. Irreversibility: The degree to which the effects of a threat can be reversed. Threats ranked as very high for irreversibility produce a stress that is not typically reversible (*e.g.* wetland converted to a shopping center). Threats ranked as high are reversible, but are not practically feasible to reverse. Medium ranked threats produces a stress that is reversible with a reasonable commitment of resources, and threats ranked as low are easily reversible.

Fourteen threats were evaluated in relation to each stress for a specific life stage:

1. Agriculture;
2. Channel Modification;
3. Disease/Predation/Competition;
4. Fire, Fuel Management and Fire Suppression;

5. Fishing/Collecting;
6. Hatcheries;
7. Livestock Farming and Ranching;
8. Logging and Wood Harvesting;
9. Mining;
10. Recreational Areas and Activities;
11. Residential and Commercial Development;
12. Roads and Railroads;
13. Severe Weather Patterns; and
14. Water Diversion and Impoundments.

Threats with a high level of contribution to a stress and/or high irreversibility were ranked as high or very high. For example, in Table 12 the threat of residential and commercial development was ranked as very high for its effects to two life stages, and high for three others, because residential development is a very high contributor to poor water quality and impaired riparian conditions in Soquel Creek. Summary tables of threats ranked for each population describe major threats for each target (Table 12). Using the CAP taxonomy, fourteen threats were evaluated in relation to each stress for a specific life stage. A summary describing each threat is provided in Appendix B. The overall threat rank summarizes the aggregate threat rating and thereby identifies the most limiting threats to a population.

The threat status for each target summarizing the aggregate ranks applied across all life stages and illustrates the targets most vulnerable. Threats ranked as high or very high are more likely to contribute to a stress that in turn, reduces the viability of a life stage. When multiple life stages of a population had high or very high threats, the viability of the population was diminished.

Table 12: CAP Threats Table for Soquel Creek

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

Some threats occurred in all or most populations (*e.g.* roads), while others were limited in distribution (*e.g.* mining); thus, some threats not relevant were not rated in some populations. Table 13 is a matrix of the threats that were evaluated against the stresses. For example, the threat of fishing and collecting was only ranked against the population stress of reduced abundance, diversity, and competition. This approach reduced overestimating the impact of a stress across multiple threats. Threats that contribute to impaired water flow, for example, were evaluated under that category rather than under each factor (*e.g.*, agriculture, urban, *etc.*).

Table 13: Matrix of Stresses Compared Against Threats

Stresses	Habitat Condition											Watershed Processes			Population
Threats	Estuary: Impaired Quality & Extent	Floodplain Connectivity: Impaired Quality & Extent	Hydrology: Gravel Scouring Events	Hydrology: Impaired Water Flow	Instream Habitat Complexity: Altered Pool Complexity and/or Pool/Riffle Ratios	Instream Habitat Complexity: Reduced Large Wood and/or Shelter	Instream Substrate/ Food Productivity: Impaired Gravel Quality & Quantity	Impaired Passage & Migration	Water Quality: Increased Turbidity or Toxocity	Water Quality: Impaired Instream Temperatures	Altered Riparian Species Composition & Structure	Impaired Watershed Hydrology	Landscape Disturbance	Altered Sediment Transport: Road Condition/ Density, Dams, etc.	Reduced Density, Abundance & Diversity
Agriculture				N/A											N/A
Channel Modification															N/A
Disease/Predation/ Competition(Invasive Animals and plants)			N/A	N/A			N/A								
Fire				N/A											N/A
Fishing/Collecting	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Hatcheries	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A	N/A	N/A	N/A	
Livestock				N/A											N/A
Logging				N/A											N/A
Mining				N/A											N/A
Recreation				N/A											N/A
Residential Development				N/A											N/A
Roads				N/A											N/A
Severe Weather															N/A
Water Diversion and Impoundments															

7.7 CAP DATA SOURCES AND ANALYSIS

To inform the CAP analyses of current conditions, stresses and threats, NMFS used a variety of data sources and data types. Sources included the CDFG, SWRCB, U.S. EPA, RCDs, private timber companies, conservation organizations, consultants, local watershed groups and other contributors. In particular, CDFG provided extensive habitat typing data for most of the focus populations.

Some data required additional evaluation, analysis and synthesis. Major data sources and the methods used to analyze and apply the data for the CAP analyses are detailed in Appendix B, and discussed in more detail below. These sources and methods are briefly summarized into the following categories:

1. CDFG Stream Survey Data: Eight indicators were informed by the CDFG stream habitat typing data. These data provided wide coverage across many of the watersheds across the NCCC Domain using a standardized data collection protocol (Flosi *et al.* 2004). NMFS obtained all available CDFG reach level habitat typing data (Hab-8) for the NCCC Domain from CDFG Regional Offices. The UC Davis Hopland Research Center entered these data into an Access database with funding provided by SCWA;
2. Stream flow: Lack of sufficient gage data in rearing and migration habitats led NMFS to derive ratings for stream flow indicators from a structured decision making model informed by a panel of experts familiar with watershed conditions (see Appendix B for the complete protocol). Five indicators were developed using this method. The indicator for number of diversions was calculated using SWRCB data sets;
3. Stream temperature: A single indicator informed this habitat attribute, but it required extensive compilation of disparate datasets. Temperature data was grouped into condition classes when multiple location information was available and extrapolated to inform a watershed-wide rating. Final ratings were made by estimating the proportion of a watershed's IP network that fell within each temperature class;

4. Water quality (turbidity and toxicity): The indicator for turbidity was difficult to quantify, so ratings were informed by an assessment of the erosion potential developed by the California Department of Conservation, Division of Mines and Geology (NMFS GIS 2008), literature review and expert opinion. A structured decision making model was used to rate toxicity;
5. Estuary conditions: Multiple indicators for open estuaries and closed lagoons were used in a structured protocol informed by a panel of NMFS staff familiar with individual estuaries to provide an overall rating. Indicators included historical extent, current configuration, and alteration to physical extent, as well as other physical, chemical and biological parameters to describe conditions for rearing and smolt life stages;
6. Land use assessments: Nine indicators were informed by GIS queries of available spatial datasets (NMFS GIS 2008);
7. Population viability: Three viability indicators (abundance, density, and spatial structure) were informed by review and synthesis of readily available fisheries monitoring data in the ESU; and
8. Other indicators: The remaining indicators were informed by various methods ranging from queries of existing databases to best professional judgment. For example, physical barriers were assessed using the Pacific States Marine Fisheries Council Passage Assessment Database[14]. The indicator for passage at mouth or confluence was assessed by NMFS staff with local knowledge of the watershed conditions.

NMFS' Habitat Conservation Division Geographical Information System (GIS) unit provided extensive information and analysis, particularly for land use attributes. For each focus population, a report was developed with information on factors such as acreage and percentage of urbanization, land ownership, land cover, current and projected development, road densities,

[14] http://nrm.dfg.ca.gov/PAD/Default.aspx

erosion potential, amount of farmland, timber harvesting history, location and types of barriers, diversions, and industrial influences (mines, discharge sites, toxic release sites) and stream temperature. These reports are called watershed characterizations. The characterizations are available at: http://swr.nmfs.noaa.gov/sr/watershed_characterizations.htm. Other resources used to evaluate conditions and threats were watershed assessment documents, government planning documents, personal communications, staff expertise, spatial data (*e.g.* GIS and Google Earth), and CDFG habitat inventories.

7.7.1 CDFG Habitat Typing Survey Data and UC Hopland Research

NMFS secured all available CDFG habitat typing data for the NCCC Domain. These datasets were standardized into an Access database under funds provided by SCWA. This "*Stream Summary Application*" (Appendix C) was developed by UC Davis Hopland Research and CDFG. UC Hopland completed the following: (1) entering field data from datasheets and importing databases from individual surveys into the stream habitat application; (2) performing quality control and assurance on spatial datasets; (3) creating spatial representations of stream surveys; and (4) using the stream habitat application to summarize the data for use by NMFS, CDFG, SCWA, stakeholders and the general public. This database summarizes reach level data of all CDFG surveys across all habitat parameters collected under the CDFG Habitat Typing protocols.

7.7.2 Contributions from NMFS Contractors

NMFS contracted with the Sonoma Ecology Center (SEC) to manage data acquisition (from CDFG and other sources); spatially reference data, conduct bias analyses and quality control, as well as develop necessary queries to match data to the 28 focus populations and associated indicators. SEC supported assessments of passage issues using the Pacific States Marine

Fisheries Council Passage Assessment Database and used the National Landcover Database[15] to calculate the percent of impervious surface and percent of land in agricultural use.

7.8 FOCUS POPULATION PROFILES & CORE AREA MAPS

Population profiles (Volume II) were developed for each focus population to provide general information and results regarding status of coho salmon, watershed conditions supporting each focus populations, CAP results, maps and population specific recovery actions.

To align implementation of recovery actions to higher probabilities of improving coho salmon survival, an assessment was conducted of occupancy patterns of coho salmon across subwatersheds. Streams known to support coho salmon were mapped and an assessment was made of associated habitats. Population profile maps were developed displaying subwatersheds for each population as Core, Phase I or Phase II areas. Subwatershed boundaries coincide with existing CalWater units. The intent is to provide a guide for restoration and protection of the most important habitats first, direct actions to prevent extinction, and increase probability of survival and set a sequence to prioritize work and expenses.

This approach front-loads recovery actions into areas critical for species survival, and further emphasizes protection of remaining habitats and their populations. Restoration of Core areas is the highest priority for near-term restoration projects and threat abatement actions. Sequentially, Phase I and II areas will need to be rehabilitated to the extent necessary to achieve recovery goals. Once restoration of Core areas is accomplished, the next priority is to restore subwatersheds with generally suitable habitat conditions that are currently unoccupied, or rarely occupied (*i.e.*, Phase I areas). Finally, as a long-term goal, the plan recommends restoring unoccupied watersheds (*i.e.*, Phase II areas). Phase II areas can be occupied in the future once

[15] http://www.mrlc.gov/nlcd2001.php

conditions improve by expanding coho salmon populations. The three ranks, the rationale behind their definitions, and the strategy for restoration and subsequent monitoring are described below:

Core Areas are:

1. Locations known to have current or recent occupancy of CCC coho salmon according to (a) status reviews conducted prior to the initial listing on October 31, 1996 (61 FR 56138) and (b) data provided by numerous agencies, individuals, and others including the presence/absence database developed by CDFG; and
2. Areas within each watershed identified for immediate focus of restoration and threat abatement actions. Most focus watersheds have identified Core Areas.

Core Area Goals:

1. Implement Priority 1 actions without delay; and
2. Restoration or threat abatement should be designed to improve freshwater survival probability of individuals at any life stage.

Core Area Concepts:

1. High-cost and intensive restoration efforts are appropriate;
2. Projects should evaluate possible short term negative impacts against long term benefits to coho salmon life stage survival. Large scale restoration projects, for example, may have significant inputs of sediment and short term habitat degradation, but will result in large long term benefits. In some special cases, short term impacts cannot be tolerated if the species is particularly vulnerable to short term impacts (*i.e.*, relatively isolated populations with low abundance). All possible impacts to remaining CCC coho salmon populations should be carefully considered;
3. Watershed assessments to focus restoration actions, water quality monitoring, and fish population monitoring (including trend monitoring) are necessary to provide feedback on the effectiveness of restoration actions; and

4. Recovery actions in Core Areas are extremely high priorities for the near term.

Phase I Areas are:

1. Areas identified for near-term expansion of coho salmon populations;
2. Locations with high potential for supporting all or some coho salmon life stages;
3. Extensive habitat restoration and threat abatement may be required; and
4. May or may not currently support low numbers of coho salmon.

Phase I Area Goals:

1. Rehabilitate, maintain, and enhance instream habitat conditions to support all freshwater life stages;
2. Projects should consider instream, upstream, and upslope processes affecting downstream habitat conditions (*e.g.*, recruit upstream wood to ensure downstream wood supply, where limited); and
3. Careful analysis of limiting factors and connectivity of project sites are necessary to ensure restoration activities address critical limiting factors in the correct sequence.

Phase I Concepts:

1. Recovery actions in Phase I areas are high priorities for the next 12 years (four coho salmon generations); and
2. Coordinate Priority I actions in Core Areas and adjacent Phase I areas.

Phase II Areas are:

1. Likely to support high valued seasonal habitat or connectivity between habitats;
2. Habitats often highly divergent from historical conditions and often require large-scale and sustained long-term restoration and threat abatement actions;
3. All remaining habitats needed by CCC coho salmon to achieve full recovery; and
4. Areas providing watershed conditions necessary for a full range of variability commensurate with historical conditions.

Phase II Area Goals:

1. Consideration for Phase II areas should focus primarily on re-establishing or maintaining watershed processes and preventing further degradation.
2. Enhance, and prevent degradation of, habitat conditions for expanding populations such that distribution and abundance begin to shift towards patterns resembling historical patterns; the long-term survival of the species depends on this shift.

Phase II Concepts:

1. Recovery actions in Phase II areas will require sustained efforts to return watersheds to more suitable conditions.

7.9 RECOVERY ACTIONS

Section 4(f)(1)(B)(i) of the ESA outlines that each recovery plan must include to the maximum extent practicable, "(i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation of the species." The Interim Guidance (NMFS 2010a) outlines that "recovery actions must include specific actions needed to control each of the identified threats to the species, as categorized under the five statutory listing factors of the ESA." Case law has affirmed that an increase in population numbers is insufficient to delist a species. In the Fund for Animals v Babbitt (903 F. Supp. 96 D.D.C. 1995), the courts determined that (grammatically) the word "specific" modifies "site", not management actions. This ruling infers that recovery plans are required to have site specific management actions rather than just specific management actions. In the same case, the court found site specific management actions must link to identified threats (*i.e.*, the underlying causes of decline) organized by the five listing factors in section 4(a)(1) and the plan must document changes in threats since listing and must recommend appropriate actions to address threats. Id.

Recovery actions for CCC coho salmon are designed to meet ESA and case law requirements, are site-specific (*e.g.*, action steps), and organized by the section 4(a)(1) listing factors. Recovery actions in this plan were written to explicitly improve an indicator in poor condition according to the CAP viability assessment (called restoration strategies), and abate threats found to rank as high or very high (threat strategies). Few actions were developed for good conditions or low threats. The objective of all recovery actions is to shift the status of the listing factors and threats to allow CCC coho salmon to recover to the point they no longer require protection under the ESA.

NMFS reviewed a wide range of resources to develop and prioritize recovery actions including the California Recovery Strategy for California Coho Salmon (CDFG 2004), and the Draft SONCC Coho Salmon Recovery Plan (NMFS 2012a). Many relevant actions were also included from State and local watershed assessment reports, total maximum daily loads (TMDLs) plans, environmental impact reports (EIRs), strategic management plans from counties, coordination with other divisions of NOAA, outreach to knowledgeable constituents, staff expertise, and many other sources.

Recovery actions are hierarchical according to the recovery guidance: Objective, Recovery Action and Action Step (Figure 21 and Figure 22 are examples of this hierarchy). Action steps are site-specific recommendations to improve the status of conditions and threats. Recovery Actions are the conditions requiring improvements as it relates to CAP criteria and Objectives are assigned to one of the five statutory Section 4(a)(1) listing factors (Figure 21). There are two categories of recovery actions: actions to improve CAP viability ratings (more restoration-based actions) and actions to abate threats. Restoration actions link to the CAP rating criteria in the viability table (*e.g.*, increase large wood frequency to 6-11 key pieces per 100 meters). For threat abatement, recovery actions focus on preventing future impairments. Each recovery action is supported by a series of site-specific action steps (*e.g.*, install large wood in the lower reaches of Scott Creek to the maximum extent practicable). Action steps are site specific management actions required to restore conditions and prevent future threats.

Restoration- Estuary

1.1. **Objective:** Address the present of threatened destruction, modification or curtailment of the species habitat or range

1.1.1. **Recovery Action:** Increase the extent of estuarine habitat

1.1.1.1. **Action Step:** Restore estuarine habitat and the associated wetlands and sloughs by providing fully functioning habitat (CDFG 2004).

1.1.1.2. **Action Step:** Remove structures impairing or reducing the historical tidal prism, where feasible, and where benefits to coho salmon and/or the estuarine environment are predicted. Evaluate benefits to lagoon tidal prism from the proposed bridge replacement for the Highway 1 bridge over Scott Creek lagoon.

Figure 21: Example Recovery Action Structure (Restoration Actions for Scott Creek, Santa Cruz)

Photo Courtesy 45: Giacomini Estuarine Restoration, Marin County, CA; *Robert Campbell.*

Threat- Roads/Railroads

1.1. **Objective:** Address the inadequacy of existing regulatory mechanisms.

23.2.1. **Recovery Action:** Prevent impairment to instream substrate

23.2.1.1. **Action Step:** Establish a moratorium on new road construction within floodplains, riparian areas, unstable soils or other sensitive areas until a watershed specific and/or agency/company specific road management plan is created and implemented.

23.2.1.2. **Action Step:** Conduct annual inspections of all roads prior to winter. Correct conditions that are likely to deliver sediment to streams. Hydrologically disconnect roads.

23.2.1.3. **Action Step:** Improve enforcement of Erosion Control Ordinance for private roads. The current Santa Cruz Erosion Control Ordinance has provisions requiring the responsible parties to repair and alleviate erosion problems that are deemed severe. Santa Cruz Planning should create new erosion control staff positions to help coordinate the County's cooperative efforts, but also to conduct inspections and enforcement actions as necessary.

Figure 22: Example Recovery Actions (Threat Abatement Actions for Scott Creek, Santa Cruz)

Objective: One of the Five Section 4(a)(1) Listing Factors

Recovery Action: CAP Conditions or Threats

Action Step: Site specific action to restore a condition or abate a threat

Specific categories of actions (*e.g.*, habitat improvements, regulatory, *etc.*) were reassigned to one of the five listing factors as described in the FRN at the time of CCC coho salmon listing. Organizing actions and actions steps to a specific listing factor allows tracking of listing factors more directly through time. Figure 23 illustrates the relationship of actions and action steps to listing factors.

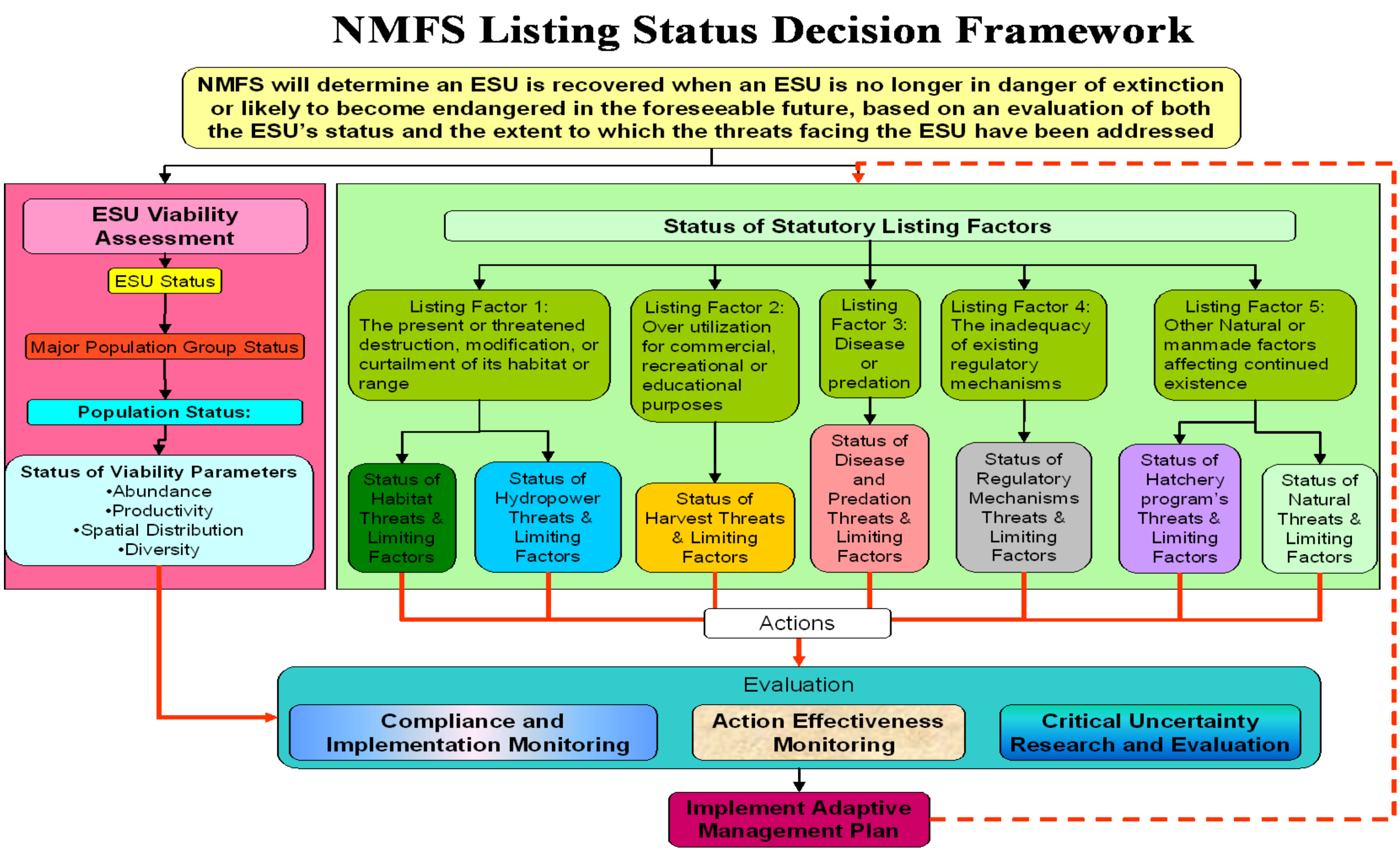

Figure 23: NMFS Listing Decision Framework

7.10 IMPLEMENTATION SCHEDULES

Volume II contains implementation schedules (tables) and outlines of all recovery actions specific to each focus population. The outline is a skeletal list of the objective, recovery actions, and action steps without accompanying descriptions found in the implementation schedule. It provides a succinct alternative to the more detailed implementation schedules. Implementation schedules satisfy the requirements under the ESA by including "estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps towards that goal" (ESA section 4(f)(1)(A)(iii)). The implementation schedule provides the basis for tracking plan implementation performance. An example implementation schedule is provided in Table 14.

The Implementation Schedule in Volume II outlines actions and estimated costs for the recovery program for the CCC coho salmon ESU. It is a guide for meeting the recovery goals outlined in this plan. This schedule indicates action priorities, action numbers, action descriptions, duration of actions, the recovery partners (either funding or carrying out), and estimated costs. Entities with authority, responsibility, ownership, or expressed interest to implement a specific recovery action are identified in the Implementation Schedule. Designation of an entity in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s).

RECOVERY STRATEGY NUMBER

A unique recovery number is assigned to each objective, action, and action step and the numbers are hierarchical. The first series of digits correspond to the specific population, the second series to the ESU and the third series is the recovery action number (Table 15).

Table 14: Example Implementation Schedule (Scott Creek Population)

Recovery Strategy Number	Level	Targeted Attribute or Threat	Action Description	Priority Number	Action Duration (Years)	Recovery Partners	Costs ($K)						Comments
							FY 1-5	FY 6-10	FY 11-15	FY 16-20	FY 21-25	Entire Duration	
ScC-CCC-1.1	Objective	Estuary	Address the present of threatened destruction, modification or curtailment of the species habitat or range										
ScC-CCC-1.1.1	Recovery Action	Estuary	Increase the extent of estuarine habitat										
ScC-CCC-1.1.1.1	Action Step	Estuary	Restore estuarine habitat and the associated wetlands and sloughs by providing fully functioning habitat (DFG 2004).	2	5	CA Coastal Commission, CalPoly, CalTrans, NOAA SWFSC, USACE	931					931	The Scott Creek estuary was reduced in size following European arrival and is currently believed to be a major limiting factor for the salmonids. The upper estuary was converted for agricultural purposes, and much of the historical tidal prism is reduced due to channelization for the Highway 1 Bridge constructed in the early 1940's. Estuary/lagoons on California's central coast have been extensively documented as superior rearing habitat for steelhead and can contribute a disproportionate total number of returning adults compared to stream habitats when conditions are even marginally suitable (Bond et al., 2008). This recommendation would include restoration of complex habitat features such as large woody material to deepen pools and provide cover. Coho will benefit from restoration during smolt transition and adult upmigration. Cost for treating 3 acres (assume 10% of total estuarine acres) at a rate of $310,216/acre.
ScC-CCC-1.1.1.2	Action Step	Estuary	Remove structures impairing or reducing the historical tidal prism, where feasible, and where benefits to salmonids and/or the estuarine environment are predicted. Work with Caltrans to restore estuary tidal prism as part of the proposed bridge replacement for the US Route 1 bridge over Scott Creek lagoon.	1	10	, CA Coastal Commission, CalPoly, CalTrans, NOAA SWFSC						TBD	Caltrans is currently evaluating bridge replacement - differentiating between anticipated replacement costs and additional actions for coho recovery benefits can not be estimated at this time due to uncertainty regarding Caltrans preferred alternative. Replacement of the bridge offers a rare opportunity to restore two sharp bends to the lower channel and replace the leveed and straightened channel.
ScC-CCC-1.1.2	Recovery Action	Estuary	Reduce frequency of artificial breaching events										
ScC-CCC-1.1.2.1	Action Step	Estuary	Post durable and attractive interpretive signage at the beach to discourage casual breaching of the lagoon sandbar.	2	10	CalTrans, CDFG, Santa Cruz County	1.50	1.50				3	Cost of signs vary widely depending on materials used and content of signs. Assume $1,000/sign with a minimum of 3 signs for lagoon.
ScC-CCC-1.1.2.2	Action Step	Estuary	Monitor sandbar to evaluate timing and frequency of natural and artificial breeching events.	2	10	CalPoly, CalTrans, CDFG, NOAA SWFSC						In-Kind	
ScC-CCC-1.1.3	Recovery Action	Estuary	Rehabilitate natural river mouth dynamics										
ScC-CCC-1.1.3.1	Action Step	Estuary	Highway 1 bridge reconstruction should restore historical river mouth dynamics to minimize delayed natural breaching.	1	10	CA Coastal Commission, CalPoly, CalTrans, Santa Cruz County						TBD	The major channel modification on Scott Creek is at the lagoon where Caltrans realigned (straightened) the stream to a new location for the original Highway 1 bridge. The original channel made a sharp bend to the west and then a second sharp bend at the cliff to enter the ocean. Both of these bends would have produced deep scour holes in the lagoon, serving as good feeding and transition habitat for down-migrating smolts. The sandbar at the mouth would also have been less likely to have delayed opening in the winter as currently occurs with the current alignment. Re-establishing the historical alignment will have major benefits to both steelhead and coho salmon.
ScC-CCC-2.1	Objective	Floodplain Connectivity	Address the present of threatened destruction, modification or curtailment of the species habitat or range.										
ScC-CCC-2.1.1	Recovery Action	Floodplain Connectivity	Rehabilitate and enhance floodplain connectivity										
ScC-CCC-2.1.1.1	Action Step	Floodplain Connectivity	Encourage breeching of old levees in the lower riparian reaches of Scott Creek.	1	10	CalPoly, CDFG, NOAA SWFSC, Scotts Creek Watershed Council, USACE	62.00	62.00				124	Breeching will improve floodplain function and provide high water refuge for juvenile salmonids. Levees were constructed on the lower Scott Creek floodplain to facilitate farming and to concentrate and direct flows under the Route 1 Bridge in the estuary. These levees receive little if any maintenance, and in the riverine reach the levees are well vegetated. Nonetheless, the levees continue to function, and likely reduce the total amount of rearing habitat in the estuary and disconnect stream flood flow from its floodplain. Cost based on treating 3 miles (assume 1 project/mile in 25% High IP) at a rate of $41,092/mile.

Table 15: Recovery Strategy Number

Recovery Strategy Number Follows Example: **XXXX-A-1.2.3.4**	
XXXX:	Unique Identifier for Population Group
A:	Species Identifier
1:	Strategy Level
2:	Objective Level
3:	Recovery Action Level
4:	Action Step Level

Table 16: Strategy Categories & Unique Identifiers

	Strategies
1	Estuary
2	Floodplain Connectivity
3	Hydrology
4	Landscape Patterns
5	Pool Habitat
6	Riparian
7	Sediment
8	Viability
9	Water Quality
10	Agricultural Practices
11	Channel Modification
12	Severe Weather Patterns
13	Disease/Predation/Competition
14	Severe Weather Patterns
15	Fire/Fuel Management
16	Fishing/Collecting
17	Hatcheries
18	Livestock
19	Logging
20	Mining
21	Recreation
22	Residential/Commercial Development
23	Roads/Railroads
24	Severe Weather Patterns
25	Water Diversion/Impoundment
26	Habitat Complexity
27	Passage
28	Watershed Process

For example, the recovery action number ScC-CCC-3.1 corresponds to an action for the Scott Creek population in the CCC coho salmon ESU and is an objective for Hydrology. The recovery action number corresponds to the targeted attribute or threat (Table 16). Not all restoration or threat actions have recovery actions and therefore the numbering system may not be sequential (*e.g.*, 3.1, 4.1, 8.1) in the implementation schedule. This will show as "No species-specific actions were developed" in the recovery outline.

LEVEL

Indicates the level of action which can be an Objective, Recovery Action or Action Step.

TARGETED ATTRIBUTE OR THREAT

Describes whether the action is intended to improve a CAP attribute (*e.g.*, habitat, population or watershed condition) or abate a future threat (*e.g.*, minimizing impacts of a land use activity, reducing fire risk and planning for natural events such as floods). Many actions written to improve a CAP attribute are restoration type actions and actions for threat abatement are recommendations for best management practices, outreach, enforcement, compliance, and implementation of existing statutes, laws, policies and education, *etc*.

ACTION DESCRIPTION

The specific action needed to improve conditions or abate threats.

PRIORITY NUMBER

Priorities are assigned to each action step in the implementation table in concordance with the NMFS Endangered and Threatened Species Listing and Recovery Priority Guidelines (55 FR 24296). Assigning priorities does not imply that some recovery actions are of lower importance; instead it implies they may be deferred while higher priority actions are implemented (NMFS 2010a). All recovery actions have assigned priorities based on the following:

Priority 1: Actions that must be taken to prevent extinction or to prevent the species from declining irreversibly. These actions are generally focused on areas where CCC coho salmon persist and where actions can increase freshwater survival probabilities,

Priority 2: Actions that must be taken to prevent a significant decline in population abundance, habitat quality, or other negative impacts (55 FR 24296) and focus primarily on efforts directed to restore and expand the current range of CCC coho salmon.

Priority 3: All other actions necessary to achieve full recovery of the species. These actions focus on preventing further degradation and reestablishing long-term recovery for expanding populations.

ACTION DURATION

These time estimates are important in estimating the overall cost of recovery and describe the estimated length of time for the action to be implemented.

RECOVERY PARTNERS

This information outlines the suite of partners who may contribute to full and effective implement the action step. Listing a recovery partner does not commit any party to actually do, fund or support the work.

COSTS

Development of costs for the lowest level actions (*e.g.* specific action steps) is required pursuant to section 4(f) of the ESA. These estimates are presented in five year intervals out to 25 years and include a total cost for the duration of the action. Estimated costs are aggregated into an estimated total for the cost to recovery CCC coho salmon and presented in the Chapter 9. The accuracy of recovery cost estimates are governed by many factors such as the specificity of the recovery action step, labor, materials, site location, duration, and timing of action. As a result, predicting costs into the future becomes increasingly imprecise due to a lack of information regarding these various constraints. Furthermore, many actions either build on previous actions to create cost benefits or are required under mandates other than the ESA, such as other Federal, State and local laws.

To account for these uncertainties, NMFS recovery staff developed a framework to estimate costs. The framework was based on Southwest Region's *Habitat Restoration Cost References for Salmon Recovery Planning* (Thomson and Pinkerton 2008) and *Cost and Socioeconomic Impacts of Implementing the California Coho Recovery Strategy* (CDFG 2004). Wherever possible, this framework was applied to determine the cost of recovery actions. Due to the varying degree of specificity for most identified recovery actions, assumptions about the type, magnitude, number or extent of individual recovery action steps were necessary. Assumptions on the costs of recovery action steps were based on various information sources that estimated the cost of similar activities.

Assumption tables were adjusted for the NCCC Domain to include information from CDFG's cost estimates from the State Coho Salmon Recovery Strategy (CDFG 2004) and reflect regional variability in costs for labor wage, materials, and inflation. To account for regional variability in costs, a multiplier was applied to standard costs as outlined in the NMFS framework, CDFG (2004) and Thomson and Pinkerton (2008). For example, Mendocino and Sonoma counties have an average county wage similar to the average of all counties in California and no multiplier was applied to costs in those areas. The San Francisco Bay Area and San Mateo County have an average county wage 20% higher than the average of all California counties; thus, a multiplier of 0.20 was adjusted for these areas. For Santa Cruz County, a multiplier of 0.14 was added since the average county wage is 14% higher than the average across California.

Assumption tables were also adjusted to 2012 values. Annual average U. S. rate of inflation for the 98 year period of record is 3.3% (Bureau of Labor Statistics 2012). Using the 2004, CDFG estimate for cost of recovery, and applying the annual average rate of inflation, recovery cost for 2012, has risen by 26.4% since 2004. For example, a passage treatment with an estimated cost of $900,000 in 2004, was estimated to cost $1,137,600 in 2012, and $1,175,140 in 2013. NMFS cannot predict the future financial projections of the U.S. economy and based our recovery costs on current 2012, estimates. Appendix D provides all the cost estimates includes the difference in cost of recovery actions from 2004, to 2012.

Cost estimates are mainly focused on the direct expenditure required to physically perform the task, and may not always include secondary costs associated with administrative needs. In instances where the timing or extent of recommended action steps was not available or were undetermined, assumptions were developed from the CAP ratings and projected amount of potential habitat requiring improvements. These assumptions include:

- Large wood placement in 50% of potential habitats;
- Off channel habitat improvements are one project per mile across 25% of potential habitats;
- Water projects are assumed at one per mile across 55% of potential habitats;
- Riparian thinning assumes 80 acres/mile planted across 5% of potential habitats;
- Road decommissioning should reduce road density to two miles per squared miles;
- 25% of roads upgraded;
- Levee setback for 1% of potential habitat and cost of breach for 1% of potential habitat at a rate of one project per mile;
- Barrier removal assumes 1 barrier/5 miles of potential habitat;
- Stabilizing banks assumes 1% of potential habitat;
- Purchasing or leasing water rights assumes 10% of low flow volume affected;
- Fuel reduction assumes 25% of potential habitat treated with mechanical thinning and 25% of potential habitat fuel management; and
- Invasive vegetation species control assumed 80 acres/mile treated in 5% of potential habitats.

Actions were grouped into four categories described in more detail below: in-kind, planning, monitoring and implementation (Table 17).

Table 17: Recovery Action Categories

Recovery Action Categories and Types	
Category	**Action Type**
In-Kind	Cost of Doing Business
Planning	Scoping
	Design
	Permitting
Monitoring	Pre-project
	Post-Project
	Effectiveness
	Biological/Ecological
Implementation	Habitat Complexity
	Riparian Vegetation Structure
	Species Diversity
	Floodplain Connectivity
	Species Migration Pattern
	Sediment Transport
	Estuarine Ecology

IN-KIND ACTIONS

In-kind actions are those occurring irrespective of Federal listing. These include actions as mandated by other laws and policies (*e.g.*, State of California ESA, Clean Water Act, county and city ordinances, *etc.*). No costs were assigned to these types of actions and are defined as those associated with the "cost of doing business."

PLANNING

Planning actions were included in the cost of implementing the action. They were assigned a cost estimate when known. If it was unclear whether or not the action would coincide with another action, costs were not assigned. Planning actions include scoping, designing, and permitting.

MONITORING

Specific habitat and fish monitoring costs are provided in the Monitoring Chapter (Chapter 11). Actions organized into monitoring include pre-project, post-project, effectiveness, and biological/ecological. Costs were calculated by mile, year, and acre or project level. Costs were applied but may vary substantially between populations depending on level of intensity, duration, and protocol.

IMPLEMENTATION

These actions have a specific focus on improving freshwater habitat conditions and were assigned costs based on the type of action as described below:

Habitat Complexity

Cost of instream habitat complexity varies with techniques implemented. To determine the cost of increasing habitat complexity for recovery actions such as increasing LWD frequency, shelter ratings, and primary pools a flat rate of $25,000 per mile was applied. This assumes a minimum of one project per mile (involving multiple structures along the targeted stream reach). In instances when placement of LWD was not feasible, the cost of an engineered log jam at a rate of $101,120 per jam was applied.

Riparian Vegetation Structure

To rehabilitate riparian composition and distribution, an estimated cost of $20,057 per acre was used. The variability in riparian buffers is difficult to determine, therefore, we assumed that an average of 80 acres per mile (40 acres per streambank) would be treated to achieve the desired recovery targets.

Species Diversity

The variability in vegetative composition between regions and populations is diverse. Therefore, we established a standard rate of $1,422 per acre with the assumption of 80 acres per mile treated for upslope vegetative management. Non-native species recovery actions consist of several distinct activities, including assessment, control, education and outreach, as well as development of monitoring programs. The costs for controlling and removing non-native species were derived on a per acre basis.

Floodplain Connectivity

The costs to reconnect floodplains are contingent upon the restoration method implemented. Removing or setting back levees, creating alcove and backwater habitat, or off-channel wetlands are some methods used to reconnect floodplains; each with a varying degree of planning, design, and implementation. A rate of $36,046 per mile, assuming one project per mile, was considered the average across the various implementation methods outlined in this recovery plan.

Species Migration Patterns

The costs of recovery actions associated with dams and diversions were calculated using the CalFish.org mapping tool when available. When specific information was unavailable, the assumption table for fish passage improvement was used.

Culvert replacement costs were calculated from the assumption that a minimum of one culvert would be replaced in each identified watershed, or sub-watershed, annually for the first five years of Recovery Plan implementation.

Sediment Transport

Costs to execute recovery actions associated with road upgrades or decommissioning were calculated from 12,000 per mile to 21,000 per mile depending on method. If number of miles to be upgraded or decommissioned were unknown, then road densities were reduced to meet viable criteria.

Estuarine Ecology

Costs to implement estuarine recovery actions were calculated at a rate of $272,120 per acre. Estimates incorporate components of wetland restoration, LWD placement, and riparian planting. Each estuary was mapped for current extent of acres and a total of 10 percent of total estuarine habitat was estimated for treatment.

COMMENTS

In some instances comments are provided with the action to provide specificity regarding rationale, context, references, *etc.* to clarify the action.

7.11 NMFS RECOVERY ACTION DATA SOURCES

NMFS capitalized on a full range of resources to develop and prioritize recovery actions which included public comments, watershed assessment reports, online resources, personal knowledge, TMDLs, EIR documents, plans from counties, coordination with other divisions of NOAA, outreach to knowledgeable individuals, staff expertise, and many other sources. The California Recovery Strategy for California Coho Salmon (CDFG 2004) was used extensively for Diversity Strata, ESU/DPS, and domain level actions, as well as watershed specific strategies. The State Plan is often cited in the implementation tables as (16 U.S.C. 1531-1544, as amended). Furthermore, high levels of coordination occurred between CDFG staff and NMFS staff in the development and finalization of these actions. While these actions focused on the needs of coho salmon, many actions will benefit steelhead and/or Chinook salmon where populations overlap.

7.11.1 THE RECOVERY ACTION DATABASE

In 2008, NMFS developed a database to facilitate the development, revision process, and final output of recovery actions. The recovery actions database is in Access and has a user interface to allow staff to input and query actions across any and all fields. This capability will allow us to track implementation of actions for each listing factor over time.

7.12 CONCLUSIONS

We believe the described methods meet the goals in the Interim Recovery Planning Guidance (NMFS 2010a) which strongly recommends “a structured approach to assessing threats, sources of threats, and their relative importance to the species’ status…” We selected populations for recovery, assessed the status of conditions and threats, and developed site specific recovery actions to shift the status of listing factors. Actions are linked with our analysis and organized according to the statutory Section 4(a)(1) listing factors. This approach will fully inform future status reviews and evaluations regarding the threats identified at the time of listing (*e.g.*, section 4(a)(1) factors A-E). This approach will also ensure that continuing or new threats are addressed to the extent recovery and delisting are possible.

8.0 RESULTS

> Whenever a large sample of chaotic elements are taken in hand … an unsuspected and most beautiful form of regularity proves to have been latent all along.
>
> Francis Galton, 19th century

This chapter summarizes the results outlining the final list of populations that will represent the recovery scenario, status of listing factors and protective efforts, CAP assessments and the total cost of implementing recovery actions over a 100 year period for the 28 focus populations. Viability and Threat result tables are provided at the end of the chapter. The individual CAP workbooks and the aggregated data that informed the analyses can be made available upon request; however, it is anticipated that the information will be uploaded online.

8.1 POPULATIONS, LISTING FACTORS & PROTECTIVE EFFORTS

A total of 28 focus populations and 11 supplemental populations were selected to fulfill recovery criteria for the CCC coho salmon ESU. The total area associated with these 28 populations represent 1736 km of potential habitat, or 33%, of the total 5,194 km of habitat identified by the historical structure analysis (Chapter 6). The status of the Section 4(a)(1) FRN listing factors and protective efforts were evaluated (See Chapters 4 and 5). While many protective efforts are in place, the threats are not sufficiently ameliorated or abated to prevent the continued decline of CCC coho salmon populations.

8.2 CAP VIABILITY RESULTS

A summary of attributes and indicator ratings for all life stages and watershed processes across diversity strata are presented in Table 18 and Table 19. These tables display the CAP results by target life stages as well as by attributes and indicators. These tables informed an analysis for each diversity stratum.

Table 18: Viability Summary Table by Target Life Stage

CCC Coho Population Conditions By Target Life Stage			Lost Coast										Navarro Pt.-Gualala Pt.			Coastal						Santa Cruz Mountains								
Target	Attribute	Indicator	Usal	Cottaneva	Wages	Ten Mile	Pudding	Noyo	Caspar	Big	Albion	Big Salmon	Navarro	Garcia	Gualala	Russian	Salmon	Pine Gulch	Walker	Lagunitas	Redwood	San Gregori	Pescadero	Gazos	Waddell	Scott	San Vicente	San Lorenz	Soquel	Aptos
Adults	Habitat Complexity	Large Wood Frequency (BFW 0-10 meters)	P	P	P	F	P	P	V	P	P	G	F	G	G	P	P	F	P	P	V	P	P	F	F	F	P	P	P	F
Adults	Habitat Complexity	Large Wood Frequency (BFW 10-100 meters)	P	V	F	P	F	P	G	P	F	F	P	P	G	P	P	ND	P	F	ND	P	P	V	V	F	P	P	P	G
Adults	Habitat Complexity	Pool/Riffle/Flatwater Ratio	F	F	F	V	G	F	V	P	F	F	F	G	P	P	F	F	P	P	F	F	G	F	P	P	F	F	P	P
Adults	Habitat Complexity	Shelter Rating	P	P	F	P	P	P	P	P	P	F	P	P	P	P	P	P	P	F	P	P	P	F	P	P	P	P	P	P
Adults	Hydrology	Passage Flows	V	V	G	G	G	G	V	G	G	V	F	G	F	F	F	G	G	V	G	P	F	F	V	G	G	G	V	V
Adults	Passage/Migration	Passage at Mouth or Confluence	F	V	V	V	G	V	V	V	G	V	G	F	G	F	G	V	F	G	V	F	G	F	V	G	G	G	G	G
Adults	Passage/Migration	Physical Barriers	V	V	V	V	V	V	V	V	V	V	G	V	V	V	V	V	F	V	V	G	G	V	V	G	V	G	G	G
Adults	Riparian Vegetation	Tree Diameter (North of SF Bay)	F	G	P	P	P	F	G	F	F	P	P	F	F	P	P	P	P	P	P	NA	NA	NA	NA	NA	NA	NA	NA	NA
Adults	Riparian Vegetation	Tree Diameter (South of SF Bay)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	G	G	F	F	F	F	G	G	F
Adults	Sediment	Quantity & Distribution of Spawning Gravels	V	G	G	G	G	G	V	G	F	F	G	F	V	F	G	F	P	G	G	G	F	F	V	V	G	V	F	P
Adults	Velocity Refuge	Floodplain Connectivity	G	G	G	F	G	F	F	F	F	F	G	G	F	P	F	F	P	P	P	F	G	G	G	G	F	F	F	P
Adults	Water Quality	Toxicity	V	G	G	G	G	G	G	G	G	G	F	G	F	F	G	F	F	G	F	F	G	G	F	G	G	F	F	F
Adults	Water Quality	Turbidity	F	F	G	P	P	G	F	F	F	P	G	G	G	F	P	F	F	G	F	P	P	F	F	F	G	P	F	P
Adults	Viability	Density	P	F	P	P	F	F	F	P	F	F	P	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P
Eggs	Hydrology	Flow Conditions (Instantaneous Condition)	V	G	G	G	G	G	V	G	F	V	F	G	F	F	G	G	F	G	G	F	G	V	V	V	G	F	F	G
Eggs	Hydrology	Redd Scour	F	V	G	G	G	F	V	F	F	G	F	F	F	P	F	V	F	F	G	P	F	F	F	P	F	P	P	F
Eggs	Sediment	Gravel Quality (Bulk)	P	F	P	F	P	F	F	F	ND	P	F	F	G	G	ND	ND	P	G	G	P	P	F	F	F	F	P	P	P
Eggs	Sediment	Gravel Quality (Embeddedness)	F	V	P	P	F	F	V	P	P	F	F	V	F	F	G	P	P	F	P	P	V	V	F	F	F	P	P	P
Summer Rearing Juveniles	Estuary/Lagoon	Quality & Extent	P	G	F	G	F	F	F	F	F	V	F	F	F	P	P	P	F	F	P	F	P	F	F	F	P	P	F	P
Summer Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	P	P	P	F	P	P	V	F	P	G	P	G	G	P	P	F	P	P	V	P	P	F	F	F	P	P	P	F
Summer Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	P	P	F	P	F	P	G	P	F	F	P	P	G	P	P	ND	P	F	ND	P	P	V	V	F	P	P	P	G
Summer Rearing Juveniles	Habitat Complexity	Percent Primary Pools	P	P	P	P	P	P	P	P	P	P	P	G	P	P	G	P	P	F	F	P	P	F	P	G	V	F	P	P
Summer Rearing Juveniles	Habitat Complexity	Pool/Riffle/Flatwater Ratio	F	F	F	V	G	F	G	P	P	F	P	G	P	P	F	F	P	P	F	F	G	F	P	P	F	F	P	P
Summer Rearing Juveniles	Habitat Complexity	Shelter Rating	P	P	F	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P
Summer Rearing Juveniles	Hydrology	Flow Conditions (Baseflow)	G	G	G	G	F	F	G	F	F	G	F	F	P	P	F	F	P	F	F	P	F	G	G	F	F	P	P	G
Summer Rearing Juveniles	Hydrology	Flow Conditions (Instantaneous Condition)	G	V	G	G	V	G	V	G	F	G	F	G	F	P	G	G	F	G	G	F	G	G	G	V	V	F	P	V
Summer Rearing Juveniles	Hydrology	Number, Condition and/or Magnitude of Diversions	V	V	F	G	G	G	V	G	F	G	F	G	G	F	F	F	G	F	P	P	P	P	F	F	G	P	F	G
Summer Rearing Juveniles	Passage/Migration	Passage at Mouth or Confluence	G	V	V	V	G	G	V	G	G	G	F	F	F	F	G	V	F	G	V	F	G	F	V	G	V	G	G	G
Summer Rearing Juveniles	Passage/Migration	Physical Barriers	V	V	V	V	V	V	V	V	G	V	F	V	V	V	G	V	F	V	V	G	G	V	V	G	V	G	V	F
Summer Rearing Juveniles	Riparian Vegetation	Canopy Cover	V	V	V	V	G	G	V	P	G	P	F	G	F	F	F	P	F	F	V	F	F	V	G	V	G	V	V	G
Summer Rearing Juveniles	Riparian Vegetation	Tree Diameter (North of SF Bay)	F	G	P	P	P	F	G	F	F	P	P	F	F	P	P	P	P	P	P	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summer Rearing Juveniles	Riparian Vegetation	Tree Diameter (South of SF Bay)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	G	G	F	F	F	F	G	G	F
Summer Rearing Juveniles	Sediment (Food Productivity)	Gravel Quality (Embeddedness)	F	V	P	P	F	F	V	P	F	F	F	V	F	F	G	F	P	F	F	P	V	V	F	F	F	P	P	P
Summer Rearing Juveniles	Water Quality	Temperature (MWMT)	G	G	V	F	G	P	F	P	F	G	P	F	F	P	F	G	P	F	G	F	F	G	F	F	G	P	F	F
Summer Rearing Juveniles	Water Quality	Toxicity	V	G	G	G	G	G	G	G	G	G	F	G	F	F	G	F	F	G	F	F	F	G	P	G	G	F	F	F
Summer Rearing Juveniles	Water Quality	Turbidity	G	F	G	G	P	G	G	V	V	F	F	G	G	F	G	V	F	V	G	G	G	G	G	G	V	F	F	P
Summer Rearing Juveniles	Viability	Density	P	F	P	P	F	F	F	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Summer Rearing Juveniles	Viability	Spatial Structure	P	G	G	F	G	V	G	G	G	V	P	G	G	F	G	P	F	G	F	P	V	P	P	P	G	P	P	P
Winter Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	P	P	P	F	P	P	V	F	P	G	P	G	G	P	P	F	P	P	V	P	P	F	F	F	P	P	P	F
Winter Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	P	P	F	P	F	P	G	P	F	F	P	P	G	P	P	ND	P	F	ND	P	P	V	V	F	P	P	P	G
Winter Rearing Juveniles	Habitat Complexity	Pool/Riffle/Flatwater Ratio	G	F	F	V	G	F	G	P	P	F	P	G	P	P	F	F	P	P	F	F	G	F	P	P	F	F	P	P
Winter Rearing Juveniles	Habitat Complexity	Shelter Rating	P	P	F	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P
Winter Rearing Juveniles	Passage/Migration	Physical Barriers	V	V	V	V	G	G	V	V	G	V	F	V	V	V	V	V	F	V	V	G	G	V	V	G	V	G	V	F
Winter Rearing Juveniles	Riparian Vegetation	Tree Diameter (North of SF Bay)	F	G	P	P	P	G	G	F	F	P	P	F	F	P	P	P	P	P	P	NA	NA	NA	NA	NA	NA	NA	NA	NA
Winter Rearing Juveniles	Riparian Vegetation	Tree Diameter (South of SF Bay)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	G	G	F	F	F	F	G	G	F
Winter Rearing Juveniles	Sediment (Food Productivity)	Gravel Quality (Embeddedness)	F	V	P	P	F	F	V	P	F	F	F	V	F	F	G	F	F	F	F	P	V	V	F	F	F	P	P	P
Winter Rearing Juveniles	Velocity Refuge	Floodplain Connectivity	G	G	G	F	F	F	P	P	F	F	F	G	F	P	F	F	P	P	P	F	F	G	G	G	F	F	P	P
Winter Rearing Juveniles	Water Quality	Toxicity	V	G	G	G	G	G	G	G	G	G	F	G	F	F	G	F	F	G	F	F	G	G	P	G	G	F	F	F
Winter Rearing Juveniles	Water Quality	Turbidity	F	F	G	P	P	F	P	F	G	P	G	G	F	F	P	F	P	G	P	P	P	F	F	F	F	P	F	P
Smolts	Estuary/Lagoon	Quality & Extent	F	G	F	G	F	F	F	F	F	V	F	F	F	F	F	P	F	F	F	G	F	F	F	F	P	P	F	F
Smolts	Habitat Complexity	Shelter Rating	P	P	F	P	P	P	P	P	P	F	F	P	P	P	P	P	P	F	P	P	P	F	P	P	P	P	P	P
Smolts	Hydrology	Number, Condition and/or Magnitude of Diversions	V	V	F	G	G	G	V	G	F	G	F	F	G	F	F	F	G	F	F	P	P	P	F	F	G	P	F	G
Smolts	Hydrology	Passage Flows	V	V	G	G	G	G	V	G	G	V	F	G	F	P	G	G	F	V	G	P	F	F	G	F	G	P	G	G
Smolts	Passage/Migration	Passage at Mouth or Confluence	P	V	V	V	G	V	V	G	G	V	G	F	F	F	F	V	F	G	V	F	G	G	V	V	V	G	V	G
Smolts	Smoltification	Temperature	V	G	V	V	V	G	V	G	G	G	F	G	F	F	F	G	F	G	G	V	G	V	G	G	V	G	G	G
Smolts	Water Quality	Toxicity	V	G	G	G	G	G	G	G	G	G	F	G	F	F	G	F	F	G	F	F	G	G	P	G	G	F	F	F
Smolts	Water Quality	Turbidity	F	F	G	P	P	F	P	F	G	F	F	G	F	F	F	G	P	G	P	P	P	F	F	F	G	P	F	P
Smolts	Viability	Abundance	P	P	P	P	F	P	P	P	F	F	P	P	F	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P
Watershed Processes	Hydrology	Impervious Surfaces	V	V	V	V	V	V	V	V	V	V	V	V	V	G	V	V	V	V	V	V	V	V	V	V	V	G	V	V
Watershed Processes	Landscape Patterns	Agriculture	V	V	V	V	V	V	V	V	V	V	V	V	V	G	V	F	P	V	V	V	V	V	V	V	V	V	V	V
Watershed Processes	Landscape Patterns	Timber Harvest	G	F	F	P	F	F	V	F	P	G	G	G	F	V	G	V	V	V	G	V	V	V	V	G	G	V	V	V
Watershed Processes	Landscape Patterns	Urbanization	V	V	V	V	P	V	V	V	G	P	G	V	V	F	P	V	V	G	G	V	V	V	V	V	P	P	P	P
Watershed Processes	Riparian Vegetation	Species Composition	V	V	V	G	V	G	G	F	V	V	P	V	G	F	F	F	P	F	G	G	G	V	V	G	F	G	G	G
Watershed Processes	Sediment Transport	Road Density	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	V	V	G	P	P	F	G	G	F	G	P	P	P
Watershed Processes	Sediment Transport	Streamside Road Density (100 m)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	P

NA = Not Applicable
ND = No Data

Table 19: Viability Summary Table by Attribute and Indicator Rating

CCC Coho Population Conditions By Habitat Attribute			Lost Coast										Navarro Pt.-Gualala Pt.			Coastal						Santa Cruz Mountains								
Target	Attribute	Indicator	Usal	Cottaneva	Wages	Ten Mile	Pudding	Noyo	Caspar	Big	Albion	Big Salmon	Navarro	Garcia	Gualala	Russian	Salmon	Pine Gulch	Walker	Lagunitas	Redwood	San Gregorio	Pescadero	Gazos	Waddell	Scott	San Vicente	San Lorenzo	Soquel	Aptos
Smolts	Estuary/Lagoon	Quality & Extent	F	G	F	G	F	F	F	F	F	V	F	F	F	F	F	P	F	F	F	G	F	F	F	F	P	P	F	F
Summer Rearing Juveniles	Estuary/Lagoon	Quality & Extent	P	G	F	G	F	F	F	F	F	V	F	F	F	P	P	P	F	F	P	F	P	F	F	F	P	P	F	P
Adults	Habitat Complexity	Large Wood Frequency (BFW 0-10 meters)	P	P	P	F	P	P	V	P	P	G	F	G	G	P	P	F	P	P	V	P	P	F	F	F	P	P	P	F
Summer Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	P	P	P	F	P	P	V	F	P	G	P	G	G	P	P	F	P	P	V	P	P	F	F	F	P	P	P	F
Winter Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 0-10 meters)	P	P	P	F	P	P	V	F	P	G	P	G	G	P	P	F	P	P	V	P	P	F	F	F	P	P	P	F
Summer Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	P	P	F	P	F	P	G	P	F	F	P	P	G	P	P	ND	P	F	ND	P	P	V	V	F	P	P	P	G
Winter Rearing Juveniles	Habitat Complexity	Large Wood Frequency (Bankfull Width 10-100 meters)	P	P	F	P	F	P	G	P	F	F	P	P	G	P	P	ND	P	F	ND	P	P	V	V	F	P	P	P	G
Adults	Habitat Complexity	Large Wood Frequency (BFW 10-100 meters)	P	V	F	P	F	P	G	P	F	F	P	P	G	P	P	ND	P	F	ND	P	P	V	V	F	P	P	P	G
Summer Rearing Juveniles	Habitat Complexity	Percent Primary Pools	P	P	P	P	P	P	P	P	P	P	P	G	P	P	G	P	P	F	F	P	P	F	P	G	V	F	P	P
Adults	Habitat Complexity	Pool/Riffle/Flatwater Ratio	F	F	F	V	G	F	V	P	F	F	F	G	P	P	F	F	P	P	F	F	G	F	P	P	F	F	P	P
Summer Rearing Juveniles	Habitat Complexity	Pool/Riffle/Flatwater Ratio	F	F	F	V	G	F	G	P	P	F	P	G	P	P	F	F	P	P	F	F	G	F	P	P	F	F	P	P
Winter Rearing Juveniles	Habitat Complexity	Pool/Riffle/Flatwater Ratio	G	F	F	V	G	F	G	P	P	F	P	G	P	P	F	F	P	P	F	F	G	F	P	P	F	F	P	P
Adults	Habitat Complexity	Shelter Rating	P	P	F	P	P	P	P	P	P	F	P	P	P	P	P	P	P	F	P	P	P	F	P	P	P	P	P	P
Smolts	Habitat Complexity	Shelter Rating	P	P	F	P	P	P	P	P	P	F	F	P	P	P	P	P	P	F	P	P	P	F	P	P	P	P	P	P
Summer Rearing Juveniles	Habitat Complexity	Shelter Rating	P	P	F	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P
Winter Rearing Juveniles	Habitat Complexity	Shelter Rating	P	P	F	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P
Summer Rearing Juveniles	Hydrology	Flow Conditions (Baseflow)	G	G	G	G	F	F	G	F	F	G	F	F	P	P	F	F	P	F	F	P	F	G	G	F	F	P	P	G
Eggs	Hydrology	Flow Conditions (Instantaneous Condition)	V	G	G	G	G	G	V	G	F	V	F	G	F	F	G	G	F	G	G	F	G	V	V	V	G	F	F	G
Summer Rearing Juveniles	Hydrology	Flow Conditions (Instantaneous Condition)	G	V	G	G	V	G	V	G	F	G	F	G	F	P	G	G	F	G	G	F	G	G	G	V	V	F	P	V
Watershed Processes	Hydrology	Impervious Surfaces	V	V	V	V	V	V	V	V	V	V	V	V	V	G	V	V	V	V	V	V	V	V	V	V	V	G	V	V
Smolts	Hydrology	Number, Condition and/or Magnitude of Diversions	V	V	F	G	G	G	V	G	F	G	F	F	G	F	F	F	G	F	F	P	P	P	F	F	G	P	F	G
Summer Rearing Juveniles	Hydrology	Number, Condition and/or Magnitude of Diversions	V	V	F	G	G	G	V	G	F	G	F	G	G	F	F	F	G	F	P	P	P	P	F	F	G	P	F	G
Adults	Hydrology	Passage Flows	V	V	G	G	G	G	V	G	G	V	F	G	F	F	F	G	G	V	G	P	F	F	V	G	G	G	V	V
Smolts	Hydrology	Passage Flows	V	V	G	G	G	G	V	G	G	V	F	G	F	P	G	G	F	V	G	P	F	F	G	F	G	P	G	G
Eggs	Hydrology	Redd Scour	F	V	G	G	G	F	V	F	F	G	F	F	F	P	F	V	F	F	G	P	F	F	F	P	F	P	P	F
Watershed Processes	Landscape Patterns	Agriculture	V	V	V	V	V	V	V	V	V	V	V	V	V	G	V	F	P	V	V	V	V	V	V	V	V	V	V	V
Watershed Processes	Landscape Patterns	Timber Harvest	G	F	F	P	F	F	V	F	P	G	G	G	F	V	G	V	V	V	G	V	V	V	V	G	G	V	V	V
Watershed Processes	Landscape Patterns	Urbanization	V	V	V	V	P	V	V	V	G	P	G	V	V	F	P	V	V	G	G	V	V	V	V	V	P	P	P	P
Adults	Passage/Migration	Passage at Mouth or Confluence	F	V	V	V	G	V	V	V	G	V	G	F	G	F	G	V	F	G	V	F	G	F	V	G	G	G	G	G
Smolts	Passage/Migration	Passage at Mouth or Confluence	P	V	V	V	G	V	V	G	G	V	G	F	F	F	F	V	F	G	V	F	G	G	V	V	V	G	V	G
Summer Rearing Juveniles	Passage/Migration	Passage at Mouth or Confluence	G	V	V	V	G	G	V	G	G	G	F	F	F	F	G	V	F	G	V	F	G	F	V	G	V	G	G	G
Adults	Passage/Migration	Physical Barriers	V	V	V	V	V	V	V	V	V	V	G	V	V	V	V	V	F	V	V	G	G	V	V	G	V	G	G	G
Summer Rearing Juveniles	Passage/Migration	Physical Barriers	V	V	V	V	V	V	V	V	G	V	F	V	V	V	G	V	F	V	V	G	G	V	V	G	V	G	V	F
Winter Rearing Juveniles	Passage/Migration	Physical Barriers	V	V	V	V	G	G	V	V	G	V	F	V	V	V	V	V	F	V	V	G	G	V	V	G	V	G	V	F
Summer Rearing Juveniles	Riparian Vegetation	Canopy Cover	V	V	V	V	G	G	V	P	G	P	F	G	F	F	F	P	F	F	V	F	F	V	G	V	G	V	V	G
Watershed Processes	Riparian Vegetation	Species Composition	V	V	V	G	V	G	G	F	V	V	P	V	G	F	F	F	P	F	G	G	G	V	V	G	F	G	G	G
Adults	Riparian Vegetation	Tree Diameter (North of SF Bay)	F	G	P	P	P	F	G	F	F	P	P	F	F	P	P	P	P	P	P	NA	NA	NA	NA	NA	NA	NA	NA	NA
Summer Rearing Juveniles	Riparian Vegetation	Tree Diameter (North of SF Bay)	F	G	P	P	P	F	G	F	F	P	P	F	F	P	P	P	P	P	P	NA	NA	NA	NA	NA	NA	NA	NA	NA
Winter Rearing Juveniles	Riparian Vegetation	Tree Diameter (North of SF Bay)	F	G	P	P	P	G	G	F	F	P	P	F	F	P	P	P	P	P	P	NA	NA	NA	NA	NA	NA	NA	NA	NA
Adults	Riparian Vegetation	Tree Diameter (South of SF Bay)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	G	G	F	F	F	F	G	G	F
Summer Rearing Juveniles	Riparian Vegetation	Tree Diameter (South of SF Bay)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	G	G	F	F	F	F	G	G	F
Winter Rearing Juveniles	Riparian Vegetation	Tree Diameter (South of SF Bay)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	G	G	F	F	F	F	G	G	F
Eggs	Sediment	Gravel Quality (Bulk)	P	F	P	F	P	F	F	F	ND	P	F	F	G	G	ND	ND	P	G	G	P	P	F	F	F	F	P	P	P
Eggs	Sediment	Gravel Quality (Embeddedness)	F	V	P	P	F	F	V	P	P	F	F	V	F	F	G	P	P	F	P	P	V	V	F	F	F	P	P	P
Adults	Sediment	Quantity & Distribution of Spawning Gravels	V	G	G	G	G	G	V	G	F	F	G	F	V	F	G	F	P	G	G	G	F	F	V	V	G	V	F	P
Summer Rearing Juveniles	Sediment (Food Productivity)	Gravel Quality (Embeddedness)	F	V	P	P	F	F	V	P	F	F	F	V	F	F	G	F	P	F	F	P	V	V	F	F	F	P	P	P
Winter Rearing Juveniles	Sediment (Food Productivity)	Gravel Quality (Embeddedness)	F	V	P	P	F	F	V	P	F	F	F	V	F	F	G	F	F	F	F	P	V	V	F	F	F	P	P	P
Watershed Processes	Sediment Transport	Road Density	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	V	V	G	P	P	F	G	G	F	G	P	P	P
Watershed Processes	Sediment Transport	Streamside Road Density (100 m)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	P
Smolts	Smoltification	Temperature	V	G	V	V	V	G	V	G	G	G	F	G	F	F	F	G	F	G	G	V	G	V	G	G	V	G	G	G
Adults	Velocity Refuge	Floodplain Connectivity	G	G	G	F	G	F	F	F	F	F	G	G	F	P	F	F	P	P	P	F	G	G	G	G	F	F	F	P
Winter Rearing Juveniles	Velocity Refuge	Floodplain Connectivity	G	G	G	F	F	F	P	P	F	F	F	G	F	P	F	F	P	P	P	F	F	G	G	G	F	F	P	P
Smolts	Viability	Abundance	P	P	P	P	F	P	P	P	F	F	P	P	F	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P
Adults	Viability	Density	P	F	P	P	F	F	F	P	F	F	P	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P
Summer Rearing Juveniles	Viability	Density	P	F	P	P	F	F	F	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Summer Rearing Juveniles	Viability	Spatial Structure	P	G	G	F	G	V	G	G	G	V	P	G	G	F	G	P	F	G	F	P	V	P	P	P	G	P	P	P
Summer Rearing Juveniles	Water Quality	Temperature (MWMT)	G	G	V	F	G	P	F	P	F	G	P	F	F	P	F	G	P	F	G	F	F	G	F	F	G	P	F	F
Adults	Water Quality	Toxicity	V	G	G	G	G	G	G	G	G	G	F	G	F	F	G	F	F	G	F	F	G	G	F	G	G	F	F	F
Smolts	Water Quality	Toxicity	V	G	G	G	G	G	G	G	G	G	F	G	F	F	G	F	F	G	F	F	G	G	P	G	G	F	F	F
Summer Rearing Juveniles	Water Quality	Toxicity	V	G	G	G	G	G	G	G	G	G	F	G	F	F	G	F	F	G	F	F	F	G	P	G	G	F	F	F
Winter Rearing Juveniles	Water Quality	Toxicity	V	G	G	G	G	G	G	G	G	G	F	G	F	F	G	F	F	G	F	F	G	G	P	G	G	F	F	F
Adults	Water Quality	Turbidity	F	F	G	P	P	G	F	F	F	P	G	G	G	F	P	F	F	G	F	P	P	F	F	F	G	P	F	P
Smolts	Water Quality	Turbidity	F	F	G	P	P	F	P	F	G	F	F	G	F	F	F	G	P	G	P	P	P	F	F	F	G	P	F	P
Summer Rearing Juveniles	Water Quality	Turbidity	G	F	G	G	P	G	G	V	V	F	F	G	G	F	G	V	F	V	G	G	G	G	G	G	V	F	F	P
Winter Rearing Juveniles	Water Quality	Turbidity	F	F	G	P	P	F	P	F	G	P	G	G	F	F	P	F	P	G	P	P	P	F	F	F	F	P	F	P

NA = Not Applicable
ND = No Data

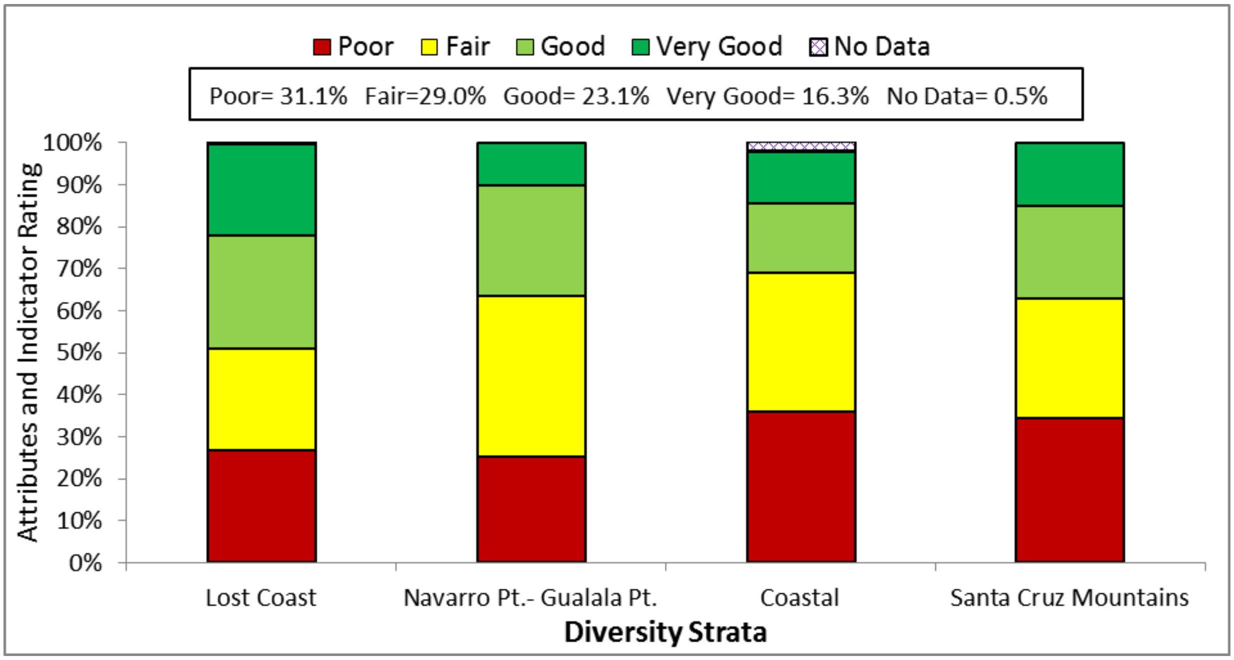

Figure 24: Attribute Indicator Ratings for CCC coho salmon across Diversity Strata

8.3 ATTRIBUTE & LIFE STAGE RESULTS: ESU LEVEL

Across strata, the Coastal stratum had a slightly larger percentage of poor and fair viability attribute ratings followed by Navarro Point- Gualala Point and Santa Cruz Mountains (Figure 24). The Lost Coast diversity stratum had the fewest attributes rated as poor or fair.

Winter rearing juveniles are the most threatened life stage across the ESU with 77% of the indicator ratings reported as poor or fair. The adult, egg, summer rearing juvenile and smolt life stages are also threatened with approximately 60% of the indicator ratings reported as poor or fair (Figure 25). Watershed processes, on an ESU level, have 37% of the attributes reported as poor or fair.

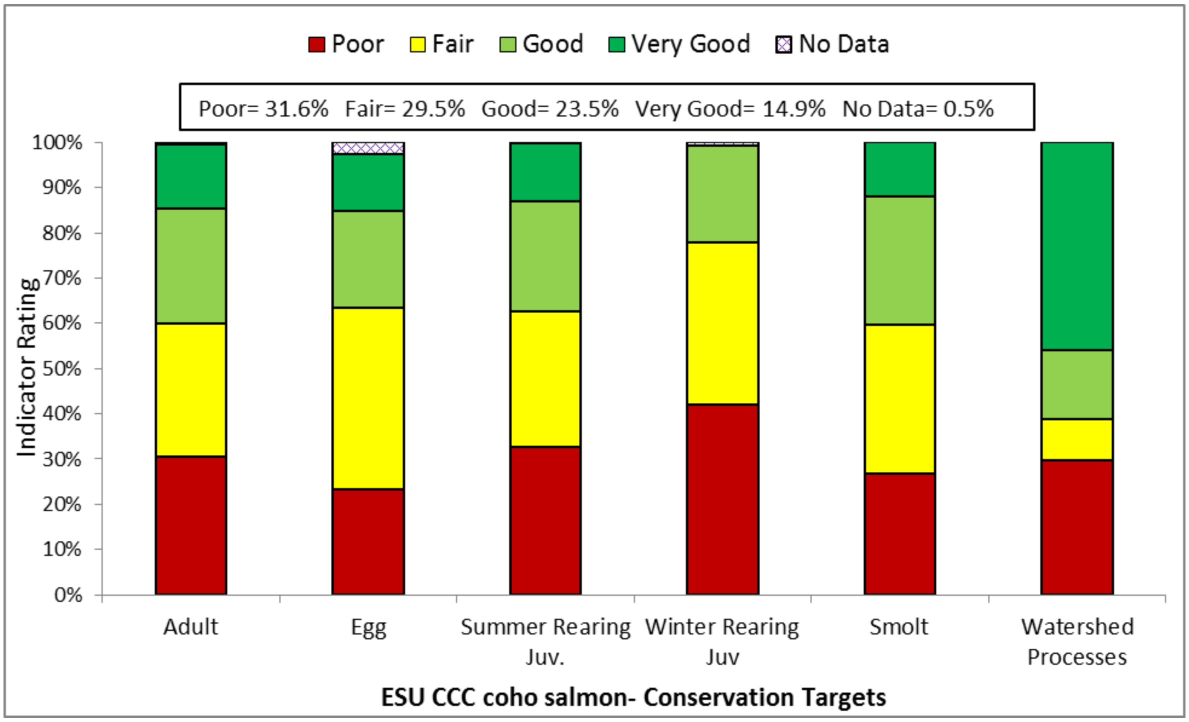

Figure 25: Attribute Indicator Ratings for CCC coho salmon- ESU by Lifestage

8.4 VIABILITY RESULTS: DIVERSITY STRATA & LIFE STAGES

The following results came from the viability tables which lists the indicator rankings for habitat attributes for each population.

Lost Coast: This stratum had the lowest percentage of poor and fair ratings of the ESU. The winter rearing life stage appears most limiting for this stratum.

Navarro Point-Gualala Point: The egg, summer rearing juvenile and smolt all had higher percent poor and fair ratings than winter rearing juveniles.

Coastal: This stratum has the greatest percent of poor and fair ratings for each life stage, except for the egg life stage, across the ESU.

Santa Cruz Mountains: This stratum had the second highest percentage of poor and fair ratings of the ESU.

Adult Viability Results

- ESU Level Results: The indicators of greatest concern were habitat complexity (LWD), pool/riffle/flatwater ratio, shelter rating, riparian, floodplain connectivity, water quality and viability (Figure 26).
- Diversity Strata Results: Adult conditions were similar across strata with little differences between stratum.

Egg Viability Results

- ESU Level Results: The indicators of most concern were redd scour and gravel quality (Figure 27).
- Diversity Strata Results:
    - Lost Coast: Sediment was the indicator of greatest concern.
    - Navarro Point – Gualala Point: Flow, redd scour and gravel quality all ranked fair.
    - Coastal: Instantaneous flow and redd scour are of greatest concern.
    - Santa Cruz Mountains: Hydrology and sediment indicators are of greatest concern.

Summer Rearing Viability Results

- ESU Level Results: Indicators of greatest concern (> 68% poor or fair) are estuary/lagoon quality and extent, habitat complexity (LWD), percent primary pools, pool/riffle/flatwater ratio, shelter rating, baseflow, riparian vegetation, sediment, water quality and viability (Figure 28).
- Diversity Strata Results:
    - Lost Coast: Hydrology had better than average summer rearing ratings than other strata.

- Navarro Point – Gualala Point: Passage/migration are more a concern in this stratum than the other diversity stratum.
- Coastal: Number of diversions, canopy cover and viability had a greater percentage of poor and fair ratings than other strata.
- Santa Cruz Mountains: Number of diversions, toxicity and viability had a greater percentage of poor and fair ratings than other strata.

Winter Rearing Viability Results

- <u>ESU Level Results</u>: This life stage had the largest percentage of poor and fair ratings across the ESU. The indicators of greatest concern were LWD, pool/riffle/flatwater ratio, shelter rating, riparian, sediment, floodplain connectivity and water quality (Figure 29).
- <u>Diversity Strata Results:</u>
  - Lost Coast: Fair to poor winter rearing conditions.
  - Navarro Point – Gualala Point: Ratings higher than other strata for LWD, sediment, floodplain connectivity and water quality.
  - Coastal: Fair to poor winter rearing conditions.
  - Santa Cruz Mountains: Fair to poor winter rearing conditions.

Smolt Viability Results

- <u>ESU Level Results</u>: Attributes of concern are quality and extent of estuary/lagoon, shelter rating, turbidity, and abundance (Figure 30).
- <u>Diversity Stratum Results:</u>
  - Lost Coast: Strata results mimic ESU level results.
  - Navarro Point – Gualala Point: Habitat complexity (shelter rating) and viability (abundance) had a 75% poor rating and a 25% fair rating. Estuary/lagoon

(quality and extent) has a 100% fair rating and all other attributes are rated 75% fair and 25% good for smolts.

- Coastal: All attributes that are of concern on the ESU level were of similar concern for smolts.
- Santa Cruz Mountains: In addition to all of the above listed ESU attributes of concern, hydrology (number, condition, and/or magnitude of diversions) had a greater poor/fair indicator rating than the ESU average for smolts.

Watershed Processes Viability Results

- ESU Level Results: Road density and streamside road density are the greatest overall source of impairment to watershed processes (Figure 31).
- Diversity Strata Results:
    - Lost Coast: Timber harvest is the most significant concern to this stratum.
    - Navarro Point-Gualala Point: Road density is the greatest concern in this stratum.
    - Coastal: Riparian vegetation and species composition are the greatest concern in this stratum.
    - Santa Cruz Mountains: Urbanization is the greatest concern in this stratum.

8.5 CAP ESU THREAT RESULTS

ESU Level Results

- Table 20 is the ESU output of threats across populations. Of the 15 identified threats, the four of greatest concern across the ESU were roads and railroads, water diversions and impoundment, residential and commercial development and severe weather (Figure 32).

Diversity Threat Results: Lost Coast

- The greatest threats were roads and severe weather the in this stratum. No very high threats were identified (Figure 33).

Diversity Threat Results: Navarro Point – Gualala Point

- Logging and wood harvesting, severe weather, roads, and water diversion and impoundment were the greatest threat in the stratum. No very high threats were identified (Figure 34).

Diversity Threat Results: Coastal

- Residential and commercial development, water diversions and impoundments, severe weather, roads and railroads, channel modification, and livestock farming and ranching are the greatest threats in this stratum (Figure 35).

Diversity Threat Results: Santa Cruz Mountains

- Roads and railroads, severe weather patterns, water diversions and impoundments, residential and commercial development, and fire and fuel management are the greatest threats in this stratum (Figure 36).

8.6 EMERGING THREATS

For the plan to be successful, it is important that actions are rapidly implemented to address, minimize, or prevent current and future threats resulting from water toxins (*e.g.,* nutrients, pesticides, and pharmaceuticals), climate change, water diversions, urbanization, and the adverse effects associated with the actual size of a population (*e.g.,* small population dynamics). We anticipate strategies and actions addressing these emerging threats are not fundamentally different than actions already recommended in this plan which address existing threats. However, some limiting factors may extend to more life stages or to larger spatial areas than anticipated, which will require implementation of recovery actions over large spatial and temporal scales. Additionally, some areas may become increasingly more important for protection and restoration than other areas. NMFS recognizes the need to develop a research, monitoring, and evaluation plan (RME) to assess the status of listed species and their habitat.

The RME should track progress toward achieving recovery goals and provide information to refine recovery strategies and actions through the process of adaptive management. For example, a formal risk analyses at the population level, specific to climate change projections, may be needed. This assessment will help prioritize existing actions and identify new strategies and actions.

8.6.1 CLIMATE CHANGE

NMFS recognizes climate change is a serious risk to coho salmon in California. The best available scientific information indicates the Earth's climate is warming, driven by the accumulation of greenhouse gasses (GHGs) in the atmosphere (IPCC 2007). The Intergovernmental Panel on Climate Change (IPCC) concluded in 2007 that warming of the climate system is unequivocal based on observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Changes in seasonal temperature regimes affect fish and wildlife (Quinn and Adams 1996; Schneider and Root 2002; Walther *et al.* 2002).

Climate shifts can affect fisheries, with profound socio-economic and ecological consequences (Osgood 2008). In a recent 2011 report on the Global Climate Change Impacts in the U. S. it was noted that, "salmon in the Northwest are under threat from a variety of human activities, but global warming is a growing source of stress." Salmon and steelhead from northern California to the Pacific Northwest are now challenged by global warming induced alteration of habitat conditions throughout their complex life cycles (Mantua and Francis 2004; Glick 2005; ISAB 2007; Martin and Glick 2008; Glick *et al.* 2009). Salmon productivity in the Pacific Northwest is sensitive to climate-related changes in stream, estuary, and ocean conditions. Specific characteristics of a population or its habitat vulnerable to climate change include temperature requirements, suitability of available habitat, and the genetic diversity of the ESU. Climate change could alter freshwater habitat conditions and affect the future survival of Pacific salmon stocks. Nearly 75 percent of California's anadromous salmonid populations are vulnerable to climate change, and future climate change will affect the ability to influence their recovery in most or all of their watersheds (Moyle *et al*. 2008). Because coho salmon depend on freshwater streams and the ocean during different stages of their life history cycle, populations throughout the ESU, but particularly at the southern end of the range, are likely to be significantly impacted by climate change in the future. Climate change as it relates to salmonids is discussed in further detail in Appendix A.

8.6.2 SMALL POPULATION DYNAMICS

As populations decline random events have a larger impact on population dynamics and the ability of a population to persist. The perils small populations face may be either deterministic, the result of systematic forces that cause population decline (*e.g.*, overexploitation, development, deforestation, inability to find mates, inability to defend against predators), or stochastic (the result of random fluctuations that have no systematic direction). Stochastic pressure can express itself in three ways: genetic, demographic and environmental. Descriptions of these pressures are described below:

- Genetic stochasticity refers to changes in the genetic composition of a population unrelated to systematic forces (selection, inbreeding, or migration), (*i.e.*, genetic drift). It can have a large impact on the genetic structure of populations, by reducing the amount of diversity retained within populations and by increasing the chance that deleterious recessive alleles may be ultimately expressed throughout a population. Loss of diversity could limit a population's ability to adaptively respond to future environmental changes. Additionally, an increase in the frequency of expressed deleterious recessive alleles (from increased homozygosity) could reduce individual viability and reproductive capacity;

- Demographic stochasticity refers to the variability in population growth rates arising from random seasonal differences between individuals in survival and reproduction.

This variability will occur even if all individuals have the same expected ability to survive and reproduce and if expected rates of survival and reproduction do not change from one generation to the next. Small populations are particularly vulnerable to the adverse consequences of demographic stochasticity; and

- Environmental stochasticity refers to variation in birth and death rates from one season to the next in response to weather, disease, competition, predation, or other factors external to the population.

Many populations of CCC coho salmon have declined in abundance to levels well below low-risk abundance targets, and several are, if not extirpated, far below the high-risk depensation thresholds specified by Spence *et al.* (2008). These populations are at risk from natural stochastic processes, in addition to deterministic threats, that may make recovery more difficult. As wild populations get smaller, stochastic processes may cause alterations in genetics, breeding structure, and population dynamics that may interfere with the success of recovery efforts. These impacts need to be considered when evaluating population response to recovery actions. The effects of stochastic processes associated with small population size have placed CCC coho salmon at a high risk of extinction.

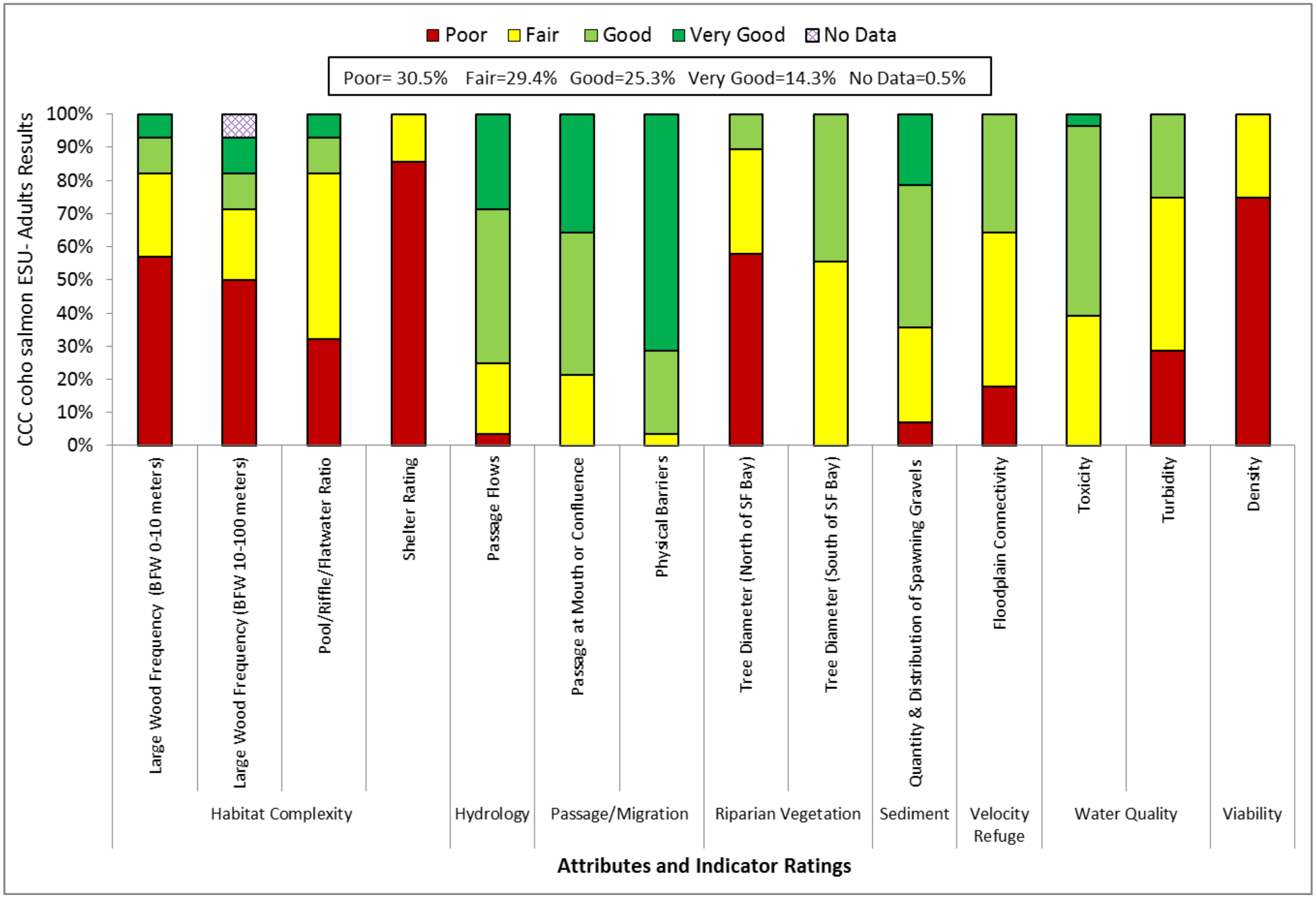

Figure 26: ESU Viability Results for Adults

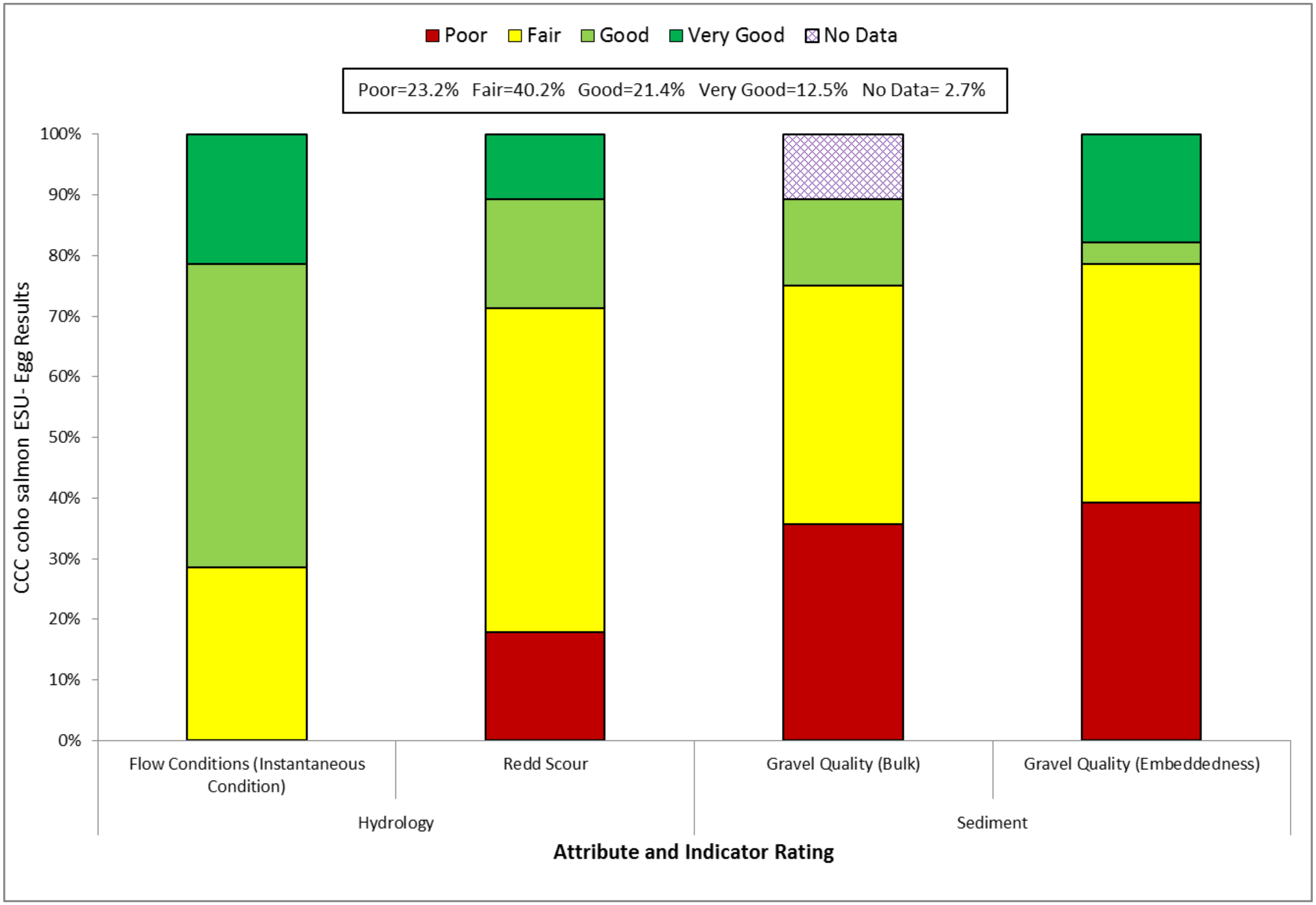

Figure 27: ESU Viability Results for Eggs

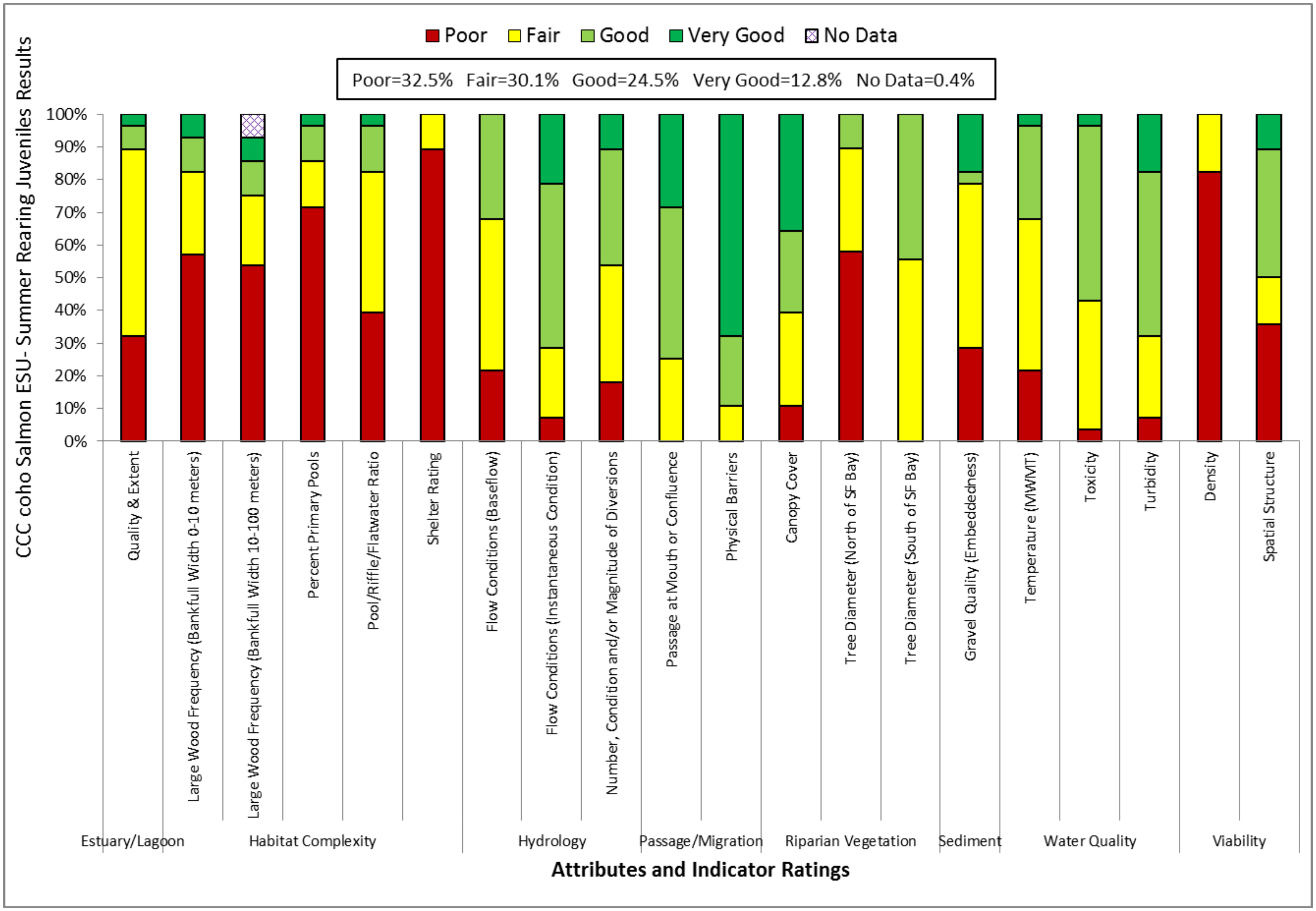

Figure 28: ESU Viability Results for Summer Rearing Juveniles

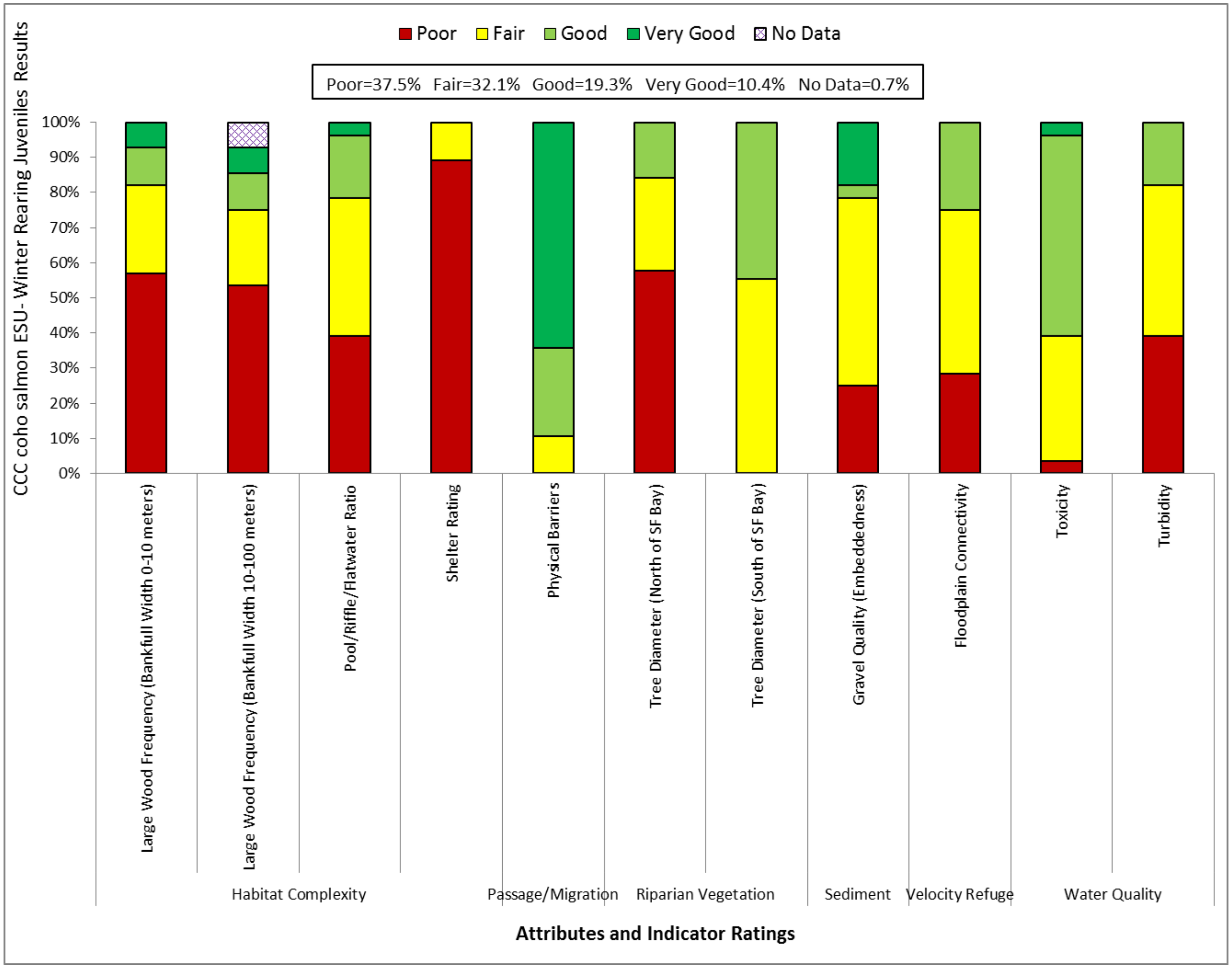

Figure 29: ESU Viability Results for Winter Rearing Juveniles

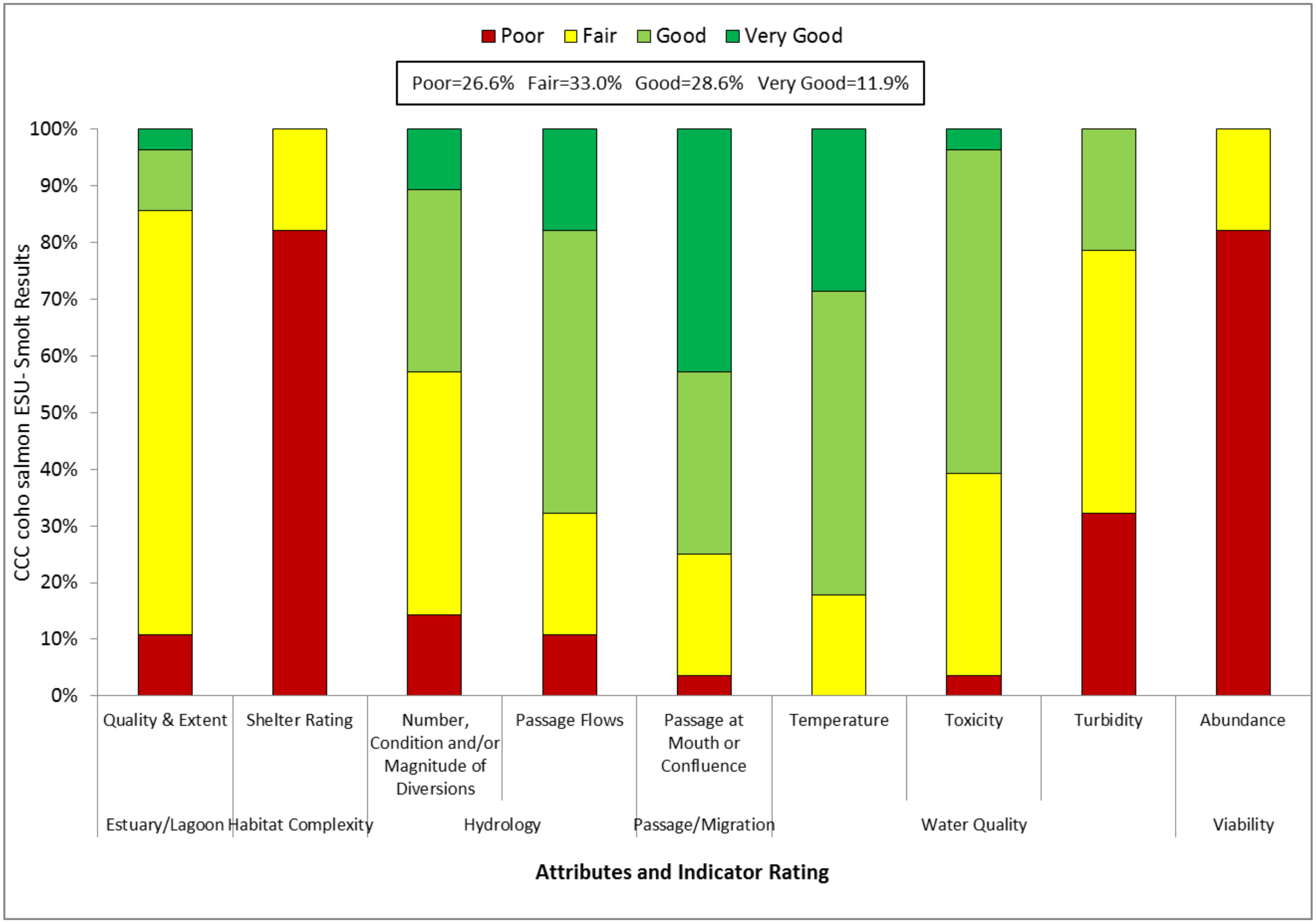

Figure 30: ESU Viability Results for Smolts

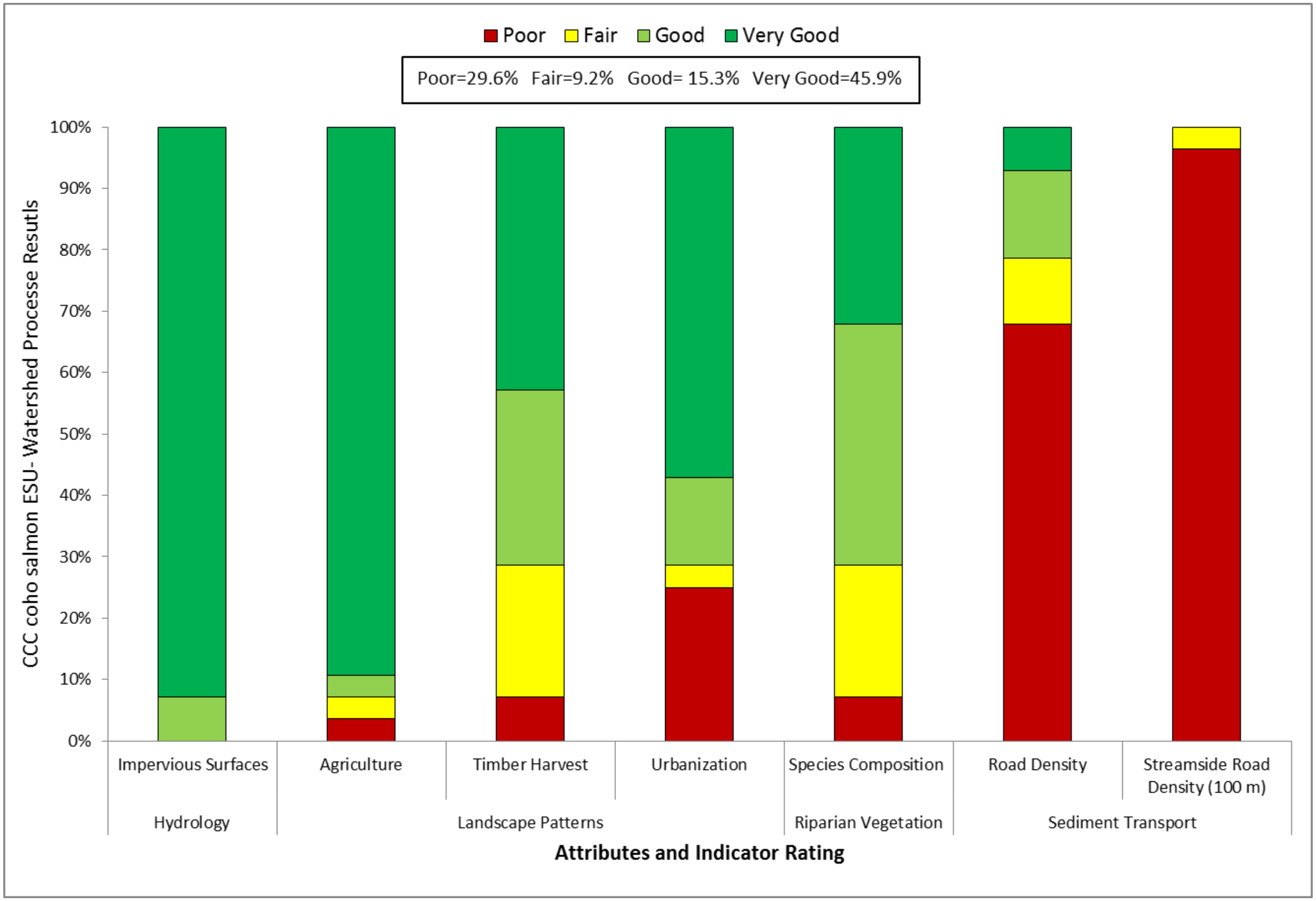

Figure 31: ESU Viability Results for Watershed Processes

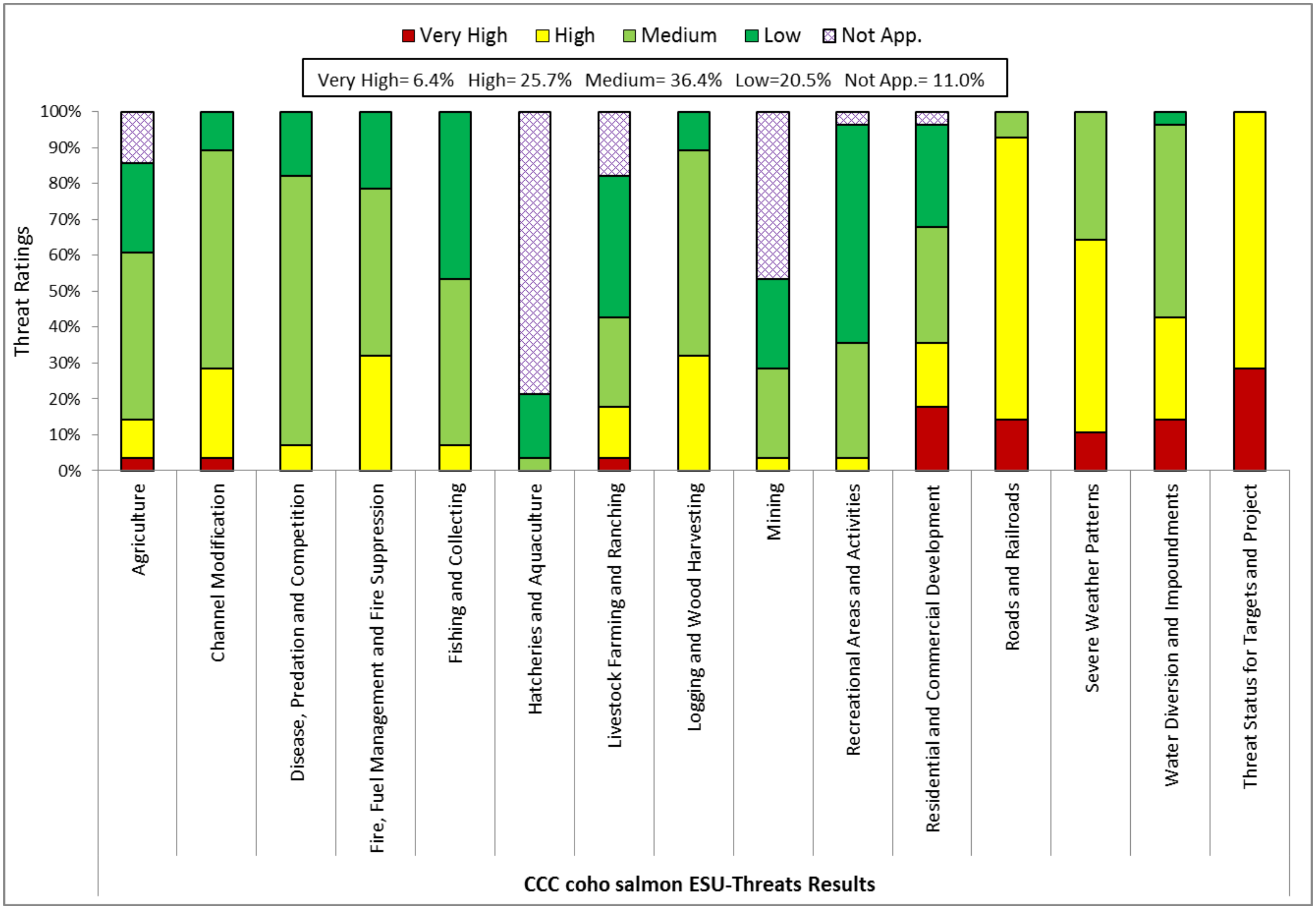

Figure 32: ESU Threat Results

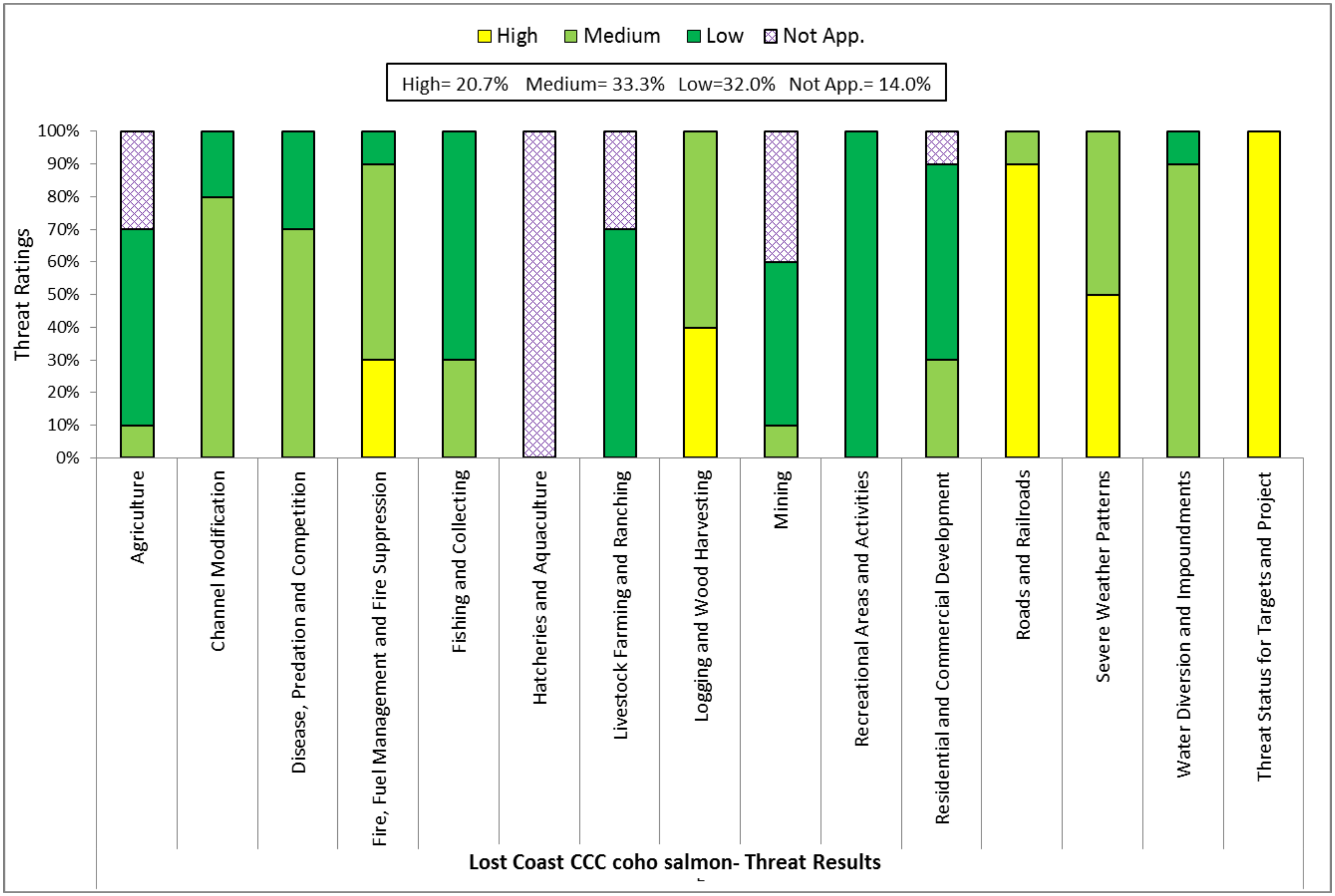

Figure 33: Lost Coast Diversity Strata Threat Results

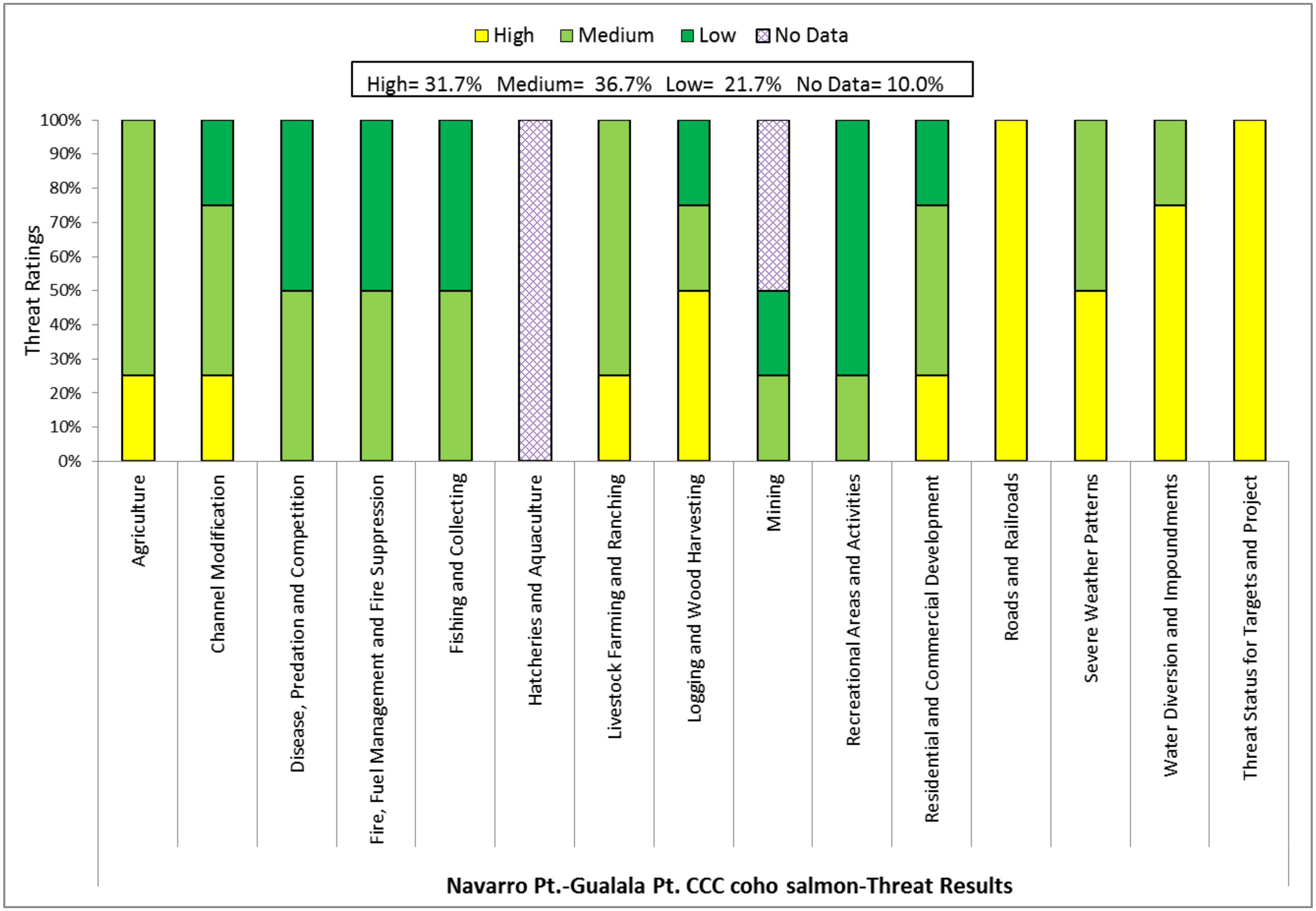

Figure 34: Navarro Pt. – Gualala Pt. Diversity Strata Threat Results

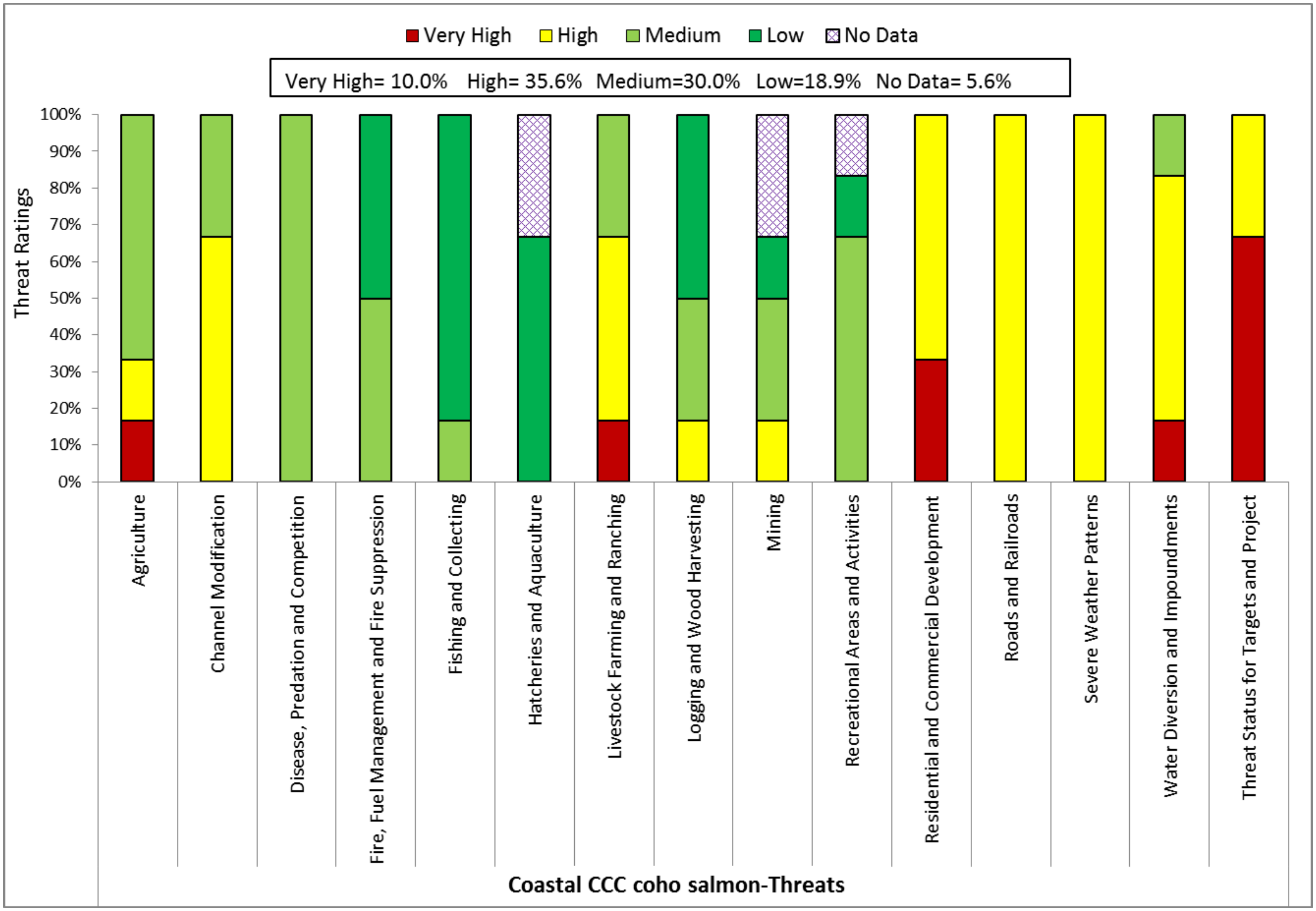

Figure 35: Coastal Diversity Strata Threat Results

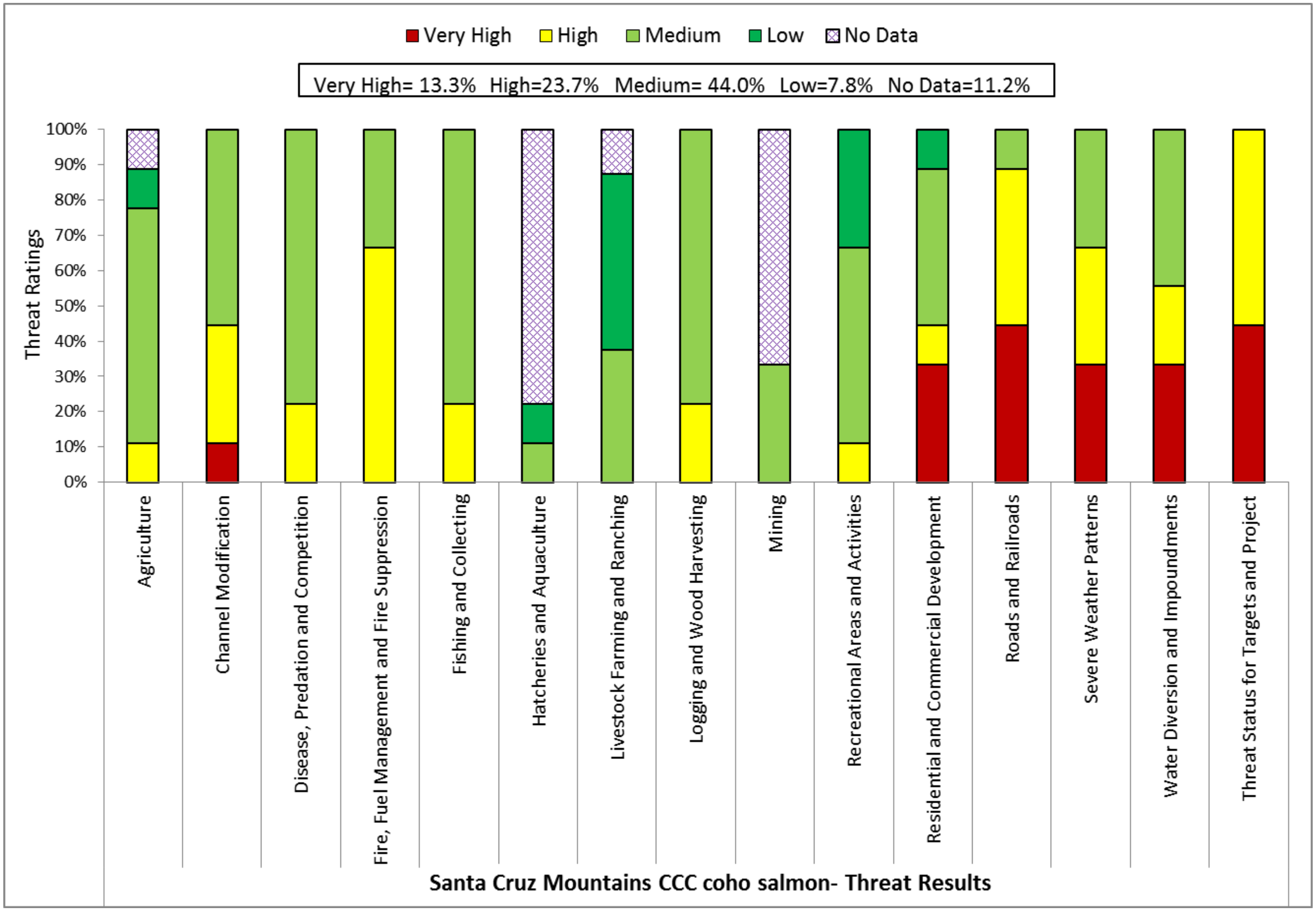

Figure 36: Santa Cruz Mountains Diversity Strata Threat Results

Table 20: Threat Summary Table

Diversity Strata	Lost Coast										Navarro Pt.- Gualala Pt.			Coastal						Santa Cruz Mountains								
CCC Coho Threat/Population	Usal	Cottaneva	Wages	Ten Mile	Pudding	Noyo	Caspar	Big	Albion	Big Salmon	Navarro	Garcia	Gualala	Russian	Salmon	Pine Gulch	Walker	Lagunitas	Redwood	San Gregorio	Pescadero	Gazos	Waddell	Scott	San Vicente	San Lorenzo	Soquel	Aptos
Agriculture	-	-	L	M	L	L	L	L	L	-	M	M	H	H	M	M	VH	M	M	H	M	L	M	M	-	M	M	M
Channel Modification	M	M	M	M	M	L	M	M	L	M	L	M	M	H	M	H	M	H	H	H	M	M	M	M	M	VH	H	H
Disease, Predation and Competition	M	M	L	M	M	M	M	L	L	M	M	L	L	M	M	M	M	M	M	M	M	M	M	M	H	H	M	M
Fire, Fuel Management and Fire Suppression	M	M	H	H	M	L	M	M	M	H	L	M	L	L	L	M	L	M	M	H	H	M	H	M	M	H	H	H
Fishing and Collecting	M	L	M	L	L	L	M	L	L	L	L	M	M	M	L	L	L	L	L	M	H	M	M	M	M	M	H	M
Hatcheries and Aquaculture	-	-	-	-	-	-	-	-	-	-	-	-	-	L	L	-	L	L	-	-	-	-	-	L	-	M	-	-
Livestock Farming and Ranching	-	-	L	L	L	L	L	L	L	-	M	H	M	H	H	M	VH	H	M	M	L	-	L	L	-	M	M	L
Logging and Wood Harvesting	M	H	M	H	H	H	M	M	M	M	M	H	H	M	H	L	L	M	L	M	M	M	M	M	M	H	H	M
Mining	L	L	L	M	L	-	-	-	-	L	-	L	M	H	-	-	M	M	L	-	-	-	-	-	M	M	M	-
Recreational Areas and Activities	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-	M	M	M	M	M	M	L	M	L	L	H	M	M
Residential and Commercial Development	-	L	M	L	L	L	M	L	M	L	M	M	L	VH	H	H	H	VH	H	VH	M	M	L	M	M	VH	VH	H
Roads and Railroads	H	H	H	H	H	M	H	H	H	H	H	H	H	H	H	H	H	H	H	VH	H	H	H	H	M	VH	VH	VH
Severe Weather Patterns	H	M	M	M	H	M	H	H	M	H	H	M	M	H	H	H	H	H	H	VH	H	M	H	M	M	VH	VH	H
Water Diversion and Impoundments	M	M	M	M	M	L	M	M	M	M	M	H	H	VH	H	H	H	H	M	VH	H	M	M	M	M	VH	VH	H
Threat Status for Targets and Project	H	H	H	H	H	H *	H	H	H	H	H	H	H	VH	VH	H	VH	VH	H	VH	H	H	H	H	H	VH	VH	VH

9.0 ACTIONS, COSTS & IMPLEMENTATION

"When I first came in – 1906 there was plenty of fish and game; Anderson Valley and its hills were a boy hunter's paradise. When we lived in Mendocino I fished in Russian Gulch many times. The fish were small but it was not trouble to catch fifty which was the limit.

The Navarro River was a fine stream for its entire length even to its smallest tributaries. Hookbills (coho) and steelhead both ran in great numbers, although it was harshly treated by the lumber industry, not as bad however as the Garcia.

Fifty years, looking back is quite a while but we well remember when the fish houses in Noyo were piled with big king salmon every day and everyone was busy. We bought them for a while for 10 cents a pound.

Throughout the years, the supply of fish and game has risen and fallen, nature took care of things. Now with smaller limits and "managing" plus civilization; fish and game as we knew it is about gone; soon we hang up the rifle and put aside the rod. We few old ones left had it; we too are also about gone."

Judge Tindall 1966-1977 Mendocino County Remembered

9.1 TURNING A PLAN INTO ACTION

The plight of salmon is tied to the story of the changing landscape. Naturalists, fishermen and biologists across Europe, the Eastern Pacific and North America have monitored salmon and chronicled their decline and extinctions. For over a century, salmon were seldom seen in England or France, that is, until recently. Actions to reduce pollution and improve stream conditions are working and salmon have returned in recent years to rivers such as the Thames in England, and Seine in France.

Fisheries biologists alone cannot shift a species trajectory from extinction to recovery; it requires a united community forming alliances and strategically implementing recovery actions to this single purpose. Salmon survival will depend on our sustainable uses of land and water. However, we also depend on salmon; perhaps more so. Salmon can support whole communities and businesses; they are our recreation, our food, a part of the environment, and our natural heritage. To achieve these goals, we can do something uniquely human, contemplate our impact on the environment and shift our actions when necessary. Improving and sustaining the human well-being, while sustainably using our natural resources (including securing a future for our salmon), are one-in-the-same challenge.

9.2 RECOVERY ACTIONS

An array of conditions have reduced the population size and historical distribution of coho salmon across the CCC ESU. Many of the causes of decline are systemic and persistent, and cross numerous environmental and political boundaries. The sources and reasons for decline are identified in the listing rule, the Recovery Strategy for California Coho Salmon (CDFG 2004), and this recovery plan. Effectively addressing these causes involves multiple challenges and opportunities including: (1) development of new and effective implementation of current laws, policies and regulations; (2) securing adequate funding for recovery implementation, (3) developing strategic partnerships; (4) assuring prioritization and implementation of restoration, threat abatement, and monitoring actions; and (5) conducting education and outreach. The status of CCC coho salmon requires addressing the highest priority issues at all appropriate levels described above (*e.g.*, policy, funding, partnerships, restoration and outreach) which in turn, dictate that a substantial and targeted investment is needed for recovery. Furthermore, action must be targeted and occur equitably across the four diversity strata; to disproportionately conduct actions in one strata over another would compromise ESU viability.

9.2.1 POPULATION PROFILES, RECOVERY ACTIONS AND COSTS

The recovery actions are organized at the ESU, diversity strata and population scales (Volume II). For each population a summary of current conditions and threats are provided along with outputs of; (1) maps providing information on Core Areas and where instream restoration should occur first, (2) CAP results tables for Viability and Threats, and (3) recovery actions and associated information (*e.g.*, priority, duration, cost, partners, *etc.*).

9.2.2 Cost of Recovery

Section 4(f) of the ESA requires that recovery plans include "estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal" (Lindley *et al.* 2007). NMFS estimates recovery of CCC coho salmon will cost approximately 1.5 billion dollars over 100 years.

9.2.3 Benefits of Recovery

Healthy salmon populations provide significant economic benefits. Entire communities, businesses, jobs and even cultures have been built around the salmon of California. Monetary investments in watershed restoration projects can promote the economic vitality in a myriad of ways. These include stimulating the economy directly through the employment of workers, contractors, and consultants, and the expenditure of wages and restoration dollars for the purchase of goods and services. Habitat restoration projects stimulate job creation at a level comparable to traditional infrastructure investments such as mass transit, roads, or water projects (Nielsen-Pincus and Moseley 2010). In addition, viable salmonid populations provide ongoing direct and indirect economic benefits as a resource for fishing, recreation, and tourist-related activities. Dollars spent on CCC coho salmon recovery will promote local, state, Federal, and tribal economies, and should be viewed as an investment that yields societal, environmental (*e.g.*, clean rivers, healthy ecosystems), and economic returns.

Based on studies that examined streams in Colorado and salmon restoration in the Columbia River Basin (Washington, Oregon and Idaho), the San Joaquin River (California), and the Elwha River (Washington), the value of salmonid recovery could be significantly larger than the fiscal or socioeconomic costs of recovery (CDFG 2004). Importantly, the general model for viewing cost versus benefits should be viewed in terms of long-term benefits derived from short-term costs. Recovery actions taken on behalf of CCC coho salmon are likely to benefit other imperiled species in the NCCC Domain, thus increasing the cost effectiveness of the actions. Habitats restored to properly functioning conditions offer enhanced resource value such as improved water quality, and future savings associated with reduced expenditures on bank stabilization or flood control actions. In addition, restoration of habitat in watersheds provides substantial benefits for human communities. These benefits include: improving and protecting the quality of important surface and ground water supplies and reducing damage from flooding resulting from floodplain development. Restoring and maintaining healthy watersheds also enhances important human uses of aquatic habitats, including outdoor recreation, ecological education, field-based research, aesthetic benefits, and the preservation of tribal and cultural heritage. Salmonid recovery is an investment and opportunity to diversify and strengthen the economy while enhancing the quality of life for present and future generations. The dollars necessary to recover salmon should be made available without delay such that the suite of benefits can begin to accrue as soon as possible.

The largest economic returns resulting from recovered salmon (and steelhead) populations are associated with sport and commercial fishing. On average 1.6 million anglers fish the Pacific region annually (Oregon, Washington, and California) and six million fishing trips were taken annually between 2004 and 2006 (NMFS 2010c). Most of these trips were trips out of California by anglers living in California. Projections of the economics and jobs impact of restored salmon and steelhead fisheries for California have been estimated from $118 million to $5 billion dollars with the creation of several thousand jobs (Southwick Associates 2009; Michael 2010). With a revived sport and commercial fishery, these substantial economic gains and the creation of jobs would be realized across California, most notably for river communities and coastal counties.

9.3 OUTREACH AND STEWARDSHIP

Successful implementation of the recovery plan will require the efforts and resources of many entities. NMFS' primary role is to promote the recovery strategy and provide technical information and expertise to other entities implementing the plan or contemplating actions that may impact the species' chances of recovery. To be successful, NMFS must commit to creating and maintaining a cooperative working environment which includes listening to stakeholders, recognizing concerns, problem-solving and developing a dialog with partners and constituents.

NMFS defines outreach as "two-way communication between the agency and the public to establish and foster mutual understanding, promote public involvement, and influence behaviors, attitudes and action with the goal of improving the foundations for stewardship" (NMFS 2012e). In addition, the agency recognizes that outreach encompasses constituent, congressional, corporate, media, non-governmental and governmental relations and includes public involvement, public information activities, and informational products.

The National Outreach Plan for NMFS was developed to help in the execution of a strategy identified in NOAA's Strategic Plan. Specifically, the strategy is to "*…develop coordinated regional and national outreach and education efforts to improve public understanding and involvement in stewardship of coastal and marine ecosystems.*" To that end and to focus our stewardship and outreach efforts in areas critical for recovery NMFS shall serve as ambassadors of the recovery plan to:

- ❑ Inform Federal, state and local governmental agencies of the provisions of the Plan, and discuss how the respective agencies' activities, planning and regulatory efforts can assist in the implementation of the plan;
- ❑ Develop outreach and educational materials to increase public awareness and understanding of the multiple societal and economic benefits that can be gained from salmon recovery;
- ❑ Develop partnerships to facilitate dissemination of information to a broad array of interested and affected parties about salmon and steelhead recovery efforts;
- ❑ Provide technical support and assistance to partners engaged in implementing recovery action's identified in the plan;
- ❑ Facilitate and participate in public forums and workshops designed to provide the public with an opportunity to directly share experiences and ideas, and learn about the methods and mechanism for implementing recovery actions;
- ❑ Advise watershed groups and other non-governmental organizations about the plan, and the role of on-going watershed conservation efforts that are directly or indirectly related to implementing recovery actions within their respective watersheds; and

- ❑ Work with all entities to support compliance of existing protective legal requirements for land and water use, natural resource protection laws, codes, regulations and ordinances for recovery of salmon.

9.4 WATERSHED RESTORATION

CCC coho salmon habitat quality currently diverges significantly from historical conditions. This divergence, along with a recent shift in marine conditions that has lowered salmon survival in the marine environment, has led to the extreme decline in CCC coho salmon abundance across the ESU. CCC coho salmon population numbers are so low that a coordinated effort across each watershed looking at limiting habitats and life stages is needed. For example, retrofitting a problem culvert can improve passage upstream, but unless upstream habitat exists that allows completion of all life stages this single action will have little effect on improving probability of survival or a net gain to the population. In this plan, restoration actions are emphasized to improve freshwater survival probability across life stages, increase carrying capacity, and ultimately improve population numbers.

This recovery plan proposes actions expected to result in substantial increases in the abundance, productivity, spatial distribution of CCC coho salmon. Recovery will require a systematic and sustained watershed by watershed approach to rehabilitate impaired habitats and degraded watershed processes and protect currently functioning processes. This will take time.

We recommend a watershed view for restoration. For example, implementing Priority 1 actions which coincide with Core Areas should be considered a high priority for immediate implementation. Difficult, expensive, controversial and unpopular projects ranking as high priorities should not be delayed in favor of uncontroversial projects with lower priority rankings. Projects must be built to appropriate specifications with appropriate funding commitments to ensure they are adequately maintained. Monitoring must reflect the goals and scale of the restoration project. Monitoring and evaluation do not usually affect the success of individual projects, but they improve the design of future projects and are an important component of a restoration strategy.

Early coordination is essential for timely approval and execution of restoration projects, particularly when many stakeholders are involved or for potentially contentious restoration projects (*i.e.*, large wood supplementation in urban areas). Considerable support is usually available to individuals and organizations willing to undertake restoration projects, even difficult or controversial projects. Local, State, and Federal agencies can provide technical and financial assistance for use in design, implementation, and monitoring. Numerous non-governmental organizations (NGOs) provide similar services and also offer project management, liability coverage, and environmental compliance coordination and support. These services are typically provided at no or low cost to the landowner or project proponent. Private consulting firms also provide technical assistance, project management, environmental compliance, monitoring, as well as engineering and other services necessary for successful project implementation.

The availability of in-kind services and grant funding depends on:

- Location: most programs serve a limited geographic area;
- Land ownership and use: some programs serve only private, public, agricultural or urban lands;
- Importance or priority of the project;
- The identification of a project in a stream inventory, watershed plan, or within a local/state/Federal management plan;
- Ecosystem type: some programs focus on streams, wetlands, estuaries or uplands; and
- Cost share, commitment or participation by private landowners or a local sponsor.

Permitting and project management can be considerable obstacles to landowners, individuals, and small organizations wishing to carry out restoration projects. Permit waivers or programmatic permits can reduce costs and streamline the regulatory process by providing umbrellas for local, state or Federal consultation. However, the availability of permit waivers or programmatic permits depends on project type, location, and funding source. Additional work by public agencies is essential to facilitate projects and remove unnecessary or redundant regulatory obstacles. Permit streamlining is an absolute necessity to provide incentives to landowners and managers wanting to implement restoration and enhancement projects, particularly for projects that do not receive funding assistance through the Pacific Coastal Salmon Recovery Fund (PCSRF) and Fisheries Restoration Grant (FRGP) programs administered by CDFG.

9.4.1 Opportunities and Challenges for Restoration Projects

Many project types use well-understood and documented techniques that have been consistently demonstrated to benefit salmonids and their habitats. Examples include: barrier removal; installing properly sized instream woody materials; and establishing and protecting riparian buffers.

High priority projects designed to lead to long-term restoration of functional stream processes, but which are not as well understood, will require more research, monitoring, and long-term evaluation to ensure success. Examples include:

- Reconnecting incised stream channels with their floodplains;
- Reconnecting wetlands with streams and re-creating off-channel habitat, especially in developed areas where channel stability is questionable or flooding is a concern; and
- Providing safe passage for adult and juvenile salmonids through channelized streams with inadequate flows, as often found in urbanized and agricultural areas.

To be more widely implemented, some high priority projects need regulatory solutions to reduce costs, time, and risk to private landowners and public entities. Examples include:

- Off-channel water storage during winter, with the goal of reducing dependency on summer water diversions (without increasing total annual water withdrawals, or impairing aquifer recharge and channel forming flows);

- Addition of secured and engineered large wood projects upstream of culverts, bridges, and urban infrastructure; and
- Actions to improve degraded lagoons and estuaries where urban or agricultural encroachment is a concern or conflicts with other listed/protected species occur.

Because many of the actions outlined in this recovery plan will be carried out on a voluntary basis, public support is important. NMFS believes collaboration by public and private entities is essential to the survival and long-term recovery of CCC coho salmon, particularly in light of the significant amount of privately owned land within the ESU. Conducting outreach and assisting interested and affected parties to become partners in restoration and recovery is critical to success, particularly for complicated and controversial projects. NMFS and other regulatory agencies must improve their outreach efforts to bring critical landowners and organizations into recovery planning efforts. Important stakeholders in restoration projects include:

- Landowners who wish to carry out restoration activities in critical stream reaches on their own property, either alone or in cooperation with agencies and NGOs. Project management and grant funding is available to help landowners carry out projects at no or reduced cost to themselves;
- Resource Conservation Districts and NGOs, who often serve as a bridge between government agencies and private landowners to assist in navigating the permitting process, assuage fears regarding regulations, and to encourage landowners to implement recovery actions;
- Members of the public who do not own land suitable for restoration yet contribute by volunteering in restoration, monitoring, or planning efforts; and
- Clubs, social organizations, and other organized groups assisting in restoration by providing volunteer labor for projects, conducting outreach within their communities, and coordinating and contacting regulatory agencies.

9.4.2 RESTORATION PARTNERS

The following is a partial list of organizations that can assist in restoration design and implementation. Additional resources are available in most areas from watershed groups, alliances, or other NGOs. Occasional funding may be available from agencies in the form of mitigation or disbursements from environmental fines. Congress established the Pacific Coast Salmon Recovery Fund to contribute to restoration and conservation of Pacific salmon and steelhead populations and their habitats (Chapter 11).

The NOAA Restoration Center

The NOAA Restoration Center provides funding and technical assistance for restoration projects benefiting NOAA trust resources, including salmon and steelhead. Since 1996, the Restoration Center has funded over 300 projects benefiting California salmon and steelhead. The Restoration Center works with NMFS staff and others to develop and implement projects addressing limiting factors to salmonid recovery; partners with grassroots organizations to encourage hands-on citizen participation, and delivers technical support to help ensure project success.

NMFS PRD will work with the NOAA Restoration Center to coordinate recovery efforts for CCC coho salmon. The PRD and the NOAA Restoration Center, in combination with other funding programs, will facilitate funding, permit streamlining, technical assistance, and outreach to the restoration community. The NOAA Restoration Center will bring its funding and restoration partners into the recovery process, while also networking to find new recovery partners and determining who is best suited to address specific recovery actions. The NOAA Restoration Center's goal to fund community-based habitat restoration and provide technical restoration assistance directly compliments the goals of the recovery plan.

NMFS Science Centers

The NMFS PRD will coordinate with the NMFS' Southwest Fisheries Science Centers to identify and address research needs for recovery.

State & Local Governmental Agencies

The State of California has a final CCC Coho Salmon Recovery Strategy (CDFG 2004) and NMFS participates on the State Coho Recovery Team. NMFS will continue coordination with the CDFG and other state agencies on planning, research, monitoring, and carrying out projects and programs. These agencies include: CDFG; CalFire; California Coastal Conservancy; University of California Cooperative Extension; California Conservation Corps; Resource Conservation Districts; the State Water Resources Control Board; local flood control districts; water agencies; and city and county governments.

Non-Governmental Organizations

Numerous non-profits, volunteer groups, watershed groups, professional organizations, and quasi-governmental organizations are engaged in ecological restoration. Where their focus intersects with NMFS recovery goals, NMFS will coordinate with those NGOs to facilitate planning, research, monitoring, and project implementation. Some NGOs include Trout Unlimited, The Nature Conservancy, Mid-Peninsula Open Space District, CalTrout, and many others.

9.4.3 Restoration Assistance

Federal programs that provide information, funding and/or technical assistance include:

- NMFS, Southwest Region swr.nmfs.noaa.gov
- NOAA Restoration Center nmfs.noaa.gov/habitat/restoration/
- USFWS Partners for Fish and Wildlife fws.gov/partners/ and Coastal Programs fws.gov/coastal/CoastalProgram
- US EPA epa.gov
- NRCS nrcs.usda.gov
- USACE http://www.usace.army.mil/missions/environment.html

State programs that provide information, funding and/or technical assistance include:

- California Department of Fish and Game www.dfg.ca.gov/fish/

- California Coastal Conservancy www.scc.ca.gov
- State Water Resources Control Board www.swrcb.ca.gov
- California Conservation Corps www.ccc.ca.gov/
- University of California Cooperative Extension http://ucanr.org/index.cfm

Local and regional programs that provide information, funding and/or technical assistance include:

- CalFish www.calfish.org
- Coastal Watershed Planning and Assessment Program (CWPAP) http://coastalwatersheds.ca.gov/Home/tabid/54/Default.aspx
- Resource Conservation Districts www.carcd.org
    - Santa Cruz Resource Conservation District http://www.rcdsantacruz.org/
    - San Mateo County Resource Conservation District http://www.sanmateorcd.org/
    - Gold Ridge Resource Conservation District http://www.goldridgercd.org/
    - Sotoyome Resource Conservation District http://sotoyomercd.org/
    - Marin Resource Conservation District http://www.marinrcd.org/
    - Southern Sonoma Resource Conservation District http://www.sscrcd.org/
    - Mendocino County Resource Conservation District http://www.mcrcd.org/
    - And others
- Various city and county governments
- Five Counties Salmonid Conservation Program www.5counties.org
- Fishnet 4C http://fishnet.marin.org
- The Fish Passage Forum: http://www.calfish.org/ProgramsandProjects/FishPassageForum/tabid/127/Default.aspx
- Klamath Resource Information System (KRIS) http://www.krisweb.com/
- Salmonid Restoration Federation http://www.calsalmon.org/
- Trout Unlimited http://www.tu.org/
- California Trout http://www.caltrout.org/

- The Nature Conservancy http://www.nature.org/

10.0 RECOVERY GOALS AND DELISTING CRITERIA

"In the end, we will conserve only what we love. We will love only what we understand. We will understand only what we are taught."

Baba Dioum, Senegal

10.1 KEY FACTS & ASSUMPTIONS

CCC coho salmon populations have been in steep decline for more than four or five decades and their risk of extinction is great. Many CCC coho salmon streams are in poor condition and these conditions limit survival across multiple life stages. While some conservation efforts are improving conditions, the rate of ongoing habitat degradation is likely greater than the rate of habitat restoration and recovery. In addition, tracking recovery will continue to be a challenge without a systematic and consistently funded monitoring program (*i.e.*, CMP) at spatial scales sufficient to evaluate status and progress.

CCC coho salmon populations are near extinction

Habitats are limiting coho survival across life stages

Rate of habitat degradation is greater than rate of restoration

Monitoring is critical to track habitats and populations

NMFS expects it may take as long to recover salmon as it did for them to decline to their current levels. Recovering a species is a challenging and slow process (Adams *et al.* 2011) as habitat conditions and population responses are typically not observable for many years once recovery or restoration actions are implemented. NMFS estimates that, in general, habitats will respond to restoration actions (depending on physical processes) between one to five years. Some recovery actions, such as installing large woody material where salmonids are present, may have more immediate results. Other recovery actions, such as growing large diameter trees in the riparian corridor for long term natural wood recruitment or increasing shade for stream temperature improvements, will take considerably longer. Populations are expected to respond positively to incremental improvements in habitat conditions even though increased abundances may not be readily observable for three to four coho salmon generations or longer. Therefore, NMFS anticipates at least 40 years or more will be necessary to change the trajectory of the species from extinction to recovery after recovery actions are fully implemented, and nearly 100 years to realize delisting.

10.1.1 PRIMARY FOCUS & PRIORITIES

The current strategy for CCC coho salmon recovery is based on the following:

- ✓ Designation of 28 focus populations and development of minimum spawner density targets across four Diversity Strata;
- ✓ Designation of 11 supplemental populations;
- ✓ Recommendations to improve habitat conditions and watershed processes;
- ✓ Recommendations to abate threats that led to the decline of habitats and populations and those to abate and/or prevent future threats; and
- ✓ Employ all ESA protections (including retention of current critical habitat designation) for the conservation of all populations, including populations not designated in the recovery scenario.

The focus of this strategy includes:

Preserve genetic integrity and provide for population growth overtime:

- ❑ Protect all extant populations and their habitats to prevent extinction;
- ❑ Conserve existing genetic diversity and provide opportunities for interchange of genetic material between and within metapopulations;
- ❑ Evaluate conservation hatchery (broodstock) programs; and
- ❑ Maintain current distribution of salmonids and restore their distribution to previously occupied watersheds and subwatersheds identified as focus populations.

Conserve habitat diversity:

- ❑ Maintain and restore freshwater and estuarine environments and the natural physical interactions of land, water, wood and sediment to support the extent, diversity and quality of habitats required for spawning, rearing, food productivity, migration, growth, predator avoidance, *etc.* that allow coho to thrive and be self-sustaining in the wild.

Adapt and modify restoration and conservation techniques to ensure they account for impacts from existing and future development and environmental change:

- ❑ Human population growth and development, and expected shifts in climate and marine conditions will demand novel and innovative approaches to planning and conservation (*e.g.*, retreats from floodplains, building climate change scenarios into restoration, *etc.*).

Shift paradigms; the status quo is insufficient to recover CCC coho salmon:

- ❑ Ongoing declines of CCC coho salmon populations are an indication the status quo, for most protective measures (in regard to land and water management) and restoration actions, are insufficient to prevent extinction.

Monitor fish and habitats and adapt to new information:

- ❑ Without long term monitoring, progress in developing and refining appropriate actions will be slow and potentially misguided. Develop, fund and maintain an adaptive program of monitoring, research, and evaluation to advance our understanding of the complex array of factors associated with salmonid survival and recovery.

10.2 RECOVERY GOALS AND OBJECTIVES

The vision of this plan is to ensure freshwater habitats, improved through restoration and threat abatement, are supporting self-sustaining and well-distributed wild CCC coho salmon populations that are providing significant ecological, cultural, social and economic benefits to the people of California.

The overarching goal of the recovery plan is to realize downlisting and delisting of the CCC coho salmon ESU. Additional goals of this recovery plan include:

1. Preventing CCC coho salmon extinction in the wild and reversing population declines;
2. Immediately protecting CCC coho salmon occupied habitats and those in good condition;
3. Restoring impaired habitats; and
4. Facilitating improvements for listing factors and protective efforts.

Objectives of the recovery plan and associated timing are:

Prevent extinction and reverse population declines over the next 24 years by:

- ✓ Ensuring adequate funding for current captive broodstock facilities in the Russian River (Sonoma County), and Scott Creek (Santa Cruz County);
- ✓ Increasing capacity of broodstock programs and/or developing additional facilities; and
- ✓ Immediately implement focused instream restoration actions where coho salmon persist to increases the probability of salmonid survival within, and across, all freshwater life stages.

Protect habitats in good conditions and supporting populations of coho salmon:

- ✓ Pursue conservation banking, easements or other mechanisms to protect, in perpetuity, high quality coho salmon habitats; and
- ✓ Secure outplanting sites with high quality habitats on private lands; and
- ✓ Immediately conduct restoration in key locations identified for broodstock outplanting.

Restore currently impaired habitats:

- ✓ Prioritize restoration projects that can have immediate benefits to coho salmon freshwater survival probability; and
- ✓ Consider restoration and threat abatement coordination at the life stage and population scales (*e.g.*, coordinate restoration in a watershed focusing on ensuring successful life stage transition to and from the marine environment).

Facilitate improvements of listing factors and protective efforts:

- ✓ Organize a comprehensive recovery implementation strategy for the ESU and each diversity stratum to reduce identified threats and improve protective efforts;
- ✓ Support and fund the CMP to ensure a long term salmonid monitoring program;
- ✓ Conduct a comprehensive education and outreach program to inform the public on the priorities for salmon recovery and how they can contribute to recovery; and
- ✓ Plan for severe weather including climate change.

10.3 CRITERIA: FRAMEWORK FOR DELISTING

Evaluating a species potential for downlisting or delisting requires both an explicit analysis of population or demographic parameters (biological recovery criteria) and the physical or biological conditions that affect the species' continued existence, categorized under the ESA section 4(a)(1) listing factors (listing factor criteria). Together these make up the "objective, measurable, criteria" and the "delisting criteria" required under section 4(f)(1)(B)[16] of the ESA.

Downlisting and delisting criteria are organized by the Section 4(a)(1) listing factors below (Table 21, Table 22) and include criteria for populations, habitat conditions, threats and implementation of recovery actions. During status reviews or consideration of a downlisting or delisting decision, NMFS will determine whether the populations have achieved viability and if section 4(a)(1) listing factors have been adequately addressed, *i.e.* whether the underlying causes of decline have been addressed and mitigated and are not likely to re-emerge.

[16] See NMFS 2010 and Fund for Animals v. Babbitt 903 F. Supp. 96 (D.D.C. 1995, Appendix B).

Table 21: Criteria for downlisting of the CCC coho salmon ESU

	Biological Downlisting Criteria		Section 4(a)(1) Listing Factor Downlisting Criteria
ALL 28 Focus Populations	**For Each Diversity Stratum:**		**50% of ESU & Diversity Strata Actions Implemented**
	Downlisting spawner target achieved		**For Each Population:** **CAP Attributes:** *Hydrology & Water Quality Indicators:* Rank **FAIR, GOOD or VERY GOOD** across all life stages *Remaining CAP Habitat* Condition Attributes:* Rank **FAIR** or better across populations **CAP Overall Threat Ranks:** Threats status for targets rank **Medium** or better **Actions Assigned to Listing Factors:** All Priority 1 actions implemented; 50% of Priority 2 actions for all Listing Factors are implemented or plans are in place for implementation; - AND - During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances). **For Each Diversity Stratum:** Two Independent populations and 50% of the remaining populations meet biological and Listing Factor criteria. *excludes landscape and size attributes

Table 22: Delisting Criteria for the CCC coho salmon ESU

<table>
<tr><th></th><th>Biological Delisting Criteria</th><th></th><th>Section 4(a)(1) Listing Factor
Delisting Criteria</th></tr>
<tr><td></td><td></td><td></td><td>All ESU & Diversity Strata Actions Implemented</td></tr>
<tr><td>All Independent Populations</td><td>Effective population size per generation > 500 OR Total population size per generation > 2500
- AND -
No population decline apparent or probable
- AND -
Catastrophic decline not apparent
- AND -
Delisting spawner target achieved
See Table 23
- AND -
No evidence of adverse genetic, demographic, or ecological effects of hatchery fish on wild populations</td><td></td><td rowspan="4"><u>For Each Population</u>
<u>CAP Attributes:</u>
Hydrology & Water Quality Indicators:
Rank GOOD or VERY GOOD across all life stages
Remaining CAP Habitat* Condition Attributes:
Rank GOOD or better across populations

<u>CAP Overall Threat Ranks :</u>
Threats status rank LOW
(Medium for Listing Factor E)

<u>Actions Assigned to Listing Factors:</u>
All Priority 1 actions implemented or deemed no longer necessary
All Priority 2 actions implemented or deemed no longer necessary
75% of Priority 3 actions implemented or deemed no longer necessary
- AND -
During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

For Each Diversity Stratum:
All Independent populations, 75% of the remaining focus populations and all supplemental populations must meet criteria.
*excludes landscape and size attributes</td></tr>
<tr><td>All Dependent Populations</td><td>Delisting spawner target achieved
See Table 23</td><td></td></tr>
<tr><td>Supplemental Populations</td><td rowspan="2">Confirm presence of juveniles or adults for at least one year class over 12 years
AND
50% of Attribute Actions for each listing factor have been implemented or determined not necessary

See Figure 37</td><td rowspan="2"></td></tr>
<tr><td></td></tr>
</table>

10.4 BIOLOGICAL CRITERIA

Downlisting Criterion:

DW-BC1	All diversity strata (and 28 focus populations) meet minimum spawner density. See Table 23.

Delisting Criteria:

DL-BC2	Effective population size per generation > 500 OR Total population size per generation > 2500 for all independent populations.
DL-BC3	No population decline apparent or probable for all independent populations.
DL-BC4	Catastrophic decline not apparent for all independent populations.
DL-BC5	Minimum spawner density achieved for all 28 populations.
DL-BC6	No evidence of adverse genetic, demographic, or ecological effects of hatchery fish on wild populations.
DL-BC7	Populations selected to support connectivity within and between Diversity Strata (*i.e.*, supplemental populations) confirm presence of juveniles or adults for at least one year class over 12 years. See Figure 37.

10.5 LISTING FACTOR CRITERIA

10.5.1 LISTING FACTOR A: PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF HABITAT OR RANGE

Downlisting Criteria

Downlisting Criterion (DW-A1): For each population the CAP Attributes (Hydrology and Water Quality) rank fair, good or very good across all life stages – AND – remaining CAP attributes rank fair or better across populations.

- AND -

Downlisting Criterion (DW-A2): For each population the Overall CAP Threat Ranks rank medium or low. This applies to all threats except Disease Predation and Competition, Fishing and Collecting, Hatcheries and Aquaculture and Severe Weather Patterns (downlisting criteria for these threats are outlined in other listing factor categories).

- AND -

Downlisting Criterion (DW-A3): For each population all Priority 1 actions implemented, 50% of Priority 2 actions under Listing Factor A are either implemented, plans are in place for implementation or the actions are deemed no longer necessary.

- AND -

Downlisting Criterion (DW-A4): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

- AND -

Downlisting Criterion (DW-A5): For each Diversity Stratum: Two Independent populations and 50% of the remaining populations are meeting both spawner and listing factor criteria.

-AND-

Downlisting Criterion (DW-A6): For the ESU & Diversity Strata: 50% of the ESU and Diversity Strata Actions are implemented.

Delisting Criteria

Delisting Criterion (DL-A1): For each population the CAP Attributes are ranked good or very good across all life stages

- AND -

Delisting Criterion (DL-A2): For each population the CAP Threat Ranks are low. This applies to all threats except Disease Predation and Competition, Fishing and Collecting, Hatcheries and Aquaculture and Severe Weather Patterns (delisting criteria for these threats are outlined in other listing factor categories).

- AND -

Delisting Criterion (DL-A3): All Priority 1 actions implemented, all Priority 2 actions implemented, and 75% of Priority 3 actions implemented for this listing factor or deemed no longer necessary.

- AND -

Delisting Criterion (DL-A4): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

- AND -

Delisting Criterion (DL-A5): For each Diversity Stratum: All Independent populations, 75% of the remaining focus populations and all supplemental populations meet population and listing factor criteria.

-AND-

Delisting Criterion (DL-A6): For the ESU & Diversity Strata: All ESU and Diversity Strata Actions are implemented.

10.5.2 LISTING FACTOR B: OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL PURPOSES

Downlisting Criteria

Downlisting Criterion (DW-B1): For each population the CAP Attribute, Viability, is ranked fair, good or very good across all life stages.

- AND -

Downlisting Criterion (DW-B2): For each population the CAP Threat Rank for Fishing and Collecting is ranked medium or low.

- AND -

Downlisting Criterion (DW-B3): For each population all Priority 1 actions implemented, 50% of Priority 2 actions under Listing Factor B are either implemented, plans are in place for implementation or the actions are deemed no longer necessary..

- AND –

Downlisting Criterion (DW-B4): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

-AND-

Downlisting Criterion (DL-B4): <u>For the ESU & Diversity Strata</u>: 50% of the ESU and Diversity Strata Actions are implemented.

<u>Delisting Criteria</u>

Delisting Criterion (DL-B1): For each population the CAP Attribute (Viability) is ranked good or very good across all life stages.

- AND -

Delisting Criterion (DL-B2): For each population the CAP Threat Rank for Fishing and Collecting is ranked low.

- AND -

Delisting Criterion (DL-B3): All Priority 1 actions implemented, all Priority 2 actions implemented, and 75% of Priority 3 actions implemented for this listing factor or deemed no longer necessary.

- AND -

Delisting Criterion (DL-B4): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

-AND-

Delisting Criterion (DL-B5): For the ESU & Diversity Strata: All ESU and Diversity Strata Actions are implemented.

10.5.3 LISTING FACTOR C: DISEASE OR PREDATION

Downlisting Criteria

Downlisting Criterion (DW-C1): For each population the CAP Attribute, Viability, is ranked fair, good or very good across all life stages.

- AND -

Downlisting Criterion (DW-C2): For each population the CAP Threat Rank for Disease and Predation is ranked medium or low.

- AND -

Downlisting Criterion (DW-C3): For each population all Priority 1 actions implemented, 50% of Priority 2 actions under Listing Factor C are either implemented, plans are in place for implementation or the actions are deemed no longer necessary.

- AND –

Downlisting Criterion (DW-C4): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

-AND-

Downlisting Criterion (DW-C5): For the ESU & Diversity Strata: 50% of the ESU and Diversity Strata Actions are implemented.

Delisting Criteria

Delisting Criterion (DL-B1): For each population the CAP Attribute Viability is found good or better across all life stages.

- AND -

Delisting Criterion (DL-B2): For each population the CAP Threat Rank for Disease and Predation is ranked medium or better.

- AND -

Delisting Criterion (DL-B3): All Priority 1 actions implemented, all Priority 2 actions implemented, and 75% of Priority 3 actions implemented for this listing factor or deemed no longer necessary.

- AND -

Delisting Criterion (DL-B4): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

-AND-

Delisting Criterion (DL-B5): For the ESU & Diversity Strata: All ESU and Diversity Strata Actions are implemented.

10.5.4 LISTING FACTOR D: THE INADEQUACY OF EXISTING REGULATORY MECHANISMS

Downlisting Criteria

Downlisting Criterion (DW-D1): For each population all Priority 1 actions implemented, 50% of Priority 2 actions under Listing Factor D are either implemented, plans are in place for implementation or the actions are deemed no longer necessary.

– AND –

Downlisting Criterion (DW-D2): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

-AND-

Downlisting Criterion (DW-D3): For the ESU & Diversity Strata: 50% of the ESU and Diversity Strata Actions are implemented.

Delisting Criteria

Delisting Criterion (DL-D1): All Priority 1 actions implemented, all Priority 2 actions implemented, and 75% of Priority 3 actions implemented for this listing factor or deemed no longer necessary.

– AND –

Delisting Criterion (DL-D2): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

-AND-

Delisting Criterion (DL-D3): For the ESU & Diversity Strata: All ESU and Diversity Strata Actions are implemented.

10.5.5 LISTING FACTOR E: OTHER NATURAL AND MANMADE FACTORS AFFECTING THE SPECIES' CONTINUED EXISTENCE

Downlisting Criteria

Downlisting Criterion (DW-E1): For each population the CAP Attribute, Viability, is ranked good or very good across all life stages.

– AND –

Downlisting Criterion (DW-E2): For each population the CAP Threat Rank for Severe Weather Patterns, Hatcheries and Aquaculture are ranked medium or better.

– AND –

Downlisting Criterion (DW-E3): For each population all Priority 1 actions implemented, 50% of Priority 2 actions under Listing Factor E are either implemented, plans are in place for implementation or the actions are deemed no longer necessary.

– AND –

Downlisting Criterion (DW-E4): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

-AND-

Downlisting Criterion (DL-E5): For the ESU & Diversity Strata: 50% of the ESU and Diversity Strata Actions are implemented.

Delisting Criteria

Delisting Criterion (DL-E1): For all populations the CAP Attribute, Viability, is ranked good or very good across all life stages.

– AND –

Delisting Criterion (DL-E2): For each population the CAP Threat Rank for Severe Weather Patterns and Hatcheries and Aquaculture are ranked medium.

– AND –

Delisting Criterion (DL-E3): All Priority 1 actions implemented, all Priority 2 actions implemented, and 75% of Priority 3 actions implemented for this listing factor or deemed no longer necessary.

– AND –

Delisting Criterion (DL-E4): During status reviews, assess progress of recovery action implementation by identifying (1) actions completed, (2) new actions needed or (3) actions no longer relevant (due to unforeseen or changed circumstances).

-AND-

Delisting Criterion (DL-E5): For the ESU & Diversity Strata: All ESU and Diversity Strata Actions are implemented.

Table 23: Population Level Downlisting & Delisting Spawner Density Criteria

Diversity Strata	**Population**	**Status**	**Miles of Potential Habitat**	**Downlisting Spawner Target**	**Delisting Spawner Target**
Lost Coast	Usal Creek	D	10.9	180	360
	Cottaneva Creek	D	14.5	235	469
	Wages Creek	D	9.8	170	340
	Ten Mile River	I	118.5	1850	3700
	Pudding Creek	D	26.4	492	983
	Noyo River	I	127.0	2000	4000
	Caspar Creek	D	12.5	218	435
	Big River	I	214.8	2750	5500
	Albion River	I	59.2	1150	2300
	Big Salmon Creek	D	16.8	289	578
				Stratum Total: 7,750	**Stratum Total: 15,500**
Navarro-Gualala Point					
	Navarro River	I	220.4	2850	5700
	Garcia River	I	103.7	1850	3700
	Gualala River	I	266.6	3100	6200
				Stratum Total: 7,800	**Stratum Total: 15,600**
Coastal	**Russian River**	I	457.5	5050	10,100
	Salmon Creek	D	35.9	684	1367
	Pine Gulch	D	11.4	197	394
	Walker Creek	I	67.6	1300	2600
	Lagunitas Creek	I	64.5	1300	2600
	Redwood Creek	D	6.8	136	272
				Stratum Total: 7,650	**Stratum Total: 15,300**
Santa Cruz Mountains					
	San Gregorio	D	36.7	682	1363
	Pescadero Creek	I	54.9	1150	2300
	Gazos Creek	I	7.1	140	279
	Waddell Creek	D	8.0	157	313
	Scott Creek	D	13.9	255	510
	San Vicente Creek	D	3.4	53	105
	San Lorenzo River	I	117.5	1900	3800
	Soquel Creek	D	31.9	561	1122
	Aptos Creek	D	26.0	466	932
				Stratum Total: 5,462	**Stratum Total: 10,924**

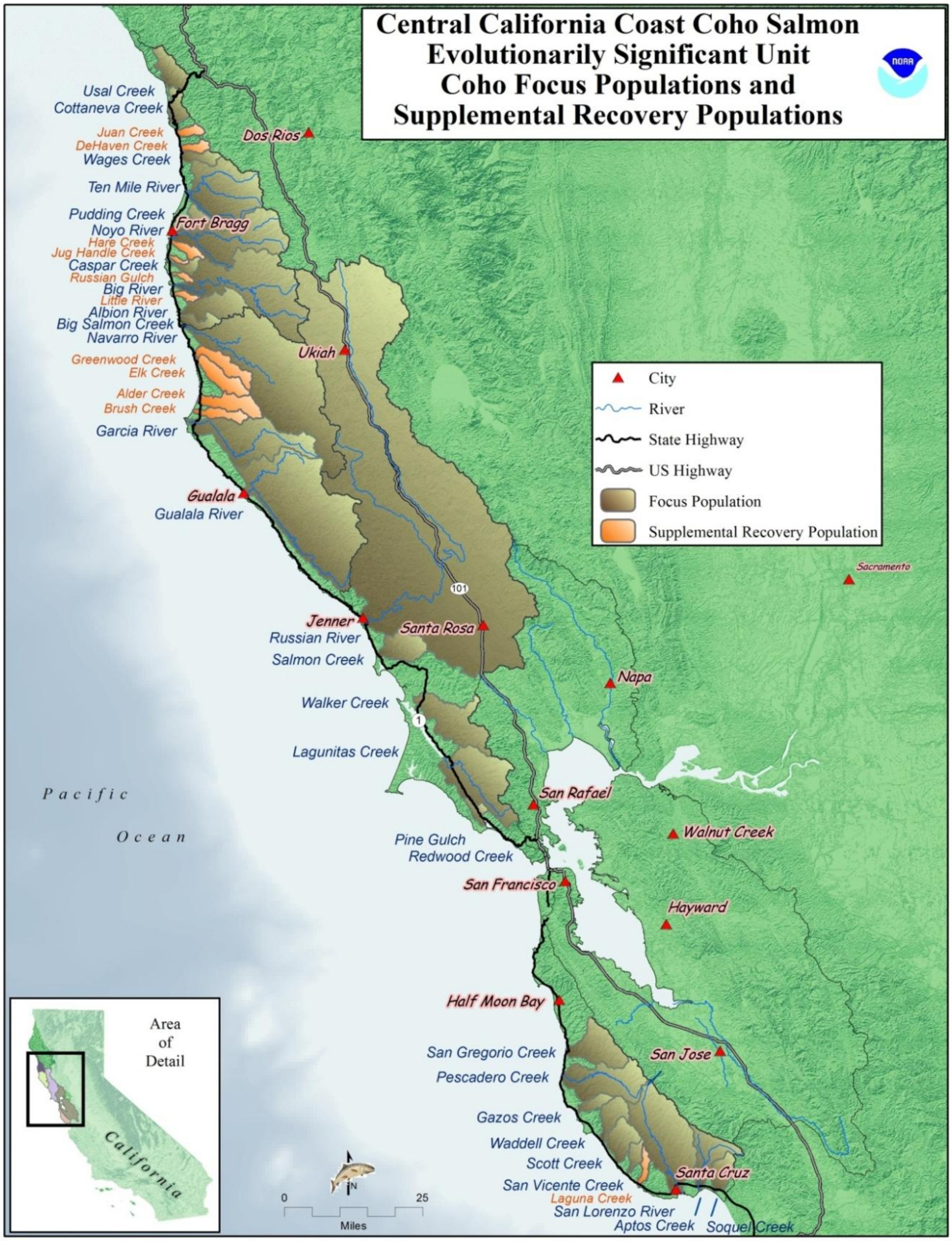

Figure 37: Coho Focus and Supplemental Populations for Recovery

11.0 MONITORING AND ADAPTIVE MANAGEMENT

"It is imperative that California, which is well behind other states in the Pacific Northwest, begin conducting monitoring at spatial scales relevant to recovery planning if we are to have any hope of accurately evaluating status and progress towards recovery."

Spence et al. 2008

11.1 INTRODUCTION

Population-level estimates of abundance and distribution are disparate and currently insufficient; yet, these data are critical to informing recovery criteria. The State of California and NMFS are engaged in the development of the California Coastal Salmonid Monitoring Plan (CMP, Shaffer in prep), which is being designed to collect data that can inform recovery criteria. Adams *et al.* (GRTS, Larsen *et al.* 2008) provides the scientific and statistical foundation for monitoring coastal salmonid populations. While the focus has been on developing a protocol for population monitoring, habitat monitoring is equally important and both are anticipated for inclusion into the monitoring plan.

Population level monitoring is a high priority as these data can be aggregated up to the biological organizational levels of a Diversity Stratum and ESU. The methods recommended and discussed in greater detail below include spatially balanced spawner/redd surveys, population-level life cycle monitoring (LCM) stations to calibrate redd survey estimates and distinguish ocean versus freshwater survival, and juvenile spatial distribution and abundance assessments. All monitoring will be conducted at the population level, which will then be used to inform diversity stratum and ESU-level abundance and viability over time.

Photo Courtesy 46: Adult CCC coho salmon males collected at the Pudding Creek dam Life Cycle Monitoring station, Fort Bragg, California. Pudding Creek maintains one of the stronger remaining runs of coho salmon in the ESU. The lifecycle station is a cooperative effort between Campbell Timberland Management (CTM) and CDFG (partially funded by the Fisheries Restoration Grants Program) and is an important source of information regarding adult coho salmon returns. *David Wright – CTM*

The ultimate goals of the CMP are to finalize a robust and adaptive monitoring program that includes all coho salmon, Chinook salmon and steelhead populations in California. The plan will:

- Provide regional (ESU-level) and population abundance estimates for both status and trend of salmonid populations that will inform recovery criteria;
- Estimate productivity trends from status abundance data;
- Provide estimates of regional and population level spatial structure of coastal salmonids;
- Consider the diversity of life history and ecological differences in the three species of interest;
- Create permanent LCM stations that will allow deeper evaluation of both freshwater and marine fish-habitat relationships and provide long-term index monitoring; and
- Assess freshwater and estuarine habitat conditions.

Currently, only a few organizations (*e.g.* CDFG Region 1 and NMFS's Southwest Science Center) have implemented population-level monitoring programs for adult returns outlined in the CMP; these efforts are critical first steps to build experience and data that can ultimately be used to inform trend data and progress towards recovery abundance targets. Several other organizations (*e.g.* CDFG Region 3, Sonoma County Water Agency, Marin Municipal Water District and National Park Service) have also begun some level of adult return and juvenile distribution monitoring in other coastal populations.

NMFS and CDFG acknowledge the CMP must be built overtime as methods are tested and refined and funding secured. While the fundamental principles of the CMP (*i.e.,* the need for random, spatially balanced sampling and the need for robust population estimates) will remain more or less the same, the specific metrics and procedures used to evaluate recovery will evolve and likely change over time as we learn from early implementation of the plan. To track coho salmon abundance trends; however, we must expand upon our existing monitoring efforts immediately throughout the ESU using the existing CMP framework. NMFS and CDFG have outlined goals for the CMP at one year, five years and 10 years. In 2013, a definitive framework should be in place with continued and expanded monitoring. In 2016, all diversity strata for CCC coho salmon should have LCM stations established and initial trend data being collected. By 2022, adult escapement trends and associated marine survival estimates should provide data that informs recovery goals. Data collected over a broad geographic scope will assist with the refinement of methods, experimentation of other methods, and highlight additional data needs. During 5-Year Status Reviews (required by NMFS) the progress of recovery action implementation will be assessed, specifically those actions aimed at improving habitat conditions and reducing threats to determine their effectiveness. Critically needed, however, are partners and a long term source of funding.

This chapter describes specific research, monitoring and adaptive management strategies necessary to inform the downlisting and delisting criteria provided in Chapter 10.

> "Given the imperiled nature of coho…in California it is critical that coastwide instream monitoring programs be implemented and maintained to allow warning of impending problems to these valuable resources. Without the existing minimal monitoring effort, since coho are not commercially fished or regulated, there would be little notice of their decline."
>
> *MacFarlane et al. 2008*

11.2 MONITORING ABUNDANCE, PRODUCTIVITY, STRUCTURE & DIVERSITY

The most important metric for population viability criteria is spawner abundance measured over time (*e.g.* multiple generations). Spawner abundance will be assessed using a two-staged sampling approach (Adams *et al.* 2011). First-stage sampling is comprised of extensive regional and spatially balanced spawning surveys to estimate escapement in stream reaches selected under a GRTS (Gallagher *et al.* 2010) design. The GRTS is a rotating panel design at a survey level of ten percent of available habitat each year. Second-stage sampling consists of producing escapement estimates in intensively monitored census streams (*e.g.* LCM stations) through either total counts of returning adults or capture-recapture studies. The second-stage estimates are considered to represent true adult escapement and resulting spawner to redd ratios are used to calibrate first-stage estimates of regional adult abundance (Crawford and Rumsey 2011).

The LCM stations consist of either fixed counting facilities, or portable, seasonally installed facilities where fish are either trapped and marked or directed through a viewing chamber and counted. Another method, especially in smaller coastal systems, is the use of DIDSON acoustic cameras. This method for counting adult escapement provides reliable estimates, particularly where species identification is not an issue (Adams *et al.* 2011). For watersheds with more than one salmonid species, the date of capture and size of fish can be used to help differentiate between species. LCM stations are used where smolt and summer rearing abundance can be monitored to estimate freshwater and marine survival and to evaluate life histories that can inform regional status and trend information (the stage one data). These populations (watersheds) are also intended to be focal points for evaluating restoration and encouraging further research. NMFS monitoring guidelines (2011) also recommend using a robust unbiased spawner abundance sampling scheme that has known precision and accuracy. Similar to Adams *et al.* (2011), they offer probabilistic sampling of all accessible spawning areas using unbiased randomized sites with rotating panels (*i.e.* GRTS) as an option that will produce statistically valid estimates of spawner abundance with known certainty. The monitoring needs and recommendations presented below rely heavily on the CMP discussions ongoing between NMFS and CDFG along with guidelines presented in Crawford and Rumsey (2008).

The recommendations outlined below address the VSP criteria of abundance, productivity, spatial distribution, and diversity, at the ESU, diversity strata and population levels. The VSP criteria are described in detail in Chapter 6. Table 24 shows the recommended monitoring that NMFS will use to inform the progress toward meeting specific recovery criteria (Chapter 10) for biological viability.

Table 24: ESU, Diversity Strata and population level biological viability recovery criteria and recommended monitoring.

	ESU	Diversity Strata	Population
Recovery Criteria	-All Diversity Strata criteria are met.	Each Diversity Strata meets Representation, Redundancy and Connectivity criteria	***Independent Populations*** - Effective population size per generation > 500 OR Total population size per generation > 2,500 AND - NO population decline apparent or probable AND - Catastrophic decline not apparent -AND- - Delisting spawner target achieved. -AND- - No evidence of adverse genetic, demographic, or ecological effects of hatchery fish on wild populations. ***Dependent Populations*** Delisting spawner target achieved ***Supplemental Populations*** Confirm presence for at least one year class over a 12 year period -AND- 50% of the recovery actions have been implemented or deemed not necessary
Recovery Criteria – monitoring	Sum of Diversity Strata-level monitoring.	Sum of Population-level monitoring.	- GRTS-based spawner/redd surveys for abundance and productivity (10 percent of habitat assessed annually); - Life Cycle Monitoring stations for abundance, productivity, and diversity; - GRTS-based summer/fall juvenile surveys for spatial distribution, and diversity (10 percent of habitat assessed annually) *Minimum of 12 years (~ 4 generations) of monitoring.

11.2.1 Adult Spawner Abundance

Recommendations for monitoring adult spawner abundance include:

1. Implementation of an unbiased two-stage GRTS based ESU-wide monitoring program (*i.e.*, the CMP) for adult CCC coho salmon that has known precision and accuracy. The monitoring plan should:

a. Provide yearly adult spawner abundance estimates for the ESU, diversity stratum, and where possible, each focus population;

b. Establish a minimum of one (preferably two) LCM stations within each diversity stratum to estimate spawner: redd ratios. These stations will be used for calibrating regional redd counts, and smolt/adult ratios for marine/freshwater survival estimations. Maintain current LCM stations in Mendocino and Santa Cruz counties and seek to incorporate other existing monitoring programs into the master sample GRTS design;

c. Overtime as populations approach recovery strive, to have ESU-level adult spawner data with a coefficient of variation (CV) on average of 15 percent or less (Crawford and Rumsey 2011);

d. Regional spawner data should have the statistical power to detect a change of ± 30 percent with 80 percent certainty within 10 years;

e. Strive to have abundance estimates at the LCM stations with a CV on average of 15 percent or less;

f. Estimate migration rates between basins and tributaries of larger basins to validate assumptions that underlie population delineations and to assess potential role of inter-basin exchange on extinction probabilities;

g. Evaluate hatchery impacts and hatchery-to-wild ratios (this should cover a range of issues from genetic changes to brood stock mining) and implement hatchery recommendations per Spence *et al.* (Johnson *et al.* 2007); and

h. All monitoring should utilize the protocols published in the American Fisheries Society Salmonid Field Protocols Handbook (1998).

11.2.2 PRODUCTIVITY

Recommendations for monitoring population productivity include:

1. Productivity is calculated as the trend in abundance over time. Develop a 12 year[17] or greater data set of accurate spawner information to estimate geometric mean recruits per spawner and evaluate population trends.
2. Using the LCM stations, conduct annual smolt abundance/trend monitoring.
    a. Juvenile monitoring should strive to have data with a CV on average of 15 percent or less;
    b. Power analysis for each monitored juvenile population should be conducted to determine the statistical power of the data to detect significant changes in abundance; and
    c. Estimate apparent marine and fresh water survival (couple adult data with the smolt abundance estimates).

11.2.3 Spatial Distribution

Recommendations for monitoring spatial distribution include:

1. Evaluate changes in adult spawning distribution (stage one sampling) using probabilistic sampling. Annually, compare spawner distribution with the total habitat available to determine the percent occupancy across the species range. Environmental conditions, such as precipitation and stream flow, will influence the distribution of spawners by expanding (wet years) or shrinking (dry years) the amount of habitat available to returning adults. Therefore, analysis of annual spawner distribution must consider both biological (small population) and environmental (weather patterns) factors.
2. Develop and implement a spatially balanced GRTS-based summer and fall sampling strategy for juvenile coho salmon. Crawford and Rumsey (2011) recommend assessments should detect a change of ≥ 15 percent with 80 percent certainty; however, further research is needed to establish which indicator will be most appropriate for evaluating trends.

[17] Approximately four generations.

3. As discussed above, the relationship between environmental factors (particularly stream flow and water temperature) can influence the likelihood of coho salmon presence and spatial distribution. Where necessary and applicable, implement stream flow and water temperature monitoring in order to assess their implications on occupancy during the adult (stream flow) and juvenile (stream flow and water temperature) life stages.

11.2.4 DIVERSITY

"Diversity traits are strongly adaptive for local areas and populations, and these traits allow salmonids to survive in the face of unique local natural and anthropogenic challenges. Higher level diversity traits have been considered in the creation of the listing and stratification units; however, population level diversity traits may be very different from one geographical or population unit to another. Therefore, local diversity traits will need to be surveyed, eventually leading to local diversity monitoring plans. Specific projects targeting both broad and focused levels and patterns of genetic diversity will be developed." Adams *et al.* (2011).

Recommendations for monitoring diversity traits include:

1. Monitor status and trends of spawn timing, sex ratio, age distribution, fecundity, *etc.* (see Adams *et al.* 2011) across populations, diversity strata, and the ESU. Spawn timing, sex ratio, and age distribution should be assessed during both stage-one (spawner surveys) and stage-two (LCM station) adult monitoring. Age distributions for juvenile coho salmon should be assessed during spatial distribution monitoring using length frequencies, analysis of scales, and by mark-recapture PIT-tagging programs.

2. Develop a genetic baseline of DNA micro satellite markers for the CCC coho salmon ESU. Tissue sample collection required for the development of this baseline can be conducted during all sampling activities associated with spawner surveys (carcasses), LCM stations (live adult and juvenile fish), and spatial distribution surveys (live juvenile fish).

3. Compare differences in population abundance, growth rates, habitat use, and juvenile migration timing with overall watershed and in-stream habitat conditions (*i.e.,* water temperature, canopy closure, shelter, and summer base stream flow).
4. Assess the influence (percentage) of hatchery fish in populations (both intended releases and from straying). The presence of adipose fin clips or tags applied at hatchery facilities will be used to identify fish origin.

11.3 COSTS FOR MONITORING BIOLOGICAL VIABILITY

Cost estimates for implementing the CMP have not been developed (Adams *et al.* 2011) although some cost estimates are available for monitoring conducted in the Pudding Creek watershed in coastal Mendocino County, California (Gallagher *et al.* 2010). These existing values were used to form preliminary costs estimates for monitoring needed to inform recovery criteria and trends for the CCC coho salmon ESU.

For streams on the Mendocino Coast, regional spawning ground surveys for CCC coho salmon cost approximately $3,000 to survey one reach a sufficient number of times each season to generate reliable redd counts (Gallagher *et al.* 2010). Sample units, or reach lengths, for both spawner distribution/abundance and juvenile spatial distribution described in Adams *et al.* (2011) range from approximately 1.6 to 3.2 km. Using the total number of kilometers of potential habitat for the focus populations listed Chapter 7 and a ten percent sample of 3 km reaches, the estimated annual cost to conduct spawning ground surveys for CCC coho salmon would be approximately $343,010 (Table 25). This does not include data storage and report preparation. For watersheds with more than one salmonid species, there will be overlap of species monitoring due to differences and overlap in run timing and life history strategies. Coho salmon adult migrations typically begin after Chinook salmon and before steelhead. Depending on the degree of overlap, total costs for monitoring CCC coho salmon spawner abundance would be reduced considerably.

In this Plan, a minimum of one LCM station was recommended for each diversity stratum. We provide cost estimates for CCC coho salmon monitoring for one and two LCM station per diversity stratum. Adult monitoring at the Pudding Creek LCM station costs about $36,000 per year (Gallagher and Wright 2008, Gallagher *et al.* 2010). This estimate does not include smolt or summer rearing abundance estimates nor does it include data analysis and reporting. Based on these values, annual cost estimates for adult monitoring at LCM stations within each diversity stratum would range from $144,000 (1 LCM station per diversity stratum) to $288,000 (2 LCM stations per diversity stratum). These costs were calculated assuming 4 diversity strata, each with a LCM station, at $36,000 per station. These annual costs could also be reduced substantially by selecting drainages with more than one listed salmonid species.

At Pudding Creek, juvenile monitoring at the LCM station costs approximately $15,000 per year to conduct (Gallagher *et al.* 2010). Based on these values, total annual cost estimates for juvenile monitoring (juvenile emigration) at the LCM stations could range between $60,000 and $120,000.

The total annual costs for LCM station (stage two) monitoring for all life stages and applicable VSP criteria could range between $204,000 and $408,000 depending on the number of stations. It is important to note these estimates are based on monitoring costs for Pudding Creek, a relatively small stream and watershed with only one landowner. Life cycle monitoring in larger populations would undoubtedly be more difficult and likely more expensive due to the larger size of the river and, in most cases, a lack of existing infrastructure and access issues.

Table 25: CCC Coho salmon spawning survey cost estimates.

Diversity Strata / populations		Potential Habitat (km)	10% Potential Habitat (km)	# of 3 km reaches sampled annually	Spawning Ground Surveys Annual Cost
Lost Coast - Navarro Point					
Usal Creek		17.6			
Cottaneva Creek		23.3			
Wages Creek		15.8			
Ten Mile River		190.7			
Pudding Creek		42.5			
Noyo River		204.4			
Caspar Creek		20.1			
Big River		345.7			
Albion River		95.2			
Big Salmon Creek		27			
	sub-total	982.3	98	33	$ 98,230
Navarro Point - Gualala Point					
Navarro River		354.7			
Garcia River		166.9			
Gualala River		429.1			
	sub-total	950.7	95	32	$ 95,070
Coastal					
Russian River		736.3			
Salmon Creek		57.8			
Pine Gulch Creek		18.3			
Walker Creek		108.8			
Lagunitas Creek		103.8			
Redwood Creek		11			
	sub-total	1036	104	35	$ 103,600
Santa Cruz Mountains					
San Gregorio Creek		59			
Pescadero Creek		88.4			
Gazos Creek		11.5			
Waddell Creek		12.8			
Scott Creek		22.3			
San Vicente Creek		5.5			
San Lorenzo River		168.3			
Soquel Creek		51.4			
Aptos Creek		41.9			
	sub-total	461.1	46	15	$ 46,110
	Total	3430.1		114	$ 343,010

Assessing juvenile spatial distribution and habitat monitoring for CCC coho salmon using the GRTS based sampling design will likely cost approximately $1,000 per reach to survey. There is a great deal more juvenile habitat than spawning habitat, perhaps twice as much, thus an annual sample of 228 reaches across the ESU might cost about $228,000 per year. This estimate does not include data analysis, storage, or report preparation. Final sample size and reach variance issues will have to be developed for juvenile spatial structure (and habitat monitoring). In watersheds with CCC coho salmon and either NC or CCC steelhead, portions of the juvenile coho distribution will be assessed simultaneously, thereby lowering costs.

Determining actual costs of this monitoring would need to include cost estimates for evaluating habitat conditions, restoration actions, implementing a recovery tracking system, and for developing and maintaining a coordinated data management system. Population or watersheds selected for LCM station placement will also affect totals costs due to watershed size differences and potential for multiple species. Finally, monitoring the recovery of CCC coho salmon will require continuing evaluation of costs, dedicated funding, and a long term commitment of resources by all involved parties.

11.4 MONITORING LISTING FACTORS

In addition to monitoring for biological criteria, recovery plans must also provide monitoring strategies to address each of the Section 4(a) (1) listing factors. These are tracked using the key habitat attributes used in the CAP analysis. In addition, NMFS developed criteria and monitoring recommendations to track reduction in threats and implementation of recovery actions. The criteria and monitoring strategies are organized in Table 26, Table 27, and Table 28). The criteria and recommended monitoring are designed to track the effectiveness of actions specifically implemented to improve current habitat conditions, reduce the impacts of current threats (and the stresses they contribute to), or highlight new and emerging threats.

11.4.1 Listing Factor A: The present or threatened destruction, modification, or curtailment of the species' habitat or range

1. Develop and implement a GRTS-based habitat status and trend monitoring program which is coordinated with the juvenile spatial structure evaluations (10 percent of available habitat each year).
   - ❑ Develop a standardized survey method for evaluating habitat attributes with a focus on population-specific attributes identified as having a *High or Very High* rating (See Chapter 8). The general methods for assessing habitat attributes should follow those outlined by Flosi *et al.* (2004) and Bleier *et al.* (2003);
   - ❑ Select one population within each diversity stratum (preferably a population with a LCM station) to conduct a basin-wide intensive habitat assessment which is repeated every 12 years;
   - ❑ Incorporate consistent habitat monitoring protocols that provide comparable watershed information and integrate ongoing habitat assessment work into a master GRTS sample design;
   - ❑ Develop and employ suitable habitat assessment criteria and models that provide high level indicators of watershed conditions; and
   - ❑ Approximately every 10 years, assess changes in land use and other non-landscape attributes using GIS. In addition to general land use patterns (*i.e.* agriculture, timber, urban), other watershed-specific attributes that should be measured include: extent of impervious surfaces, landslides, watershed road density, and overall riparian conditions.
2. NMFS is currently emphasizing to Oregon, Washington, Idaho, Alaska, Nevada and California the importance of effectiveness monitoring when using Pacific Coastal Salmon Recovery Funds (Whiteway *et al.* 2010; NMFS 2012d). Implementation of all habitat restoration activities should have both implementation and effectiveness monitoring components. Work in populations with LCM stations and other intensively monitored

watersheds should also incorporate validation monitoring.

- The design and implementation of all restoration actions should be reported and correlated with habitat limiting factors so cumulative impacts can be tracked across the ESU;
- Where restoration actions are implemented, effectiveness monitoring should be conducted at both the reach and site-specific scales following the Before After Control Impact (BACI) design. For example, the installation of large woody debris and other habitat enhancement structures should be coupled with long-term monitoring plans that attempt to determine success in terms of habitat enhancement/creation and coho salmon abundance (Isaak *et al.* 2011);
- Establish at least one Intensively Monitored Watershed (as detailed in Crawford and Rumsey 2011) within each diversity stratum (preferably a population with a LCM station). Conduct power analysis early in development to determine amount of watershed required to be treated necessary to detect 30-50 percent change in salmon response; and,
- Use salmonid response (presence, abundance, and fitness monitoring) at restoration sites to inform effectiveness over time.

3. Conduct annual assessments of the status and spatial patterns of water quality and stream flow conditions within individual populations and across diversity strata.

- EPA, state agencies, and local governments should monitor storm-water and agricultural runoff to assess status/trends of turbidity and concentrations of other identified toxins and identify their sources;
- Basin-wide water temperature monitoring using stratified arrays of automated data loggers (Hill *et al.* 2010; Moore *et al.* 2011) should be implemented wherever feasible and particularly within each watershed with an LCM station. In addition, water temperature monitoring using data loggers should be conducted in streams within populations where water temperature has been identified as Fair or Poor; and,

- Annually monitor the status and spatial pattern of stream flows particularly for populations where impaired stream flow was rated as Fair or Poor. Stream flow monitoring should include assessing for stream flow response (*i.e.,* degree of flashiness) in urban and urbanizing watersheds which could affect the potential for redd scour. Where necessary, coordinate with USGS and/or local governments, non-governmental organizations and water agencies to install additional stream flow gages to assist with stream flow tracking.

4. Conduct baseline water-quality and habitat-condition monitoring of estuaries and bar-built lagoons.

   - Lagoon water quality monitoring should be conducted for populations where the quality and extent of estuarine/lagoon habitat were rated as Fair or Poor. This should include diurnal, seasonal, and event-based (*i.e.,* a sudden change in weather, inflow, or management actions) monitoring of water temperature, dissolved oxygen, and salinity profiles, as well as an analysis of seasonal changes in freshwater inflow, lagoon depth, and finally, invertebrate abundance and community composition; and,
   - Monitor the frequency, timing, and associated impacts (see above) of sand bar breaching for all lagoons where authorized and unauthorized manual breaching occurs.

5. Monitor the implementation and effectiveness of Best Management Practices (BMPs).

   - With the assistance of other Federal, State, and local resource agencies, track voluntary and required implementation of best management practices (BMPs) within each diversity stratum, compile any post-implementation data that may indicate the effectiveness of the implemented BMPs, and where necessary, conduct effectiveness monitoring of BMPs.

11.4.2 LISTING FACTOR B: OVER-UTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC OR EDUCATIONAL PURPOSES

1. A comprehensive and coast-wide monitoring program tracking the freshwater and ocean catch/harvest of CCC coho salmon does not exist. NMFS recommends:
   - ❑ Develop Fisheries Monitoring and Evaluation Plans (FMEP) which are specifically designed to monitor and track catch and mortality of wild and hatchery salmon stemming from recreational fishing in freshwater and the marine habitats; and,
   - ❑ Encourage funding for the continued implementation, refinement, and expansion of the GSI monitoring of Pacific salmon. This will help track ocean migrations of CCC coho salmon, origin, and an index of incidental capture and mortality rates of CCC coho salmon in the commercial and recreational salmon fisheries.
2. Encourage continued scientific research on the effects of CCC coho salmon population decline on reduced marine-derived nutrients in freshwater habitats (Walters 1997; Walters 2002).
3. NMFS will continue to coordinate with CDFG on revisions to freshwater sport fishing regulations to ensure adverse effects to CCC coho salmon during migrations are minimized.
4. Annually review results from Steelhead Fishing Report-Restoration Cards and creel surveys conducted by CDFG to assess incidental capture and mortality rates of CCC coho salmon in the recreational freshwater fishery for steelhead.
5. Continue to annually monitor and assess intentional and incidental capture and mortality rates of CCC coho salmon resulting from permitted research to ensure established take limits are adequate to protect these species. Utilize the results of this research to help assess population status.

11.4.3 Listing Factor C: Disease or predation

1. Annually estimate the infection and mortality rates of juvenile CCC coho salmon from pathogens in populations where diseases are identified as a *High* or *Very High* threat.
2. Annually monitor the status and trends of non-native predators in populations where predation is identified as a *High* or *Very High* threat. Coordinate with CDFG to develop and implement plans to track their impacts on CCC coho salmon populations and, where necessary, reduce populations of these predatory, non-native species.
3. During the 5-year status reviews, re-assess the status of non-native predatory species in populations where predation was not originally identified as a *High* or *Very High* threat to ensure expansion of non-native predatory species or the introduction of new predatory species has not occurred.
4. Compile information on predation rates of juvenile coho salmon by birds (freshwater and marine) and pinnepeds, and encourage additional research and monitoring to further evaluate their impacts and potential strategies for predation reduction.

11.4.4 Listing Factor D: The inadequacy of existing regulatory mechanisms

1. Develop a recovery plan tracking system to track the implementation status of specific recovery actions identified in this recovery plan.
2. Develop and implement a randomized sampling program to test whether permits issued under local and State regulatory actions designed to protect riparian and instream habitat are in compliance and that the provisions have been enforced.

11.4.5 Listing Factor E: Other natural or manmade factors affecting the species' continued existence

1. Monitoring the effects of climate change (severe weather patterns) on CCC coho salmon and their habitat should include expanding stream flow and water temperature monitoring and their effects on freshwater and estuarine survival. See monitoring

associated with the CAP attributes (*e.g.* water temperature, stream flow, and estuarine conditions).

2. Tracking ocean conditions (*i.e.* productivity) will rely on monitoring data obtained from the LCM stations (ocean survival), ocean net surveys conducted by the SWFSC as part of their California Current Salmon Ocean Survey (early ocean survival/condition), hatchery returns, and compiling and assessing existing and ongoing oceanic data collected by satellites and buoy arrays along the Pacific Coast.
3. Where applicable, conduct annual assessments of the percent of hatchery origin spawners (pHOS). To achieve broad sense recovery, pHOS should not exceed 10 percent in any population. Provide monitoring and documentation which demonstrates HGMPs have been developed and implemented.
4. Encourage Conservation Hatchery programs for CCC coho salmon that follow criteria outlined in Spence *et al.* 2008.

Table 26: Recovery criteria and recommended monitoring for listing factors and CAP attributes.

	ESU	Diversity Strata	Population
Section 4(a)(1) Listing Factor Recovery Criteria	All Diversity Strata within ESU meet Diversity Strata and Population-level criteria.	75% (or at least 2) of the populations in each stratum must meet Population-level criteria.	***<u>CAP Attributes</u>:*** *Hydrology & Water Quality Indicators:* Rank **GOOD** or better across life stages *Remaining CAP Habitat* Condition Attributes:* Rank **GOOD** or better across populations * excludes landscape and size attributes
Section 4(a)(1) Listing Factor Monitoring	- Sum of Diversity Strata and Population-level habitat monitoring	- Establish at least one Intensively Monitored Watershed habitat condition assessment (preferably a population with a LCM station): Repeat every 12 years. - Sum of Population-level habitat and water-quality monitoring results - Update CAP workbooks;	- Develop and implement a spatially balanced habitat monitoring protocol as part of the CMP to track condition of key CAP habitat attributes; - Assess effectiveness of population-specific Recovery Actions and other restoration projects (using BACI approach). - Conduct water quality and stream flow monitoring - Install and monitor water temperature using data logger arrays in populations with LCM stations. - Develop and implement a comprehensive estuary/lagoon monitoring program that tracks the condition, management scenarios and highlights elements of concern. - Track implementation and effectiveness of BMPs aimed at improving water quality and substrate. - Assess general land-use patterns using GIS every 10 years. Some non-landscape attributes (*e.g.*, extent of impervious surfaces) will be tracked using GIS, others will rely on Habitat Monitoring at the Population level.

Table 27: Recovery criteria and recommended monitoring for CAP threats.

	ESU	Diversity Strata	Population
CAP Threat Condition – criteria	All Diversity Strata within the ESU meet Diversity Strata and Population-level criteria.	75% (or at least 2) of the populations in each stratum must meet Population-level criteria.	***<u>CAP Overall Threat Ranks</u>:*** - Threats Status rank **Medium** or better
CAP Threat Condition – monitoring	- In order to assess the impacts of climate change on salmonid freshwater and estuarine habitats expand assessments of water temperature and stream flow. - Track ocean conditions (productivity) using Life Cycle Monitoring stations, ocean net surveys (SWFSC California Current Salmon Ocean Survey), hatchery returns, and water quality data collected along the Pacific Coast; - Continue/expand the GSI monitoring program for Pacific salmon captured in the ocean fisheries; - Annually assess capture/ mortality rates of CCC coho resulting from permitted research	- Annually assess Diversity Strata-wide impacts of sport fishing pressure through the development of FMEPs, Steelhead Fishing Report-Restoration Card and annual creel survey results. - Assess predation impacts on coho salmon by birds and pinnepeds and develop methods to reduce mortality where applicable. * CMP results should track Diversity Strata level trends	- See also CAP Habitat Attribute Monitoring above. - Address/modify freshwater sport fishing regulation changes. - Monitor infection and mortality rates of juvenile coho salmon from pathogens where diseases are identified as High or Very High; - Assess the abundance and distribution of non-native predators and develop strategies for their reduction. - Assess the distribution and impact of non-predatory species that affect salmonid habitats. - Annually assess pHOS in watersheds with hatchery influences and develop HGMPs where necessary.

Table 28: Recovery criteria and recommended monitoring for recovery action implementation.

	ESU	Diversity Strata	Population
Recovery Action Implementation - Criteria	All Diversity Strata within the ESU meet Diversity Strata and Population-level criteria.	75% (or at least 2) of the populations in each stratum must meet Population-level criteria.	***Actions Assigned to Listing Factors:*** - All Priority 1 Actions Implemented - All Priority 2 Actions Implemented - All Priority 3 Actions implemented for Listing Factor A or plans are in place for implementation - AND - - During status reviews assess existing, and identify new actions, and those no longer relevant due to unforeseen or changed circumstances.
Recovery Action Implementation – Monitoring			- Develop a central tracking database for tracking the implementation of all recovery actions at the Population, Diversity Stratum and Recovery Domain/ESU levels.

11.4.6 Data Management and Reporting

All monitoring data must be coordinated in a regional set of databases or distributed data system using a common set of metadata and data dictionaries that fits within an integrated master sample program. This should be housed and maintained in one place by one entity. All entities collecting habitat and fish monitoring data should coordinate their sampling and data collection to fit into a master sample program for the CCC coho salmon ESU.

11.4.7 Post-Delisting Monitoring

The ESA requires NMFS to monitor delisted species for at least five years post-delisting to ensure that removal of the protections of the ESA does not result in a return to threatened or endangered status. Section 4(g), added to the ESA in the 1988 reauthorization, requires NMFS to implement a system in cooperation with the states to monitor for not less than five years the status of all species that have recovered and been removed from the lists of threatened and endangered {50 CFR 17.11, 17.12, 224.101, and 227.4}. The development of a post-delisting monitoring plan is, thus, a recommended recovery criterion to ensure a plan is in place at the time of delisting.

11.5 ADAPTIVE MANAGEMENT: LEARNING FROM RECOVERY

Adaptive management is a systematic process that uses scientific methods for monitoring, testing, and adjusting resource management policies, practices, and decisions, based on specifically defined and measurable objectives and goals (Panel on Adaptive Management for Resource Stewardship 2011). Adaptive management is predicated on the recognition that natural resource systems are variable, and that knowledge of natural resource systems is often uncertain. Further, the response of natural resources systems to restoration and management actions is complex and frequently difficult to predict with precision. The CCC Coho Salmon Recovery Plan provides both overall goals in the form of viability criteria and a suite of ESU-wide watershed specific recovery actions. However, there is a need to adapt resource management policies, practices and research decisions to changing circumstances, or a better understanding of natural resource systems and their responses.

The success of an adaptive management program depends on coordination among stakeholders and scientists who develop a shared vision for an undefined future together. The development of a guiding image for recovery will aid in an adaptive management program, align interests, and enhance cooperation in a complex recovery plan process. Focusing on fundamental values can help open up possible alternative solutions.

Adaptive management can be applied at two basic levels: the overall goals of the recovery effort, or the individual recovery or management actions undertaken in pursuit of overall goals. The monitoring sections above are intended to address the first application. The following discussion is focused on the second application of the concept of adaptive management.

11.5.1 ELEMENTS OF AN ADAPTIVE MANAGEMENT PROGRAM

While adaptive management must be tailored to action-, site- and impact-specific issues; any effective adaptive management programs will contain three basic components: 1) adaptive experimentation where scientists and others with appropriate expertise learn about ecosystem functions response to recovery or management actions; 2) social learning (through public education and outreach) where stakeholders share in the knowledge gained about ecosystem functions, and 3) institutional structures and processes of governance where people respond by making shared decisions regarding how the ecosystem will be managed and how the natural services it provides will be allocated. Six specific elements associated with adaptive management have been identified (Thomas *et al.* 2001) and explained below.

1st Element: Recovery Action Strategy and Goals are Regularly Revisited and Revised

The recovery strategy and actions should be regularly reviewed in an iterative process to maintain focus and allow revision when appropriate. Progress and implementation of the recovery actions at the ESU, diversity stratum and population scales, should provide a starting point for the adjustment of recovery strategy and goals. The mandatory five-year review process can serve as a means of conveying any needed modification to the overall recovery goals, as well as individual recovery actions.

2nd Element: Model(s) of the System Being Managed

Four types of models are identified in the use of adaptive management program to test hypotheses regarding the effectiveness of recovery actions (Ruckelshaus *et al.* 2008; Levin *et al.* 2009; Tallis *et al.* 2010). These include:

- **Conceptual model:** Synthesis of current scientific understanding, field observation and professional judgment concerning the species, or ecological system;
- **Diagrammatic model:** Explicitly indicates interrelationships between structural components, environmental attributes and ecological processes;
- **Mathematical model:** Quantifies relationships by applying coefficients of change, formulae of correlation/causation; and,
- **Computational Model:** Aids in exploring or solving the mathematical relationships by analyzing the formulae on computers.

River systems are generally too complex and unique for controlled, replicated experiments per traditional scientific models. However, conceptual models based on generally recognized scientific principles can provide a useful framework for refining recovery actions and testing their effectiveness. Diagrammatic models, such as the one used to characterize the parallel and serial linkages in the coho salmon life cycle, can also be used in lieu of formal mathematical models to test hypotheses regarding the effectiveness of recovery actions. Mathematical and computational models themselves have their limitations in the context of an adaptive management program: they are difficult to explain and they require specific assumptions that may be difficult to justify.

3rd Element: A Range of Management Choices

Even when a recovery goal is agreed upon, uncertainties about the ability of possible recovery or management actions to achieve that goal are common. The range of possible recovery or management choices should be considered at the outset. This evaluation addresses the likelihood of achieving management objectives and the extent to which each alternative will generate new information or foreclose future choices. A range of recovery actions and management measures should be considered, either through a planning process or the environmental review process prior to permitting the individual recovery action.

4th Element: Monitoring and Evaluation of Outcomes

Gathering and evaluating data allow testing of alternative hypotheses and are central to improving knowledge of ecological and other systems. Monitoring should focus on significant and measurable indicators of progress toward meeting recovery objectives. Monitoring programs and results should be designed to improve understanding of environmental systems and models, to evaluate the outcomes of recovery actions, and to provide a basis for improved decision making. It is critical that "thresholds" for interpreting the monitoring results are identified during the planning of a monitoring program. This element of adaptive management will require a design based upon scientific knowledge and principles. Practical questions include which indicators to monitor, and when and where to monitor. Guidance on a number of these issues is provided in the sections above regarding research and monitoring.

5th Element: A Mechanism for Incorporating Learning into Future Decisions

This element recognizes the need for protocols and guidance to disseminate information to a variety of stake-holders and a decision process for adjusting various management measures in view of the monitoring findings. Periodic evaluations of a proposed recovery action, monitoring data and other related information, and decision-making should be an iterative process where management objectives are regularly revisited and revised accordingly. Public outreach, including web-based programs, should be actively pursued. Additionally, the mandatory five-year review process can serve as the process for conveying needed modification to the Recovery Plan as well as individual recovery actions.

6th Element: A Collaborative Structure for Stakeholder Participation and Learning

This element includes dissemination of information to a variety of stakeholders as well as a proactive program for soliciting decision-related inputs. This general framework can be a shared vision to develop and pursue restoration that supports a network of viable coho salmon populations while providing sustainable ecological services to the human communities of northern and central coasts of California (NMFS 2010a). Such a vision also provides opportunities for the protection and restoration of other native freshwater and riparian species which form an integral part of the ecosystems upon which coho salmon depend.

12.0 IMPLEMENTATION

Recovery plans and the threats assessment process will provide the guide map for priority setting. Once recovery plans are in place, species protection and conservation will be facilitated by ongoing use of the plans to guide policy and decision-making. The Division will refocus its priorities from a project-by-project approach to one that focuses efforts on those activities or areas that have biologically significant beneficial or adverse impacts on species and ecosystem recovery."

NMFS SWR PRD Strategic Plan for 2007-2011 (NMFS 2006)

12.1 INTEGRATING RECOVERY INTO NMFS ACTIONS

To promote species and ecosystem conservation, NMFS will coordinate the recovery actions outlined in this recovery plan with its decision-making, programs and policies. For example, listing reviews, critical habitat designations (ESA section 4), consultations (ESA section 7), and permit actions (ESA section 10) are all components of the ESA that NMFS will use to guide recovery efforts.

Implementation of the recovery plan will take many forms. To maximize existing resources with ongoing workload issues and existing budgets, the SWR PRD Strategic Plan champions organizational changes and shifts in workload priorities to focus efforts towards "those activities or areas that have benefits or which adversely impact listed species and ecosystem recovery" (NMFS 2006). Additionally, NMFS plans to be more strategic and proactive, rather than reactive in regards to issues impacting CCC coho salmon. The resultant shift will reduce NMFS engagement in activities or projects not significant to species and ecosystem recovery. The Interim Recovery Planning Guidance (NMFS 2010a) also outlines how NMFS will work with other agencies to fulfill the objective and goals of the plan. These documents, in addition to the ESA, will be used by NMFS to set a strategic and proactive framework for coho salmon.

To promote implementation of the recovery plan NMFS will:

- Formalize recovery planning goals on a program-wide basis to prioritize work load allocation and decision-making, including developing mechanisms to promote implementation (*e.g.*, restoration);
- Participate in the land use and water planning processes at the federal, state, and local level to ensure recommendations of the plan are reflected in a wide range of decision making processes;
- Conduct outreach and education programs aimed at stakeholders (*i.e.*, federal, tribal, state, local, non-governmental organizations, landowners and interested parties);
- Provide a consistent framework for research, monitoring, and adaptive management that directly informs recovery objectives and goals listed in the plan; and
- Develop an adaptive management strategy that includes tracking implemented recovery actions over various spatial and temporal scales within the NCCC Domain. This tracking mechanism can be used to inform annual reporting for the Government Performance and Results Act, bi-annual recovery reports to Congress and five-year status review up-dates for ESA-listed species.

12.2 FUNDING IMPLEMENATION FOR RECOVERY PLANNING

As a means of providing funding to the states, Congress established the PCSRF to contribute to restoration and conservation of Pacific salmon and steelhead populations and their habitats. The states of Washington, Oregon, California, Nevada, Idaho, and Alaska, and the Pacific Coastal and Columbia River tribes receive PCSRF appropriations from NMFS each year. The fund supplements existing state, tribal, and local programs to foster development of Federal-state-tribal-local partnerships in salmon and steelhead recovery and conservation. NMFS has established memorandums of understanding (MOUs) with Washington, Oregon, California, Idaho, and Alaska, and with three tribal commissions on behalf of 28 Indian tribes. The MOUs establish criteria and processes for funding priority PCSRF projects. In California, NMFS will continue to work with CDFG to ensure the recovery strategies and priorities are considered when funding restoration projects. NMFS will also use PCSRF reports as a mechanism to highlight where recovery actions in high priority areas have been implemented (using PCSRF funds) that otherwise might not have occurred in the absence of PCSRF funds.

12.3 ONGOING REGULATORY PRACTICES

The ESA provides NMFS with various mechanisms for protecting and recovering listed species. The ESA focuses on identifying species and ecosystems in danger of immediate or foreseeable extinction or destruction and protecting them as their condition warrants. Secondly, the ESA focuses on the prevention of further declines in a species condition through the consultation provisions of section 7(a)(2), habitat protection and enhancement provisions of sections 4 and 5, take prohibitions through sections 4(d) and 9, cooperation with the state(s) where these species are found (section 6) and needed research and enhancement as well as conservation of species taken by non-federal actions through section 10. Finally, the ESA focuses on the conservation of these species and ecosystems through the recovery planning provisions of section 4, and direction to all federal agencies to conserve species in section 7(a)(1). Clean Water Action section 404 is an important tool for regulating the discharge of material or the addition of fill material to the rivers, streams, and estuaries of California, and is one of the principle means by which consultations under section 7(a)(2) can be initiated.

12.3.1 ESA SECTION 4

Section 4 provides a mechanism to list new species as threatened or endangered, designate critical habitat, develop protective regulations for threatened species, and develop recovery plans. Critical habitat is designated in specific geographic areas where physical or biological features essential to the species are found and where special management considerations or protections may be needed to preserve and protect them. Critical habitat for CCC coho salmon was designated in 1999 (64 FR 24049), and included all areas occupied by naturally spawned populations at that time. Critical habitat was not designated with the recent range extension into Soquel and Aptos Creeks (77 FR 19552). Prior to making any determination regarding the designation of critical habitat in these watersheds, NMFS will complete an analysis to determine if habitat in Soquel and Aptos creeks should be designated and whether any modification of the existing critical habitat designation is warranted.

Unlike endangered species, which are automatically subject to the prohibitions of section 9, special regulations must be developed under section 4(d) to prohibit take of threatened species. Tailored 4(d) take prohibitions, under section 9, and regulatory limits that contribute to the recovery of the species may be developed for threatened species. However, because CCC coho salmon are listed as endangered, section 4(d) is not allowed and, thus, section 7(a)(2) and section 10 processes are the only legal mechanisms available under the ESA to address actions that may result in take.

12.3.2 5-YEAR STATUS REVIEWS

Section 4 of the ESA requires NMFS to conduct a review of listed species at least once every five years. Five year status reviews conducted by the Services consider the status of listed species and identified threats as well as progress towards recovery as outlined in the recovery plan. A determination to change the status is made on the basis of the same five listing factors that resulted in the initial listing of the species [50 C.F.R. 424.11 (d)] and recovery plan criteria. Recovery plans provide delisting criteria, summaries of species status, descriptions of threats and limiting factors, site-specific actions, estimates of the time and cost to achieve recovery, and research monitoring and evaluation plans. They also provide important context for evaluating the status of the species and the listing factors for the five-year reviews. NMFS will continue to provide periodic reports on species status and trends, limiting factors, threats, and plan implementation status. A recent review of the status of CCC coho salmon ESU was conducted and it was determined that the ESU is at greater risk of extinction than the previous status review in 2005 (Spence and Williams 2011). All future status reviews should build on the two

Chapters describing the assessment of the Section 4(a)(1) listing factors and protective efforts (Chapters 4 and 5).

12.3.3 ESA SECTION 5

Section 5 is a program that applies to land acquisition with respect to the National Forest System. No National Forest lands are present within the range of CCC coho salmon. It is unlikely that new National Forests will be established within this species range in the foreseeable future. Therefore, this program is not anticipated to benefit coho salmon recovery.

12.3.4 ESA SECTION 6

In 2003, NMFS instituted a grant program for states pursuant to section 6 of the ESA using funding provided by Congress. Species recovery grants to states can support management, research, monitoring and outreach activities that provide direct conservation benefits to listed species and recently delisted species. However, projects focusing on listed Pacific salmonids are not considered under this grant program because state conservation efforts for these species are supported through the Pacific Coastal Salmon Recovery Fund.

12.3.5 ESA SECTION 7

Section 7(a) (1)

Section 7(a)(1) states all federal agencies shall "…in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species…." Section 7(a)(1) allows a federal agency the discretion to deem the conservation of endangered species a high priority. "Conservation" is defined in the ESA as those measures necessary to delist a species. Recovery plans generally do not create legally enforceable obligations for action agencies to carry out any particular measure, but they may be directly relevant and highly informative to the question of whether or not an action agency will reduce appreciably the likelihood of recovery of the species. Information gathered through section 7 consultations, including providing technical assistance to avoid and minimize project impacts, tracking required actions, and monitoring reports, will help NMFS to update the plan as needed.

To aid in the development of conservation programs, NMFS will:

- Prepare and send, after recovery plan approval, a letter to all other appropriate federal agencies outlining section 7(a)(1) obligations and meet with these agencies to discuss coho salmon conservation and recovery priorities;
- Consider development of a formal agreement with other Federal agencies to further implementation of recovery priorities (*e.g.*, MOU similar to a now-expired 1994 MOU between Bureau of National Affairs Inc. and other agencies which expired in 1999).
- Incorporate recovery actions in formal ESA consultations as conservation recommendations;
- Encourage meaningful and focused recommendations, in alignment with recovery goals for restoration and threat abatement, for all actions that incidentally take CCC coho salmon or affect their habitat (*e.g.,* Conservation Banking);
- Encourage federal partners and their constituents to include recovery actions in project proposals;
- Encourage all entities to implement conservation efforts (*i.e*., restoration and mitigation efforts) in focus watersheds that are in alignment with recovery goals and objectives identified in the plan;
- When feasible, support the establishment of conservation bank sites that will protect and restore habitat and provide credits as compensation for unavoidable impacts from actions that may affect CCC coho salmon; and
- Incorporate conservation actions, as appropriate, into the actions that NMFS authorizes, funds or carries out.

Section 7(a)(2)

The purpose of section 7(a)(2) is to "ensure that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of a listed species' critical habitat." Federal agencies request interagency consultation with NMFS and/or USFWS when they determine an action may affect a listed species or its critical habitat. NMFS then conducts an analysis of potential effects of the proposed action and provides a biological opinion on whether an agency's actions jeopardizes a species continued existence or destroys or adversely modifies its critical habitat. As a result, consultations with NMFS have helped to minimize direct take and, in many instances, contribute to recovery.

Because section 7(a)(2) applies only to federal actions, its applications are limited only to those areas and actions with federal ownership, oversight, or funding. Across the CCC coho salmon ESU, land ownership varies by watersheds from areas with some portions of publicly owned land to areas entirely privately owned. Current land use practices on private lands do not trigger interagency consultation. There is a lack of a federal review and oversight regarding consultations, due in part to the USACE's Clean Water Act section 404(f) exemptions for farming, logging, and ranching activities. Although take is prohibited under the ESA, these exemptions hinder federal oversight, including actions that may adversely affect coho salmon and their habitat.

Currently, NMFS devotes significant staff time and resources on section 7(a)(2) consultations. In order to devote more resources to recovery action implementation and to ensure section 7(a)(2) consultations are effective, NMFS will utilize its authorities to:

- ❑ Use the plan's recovery criteria, objectives, and recommended monitoring efforts as a reference point to determine effects of proposed actions on the likelihood of species' recovery;

- Use identified threats information when evaluating impacts of proposed federal actions on CCC coho salmon;
- Prioritize and streamline consultations for actions that implement the recovery strategy or specific recovery actions;
- Develop and maintain databases to track the amount of incidental take authorized through section 7 consultations and the effectiveness of conservation and mitigation measures;
- Incorporate recovery actions in formal consultations as Reasonable and Prudent Measures (RPMs) and conservation recommendations;
- Focus staff priorities towards sections 7 and 9 compliance in watersheds with extant coho salmon populations for the purposes of minimizing take and preventing extirpation;
- Streamline consultations for actions with little or no adverse effects on recovery areas or priorities;
- Develop streamlined programmatic approaches for those actions that do not pose a threat, or are entirely beneficial, to the survival and recovery of the species;
- Consider conducting the jeopardy analysis for each Diversity Stratum since jeopardizing one stratum would jeopardize the overall ESU; and
- Apply the VSP framework and recovery priorities to evaluate population and area importance in jeopardy and adverse modification analyses.

In addition, NMFS will utilize its' authorities to implement a framework for encouraging:

- USACE to reevaluate section 404 Clean Water Act exemptions for farming, logging, and ranching activities. Specifically NMFS will focus efforts towards terminating section 404(f) exemptions for discharges of dredged or fill material into waters of the United States associated with agricultural activities;

- ❑ FEMA to fund upgrades and modify flood insurance program for flood-damaged facilities to meet both ESA requirements and facilitate recovery objectives;
- ❑ The EPA to prioritize actions on pesticides known to be toxic to salmonids and/or are likely to be found in and potentially degrade fish habitat. For example, encourage the EPA to develop guidelines restricting pesticide use near surface waters;
- ❑ The FHWA and Caltrans to develop pile driving guidelines approved by NMFS for bridge construction projects in key focus populations and other watersheds;
- ❑ The development of section 7 conservation recommendations based on recovery actions to help prioritize federal funding towards recovery actions (NFMS, USFWS, NRCS, EPA, *etc.*) during formal consultations;
- ❑ Early engagement by NMFS to provide technical assistance to federal and non-federal agencies prior to the development of a biological assessment (BA) to ensure BA's are adequate and in compliance with regulations;
- ❑ Federal agencies to coordinate and develop programmatic incidental take authorization for activities that contribute to species recovery and to streamline their permitting processes, particularly for recovery and restoration actions; and
- ❑ The development and adoption of a systematic approach for fish passage improvement projects and programs supporting recovery actions recommended in the plan. The approach should be supported by scientifically sound biological and ecological principles and support recovery plan goals and objectives.

12.3.6 ESA SECTION 9

Section 9 prohibits any person from harming listed species, which includes direct forms of harm such as killing an individual fish, or indirect forms such as destroying habitat where fish rear or spawn. NOAA OLE is dedicated to enforcing laws that conserve and protect our nation's living marine resources and their natural habitat. Focus watersheds and their Core areas should be considered the highest priority areas for oversight and enforcement. The plan is designed to assist NOAA's OLE personnel by targeting key focus populations and watersheds essential for CCC coho salmon recovery. NMFS PRD staff will work closely with OLE to identify threats and other activities that put CCC coho salmon at high risk of take and/or extirpation. NMFS actions will include the following:

- Identifying and prioritizing activities that occur to focus populations that pose the greatest threat to recovery efforts;
- Conducting outreach and providing NOAA's OLE with a summary document which includes threats, recovery priorities, and high priority focus areas for oversight and enforcement. NMFS PRD will continue work with OLE and the CDFG, under the Joint Enforcement Agreement, to inform landowners of outreach opportunities and potential areas for increased patrols in focus watersheds;
- When unauthorized take has occurred in a focus population and/or watershed, NMFS SWR PRD will make it a high priority to work closely with OLE to develop take statements; and
- Periodically assess and review existing protocols that increase and streamline collaboration between NMFS PRD and OLE in high priority areas to ensure the highest level of protection for ESA-listed species.

12.3.7 ESA SECTION 10

Section 10(a)(1)(A) provides permits for the authorization of take for scientific research, or to enhance the propagation or survival of listed species. NMFS has authorized conservation hatcheries and research activities under section 10(a)(1)(A). Section 10(a)(1)(B) (*i.e.,* Habitat Conservation Plans) provides permits for otherwise lawful non-federal activities regarding incidental take of listed species. Habitat conservation plans are required to minimize and mitigate the incidental take of listed species from non-federal activities. Currently, both processes take a significant amount of time to implement, however; recovery plans will be used to guide priorities for permit issuance. To improve the section 10 authorization process, NMFS will utilize its authorities in the following ways:

Section 10(a)(1)(A) Research and Enhance Survival Permits

- Prioritize staff time and increase staff resources to streamline the section 10 permitting process to achieve recovery objectives and goals in the plan;
- Prioritize permit applications that address identified research and monitoring needs in the recovery plan, and/or enhance the survival of CCC coho salmon populations (*e.g.*, captive brood stock programs). Develop streamlined approaches to permit similar types of research and monitoring in high priority watersheds;
- Encourage development of pilot projects with federal and non-federal agencies to address specific research topics related to summer and winter rearing survival and key limiting factors. These pilot projects could potentially proceed under a 10(a)(1)(a) research permit;
- Encourage the development of monitoring programs to assess spawner abundance, population viability and key habitat attributes in all independent populations (*i.e.*, functionally independent populations). These programs will require consistent methods, reporting, databases and adaptive management across the NCCC Domain to evaluate population and habitat responses to recovery actions; and
- Promote the implementation of the California Coastal Salmonid Population Monitoring Plan to provide information on population abundance at the appropriate life stages and spatial scales to evaluate adult salmonid abundance (*i.e.*, larger regional scales and population level). Conduct population research and monitoring focusing on life stage survival (*e.g.*, life cycle stations) within each Diversity Stratum, including survival and fitness in wetlands, estuaries and lagoons.

It is important to note that the combined CDFG and NMFS efforts to implement the CSMP should continue. Funding and implementation of a coordinated program is necessary to enable population tracking to inform status and recovery. Additionally collaboration with NMFS PRD and SWFSC is essential to ensure the monitoring program will meet the data needs for ESA listed species and 5-year status reviews.

In addition, under section 10(a)(1)(A) NMFS will work to:

- Develop and maintain a national research and enhancement database to track the take authorizations; the effectiveness of conservation and mitigation measures identified in the recovery plan; and
- Facilitate regional forums to develop research, monitoring, and evaluation (RME) processes that track action effectiveness and status and trends of ESA-listed species at the population and ESU and DPS levels.

Section 10(a)(1)(B) Habitat Conservation Plans (HCPs)

NMFS recommends all future HCPs adopt the viability and threats assessment protocols established in this recovery plan. Adopting these guidelines addresses the need for broad-based standardization to track recovery actions and threat abatement strategies. Adopting the assessment protocols will facilitate consistency in the development of standards to determine the appropriate levels of mitigation necessary to ensure the continued existence of CCC coho salmon. HCPs should strive for consistency of mitigation measures. Although not a preferred option, if offsite mitigation is necessary, this recovery plan can be used to direct mitigation efforts in watersheds with one of the 28 focus populations (or the 11 supplemental populations). At present, NMFS is currently working to establish other ESA compliance tools, such as Safe Harbor Agreements; a policy that provides landowners with incentives for private property owners to restore, enhance, or maintain habitats for listed species. Within this framework, NMFS will utilize its authorities to:

- Prioritize areas and actions where restoration and threat abatement has the potential to provide the most effective contribution to species recovery based on the threats assessment developed in the plan;
- Develop and establish a framework for a standardized monitoring approach for HCPs

tailored to recovery plans. A standardized monitoring approach will set the framework for consistent data collection techniques, allowing comparison between similar datasets over space and time. In addition, these data can inform the five year status review and tracking recovery actions;

- Develop strategies to identify potential focus areas to increase the number of HCP and Safe Harbor agreements (*e.g.*, key watersheds, activities amenable to consolidated landowner application such as forestry, water diverters and target increased participation, *etc.*);
- Streamline the approval process for HCPs (*i.e.*, develop a template for small scale HCPs agreements). A streamlined approval process will likely increase land owner participation (by reducing time and cost in HCP development); and
- Work with NOAA OLE to encourage ESA compliance through HCPs.

Section 10(j) Experimental Populations

Among changes made in the 1982 amendments to the ESA was the creation of section 10(j), which provides for the designation of specific populations of species listed as "experimental populations" so long as they are wholly separate from other non-experimental populations. Under section l0(j), reintroduced populations of endangered or threatened species established outside the current range may be designated, at the discretion of NMFS, as "experimental," lessening the ESA's regulatory authority over such populations. Because these populations are not provided full ESA protection, management flexibility is increased, local opposition is reduced, and more re-introductions are possible. NMFS has not promulgated regulations implementing section 10(j) of the ESA or authorized the release of any experimental populations to date. However, the USFWS has promulgated implementing regulations to guide their use of section 10(j) (see 50 CFR 17.80 through 17.84) and has authorized the release of many experimental populations, including fish (*e.g.*, bull trout). The SWR continues to explore the designation of 10(j) experimental populations in the NCCC Domain. Currently in the Central Valley and southern California, NMFS is considering the designation of 10(j) experimental populations primarily due to the loss of historical spawning and rearing habitat above dams. In the Central Valley NMFS can use regulatory tools such as section 7 and FERC relicensing (*e.g.*, on the Feather, Merced, and Tuolumne Rivers) to promote reintroduction of listed fish to blocked historical habitat above dams; the use of 10(j) could facilitate these regulatory processes.

12.4 RECOVERY PLANS A "LIVING DOCUMENT"

For the past two decades, NMFS has worked closely with federal agencies and private landowners pursuant to sections 7(a)(2) and 10(a)(1) of the ESA to avoid and minimize harm to listed species as a result of water and land use activities. As a result significant ecological benefits to the species occurred in some portion of the ESU. However, in many watersheds, salmon populations continue to decline (Spence and Williams 2011; Williams *et al.* 2011). NMFS will use a broad suite of regulatory mechanisms under the ESA as well as cooperation between all entities to implement the plan. Table 29 briefly summarizes a few of the regulatory mechanisms and/or authorities under the ESA and Magnuson Stevens Fisheries Management Act we will utilize for recovery plan implementation.

Successful implementation of the recovery plan will require the efforts and resources of many entities, from federal agencies to individual members of the public. NMFS' efforts must be as far-reaching as the issues adversely affecting the species, extending beyond the direct regulatory jurisdiction of NMFS. NMFS is committed to working cooperatively with other individuals and agencies to implement recovery actions and to encourage other federal agencies to implement actions where they have expertise or authority. To achieve recovery, NMFS will promote the recovery plan and provide technical information and assistance to other entities that implement actions that may impact the species' recovery.

Table 29: Regulatory mechanisms and/or authorities under the ESA and Magnuson Stevens Fisheries Management Act

ESA Authority	Description	Implementation Actions
Section 7	Section 7(a)(1) Interagency Cooperation	Use threats assessments and recovery actions to guide federal partners to further the conservation of salmonids.
Section 7	Section 7(a)(2) Interagency Cooperation (Consultation)	Use recovery criteria and objectives to determine effects of proposed actions on the likelihood of species' recovery, and to develop conservation recommendations and reasonable and prudent measures and alternatives.
Section 7	Note: Permits issued under section 10(a)(1) of the ESA undergo section 7 consultation prior to issuance.	Use threats assessments and recovery strategy to prioritize consultations when making workload decisions.
Section 7		Prioritize and streamline consultations for actions that implement recovery strategy or specific recovery actions.
Section 7		Streamline consultations for actions with little or no effect on recovery areas or priorities.
Section 9	Section 9 Enforcement	Prioritize actions and areas deemed of greatest threat or importance to recovery efforts for focused efforts to halt illegal take of listed species.
Section 9		Consider development of no-take guidelines for land use activities associated with high threats in identified high-priority areas.
Section 10	Section 10(a)(1)(A) Research Permits	Prioritize permit applications that address research and monitoring needs identified in the recovery plan.
Section 10	Section 10(a)(1)(B) Incidental Take Permits	Prioritize cooperation and assistance to landowners proposing activities or programs designed to achieve recovery objectives.
Section 10		Standardize monitoring methods in GCPs/HCPs to conform to TRT research needs and the recovery plan template.
MSFMA	Fishery Management	Assess and implement, if necessary, fishery regulations to maintain salmon harvest levels at or below those necessary to allow the recovery of listed salmon and steelhead.
MSFMA		Assess and implement, if necessary, fishery regulations to reduce by-catch of salmonids in Federally-managed fisheries.

NMFS specific recovery goals, objectives, strategies and action items are clearly identified in the plan. Not all of the strategies will be implemented each year and specific activities related to the identified strategies will be tied to available resources and agency priorities. The plan will be updated as actions are implemented and new information or data are made available. NMFS

SWR will focus efforts to create a plan that can be updated easily. NMFS SWR is proposing a protocol to ensure recovery plans remain relevant over time, as "living plans." The plan will be updated when a major change to the plan is made (*e.g.*, those that affect the recovery strategy, recovery criteria, or significant changes to the threats analysis or recovery actions). NMFS SWR expects that both minor and major changes to the plan will be necessary as more information is gathered and recovery actions and strategies are implemented. For example, improvements in scientific understanding of the species and its population dynamics may lead to changes in the recovery criteria. In other cases, changes may be simple updates or edits to plan text and tables to reflect ongoing plan implementation.

In addition, NMFS SWR is developing a web-based Recovery Action Tracking System (RATS) in coordination with the NMFS Northwest Region. Because the progress of recovery action implementation will be tracked using this web-based system the public will be able to monitor the current status of all implemented actions in the NCCC Domain. The living plan approach will be used to synchronize and update information for use by the public when applying for restoration grant programs.

GLOSSARY

This glossary contains terms commonly used in fisheries and resource sciences and terms used throughout the National Marne Fisheries Service documents, as defined by laws, regulations, manuals, handbooks and specifications.

Abundance: Refers to the total number of individual organisms in a population or subpopulation. For the Plan, abundance refers to the total number of spawning adults within a population.

Adaptive management: An action-oriented approach to resource management that brings science and management together and allows managers to move forward in the face of uncertainty when dealing with complex ecological problems. Adaptive management tackles uncertainty about the system head-on by identifying clear objectives, developing conceptual models of the system, identifying areas of uncertainty and alternative hypotheses, learning from the system as actions are taken to manage it, updating the conceptual models, and incorporating what is learned into future actions.

Adipose fin: A small fleshy fin found on the back behind the dorsal fin, and just forward of the caudal fin.

Alevin: The larval salmonid that has hatched but has not fully absorbed its yolk sac and generally has not yet emerged from the spawning gravel.

Allele: An allele is an alternate form of a gene (the basic unit of heredity passed from parent to offspring). By convention, the "100 allele" is the most common allele in a population and is the reference for the electrophoretic mobility of other alleles of the same gene. Other genetic terms used in this document include allozymes (alternate forms of an enzyme produced by different alleles and often detected by protein electrophoresis); dendrogram (a branching diagram, sometimes resembling a tree, that provides one way of visualizing similarities between different groups or samples); gene locus (pl. loci; the site on a chromosome where a gene is found); genetic distance (D) (a quantitative measure of genetic differences between a pair of samples); and introgression (introduction of genes from one population or species into another).

Anadromous Fish: Pertaining to fish that spend part of their life cycle in the ocean and return to freshwater streams to spawn, for example salmon, trout, and shad.

Anthropogenic: Caused or produced by humans.

Artificial propagation: See hatchery.

Bacterial Kidney Disease (BKD): A bacterial kidney disease in fish caused by the bacterium *Renibacterium salmoninarum*.

Basin: Region drained by a single river system.

Benthic: Animals and plants living on or within the substrate of a water body

Biodiversity: The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems.

Biological Review Team (BRT): The team of scientists from National Marine Fisheries Service formed to conduct the status review.

Biota: The combined flora and fauna of a region

Brackish Water: A combination of seawater and freshwater.

Captive Broodstock Program: A form of artificial propagation that breeds coho salmon from local genetic stock at a conservation hatchery and releases the produced juveniles into historic coho streams.

Carrying Capacity: The maximum equilibrium number of a particular species that can be supported indefinitely in a given environment.

Channel: A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks that serve to confine water.

Channel Complexity: Measure of multiple components determining the makeup of a given waterway. Some of these would include slope, meander, bedload/substrate makeup (i.e. gravel, cobble, boulder, or combination), presence/absence of large instream woody material, thalweg, *etc*.

Coded-wire Tag (CWT): A small piece of wire, marked with a binary code, which is normally inserted into the nasal cartilage of juvenile fish. Because the tag is not externally visible, the adipose fin of coded wire-tagged fish is removed to indicate the presence of the tag. Groups of thousands to hundreds of thousands of fish are marked with the same code number to indicate stock, place of origin, or other distinguishing traits for production releases and experimental groups.

Cohort: A group of fish that hatched during a given spawning season. When the spawning season spans portions of more than one year, as it does for coho salmon, the brood-year is identified by the year in which spawning began. For example, offspring of coho salmon that spawned in 1996-1997 are identified as "brood-year 1996." (Synonym: Brood-year).

Conceptual Model: A qualitative model of the system and species life stages with the interrelations between the system and threats shown in diagrammatic form. Several threats are interlinked or Independent and these can be illustrated on the model of the system.

Confluence: A flowing together of two or more streams.

Connectivity: A natural pathway that provides for the movement of organisms from one habitat to another and creates a physical linkage between habitats. Spatial structure should have permanent or appropriate seasonal connectivity to allow adequate migration between spawning, rearing, and migration patches.

Conservation-Reliant Species: Species dependent on enforced protections for survival.

Conveyance: A pipeline, canal (natural or artificial), or similar conduit that transports water from one location to another.

Copepod: Small aquatic crustacean.

Critical Habitat: The specific areas within the geographical area occupied by the listed species, at the time it is listed in accordance with the provisions of the ESA. The habitat has the needed physical or biological features that are essential to the conservation of the species and may require special management considerations or protection.

Culvert: Buried pipe structure that allows streamflow or road drainage to pass under a road.

Cumulative Effects: Cumulative effects are "those effects on the environment that result from the incremental effect of the action when added to past, present and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time" (FEMAT, 1993).

Delisting: A species formally listed as threatened or endangered under the ESA.

Deme: A local population of organisms of one species that actively interbreed with one another and share a distinct gene pool. When demes are isolated for a very long time they can become distinct subspecies or species.

Dependent Population: Populations that rely upon immigration from surrounding populations to persist. They are an "at risk" group that has a substantial likelihood of going extinct within a

100-year time period in isolation, yet receives sufficient immigration to alter their dynamics and extinction risk, and presumably increase persistence or occupancy.

Depensation: The effect where a decrease in spawning stock leads to reduced survival or production of eggs through either 1) increased predation per egg given constant predator pressure, or 2) the "Allee effect" (the positive relationship between population density and the reproduction and survival of individuals) with reduced likelihood of finding a mate.

Desiccation: To dry out thoroughly, dehydrate.

Distinct Population Segment (DPS): A subdivision of a vertebrate species that is treated as a species for purposes of listing under the Endangered Species Act (ESA). To be so recognized, a potential distinct population segment must satisfy standards specified in a FWS or NOAA Fisheries policy statement (See the February 7, 1996, Federal Register, pages 4722 – 4725). The standards require it to be separable from the remainder of and significant to the species to which it belongs.

Diversity: All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population.

Diversity Strata (Recovery Unit): Populations are categorized into diversity strata based on the geographical structure described in Spence *et al.* (2008).

DNA (deoxyribonucleic acid): DNA is a complex molecule that carries an organism's heritable information. The two types of DNA commonly used to examine genetic variation are mitochondrial DNA (mtDNA), a circular molecule that is maternally inherited, and nuclear DNA, which is organized into a set of chromosomes.

Downlisting: The moving of a species from the "Endangered" list to the "Threatened" list under CESA as a result of recovery of population sizes to the point where danger of extinction is less extreme than before, although continued protection is still warranted.

Ecosystem: The physical and climatic features of all the living and dead organisms in an area and are interrelated in the transfer of energy and material.

Effective population size: Used in management of genetic resources to express information about expected rates of random genetic change due to inbreeding and/or genetic drift. Typically the effective population size is lower than the census population size.

Effluent: Discharge or emission of a liquid or gas (usually waste material).

El Nino: A warming of the ocean surface off the western coast of South America that occurs every 4 to 12 years when upwelling of cold, nutrient-rich water does not occur. It causes die-offs of plankton and fish and affects Pacific jet stream winds, altering storm tracks and creating unusual weather patterns in various parts of the world.

Endangered Species Act (ESA): Federal legislation that provides protection for species at risk of extinction. Through federal action and by encouraging the establishment of state programs, the 1973 Endangered Species Act provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend.

Endangered Species: Any species which is in danger of extinction throughout all or a significant portion of its range

Endemic: Native to or confined to a certain region

Entrainment: To capture in a diversion by the flow of water.

Ephemeral stream: A stream that flows briefly and only in direct response to local precipitation, and whose channel is always above the water table.

Essential Fish Habitat (EFH): Those waters and substrate necessary for fish spawning, incubation, breeding, feeding, or growth to maturity. These areas include migration corridors and adult holding areas. Essential Fish Habitat must also include wetland/riparian shore that supports vegetation that projects shade/cover over waterways used by listed species.

Escapement: Adult fish that "escape" fishing gear to migrate upstream to spawning grounds. The quantity of sexually mature adult salmon (typically measured by number or biomass) that successfully pass through a fishery to reach the spawning grounds. This amount reflects losses resulting from harvest, and does not reflect natural mortality, typically partitioned between enroute and pre-spawning mortality. Thus, escaped fish do not necessarily spawn successfully.

Estuarine: Relating to an estuary.

Estuary: An area of water which joins marine and freshwater components. As such, these areas are heavily influenced by both tidal and riverine inputs.

Evolutionarily Significant Unit (ESU): A population (or group of populations) considered distinct (and hence a "species") for purposes of the ESA. A population must meet two criteria in order to be considered an ESU: 1) it must be reproductively isolated from other conspecific population units; and 2) it must represent an important component of the evolutionary legacy of the species.

Extant: A population still existing or persistent.

Extinction: The failure of groups of organisms of varying size and inclusiveness (e.g., local geographic or temporally-defined groups to species) to have surviving descendants.

Extinction risk: In this document, the probability that a given population will become extinct within 100 years. Low probability of extinction is arbitrarily defined for this purpose as 5 percent over 100 years.

Extirpation: Loss of a taxon from a portion of its range.

Extirpated Species: A species that no longer survives in regions that were once part of its range, but that still exists elsewhere in the wild or in captivity.

Exotic Species (Also called Alien, Non-Indigenous or Non-Native Invasive Species): Plants and animals that originate elsewhere and migrate or are brought into an area. They may dominate the local species or have other negative impacts on the environment because they can often outcompete native species and they typically have no natural predators.

Fauna: Animals, especially the animals of a particular region or period, considered as a group

Fecundity: The number of offspring produced per female

Federal Register: The official journal of the U.S. Government, containing public notices and other routine publications. Published daily, the Federal Register includes rules, proposed rules, and notices of Federal agencies and organizations, as well as executive orders and other presidential documents. Fisheries regulations are not considered final until they are published in the Federal Register.

Fish Ladder: Structure that allows fish passage to areas upstream of obstructions (e.g. dams, locks). Fish ladders employ a series of stepped, terraced pools fed with spillover water cascading down the ladder. This allows fish to make incremental leaps upstream from pool to pool to access historical/ancestral habitat upstream...

Fish Screens: Physical exclusion structures placed at water diversion facilities to keep fish from becoming entrained, trapped and dying in a given water body.

Fishery Management Council: A regional fisheries management body established by the Magnuson-Stevens Fishery Conservation and Management Act to manage fishery resources in eight designated regions of the United States

Fishery Management Plan (FMP): A document prepared under supervision of the appropriate fishery management council for management of stocks of fish judged to be in need of management. The plan must generally be formally approved. An FMP includes data, analyses, and management measures.

Floodplain: Level lowland bordering a stream onto which the stream spreads at flood stage

Flora: Plants considered as a group, especially the plants of a particular country, region, or time.

Focus Population: Populations selected by the recovery team to fulfill biological viability criteria per Spence *et al.* 2008 and be the focus of the CCC coho salmon recovery plan.

Fry: The life stage of salmonids between alevin and parr and must attain a length of at least one inch. They can typically swim and catch their own food. They are sometimes called "fingerlings."

Functionally Independent Population (FIP): Population having a high likelihood of persisting over 100-year time scales and conform to the original definition of Independent "viable salmonid population."

Fundamental Unit: A set of units for physical quantities from which every other unit can be generated. A reference unit.

Genetic Drift: The random change of the occurrence of a particular gene in a population; genetic drift is thought to be one cause of speciation when a group of organisms is separated from its parent population.

Gene(tic) Flow: The rate of entry of non-native genes into a population, measured as the proportion of the alleles at a locus in a generation that originated from outside of the population. Can be thought of as the genetically successful stray rate into a population.

Genetic Divergence: The process of one species diverging over time into more than one species.

Genetic Fitness: Generally depicted as the reproductive success of a genotype, usually measured as the number of offspring produced by an individual that survive to reproductive age relative to the average for the population.

Genetic Introgression: Introduction by interbreeding or hybridization of genes from one population or species into another.

Genetic Robustness: Demographic robustness.

Genotype: The genetic makeup, as distinguished from the physical appearance, of an organism or a group of organisms.

Gill net: With this type of gear, the fish are gilled, entangled or enmeshed in the netting. These nets can be used either alone or, as is more usual, in large numbers placed in line. According to their design, ballasting and buoyancy, these nets may be used to fish on the surface, in midwater or on the bottom.

Grilse: Salmon that have returned to their natal river.

Habitat: Areas that provide specific conditions necessary to support plant, fish, and wildlife communities. The natural abode of a plant or animal, including all biotic, climatic, and soil conditions, or other environmental influences affecting life.

Hatchery: Salmon hatcheries typically spawn adults in captivity and raise the resulting progeny in freshwater for release into the natural environment. In some cases, fertilized eggs are out-planted (usually in "hatch-boxes"), but it is more common to release fry (young juveniles) or smolts (juveniles that are physiologically prepared to undergo the migration into salt water). This "outplanting" of fish are released either at the hatchery (on-station release) or away from the hatchery (off-station release). Releases may also be classified as within basin (occurring within the river basin in which the hatchery is located or the stock originated from) or out-of-basin (occurring in a river basin other than that in which the hatchery is located or the stock originated from). The broodstock of some hatcheries is based on adults that return to the hatchery each year; others rely on fish or eggs from other hatcheries, or capture adults in the wild each year.

Hatchery-origin Fish: Also, "hatchery fish". Fish that have spent some portion of their lives, usually their early lives, in a hatchery (see natural-origin fish.).

Headwaters: The source of a stream. Headwater streams are the small swales, creeks, and streams that are the origin of most rivers. These small streams join together to form larger streams and rivers or run directly into larger streams and lakes.

Heavy Metal: A group that includes all metallic elements with atomic numbers greater than 20, the most familiar of which are chromium, manganese, iron, cobalt, nickel, copper and zinc but that also includes arsenic, selenium, silver, cadmium, tin, antimony, mercury, and lead, among others.

Hook-and-line: A type of fishing gear consisting of a hook tied to a line. Fish are attracted by natural bait that is placed on the hook, and are impaled by the hook when biting the bait. Artificial bait (lures) with hooks are often used. Hook-and-line units may be used singly or in large numbers.

Hybridization: The process of mixing different species or varieties of organisms to create a hybrid.

Hydrologic Unit: A definitive geographical area, typically an entire watershed defined by the United States Geological Survey (USGS).

Inbreeding Depression: Reduced fitness in a given population as a result of breeding of related individuals.

Independent Population: A population that is any collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations. In other words, if one Independent population were to go extinct, it would not have much impact on the 100-year extinction risk experienced by other Independent populations. Independent populations are likely to be smaller than a whole ESU and they are likely to inhabit geographic ranges on the scale of entire river basins or major sub-basins.

Indigenous: Originating and living or occurring naturally in an area or environment.

Interbreeding: To breed with another kind or species.

Intrinsic Potential: The potential of the landscape to support a fish population.

Invasive Species: See exotic species.

Irreversibility: The trend/probability of a process to continue in only one direction once a tipping threshold has been crossed or met.

Iteroperous: A condition in which a fish may spawn multiple times. Steelhead (*Oncorhynchus mykiss*) and cuttroat trout (*O. clarkii*) display this trait routinely while other Pacific salmonids expire after spawning only once (see semelparous).

Jacks: Precocious male salmonids that return from the ocean to spawn one or more years before full-sized adults of their same cohort return. For coho salmon in California, Oregon, Washington, and southern British Columbia, jacks are typically 2 years old, having spent only 6 months in the ocean, in contrast to adults, which are 3 years old after spending 1½ years in the ocean.

Jeopardize: To reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing reproduction, numbers, or distribution of that species.

Jills (sometimes also called "Jennys"): Female salmonids that have spent only a year at sea but have returned to spawn. This is a relative rarity within the population.

Kelt: A post-spawning salmonid. Salmon or trout that remains in freshwater after spawning in the fall and may return to the ocean. This is extremely rare in salmon and uncommon in trout.

Large Woody Debris: Any large piece of woody material that intrudes into a stream channel, whose smallest diameter is greater than 10cm, and whose length is greater than 1 m.

Limiting Factor: An environmental factor that limits the growth or activities of an organism or that restricts the size of a population or its geographical range.

Listed Species: Any species of fish, wildlife or plant which has been determined to be endangered or threatened under the Endangered Species Act.

Magnuson-Stevens Fishery Conservation and Management Act: Federal legislation responsible for establishing the fishery management councils (FMCs) and the mandatory and discretionary guidelines for Federal fishery management plans (FMPs). This legislation was originally enacted in 1976 as the Fishery Management and Conservation Act; its name was changed to the Magnuson Fishery Conservation and Management Act in 1980, and in 1996 it was renamed the Magnuson-Stevens Fishery Conservation and Management Act.

Mass Wasting: Downslope transport of soil and rocks due to gravitational stress.

Metapopulation: A population of sub-populations which are in turn comprised of local populations or demes. Individual sub-populations can be extirpated and consequently recolonized from other sub-populations. Stability in a metapopulation is maintained by a balance between rates of sub-population extinction and colonization.

Monitoring: Scientific inquiry focused on evaluation of a program in relation to its goals (see Research).

Morphology: Refers to the form and structure of an organism, with special emphasis on external features.

Natal Stream: The stream where a salmonid was produced and hatched.

Natural-origin fish: Also, "natural or wild fish". Fish that are offspring of parents that spawned in the wild. Natural-origin fish spend their entire lives in the natural environment. (See hatchery-origin fish).

Nautical Miles: A unit of length used in sea and air navigation, based on the length of one minute of arc of a great circle. One nautical mile is equal to 1,852 meters.

Pacific Northwest: A region of the northwest United States usually including the states of Washington and Oregon.

Parr: A young salmonid, in the stage between alevin and smolt, which has developed distinctive dark "parr marks" on its sides and is actively feeding in freshwater. Parr marks are vertical oval bars on the flanks of salmon fry that fade completely as the fish go through the smoltification process

Pelagic: Living in open oceans or seas rather than waters adjacent to land or inland waters.

Phenotype: The observable physical or biochemical characteristics of an organism, as determined by both genetic makeup and environmental influences.

Pinniped: Piscivorous aquatic mammals that include the seals, walrus, and similar animals having finlike flippers to use for locomotion.

Polymorphic: Having more than one form (e.g., polymorphic gene loci have more than one allele).

Population: A group of individuals of the same species that live in the same place at the same time and exhibit some level of reproductive isolation from other such groups. In some contexts, a randomly mating group of individuals that is reproductively isolated from other groups. A population may consist of a single isolated run or more than one connected run.

Population size: In this document, is the number of adult fish in the population. Also known as census size of the population.

Potentially Independent Population (PIP): Populations having a high likelihood of persisting in isolation over 100-year time scales, but are too strongly influenced by immigration from other populations to exhibit independent dynamics.

Precocious: Early arrival of sexual maturity. Some precocious males (jacks) return after only six months of ocean residence.

Predation: The act of acquiring sustenance and nutrition by killing and consuming living animals.

Primary Constituent Elements (PCE): A physical or biological feature essential to the conservation of a species for which its designated or proposed critical habitat is based on, such as space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring, and habitats that are protected from disturbance or are representative of the species historic geographic and ecological distribution.

Principal component analysis (PCA): A statistical technique that attempts to explain variation among several variables in terms of a smaller number of composite independent factors called principal components.

Progeny: An offspring or a dependent.

Proposed Rule: When one of the agencies of the United States wishes to add, remove, or modify a regulation, they inform the public through the administrative process called a proposed rulemaking. The public can comment on proposed rules. Rules are incorporated in the Code of Federal Regulations when approved.

Recovery: The reestablishment or rehabilitation of a threatened or endangered species to a self-sustaining level in its natural ecosystem. NMFS (2010) defines recovery as: "…the process by which listed species and their ecosystems are restored and their future safeguarded to the point that protections under the ESA are no longer needed."

Recovery Domain: The geographic area for which a Technical Recovery Team is responsible.

Recovery Plan: Under the ESA, a document identifying actions needed to improve the status of a species or ESU to the point that it no longer requires protection.

Recovery Supplementation: Short-term artificial propagation designed to reduce the risk of extinction of a small or chaotically fluctuating recovering population in its natural habitat by temporarily increasing population size using recovery hatchery fish, while maintaining available genetic diversity and avoiding genetic change in the natural and hatchery populations.

Redd: Nest-like depression constructed by female salmonids facilitating increased hyporheic flow for developing eggs and alevins. A type of fish-spawning area associated with running water and clean gravel.

Refugia: An area where special environment circumstances occur, enabling a species to survive in specific life stages.

Research: Scientific inquiry focused on answering original questions or increasing knowledge. May consist of experiments, systematic observations, or original descriptions of structures, relationships, and processes.

Restoration Potential: The potential for returning a damaged habitat, watershed or ecosystem to a condition or function that is (1) similar to pre-disturbance, or (2) self-sustaining and in equilibrium with the surrounding landscape and ecological processes necessary for carrying out the basic life history functions of target organisms. An area characterized as having a high restoration potential would be considered to have a high likelihood of returning to this condition or function. Conversely, an area with low restoration potential would have little to no likelihood of returning to this condition or function.

Riparian Area: An area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Riparian Vegetation: Vegetation growing on or near the banks of a stream or other body of water in soils that exhibit some wetness characteristics during some portion of the growing season.

Rip-rap: Layer of large, durable materials (usually rock) used to protect a stream bank or lake shore from erosion.

Riverine: Habitat within or alongside a river or channel.

River kilometer (RKm): Distance, in kilometers, from the mouth of the indicated river. Usually used to identify the location of a physical feature, such as a confluence, dam, waterfall, or spawning area.

Run: The spawning adults of a given species that return to a stream during a given season (*e.g.* winter run).

Salmon or salmonid: Any of various large food and game fishes of the family Salmonidae, the biological Family which includes the salmon, trout, and whitefish (genera *Salmo* and *Oncorhynchus*), of northern waters, having delicate pinkish flesh and characteristically swimming from salt to fresh water to spawn.

Salmon Fishery Management Plan: Any of a variety planning documents relating to salmon fisheries implemented or enforced by Federal or State, or local agencies.

Scope: The geographic area of the threat to the species or system. Impacts can be widespread or localized.

Sedimentary Rocks: Rocks formed by the deposition of sediment. Sediment: solid fragments of inorganic or organic material that comes from the weathering of rock and are carried and deposited by wind, water, or ice.

Sedimentation: Deposition of materials suspended in water or air, usually when the velocity of the transporting medium drops below the level at which the material can be supported.

Seine: A large fishing net made to hang vertically in the water by weights at the lower edge and floats at the top.

Self-sustaining Population: A population that perpetuates itself without human intervention, without chronic decline, and in its natural ecosystem, at sufficient levels that listing under ESA is not warranted.

Semelparous: Reproducing only once in a lifetime. Most salmon are semelparous, and die after spawning (see also interparous).

Severity: A measure of the level of damage to species or system(s) that can reasonably be expected within 10 years under current circumstances. Severity ranges from total destruction down to slight impairment.

Smolt: (Verb) - The physiological process that prepares a juvenile anadromous fish to survive the transition from fresh water to salt water. (Noun) - A juvenile anadromous fish that has made those physiological changes.

Smoltification: Describes the process by which salmonid fish acclimate metabolically over time from fresh water to marine environments as they emigrate from their natal streams to the ocean. During this process, parr marks fade and the fish takes on a silver color.

Spawner surveys: Spawner surveys utilize counts of **redds** (nests dug by females in which they deposit their eggs) and fish carcasses to estimate spawner escapement and identify habitat being used by spawning fish. Annual surveys can be used to compare the relative magnitude of spawning activity between years.

Spawner-to-spawner Ratio: Several measures are employed to estimate the productivity of salmon populations. The spawner-to-spawner ratio estimates the number of spawners (those fish that reproduced or were expected to reproduce) in one generation produced by the previous generation's spawners. A spawner-to-spawner ratio of 1.0 indicates that, on average, each spawner produced one offspring that survived to spawn. The recruit-to-spawner ratio estimates the number of recruits (fish that are available for harvest in addition to those that bypass the fishery to spawn) produced by the previous generation's spawners.

Species: A fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding.

Splash Dam: A dam built to create a head of water for driving logs downstream.

Stochastic: The term is used to describe natural events or processes that are random and unpredictable. Examples include environmental conditions such as earthquakes and severe storms, or life-cycle events, such as radically changed survival or fecundity rates.

Stock: See population.

Stock transfer: Human-caused transfer of fish from one location to another, typically in the context of out-of-basin or out-of-ESU transfers.

Stratified Random Sampling (SRS): Provides an estimate of the number of spawners in a given area based on spawner counts in both standard and supplemental surveys.

Straying: Occurs when some adult salmonids spawn in a stream other than the one they were produced in. Straying may be influenced by hatchery practices, water quality or water diversions.

Take: As defined by the Endangered Species Act, take refers to activities that harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or attempt to engage in any such conduct to a listed species.

Technical Recovery Team (TRT): An appointed group of fishery experts, led by the NMFS Southwest Fisheries Science Center, and charged with development of technical documents providing the foundation for the development of recovery plans.

Thalweg: A line defining the deepest continuous portion of a valley, stream or waterway. Sometimes referred to as the "valley line".

Thermocline: That layer in a body of water where the temperature difference is greatest per unit of depth. It is the layer in which the drop in temperature equals or exceeds one degree C. (1.8 degrees F) per meter (39.37 inches).

Threatened Species: Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Total Maximum Daily Load: The amount of pollutant that a water body can receive and still meet water quality standards. These levels are set by the Environmental Protection Agency.

Tributary: A stream that flows into a larger stream or other body of water.

Trophic Levels: Hierarchical tiers within a food web system (*e.g*. top predator or primary producer).

Turbid: Water that is not clear, having sediment or foreign particles stirred up or suspended.

Viability: The likelihood that a population will sustain itself over a 100-year time frame.

Viable Salmonid Population: An independent population of any Pacific salmonid (genus *Onchorhynchus*) that has a negligible risk of extinction due to threats for demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame

Watershed: The region draining into a river, river system, or other body of water

Weir: A notch or depression in a dam or other water barrier through which the flow of water is measured or regulated. Also, a barrier constructed across a stream to divert fish into a trap or to raise the water level or divert water flow

Wetland: An ecological community such as a marsh or swamp that is permanently or seasonally saturated with moisture.

Zooplankton: Non-photosynthetic, heterotrophic planktonic organisms, including protists, small animals, and larvae, which exist within the water column.

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