

Appendix D

*CCC Coho Salmon Recovery Plan
Threats Description and Taxonomy*

Appendix D: CCC coho salmon Recovery Plan - Threats Description and Taxonomy

NMFS utilized The Nature Conservancy Conservation Assessment Planning (CAP) threat taxonomy to develop threats relevant to the recovery of CCC coho salmon. In the CAP protocol these are termed “sources of stress”. These “sources of stress” are direct threats to the species, and are defined as the “proximate activities or processes that have caused, are causing or may cause the stress (*e.g.*, the direct or indirect impairment of salmonid habitat from human or natural sources)” (TNC 2007). The NCCC Domain refined the CAP threat taxonomy to include both human activities and natural events as threats.

Threats are distinct from the key attributes developed to define current conditions in each watershed. Instead of conditions that currently exist, they attempt to define future conditions likely to limit recovery resulting from currently active issues such as ongoing land use practices, or from issues likely to occur in the future (usually within 10 years), such as residential development. Each threat is compared against a series of altered or impaired key attributes for each population, and ranked using the following metrics:

1. Source of Stress (Irreversibility): Reversibility of the stress; and
2. Source of Stress (Contribution): Expected contribution of the source, acting along, to the full expression of a stress under current circumstances (*i.e.*, given the continuation of the existing management/conservation situation).

Many threats are driven by social, economic, or political causes that then become the focus of conservation strategies. NMFS evaluated stresses and threats according to the CAP workbook protocols. Sixteen threats were identified and evaluated for the CAP analyses. For threats ranked as high or very high, the NCCC Domain Recovery Team developed strategies to reduce or abate the threats. Where threats were identified as moderate, NMFS in some cases developed recovery actions based on knowledge or information that that threat rank could worsen in the near future due to anticipated . NMFS used the following definitions and methods of assessment in this Threat Taxonomy for ranking each major threat to CCC coho recovery.

Agriculture

DEFINITION:

Annual and perennial crop farming and associated operations and, for recovery planning analysis purposes, excludes grazing, ranching or timber harvest.

IMPACTS TO SALMONIDS:

Agricultural practices can adversely affect salmon habitats by altering riparian vegetation and natural drainage patterns, introducing water-borne pollutants, increasing the likelihood of channel simplification, and decreasing streamflow through water diversion.

APPLICATION TO ESU:

The major agricultural practices within the CCC coho salmon ESU are vineyards and orchards (apples and pears), generally located north of the San Francisco Bay. Brussel sprouts, lettuce, and flower crops (greenhouse and row crops) are found in the southern areas of the ESU.

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THREAT CONTEXT:

Some agricultural activities and programs have made strides in improving riparian protections, implementing pollution and sediment discharge controls, and promoting instream habitat restoration (e.g., Fish Friendly Farming, TMDL's and others). However, the overall impact to coho salmon and their habitat is generally very significant where these activities occur, and particular aspects of agriculture can have major direct and indirect impacts (e.g., use of plethoris to control gypsy moth, removal of riparian vegetation from farming areas due to perceived threats regarding e-coli).

THREATS EVALUATED & RANKED:

The analysis included the practice and all associated operations of developing and maintaining, continuous or seasonal ground disturbance, planting, harvesting, fertilizing, and irrigating row crops, orchards, vineyards, commercial greenhouses, nurseries, gardens, etc.

Threats were evaluated for their potential to:

1. Introduce into the stream channel water-borne pollutants such as sediment and pesticides, and elevate nutrient levels;
2. Alter riparian vegetation integrity, diversity, function, and composition;
3. Alter natural drainage channels and hydrology patterns; and
4. Simplify channel complexity and destabilize stream banks.

The final threat rankings were determined by the following:

A High threat ranking results when ecosystem function and process are (or are expected to be) severely altered. A High threat could include practices requiring large areas of cultivation and large quantities of pesticides and herbicides over significant proportions of the watershed.

A Moderate threat ranking results when ecosystem function and process are (or are expected to be) moderately altered, but could be reversed or ameliorated.

A Low threat ranking results when ecosystem function and process are (or are expected to be) largely intact, slightly altered, and easily reversible. A Low threat could include practices that have a low impact and use little or no herbicides and pesticides in the watershed.

RESOURCES UTILIZED:

GIS analysis of the percentage of land zoned for agriculture, watershed specific assessments, NMFS staff knowledge of watersheds and ongoing practices, *etc.* (See Appendix C for more information).

Channel Modification

DEFINITION:

Directly and/or indirectly modifying and/or degrading natural channel-forming processes and morphology of perennial, intermittent and ephemeral streams and estuarine habitats.

IMPACTS TO SALMONIDS:

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Channel modifying structures such as riprap and gabions reduce the occurrence and creation of undercut banks and side channels, limit or eliminate LWD recruitment, and often result in the removal of riparian vegetation. These techniques are used extensively to line channel banks and beds, bank stabilization structures eliminate or severely reduce streambed gravel recruitment necessary for salmonid spawning and macro invertebrate habitat. Bank stabilization, levee construction for flood control, and filling in floodplains for land reclamation also disconnect rivers and streams from their floodplains. These activities prevent the creation of, or block access to, off channel habitat used by salmonids as refuge from high stream flows, and impede stream geomorphic processes.

APPLICATION TO THE ESU:

In the process of protecting public and private infrastructure and property, channel modification has reduced salmonid habitat suitability by permanently altering natural channel forming processes, particularly in the many urbanized watersheds within the CCC coho salmon ESU.

THREAT CONTEXT:

Currently, in most circumstances, permits from the U.S. Army Corps of Engineers are required for channel modifications, which in turn require ESA consultations with NMFS. However, the majority of habitat damage resulting from channel modification (including channelization, removal of LWD, and placement of rock slope protection etc.) took place prior to the listing of CCC coho salmon. Once channel modifying infrastructure is in place it is usually followed by increased development, which in turns leads to additional channel modification. Once infrastructure is in place it is often impractical, difficult, and expensive to remove. With a growing human population the pressure to modify natural stream channels is anticipated to continue.

THREATS EVALUATED & RANKED:

The analysis included evaluation of estuarine management (e.g., lagoon breaching, dredging), flood control activities, large woody debris removal, levee construction, vegetation removal, herbicide application, stream channelization, bank stabilization (hardening that limits channel movement or meander), dredging and other forms of sediment removal. These actions typically occur within the two-year bankfull stage and adversely affect natural channel forming processes.

Threats were evaluated for their potential to:

1. Damage instream and near stream habitat and lower habitat complexity;
2. Precipitate riparian habitat loss, decreasing channel roughness (decrease in Manning's N roughness coefficient);
3. Alter drainage channels and hydrologic patterns;
4. Alter riparian zone diversity, function, and composition;
5. Alter in channel and stream bank stability;
6. Alter or destroy floodplain/estuarine/wetland habitats;
7. Introduce water-borne pollutants, such as sediment and chemicals, into the aquatic environment, and adversely alter nutrient levels; and
8. Simplify channel morphology (e.g., incision rate and floodplain connectivity).

A High threat ranking results when ecosystem function and process are (or are expected to be) severely altered. A High threat could include large levee projects within IP-km that adversely

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modify sediment transport, accelerate stream velocities, and alter riparian vegetation structure from historical conditions.

A Moderate threat ranking results when ecosystem function and process are (or are expected to be) moderately altered but could be reversed or ameliorated.

A Low threat ranking results when ecosystem function and process are (or are expected to be) largely intact, slightly altered, and easily reversible. A lower threat could include bank stabilization projects that use bioengineering techniques.

RESOURCES UTILIZED:

No central repository of channel modifying activities exists for watercourses in the CCC ESU, and the quality and quantity of information varies significantly between watersheds. Information sources included watershed assessments, DFG habitat typing information, personal communications with local experts, and NMFS staff knowledge of individual watersheds.

Climate Change

DEFINITION:

Long-term climatic changes outside the range of natural variation that may be linked to global climate change and other large-scale climatic events.

IMPACTS TO SALMONIDS:

Climate change may profoundly affect salmonid habitat on a regional scale by altering streamside canopy structure, increasing forest fire frequency and intensity, elevating instream water temperatures; and altering rainfall patterns that in turn affect water availability. These impacts are likely to negatively impact salmonid population numbers, distribution, and reproduction.

APPLICATION TO ESU:

Coho salmon in the CCC ESU are at the southern extent of the species range, and may be more vulnerable to changes in water availability and instream temperatures. This threat is discussed in more detail in Appendix A: Marine and Climate Scenarios. Significant alteration in the instream and near-stream environments due to climate change may result in further range contraction for CCC coho and a reduction in overall habitat availability in the more resilient watersheds.

THREAT CONTEXT:

This threat was evaluated by assuming future effects of climate change and the expected sea level rise in California will result in lost estuarine habitat, reduced groundwater recharge and base-flow discharge, with associated rises in stream temperature and demand for water supplies in the ESU. Smaller (remnant) populations in such areas are likely at most risk from climate change.

THREATS EVALUATED & RANKED:

Threats were evaluated for their potential effects to managing limited water storage to provide cool water refugia, additional demands on existing water supplies, and changes in vegetation patterns.

Threats were evaluated for their potential to:

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1. Elevate instream water temperatures and alter historical hydrologic patterns, and
2. Alter the composition of native plant communities, which may adversely alter riparian process and function.

A High threat ranking results when ecosystem function and process are (or are expected to be) severely altered. A High threat may include circumstances that preclude future opportunities to protect critical refugia habitats.

A Moderate threat ranking results when ecosystem function and process are (or are expected to be) moderately altered but could be reversed or ameliorated.

A Low threat ranking results when ecosystem function and process are (or are expected to be) largely intact, slightly altered, and easily reversible.

RESOURCES UTILIZED:

NMFS has considered numerous future habitat condition scenarios for the CCC coho based on projected climate change impacts as described in Appendix A. We used existing information on the current distribution of extant populations and areas targeted for recovery, and evaluated current stresses into the future.

Disease, Predation and Competition

DEFINITION:

Native (e.g., sea lions, mergansers, etc.) and non-native species (e.g., *Arundo donax*, large mouth bass) and diseases having, or predicted to have, significant harmful effects on salmonids and/or their habitat.

IMPACTS TO SALMONIDS:

Infectious disease can influence adult and juvenile coho salmon survival. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Specific diseases such as bacterial kidney disease, *ceratomyxosis*, *columnaris*, *furunculosis*, infectious hematopoietic necrosis virus, redmouth and black spot disease, erythrocytic inclusion body syndrome, and whirling disease, among others, are present and are known to affect coho salmon (Foott *et al.* 1994; Leek 1987; Wood 1979; Rucker *et al.* 1953). Diseases such as bacterial kidney disease have been identified as a limiting factor in some populations (e.g., Noyo River), particularly those subject to artificial propagation.

Cooper and Johnson (1992) and Botkin *et al.* (1995) reported marine mammal and avian predation may occur on some local salmonid populations, but it was a minor factor in the decline of coast wide salmonid populations. According to Moyle (2002), predation by seals and sea lions on returning fish when populations are low may prevent recovery.

Principal competitors for the food and space of juvenile coho salmon are other salmonids, especially Chinook salmon and steelhead (Moyle 2002), both of which are listed species within the range of CCC coho salmon. Other sources of competition include alien species, including alien riparian species (such as *Arundo donax*) which can completely disrupt riparian communities.

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APPLICATION TO ESU:

Disease, predation and competition may significantly influence salmonid abundance in some local populations when other prey species are absent and physical conditions lead to the concentration of salmonid adults and juveniles (Cooper and Johnson, 1992). Also, altered stream flows can create unnatural riverine conditions that favor the non-native species life histories more than the native coldwater species (NMFS 1996; McEwan and Jackson 1996; DFG 1994, Brown *et al.* 1994).

THREAT CONTEXT:

Relative to the other threats, disease and predation are not major factors contributing to the overall decline of coho salmon in the CCC ESU. However, they may compromise the ability of depressed populations to rebound. Competition in the context of habitat alteration leading to reduced survival is a serious limiting factor in some streams in the ESU.

THREATS EVALUATED & RANKED:

The following threats were evaluated and ranked: introduction of non-native animal species that prey upon and/or (directly or indirectly) compete with native salmonids; introduction of non-native vegetation that competes with and/or replaces native vegetation; and creation of conditions favorable to increased populations and/or concentration of native predators.

Threats were evaluated for their potential to:

1. Simplify or modify instream or riparian habitat condition;
2. Reduce feeding opportunities;
3. Shift the natural balance between native/non-native biotic communities and salmonid abundance, resulting in disproportional predation and competition;
4. Increase opportunities for infectious disease, and
5. Change water chemistry (*e.g.* inputs of acidic detritus from eucalyptus, or low DO resulting from increased foreign biomass), and
6. Impede instream movement and migration, or reduce riparian function (*e.g.*, *Arundo donax*).

A High threat ranking results when (1) ecosystem function and process are (or are expected to be) severely altered or (2) impacts to the population are severe. A High threat occurs when amelioration of the consequences of this threat are largely irreversible.

A Moderate threat ranking results when (1) ecosystem function and process are (or are expected to be) moderately altered or (2) impacts to the population are moderate. A Moderate threat occurs when the consequences of this threat are largely irreversible but could be ameliorated.

A Low threat ranking could result when (1) ecosystem function and process remain largely intact or (2) are slightly altered, and easily reversible.

RESOURCES UTILIZED:

NMFS used a variety of resources to evaluate this threat, from region wide assessments of the impacts of predation to site specific watershed assessments and individual reports. In general, there was little site specific information by which to evaluate this threat, and in many cases

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NMFS staff solicited the opinions of local experts as well as utilizing best professional judgment after considering information on pinniped and bird predation and competition and predation by non-native species.

Droughts

DEFINITION:

Less than the seasonal average (mean) of rainfall during a calendar “water year” with attendant effects to streamflow and riparian conditions.

IMPACTS TO SALMONIDS:

Droughts can have a variety of negative impacts on salmon and other fish populations at several points of their life cycles. Adult salmon can experience difficulties reaching upstream spawning grounds during certain low-flow conditions. Low flows can also increase pre-spawn mortality rates in returning adult salmon when high adult escapement coincides with elevated water temperatures, low dissolved oxygen levels, and increased disease transmission between fish (DFG 2003). Drying streams can severely lower juvenile rearing habitat and carrying capacity. Some salmon species spawn in channel margins, side channels and smaller tributaries, and spawning for those species would have to occur in mainstem waters if off-channel and tributary habitat is unavailable because of low flows. Where this occurs, salmon redds within the mainstem river channel may be more susceptible to bed scour during the fall and winter (Washington Dept. Fish and Wildlife <http://wdfw.wa.gov/drought/index.htm>). In other cases, instream flow can drop after the salmon spawn, leaving salmon redds dewatered.

APPLICATION TO ESU:

Droughts are a natural phenomenon in Mediterranean climate on the CCC ESU. Nonetheless, drought impacts can result in depressed salmon runs three years later, when those coho salmon would be returning as adults. The drought of 1976/1977 is believed to have significantly impacted coho populations south of San Francisco Bay (Hope 1994).

THREAT CONTEXT:

In the ESU there is increased pressure for limited water resources in many of the targeted watersheds. This problem is most severe in the southern part of the ESU where rainfall is generally less than in the northern part of the ESU. Compounding this problem is a larger human population in the southern streams with an attendant higher number of instream water diversions.

THREATS EVALUATED & RANKED:

Less than the seasonal average (mean) of rainfall during a calendar “water year” with attendant effects to streamflow and riparian condition.

Threats were evaluated for their potential to effect:

1. Insufficient flows to facilitate egg incubation, juvenile rearing, smolt emigration, and juvenile immigration,
2. Poor water quality leading to increased instream temperatures, low DO, decreased food availability, increased concentrations of pollutants, *etc.*,
3. Earlier than normal water diversion for anthropogenic purposes, and

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4. Insufficient flows to breach sandbars at river mouths.

A High threat ranking results when ecosystem function and process are (or are expected to be) severely altered. A High threat ranking may occur in watersheds where water is already over allotted under normal flow conditions.

A Moderate threat ranking results when ecosystem function and process are (or are expected to be) moderately altered but could be reversed or ameliorated.

A Low threat ranking results when ecosystem function and process are (or are expected to be) largely intact, slightly altered, and easily reversible.

RESOURCES UTILIZED:

This threat was evaluated in the context of available information regarding ongoing water diversions coupled with the effects of drought. A variety of resources were used to evaluate this potential impact, including individual watershed assessments, briefings with NMFS, DFG, and others familiar with individual watersheds and existing diversions, *etc.*

Fire and Fuel Management

DEFINITION:

Fires (including wildfires and prescriptive burns) and fire suppression actions (fire fighting and fire prevention).

IMPACTS TO SALMONIDS:

Fire, particularly catastrophic wildfires, can impair salmonid habitat by reducing or eliminating stream side canopy, resulting in increased soil erosion that can render instream rearing habitat unsuitable for many decades. Hotter fires consume organic matter that binds soils, leading to an increase in erosion potential; in the worst case, high intensity fires can volatilize minerals in the soil causing it to become hydrophobic.

APPLICATION TO ESU:

The interior and southern areas of the ESU may have significant fire risk with potential for watershed disturbance and increased sediment yield. Coastal ecosystems have higher rainfall, more resilient vegetation (redwood forest), less extreme summer air temperatures and, therefore, less risk of catastrophic fire. Spence *et al.* (1996) recognized the extent of watershed damage and risk to salmonid habitat is directly related to burn intensity.

THREAT CONTEXT:

Fire management would not normally take place in riparian vegetation, so impacts to coho salmon are expected to be inadvertent, or resulting from severe conditions. Few areas within the range of CCC coho salmon are on Federal lands, so most fire fighting activities are conducted by local fire districts and CalFire. Unlike federal lands, where NMFS has extensive interaction with the Forest Service to minimize adverse consequences from fire fighting actions, NMFS has little interaction with fire fighting agencies in the CCC ESU. Consequently, impacts from fire fighting (road building, water diversion, aerial retardants) likely have a great adverse impact to CCC coho salmon and their habitats.

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THREATS EVALUATED & RANKED:

Construction of fire breaks, roads, application of fire retardants, water use planning, fuels management, and fire suppression.

Threats were evaluated for their potential to:

1. Increase erosion, sedimentation and landslide potential;
2. Elevate fuel loading leading to a higher potential of catastrophic burns;
3. Impair future large woody debris recruitment; and
4. Alter vegetative/riparian communities through invasive species/post-fire management.

A High threat ranking results when ecosystem function and process are (or are expected to be) severely altered. A High threat may include high fuel loading over a large area, or extensive burns above, or adjacent to, critical spawning and rearing areas.

A Moderate threat ranking results when ecosystem function and process are (or are expected to be) moderately altered but could be reversed or ameliorated.

A Low threat ranking results when ecosystem function and process are (or are expected to be) largely intact, slightly altered, and easily reversible. A mature redwood forest upstream and adjacent to IP-km generally will rank as a Low threat due to the fire resistant qualities of redwood.

RESOURCES UTILIZED:

The current prediction for regional effects from fire intensity, frequency and duration as well as fire and fuel management practices (fire suppression, prescribed burning and limited use of mechanical treatments to reduce fire fuel loads) were examined.

Fishing and Collecting

DEFINITION:

Harvesting salmonids for recreation, subsistence, in-situ research, or cultural purposes; which includes illegal and legal activities, such as accidental mortality/bycatch

IMPACTS TO SALMONIDS:

Commercial and sport fishing for coho salmon is closed in California due to recognition of the dramatic species declines. However, coho salmon are incidentally caught as bycatch by both commercial and sport fishers. These activities are most likely to impact the adult lifestage. The amount of bycatch is unknown, but it may have a significant adverse effect due to the extremely low population levels where every individual is of greater significance to the population's persistence than when the population was large. Fish deaths caused by activities such as fishing could be more damaging to the population when populations are depleted due to natural conditions (such as changes in ocean productivity) (NRC 1996). Handling hooked fish before releasing them also contributes to mortality (Clark and Gibbons 1991).

APPLICATION TO ESU:

According to Moyle (2002), present populations are so low that moderate fishing pressure on wild coho may prevent recovery, even in places where stream habitats are adequate. In California,

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coho salmon caught incidentally must be released, but the act of capture comes at a cost to the individual through energetic expenditure, wounding, increased susceptibility to disease, or eventual predation (i.e. sea mammals eating the fish before it is landed).

THREAT CONTEXT:

The opening of freshwater the sport fishing season (Table 1), as early as November 1 north of San Francisco Bay¹ and December 1 south of San Francisco Bay², likely preferentially targets coho salmon during the early portion of fishing season as this species migrates into freshwater earlier than steelhead (Shapovalov and Taft 1954). This early start likely places adult coho salmon at greater risk of capture than if the season were setback to a later date.

Table 1: Independent (I) and Dependent (D) focus watersheds where winter freshwater fishing for steelhead is permitted.

Watershed	Season	Bag Limit
Albion (I)	Nov 1 – Mar 31	1 hatchery trout or 1 hatchery steelhead
Aptos (D)	Dec 1 – Mar 7	0
Big River (I)	Nov 1 – Mar 31	1 hatchery trout or 1 hatchery steelhead
Cottaneva (D)	Nov 1 – Mar 31	1 hatchery trout or 1 hatchery steelhead
Garcia (I)	Nov 1 – Mar 31	1 hatchery trout or 1 hatchery steelhead
Gualala (I)	Nov 1 – Mar 31	1 hatchery trout or 1 hatchery steelhead
Lagunitas (I)	Closed	
Navarro (I)	Nov 1 – Mar 31	1 hatchery trout or 1 hatchery steelhead
Noyo (I)	Nov 1 – Mar 31	1 hatchery trout or 1 hatchery steelhead
Pescadero (I)	Dec 1 – Mar 7	0
Butano		
Russian (I)	Nov 1 – Mar 31	2 hatchery trout or 2 hatchery steelhead
San Gregorio (D)	Dec 1 – Mar 7	0
San Lorenzo (I)	Dec 1 – Mar 7	0

¹ Minimum flow requirements (based on a minimum of 500 cfs at the gauging station on the mainstem Russian River near Guerneville (Sonoma County) and 15 cfs at the gauging station at the Oak Knoll Bridge on the mainstem Napa River (Napa County))

² Minimum flow requirements are determined (based on an undefined flow at the Big Sur and Carmel rivers in Monterey County) by DFG.

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Scott (D)	Dec 1 – Mar 7	0
Soquel (D)	Dec 1 – Mar 7	0
Ten Mile (I)	Nov 1 – Mar 31	1 hatchery trout or 1 hatchery steelhead
Waddell (D)	Dec 1 – Mar 7	0
Walker (~I)	Nov 1- Mar 31	0

The Bag Limits set forth in the 2009-2010 California Freshwater Sport Fishing Regulations are likely a source of confusion for some fishers and should be amended to reflect actual fishery conditions. Eight Independent and two Dependent watersheds have a bag limit for both hatchery trout or hatchery steelhead, when in reality only the Russian River has hatchery trout or steelhead plantings. The current stated Bag Limits may encourage fishers to unknowingly target specific streams where no stocking occurs and in turn, incidentally hook coho salmon.

Commercial and sport ocean fishing near the mouths of watershed when sandbars remain closed may result in increased rates of adult coho salmon capture. Adult coho salmon congregating offshore while awaiting entry into the estuaries are likely at more risk of capture than those returning to watersheds without sandbars, or where sandbars have breached.

Most streams in the ESU do not have minimum flow requirements, which has resulted in some sport fishing in streams at extremely low flows early in the season when coho are likely present – disproportionately to steelhead. This may also result in increased risk to adults.

THREATS EVALUATED & RANKED:

Incidental harvest for recreation and subsistence, authorized relocation, research and collection, incidental capture (e.g., hooking), and illegal activities such as poaching and unpermitted collection.

Threats were evaluated for their potential to:

1. Increase mortality/harm and displacement;
2. Increase competition when fish are relocated; and
3. Precipitate compensatory effects at the population level.

A High threat ranking results when impacts to the population are (or are expected to be) severe. A High threat may occur in critical adult staging areas with extensive legal and illegal fishing pressure.

A Moderate threat ranking results when impacts to the population are (or are expected to be) moderate but could be reversed or ameliorated. (See Appendix C for more information)

A Low threat ranking results when impacts to the population are (or are expected to be) low and easily reversible. A Low threat may occur in watersheds under large private (i.e., commercial

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timberlands) ownership where public access is restricted or in areas with significant enforcement presence.

RESOURCES UTILIZED:

Recreational steelhead angling was the principle activity considered for this indicator rating because it is the type of fishing most likely to impact adult salmonids of other species. We ranked the impact of Fishing and Collecting by tallying the number of fishing trips reported in the Steelhead Report Card during each species' adult migration period for the most recent year of record.

Hatcheries

DEFINITION:

Hatcheries are artificial propagation facilities designed to produce fish for harvest, or for escaping harvest to spawn. A conservation hatchery differs from a production hatchery since it specifically tries to supplement or restore naturally spawning salmon populations. Artificial propagation, especially the use of production hatcheries, has been a prominent feature of Pacific salmon fisheries enhancement efforts for several decades.

IMPACTS TO SALMONIDS:

Potential impacts to salmonids from hatchery operations include a number of categories including; genetic, ecological, overfishing, behavioral, and disease.

Genetic

Genes determine the characteristics of living things. Human intervention in the rearing of wild animals has the potential to cause genetic change. These genetic changes impact salmon diversity and the health of salmon populations. Hatchery programs vary and therefore the risks identified below vary by hatchery. Genetic risks of artificial propagation on wild populations include:

1) Inbreeding

Inbreeding can occur when the population for a hatchery comes from a small percentage of the total wild and/or hatchery fish stock (for example, 100 adults are used out of a population of 1 million). If only a small number of individuals are used to create the new hatchery stock, genetic diversity within a population can be reduced. Inbreeding can affect the survival, growth and reproduction of salmon.

2) Intentional or artificial selection for a desired trait (such as growth rate or adult body size)

Although not common practice today, some hatchery programs intentionally select for larger fish (or other specific traits). This selection changes the genetic makeup of the hatchery stock, moving it further away from naturally reproducing salmon stocks.

3) Selection resulting from nonrandom sampling of broodstock

The makeup of a hatchery population comes from a selection of wild salmon and/or returning hatchery salmon that are taken into captivity (*i.e.*, broodstock). If, for example, only early-returning adults are used as broodstock, instead of adults that are representative of the population as a whole (*i.e.*, early, normal, and late-returning adults), there will be genetic selection for salmon that return early.

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4) Unintentional or natural selection that occurs in the hatchery environment

Conditions in hatchery facilities differ greatly from those in natural environments. Hatcheries typically rear fish in vessels (*i.e.*, circular tanks and production raceways) that are open and have lower and more constant water flow than that which occurs in natural streams and rivers. They also tend to hold fish at higher densities than those that occur in nature. This type of environment has the potential to alter selection pressures in favor of fish that best survive in hatchery, not natural, environments.

5) Temporary relaxation during the culture phase of selection that otherwise would occur in the wild

Artificial mating disrupts natural patterns of sexual selection. In hatcheries, humans select the adult males and females to mate, not the salmon. Humans have no way of knowing which fish would make the best natural breeders. In addition, selection is relaxed up until the time when juveniles are released from the hatchery (because they don't face the same predation and foraging challenges as wild juvenile fish). Fish raised in hatchery environments face very different pressures than those raised in the wild.

Ecological Risk

Hatchery-produced fish often differ from wild fish in their behavior, appearance, and/or physiology. Ecological risks of artificial propagation on wild populations include:

1) Competition for food and territory

Competition between wild and hatchery fish can occur. It is most likely to occur if the fish are of the same species (wild Chinook salmon and hatchery reared Chinook salmon) and they share the same habitat (quiet, shallow water or deep fast water) and diet.

2) Predation by larger hatchery fish

If hatchery-released salmon are larger than wild salmon, evidence suggests that, for certain species, hatchery-released salmon can eat wild salmon.

3) Negative Social Interactions

Juvenile salmon establish and defend foraging territories through aggressive contests. When large numbers of hatchery fish are released in streams where there are small numbers of wild fish, hatchery fish are more likely to be more aggressive, disrupting natural social interactions.

4) Carrying Capacity Issues

Carrying capacity is a measure of the amount of a population (like the amount of salmon) that can be supported by a particular ecosystem. Carrying capacity changes over time with the abundance of predators and resources such as food and habitat. When hatchery fish are released into streams where there are wild fish, there can be competition for food and space. Many streams and watersheds are degraded due to contamination, development, etc. Questions are now being asked about the numbers of fish that different streams and ecosystems can support.

Behavioral

Hatchery environments are different than stream environments. Hatcheries typically rear fish in vessels (*i.e.*, circular tanks and production raceways) that produce sterile environments where there is no underwater structure (*i.e.*, sticks and wood), little or no overhead cover (such as cover

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from nearby trees and shrubs), and a predictable food supply. Consequently, hatchery fish tend to have different foraging, social, and predator-avoidance behavior.

Overfishing

Large-scale releases of hatchery fish have supported commercial, Tribal, and sport fishing practices for many years. However, large-scale releases of hatchery fish in a mixed-population fishery create a risk of overfishing for wild populations. For example, if fishers are allowed to catch half of the more abundant, hatchery stocks, half of the wild stocks will also be harvested if they occur at the same time and place as the hatchery fish. Because hatchery populations have high survival in the hatcheries, they can generally support higher harvest rates. Wild stocks, on the other hand, are typically much smaller, and their population could be harmed by such high harvest rates. The National Marine Fisheries Service and fisheries managers are currently looking for opportunities to support selective harvest of hatchery fish (i.e., harvest that doesn't impact wild stocks). Selective harvest opportunities could be supported through catch and release programs and/or in places where hatchery stocks are isolated from wild stocks (i.e., if hatchery stocks use a different stream or enter the stream at a different time than wild stocks).

Fish Health

The effects of disease on hatchery fish and their interaction with wild fish are not well understood. Hatcheries can have disease outbreaks. Once released, these fish can transmit disease to wild fish.

APPLICATION TO ESU:

Historically, out of basin and out-of-ESU hatchery coho were outplanted in many watersheds in the ESU. Some fish originated from Baker Lake in Washington State in the early part of the last century and until recently coho from the Noyo River Egg Collecting Station (ECS) were outplanted in many watersheds in the ESU. Most of the hatcheries in the ESU were smaller than the production hatcheries in other parts of the state but the long history of outplanting has likely adversely affected genetic diversity of coho in the ESU. Disease, particularly bacterial kidney disease, has been a source of concern in regards to the Noyo ECS. In addition, excluding grisle from the Noyo ECS spawning program may have decreased genetic diversity of the Noyo population.

THREAT CONTEXT:

Two hatcheries are present in the ESU; the Corps' Don Clauson Hatchery at Warm Springs Dam in the Russian River watershed and the King Fisher Flat facility on Scott Creek operated by Monterey Bay Salmon and Trout Project. Both facilities are operated as broodstock programs and receive considerable oversight from DFG and NMFS.

THREATS EVALUATED & RANKED:

A High threat ranking results when impacts to the population are (or are expected to be) severe. A high threat may include a facility operated for the purpose of maximum production with no consideration for genetic impacts to the population.

A Moderate threat ranking results when impacts to the population are (or are expected to be) moderate but could be reversed or ameliorated. A moderate threat might include a facility operated with minimal regulatory oversight or that takes a significant proportion of a spawning run but attempts to minimize genetic impacts.

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A Low threat ranking results when impacts to the population are (or are expected to be) low and easily reversible. An example of a low threat would include a broodstock facility operated with significant oversight by regulatory agencies and with backup rearing facilities.

RESOURCES UTILIZED:

Sources of information included, personal communications with local experts, hatchery managers, and NMFS and DFG staff knowledgeable on the operations of the two existing broodstock facilities.

Livestock Farming and Ranching

DEFINITION:

Domestic terrestrial animals raised in one location, or domestic or semi-domesticated animals allowed to roam in the wild and supported by natural habitats (*e.g.*, cattle feed lots, chicken farms, dairy farms, cattle ranching)

IMPACTS TO SALMONIDS:

Livestock grazing is the most widespread land-management practice in the western North America, occurring over 70 percent of the western United States (Noss and Cooperrider cited in Donahue 1999). The impacts of livestock grazing in riparian areas have been widely studied. Direct effects include elevated levels of fecal coliform bacteria and sediment in streams, degraded stream banks and bottoms, altered channel morphology from livestock trampling, lowered ground water tables and reduced streamside vegetation leading to a deterioration of fish habitat (Armour and others 1991, Behnke 1980, Belsky and others 1999, Donohue 1999, Kovalchik and Elmore 1992, Overton, Chandler, and Pisano 1994).

Animal wastes carried by runoff can contaminate water sources through the addition of oxygen-depleting organic matter (Knutson and Naef 1997). Runoff from concentrated fecal sources can change water quality, causing lethal conditions for fish. As the biochemical oxygen demand increases, dissolved oxygen within the water column decreases and ammonia is released, creating water quality conditions stressful to fish.

APPLICATION TO ESU:

Behnke and Zarn (1976) and Armour *et al.* (1991) indicate that overgrazing is one of the major contributing factors in the decline of Pacific Northwest salmon. George *et al.* (2002) found that cattle trails in California produced 40-times more sediment than adjacent vegetated soil surfaces. In the CCC ESU, the adverse impacts from cattle grazing are believed less problematic than other areas of California, because it is limited in extent within the CCC coho ESU. Point source impacts from livestock facilities have impacts in some targeted watersheds.

THREAT CONTEXT:

To address potential environmental impacts of agricultural operations, several programs have been developed. These programs assist landowners in developing best management practices for their respective crops and land use. Some of the programs developed include the Rangeland Water Quality Short-course and the Dairy Quality Assurance Program. Livestock grazing and ranching is generally concentrated in just a few of the watersheds targeted for coho recovery.

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THREATS EVALUATED & RANKED:

Grazing intensity and seasonality, stockyard proximity to the stream channel, damage to riparian zones, and water quality impacts resulting from animal waste and increased erosion.

Threats were evaluated for their potential to:

1. Elevate the concentration of water-borne pollutants such as sediment, toxic chemicals/substances (i.e. hormones), and nutrient levels,
2. Alter riparian zone diversity, function, and composition,
3. Alter drainage channels and hydrology (soil compaction), and
4. Simplify channel structure and alter stream bank stability.

A High threat ranking results when ecosystem function and process are (or are expected to be) severely altered.

A Moderate threat ranking results when ecosystem function and process are (or are expected to be) moderately altered but could be reversed or ameliorated.

A Low threat ranking results when ecosystem function and process are largely intact, (or are expected to be) slightly altered, and easily reversible.

RESOURCES UTILIZED:

The quality and quantity of information varied significantly between watersheds. Sources of information included watershed assessments, DFG stream survey notes, personal communications with local experts, and NMFS staff knowledge of individual watersheds.

Logging and Wood Harvesting

DEFINITION:

Harvesting trees and ancillary post-harvest effects of these activities, including changes to hydrologic patterns and increased contribution of water-borne pollutants, such as sediment and elevated nutrient levels. Additionally, this threat includes conversion of timberland (to vineyards or other uses) as a first course of action in CalFire's conversion process.

IMPACTS TO SALMONIDS:

Many watersheds in the CCC coho salmon ESU are heavily forested, and timber harvest is a major threat to coho salmon habitat condition. Spence *et al.* (1996) summarized the major effects of timber harvest on salmonids as follows: "Riparian logging depletes large woody debris (LWD), changes nutrient cycling and disrupts the stream channel. Loss of LWD, combined with alteration of hydrology and sediment transport, reduces complexity of stream micro- and macro-habitats and causes loss of pools and channel sinuosity. These alterations may persist for decades or centuries. Changes in habitat conditions may affect fish assemblages and diversity." Spence *et al.* (1996) cited studies by McCammon (1993) and Satterland and Adams (1992) showing increased peak flows resulting from alteration of 15-30% of a watershed's vegetation, and concluded "that no more than 15-20% of a watershed should be in a hydrologically immature state at any given time." In many streams, reduced LWD as a result of past forestry practices has resulted in decreased cover and reduced gravel and organic debris storage. Reduced LWD has also decreased pool habitat volume and reduced overall hydraulic complexity (DFG 2002). LWD

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also provides cover from predators and shelter from turbulent high flows. Heavy rainfall occurring after timber harvest operations can increase stream bank erosion, landslides, and mass wasting, resulting in higher sedimentation rates than historical amounts. This can reduce food supply, increase fine sediment concentrations that can reduce the quality of spawning gravels, and increase the severity of peak flows during heavy precipitation. Removing vegetative canopy cover increases solar radiation on the aquatic surface, which can increase water temperatures (Spence *et al.* 1996).

APPLICATION TO ESU:

Timber harvest on non-federal land in California is regulated by the Z'berg-Nejedly Forest Practice Act of 1973 (Section 4511 of the Public Resources Code). NMFS believes that the current regulations are a qualitative improvement over historical practices; unfortunately, their effectiveness in protecting watershed processes that support salmonids has never been established (Dunne *et al.* 2001). The specific inadequacies of the Rules have been well-described by State organized Committees, State and Federal agencies and scientists (BOF Technical Committee 1994; Little Hoover Commission 1994; DFG 1995; CDF 1995; California Senate Natural Resources and Wildlife Committee 1996; BOF Ecosystem Management Committee 1996; LSA Associates 1990; LSA Associates 1991, DFG 1993; CDF 1994; NMFS 1997; NMFS 1998, Dunne *et al.* 2001, Ligon *et al.* 1999). Additionally, some timber harvest practices authorized in the ESU by CalFire (conversion) have been proven by NMFS Office of Law Enforcement to result in take of listed salmonids.

THREAT CONTEXT:

Substantial timber harvesting has occurred in this ESU. Privately held forestlands currently support many of the remaining populations of CCC coho salmon, and the species is provided greater protection on forestlands than landscape subject to most other land use practices. The regulatory infrastructure and oversight represents an opportunity to meet recovery goals. The objectives below assume forest practices are being implemented at the minimum standard of the Forest Practice Rules.

THREATS EVALUATED & RANKED:

All operations associated with timber removal within the harvest unit, including skid trails, new road construction, opening of old road systems, and construction of landings and yarding corridors (does not include mainline transportation systems). Maintenance of road networks and erosion control devices following completion of harvest activities are also included.

Threats were evaluated for their potential to:

1. Increase water-borne pollutants such as sediment, toxic chemicals, and elevated nutrient levels,
2. Alter riparian zone integrity, diversity, function (i.e., LWD recruitment), and composition,
3. Alter drainage channels and hydrology,
4. Simplify channel complexity and lower in stream bank stability, and
5. Compromise hillslope stability.

A High threat ranking results when (1) ecosystem function and process are (or are expected to be) severely altered or (2) impacts to the population are severe. A High threat occurs when amelioration of the consequences of this threat are largely irreversible. Includes activities that

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result in a permanent change to the landscape (e.g., conversion to agriculture, urban, or other uses or results in long-lived changes to vegetative communities).

A Moderate threat ranking results when (1) ecosystem function and process are (or are expected to be) moderately altered or (2) impacts to the population are moderate. A Moderate threat occurs when the consequences of this threat are largely irreversible but could be ameliorated. Includes harvest activities meeting minimum requirements of California Forest Practice Rules (CFPRs).

A Low threat ranking results when (1) ecosystem function and process remain largely intact or (2) are slightly altered, and easily reversible. This ranking includes, activities such as timber harvest that conforms to (or has higher standards beyond) CFPR (e.g., Pacific Forest Trust certified).

RESOURCES UTILIZED:

NMFS used Calfire's THPs in digital GIS format, which focused on land use over the last ten years, to analyze the percentage of land managed as timberlands. NMFS staff also used knowledge of watersheds assessments and ongoing practices for land use analysis.

Mining

DEFINITION:

All types of mining and quarrying (e.g., instream gravel mining)

IMPACTS TO SALMONIDS:

Extraction of minerals and aggregate has affected fishery resources tremendously, and it continues to degrade salmonid habitat in many areas (Nelson *et al.* 1991). According to DFG (2004) Gravel extraction (the removal of sediment from the active channel) has various impacts on salmonid habitat by interrupting sediment transport and often causing channel incision and degradation (Kondolf 1993). The impacts that can result from gravel extraction include: direct mortality; loss of spawning habitat; noise disturbance; disruption of adult and juvenile migration and holding patterns; stranding of adults and juveniles; increases in water temperature and turbidity; degradation of juvenile rearing habitat; destruction or sedimentation of redds; increased channel instability and loss of natural channel geometry; bed coarsening; lowering of local groundwater level; and loss of LWD and riparian vegetation (Humboldt County Public Works 1992; Kondolf 1993; Jager 1994; Halligan 1997). Terrace mining (the removal of aggregate from pits isolated from the active channel) may have similar impacts on salmonids if a flood causes the channel to move into the gravel pits.

APPLICATION TO ESU:

Mining occurs within many watersheds in the ESU, including instream gravel mining on the mainstem Russian River. Upslope mining operations include barrow pits and major minimizing operations in San Vicente Creek.

THREAT CONTEXT:

According to DFG (2004) while instream gravel extraction has had direct, indirect, and cumulative impacts on salmonids in the recent past, no direct impacts to coho salmon have been

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documented under the current (post-1995) mining monitoring and reporting standards developed by the Department and the mining industry which were incorporated into: County Conditional Use Permits; reclamation plans required by the Surface Mining and Reclamation Act; and U.S. Army Corps of Engineer (USACE) Letters of Permission. Many rivers continue to suffer the effects of years of channel degradation from the millions of tons of aggregate removed from the systems over time (Collins and Dune 1990). Most gravel mining operations occur in habitat that is currently considered migration habitat rather than current spawning and rearing. However, some of these instream operations occur in habitats designated as IP-km and are important areas for recovery of coho spawning and rearing habitat.

THREATS EVALUATED & RANKED:

Exploring for, developing, processing, storing, and producing minerals and rocks.

Threats were evaluated for their potential to:

1. Reduce the quantity and quality of stream gravel,
2. Reduce channel complexity,
3. Modify upstream channel sections (e.g., headcuts),
4. Alter in riparian zone integrity, diversity, function, and composition,
5. Alter of channel geometry and hydrology,
6. Alter stream bank stability,
7. Simplify channels or cause incision and disconnection from its floodplain,
8. Alter or cause the loss of floodplain/estuarine habitats, and
9. Alter water quality by increasing sedimentation or turbidity, elevating water temperatures, and input of toxic metals.

A High threat ranking results when ecosystem function and process are (or are expected to be) severely altered. Activities that rank as a High threat may include instream gravel mining and mining activities within the 20-year bankfull channel.

A Moderate threat ranking results when ecosystem function and process are (or are expected to be) moderately altered could be reversed or ameliorated. Activities ranking as a Moderate threat may include activities outside of the 20-year bankfull channel.

A Low threat ranking results when ecosystem function and process are largely intact, (or are expected to be) slightly altered, and easily reversible. Activities that rank as a Low threat generally occur outside of the 100-year floodplain.

RESOURCES UTILIZED:

No numeric values or categories were used to develop rankings. Instead NMFS utilized, watershed documentation, professional judgment, as well as consultations with knowledgeable individuals when ranking this threat after considering information and analyses from biological opinions on gravel mining operations through the CCC coho salmon ESU.

Recreational Areas and Activities

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DEFINITION:

Recreational activities (legal and illegal) altering, destroying and/or disturbing habitats and species outside of established transport corridors, usually for recreational reasons.

IMPACTS TO SALMONIDS:

The category of Recreational Areas and Activities encompasses some aspect of impacts address by some of the other threats listed herein such as Residential and Commercial Development, Roads and Railroads, and Water Diversion and Impoundment. The category covers many types of activities that may directly and indirectly impact salmonids such as increased sedimentation to salmon stream due to off road vehicle use in the upper portion of a watershed; concentrated animal waste discharge from a horse riding facility that is directed into rearing habitat; loss of riparian vegetation due to construction and operation of on-stream recreational summer dams which leads to increased water temperature., *et. cetera.*

APPLICATION TO ESU:

Recreational areas and activities are numerous and diverse in the ESU. This threat category is often more likely to occur in areas with high human populations and includes legal and illegal activities and activities with temporary and permanent impacts.

THREAT CONTEXT:

Since listing a number of actions have been undertaken to address some of the impacts related to recreational areas and activities. These actions include development of a white paper by NMFS regarding the impacts of recreational summer dams and increased enforcement and oversight by NMFS and CDFG regarding installation of these facilities. However, many of actions and their impacts remain unaddressed and impacts to salmonids and their habitat continue.

THREATS EVALUATED & RANKED:

Use of off-road vehicles, mountain bikes, trail maintenance, equestrian uses, summer dams, amusement parks, and golf courses.

Stresses to be considered:

1. Excessive erosion and sedimentation,
2. Fords and effects of ORV use in the channels,
3. Introduction of pollutants, garbage, toxic chemicals, and changes in nutrient levels,
4. Alteration in riparian zone integrity, diversity, function, and composition,
5. Alteration in streambank stability,
6. Diversion and/or impoundment of streams, and
7. Channel simplification, incision and disconnection from its floodplain.

A High threat ranking results when ecosystem function and process are (or are expected to be) severely altered. A High threat ranking may include heavy ORV use in riparian channels that results in the destruction or modification of stream banks and riparian vegetation or permanent alteration of high quality habitat due to construction of recreational facilities.

A Moderate threat ranking results when ecosystem function and process are (or are expected to be) moderately altered but could be reversed or ameliorated. A Moderate threat ranking may

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include extensive mountain biking trails on steep slopes with substandard maintenance oversight.

A Low threat ranking results when ecosystem function and process are largely intact, (or are expected to be) slightly altered, and easily reversible. A Low threat ranking may include low impact activities such as hiking on designated and properly located and maintain trails.

RESOURCES UTILIZED:

The category of Recreational Areas and Activities encompasses a diverse array of land and water uses and types of recreation. No one centralized database is available that adequately assesses this threat category. Staff used available watershed assessments and relied heavily upon their professional experience from working within the various watersheds to assess the degree of impact posed by this threat.

Residential and Commercial Development

DEFINITION:

Urban, industrial, suburban, recreational, or rural residential developments resulting in permanent alteration of the natural environment and encroachment on floodplains and riparian areas. Development includes military bases, factories, shopping centers, resorts, *etc.* This includes the physical and social (*i.e.*, homeless encampments) consequences of development such as increased impervious surfaces, increased runoff, changes to the natural hydrograph (*e.g.* flashy flows), household sewage, urban wastewater, increased sedimentation, industrial effluents, and garbage and solid waste.

IMPACTS TO SALMONIDS:

Urbanization not only affects habitat in obvious ways – for example, direct loss of habitat, channelization of streams, degradation of water quality, and dewatering of streams – but it can also affect habitat in less obvious ways by altering and disrupting ecosystem processes that can have unintended impacts to aquatic ecosystems through increased flooding, channel erosion, landslides, and aquatic habitat destruction (Booth 1991).

According to DFG (2004) the structure of the biological community and abundance and diversity of aquatic organisms are greatly altered by urban impacts on channel characteristics and water quality. Wang *et al.* (1997) found that high urban land use was strongly associated with poor biotic integrity and was associated with poor habitat quality. Fish populations are also adversely affected by urbanization. Limburg and Schmidt (1990, as cited in Spence *et al.* 1996) found a measurable decrease in spawning success of anadromous species in Hudson River tributaries that had 15% or more of the watershed in urban development. Wang *et al.* (2003) found a strong negative relation between urban land cover in the watershed and the quality of fish assemblages in coldwater streams in Wisconsin and Minnesota. In a study of urbanized Puget Sound streams, Lucchetti and Fuerstenberg (1993, as cited in Spence *et al.* 1996) found that coho salmon appeared to be more sensitive than cutthroat trout (*O. clarki*) to habitat alteration, increased nutrient loading, and degradation of the inter-gravel environment. They found that as impervious surfaces increased, coho salmon abundance declined, and concluded that coho salmon are of particular concern in urbanized areas because of their specific habitat needs (smaller streams, relatively low velocity microhabitats, and large pools). Other recent studies have documented that pollution associated with urban areas is causing impacts to juvenile Chinook salmon,

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including suppressed immune response due to bioaccumulation of PCBs and PAHs, increased mortality associated with disease, and suppressed growth (Spence *et al.* 1996).

APPLICATION TO ESU:

Historical records suggest coho salmon occurred in the Sacramento River system, where it was considered the rarest of the five salmon species known to inhabit the Central Valley (Hallock and Fry 1967, Brown *et al.* 1994). Coho salmon occurred in streams of the San Francisco Bay estuary, where in fact the earliest specimen of coho salmon was collected by Professor Alexander Agassiz from Harvard University in San Mateo Creek, San Mateo County, in 1860 (Leidy 2004). Coho salmon are now extirpated from the Central Valley and the San Francisco Bay due to a variety of human caused factors – including urbanization. In fact, watersheds where CCC coho salmon continue to persist have ongoing land management practices frequently cited as reasons for decline (dams, logging, roads, *etc.*) but in general have low rates of commercial and urban development. Impacts of residential and commercial development are numerous, and these impacts are often closely interrelated with other activities evaluated separately in this document (*i.e.*, roads and channel modification).

THREAT CONTEXT:

Within the California range of coho salmon, urban and suburban development occupy many of the watersheds targeted for recovery actions. Cities and towns with large developed areas within the range of California coho salmon include, from north to south, Fort Bragg, Ukiah, Healdsburg, Sebastopol, Santa Rosa, and Santa Cruz. Cities and towns with watersheds draining into the San Francisco Bay were not included in the recovery strategy.

THREATS EVALUATED & RANKED:

Threats were evaluated for their potential to:

1. Introduce pollutants, garbage (e.g., tires), urban/industrial wastewater, sedimentation, toxic chemicals, and changes in nutrient levels (“shock pollution” aka first flush),
2. Alter riparian zone integrity, diversity, function, and composition,
3. Alter stream bank stability,
4. Simplify channels, or cause incision and disconnection from the floodplain,
5. Alter drainage channels and hydrology,
6. Increase stormwater runoff, and
7. Induce growth and associated consequences.

A High threat ranking results when (1) ecosystem function and process are (or are expected to be) severely altered or (2) impacts to the population are severe. A High threat occurs when amelioration of the consequences of this threat is largely irreversible. A High threat ranking may occur in watersheds with extensive urban development adjacent to IP-km resulting in extensive modification of riparian zones from historical conditions.

A Moderate threat ranking results when (1) ecosystem function and process are (or are expected to be) moderately altered or (2) impacts to the population are moderate. A Moderate threat occurs when the consequences of this threat are largely irreversible but could be ameliorated.

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A Low threat ranking results when (1) ecosystem function and process remain largely intact or (2) are slightly altered, and easily reversible.

RESOURCES UTILIZED:

GIS analysis of the percentage of watershed with impervious surfaces, watershed specific assessments, NMFS staff knowledge of watersheds and ongoing practices, *etc.*, were examined.

Roads and Railroads

DEFINITION:

Roadways (highways, secondary roads, primitive roads, logging roads, bridges & causeways) and dedicated tracks. Includes all roads (including mainline logging roads) not associated with the site-specific footprint of timber harvest activities.

IMPACTS TO SALMONIDS:

Studies have documented the degradation that occurs to salmonid habitats as a result of forest, rangeland and other road networks (Furniss et al. 1991). Roads alter natural drainage patterns and accelerate erosion processes causing changes in streamflow regimes, sediment transport and storage, channel bed and bank configuration, substrate composition, and stability of slopes adjacent to roads systems (Furniss et al. 1991).

APPLICATION TO ESU:

Matthews (1999) linked increased road densities to increased sediment yield in the Noyo River. NMFS (1996) guidelines for salmon habitat characterize watersheds with road densities greater than three miles of road per square mile of watershed area (mi/mi²) as "not properly functioning" while "properly functioning condition" was defined as less than or equal to two miles per square mile, with few or no streamside roads.

THREAT CONTEXT:

Since listing a number of actions have been undertaken to address roads and road related threats. Through FishNet 4C an evaluation of county road related issues, including passage and ongoing maintenance has been conducted. A Road Maintenance manual and training for roads staff is an ongoing program in most counties in the CCC ESU. The key focus of this program is on implementing best management practices related to protecting water quality, aquatic habitat and salmonid fisheries. The guidelines outlined in the manual address most routine and emergency road related maintenance activities undertaken by County Departments of Public Works, Parks, and Open Space Districts, and they also address common facilities such as spoils storage sites and maintenance yards. The guidelines apply to in-house county activities related to county facilities, not to private development.

Restoration of problematic private and public roads is a large part of the DFG restoration program and occurs in many of the targeted watersheds in the ESU. The magnitude of road related problems in the ESU is significant and it is anticipated that it will take many years to adequately address the most problematic roads. Additionally, many roads, particularly private non-timber roads are not subject to routine maintenance and chronic sediment input from these roads is a major problem in some watersheds.

THREATS EVALUATED & RANKED:

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Threats were evaluated for their potential to affect:

1. Chronic and acute introduction of sediment from surface erosion and drainage,
2. Delivery of large quantities of sediment from road crossing or mass wasting associated with roads,
3. Passage impairment or blockage due to culverts, bridges, *etc.*,
4. Risks of spills,
5. Alteration of drainage channels, hydrology, infiltration and runoff,
6. Alteration in riparian zone diversity, function, and composition,
7. Channel simplification, incision and disconnection from its floodplain,
8. Alteration in channel and streambank stability,
9. Alteration or loss of floodplain or estuarine habitats,
10. Water-borne pollutants such as sediment, chemicals, and adverse changes in nutrient levels, and
11. Growth-inducing consequences.

A High threat ranking results when (1) ecosystem function and process are (or are expected to be) severely altered or (2) impacts to the population are severe. A High threat occurs when amelioration of the consequences of this threat is largely irreversible. A High threat may occur in watersheds with high road densities, poor road maintenance practices, numerous stream crossings, and placement of roads on unstable areas and adjacency to stream zones.

A Moderate threat ranking results when (1) ecosystem function and process are (or are expected to be) moderately altered or (2) impacts to the population are moderate. A Moderate threat occurs when the consequences of this threat are largely irreversible but could be ameliorated.

A Low threat ranking results when (1) ecosystem function and process remain largely intact or (2) are slightly altered, and easily reversible.

RESOURCES UTILIZED:

For coastal areas of California, road densities were calculated using roads included in CalFire timber harvest GIS data. For inland areas, road densities were calculated using a roads theme produced by Legacy – The Landscape Connection which uses multiple sources. Road density data from the SWOP GIS project and USFS (2000) in California were also considered, but these data were older than the CBI, CalFire, and Legacy datasets and were not applied.

Storms and Flooding

DEFINITION:

Above average rainfall and stream flow events. Natural events that exacerbate already degraded conditions.

IMPACTS TO SALMONIDS:

High flows associated with storms and floods can result in complete loss of eggs and alevins as they are scoured from the gravel or buried in sediment (Sandercock 1991; NMFS 1998). Juveniles and smolts can be stranded on the floodplain, washed downstream to poor habitat such as

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isolated side channels and off-channel pools, or washed out to sea prematurely. Peak flows can induce adults to move into isolated channels and pools or prevent their migration through excessive water velocities (DFG 2004).

APPLICATION TO ESU:

Streams can be drastically modified by erosion and sedimentation in large flood flows almost to the extent of causing uniformity in the stream bed (Spence *et al.* 1996). After major floods, streams can take years to recover pre-flood equilibrium conditions. Flooding is generally not as devastating to salmon in morphologically complex streams, because protection is afforded to the fish by the natural in-stream structures such as LWD and boulders, stream channel features such as pools, riffles, and side channels and an established riparian area (Spence *et al.* 1996).

THREAT CONTEXT:

Flooding does, however, have beneficial effects: cleaning and scouring of gravels; transporting sediment to the flood plain; moving and rearranging LWD; recharging flood plain aquifers (Spence *et al.* 1996); allowing salmonids greater access to a wider range of food sources (Pert 1993); and maintaining the active channel.

THREATS EVALUATED & RANKED:

Threats were evaluated for their potential to:

1. Increase the frequency, duration, and magnitude of flooding beyond natural conditions,
2. Require flood control or management actions,
3. Cause loss of riparian and instream habitat attributes,
4. Increase frequency of channel scour beyond natural conditions,
5. Increase turbidity beyond natural conditions.

A High threat ranking results when (1) ecosystem function and process are (or are expected to be) severely altered or (2) impacts to the population are severe. A High threat occurs when amelioration of the consequences of this threat is largely irreversible. A High threat ranking may occur in heavily urbanized watersheds subjected to extensive and ongoing instream modification conducted for flood control purposes.

A Moderate threat ranking results when (1) ecosystem function and process are (or are expected to be) moderately altered or (2) impacts to the population are moderate. A Moderate threat occurs when the consequences of this threat are largely irreversible but could be ameliorated.

A Low threat ranking results when (1) ecosystem function and processes remain largely intact or are (2) slightly altered, and easily reversible. A Low threat ranking may occur in watersheds with little urban interface, intact floodplains, and instream habitat forming features (such as LWD) are present and are not routinely removed.

RESOURCES UTILIZED:

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NMFS staff knowledge of watersheds and ongoing practices, *etc.*, was examined. In addition, NMFS reviewed models related to climate change where they predicted increased storms or flooding.

Water Diversion and Impoundment

DEFINITION:

Appropriative and riparian surface water diversions and, groundwater pumping resulting in changes to water flow patterns outside the natural range of variation. This threat includes use, construction, and maintenance of seasonal dams for water diversions.

IMPACTS TO SALMONIDS:

According to DFG (2004) losses of coho salmon result from a wide range of conditions related to unscreened water diversions and substandard fish screens. Primary concerns and considerations for fish at diversions that are unscreened or equipped with poorly functioning screens are:

- a. Delay of downstream migration and reduced overall survival of downstream migrants; Entrainment of juvenile coho salmon into the diversion;
- b. Impingement of juvenile coho salmon on the screen because of high approach velocities or low sweeping velocities;
- c. Desiccation of redds and/or stranding of adults when diversion have a rapid effect on water surface levels
- d. Predator holding areas created by localized hydraulic effects of the fish screen and related facilities;
- e. Entrapment of juvenile coho salmon in eddies or other hydraulic anomalies where predation can occur;
- f. Elevated predation levels due to concentrating juveniles at diversion structures; and
- g. Disruption of normal fish schooling behavior caused by diversion operations, fish screen facilities, or channel modifications.

APPLICATION TO ESU:

Water is often handled in the regulatory or legal arena due to its relative scarcity in California's Mediterranean climate. Summer baseflow is a critical attribute that is degraded in many streams across the ESU. A substantial amount of coho salmon habitat has been lost or degraded as a result of water diversions and groundwater extraction (DFG 1997, KRBFTF 1991). The nature of diversions varies from major water developments which can alter the entire hydrologic regime in a river, to small domestic diversions which may only have a localized impact during the summer low flow period. In some streams the cumulative effect of multiple small legal diversions may be severe. Illegal diversions are also believed to be a problem in some streams within the range of coho salmon (DFG 2004).

THREAT CONTEXT:

Water is the most important of all habitat attributes necessary to maintain a viable fishery and, based on the last 150 years of water development in California, one of the most difficult threats to address effectively. Few restoration projects address water because; in large part it is a very divisive issue. Diversions are subject to regulation by the State Water Resources Control Board through the appropriative water rights process, and by the Department under FGC § 1600 et seq.

Appendix D: CCC coho salmon Recovery Plan - Threats Description and Taxonomy

(which requires an agreement with the Department for any substantial flow diversion), FGC § 2080 et seq. (CESA take authorization), and FGC § 5937 (which requires sufficient water below a dam to maintain fish in good condition). NMFS has authority under ESA to regulate the take of coho salmon at diversions (DFG 2004).

In some watersheds, the demand for water has already exceeded the available supply and some water rights have been allocated through court adjudication. These adjudications usually did not consider coho salmon habitat needs at a level that could be considered protective under CESA. The use of wells adjacent to streams is also a significant and growing issue in some parts of the coho salmon range. Extraction of flow from such wells may directly affect the adjacent stream, but is often not subject to the same level of regulatory control as diversion of surface flow. Site specific groundwater studies are required to determine a direct connection between surface flow and groundwater, and these are often very costly and take a significant amount of time to complete.

THREATS EVALUATED & RANKED:

Threats were evaluated for their potential to affect:

1. Water diversion and withdrawal, legal and illegal
2. Chronic and acute introduction of sediment from surface erosion and drainage,
3. Passage impairment or blockage,
4. Alteration of drainage channels and hydrology,
5. Alteration in riparian zone diversity, function, and composition,
6. Alteration in channel and streambank stability,
7. Alterations or loss of floodplain and/or estuarine habitats due to reduced freshwater inflow,
8. Water-borne pollutants such as sediment, chemicals, and adverse changes in nutrient levels,
9. Growth-inducing consequences,
10. Changes in water flow, fish habitat, and temperature,
11. Loss of gravel recruitment to downstream areas,
12. Dewatering and flow reductions,
13. Secondary effects to salmonids (e.g., Bacterial Gill disease),
14. Delay in sandbar breaching (e.g., Scott Creek).

A High threat ranking results when (1) ecosystem function and process are (or are expected to be) severely altered or (2) impacts to the population are severe. A High threat occurs when amelioration of the consequences of this threat are largely irreversible.

A Moderate threat ranking results when (1) ecosystem function and process are (or are expected to be) moderately altered or (2) impacts to the population are moderate. A Moderate threat occurs when the consequences of this threat are largely irreversible but could be ameliorated.

A Low threat ranking results when (1) ecosystem function and process remain largely intact or (2) are slightly altered, and easily reversible.

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RESOURCES UTILIZED:

Fisheries biologists from DFG and Regional Water Quality Control Boards were invited to participate in a structured decision-making process to provide individual opinions regarding flow conditions for specific habitat attributes, and also considered diversion and impoundments for each watershed. Workshop participants were asked to individually rate the hydrologic setting, the degree of exposure to flow impairments, and the intensity of those impacts for each CCC coho salmon population. GIS analysis of known diversion points, and the DFG Passage Assessment Database (PSMFC 2006) (PAD) were reviewed. NMFS GIS watershed characterizations, NMFS staff knowledge of watersheds and ongoing practices, *etc.*, were also examined.