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EXECUTIVE SUMMARY

RECOVERY PLAN

for the Evolutionarily Significant Unit of Central California Coast Coho Salmon

Photo courtesy: Juvenile Coho Salmon, Scott Creek, CA, Morgan Bond, SWFSC

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

Salmon: Paleolithic Times to Today

L'Abri du Poisson, Les Eyzies-De-Tayac ***Photo Courtesy: Ambrose, NMFS, 2012***

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. Salmon are believed to have been a preferred food as evidenced by the debris of Paleolithic and Plinian man in France. Around the world, our ancestors have relied on salmon as a food source for thousands of years. Around 200 BC in 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).

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

The 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
- 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)

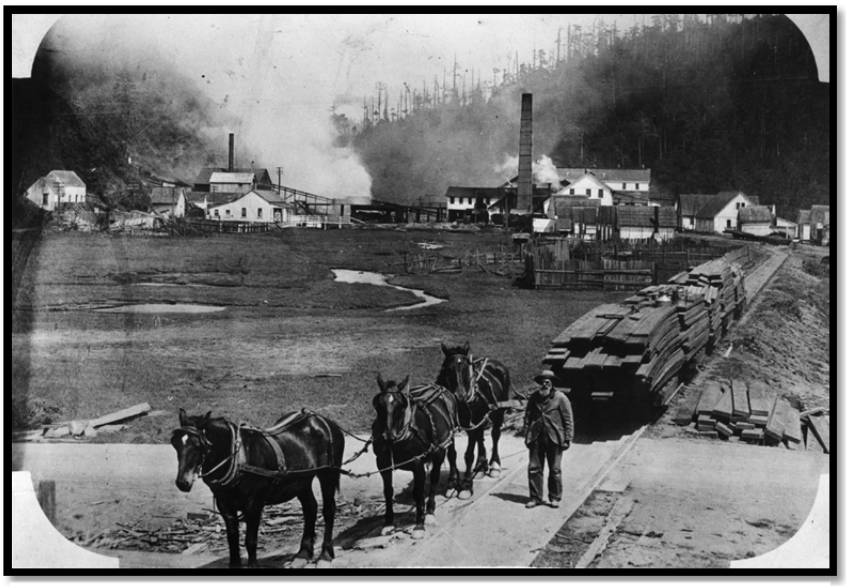
However, the lack of enforcement, the "old plea of ruin…to undertake such work [salmon protections]" and the "political paralysis over the salmon crisis" (Montgomery 2003) rendered salmon extinct by the end of the 19th century in nearly all English rivers. These catastrophic declines and extinctions were also observed in Scotland, France and many other European counties where salmon had once been in great abundance. Today salmon 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 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 and 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).

CCC Coho Salmon: The Edge of Its Range & The Brink of Extinction

Salmon in European countries and eastern US are collectively called Atlantic Salmon and salmon along North America's Pacific Northwest are collectively called Pacific Salmon. There are 28 distinct populations of Pacific Salmon listed under the Federal Endangered Species Act (ESA), the populations are unique and do not substantially interbreed; and all are experiencing

significant declines or nearly extinct (16 U.S.C. 1531 *et seq*.). There are two coho salmon distinct populations in California: Southern Oregon Northern California Coast Evolutionarily Significant Unit and Central California Coast (CCC) Evolutionarily Significant Unit (ESU). The CCC coho salmon ESU represents the southernmost extent of coho salmon on the American continent and one of the most endangered of the 28 ESA listed along the west coast.



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

The precipitous decline of coho salmon in California prompted a series of State and Federal listings under the respective Endangered Species Act's. Despite both State and Federal listings of CCC coho salmon in 1995 and 1996 (61 FR 56138), populations continued to decline resulting in a Federal reclassification 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.

> ***"…[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 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 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."***
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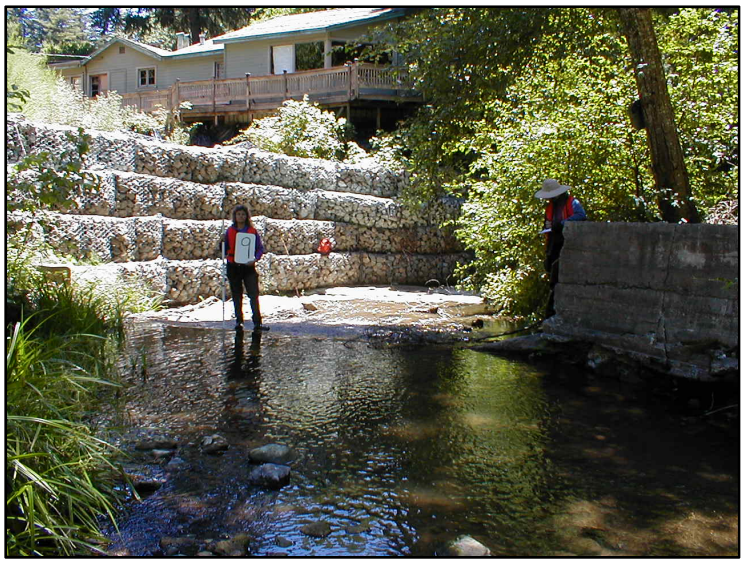
> ***Wakeman 1880, Pescadero Creek, Santa Cruz County, in Spence et al. 2011***



Urbanization of stream channels, Santa Cruz County
Photo Courtesy: 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***

Why a Recovery Plan?

The ESA was enacted by Congress and signed into law December 28, 1973, by President Richard Nixon (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, 437 U.S. 153 1978)).

Thus, when a species is listed as Federally threatened or endangered under the ESA, the agency with jurisdiction over the species must develop and implement a plan for the species' recovery.

NOAA's National Marine Fisheries Service (NMFS) has jurisdiction over salmon and steelhead across the Pacific Northwest. These plans for recovery are developed to guide the process of restoring and safeguarding a future for the species and their ecosystems such that the protections of the ESA are no longer needed. The ESA requires recovery plans to include:

- 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;
- Objective, measurable criteria which, when met, would result in the determination that the species be removed from the list; and
- Estimates of the time required, and cost to carry out, those measures needed to achieve the plan's goal (of species recovery) and to achieve the intermediate steps toward that goal.

Building a Plan for Recovery: Setting the Biological & Informational Foundation

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 recovery plan covers the geographic area associated with the CCC coho salmon ESU; an area of approximately several million acres across California's central coast extending from Punta Gorda in southern coastal Humboldt County south to Aptos Creek in Santa Cruz County (Figure 1). The diverse geographic setting includes redwood and oak forestlands, rural working forests and agricultural lands as well as 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 led by the NMFS Southwest Fisheries Science Center. These memoranda describe the species historical population structure and biological viability (Bjorkstedt *et al.* 2005; Spence *et al.* 2008) and also describe the environmental and biological settings necessary to reduce the risk of extinction. A total of 75 watersheds (*e.g.*,

populations), between Punta Gorda and Santa Cruz County (including San Francisco Bay tributaries) were identified as historically supporting CCC coho salmon. These populations were grouped into five Diversity Strata which have geographically distinct areas with similar environmental conditions. For the ESU to be viable and at low risk of extinction, collectively the populations in four of the five Diversity Strata must be viable and for populations to be viable a high number of individuals need to survive to adulthood. This hierarchy of ESU, Diversity Strata, Population and Individual is carried forward throughout the analyses and final strategy of the recovery plan.

Not all populations are needed for, or capable of supporting recovery. We 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 populations and 11 supplemental populations across four Diversity Strata, to focus on for recovery (Figure 1).

The NCCO recovery team solicited and received input and assistance from many constituents and prepared multiple drafts of the CCC coho salmon recovery plan for internal, peer, headquarters, General Counsel, co-manager and public reviews. We thank all who invested time to review drafts and provide comments.

Figure 1: CCC coho salmon Diversity Strata and focus populations for recovery

Building a Plan for Recovery: The Life Cycle of Coho Salmon

Coho salmon are anadromous (ocean-going) fish and guided by the instincts of their ancestors 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 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 lasts about two years before they return to the stream they were born; to spawn and die. Death comes naturally after spawning and their carcasses gives new life and nutrients to the next generation of salmon and the ecosystem.

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 our 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.

> *"…ascending from the depths of the ocean to the sweet waters of some sequestered woodland pool, salmon fall easy victim to its human enemies, and perish by the hundreds every year just at the time when it is most valuable on the point of multiplying and replenishing its kind."*
>
> *Daniel B. Fearing, 1878*

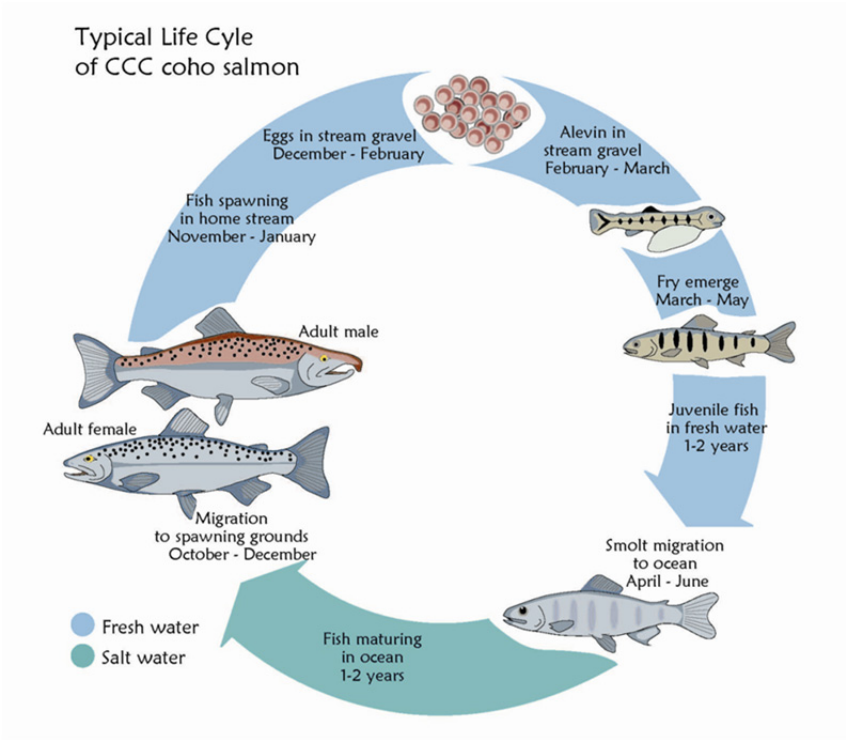


Figure 2: General overview of life stages (modified from Reeves 2009)

Adult Coho Salmon, Scott(s) Creek, ***Photo Courtesy: SWFSC***

Juvenile coho salmon, Scott(s) Creek, ***Photo Courtesy: Morgan Bond, SWFSC***

Smolt coho salmon, San Vicente Creek, ***Photo Courtesy: Chris Berry, City of Santa Cruz Water Department***

Building a Plan for Recovery: Assessing Conditions & Threats to CCC Coho

The more impaired the stream, the less likely coho salmon survive to reach the ocean and return as adults. 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). Habitat conditions evaluated were

passage, hydrology, habitat complexity, sediment, velocity refuge, estuary/lagoon, water quality, landscape patterns and viability. Natural and anthropogenic threats evaluated included disease, predation, severe weather, and habitat degradation from water diversions, road building and maintenance, urbanization, channel modification, unsustainable timber operations and climate change. 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.

Building a Plan for Recovery: Condition & Threat Results for CCC Coho Salmon

Results are displayed in "score cards" and provide a glimpse into those factors likely limiting survival and abundance of a specific life stage, population and the overall ESU; results are used to develop recovery actions. Summer and winter rearing survival for CCC coho salmon are likely very low due to impaired instream habitats such as a lack of complexity formed by instream wood, high sediment loads, lack of refugia habitats during winter, low summer flows and high instream temperatures (Table 1). The sources of these impairments are roads, water diversions and impoundments, residential and commercial development and severe weather patterns (Table 2). Comparing results across the ESU; patterns emerge. 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 show increasing high and very high threats. While ocean conditions and marine predation have impacts on the survival of CCC coho salmon they are natural forces that have been acting on these populations for millions of years. Coho salmon survival in the marine environment is largely affected by individual attributes, such as body size, growth rate, and ocean entry date; as well as environmental conditions, food availability, predation and competition (Quinn 2005). Thus, the number and health of smolts leaving freshwater for the ocean ultimately dictates the number of adults returning.

Table 1: Summary table of habitat conditions for each life stage. Results are color coded, with dark green representing very good habitat conditions for that attribute, light green representing good condition, yellow representing fair condition, and red representing conditions in poor condition.

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	Laguntas	Redwood	San Gregorio	Pescadero	Gazos	Waddell	Scott	San Vicente	San Lorenzo	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	F	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	F	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	F	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 2. Summary of threats across the CCC coho salmon ESU. Results are color coded, with dark green representing a low threat (L), light green representing medium (M), yellow representing high (H), and red representing a very high (VH) threat for each population.

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

The low survival of juveniles due to unsuitable habitat conditions has had a significant influence on the precipitous declines of CCC coho salmon populations. Long term historical data sets describing wild coho salmon abundances in California are limited; nonetheless, documentation and estimates by researchers and agencies show a pronounced decline of coho salmon over the past 70 years (Figure 3):

- 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);
- Less than 500 wild adults in 2009 (Spence, pers. comm. 2009); and
- Between 2,000 to 3,000 wild adults in 2011 (Gallagher and Wright 2012, Spence, pers. comm.2012).

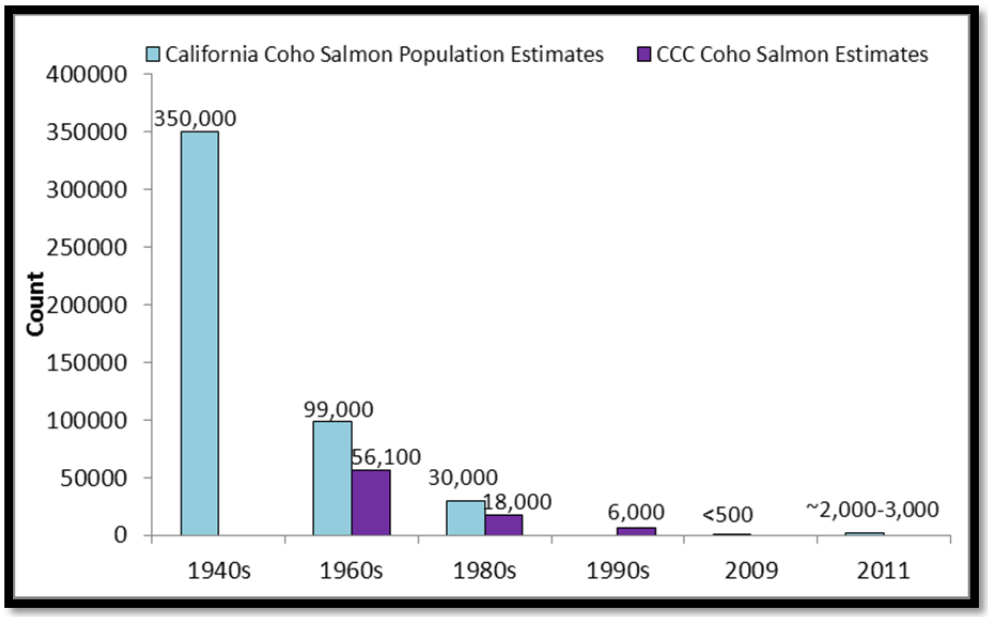


Figure 3: Historical estimates of coho salmon spawners across ESU

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

- Coho salmon are at a greater risk of extinction than five years ago;
- Populations at extreme risk of extirpation or extinct are Garcia River, Gualala River, Russian River, Walker Creek, Pescadero Creek and San Lorenzo;
- 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…indicate that the CCC coho salmon ESU is in danger of extinction."

Recovery or Extinction Prevention? Turning a Plan into Action for CCC coho

The impending extinction of CCC coho salmon is a call to shift our focus from long term recovery to include a short term strategy to prevent extinction. The situation is dire but not hopeless. 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 in the CAP analysis. In the lens of preventing 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) once key restoration work is near completion in occupied habitats.

NMFS has identified three overarching objectives to prevent CCC coho salmon from disappearing and ultimately, achieving recovery:

Objective 1: Prevent extinction by protecting habitats and reducing threats.

Objective 2: Re-establish viable populations in (at least) the 28 prioritized watersheds.

Objective 3: Begin standardized monitoring of coho salmon populations and their habitat across the CCC coho ESU. This will reduce uncertainty associated with habitat assessment methods and increase confidence in population estimates. Standardization will also improve accuracy in measuring effectiveness of recovery actions and tracking progress towards downlisting and delisting criteria.

Volume I of the Plan provides background, life history, population viability, an assessment of conditions and threats, NMFS implementation of the plan and monitoring recommendations. Volume II of the Plan provides population specific CAP results and recommended recovery actions as well as higher level actions needed to address more programmatic issues affecting the ESU as a whole.

Overall ESU Recovery Actions (summarized):

- Fund and expand Conservation Hatchery Captive Broodstock Programs.
- Immediately implement restoration to improve freshwater survival of all life stages.
- Continue and seek long-term funding for population and habitat monitoring.
- Incentivize landowners to maintain forestlands and restore unproductive timberland.
- Pursue protection and preservation of key habitats (*e.g.*, Conservation Banks).
- Establish CCC coho salmon plan outreach and implementation groups across the ESU.

Diversity Strata Actions (summarized):

Lost Coast

- Promote restoration focused at improving stream complexity and road improvements.
- Discuss benefits of incidental take permits (*e.g.*, Safe Harbor, etc.) for landowners that result in habitat improvements.
- Encourage Mendocino County to institute ordinances protective of CCC coho salmon.

Navarro-Gualala Point

- Institute water conservation programs.
- Promote restoration focused at improving stream complexity and road improvements.
- Discuss benefits of incidental take permits (*e.g.*, Safe Harbor, etc.) for landowners that result in habitat improvements.
- Encourage Mendocino County to institute ordinances protective of CCC coho salmon.

Coastal

- Evaluate expansion opportunities, and secure long term funding, for the Warm Springs Hatchery and Russian River Captive Broodstock Program to provide an expeditious alternative to conserve broodstock across the ESU.
- Encourage Counties to institute ordinances protective of CCC coho salmon.
- Discuss benefits of incidental take permits (*e.g.*, Safe Harbor, etc.) for counties, cities, etc.
- Improve and restore historical estuarine habitats.
- Institute water conservation programs.

San Francisco

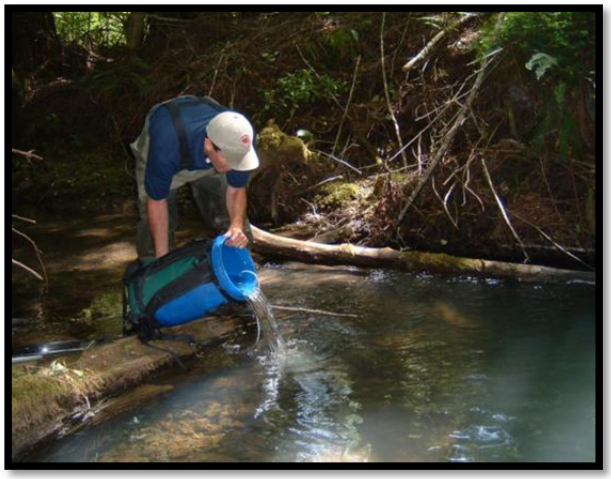
- Evaluate the feasibility and likelihood of success of re-establishing coho salmon populations into tributaries of the SF Bay where potential habitat exists. In addition, efforts should continue to protect those habitats from further degradation to increase the likelihood of successful re-establishment in the future.

Santa Cruz

- Fund captive broodstock program and expand outplanting opportunities in Stratum.
- Conduct outreach to landowners the value and benefits of instream large wood.
- Improve and restore estuarine habitats.
- Institute water conservation programs.

Adult CCC coho salmon, Russian River Captive Broodstock Program. ***Photo Courtesy: Ben White***

Broodstock programs may be a necessary step to prevent extinction; a process that is showing success for the Russian River population of CCC coho salmon. In 2001, the critically low numbers of CCC coho salmon in the Russian River led to emergency actions and intervention. A Russian River Captive Broodstock Program was organized and funded using conservation hatchery techniques for breeding, captive rearing and releases into the wild. It is intended to be a "genetic lifeboat" to preserve CCC coho salmon in the Russian River with the goal of living and reproducing in the wild on their own. The Russian River Captive Broodstock Program is showing strong signs of success and each year more adults are returning to the streams they were outplanted as juveniles to spawn. Captive broodstock programs will be necessary in specific locations in the ESU to prevent CCC coho salmon from going extinct. However, captive broodstock programs alone cannot save the salmon, conditions must be improved and threats reduced to provide salmon a home with safe passage to and from the ocean; only then will the natural setting be sufficient to ensure long term sustainability of CCC coho salmon.



Release of juvenile broodstock coho salmon into Russian River tributaries.
Photo Courtesy: Russian River Captive Broodstock Program

The Bottom Line: A Word on Costs

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" (16 U.S.C. 1531-1544, as amended). This Plan estimates recovery for CCC coho salmon could take 50 to 100 years with costs for implementing the actions roughly $1.5 billion. Since 1999, on average $12 million per year has been dedicated for salmon restoration in California through the Pacific Coastal Salmon Recovery Fund alone with the State matching those funds at 25-33%. Many agencies, non-profit organizations and others are making financial commitment for the preservation of coho salmon in California. Funding mechanisms are already in place, and can be viewed as an investment to realize long term economic, societal and ecosystem benefits for not only CCC coho salmon but the other species in these streams such as Chinook salmon and steelhead.

Healthy salmon populations provide significant economic benefits. Entire communities, businesses, jobs and even cultures have been built around the salmon of California. 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.*, 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). Salmonid recovery is an 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.

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, 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 stated that, "Success or failure will depend on whether salmon are recognized as equal stakeholders" (2003).

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 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.

> *"…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*

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 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. 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.

Please join us! If we can do it for the Condor, the Bison, the Bald Eagle, the Whooping Crane…we can do it for our CCC coho salmon. Yes we can.

Whooping Cranes. ***Photo Courtesy: Operation Migration***

"…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

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