Recovery Strategy for California Coho Salmon

Report to the California Fish and Game Commission
February 2004

STATE OF CALIFORNIA RESOURCES AGENCY DEPARTMENT OF FISH AND GAME

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PREPARED BY

The California Department of Fish and Game

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In remembrance of Joseph R. Blum, NOAA Fisheries, who died suddenly on April 7, 2004, we would like to acknowledge his exceptional contributions to this Recovery Strategy. Joe brought a special blend of dedication, professionalism, and creativity to the Coho Recovery Team meetings. His dedication to the conservation of fish, wildlife, and the environment, was evident to all he worked with. His collaborative efforts will be missed at future Coho Recovery Team meetings.

Executive Summary

The California Department of Fish and Game (Department), with the assistance of recovery teams representing diverse interests and perspectives, created the *Recovery Strategy for California Coho Salmon (Oncorhynchus kisutch)* (Recovery Strategy), a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy is organized at three scales. The first is at a broad geographic, range-wide resolution; the second is at a large watershed scale; and the third is at a finer scale that identifies actions needed within specific sub-watersheds.

The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts. Landowner incentives and grant programs are some of the many tools available to recover coho salmon. However, the success of this Recovery Strategy will ultimately be determined by the long-term commitment and efforts of all who live in, or are involved with, coho salmon watersheds. The Department believes that the commitment is there and that the execution of this plan will ultimately lead to the recovery of coho salmon throughout its California range.

BACKGROUND

A citizen's group called the Salmon and Steelhead Recovery Coalition petitioned the Fish and Game Commission (Commission) to list coho salmon north of San Francisco as an endangered species under the California Endangered Species Act (CESA) (FGC §2050 *et seq.*). In response to the petition, the Department issued a report to the Commission describing the status of coho salmon north of San Francisco (April 2002), recommending that coho salmon from San Francisco north to Punta Gorda be listed as endangered and that coho salmon from Punta Gorda north to the Oregon border be listed as threatened pursuant to the provisions of CESA. The division of coho salmon in California at Punta Gorda follows the Federal designation of Evolutionarily Significant Units (ESU): the California Central Coast (CCC) Coho ESU and the Southern Oregon-Northern California Coasts (SONCC) Coho ESU. On August 30, 2002, the Commission found that coho salmon warranted listing per the Department's recommendations.[1]

The Department's recommendations and the Commission's decision were based on the best available information, which indicates coho salmon from San Francisco to the Oregon border have experienced a significant decline in the past 40 to 50 years. Coho salmon, including hatchery stocks, are currently six to 15 percent of their abundance during the 1940s. Coho salmon harvest decreased considerably in the late 1970s, despite a fairly stable rate of hatchery production. Recent abundance-trend information for several stream systems along the central and north coasts indicates an overall declining trend throughout California.

[1] Coho salmon south of San Francisco were previously listed as endangered by the State in 1994. The National Marine Fisheries Service (NMFS) listed coho salmon in the Central California Coast Evolutionarily Significant Unit (ESU) as threatened in 1996, and in the Southern Oregon/Northern California Coasts ESU as threatened in 1997, under the Federal Endangered Species Act of 1973.

In accordance with the Commission's direction and statutory requirements, the Department established a 21-member Coho Salmon Recovery Team (CRT) to focus on the species range-wide, and a 13-member local Shasta-Scott Recovery Team (SSRT) to focus on water and land use associated with agricultural practices in the Shasta and Scott river valleys in Siskiyou County. Tremendous effort, over a very constricted timeframe, was expended by both teams as members labored in good faith to find solutions to seemingly intractable problems. The Department is indebted to all team members for their creativity, perseverance, and valuable contributions to the completion of this critically important document. The teams provided numerous recommendations for the Department to consider in the development of this Recovery Strategy.

Rather than proceeding immediately with regulatory action to add the species to the threatened and endangered species lists, the Commission, pursuant to Fish and Game Code (FGC) §2114, deferred the regulatory action and directed the Department to prepare a recovery strategy for coho salmon within 12 months in accordance with FGC §2105 *et seq.* The Commission subsequently extended this deadline to February 2004. On February 4, 2004, the Commission adopted the Recovery Strategy, with amendments and inclusive of the selected timber management alternative.

RECOVERY GOALS

The primary objective of this Recovery Strategy is to return coho salmon to a level of sustained viability, while protecting the genetic integrity of both ESUs, so that they can be delisted and regulations or other protections under the CESA (FGC §2050 *et seq.*) will not be necessary. The Department defines sustained viability as a future condition when naturally producing coho salmon are adequately abundant and occupy a sufficient range and distribution to ensure against extinction due to environmental fluctuations, stochastic events, and human land- and water-use impacts.

A second objective of this Recovery Strategy is to achieve harvestable populations of coho salmon for Tribal, recreational, and commercial fisheries, so important to the cultural and economic well-being of California. The Department intends to continue its partnership with all stakeholders to implement appropriate portions of this plan to achieve this objective once the coho salmon has been delisted. Improving coho salmon populations and habitat is the means to achieve these two objectives.

Five goals have been identified to achieve delisting:

GOAL I Maintain and improve the number of key populations and increase the number of populations and cohorts of coho salmon.

GOAL II Maintain and increase the number of spawning adults.

GOAL III Maintain the range, and maintain and increase distribution of coho salmon.

GOAL IV Maintain existing habitat essential for coho salmon.

GOAL V Enhance and restore habitat within the range of coho salmon.

An additional goal[2] has been identified for the second objective, which is to:

GOAL VI Reach and maintain coho salmon population levels to allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.

[2] This additional goal meets the requirements of FGC §2111(e), which was added by SB 216 (Statutes 2003 Chap. 854). This goal does not affect the first objective of the Recovery Strategy or the goals to achieve delisting.

RECOVERY IMPLEMENTATION

The causes for the decline of coho salmon are many and complex. In general, coho salmon require adequate flows, cold water, streamside shade, instream shelter and pools, and access to spawning gravels with a low fine sediment component. Protection of the best remaining habitat, especially in areas where coho salmon are still present, and improvements to degraded habitat are both necessary to recover coho salmon. Each of the recommendations addresses these two aspects of coho salmon recovery. On the whole, the strategy for recovery of coho salmon involves several approaches:

a. Interim and long-term actions;
b. Equitable apportionment of both public and private support and action;
c. Equitable apportionment of regulatory and nonregulatory obligations;
d. Scientifically, technologically, and economically reasonable means;
e. Best available scientific data;
f. Financial investments; and
g. Long-term commitment and efforts of all involved in coho salmon watersheds.

This document includes over 85 range-wide recommendations, 320 watershed recommendations for the SONCC Coho ESU, 205 watershed recommendations for the CCC Coho ESU, and 145 watershed recommendations for the Shasta-Scott Pilot Program (SSPP). Three alternative recommendations for timber management were presented to the Commission in February 2004. The timber alternative recommended by the Department and approved by the Commission (Alternative C, with amendments) has been incorporated into this document.

As an example of range-wide recommendations, the following was taken from Chapter 7:

7.3 FISH PASSAGE

RW-III-A-01	Continue and complete assessments and prioritizations for correction of fish passage barriers.
RW-III-A-02	Develop and maintain a database of barriers to fish passage.
RW-III-C-01	Encourage funding authorities to allocate adequate resources to construct new crossings and upgrade existing crossings (bridges, culvert and fills, other crossings) within the range of coho salmon to accommodate 100-year flows and associated bedload and debris. Priority for upgrading should be based upon the potential impact to coho salmon habitat.

As an example of watershed recommendations, the following was taken from Chapter 8 for the Albion River HSA:

8.2.1.1 Albion River HSA

MC-AR-01	Place instream structures to improve gravel retention and habitat complexity.
MC-AR-02	Provide technical assistance and incentives to landowners in developing and implementing sediment reduction plans to meet requirements of the CWA TMDL, making watersheds with an implementation schedule the highest priority.
MC-AR-03	Conduct collaborative evaluations of priorities for treatment of barriers such as Fish Passage Forum.

Implementation schedules (presented in Chapters 9 and 10) provide stakeholders with an easy manual for restoration; that is, they can find a watershed of interest and then consider implementing the tasks for that watershed according to the task-levels assigned, or they can find a high priority watershed and then propose implementing the tasks accordingly. The prioritization of watersheds and tasks will assist the recovery effort by ensuring that limited public and private funds are directed where they will likely contribute most to coho salmon recovery.

As an example of an implementation schedule, here are the table entries from Chapter 9 for the Albion River HSA:

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION
Albion River HSA					
5	C	MC-AR-01	Place instream structures to improve gravel retention and habitat complexity.	**Potential Lead:** CDFG **Others:** Landowners, CCC, CDF, Watershed Groups, Mendocino County, RCDs	Interim/ Continual
5	C	MC-AR-02	Provide technical assistance and incentives to landowners in developing and implementing sediment reduction plans to meet requirements of the CWA TMDL, making watersheds with an implementation schedule the highest priority.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF, DPR	Interim
5	C	MC-AR-03	Conduct collaborative evaluations of priorities for treatment of coho salmon passage barriers, such as the Fish Passage Forum.	**Potential Lead:** CDFG, NOAA Fisheries, Caltrans, Mendocino County Landowners, Watershed Groups.	Interim/ Continual

Successful implementation of even the highest priority tasks will require individuals, organizations, and agencies to work in concert and with a clear understanding of what must be done to complete the recommended tasks and the time frame within which the tasks should be completed. To establish and maintain the coordination necessary for coho salmon recovery, the Department will designate a range-wide coordinator and at least one regional coordinator for each of the Department's central and northern coastal regions. The coordinators will work with the appropriate Department personnel, representatives from other agencies, watershed groups, landowners, and private and non-profit entities to leverage resources and coordinate recovery tasks. These tasks address coho salmon population and habitat protection and restoration, cooperation and collaboration between public and private entities, education and outreach, implementation and enforcement of existing laws, improved land management, assessment, monitoring and research, and better coordination among funding agencies for grant programs.

RECOVERY COSTS

An economic evaluation estimated the costs required to implement the Recovery Strategy. The total cost of the Recovery Strategy is about 4.5 billion dollars. However, this figure does not account for the cost of water acquisition for areas outside of the Scott and Shasta valleys. If water acquisition costs in other areas of the SONCC Coho ESU and in the CCC Coho ESU are proportional to those in the SSPP (where water acquisition accounts for about 20 percent of the total), it is likely that the costs of Recovery Strategy implementation will be closer to 5 billion dollars.

Although coho salmon recovery will have significant costs, it will also provide economic benefits. While this report does not quantify the economic benefits, they will very likely exceed the cost of recovery. The recovery of coho salmon to the point where they can be delisted will provide an economic stimulus to the coastal economy due to the lifting of regulatory requirements associated with a listed species. Benefits associated with Federally reserved fishing rights, increased commercial land and water use activities, multiple species benefits, improved water quality, and watershed health will be realized. The process of conducting restoration projects will create local jobs, and the flow of restoration dollars will have significant direct and trickle-down benefits to economically depressed coastal communities. Recovering coho salmon to the point of sustained harvestable surpluses will provide economic expansion to the commercial and recreational fishing industries, and to the businesses and communities that depend on them. Harvestable surpluses will also provide direct economic benefit to Tribal fisheries.

Coho salmon recovery can also result in benefits associated with non-use values. These values include intrinsic values, which are based simply on the knowledge of the resource's existence, and bequest values which confer value to the resource for the benefit of future generations. For California coho salmon recovery, these could be significantly higher than the fiscal costs of recovery.

It should be clearly understood that coho salmon recovery will not require the identification of five billion dollars of "new" funds. Many sources of funds are already being directed at coho salmon recovery directly or at ecosystem restoration at the watershed level, which will likewise facilitate recovery. Examples of existing programs that address coho salmon recovery goals include the Department's Fisheries Restoration Grant Program, the California Coastal Conservancy's grant programs, and the various programs authorized by the Federal Farm Bill (Section 5.2). Many in-kind donations from the private sector of time, equipment, and expertise will continue to defray the total cost of recovery. The Recovery Strategy also identifies where existing local, State and Federal programs could be reprioritized and staff redirected to accomplish critical tasks.

Successful recovery of coho salmon will require a sustained long-term commitment of significant amounts of public and private funding, sufficient staff to provide technical assistance, and an accountable grant funding infrastructure. It is imperative that public funds spent on this effort are invested in scientifically sound projects that help coho salmon where they need it most. It is also important that the effort be coordinated among all agencies that fund watershed projects within the range of California coho salmon.

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1 Introduction

Coho salmon *(Oncorhynchus kisutch)* have experienced a significant decline in the past 40 to 50 years. Coho salmon abundance, including hatchery stocks, has declined at least 70% since the 1960s, and is currently 6 to 15% of its abundance during the 1940s. Coho salmon harvest decreased considerably in the late 1970s, despite a fairly stable rate of hatchery production. Recent abundance-trend information for several stream systems along the central and north coasts indicates an overall declining trend throughout California.

As a result, the California Fish and Game Commission (Commission) received a petition to list coho salmon north of San Francisco to the Oregon border as an endangered species under California Endangered Species Act (CESA). The California Department of Fish and Game (Department) prepared a comprehensive status review of the species, which recommended that the species be listed as endangered south of Punta Gorda to San Francisco Bay and threatened north of Punta Gorda to the California-Oregon border. The Commission found the recommendation to be warranted, but deferred regulatory action to add the species to the threatened and endangered species lists, and directed the Department to prepare a recovery strategy for coho salmon. This report fulfills that mandate, and the Commission formally adopted the Recovery Strategy on February 4, 2004.

1.1 STATE OF CALIFORNIA COHO SALMON LISTING ACTIONS

On December 16, 1993, the Santa Cruz County Fish and Game Advisory Commission submitted a petition to the California Fish and Game Commission (Commission) to list coho salmon south of San Francisco Bay under CESA. On April 7, 1994, the Commission designated the coho salmon south of San Francisco Bay a candidate species, starting the one-year review process by the Department. Based on this review, the Department recommended that coho salmon south of San Francisco Bay be listed as endangered. The Commission accepted the recommendation and listed those coho salmon as endangered, effective December 31, 1995.

On July 28, 2000, the Commission received a petition to list coho salmon north of San Francisco as an endangered species under CESA. The Commission referred the petition to the Department on August 7, 2000, for evaluation. The Department found that the information in the petition was sufficient to indicate the action may be warranted and recommended that the Commission accept the petition. The petition was accepted by the Commission on April 5, 2001. On April 27, 2001, the Commission published a Notice of Findings in the California Regulatory Notice Register declaring coho salmon a candidate species, thereby starting the candidacy period. Pursuant to Fish and Game Code (FGC) §2074.6, the Department prepared a status review evaluating the status separately for the two coho salmon Evolutionary Significant Units (ESUs) that occur in California. (See section 1.2 below regarding ESUs.) The Department recommended that coho salmon be listed as endangered from Punta Gorda south to San Francisco Bay and threatened north of Punta Gorda to the California-Oregon border.

On August 30, 2002, the Commission found that coho salmon warranted listing as an endangered species under CESA from San Francisco Bay north to Punta Gorda and as a threatened species from Punta Gorda north to the California-Oregon border. However, the Commission deferred regulatory action to add the species to the State threatened and endangered species lists while a recovery strategy was prepared, keeping in place regulations, which were adopted by the Commission pursuant to FGC §2084 in April 2001, that allow for incidental take of coho salmon. Both hatchery and naturally produced coho salmon are included in the CESA listing and are addressed by the Recovery Strategy.

1.2 FEDERAL COHO SALMON LISTING ACTIONS

In 1993, Oregon Trout, Pacific Rivers Council, and others petitioned for listing of coho salmon in California, Oregon, Washington, and Idaho under the Federal Endangered Species Act (ESA). National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries)[1] identified six ESUs of coho salmon in California, Oregon, and Washington. The ESUs in California are the California Central Coast (CCC) Coho ESU and the Southern Oregon-Northern California Coasts (SONCC) Coho ESU. The CCC Coho ESU extends from the San Lorenzo River in Santa Cruz County north to Punta Gorda in Humboldt County (Federal Register 1996). The SONCC Coho ESU begins at Punta Gorda and extends north into Oregon to Cape Blanco (Federal Register 1997). The CCC Coho ESU and SONCC Coho ESU were listed as threatened on December 2, 1996 and June 5, 1997, respectively (Federal Register 1996, 1997).

The status of California coho salmon populations was recently reviewed and updated by NOAA Fisheries Southwest Fisheries Science Center (NMFS 2001a). This status review update confirms previous conclusions of the NOAA Fisheries Biological Review Team: 1) the CCC Coho ESU is presently in danger of extinction and the condition of coho salmon is worse than indicated by previous reviews, and 2) the California portion of the SONCC Coho ESU warrants threatened status and is likely to become endangered in the foreseeable future. NOAA Fisheries is presently updating status reviews and revisiting listing determinations for all salmon and steelhead ESUs that have one or more hatchery populations included in the ESU. This includes both the CCC and SONCC Coho ESUs.

1.3 STRATEGIC PLANNING FOR RECOVERY

Planning for coho salmon recovery is a complex process that involves both State and Federal actions because of the species' status under both the ESA and CESA. This section describes actions of the Commission, the recovery teams that were assembled to aid the Department in its development of a coho salmon recovery strategy (Recovery Strategy), and the Federal government's preliminary steps toward a Federal recovery plan.

1.3.1 FISH AND GAME COMMISSION ACTION

Following the determination that coho salmon warranted CESA listing, rather than proceeding immediately with regulatory action, the Commission, pursuant to FGC §2114, directed the Department to prepare a Recovery Strategy for coho salmon within 12 months under FGC §2105 *et seq*. The Commission subsequently extended this deadline a total of 18 months, to February 2004.

[1] National Marine Fisheries Service now uses the acronym NOAA Fisheries. NMFS was used until mid-2003. In this document, NMFS is used in direct quotations from and citations to documents that were published when NMFS was used; otherwise, NOAA Fisheries is used.

During this time extension, the Department released a public review draft of the Recovery Strategy (dated November 2003). The Department voluntarily provided a 21-day comment period on the public review draft and held three public meetings. Approximately 173 people attended the public meetings and a total of 79 people submitted written and/or verbal comments during this period. The Department prepared a formal Response to Comments (available on the Department's website) that detailed changes made, in response to public comments received, in the November 2003 draft of the Recovery Strategy. During the Commission meeting on February 4, 2004, the Commission approved the Recovery Strategy, as modified by the Response to Comments, and inclusive of the Department's recommendations for specific provisions of the timber management alternatives.

1.3.2 DEPARTMENT OF FISH AND GAME ACTION

In accordance with the Commission's direction as well as statutory requirements, the Department immediately embarked on establishing two recovery teams: a Range-wide Coho Salmon Recovery Team (CRT), and a local Shasta-Scott Recovery Team (SSRT) for a special focus on agricultural water and land use in the Shasta and Scott River valleys in Siskiyou County. The Department sought innovative ideas and creativity in the development of a strategy that balances coho salmon recovery with other interests. Both teams brought together people with a variety of concerns and perspectives. The efforts of the two teams, over a short time frame, aided the Department in the development of a single Recovery Strategy to recover coho salmon throughout its range in California.

1.3.3 RANGE-WIDE COHO SALMON RECOVERY TEAM

The CRT is made up of 21 members from a wide range of interests, professions, and perspectives. The team represents county, State, and Federal governments, tribes, commercial and recreational fishing, forestry, agriculture, ranching, water management, and environmental interests. The CRT first met and commenced its work in December 2002. The team addressed many significant issues affecting coho salmon range-wide: coho salmon habitat; coho salmon population numbers; water quality, quantity and use; county and other agencies public works; agriculture, forestry, and ranching; legacy effects of activities that took place decades ago; monitoring of habitat improvement efforts and coho salmon population numbers; respecting private property rights; incentives to promote voluntary efforts to improve habitat; prioritizing recovery actions across the range of both ESUs; and restoration of Tribal, recreational, and commercial fisheries.

The CRT recognizes that recovery of the coho salmon requires a cooperative effort across entire watersheds, considerable financial investment, and many years of effort. The CRT developed a mission statement to guide their effort to aid the Department:

> *Within our vision of restoring populations of coho salmon, including healthy, wild, naturally reproducing populations throughout its range, and restoring Tribal, commercial, and recreational fisheries in California, it is our mission to aid the Department in the development of a recovery strategy for coho salmon, with the goal that the species will no longer warrant listing.*

On August 4, 2003, the CRT sent an independent report to the Director detailing their findings and recommendations. The report also included a partial list of existing voluntary and cooperating groups and activities focused on recovery of coho salmon by watershed. The CRT report to the Director can be viewed on the Department website. CRT recommendations are presented in Chapter 7 (Range-wide Recommendations) and Chapter 8 (Watershed Recommendations).

1.3.4 SHASTA-SCOTT RECOVERY TEAM

The SSRT is made up of 13 members representing a variety of interests in the Shasta and Scott valleys in Siskiyou County. Members include landowners, local governments, State and Federal agencies, environmental groups, and recreational anglers. The SSRT held its first meeting in January 2003 and was tasked with assisting the Department in development of recommendations that will help recover coho salmon relative to agricultural water and land uses in the Shasta and Scott valleys. The focal points of the SSRT are to restore coho salmon populations, maintain a healthy agricultural industry, and water management in each valley. A mission statement was agreed to as follows:

> *Within our vision of restoring healthy, wild and naturally reproducing populations of coho salmon in the Shasta and Scott Rivers, it is our mission to provide the Department of Fish and Game with recovery recommendations focusing on agriculture and agricultural water use, based on local knowledge and scientific information regarding the biological and physical environment, local customs and preferences, as well as local experiences with habitat restoration efforts and strategies. It is our goal to aid the Department in development of a recovery strategy for coho salmon, with the eventual goal that environmental conditions in the Shasta and Scott Rivers will no longer be found to be contributing to the need for listing of coho salmon as a threatened or endangered species in California. Further, it is our intent that the Recovery Strategy developed by the "Scott and Shasta Rivers Pilot Program" will become a demonstration project for future recovery strategies for other threatened or endangered species in California and the nation.*

On July 28, 2003, the SSRT sent an independent report to the Director entitled *Shasta and Scott River Pilot Program for Coho Salmon Recovery: with recommendations relating to Agriculture and Agricultural Water Use*, which can be viewed on the Department's website. SSRT recommendations, presented as the Shasta-Scott Pilot Program (SSPP), are in Chapter 10.

1.3.5 FEDERAL TECHNICAL RECOVERY TEAMS

NOAA Fisheries is in the process of developing scientifically based criteria for delisting ESUs of anadromous salmonids, including the CCC and SONCC Coho ESUs of coho salmon. Federal recovery efforts are focused on geographically defined Recovery Domains. There are two phases in the Federal recovery planning process for anadromous salmonids. Phase I is the development of recovery goals. These goals will be developed by Technical Recovery Teams (TRTs), which will also be responsible for developing criteria that, when met, will allow listed species to be removed from the Federal Endangered Species List.

Four Recovery Domains exist in California, and TRTs have been created for both California Recovery Domains that include coho salmon. The TRTs are responsible for developing recovery criteria for all the listed salmonids in the recovery domain. The TRTs are composed of scientists from NOAA Fisheries, other Federal and State agencies, academia, and other local experts on salmon biology. Department biologists are part of both coho salmon TRTs, which are chaired by NOAA Fisheries staff.

TRT activity will be the primary focus of all teams for the next several years. Both the Southern Oregon/Northern California and North-Central California Coast TRTs had their first meetings in October 2001.

1.4 RECOVERY STRATEGY FOR COHO SALMON IN CALIFORNIA

This Recovery Strategy is based on general goals identified in this section, which also describes the approach to recovery and implementation considerations. For reference, the abbreviations and acronyms used in this document are listed in Appendix A and technical terms are defined in Appendix B.

1.4.1 GENERAL GOALS

The primary purpose the Recovery Strategy is to recover coho salmon to the point where the regulations or other protections for coho salmon listed under CESA are not necessary. In addition, the Recovery Strategy seeks to restore Tribal, recreational, and commercial coho salmon fisheries in California.

On February 4, 2004, the Commission found that the Recovery Strategy met specific conditions contained in statute [FGC §2111(a)-(e)][2] and approved its adoption. These conditions are:

a. The Recovery Strategy would conserve, protect, restore, and enhance the species;

b. The Recovery Strategy and the implementation schedule are capable of being carried out in a scientifically, technologically, and economically reasonable manner;

c. The Recovery Strategy is supported by the best available scientific data;

d. The Recovery Strategy represents an equitable apportionment of both public and private and regulatory and nonregulatory obligations; and

e. The Recovery Strategy would recover a formerly commercially valuable species to a level of abundance that would permit commercial use of that species.

The approach to achieving the primary goal of recovery is to improve coho salmon populations and habitat so the species is neither threatened nor endangered with extinction throughout or in a significant portion of its range and the regulations or other protections for coho salmon under CESA are not necessary. In order for an ESU to be down or delisted, recovery goals should be attained in each recovery unit within the ESU (see Chapter 6). Significance is not defined by CESA but is a scientific judgment based on the entire record of the species.

Achieving recovery will require meeting five delisting goals and corresponding criteria that address coho salmon populations and habitat:

GOAL I	Maintain and improve the number of key populations and increase the number of populations and brood years of coho salmon.
GOAL II	Maintain and increase the number of spawning adults.
GOAL III	Maintain the range and maintain and increase the distribution of coho salmon.
GOAL IV	Maintain existing habitat essential for coho salmon.
GOAL V	Enhance and restore habitat within the range of coho salmon.

A sixth goal meets the criterion set forth in CESA, which requires that in order to approve the Recovery Strategy, the Commission must find, among other things, that the Recovery

[2] FGC § 2111(e) was added by SB 216 (Statutes 2003 Chap. 854). The author of SB 216 notes in a letter, dated September 12, 2003 (published in the Senate Journal on September 13, 2003) that it "does not change the primary goal of the Recovery Strategy program as set forth in Section 2105 of the Fish and Game Code... Therefore, if a species has recovered to the point that the regulatory requirements or other protections for species listed pursuant to CESA are no longer necessary, then no permit pursuant to CESA would be required for incidental take of the species, even if the species has not achieved a level of abundance that would permit resumption of commercial use."

Strategy would recover a formerly commercially valuable species to a level of abundance that would permit commercial use of that species [FGC § 2111(e)].

GOAL VI Reach and maintain coho salmon population levels to allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.

Once delisting is achieved and protections under CESA are not necessary, it is the intention of the Department to collaborate with the CRT and the SSRT to determine how to continue implementation of appropriate elements of the Recovery Strategy.

1.4.2 ELEMENTS NECESSARY TO ACHIEVE RECOVERY GOALS

The Recovery Strategy is centered on several elements necessary to achieve the goals of recovery. The foundation of recovery will be based on these elements and implementation of recovery actions at various biological and geographic levels. The Department's recovery elements are education and public outreach, emphasizing the cooperation and coordination of the public and private sectors, implementing and enforcing existing laws, maximizing use of public lands for protection and recovery, and conducting research and monitoring to track and understand the progress of recovery and make needed changes over time to advance coho salmon recovery.

The Recovery Strategy takes the approach of dividing California coho salmon into geographic and biological units. The primary biological division is the ESU. With the CCC Coho ESU designated as endangered and the SONCC Coho ESU designated as threatened, the Recovery Strategy treats each ESU separately. Additionally, as unique populations are identified within either ESU, specific directed actions may occur to promote the potential of recovery.

Prioritization is of paramount importance to the Recovery Strategy. By establishing priorities, the Recovery Strategy will ensure efficient use of resources on the most effective recovery activities. These priorities, which were derived with involvement of the recovery teams, land owners and watershed councils, are set both geographically (by HSA) and by task. Entire watersheds and subunits of watersheds are the primary geographic divisions and are discussed individually.

1.4.3 IMPLEMENTATION

The Recovery Strategy includes hundreds of potential actions to recover coho salmon. FGC §2114 states: "The Recovery Strategy itself shall have no regulatory significance, shall not be considered to be a regulation for any purpose ... and is not a regulatory action or document." Therefore, the recommendations will be implemented through existing statutory and/or regulatory authorities, voluntary actions, and/or new statutory and/or regulatory authority.

Responsibility for implementation of the Recovery Strategy lies primarily with the Department, which intends to work closely with other entities to ensure that the tasks are undertaken. Implementation of these actions will require many years, long-term commitments and involvement of many parties and organizations, considerable financial support, and careful planning and management.

The Recovery Strategy describes issues facing coho salmon and the many recommendations to address the issues, the vast majority of which were discussed and recommended by the recovery teams to the Department. The implementation schedules in Chapters 9 and 10 list actions by task-level priority, potential party or parties capable of (and in some cases responsible for) carrying out the actions, and the estimated commencement time and duration. The task level priorities identified in the implementation schedule are to be considered in conjunction with watershed priorities developed by the CRT and the Department, which are identified in the implementation schedules and described in section 6.3.

Implementation of recovery tasks has the potential to affect other species listed under ESA and under CESA. Potential effects on the conservation of these species could range from beneficial to detrimental. Other species at risk within the range of coho salmon, and any constraints on the implementation of recovery actions, are described in Appendix C.

1.4.3.1 Interim Actions

Some recommendations for recovery of coho salmon can be implemented immediately, both because it is economically and technical feasible and because no regulatory or statutory change is required to start the recovery activity or decision. For the purposes of this Recovery Strategy, interim actions are defined as those actions that can be initiated immediately or within the first five years of the strategy and require no regulatory or statutory changes.

1.4.3.2 Long-term Actions

Long-term recommendations require more time and planning before they can be implemented, a long duration to complete, additional funding, or require changes to law or regulation to be successful or even allowable.

1.4.4 ADAPTIVE MANAGEMENT

The Department believes adaptive management[3] is essential for successful planning and implementation of coho salmon recovery. Adaptive management is the process of involving scientific method and the experience of stakeholders and resource managers in an iterative process that allows for plan flexibility and responsiveness in revising the Recovery Strategy based on the best available scientific and other data. The Recovery Strategy is based on the current best available scientific and other information, but comprehensive and predictive knowledge is not available regarding ecological processes, synergistic effects of human activities, stochastic natural events, the most effective management practices, and the means of addressing stakeholder issues or conflicts. As we learn more about these things, adaptive management allows the Recovery Strategy to benefit accordingly.

The adaptive management process used in the Recovery Strategy is a six-step cycle, the success of which depends on the completion of all six steps:

1. Assess the problem by identifying the issues facing coho salmon and habitat and evaluate the scientific, management, and economic options and feasibility of potential solutions;
2. Design and select the policies, programs, and activities to be applied to recovery and additional assessment;
3. Implement programs and activities for recovery of coho salmon and continuing assessment designed to reveal the critical knowledge that is currently lacking;
4. Monitor the key response indicators that inform the Department on the progress and effectiveness of recovery programs and activities, and status and trend of coho salmon and habitat;
5. Evaluate recovery activities, programs, and assessment and monitoring information; and
6. Adjust and incorporate the results of implementation and monitoring into future decisions and revisions of the Recovery Strategy.

[3] Adapted from Taylor et al., 1997.

Biology 2

Coho salmon are one of seven species of Pacific Salmon belonging to the genus *Oncorhynchus*, and one of two native salmon species regularly occurring in California. This chapter, which describes coho salmon biology, is summarized from the Department's *Status Review of California Coho Salmon North of San Francisco* (CDFG 2002). The Status Review compiled the best available data on coho salmon. To the extent that new studies are provided, they must be evaluated in context of the entire body of literature as the recovery effort proceeds.

2.1 RANGE

Coho salmon occur naturally in the northern Pacific Ocean and tributary drainages. It ranges in freshwater drainages from Hokkaido, Japan, and eastern Russia, around the Bering Sea and Aleutian Islands to mainland Alaska, and south along the North American coast to Monterey Bay, California.

Within California, coho salmon historically ranged from the Oregon-California border (including the Winchuck and Illinois River drainages) south to the streams of northern Monterey Bay (Snyder 1931; Fry 1973), including small tributaries to San Francisco Bay (Brown and Moyle 1991; Leidy and Becker 2001). However, there is some evidence that they historically ranged as far south as the Pajaro River (Anderson 1995), the Big Sur River (Hassler et al. 1991), or even the Santa Ynez River (Lucoff 1980, as cited in National Council on Gene Resources 1982), although evidence of spawning populations south of the Pajaro River is anecdotal (Anderson 1995). Currently, the southernmost stream that contains coho salmon is Aptos Creek in Santa Cruz County (NMFS 2001). Historic and present ranges of coho salmon are shown in Figure 2-1.

Information on the possible existence of coho salmon in the San Joaquin and Sacramento rivers is sparse. Fry (1973) states that coho salmon did not occur in the Sacramento-San Joaquin river system prior to attempts to introduce them beginning in 1956. Hatchery fish returned in large numbers and spawned naturally, but were unable to sustain a natural run. Moyle (1976) noted that coho salmon in the Sacramento River are rare. It is likely that coho salmon historically observed in these streams were occasional strays (Hallock and Fry 1967; Hopkirk 1973). Intensive sampling efforts using trawling and beach seining by the United States Fish and Wildlife Service (USFWS) in the Sacramento and San Joaquin rivers and estuary have recorded no coho salmon since the project began in 1976 (USFWS 2001 unpublished data). For these reasons, the Department does not consider the Sacramento-San Joaquin river system to be within the historical range of coho salmon.

2.2 EVOLUTIONARILY SIGNIFICANT UNITS

The Federal Endangered Species Act (ESA) includes in the definition of species "any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." In order to improve consistency, NOAA Fisheries developed the ESU concept. In the document describing this concept, Waples (1991a) states, "A population (or group of populations) will be considered distinct (and hence a 'species') for purposes of the ESA if it represents an ESU of the biological species." A population must meet two criteria in order to be considered an ESU: 1) it must be reproductively isolated from other conspecific population units; and 2) it must represent an important component of the evolutionary legacy of the species (Waples 1991a).

ESUs reflect the best and most current understanding of the likely geographic boundaries of reproductively isolated salmon populations. Understanding these boundaries is especially important for NOAA Fisheries, which is charged with evaluating and protecting salmon species with broad ranges extending across State borders. Similar populations are thus grouped for efficient protection of biological and genetic diversity. The Department, in contrast, has responsibility for evaluation and protection of California stocks only and typically evaluates and manages salmon on a watershed basis, regardless of the biological affinities of California stocks to stocks across our borders. The Department recognizes the importance of genetic structure and biodiversity among California stocks in evaluating and protecting coho salmon.

Two coho salmon ESUs are found in California: the SONCC Coho ESU (from Punta Gorda, California, north across the State border to Cape Blanco, Oregon) and the CCC Coho ESU (from Punta Gorda, California, south to the San Lorenzo River) (Figure 2-2).

Only naturally spawning populations within these ESUs were included in the Federal listings. Mad River Hatchery stocks in northern California were not included in the SONCC Coho ESU. The relationship of the Iron Gate Hatchery stock with the rest of the SONCC Coho ESU was judged uncertain and it was, therefore, not included in the ESU. Four other hatchery populations in the Mattole, Eel, and Trinity rivers, and Rowdy Creek were specifically included as part of the ESU, but these populations were not deemed essential to recovery and they were, therefore, not included in the listing. Any hatchery population that is included as part of an ESU may have a role in its recovery under certain conditions.

2.2.1 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS COHO ESU

Coho salmon are now found in less than 60% of the SONCC Coho ESU streams that were historical coho salmon streams. However, these declines appear to have occurred prior to the late 1980s and the data do not support a significant decline in distribution between the late 1980s and the present. Some streams in this ESU have lost one or more brood-year lineages.

Although streams supporting coho salmon in the California portion of the SONCC Coho ESU are fewer now in comparison to the period 1985 to 1991, the available data suggest that population fragmentation within the larger river systems is not as severe as in the CCC Coho ESU. The major stream systems within the California portion of the SONCC Coho ESU still contain coho salmon populations, although many tributaries may have missing runs. Department analysis of the SONCC data when grouped (1986 to 1991 vs. 1995 to 2000) indicates that the decline is not statistically significant, whereas the NOAA Fisheries analysis of the ungrouped data (1989 to 2000) indicates that the decline in the northern ESU is significant.

Because of the decline in distribution prior to the 1980s, together with the possibility of a severe reduction in distribution as indicated by the field surveys and the downward trend of most abundance indicators, the Department believes that coho salmon populations in the California portion of this ESU will likely become endangered in the foreseeable future in the absence of the protection and management required by CESA.

FIGURE 2-1: Historic and present ranges of coho salmon in California

FIGURE 2-2: Coho Evolutionarily Significant Units in California

2.2.2 CENTRAL CALIFORNIA COAST COHO ESU

Coho salmon populations in streams in the northern portion of this ESU seem to be relatively stable or are not declining as rapidly as those to the south. However, the southern portion, where widespread extirpation has occurred, is a significant portion of the range of coho salmon in this ESU. Widespread extirpation or local extinctions have already occurred within some larger stream systems (e.g., Gualala and Russian rivers), or over broad geographical areas (e.g., Sonoma County coast, San Francisco Bay tributaries, streams south of San Francisco).

Most abundance trend indicators for streams in the CCC Coho ESU suggest a decline since the late 1980s. However, some streams of the Mendocino County coast showed an upward trend in 2000 and 2001. Time-series analyses for these streams show a declining trend and predict that this trend will continue, despite the recent increases.

Small population size, along with large-scale fragmentation and collapse of range, indicate that metapopulation structure may be severely compromised and remaining populations may face greatly increased threats of extinction. For this reason, the Department concluded that coho salmon in the CCC Coho ESU are in serious danger of extinction throughout all or a significant portion of their range.

2.3 PRESENT DISTRIBUTION

Coho salmon distribution is described as the streams within the range where the species can be, or has been, detected. The Department has mapped the present distribution of coho salmon in the SONCC Coho ESU (Figure 2-3) and the CCC Coho ESU (Figure 2-4). Present distribution is based on the most recently available information and includes streams where coho salmon are still believed to exist.

The Department used a conservative approach when determining the upper extent of coho salmon distribution. Where data were present, the upper mapped extent was defined as that point furthest upstream where coho were last observed. This uppermost point on the map does not preclude coho usage further upstream, only that they have not been documented as yet in those areas.

The full extent of a stream was mapped when the data available indicated coho existed there, but had no location information. An exception to this was when there was a known limit to anadromy. Known limits to anadromy include natural (e.g., waterfalls) as well as man-made barriers (e.g., dams). Some of these known man-made barriers may be removed or modified to allow access to more of the stream, increasing the limit of anadromy.

Waterways that are not indicated as coho streams may still support populations or provide seasonal refugia, but as yet have no usage documented. Therefore the known present distribution for coho salmon will change with new information.

2.4 LIFE HISTORY

Adult coho salmon enter fresh water from September through January in order to spawn. In the short coastal streams of California, migration usually begins between mid-November and mid-January (Baker and Reynolds 1986). Coho salmon move upstream after heavy rains have opened the sand bars that form at the mouths of many California coastal streams, but may enter larger rivers earlier. On the Klamath River, coho salmon begin entering in early to mid-September and reach a peak in late September to early October. On the Eel River, adult coho salmon return four to six weeks later than on the Klamath River (Baker and Reynolds 1986). Arrival in the upper reaches of these streams generally peaks in November and December. Timing varies by stream and/or flow (Neave 1943; Brett and MacKinnon 1954; Ellis 1962) (Figure 2-5).

Generally, coho salmon spawn in smaller streams than do Chinook salmon. In California, spawning occurs mainly from November to January, although it can extend into February or March if drought conditions are present (Shapovalov and Taft 1954). In the Klamath and Eel rivers, spawning occurs in November and December (USFWS 1979). Shapovalov and Taft (1954) note that females usually choose spawning sites near the head of a riffle, just below a pool, where the water changes from a laminar to a turbulent flow and there is a medium to small gravel substrate. The female digs a redd (nest) by turning partly on her side and using powerful, rapid movements of the tail to dislodge the gravels, which are transported a short distance downstream by the current. Repeating this action creates an oval-to-round depression at least as deep and as long as the fish. Eggs and milt (sperm) are released into the redd, where, because of the hydrodynamics of the redd, they tend to remain until they are buried. Approximately one-hundred or more eggs are deposited in each redd. The fertilized eggs are buried by the female digging another redd just upstream. The flow characteristics of the redd location usually ensure good aeration of eggs and embryos, and the flushing of waste.

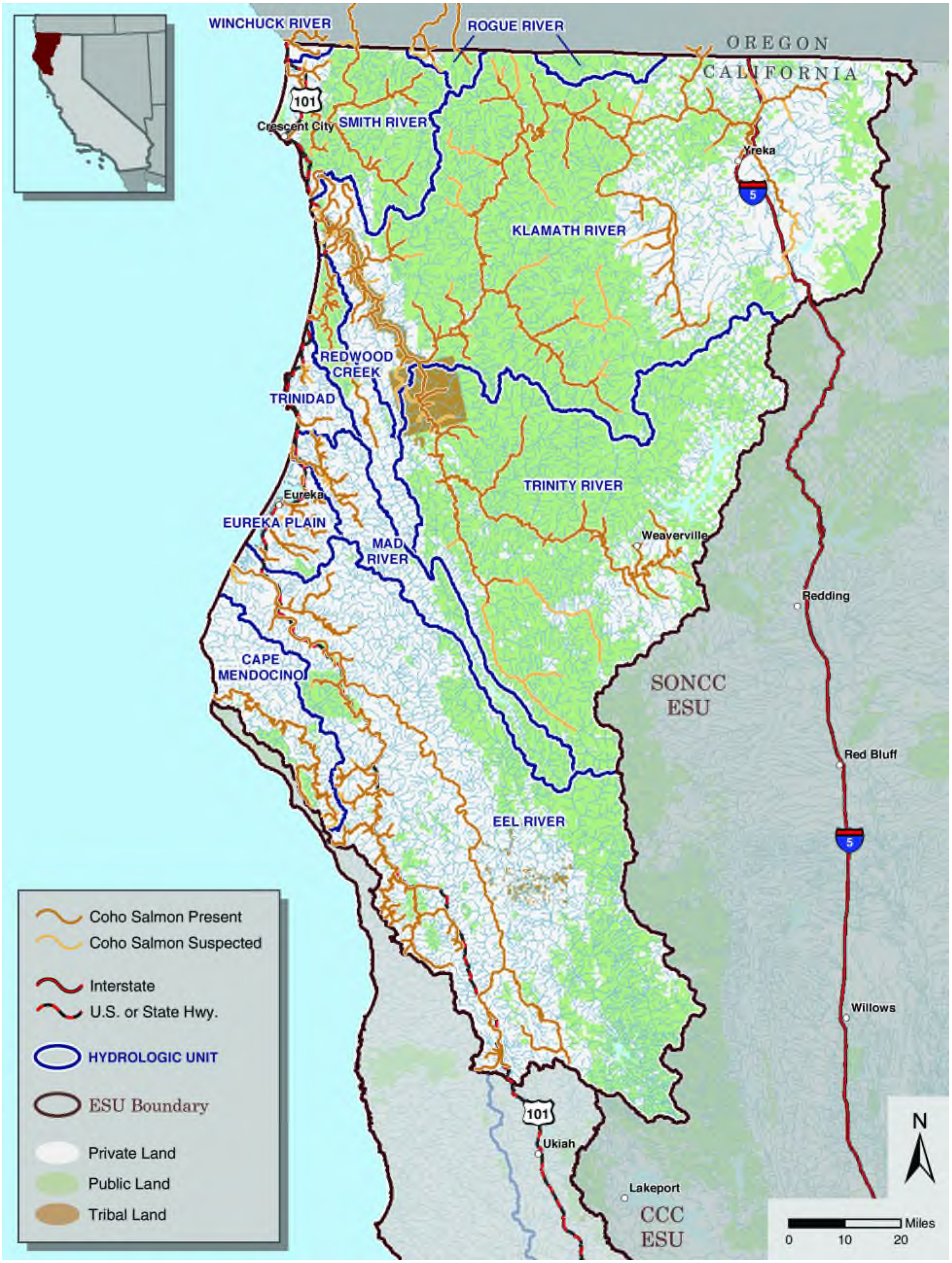
Larger coho salmon produce more eggs and there is a definite tendency for fecundity to increase from California to Alaska (Sandercock 1991). Average coho salmon fecundities, as determined by various researchers working on streams in British Columbia, Washington, and Oregon, range from 1,983 to 2,699 and average 2,394 eggs per female (Sandercock 1991). The fecundity of coho salmon in Washington streams ranged from 1,440 to 5,700 eggs for females that were 44 cm to 72 cm in length (Scott and Crossman 1973).

In California, eggs incubate in the gravels from November through April. The incubation period is inversely related to water temperature. California coho salmon eggs hatch in about forty-eight days at 48°F, and thirty-eight days at 51.3°F (Shapovalov and Taft 1954). After hatching, the alevins (hatchlings) are translucent in color (Shapovalov and Taft 1954; Laufle et al. 1986; Sandercock 1991). This is the coho salmon's most vulnerable life stage, during which they are susceptible to siltation, freezing, gravel scouring and shifting, desiccation, and predation (Sandercock 1991; Knutson and Naef 1997; Pacific Fisheries Management Council [PFMC] 1999). Alevins remain in the interstices of the gravel for two to ten weeks until their yolk sacs have been absorbed, at which time their color changes to that more characteristic of fry (Shapovalov and Taft 1954, Laufle et al. 1986, Sandercock 1991). The fry are silver to golden with large, vertical, oval, dark parr marks along the lateral line that are narrower than the spaces between them.

Fry emerge from the gravel between March and July, with peak emergence occurring from March to May, depending on when the eggs were fertilized and the water temperature during development (Shapovalov and Taft 1954). They seek out shallow water, usually moving to the stream margins, where they form schools. As the fish feed heavily and grow, the schools generally break up and individual fish set up territories. At this stage, the fish are termed parr (juveniles). As the parr continue to grow and expand their territories, they move progressively into deeper water until July and August, when they inhabit the deepest pools (CDFG 1994a). This is the period when water temperatures are highest, and growth slows (Shapovalov and Taft 1954). Food consumption and growth rate decrease during the winter months of highest flows and coldest temperatures (usually December to February). By March, parr again begin to feed heavily and grow rapidly.

Rearing areas used by juvenile coho salmon are low-gradient coastal streams, lakes, sloughs, side channels, estuaries, low-gradient tributaries to large rivers, beaver ponds, and large slackwaters (PFMC 1999). The most productive juvenile habitats are found in smaller streams with low-gradient alluvial channels containing abundant pools formed by large woody

FIGURE 2-3: Present distribution of coho salmon in the SONCC Coho ESU



2 BIOLOGY

FIGURE 2-4: Present distribution of coho salmon in the CCC Coho ESU

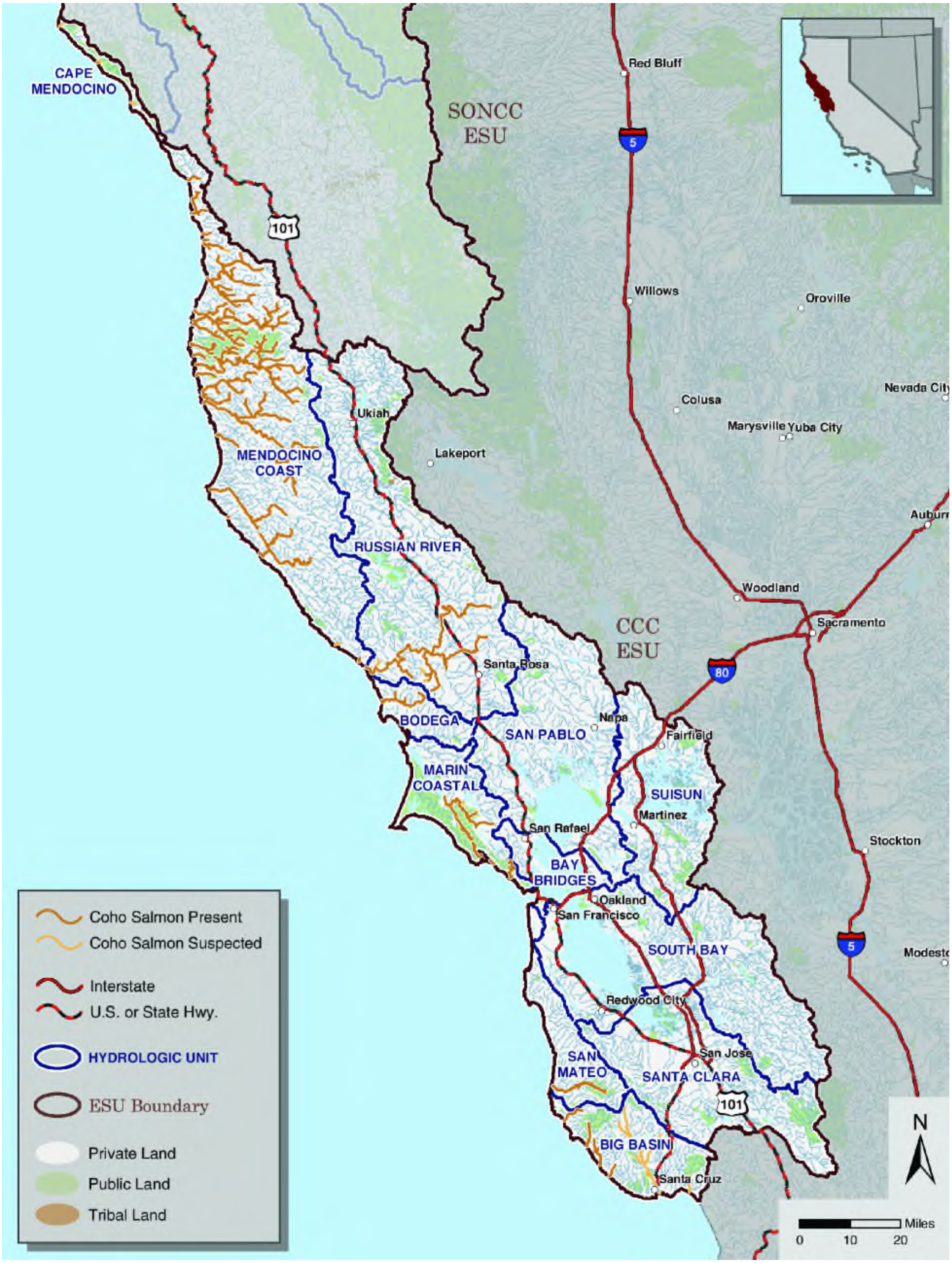
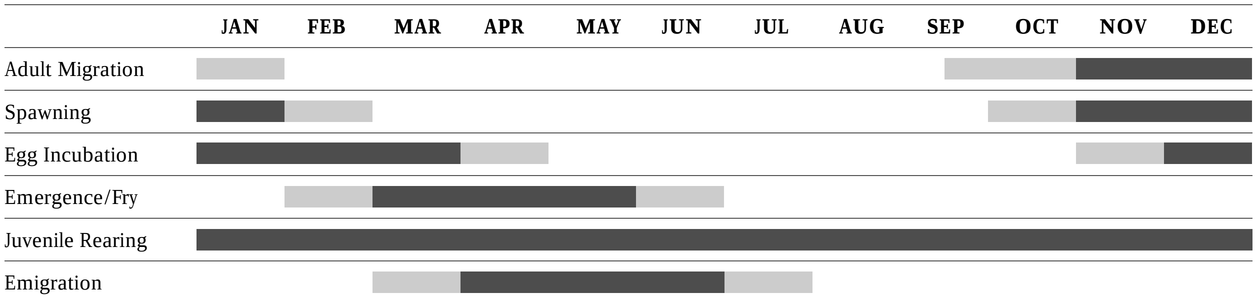


FIGURE 2-5: Calendar indicating the seasonal presence of coho salmon in California coastal watersheds



NOTE: Dark shading indicates months of peak activity for a particular life stage; the lighter shading indicates months of lesser activity.

debris (LWD). Adequate winter rearing habitat is important to successful completion of coho salmon life history.

After one year in fresh water, smolts begin migrating downstream to the ocean in late March or early April. In some years emigration can begin prior to March (CDFG unpublished data) and can persist into July (Shapovalov and Taft 1954; Sandercock 1991). Weitkamp et al. (1995) indicate that peak downstream migration in California generally occurs from April to early June. Factors that affect the onset of emigration include the size of the fish, flow conditions, water temperature, dissolved oxygen (DO) levels, day length, and the availability of food. In Prairie Creek, Bell (2001) found that a small percentage of coho salmon remain more than one year before emigrating to the ocean. Low stream productivity, due to low nutrient levels or cold water temperatures, can contribute to slow growth, potentially causing coho salmon to postpone emigration (PFMC 1999). There may be other factors that contribute to a freshwater residency of longer than one year, such as late spawning, which can produce fish that are too small at the time of smolting to migrate to sea (Bell 2001).

The amount of time coho salmon spend in estuarine environments is variable, and the time spent there is less in the southern portion of their range (PFMC 1999). Upon entry into the ocean, the immature salmon remain in inshore waters, congregating in schools as they move north along the continental shelf (Shapovalov and Taft 1954; Anderson 1995). Most remain in the ocean for two years; however, some return to spawn after the first year, and these are referred to as grilse or jacks (Laufle et al. 1986). Data on ocean distribution of California coho salmon are sparse, but it is believed that the coho salmon scatter and join schools from Oregon and possibly Washington (Anderson 1995).

2.5 POPULATION STRUCTURE AND VIABILITY

McElhany et al. (2000) define an independent fish population as a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season. This definition of a population is the one used for purposes of this document and is much the same as Ricker's definition of stock (1972, as cited in McElhany et al. 2000). The term "coho salmon population" typically refers here to spawning adults.

The Department defines and manages runs of anadromous salmonids based on genetic distinctiveness, run-timing differences, juvenile emigration timing, and watershed distinction (CDFG 1998). In many cases, California coho salmon populations roughly correspond to distinct spawning runs within watersheds. However, there is not enough information to assess the degree of gene flow between groups of spawners in different reaches of large streams. The relationship of tributary spawners to one another and to mainstem spawners is similarly unknown. Therefore, coho salmon spawning runs may actually be composed of more than one population.

2.5.1 POPULATION STRUCTURE

Salmon have strong fidelity to breeding in the stream of their origin. This provides the potential for substantial reproductive isolation of local breeding populations, and may result in significant local adaptation. Isolated populations are subject to different levels of genetic drift and unique natural selection pressures that tend over time to result in differences between them. In addition, populations arising through colonization or artificial production, and populations that have experienced recent drastic reductions in size, are often genetically different from the population from which they were derived. Salmon also naturally exhibit a small and variable amount of exchange among populations, connecting them genetically, and tending to make them more similar to one another. Even small amounts of gene flow between stocks (e.g., due to straying) can prevent their complete separation unless there is strong differential selection to maintain separation (Nei 1987). The amount of exchange may be influenced by factors like stream blockages (e.g., road crossings or sandbars at the mouths of rivers) and straying. Because of these factors, salmon populations are largely, but often not completely, isolated.

Levins (1969) proposes the idea of the metapopulation to describe a "population of populations." A metapopulation is comprised of subpopulations that are local breeding populations, with limited exchange among the subpopulations so that they are reasonably isolated but connected. Similarly, larger assemblages (e.g., all of the breeding populations in a watershed) can themselves form a metapopulation due to the connection between them afforded by natural straying. Fragmentation of this structure can affect the ability of populations to respond to natural environmental variation and catastrophic events.

Differential productivity among habitat patches can lead to a source-sink relationship in which some highly productive habitats support self-sustaining subpopulations (source subpopulations) that continually supply individuals to other non-self-sustaining subpopulations (sink subpopulations) in less productive habitats (Pulliam 1988). Data for at least one coho salmon population in Washington (McElhaney et al. 2000) are consistent with this model. Because of the fact that sink subpopulations are not self-sustaining and rely on source subpopulations for their existence, Schlosser and Angermeier (1995) and Cooper and Mangel (1999) stress the importance of protecting natural source subpopulations. However, over longer periods, the relationship between source and sink subpopulations may change (i.e., sources may become sinks and vice versa). Thus protecting only current source subpopulations may be inadequate to ensure long-term persistence. In some salmonid systems, hatchery and wild populations may represent sources and sinks, respectively (McElhaney et al. 2000).

Structure within a salmon species can be seen as hierarchical and there can be more than one hierarchical system. For example, the National Research Council (NRC 1996) describe the structure of genetic variation in salmon populations as beginning with substantially reproductively isolated local breeding populations that together constitute metapopulations typically connected by some small amount of gene flow, followed by larger biological races, then by subspecies (or ecotypes), and culminating with the species as a whole. McElhaney et al. (2000) suggest a hierarchy containing individual, subpopulation, population, ESU, and species levels. An ESU can also function as a metapopulation (McElhaney et al. 2000). For purposes of this document, coho salmon populations are assumed to be organized in a hierarchical structure that includes connections among subpopulations as well as connections over a larger geographic scale.

Coho salmon have an almost fixed three-year life cycle throughout most of their range, including California (Sandercock 1991; Waples et al. 2001). Therefore, a complete generation of coho salmon in a stream consists of three consecutive, almost completely non-overlapping, brood years. Because of this, the number of locally produced adults returning to a stream in a given spawning season is almost entirely dependent upon the number of juveniles produced there three years earlier. Loss of one of the three coho salmon brood years in a stream (called brood-year extinction or cohort failure), therefore, represents loss of a significant component of the total coho salmon resource in that stream. Brood-year extinction in a stream may be the result of the inability of adults to return to their place of origin, productivity failure, or high mortality. Recovery of an extinct coho salmon brood year in a stream is made more difficult by its almost complete dependence on strays from other, usually nearby, sources (including hatcheries). Stray rates among natural populations are variable, unpredictable, and are probably low in healthy natural populations (McElhaney et al. 2000). This dependence on sources that may also be depressed and fragmented adds considerable uncertainty to the potential for natural recovery of missing coho salmon brood years.

2.5.2 POPULATION VIABILITY

McElhaney et al. (2000) define a viable salmonid population for purposes of the ESA as "an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a one-hundred year time frame." One hundred years was chosen to represent the time frame over which to evaluate risk of extinction. This long time frame is important because typical recovery actions can affect populations over many years. Many genetic processes (e.g., loss of diversity) can occur over decades or centuries, and at least some environmental cycles occur over decadal or longer time frames. By considering extinction risk far into the future, large-scale environmental oscillations and long-term trends can be accounted for. Short-term viability (i.e., one-hundred or fewer years) is also considered. Evaluations of both long-term viability (i.e., 100 years) and short-term viability use the same criteria over different time scales.

The number of individuals that would ensure population viability to a negligible probability of extinction over one-hundred years is difficult to calculate (e.g., McElhaney et al. 2000; Morris et al. 1999; Dennis et al. 1991). For California coho salmon, evaluation of viability is based on assessments of abundance, population growth rate, population structure, and diversity, for which reliable estimates are not available. Therefore, it is not possible to determine viability targets, in terms of numbers of fish, for coho salmon at this time.

2.6 GENETICS

California coho salmon population genetics have been studied using allozymes (Bartley et al. 1982; Hjort and Schreck 1982; Olin 1984, Sollazi 1986; Weitkamp et al. 1995), transferrin (Hjort and Schreck 1982), and microsatellite deoxyribonucleic acid (DNA) (Banks et al. 1999; Hedgecock 2001; Hedgecock et al. 2002). CDFG (2002) and Weitkamp et al. (1995) contain reviews of the recent population genetic analyses. Table 2-1 lists locations in California from which genetic samples have been analyzed and reported, along with the loci used in each analysis.

Recent work (Weitkamp et al. 1995; Banks et al. 1999; Hedgecock et al. 2001; Hedgecock et al. 2002) has added considerably to the understanding of coho population genetics in California. While the distribution of genetic sampling within California (Table 2-1) is likely not sufficient to resolve coho population genetics at a scale useful to recovery in many watersheds (e.g., identification of local populations), it may prove useful in some of them. Large-scale relationships (e.g., at the ESU scale) are fairly consistent, although some of the existing studies may not have adequately captured the true range of genetic variation in coho salmon. This could be the result of one or more of the following factors: limited geographic context, availability of variable loci, small sample size coupled with low levels of variation in a large number of loci examined, and complications due to the effects of selection in transferrin studies (Weitkamp et al. 1995; Ford et al. 1999). The Department is working with geneticists at NOAA Fisheries Southwest Fisheries Science Center (Santa Cruz Laboratory) to further characterize California coho population structure. Data from these analyses will be incorporated into the Department's recovery strategy as they become available.

Waples et al. (2001), in a review of Pacific salmon diversity, report that coho salmon (along with pink and chum salmon), show relatively low levels of heterozygosity and only modest levels of genetic differentiation among populations across their species range, but that a strong

TABLE 2-1: California streams for which coho salmon genetic tissue samples have been collected, analyzed, and reported, 1982 to the present

LITERATURE SOURCE	CALIFORNIA SAMPLE LOCATIONS	TYPE OF GENETIC DATA	LOCI/ALLOZYMES USED IN ANALYSIS
Hjort and Schreck 1982	Iron Gate Hatchery/Klamath River, Trinity River Hatchery, Mad River Hatchery	Transferrin locus Allozyme	Transferrin, PGI
Olin 1984[a]	Iron Gate Hatchery/Klamath River	Allozymes	AAT-1, 2, 3; ACON; CK-2; EST-2, 3, 4, 5; GL-1, 2; IDH-1, 2, 3, 4; LDH-1, 2, 4; LGG; MDH-2, 3; 6-PGD; PGI-2, 3; PGM-1, 2; PHAP; PMI; SDH-1, 2; TFN.
Bartley et al. 1992[a]	Scott Creek, Waddell Creek, Lagunitas Creek, Tanner Creek/Salmon Creek, Willow Creek/Russian River, Flynn Creek/Navarro River, John Smith Creek/Navarro River, Albion River, Little River, Twolog Creek/Big River, Russian Gulch, Caspar Creek, Hare Creek, Little North Fork Noyo River, Kass Creek/Noyo River, Pudding Creek, Little North Fork Ten Mile River, Cotteneva Creek, Huckleberry Creek/South Fork Eel River, Butler Creek/South Fork Eel River, Redwood Creek/South Fork Eel River, Elk River, Prairie Creek, Rush Creek/Trinity River, Trinity River Hatchery, Deadwood Creek/Trinity River, West Branch Mill Creek/Smith River	Allozymes	AAD, AH, ADH, AK, FBA, CK, GALA, GPDH, GPI, IDDH, IDH, LDH, MDH, MPI, PGDH, PGK, PGM, SOD, TFN, PEPA, PEPC, PEPB, PEPD
Weitkamp et al. 1995[b]	Trinity River Hatchery	Allozymes	sAAT-1, 2*; sAH; GPI-A*; IDDH-1*; LDH-B1*; LDHB2*; sMDH-B1, 2*; MPI*; PEPA*; PEPC*; PEPD-2*; PGDH*; PGM-1*.
Banks et al. 1999	Warm Springs Hatchery/Russian River, Green Valley Creek/Russian River, Olema Creek, Noyo Egg Taking Station/Noyo River, Hare Creek	Microsatellite DNA	Ots-1, Ots-2, Ots-3, Ots-4, Omy-77
Hedgecock et al. 2001	Eel River, Noyo River, Russian River, Lagunitas Creek, Olema Creek, Scott Creek	Microsatellite DNA	Ots-2; iso-Ots-2; Ots-3; Ots-103; Oki-1; One-13; P-53
Hedgecock et al. 2002[c]	Klamath River, Trinity River, Little River, S.F. Eel River, Mattole River, Pudding Creek, S.F. Noyo River, Albion River, Russian River, Lagunitas Creek, Olema Creek, Redwood Creek, Waddell Creek, Scott Creek	Microsatellite DNA	Ots-2, iso-Ots-2, Ots-3, Ots-103, Oki-1, One-13, P-53

NOTES: Literature sources marked with bold contain a majority of data from sampling locations outside California, and those locations are not listed here. See CDFG (2002) for a complete review.

a Reanalysis of these data appear in Sollazi (1986).

b Contains a reanalysis of 20 samples from Bartley et al. (1982) and the Iron Gate Hatchery sample from Olin (1984) along with four newly collected samples from Oregon and one from California.

c Samples in this analysis overlap with those in Banks (1999) and Hedgecock et al. (2001).

geographic component exists nevertheless. Although some earlier studies found low levels of diversity (Bartley et al. 1982; Olin 1984), Weitkamp et al. (1995), Banks et al. (1999), Hedgecock (2001), and Hedgecock et al. (2002) found substantial genetic diversity in the California samples that they analyzed. All of the studies that have attempted to do so discriminate groups of coho salmon with some geographic component to the pattern. These relatively consistent patterns are summarized in the NOAA Fisheries ESU delineations.

Data summarized in the NOAA Fisheries status review of coho salmon (Weitkamp et al. 1995) were used to document areas of "genetic discontinuity/transition" for delineation of ESU boundaries (Figure 2-2). These discontinuities represent areas of restricted gene flow that likely result in some level of reproductive isolation. In California, this area of discontinuity occurs around Punta Gorda. Populations north of Punta Gorda (i.e., SONCC Coho ESU) and those south (i.e., CCC Coho ESU) are likely to experience some level of gene-flow restriction that is greater than that experienced within each geographic region. Populations in the transition region around Punta Gorda are not easily placed in either of the two geographic regions. NOAA Fisheries identified four other more northerly coho salmon ESUs that extend from Oregon to Canada.

Identification of populations and determination of local population genetic structure are essential to recovery. Figures 2-6, 2-7, and 2-8 show recently constructed genetic distance dendrograms using microsatellite DNA (Hedgecock et al. 2002) and allozyme (Weitkamp et al. 1995) data that depict the scale and relationships among the analyzed California coho salmon samples. Figures 2-7 and 2-8 present phylograms developed using the unweighted pair group method with arithmetic averages (UPGMA). These relationships can be used as a starting point in identifying populations of coho salmon for recovery purposes. These analyses are supportive of California ESU delineations drawn by Weitkamp et al. (1995) and adopted by the Department (CDFG 2002). The available analyses suggest that two to three somewhat reproductively isolated ESU-level groups exist across the range of coho salmon in California. These correspond to the SONCC Coho ESU, the CCC Coho ESU, and, arguably, populations of coho salmon south of San Francisco. Whether these ESU-level groups are equivalent to populations of coho salmon is not known. There may be more than one population in each ESU. However, at this time we accept that the ESU structure depicted here is a good guide to broad patterns of reproductive isolation of California coho.

2.7 HABITAT REQUIREMENTS

Each life stage of the coho salmon requires specific stream and habitat conditions in order to survive and to develop sufficiently to reach the next life stage at the time when naturally occurring favorable conditions prevail. Any natural or man-made changes in the stream environment jeopardize the success of a generation of fish that are adapted to the specific conditions of a watershed.

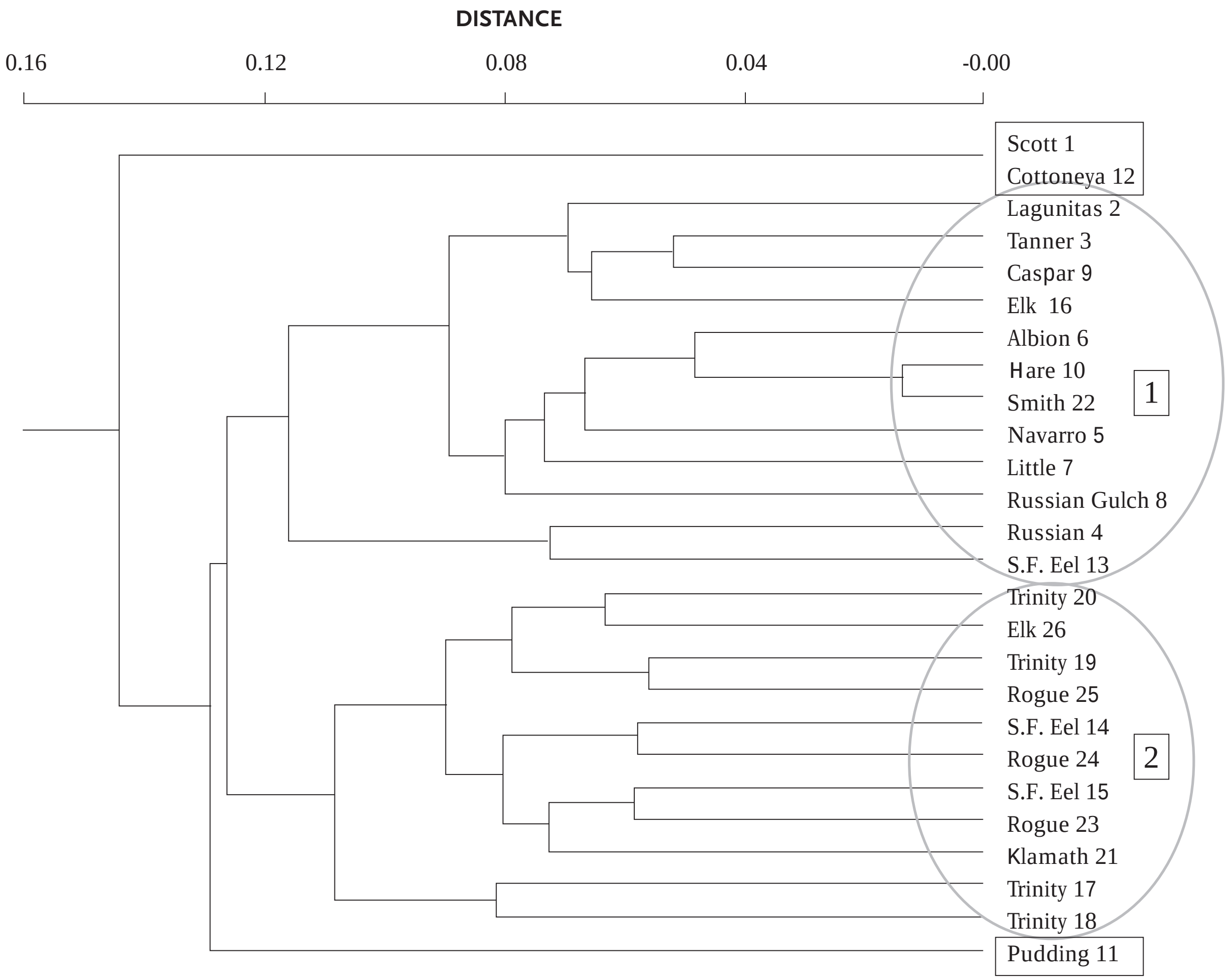
2.7.1 HABITAT REQUIREMENTS FOR ADULTS

Most coho salmon spend approximately half of their three-year life cycle in the ocean environment before returning to fresh water. They then migrate upstream and spawn mainly in small streams that flow directly into the ocean or in tributaries of large rivers.

2.7.1.1 Migration

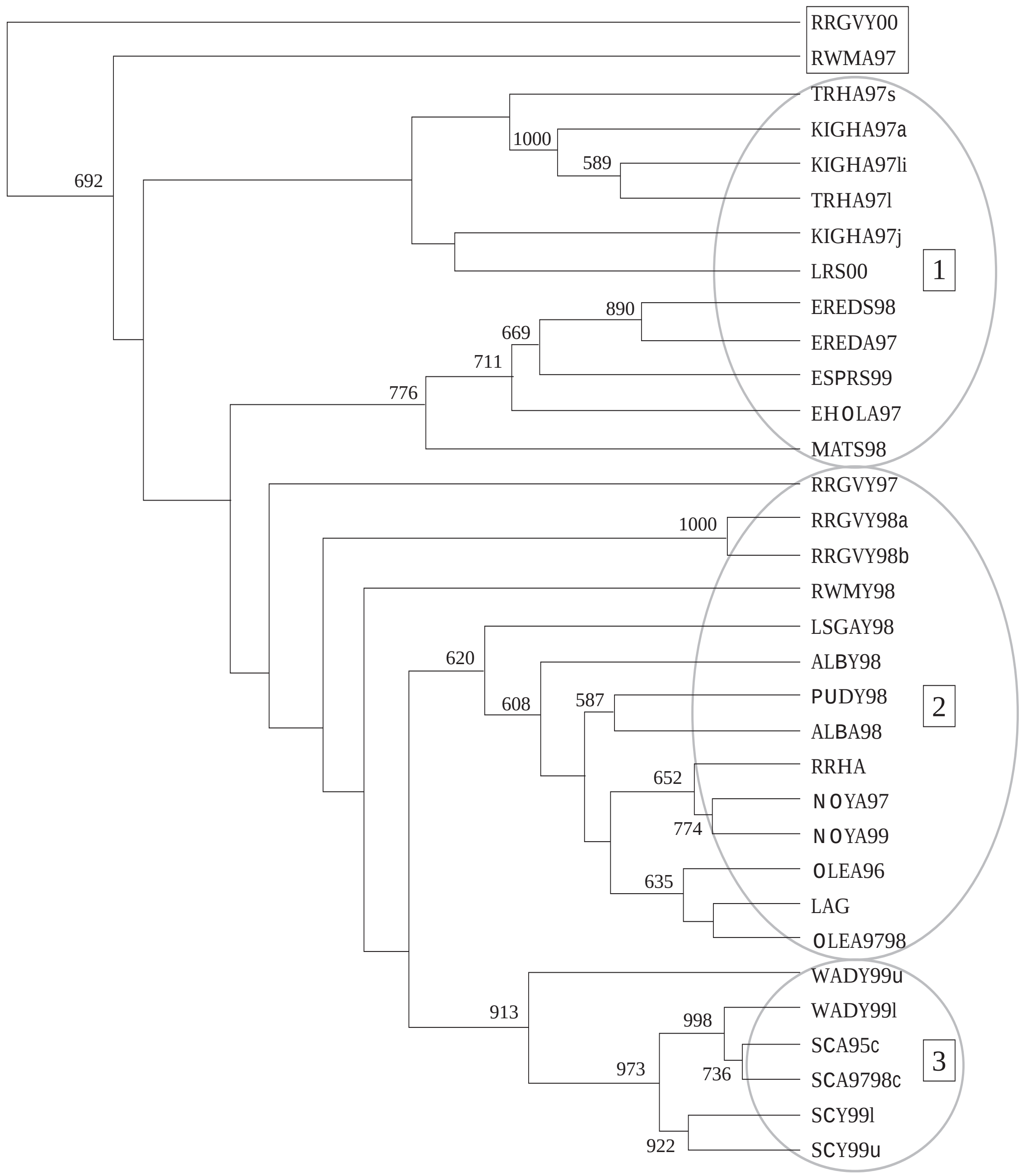
Coho salmon usually migrate during late summer and fall and their specific timing may have evolved in response to particular flow conditions. For example, obstructions that may be passable in high waters may be insurmountable during low flows. Conversely, early-running stocks are

FIGURE 2-6: Dendrogram based on pairwise genetic distances (Cavalli-Sforza and Edwards 1967) between 26 samples of coho salmon from southern Oregon and California



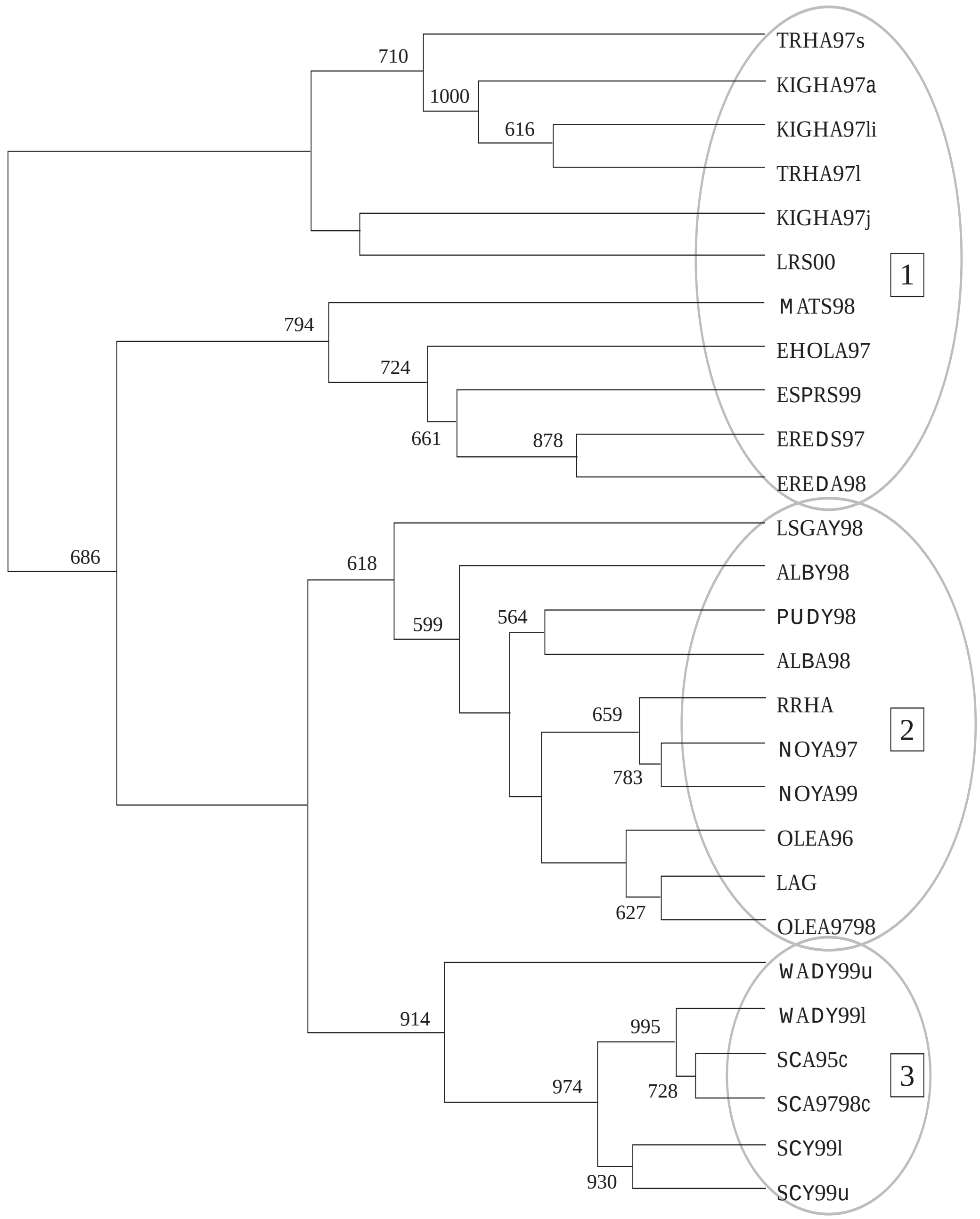
NOTES: Distances were calculated using data for 13 polymorphic allozyme loci from Bartley et al. (1982), Olin (1984), and new NOAA Fisheries samples. Ellipses encompass two major clusters: 1) mostly central California samples generally corresponding to the CCC Coho ESU, and 2) samples corresponding to the SONCC Coho ESU. Boxed samples are outliers to the two major groups from Scott Creek, and Pudding and Cotteneva creeks. From Weitkamp et al. (1995) with modification.

FIGURE 2-7: Unrooted UPGMA phylogram showing chord distances (Cavalli-Sforza and Edwards 1967) among 33 California coho salmon populations after adjustments for admixture and family structure and pooling of homogeneous samples within drainages and sites



NOTES: Genetic analysis is of microsatellite DNA. Nodes with significant bootstrap values (greater than 500 out of 1,000) are shown. Ellipses encompass groups of samples from 1) SONCC Coho ESU, 2) CCC Coho ESU, and 3) locations south of San Francisco. Boxed samples are outliers from Green Valley Cr. and Redwood Cr. Abbreviations: K*, Klamath; T*, Trinity ; LR*, Little R.; ERHO*, Eel-Hollow Tree Cr.; ERED*, Eel-Redwood Cr., ESPR, Eel-Sprowl Cr.; M*, Mattole; PUD*, Pudding Cr.; NOY*, Noyo; ALBA*, Albion; ALBY, Albion-Marsh Cr.; RRH*, Warm Springs Hatchery; RRGV, Green Valley Cr.; RRDS, Russian River Delta; RRM, Mirabel; LAG, Lagunitas Cr.; LSGA*, San Geronimo; OLE*, Olema Cr.; RWM*, Redwood Cr.; WAD*, Waddell Cr.; SC*, Scott Cr. Modified from Hedgecock et al. (2002).

FIGURE 2-8: Unrooted UPGMA phylogram showing chord distances (Cavalli-Sforza and Edwards 1967) among 27 California coho salmon populations after adjustments for admixture and family structure, pooling of homogeneous samples within drainages and sites, and removal of Green Valley and Redwood Creek outliers shown in Figure 2-7



NOTES: Genetic analysis is of microsatellite DNA. Nodes with significant bootstrap values (greater than 500 out of 1,000) are shown. Ellipses encompass groups of samples from 1) SONCC Coho ESU, 2) CCC Coho ESU, and 3) locations south of San Francisco. Abbreviations: K*, Klamath; T*, Trinity; LR*, Little R.; ERHO*, Eel-Hollow Tree Creek; ERED*, Eel-Redwood Cr., ESPR, Eel-Sprowl Cr.; M*, Mattole; PUD*, Pudding Cr.; NOY*, Noyo; ALBA*, Albion; ALBY, Albion-Marsh Creek; RRH*, Warm Springs Hatchery; RRGV, Green Valley Cr.; RRDS, Russian River Delta; RRM, Mirabel; LAG, Lagunitas Creek; LSGA*, San Geronimo; OLE*, Olema Cr.; RWM*, Redwood Creek; WAD*, Waddell Cr.; SC*, Scott Creek. Modified from Hedgecock et al. (2002).

thought to have developed because those fish could surmount obstacles during low or moderate flows but not during high flows. If flow conditions in a stream are unsuitable, the fish will often mill about in the vicinity of the stream mouth, sometimes waiting weeks, or even (in the case of early-run fish) months for conditions to change (Sandercock 1991). Although substantially greater depth may be needed to negotiate some barriers, minimum depth to allow passage of coho salmon is approximately 7.1 inches (Bjornn and Reiser 1991).

Reiser and Bjornn (1979) indicate that adult migration normally occurs when water temperature is in the 45 to 61°F range. Excessively high temperature may result in delays in migration (Monan et al. 1975). Additionally, excessively high temperature during migration may lead to disease outbreaks (Spence et al. 1996) and may reduce the egg viability (Leitritz and Lewis 1980).

The high-energy expenditure during sustained upstream swimming requires adequate concentrations of DO (Davis et al. 1963). Supersaturation of dissolved gases (especially nitrogen), however, has been found to cause gas-bubble disease in migrating salmonids (Ebel and Raymond 1976).

Reid (1998) found that high turbidity affects all life stages of coho salmon. In the case of adults, high concentrations of suspended sediment may delay or divert spawning runs (Mortensen et al. 1976). As an example of a response to a catastrophic event (the eruption of Mount St. Helens, Washington) coho salmon strayed from the highly impacted Toutle River to nearby streams for the two following years (Quinn and Fresh 1984). Salmonids have been found to wait rather than travel up a stream where the suspended sediment load reached 4,000 mg/l (Bell 1986).

Migrating coho salmon require deep and frequent pools for resting and to escape from shallow riffles where they are susceptible to predation. Deep pools are also necessary for fish to attain swimming speeds necessary to leap over obstacles. Pools need to be 25% deeper than the height of the jump for adult fish to attain the necessary velocity for leaping (Flosi et al. 1998).

LWD and other natural structures such as large boulders provide hydraulic complexity and pools. They also facilitate temperature stratification and the development of thermal refugia by isolating pockets of cold water (Bilby 1984; Nielsen et al. 1994). Riparian vegetation and undercut banks provide cover from terrestrial predators in shallow reaches.

2.7.1.2 Spawning

Coho salmon typically spawn in small streams where the flow is 2.9 to 3.4 cubic feet per second (cfs) and the stream depth ranges between 3.94 and 13.78 inches, depending on the velocity (Gribanov 1948; Briggs 1953; Thompson 1972; Bovee 1978; Li et al. 1979). On the spawning grounds, they seek out sites of groundwater seepage and favor areas where the stream velocity is 0.98 to 1.8 ft/s. They also prefer areas where water upwells through the redds, eliminating wastes, and preventing sediments from filling the interstices of the spawning gravel. The female generally selects a redd site at the outlet of a pool or at the head of a riffle, where there is good circulation of oxygenated water through the gravel. A pair of spawning coho salmon requires about 126 square feet for redd and inter-redd space.

About 85% of redds are located in areas where the substrate is comprised of gravel of 15cm diameter or smaller. There must be sufficient appropriately sized gravel and minimal fine sediments to ensure adequate interstitial space for egg survival. In situations where there is mud or fine sand in the nest site, it is removed during the digging process. LWD and other structures such as large boulders provide stream-bank support, which over time helps to reduce sediment input resulting from bank erosion.

Eggs deposited within a zone of scour and fill can wash downstream. LWD, riparian vegetation, and upslope stability enhance bank stability, which in turn promotes gravel stability and minimizes the risk to redds from the scouring effects of high flows. In addition to promoting bank stability, LWD also diversifies flows, reducing stream energy directed towards redds (Naiman et al. 1992).

2.7.2 HABITAT REQUIREMENTS FOR JUVENILES

The coho salmon typically spends the first half of its life in the freshwater or estuarine environment. The following sections describe habitat requirements for the early life stages.

2.7.2.1 Eggs and Alevin Incubation

Low winter flows can result in the desiccation of redds or may expose eggs to freezing temperatures. High water flows can disturb redd gravel, resulting in eggs being dislodged and swept downstream. Winter storms often cause excessive siltation that can smother eggs and inhibit intragravel movement of alevins. Siltation from these storms can reduce water circulation in the gravel to the point where low oxygen levels become critical or lethal.

According to Bjornn and Reiser (1991), the optimum temperature for coho salmon egg incubation is between 40 and 55°F. In one study, coho salmon embryos suffered 50% mortality at temperatures above 56.3°F (Beacham and Murray 1990). Because of the close connection between temperature and developmental processes, changes in thermal regime, even when well within the physiologically tolerable range for the species, can have significant effects on development time (and hence emergence timing), as well as on the size of emerging fry.

A high proportion of fine sediments in the gravel effectively reduces DO levels and also results in smaller emergent fry. Embryos and alevins need high levels of oxygen to survive (Shirazi and Seim 1981), and Phillips and Campbell (1961) suggest that DO levels must average greater than 8.0 mg/l for embryos and alevins to thrive. Excessive sediment deposition may also act as a barrier to fry emergence (Cooper 1959). McHenry et al. (1994) found that when sediment particles smaller than 0.85 mm[1] made up more than 13% of the total sediment, it resulted in intragravel mortality for coho salmon embryos because of oxygen deficiency. Cederholm et al. (1981) found that in the Clearwater River in Washington, the survival of salmonid eggs to emergence from gravel was inversely correlated with the percent of fine sediment when the proportion of fines exceeded the natural level of 10%. Tagart (1984) found that if sediment composition included a high concentration (up to 50%) of fine sediment (<0.85 mm), survival rate was lowered.

Shade provided by tall and/or mature vegetation is an important temperature regulator. LWD and large boulders provide stream-bank support that helps to meter out sediment deposition resulting from bank erosion and runoff, thus decreasing sediment input to spawning gravel.

2.7.2.2 Fry Emergence

Recently emerged coho salmon fry prefer shallow water, which leaves them vulnerable to floods that can displace them downstream into unsuitable habitat. This problem is greatly exacerbated in streams having little complexity due to lack of in-channel LWD. Displacement downstream may lead to early migration toward the estuary, and fry are poorly equipped to survive in brackish or salt water.

After emergence, fry continue to hide in gravel and under large stones, and within a few days they progress to swimming close to the banks, taking advantage of available cover. They congregate in quiet backwaters, side channels, and small creeks, especially in shady areas with overhanging branches. Fry are found in both pools and riffles, but they are best adapted to holding in pools. Cold, deep, dark, complex pools surrounded by streamside vegetation are optimal for coho salmon rearing. LWD and associated pool habitats provide cover from predators and refugia during high flow events (Everest et al. 1985).

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[1] This size category includes clay, silt, and some sand. It excludes larger sand particles.

2.7.2.3 Juvenile Rearing

The area of a particular stream available to juveniles for rearing is directly related to the turbidity of stream discharges (Everest et al. 1985). Lloyd et al. (1987) found that juveniles avoided chronically turbid streams, although they appear to be little affected by short transitory occurrences (Sorenson et al. 1977). Published data suggest that the feeding efficiency of juvenile coho salmon drops by 45% at a turbidity of one hundred Nephelometric Turbidity Units (NTUs) (Reid 1998). Coho salmon rarely eat stationary food or from the bottom, preferring food in suspension or on the surface of the water. At the yearling stage, they may supplement their insect diet with the fry of their own or of other species.

By late summer or early fall, juvenile feeding activity decreases and the fish move into deeper pools, especially those with overhanging logs, submerged woody debris and dense riparian vegetation. Juveniles spend time hiding under the cover of logs, exposed tree roots, and undercut banks. Lack of adequate pools and side channels makes them more susceptible to predation and to being swept out of the stream during winter high flows. At this stage they are especially vulnerable as their swimming ability is reduced because of lowered metabolic rate.

Salmonid behavior for coping with high turbidity includes the use of off-channel and clean-water refugia and holding temporarily at clean-water tributary mouths. These coping strategies are partially defeated by sediment inputs from roads, for example, when road runoff discharges into small tributaries that formerly provided clean inflows. In addition, roads adjacent to streams can reduce availability of flood-plain and off-channel pools to juvenile coho salmon (Reid 1998). Coho salmon streams with the best over-wintering habitat are those with LWD accumulations, spring-fed ponds adjacent to the main channel, or protected and slow-flowing side channels that may only be filled in winter. Backwaters and side channels that develop along unconstrained reaches in alluvial flood plains were historically important rearing habitats for juveniles (Sedell and Luchessa 1982).

In unstable coastal systems, coho salmon production may be limited by the lack of side channels and small tributaries to provide additional habitat for protection from winter floods. Beaver ponds can create additional habitat for coho salmon, both in winter to avoid high flows, and in summer to avoid stranding as a result of low flows. Habitat complexity contributes to the creation of microhabitats within reaches, thus providing more opportunities for inter- and intra-species stratification (Bjornn and Reiser 1991). Terrestrial insects and leaves falling into streams from riparian vegetation constitute much of the food base for stream macroinvertebrates, which in turn are a major food source for juvenile coho salmon.

2.7.2.4 Emigration

Stream flow is important in facilitating the downstream migration of coho salmon smolts. Dorn (1989) found that increases in stream flow triggered downstream movement of coho salmon. Spence (1995) also found short-term increases in stream flow to be an important stimulus for smolt emigration. Thus, the normal range of stream flow may be required to maintain normal temporal patterns of migration. In years with low flows, emigration is earlier. Artificial obstructions such as dams and diversions of water may impede emigration where they create unnatural flow patterns.

Water temperature affects timing of emigration of smolts by influencing their rate of growth and physiological development, and their responsiveness to other environmental stimuli (Groot 1982). Alteration of thermal regimes through land-use practices and dam operations can influence the timing of emigration. The probability that coho salmon smolts will migrate downstream increases with rapid increases in temperature (Spence 1995). Holtby (1988) found that coho salmon smolts in British Columbia emigrated approximately eight days earlier in response to logging-induced increases in stream temperatures. In addition, the age-class distribution was shifted from populations evenly split between one- and two-year-old smolts to populations dominated by one-year-old fish. If most smolts emigrate at the same age, poor ocean conditions would have a greater effect on that particular year class than if the risk were spread over two years. Coho salmon have been observed throughout their range to emigrate at temperatures ranging from 36.6°F up to as high as 55.9°F (Sandercock 1991). Coho salmon have been observed emigrating through the Klamath River estuary in mid- to late-May when water temperature ranged from 53.6 to 68°F (CDFG unpublished data).

Supersaturation of dissolved gases (especially nitrogen) has been found to cause gas-bubble disease in downstream-migrating salmonids (Ebel and Raymond 1976). Smolts are particularly vulnerable to predation (Larsson 1985). Physical structures in the form of undercut banks and LWD provide refugia during resting periods and cover from predators.

2.7.3 ESTUARINE HABITAT

Estuaries are essential habitat of Pacific salmon, including coho salmon (Sedell et al. 1991). Adults use estuaries as a holding area as they prepare for their migration upstream. Juveniles use estuaries for rearing, and completion of smoltification. Juveniles may occupy estuaries for several weeks before migrating out to sea. In fact, the phenomenon of smolts migrating out is not a single, unidirectional event; smolts may move in and out of an estuary a few times before finally remaining in the marine environment.

Returning adults enter the freshwater environment through estuaries. Access to the estuaries, sufficient cover, and adequate flow and water quality, including suitable temperature, are all important factors for these fish. Once in the estuaries, upstream migration is generally associated with high outflow combined with high tides (Sandercock 1991).

Young fish are very susceptible to predation once they reach the lower river system and estuary, where water quality and habitat complexity is a crucial factor in their ability to survive. Substrate habitat complexity and adequate woody debris are imperative for shelter and hiding, while a sufficient invertebrate food source is imperative for continued growth and physiological development prior to leaving the estuary. These physical and biological requirements are related to: 1) the type, diversity, distribution, and quality of substrate; 2) the amount, timing and quality of freshwater discharge; and 3) the tidal pattern and quality of marine waters. Estuaries provide important rearing habitat, especially in smaller coastal streams where freshwater rearing habitat is limited.

2.7.4 SUMMARY OF ESSENTIAL HABITAT

Coho salmon inhabit three aquatic environments during the course of their life cycle: freshwater streams, coastal estuaries, and the ocean. In each of these environments, particular ecological conditions are necessary for each coho salmon life stage, as described below. Each condition has a broader range that allows for survival and a narrower range that represents the optimum for coho salmon health, as measured by activity, growth, resistance to disease, and other factors.

It should be noted that most studies define optimal conditions as those producing defined physiological responses or efficiencies under laboratory conditions. Assuming that coho salmon populations are locally adapted to the particular suite of environmental conditions in their natal stream, ecologically optimal conditions in fact may produce physiological responses in fish that lie outside of the narrow range deemed physiologically optimal in laboratory conditions. Most important of these potential influences is the alteration in timing of events relating to the species' life history.

The major freshwater habitats used by each life stage of coho salmon are identified in Table 2-2. Table 2-3 summarizes essential habitat elements by life stage and for each element shows the range of suitability necessary for the viability and survival of coho salmon.

TABLE 2-2: Freshwater habitats of the different life stages of coho salmon

FRESHWATER HABITAT	COHO SALMON LIFE STAGE
Flat water riffle	fry, juveniles, spawning adults
Flat water	juveniles, spawning adults
Gravel streambed	eggs, alevins, young fry, spawning adults
Pool	fry, juveniles, migrating adults
Side-channel	fry, juveniles
Stream bank	fry, juveniles
Submerged vegetation and LWD	juveniles

2.7.4.1 Stream Vegetation

Vegetation in the riparian corridor provides many essential benefits to stream conditions and habitat. It serves as a buffer from sediment and pollution, influences the geomorphology and stream flow, and provides stream-bank stability. Vegetation adjacent to the water stabilizes the stream bank. The riparian buffer is vital to moderating water temperatures that influence spawning and rearing by providing the canopy, which protects the water from direct insolation, and the buffer, which provides a cooler microclimate and lower ambient temperatures near the stream. The riparian canopy also serves as cover from predators, and supplies both insect prey and organic nutrients to streams.

2.7.4.2 Large Woody Debris

LWD is an essential component with several ecological functions. Within the estuarine environment, it stabilizes substrate, provides cover from predators, and provides shelter. In the freshwater environment, it serves these same functions as well as providing for pool establishment and maintenance, spawning bed integrity, habitat for aquatic invertebrate prey, and instream productivity.

2.7.4.3 Sediment and Substrate

The channel substrate type and size, and the quantity and distribution of sediment have essential direct and indirect functions at several life stages of coho salmon. Adults require gravel of appropriate size and shape for spawning, building redds, and laying eggs. Eggs develop and hatch within the substrate, and alevins remain there for some time for protection and shelter. The substrate also functions as habitat for rearing juveniles by providing shelter from faster flowing water and protection from predators. Also, some invertebrate prey inhabit the benthic and epibenthic environment of the stream substrate. An excess of fine sediment is a significant threat to eggs and fry because it can: 1) reduce the interstitial flow necessary to regulate water temperature and DO, remove excreted waste, and provide food for fry; 2) reduce available habitat; and 3) envelop, and then suffocate, eggs and fry. The flushing and cycling of fine sediments is paramount to coho salmon survival.

2.7.4.4 Hydrological Regime

The characteristics of the water and the geomorphology of the stream channel are fundamentally essential to all coho salmon life stages that inhabit coastal watersheds. Important charac-

TABLE 2-3: Fundamental habitat elements and suitable ranges for coho salmon life stages[a]

ELEMENT	LIFE STAGE	SUITABLE RANGE	REFERENCE OR CITATION
Large woody debris	rearing juvenile	>400 ft^3/100 ft reach[b]	Murphy 1995
Riparian cover	rearing juvenile	>80%	Flosi et al. 1998
Sediment and substrate	spawning adult	20% fine sediment; 0.51-4.02 inches (size)[c]	Reiser and Bjornn 1979; Bjornn and Reiser 1991
	egg and fry	depth: 7.01-15.41 in; ~9.85 in; diameter: 1.54-5.40, ~3.70; <20% fine; <12% fine, <5% fine (optimum)	Briggs 1953; Cederholm and Reid 1987; PFMC 1999
Stream ow (peak ow, freshets, minimum summer ow)	migrating adult	discharge is specific to stream	
	spawning adult	discharge is specific to stream	
	rearing juvenile	discharge is specific to stream	
Territory (square feet)	spawning pair	126	Bjornn and Reiser 1991
	rearing juvenile	26-59/fish; 0.001-1.0 fish per 3.281 [0.5-1 year old]	Reiser and Bjornn 1979; Bjornn and Reiser 1991
Turbidity (NTU[d])	migrating adult	<30 ounces/gal	Bjornn and Reiser 1991
	spawning adult	clear to heavily silted	Sandercock 1991
	juvenile	>60 (disrupted behavior); >70 (avoidance)	Bjornn and Reiser 1991
Water depth (inches)	migrating and spawning adult	4.02-7.88; ~6.19; 7 (minimum)	Briggs 1953; Bjornn and Reiser 1991
	rearing juvenile[e]	9.46-48.07	Bjornn and Reiser 1991
Dissolved oxygen (oz/gal)	migrating adult	‡80% saturation and >0.037	Bjornn and Reiser 1991
	rearing juvenile	100% saturation (preferred); 0.037-0.044 (stressed); >.059 (optimum)	Reiser and Bjornn 1979; Bjornn and Reiser 1991, PFMC 1999
	egg and fry	near saturation (preferred); >0.059 (optimum)	Reiser and Bjornn 1979; Bjornn and Reiser 1991; PFMC 1999
Water temperature (¡F)	migrating adult	44.6-59	Reiser and Bjornn 1979
	spawning adult	39.2-48.2	Bjornn and Reiser 1991
	rearing juvenile	35 (lower lethal); 78.8-83.8 (upper lethal); 53.6-57.2 (optimum); 48-59.9 (optimum); 63.7-64.9 (MWAT[f]); 62.1 (MWAT) and 64.4 (MWMT[g])	Bjornn and Reiser 1991; Flosi et al. 1998; Ambrose et al. 1996; Ambrose and Hines 1997, 1998; Hines and Ambrose ND; Welsh et al. 2001
	egg and fry	39.2-51.8; 39.2-55.4 (optimum); 32-62.6	Davidson and Hutchinson 1938; Bjornn and Reiser 1991, PFMC 1999
Water velocity (ft/s)	migrating adult	<8	Reiser and Bjornn 1979
	spawning adult	0.98-2.46; 1.02; 1.9, 0.98-2.99	Briggs 1953; Reiser and Bjornn 1979; Bjornn and Reiser 1991
	rearing juvenile	0.30-0.98 (preferred for age 0), 1.02-1.51 (riffle), 0.30-0.79 (pool); 0.16-1.283; 0.16-0.98	Reiser and Bjornn 1979; PFMC 1999
	egg and fry	0.82-2.95	PFMC 1999

NOTES:

[a] Values presented in this table are based on general conditions found within suitable coho salmon habitat in California and elsewhere. Individual determinations of habitat suitability and restoration potential should be based on site-specific conditions in consultation with the Department.

[b] Coho salmon research conducted in southeast Alaska.

[c] Estimated from other species or general for anadromous salmonids.

[d] NTU = Nephelometric Turbidity Units

[e] Various sizes and ages. Fish either aged (0 or 1) or measured (15.8-24.4 cm).

[f] MWAT = Maximum weekly average temperature

[g] MWMT = Maximum weekly maximum temperature

teristics include water temperature, water velocity, flow volume, and the seasonal changes and dynamics of each of these (e.g., summer maximum and mean temperature, summer flow, peak flow, winter freshets).

2.7.4.5 Water Temperature

Appropriate water temperature regines are essential throughout the freshwater phases of the coho salmon life cycle. Water temperature affects the rate and success of egg development; fry maturation; juvenile growth, distribution, and survival; smoltification; initiation of adult migration; and survival and success of spawning adults. Water temperature is influenced by many factors including stream flow, riparian vegetation, channel morphology, hydrology, soil-geomorphology interaction, climate, and impacts of human activities. The heat energy contained within the water and the ecological paths through which heat enters and leaves the water are dynamic and complex. There is also small- and large-scale heterogeneity of temperatures based on stream depth, width, and flow (Essig 1998).

Water temperature requirements must be considered in relation to the unique physiological phenomena associated with each life stage. Additionally, environmental conditions in specific watersheds may affect the normal range and extreme end-points for any of these temperature conditions for coho salmon within these watersheds. Water temperature requirements are dependent on fish metabolism and health, and on available food. Individual coho salmon populations are genetically adapted to habitat conditions within specific watersheds; therefore some populations may differ slightly in their temperature requirements and tolerances. These factors need to be considered together when trying to understand the habitat needs of coho salmon in a particular watershed or river system.

2.7.4.6 Dissolved Oxygen

An adequate level of dissolved oxygen is necessary for each life stage of coho salmon and is affected by water temperature, instream primary productivity, and stream flow. Fine sediment concentrations in gravel beds can also affect DO levels, impacting eggs and fry.

3 Threats

This chapter summarizes threats to coho salmon. The severity of the decline in the numbers of coho salmon and the number of extirpated populations increases as one moves closer to the historical southern limit of the species' range, suggesting that these environments are less able to support coho salmon populations than in the past. Freshwater habitat loss and degradation have been identified as leading factors in the decline of anadromous salmonids in California, including the coho salmon. Past timber harvest activities, especially road construction, have had deleterious effects on coho salmon habitat. Urbanization and increased diversion of water for agricultural, domestic, and other purposes, and dams that block access to former habitat, have resulted in further reduction of habitat. Water quality in streams historically inhabited by coho salmon has degraded, as evidenced by the number of north- and central-coast streams that have been placed on the list of impaired water bodies, pursuant to §303 of the Clean Water Act (CWA).

3.1 CLIMATIC VARIATION

California experiences wide variation in climatic and hydrologic conditions. Various climatic phenomena including severe storms, drought, seasonal cycles, El Niño and La Niña events, decadal events, and regime shifts can alter the physical, chemical, and biological aquatic environment (Parrish and Tegner 2001). These changes can, in turn, play a major role in the life history, productivity, and persistence of coho salmon populations. Coho salmon evolved with, and have persisted in the face of, extreme variability in habitat conditions caused by these natural phenomena. However, catastrophic conditions combined with low population numbers, habitat fragmentation, impacts of human activities, and habitat degradation or loss can cause an unrecoverable decline of a given population or species (Moyle et al. 1995).

3.1.1 DROUGHT

In California, coho salmon populations exist in many coastal streams where stream closures occur at their mouths when coastal wave action and low summer flows lead to sandbar formation. Coho salmon are able to identify their natal stream by the seepage of fresh water entering the ocean through the bars, but they are unable to enter the streams until fall or winter rains increase flows sufficiently to breach the sand bars. Shapovalov and Taft (1954) found that streams south of San Francisco may not be passable until as late as March. When this happens, a large portion of the run may enter the stream over a short period. Up to 70% of the total returning spawning population may enter the stream from the ocean within a few days (Sandercock 1991). During prolonged droughts, sandbars may never open in a given season. When that happens, spawners are unable to enter those streams (Anderson 1995). Reduced flows can reduce habitat quantity and result in increased water temperature, causing increased heat stress to fish and thermal barriers to migration.

3.1.2 FLOODING

High flows associated with 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 flood plain, washed downstream to poor habitat such as 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.

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).

Flooding does, however, have beneficial effects such as 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.

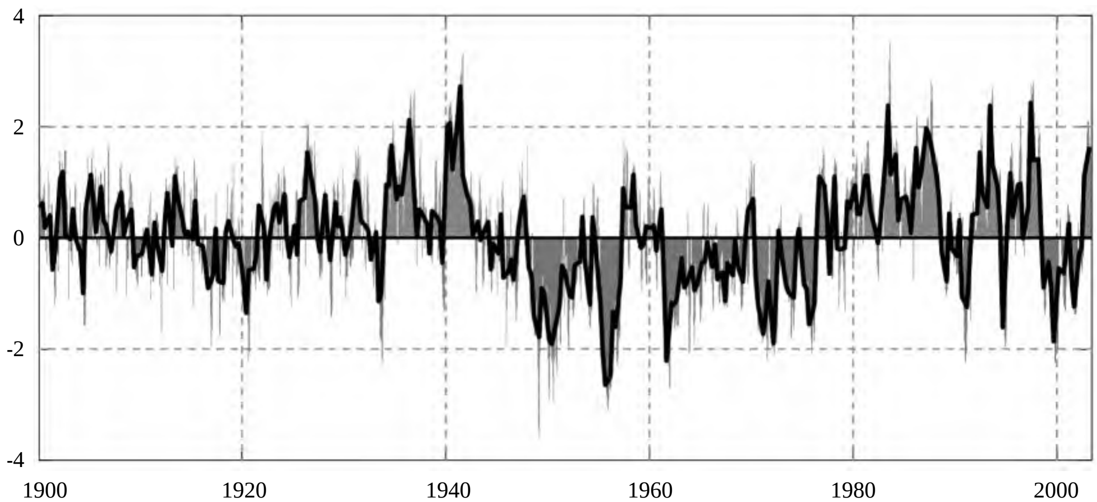
3.1.3 OCEAN CONDITIONS

Changing ocean conditions, extreme climatic conditions, and natural variation in ocean conditions can strongly impact Pacific salmon populations. However, salmon populations have not, until the past century, experienced these conditions in conjunction with the widespread degradation of their spawning, rearing, and overwintering habitat caused by human related activities (Brown et al. 1994; Anderson 1995).

Periodic changes in Pacific currents, winds, and upwelling regimes have had major impacts on the primary and secondary productivity of the northeast Pacific Ocean (Brown et al. 1994; Mantua et al. 1997). These oceanic events, described as El Niño/Southern Oscillation (ENSO) and Pacific interdecadal oscillation (PDO) are associated with declines and increases in ocean survival and decreases and increases in size of coho and Chinook salmon (Johnson 1988; Spence et al. 1996; Tschaplinski 1999; Cole 2000; Ryding and Skalski 1999; Koslow et al. 2002). ENSO events are of relatively short duration (6-18 months) with their primary influence in the tropics and secondary expression in the North Pacific/North American sector. In contrast, PDO events are most visible in the North Pacific and typically cycle over periods of about 50 years; within a PDO cycle there may be short-lived reversals of conditions (Mantua 2003). Figure 3-1 summarizes monthly PDO indices developed by the University of Washington; negative values indicate cool PDO periods that are generally favorable for coho salmon populations in California.

Marine conditions have several ramifications that must be considered in planning for coho salmon recovery and the interpretation of monitoring results. The cyclic nature of marine productivity, as outlined by Lawson (1993), can mask the reproductive decline of a salmonid population. The conceptual model he presents combines the effects of oceanic cycles and freshwater habitat degradation. As the freshwater habitat degrades, the salmon populations do not decline in an immediate and linear fashion. Instead, due to the long-term cycles of productivity in the marine environment, the downward trend in freshwater productivity can be masked by higher escapement due to more favorable oceanic conditions. These trends must be considered when assessing the success of coho salmon recovery efforts.

FIGURE 3-1: Monthly values for the Pacific interdecadal oscillation index: January 1900 to April 2003



SOURCE: http://tao.atmos.washington.edu/pdo/

3.2 DISEASE

Coho salmon are susceptible to an array of bacterial, viral, parasitic, and fungal diseases found in many salmonids of the Pacific Northwest. Symptomatic conditions appear when fish are stressed by high water temperatures, crowding, environmental contaminants, or decreased oxygen supply (Warren 1991). Diseases affect various life stages differently. Diseases and disease agents in California that can cause significant losses in adult salmonids include: bacterial kidney disease *(Renibacterium salmoninarum)*, furunculosis *(Aeromonas salmonicida)*, columnaris *(Flexibacter columnaris)*, pseudomonas infection, aeromonas infection, and ichthyopthirius or "ich" *(Ichthyophthirius multifiliis)* (W. Cox pers. comm.). The diseases that are known to cause significant losses in juvenile salmonids are furunculosis, columnaris, coldwater disease *(Flexibacter psychrophilis)*, pseudomonas, aeromonas, ichthyopthirius, nanophyetes, and ceratomyxosis *(Ceratomyxa shasta)* (William Cox pers. comm.).

The introduction of disease by hatchery fish into wild stocks is an increasing concern, but the degree of risk and seriousness of the problem are little known (Brown et al. 1994).

3.3 PREDATION

Predation occurs during all life stages of the coho salmon and it is accommodated by a healthy population; however it can be detrimental to those populations with low numbers or poor habitat conditions (Anderson 1995).

3.3.1 FRESHWATER PREDATION

Predators in the freshwater environment, such as invertebrates, fish, and birds, reduce the survival rate of eggs and alevins (Sandercock 1991). Some native fishes known to consume coho salmon are: sculpin *(Cottus spp.)*, Sacramento pikeminnow *(Ptychocheilus grandis)*, steelhead rainbow trout *(Oncorhynchus mykiss)*, coastal cutthroat trout *(O. clarki clarki)*, and other coho salmon (Shapovalov and Taft 1954; Sandercock 1991; Anderson 1995). Non-native fishes such as Sacramento pikeminnow *(Ptychocheilus grandis)* introduced to the Eel River, smallmouth bass *(Micropterus dolomieu)*, and channel catfish (*Ictalurus punctatus*) can consume significant numbers of juvenile salmon if the conditions are favorable for them (NMFS 1998). Striped bass *(Morone saxatilis)* can also be a significant predator of juvenile salmonids, and has been observed in the Russian River system. However, current information does not indicate that they have had a significant impact on coho salmon populations. Avian predators of juvenile salmonids include dipper *(Cinclus mexicanis)*, gulls *(Larus spp.)*, double-crested cormorant *(Phalacrocorax auritus)*, belted kingfisher *(Megaceryle alcyon)*, herons *(Ardea spp.)*, common merganser *(Mergus merganser)*, and osprey *(Pandion haliaetus)* (Fresh 1997; Sandercock 1991; Spence et al. 1996). Among mammalian predators that can impact salmonid populations, mink *(Mustela vison)* and otter *(Lutra canadensis)* can take significant numbers of the overwintering coho salmon juveniles and migrating smolts, although this is dependent upon conditions favorable to predators and the availability of other prey (Sandercock 1991).

3.3.2 MARINE PREDATION

The relative impacts of marine predation on anadromous salmonids are not well understood, though documentation of predation from certain species is available. NMFS (1998) noted that several studies have indicated that piscivorous predators may control salmonid abundance and survival. Beamish et al. (1992) documented predation of hatchery-reared Chinook and coho salmon by spiny dogfish *(Squalus acanthias)*. Pacific hake *(Merluccius productus)* and pollock *(Theragra chalcogramma)* are known to consume salmon smolts (Holtby et al. 1990). Marine sculpins also consume juvenile salmonids, although salmonids are not a major part of their diet.

There are many known avian predators of juvenile salmonids in the estuarine and marine environments. Some of these include belted kingfisher, gulls, grebes *(Podicipedidae)*; and loons *(Gavia spp.)*, herons, egrets, bitterns *(Ardeidae)*; cormorants *(Phalacrocorax spp.)*, terns (*Sterna* spp.), mergansers *(Mergus spp.)*, pelicans *(Pelecanus spp.)*, auklets, murres, murrelets, guillemots, and puffins *(Alcidae)*; and sooty shearwater *(Puffinus grisens)* (Emmett and Schiewe 1997; NMFS 1998). Bald eagles *(Haliaeetus leucocephalus)* and osprey are predators of adult salmonids (Emmett and Schiewe 1997). It is important to note that these predators are opportunistic feeders, preying upon the most abundant and easiest to catch.

In most cases, salmonids appear to be a minor component of the diet of marine mammals (Scheffer and Sperry 1931; Jameson and Kenyon 1977; Graybill 1981; Brown and Mate 1983; Roffe and Mate 1984; Hanson 1993; Botkin et al. 1995; Goley and Gemmer 2000; Williamson and Hillemeier 2001a, 2001b). The principal food sources of marine mammals include lampreys (Jameson and Kenyon 1977; Roffe and Mate 1984; Hanson 1993), benthic and epibenthic species (Brown and Mate 1983; Hanson 1993), and flatfish (Scheffer and Sperry 1931; Graybill 1981; Hanson 1993; Goley and Gemmer 2000; Williamson and Hillemeier 2001a, 2001b). Although salmonids appear to make up a relatively minor component of the diet of seals and sea lions, this does not indicate conclusively that pinniped predation is not significant. Predation may significantly influence salmonid abundance in populations when other prey are absent and physical habitat conditions lead to the concentration of adult and juvenile salmonids in small areas (Cooper and Johnson 1992).

3.4 HATCHERIES

A large body of evidence supports the conclusion that artificial propagation can be detrimental to natural and hatchery salmonid populations (Steward and Bjornn 1990; Hindar et al. 1991; Waples 1991b; Campton 1995; Flagg et al. 2000). Several published studies have found that hatchery stocks are generally less productive in the wild than locally adapted natural stocks, and that transplanted stocks are also less productive than locally adapted natural ones (Leider et al. 1990; Waples 1991b; Meffe 1992; Fleming and Gross 1993; Reisenbichler and Rubin 1999).

Although no direct connection can be made because specific data are lacking, stock transfers from various sources from within and from outside California have been implicated by several authors as a factor that might have contributed to the low diversity and weak population genetic divergence observed in California coho salmon stocks (Brown and Moyle 1991; Bartley et al. 1992; Weitkamp et al. 1995; NMFS 2001). Prolonged hatchery stocking in a particular stream should not be used by itself as documentation of extinction of a distinct wild population. Wild coho salmon stocks can persist in the presence of extensive hatchery stocking.

Hatcheries may have contributed to declines of coho salmon in California, although to what degree is unknown. Currently, their potential to do harm is limited by decreased hatchery production and modern management policy. Hatcheries in California have dramatically reduced their production of coho salmon, limited outplanting, and stopped virtually all stock transfers in recent years. Therefore, current impacts of hatchery fish on remaining natural stocks are significantly less than in the past.

3.5 GENETIC DIVERSITY

An understanding of the existing range and pattern of genetic diversity is essential to effective recovery planning. Section 2.6 reviews the available population genetics information for coho salmon, including patterns of genetic variation that will be useful first approximations for delimiting populations.

Maintenance of genetic diversity is crucially important to the recovery of depleted stocks because genetically diverse taxa:

a. Have a potential for greater overall abundance because different populations can exploit different habitats and resources;

b. Exhibit enhanced long-term stability due to spread risk and redundancy in the face of unpredictable catastrophes (e.g., dramatic rapid fluctuation of climatic or ocean conditions); and

c. Contain a broad range of raw material that allows adaptation and increases the probability of persistence in the face of long-term environmental change (McElhany et al. 2000; Levin and Shiewe 2001).

Numerous literature sources have expressed concerns about loss of genetic diversity in California coho salmon populations (CDFG 2002; Hedgecock et al. 2002; NMFS 2001; Weitkamp et al. 1995; Brown et al. 1994; Brown and Moyle 1991). Coho salmon status reviews (CDFG 2002; NMFS 2001; Weitkamp et al. 1995; Brown et al. 1994; Brown and Moyle 1991) have consistently characterized many California coho salmon populations as small and fragmented, with missing brood years in some places. Some of the threats to genetic diversity that were identified in these reviews are shown in Table 3-1. These threats include small population size effects, inappropriate levels of migration or straying, negative hatchery-natural interactions, and missing brood years. Any recovery actions should take these possible factors into account.

TABLE 3-1: Identified concerns about maintenance of existing genetic diversity and possible causes of reduction of genetic diversity in California coho salmon

FACTOR	RESULTS	EFFECT ON RECOVERY POTENTIAL
Few breeding individuals in each population	• Reduced N_e • Inbreeding depression • Increased rate of genetic drift • Allee Effect	• Loss of within-population genetic diversity • Reduced fitness • Reduced adaptive potential • Reduced evolutionary potential • Inability to find mates • Reduced productivity • High vulnerability to catastrophic events and rapid environmental change
Migration and straying (both more and less than natural rates)	• Impaired metapopulation structure • Inappropriately high migration rate among populations • Outbreeding depression	• Reduced connectivity among populations • Loss of between-population genetic diversity (Homogenization of stocks) • Loss of adaptive complexes • Reduced fitness • Reduced productivity
Hatcheries	Domestication of broodstock Negative natural/hatchery interactions	• Loss of adaptive complexes • Genetic swamping • Reduced fitness of all run components (HO, NO, and HO+NO) • Replacement of well adapted natural runs with poorly adapted hatchery runs • Inappropriate levels of straying • Masking of declines in natural run size
Missing brood years and local extinction	• Reduced N_b, N_e • Loss of potential migrants • Change in population age structure • Incomplete brood-year cycles • Impaired metapopulation structure	• Loss of genetic diversity components • Reduction of potential for gene flow among brood years • Loss of adaptive potential

SOURCES: CDFG 2002; Hedgecock et al. 2002; NMFS 2001; Weitkamp et al. 1995; Brown et al. 1994; Brown and Moyle 1994.

Loss of genetic variation can mean loss of alleles, loss of heterozygosity, or changes in allele frequencies. All of these have the potential to reduce fitness, and can be detrimental to the character and persistence of breeding populations. The risks associated with loss of genetic diversity have been explored in a number of published works including Waples (1991b), Currens and Busack (1995), Busack and Currens (1995), Campton (1995), Grant (1997), and Utter (1998). Loss of variation has been implicated as a factor limiting evolutionary potential (Frankham et al. 1999), and can affect the potential range of response to pathogens (O'Brien and Everman 1989).

Small populations can experience genetic diversity losses through inbreeding and genetic drift. Loss of variation due to inbreeding depression has been reported as a factor that may increase the probability of local extinction (Saccheri et al. 1998). When new populations arise from small numbers of individuals, founder effects can also cause geographically close populations to be different from one another. These effects are countered by migration among populations (straying), mutation, and selection.

Introgressive hybridization can reduce genetic diversity and fitness of genetically different stocks. Straying, artificially high levels of gene flow, and/or inappropriate choice of broodstock for hatchery supplementation may cause locally adapted populations to be more similar to one another with concomitant loss of adaptive complexes, reduced fitness, lowered productivity, and reduction of recovery potential. Even if hybridization effects only become evident in the second generation, long-term recovery may be impeded. It is important to draw a distinction between total genetic diversity and adaptive genetic diversity. The ability of a population to respond to change can be negatively affected by unique but maladaptive genes that nonetheless add to total genetic diversity.

Much of the discussion in the literature regarding loss of diversity has been in the context of impacts associated with hatchery management and practice, and interactions of hatchery fish with natural fish. These impacts include loss of fitness due to domestication and artificial selection that can occur in hatcheries and a variety of other possible negative effects (see CDFG 2002 for a review). In the course of recovery planning, it is important to avoid hatchery impacts on recovering stocks, even as we consider the valid use of hatcheries as a recovery tool.

Many of the causes of genetic diversity loss are related to decreases in population size and associated decreases in effective population size and number of breeders. Because per generation loss of genetic diversity is related to the effective population size of the spawner population, several authors have proposed N_e thresholds that can be used as guidelines in evaluating the severity of potential genetic diversity reductions. The upper portion of Table 3-2 shows some effective population size guidelines from the literature. The lower portion of Table 3-2 shows estimates of the number of breeders per generation and the number of breeders per year that would theoretically be needed to maintain genetic diversity in populations of California coho salmon.

Because salmon populations are usually connected by some small amount of gene flow, and gene flow between populations is a contributor to overall genetic variation, smaller than predicted effective sizes might be sufficient to maintain diversity. Because of this, these guidelines may be more appropriate for evaluating the potential for genetic diversity loss in isolated runs that do not experience immigration from other places. Estimates from two of the studies shown in Table 3-2 (Franklin 1980 and Lande 1995) were based on study of a single species, the fruit fly *Drosophila melanogaster*, and might not be generally applicable to salmon (McElhaney et al. 2000). Therefore, these guidelines should not be used as hard targets for recovery unless they are supported on a case-by-case basis. They can be useful for roughly estimating the potential for diversity loss due to small population size in the absence of specific data. For example, a population with consistent returns of 50 spawners per year might be judged large enough to avoid inbreeding depression, but we would be less confident that a population of this size could maintain adaptive potential over the long term.

TABLE 3-2: Guidelines for number of breeders per generation and number of breeders per year needed to maintain genetic diversity in populations of California coho salmon

Values of N_e or N_b needed to maintain genetic variation:

- Franklin (1980): avoidance of inbreeding depression: $N_e = 50$
- Waples (1990): maintain short term genetic variation [based on p(loss of rare alleles)]: N_b/year = 100
- Franklin (1980) and Lande and Barrowclaw (1987): avoidance of long-term loss of genetic variation: $N_e = 500$
- Lynch (1990), maintain genetic variation in a population: $N_e = 1{,}000$
- Lande (1995), maintain potentially adaptive genetic variation: $N_e = 5{,}000$

$N_e/N_t = N_e$ MIN	0.1 N_b PER GENERATION	0.1 N_b PER YEAR	0.33 N_b PER GENERATION	0.33 N_b PER YEAR
50	500	167	152	51
100	1,000	333	303	101
500	5,000	**1,667**	1,515	505
1,000	10,000	3,333	3,030	1,010
5,000	50,000	**16,667**	15,152	5,051

NOTES: N_e is effective population size, N_b is number of breeders, and N_t is the total census population size. Estimates of N_e/N_t for pacific salmon range from 0.1 to 0.33. An average generation length of three years is used in the calculations.

Values in bold were identified in CDFG (2002) as precautionary targets for maintenance of genetic variation in coho salmon populations.

3.6 LAND USES

A variety of problems and land uses have degraded freshwater and estuarine habitat, created barriers to salmon passage, or degraded coho salmon habitat in other ways. This section describes some of these actions.

3.6.1 FORESTRY ACTIVITIES

Historical forestry practices and some current forestry practices have been shown to impact several freshwater habitat components important to anadromous salmonids in general, and coho salmon specifically. These impacts include increased maximum and average summer water temperatures, decreased winter water temperature, and increased daily temperature fluctuations; increased sedimentation; loss of LWD; decreased DO concentrations; increased instream organic matter; and decreased stream-bank stability (Salo and Cundy 1987; Meehan 1991; Moring et al. 1994; Murphy 1995; Monschke 1996). Table 3-3 lists forestry practices, and describes changes to the landscape and the potential effects on salmonid habitat conditions.

Even when some habitat conditions return to pre-timber-harvest levels, fish populations do not always recover, which may be due to other habitat conditions remaining sub-standard or having been permanently altered (Moring et al. 1994). Logged areas are further affected and aggravated by natural incidents (e.g., blow-downs, landslides) and by human activity subsequent to logging, all of which may result in negative cumulative impacts.

Identifying the relationships between forestry practices and habitat impacts is complicated for several reasons. First, there is a long history of timber harvesting, and some effects, such as sedimentation and slope instability, continue long after harvesting has occurred. These alterations are referred to as "legacy" effects, and recovery may take many decades (Murphy 1995). Legacy effects are a factor along the north coast of California (Monschke 1996). Second, there have been many technological and management changes in timber harvest, and it is difficult to differentiate legacy effects from recent or current effects. Third, the salmonid habitat elements affected by timber harvest are themselves intimately inter-related. The amount and size frequency distribution of LWD, water temperature, near-stream vegetation, sediment transport and deposition, landsliding, stream flow and supply, and turbidity are all linked to one another.

During the approximate 150-year history of timber harvest in coastal northern California, harvest practices have changed dramatically, primarily due to changes in technology and decreasing availability of larger or higher quality logs. Historical harvest and milling were often close to waterways; whereas modern trucks and tractors have enabled more recent harvesting to occur in a wider variety of areas within a watershed. Logs were once primarily transported by river and are now transported by trucks along specially constructed roads. Logs used to be removed from the forest by mules and railroad, and these mechanisms have been replaced by tractors and cabling networks.

Current forestry activities, including forest nonpoint source control programs, have made strides in improving pollution and sediment discharge into streams over historical forestry practices. Forest Practice Rules (FPRs) adopted, in part, for the benefit of anadromous fishes (e.g., FPR 916.9, 936.9, 956.9. Watershed Protection Extension, a.k.a. Threatened and Impaired Watersheds) have been in effect since 2000. Table 3-4 compares the different watercourse protection standards, under pre-2000 FPRs, current California FPRs, and Federal protection (Forest Ecosystem Management Assessment; FEMAT). Although the new rules reduce some site-specific impacts, there has not been sufficient time to determine if there have been benefits to coho salmon.

The Department's conclusion is that historical forestry practices impacted and continue to impact watersheds inhabited by northern California coho salmon, and that current activities

TABLE 3-3: Forestry activities and potential effects to stream environment, salmonid habitat, and salmonid biology

FORESTRY PRACTICE	POTENTIAL EFFECTS TO:		
	STREAM ENVIRONMENT	SALMONID HABITAT	SALMONID BIOLOGY
Timber harvest in the riparian zone	increased incident solar radiation	increased stream temperature, light levels, and primary production	decreased growth efficiency; increased susceptibility to disease; increased food productivity; changes in growth rate and age at smolting
	decreased supply of LWD	decreased cover, storage of gravel and organic debris, and protection from high flows; loss of pool habitat and hydraulic and overall habitat complexity	decreased carrying capacity, spawning gravel, food production, and winter survival; increased susceptibility to predation; loss of species diversity
	increased, short-term input of LWD	increase in number of pools and habitat complexity; creation of debris jams	increased carrying capacity for juveniles and winter survival; barrier to migration and spawning and rearing habitat
	increased influx of slash	increased oxygen demand, organic matter, food, and cover	decreased spawning success; short-term increase in growth
	stream-bank erosion	reduced cover and stream depth	increased carrying capacity for fry; decreased carrying capacity for older juveniles; increased predation
		increased instream fine sediment; reduced food supply	reduced spawning success; slower growth rates for juveniles
Timber harvest on upslope areas	altered stream flow	temporary increase in summer stream flow	temporary increase in survival of juveniles
		increased severity of peak flows during storm season; bedload shifting	increased egg mortality
Timber harvest on upslope areas and road construction and use	increased erosion and mass wasting	increased instream fine sediment; reduced food supply	reduced spawning success, growth and carrying capacity; increased mortality of eggs and alevins; decreased winter hiding space and side-stream habitat
		increased instream coarse sediment	increased or decreased carrying capacity
		increased debris torrents; decreased cover in torrent tracks; increased debris jams	blockage to migration of juveniles and spawning adults; decreased survival in torrent tracks
	increased nutrient runoff	increased primary and secondary production	increased growth rate and summer carrying capacity
	stream crossings	barrier in stream channel; increased sediment input	blockage or restriction to migration; reduced spawning success, carrying capacity and growth; increased winter mortality
Scarification and slash burning	increased nutrient runoff	increased primary and secondary production	increased growth rate and summer carrying capacity
	increased input of fine organic and inorganic sediment	increased sedimentation in spawning gravels and production areas; temporary increase in oxygen demand	decreased spawning success; increased mortality of eggs and alevins

SOURCE: Adapted from Hicks et al. 1991

TABLE 3-4: Comparison of watercourse protection standards

Management Application	California Forest Practice Rules (FPR) Prior To July 1, 2000	FPRS; Protection In Watersheds With Threatened Or Impaired Values	Forest Ecosystem Management Assessment Team (FEMAT) July 1993[a]
CLASS I WATERCOURSE			
Watercourse and Lake Protection Zone (from the hillslope edge of channel zone)	1. to 75' for <30% slopes 2. to 100' for 30-50% 3. to 150' for >50% Widths may be reduced if cable or helicopter system is used	1. 150' minimum 2. No Emergency Notice or Exemption operations allowed within the WLPZ	To top of inner gorge, outer edges of 100-year flood plain, outer edge of riparian vegetation, or to distance equal to height of two site potential trees, or 300 feet, whichever is greatest
WLPZ retention	1. 50% overstory canopy 2. 50% understory canopy 3. Retained overstory canopy must be at least 25% existing overstory conifer 4. Retention of at least 75% surface cover	1. Inner band (0-75'): 85% overstory canopy 2. Outer band (75-150'): 65% overstory canopy 3. Retained overstory canopy must be at least 25% overstory conifer 4. Retention of at least 75% surface cover	Removed from timber base; no timber harvest
Large wood debris retention	Two living conifers/acre, and 50' tall, within 50' of Class I and II watercourses.	The 10 largest trees (dead or alive) per 330' of stream, within 50' of the water-course transition line.	No harvest zones in Riparian Reserves; salvage allowed only if required to attain Aquatic Conservation Strategy (ACS) objectives
Inner gorge special treatment (special zone established where the slope >55%)	None	1. Extends to the first major break-in-slope a distance of 100' or 300' from the water-course transition line, whichever is less 2. Requires use of selection harvesting 3. Even-age management above zone on slope >65% to be reviewed by geologist 4. All slopes exceeding 65% in the zone reviewed by Certified Engineering Geologist	Included in Riparian Reserve; no harvest
CLASS II WATERCOURSE			
WLPZ	1. to 50' for <30% slopes 2. to 75' for slopes 30-50% 3. to 100' for >50% slopes	1. to 50' for <30% slopes 2. to 75' for slopes 30-50% 3. to 100' for >50% slopes 4. No Emergency Notice or Exemption operations allowed within the WLPZ	Permanently flowing non-fish bearing streams – measure from edge of active stream channel; use distance from top of inner gorge, outer edge of 100-year flood plain, outer edges of riparian vegetation, distance of one site potential tree, or 150 feet, whichever is greatest
WLPZ retention	1. 50% total canopy 2. Overstory canopy must be at least 25% existing overstory conifer 3. At least 75% surface cover	1. 50% total canopy 2. Overstory canopy must be at least 25% existing overstory conifer 3. At least 75% surface cover	Removed from timber base, no timber harvest
Large woody debris retention	None	None	No harvest zones in Riparian Reserves; salvage allowed only if required to attain ACS objectives
Inner gorge special treatment	None	None	Included in Riparian Reserve; no harvest
CLASS III WATERCOURSE			
WLPZ	Established at the discretion of the Registered Professional Forester or California Department of Forestry and Fire Protection (CDF)	Established at the discretion of the Registered Professional Forester or CDF	Definable channel and evidence of annual scour or deposition; includes extent of unstable, potentially unstable areas, top of inner gorge, distance equal to site poten-tial tree height or 50', whichever is greatest
WLPZ retention	1. No canopy retention required. 2. 0-30% slope: 25' equipment limitation zone (ELZ) 3. >30% slope: 50' ELZ 4. 50% understory vegetation 5. Trees in channel zone	1. No canopy retention required 2. 0-30% slope: 25' ELZ 3. >30% slope: 50' ELZ 4. 50% understory vegetation 5. Trees in channel zone	No harvest
LWD retention	None	None	No harvest zones in Riparian Reserves; salvage allowed only if required to attain ACS objectives
Inner gorge special treatment	None	None	Included in Riparian Reserve; no harvest

[a] Title 14 of the California Code of Regulations (14 CCR):
§ 895.1 Definitions
§ 898(a) Feasibility Alternatives
§§ 914.8 [934.8, 954.8](g) Tractor Road Watercourse Crossing
§§ 916 [936, 956](e) Intent of Watercourse and Lake Protection
§§ 916.2 [936.2, 956.2](d) Protection of Beneficial Uses of Water and Riparian Functions
§§ 916.9 [936.9, 956.9](y) Protection and Restoration in Watersheds with Threatened or Impaired Values
§§ 916.11 [936.11, 956.11](b) Effectiveness and Implementation Monitoring
§§ 916.12 [936.12, 956.12](f) Section 303(d) Listed Watersheds
§§ 923.3 [943.3, 963.3](h) Watercourse Crossings
§§ 923.9 [943.9, 963.9](g) Roads and Landings in Watersheds with Threatened and Impaired Values

(e.g., road construction, use, and maintenance; activity near streams and on unstable slopes; removal of sources of future LWD), depending on how they are managed, can still affect important habitat elements essential to coho salmon.

3.6.2 WATER DIVERSIONS AND FISH SCREENS

A substantial amount of coho salmon habitat has been lost or degraded as a result of water diversions and groundwater extraction (CDFG 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.

Diversions are subject to regulation by the State Water Resources Control Board (SWRCB) through the appropriative water rights process, and by the Department under FGC §1600 *et seq.* (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). NOAA Fisheries has authority under ESA to regulate the take of coho salmon at diversions. Hydroelectric diversions, such as those on the Klamath and the Eel rivers are also subject to regulation by the Federal Energy Regulatory Commission (FERC).

In some watersheds, the demand for water has already exceeded the available supply and some water rights have been allocated though 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.

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;

b. Entrainment of juvenile coho salmon into the diversion;

c. Impingement of juvenile coho salmon on the screen because of high approach velocities or low sweeping velocities;

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.

3.6.3 INSTREAM FLOWS

Land-use practices such as urbanization, agricultural activities, and timber harvest can alter natural hydrologic cycles and impact stream flows, peak flows, flow timing, and flood frequencies. Alteration of the natural hydrological cycle can in turn create significant impacts to coho salmon and their habitat. Impacts to coho salmon can include increasing juvenile and adult mortality by delaying migration because of insufficient flows, stranding fish during rapid flow fluctuations; decreased food supply because of reduced invertebrate drift, and increasing mortality due to higher water temperatures (California Advisory Committee on Salmon and Steelhead Trout [CACSST] 1988; CDFG 1991; Berggren and Filardo 1993; Reynolds et al. 1993; Chapman et al. 1994; Cramer et al. 1995; NMFS 1996). In addition to these factors, alteration of the natural hydrograph can increase deposition of fine sediments in spawning gravels, decrease recruitment of LWD and spawning gravels; it may also lead to encroachment of riparian and non-endemic vegetation into spawning and rearing areas (e.g., on the Trinity River) (CACSST 1988; Forest Ecosystem Management Assessment Team 1993; Botkin et al. 1995; NMFS 1996).

Many of the watersheds where coho salmon are present have been developed and flows have been regulated and significantly reduced compared to natural flows. Base flow necessary for coho salmon rearing during the typical May to November low flow period may be severely limited due to interactions between watershed area, climate, geology, and land use. For example, an Instream Flow Incremental Methodology study of lower Scott Creek, Santa Cruz County (Snider et al. 1995) found that optimum habitat conditions for juvenile steelhead and coho salmon in Scott Creek are provided at 20 cfs, and only half of the maximum habitat remains at 5 to 6 cfs. However, median flows in Scott Creek in August, September and October are 2 cfs or less (roughly 16% of maximum habitat).

A common problem in minimizing the direct and cumulative effects of diversions on instream flow is the lack of detailed data regarding minimum instream flow needs for coho salmon in a given stream. Some of the major water developments in the range of coho salmon are, or have been, the subject of extensive studies and programs aimed at evaluating and reducing the impact of those projects on coho salmon and other species. However, studies on the effects of smaller diversions are generally lacking, as are studies of overall instream flow needs in watersheds in the range of coho salmon. The owners of smaller diversions frequently lack the resources to conduct the appropriate studies to evaluate instream issues.

For small diversions (≤ 3 cfs and ≤ 200 acre-feet) in Mendocino, Sonoma, Marin and Napa counties, the Department and NOAA Fisheries have proposed draft guidelines that may serve as conditions for protection of salmonid habitat in lieu of results from site-specific studies (CDFG/NOAA Fisheries 2002), and in some cases these conditions may require substantial alteration of existing diversion and storage patterns. Current resource agency staffing and funding is generally inadequate to conduct watershed-level instream flow studies and to take the effective regulatory actions to restore flow for coho salmon habitat where it is an issue. The lack of adequate enforcement staff and problems coordinating efforts by regulatory agencies also makes consistent control of illegal diversions difficult.

3.6.4 ARTIFICIAL BARRIERS

Artificial structures on streams fragment aquatic ecosystems by blocking or impeding migration and altering nutrient cycling patterns, streamflows, sediment transport, channel morphology, and stream-corridor species composition. This reduces available habitat, changes habitat conditions for anadromous salmonids, and reduces native biodiversity. Instream structures have the potential to, depending on conditions, either entirely or partially block fish from accessing upstream reaches and block critical habitat necessary for survival. Barriers can be formed by:

a. Road crossings (e.g., bridges, culverts, and low-water fords);
b. Dams;
c. Flood-control structures (e.g., concrete channels);
d. Erosion control structures (riprap and energy dissipaters);
e. Canal and pipeline crossings;
f. Pits from gravel mining; and
g. Conditions that sever surface or subsurface hydrologic connections between the stream channel and adjacent wetlands.

Even if stream barriers are eventually negotiated by fish, the extra energy expended may result in their death prior to spawning or in reductions in viability of eggs and offspring. Barriers that increase the time required for migration can limit the distance adult fish are able to travel upstream before spawning, resulting in the crowding of redds in lower stream reaches and under-utilization of upstream habitat. Migrating adults and juveniles concentrated below barriers with impassable crossings are also more vulnerable to predation and illegal harvest.

Hydropower and water storage projects alter the hydrograph of downstream river reaches and can affect migration cues and physical passage conditions. Dams often block access to areas used historically by coho salmon. Weitkamp et al. (1995) identified nine dams in California that currently have no fish passage facilities to allow coho salmon access to former spawning and rearing habitats. Blocked habitat constitutes approximately 9 to 11% of the historical range of each coho salmon ESU. Five major dams within the California portion of the SONCC Coho ESU (Table 3-5) and four major dams within the CCC Coho ESU (Table 3-6) block access to historical spawning and rearing areas of coho salmon. In addition to these, there are five smaller impoundments on the mainstem Russian River, and approximately five hundred licensed or permitted dams on its tributaries (SEC 1996).

3.6.5 GRAVEL EXTRACTION

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.

Instream gravel extraction has had direct, indirect, and cumulative impacts on salmonids in the recent past. 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, seek to avoid and minimize current impacts. 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).

TABLE 3-5: Major dams within the California portion of the SONCC Coho ESU that block coho salmon from accessing historical spawning and rearing habitat

NAME OF DAM	LOCATION	UPSTREAM HABITAT BLOCKED	PERCENT OF ENTIRE BASIN
Scott Dam	Eel River, approximately 169 miles upstream from the Pacific Ocean, forming Lake Pillsbury in Lake County	36 miles	8% (Eel River Basin)
Matthews Dam	Mad River, approximately 79 miles upstream from the Pacific Ocean, forming Ruth Lake in Trinity County	2 miles	13% (Mad River Basin)
Lewiston Dam	Trinity River (tributary to the lower Klamath River), approximately 112 miles upstream from the Pacific Ocean, forming Lewiston Reservoir in Trinity County	109 miles	24%(Trinity Basin) 9% (Klamath Basin
Dwinnell Dam	Shasta River (tributary to the upper Klamath River), approximately 214 miles upstream from the Pacific Ocean, forming Dwinnell Reservoir in Siskiyou County	17 miles	17% (Shasta Basin) 2% (Klamath basin)
Iron Gate Dam	Klamath River, approximately 190 miles upstream from the Pacific Ocean, forming Iron Gate Reservoir in Siskiyou County	30 miles	8% (Klamath basin)

TABLE 3-6: Major dams within the CCC Coho ESU that block coho salmon from accessing historical spawning and rearing habitat

NAME OF DAM	LOCATION	UPSTREAM HABITAT BLOCKED	PERCENT OF ENTIRE BASIN
Peters Dam	Lagunitas Creek, approximately 14 miles upstream from the Pacific Ocean, forming Kent Lake in Marin County	8 miles	6%
Nicasio Dam	Nicasio Creek, (tributary to Lagunitas Creek), approximately 8 miles upstream from the Pacific Ocean, forming Nicasio Reservoir in Marin County	5 miles	10%
Warm Springs Dam	Dry Creek (tributary to the Russian River), approximately 45 miles upstream from the Pacific Ocean, forming Sonoma Lake in Sonoma County	50 miles	9%
Coyote Dam	Russian River, approximately 95 miles upstream from the Pacific Ocean, forming Lake Mendocino in Mendocino County	36 miles	7%
Newell Creek Dam	San Lorenzo River, approximately 14 miles upstream from the Pacific Ocean, forming Loch Lomond Reservoir in Santa Cruz County	6 miles	10%

3.6.6 SUCTION DREDGING

Suction-dredge placer miners extract gold from the river gravels by sucking the gold- bearing gravels through a nozzle (typically 6 to 8 inches in diameter) into floating dredges, pumping the gravel and water mixture across a settling table where the gold concentrates by gravity, and then discharging the gravel and water back into the river. Both the pump and the sluice box are usually mounted on a floating platform, often positioned over the work area by ropes or cables secured to trees or rocks. The portion of stream bottom dredged ranges from a few small excavations to the entire wetted area in a section of the stream. Larger suction dredges have the capacity to process as much as several cubic yards of gravel from the river bottom at one time. An annual permit from the Department (Title 14 California Code of Regulations [CCR], §228) and, in some circumstances, a Lake and Streambed Alteration Agreement (FGC §1600) is required to engage in this activity.

Dredging activities in freshwater environments can have a variety of direct impacts on the environment, including impacts on aquatic and riparian organisms (Griffith and Andrews 1981;

Thomas 1985; Harvey 1986) and channel stability. Impacts can also result from the potential release of hazardous materials such as mercury into aquatic and terrestrial environments. However, there are no studies that document such dredging-related impacts on coho salmon or their habitat within the range of coho salmon. The restrictions currently imposed by regulations on this activity are designed to eliminate the potential for impacts to coho salmon by restricting suction dredging actions to locations and times when such activities should not impact the species.

3.6.7 STREAMBED ALTERATION

Streambed alteration activities such as construction of roads, navigational improvements, dams, bank stabilization structures, and channels can result in a loss of habitat complexity (Bisson et al. 1987). Effects include decreases in the range and variability of stream flow velocities and depths, and reductions in the amount of large wood, boulders, and other stream structures. Construction activities in the stream channel can cause excess sediment to fill pools. Channelization that includes paving the channel bottom, or changing the length or sinuosity of the channel, permanently alters the substrate, eliminating macroinvertebrate habitat, instream vegetation, and the gravel substrate necessary for spawning.

3.6.8 WATER QUALITY

Water pollution originates from point sources and non-point sources as listed in Table 3-7, and includes sediment, nutrients, biocides, metals, and metalloids. It is difficult to correlate specific pollutants with specific and direct effects on coho salmon. Mixed compounds may have different effects on the biological community of a stream than would an accumulation of the same compounds considered separately. In addition, effects vary with habitat alteration, temperature, and the concentration of dissolved materials in the surface waters (Brown and Sadler 1989). Water quality within coho salmon range is known to be affected by industrial discharges, agricultural discharges, silvicultural discharges, mineral mining wastes, municipal wastewater discharge, road surface discharge, and urban stormwater discharge.

Under CWA § 303(d), states, territories and authorized tribes are required to develop lists of impaired waters that do not meet water quality standards, even after those responsible for point sources of pollution have installed the minimum required levels of pollution control technology. In addition, the law requires that they establish priority rankings for waters on the lists and develop action plans, including total maximum daily load (TMDL) plans to improve water quality. Within the California range of coho salmon, there are 74 water bodies that are on the § 303(d) list of impaired water bodies (Table 3-7).

TMDLs in California are developed either by Regional Water Quality Control Boards (RWQCB) or by the U.S. Environmental Protection Agency (EPA). TMDLs developed by RWQCBs are designed as Basin Plan amendments and must include implementation provisions. TMDLs developed by EPA typically contain the total load and load allocations required by § 303(d), but do not contain comprehensive implementation provisions. It is the responsibility of the RWQCBs to develop implementation programs for TMDLs established by the EPA and during that process, it has often been necessary for the RWQCBs to reevaluate, and sometimes change, the EPA requirements.

3.6.9 AGRICULTURAL IMPACTS

Historic, and some current, agricultural practices impact freshwater habitat components important to coho salmon. While current agricultural activities and programs have made strides in improving pollution and sediment discharge into streams and in habitat restoration,

TABLE 3-7: Clean Water Act §303(d) list of impaired water bodies within the range of coho salmon in California (as approved by USEPA, July 2003)

NAME	EST. SIZE/LENGTH OF AFFECTED AREA	POLLUTANT/STRESSOR	SOURCE OF POLLUTION[a]
SAN FRANCISCO BAY			
Carquinez Strait	5,657 acres	Chlordane; DDT; PCBs; PCBs (dioxin-like); Diazinon; Dieldrin; Dioxin compounds; Exotic species; Mercury; Furan compounds; Selenium	5, 6, 20, 26, 27, 28, 36, 48
Richardson Bay	2,439 acres	Chlordane; DDT; PCBs; PCBs (dioxin-like); Dieldrin; Dioxin compounds; Exotic species; Mercury; Furan compounds; High coliform counts	5, 6, 7, 26, 27, 28, 36, 38, 45, 48
San Francisco Bay[b]	171,954 acres	Agriculture; Chlordane; DDT; Diazinon; Dieldrin; Dioxin compounds; Exotic species; Furan compounds; Mercury; Nickel; PCBs; PCBs (dioxin-like); Selenium	1, 5, 6, 20, 26, 27, 28, 36, 48
San Pablo Bay	68,349 acres	Agriculture; Chlordane; DDT; Diazinon; Dieldrin; Dioxin compounds; Exotic species; Furan compounds; Mercury; Nickel; PCBs; PCBs (dioxin-like); Selenium	1, 5, 6, 20, 26, 27, 28, 36, 48
Suisun Bay	27,498 acres	Chlordane; DDT; Diazinon; Dieldrin; Dioxin compounds; Exotic species; Furan compounds; Mercury; Nickel; PCBs; PCBs (dioxin-like); Selenium	5, 6, 20, 27, 28, 36, 48
Suisun Marsh Wetlands	66,339 acres	Metals; Nutrients; Organic enrichment/low dissolved oxygen; Salinity/TDS/chlorides	1, 45, 15
Suisun Slough	1,124 acres	Diazinon	45
Tomales Bay	8,545 acres	Mercury; Nutrients; Pathogens; Sedimentation/siltation	1, 4b, 25, 38, 44
Alameda Creek	51 miles	Diazinon	45
Arroyo Corte Madera Del Presidio (Mill Creek)	4 miles	Diazinon	45
Corte Madera Creek	4.1 miles	Diazinon	45
San Antonio Creek	18 miles	Diazinon	45
San Pablo Creek	9.9 miles	Diazinon	45
Walker Creek	16 miles	Mercury; Nutrients; Sedimentation/siltation	1, 25, 42
Walnut Creek	9 miles	Diazinon	45
NORTH COAST			
Albion River	77 miles	Sediment/siltation	23, 28, 39
Big River	225 miles	Sediment/siltation; Temperature	12, 13, 17, 22, 23, 28, 32, 37, 39, 41
Eel River[b]	4,637 miles	Sediment/siltation; Temperature	4b, 9, 10, 12, 13, 15, 16, 17, 19, 22, 23, 28, 32, 33, 34, 35, 36, 39, 41, 43, 44
Elk River	88 miles	Sediment/siltation; Temperature	13, 16, 23, 27, 28, 32, 33, 34, 39, 41

continued

TABLE 3-7: Clean Water Act §303(d) list of impaired water bodies within the range of coho salmon in California (as approved by USEPA, July 2003) (continued)

NAME	EST. SIZE/LENGTH OF AFFECTED AREA	POLLUTANT/STRESSOR	SOURCE OF POLLUTION[a]
Estero Americano	199 acres	Nutrients; Sediment/siltation	13, 19, 24, 28, 32, 35, 41, 43
Freshwater Creek	84 miles	Sediment/siltation	13, 16, 23, 27, 28, 32, 33, 34, 39, 41
Garcia River	154 miles	Temperature	17, 28, 32, 41
Gualala River	455 miles	Sediment/siltation; Temperature	16, 33, 34, 39,
Humboldt Bay	16,075 acres	PCBs	49
Klamath River[b]	4,759 miles	Nutrients; Temperature; Organic enrichment/low dissolved oxygen	1, 2, 3, 4a, 4b, 9, 11, 12, 15, 17, 19, 20, 21, 26, 27, 28, 32, 35, 40, 43, 44, 46, 49, 50, 51
Mad River	654 miles	Sediment/siltation; Temperature; Turbidity	15, 17, 28, 32, 36, 39, 44, 49
Mattole River	503 miles	Sediment/siltation; Temperature	13, 17, 19, 27, 28, 32, 35, 37, 39, 40, 41, 43
Navarro River Delta	48 acres	Sediment/siltation	13
Navarro River	415 miles	Sediment/siltation; Temperature	1, 3, 8, 9, 10, 12, 13, 15, 16, 17, 18, 21, 22, 23, 28, 32, 33, 34, 35, 36, 39, 40, 41, 46
Noyo River	144 miles	Sediment/siltation	28, 39
Redwood Creek	332 miles	Sediment/siltation; Temperature	10, 13, 16, 23, 27, 28, 32, 33, 34, 35, 39, 41
Russian River[b]	1,711 miles	Sediment/siltation; Temperature; Pathogens	1, 4a, 4b, 8, 9, 10, 11, 12, 13, 15, 17, 19, 21, 22, 27, 28, 32, 35, 39, 41, 43, 44, 52, 53
Scott River	902 miles	Sediment/siltation; Temperature	3, 12, 15, 17, 21, 27, 28, 32, 35, 36, 39, 43, 46, 54
Shasta River	630 miles	Organic enrichment/low dissolved oxygen; Temperature	2, 4a, 11, 12, 15, 17, 19, 32, 55
Ten Mile River	162 miles	Sediment/siltation; Temperature	17, 23, 28, 32, 33, 34, 39, 41
Trinity River[b]	3,410 miles	Sediment/siltation; Temperature	9, 11, 12, 13, 15, 16, 17, 19, 23, 25, 27, 28, 32, 33, 34, 35, 36, 39, 41, 42, 44, 46
Van Duzen River	585 miles	Sediment/siltation	9, 10, 13, 16, 17, 23, 27, 32, 33, 34, 35, 39, 41, 43,
CENTRAL COAST			
Aptos Creek	8.4 miles	Sediment/siltation; Pathogens	9, 22, 45
San Lorenzo River	27 miles	Nutrients; Pathogens; Sedimentation/siltation	10, 28, 38, 39, 45
San Lorenzo River Lagoon	66 acres	Pathogens	27, 45
Soquel Lagoon	1.2 acres	Nutrients; Pathogens; Sedimentation/siltation	10, 27, 28, 28, 45
Waddell Creek, East Branch	3.5 miles	Nutrients	26

[a]
1 Agriculture
2 Agriculture-irrigation tailwater
3 Agricultural return flows
4a Agriculture-storm runoff
4b Animal operations
5 Atmospheric deposition
6 Ballast water
7 Boat discharges/vessel wastes
8 Bridge construction
9 Channel modification, channelization
10 Construction/land development
11 Dam construction and operation
12 Drainage/filling of wetlands
13 Erosion/siltation
14 Filling of wetlands
15 Flow regulation/modification
16 Harvesting
17 Habitat modification
18 Highway/road construction
19 Hydromodification
20 Industrial point source
21 Irrigated crop production
22 Land development
23 Logging road construction/maintenance
24 Manure lagoons
25 Mine tailings
26 Municipal point source
27 Natural sources
28 Nonpoint source
29 Other urban runoff
30 Pasture land
31 Range land
32 Removal of riparian vegetation
33 Residue management
34 Restoration
35 Riparian grazing
36 Resource extraction
37 Road construction
38 Septage disposal
39 Silviculture
40 Specialty crop production
41 Stream-bank modification/destabilization
42 Surface mining
43 Upland grazing
44 Upstream impoundment
45 Urban runoff/storm sewers
46 Water diversions
47 Water (groundwater), domestic use
48 Source unknown
49 Out-of-state source
50 Wastewater land disposal
51 Combined sewer overflow
52 Geothermal development
53 Surface runoff
54 Mill tailings
55 Dairies

[b] Contains combined information for two or more separate river forks or subsystems.

some activities can affect coho salmon habitat. Agricultural practices affect aquatic and riparian areas through non-point source pollution, since these areas eventually receive sediments, fertilizers, pesticides, and wastes from associated agricultural lands.

While it has been reported that sediment delivery to streams in the form of non-point source pollution is caused mainly by roads (Lewis et al. 2001), sediment is the most common type of non-point source pollution from agricultural lands (Knutson and Naef 1997). According to Terrell and Perfetti (1989), erosion of crop lands accounts for 40 to 50% of the sediment in United States waterways. Storm runoff erodes the topsoil from open agricultural areas, and irrigation water from standard agricultural practices also carries significant amounts of sediment to the stream environment. According to Terrell and Perfetti (1989), two types of irrigation systems, sheet flow and rill, cause the greatest amount of surface erosion, while drip irrigation and piped laterals produce the least. Irrigation often uses water that is drawn from a stream, lake, pond, or the ground. Pumping from the water table reduces its level, decreasing flow to and in the river. The ability of a stream to diminish the effects of irrigation waste discharged decreases proportionally with reductions in stream flow.

Small coastal streams often rely on springs to maintain flows through the summer months, but the flow of these springs is often diminished by pumping from the aquifers that supply them. Many streams that once flowed year-round no longer do so, because of recent increases in hillside agricultural land conversion and reduction in local groundwater levels. The conversion of uplands from forest or grasslands to agriculture increases erosion and ground water use (CDFG 2001). In February 2000, Sonoma County adopted a vineyard ordinance to control sedimentation caused by vineyard erosion (Merenlender et al. 2000). The ordinance identifies three levels of vineyards and seven types of highly erosive soils, imposing corresponding requirements (CDFG 2001).

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 decreases, and ammonia is released, causing additional changes that are stressful to fish.

Grazing can affect riparian characteristics and associated aquatic systems, such as vegetative cover, soil stability, bank and channel structure, instream structure, and water quality and quantity. 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. Trampling may compact soils, decreasing water infiltration and increasing runoff. However, light trampling can break up surface soils that have become impervious, and allow for greater water absorption; but this also makes the soil more susceptible to erosion (Spence et al. 1996). George et.al. (2002) found that cattle trails in California produced 40 times more sediment than adjacent vegetated soil surfaces. Possible grazing impacts also include increased nutrient inputs from deposition or release of animal waste in watercourses. According to Knutson and Naef (1997), some of the ways that poor grazing practices can impact fish and wildlife include:

a. Destruction of riparian vegetation;

b. Reduction or elimination of regeneration of woody vegetation;

c. Changes to plant species composition in favor of non-riparian species;

d. Loss of protective vegetation and associated bank stability and structure;

e. Soil compaction;

f. Increase of stream-bank erosion, causing stream channel widening, shallowing, trenching, or braiding;

g. Reduction in the ability of riparian areas to trap and filter sediments and pollutants;
h. Increase in stream temperatures due to loss of cover;
i. Increase in the magnitudes of high and low flows;
j. Lowering of the water table, and associated loss of riparian vegetation; and
k. Loss of nutrient inputs, especially invertebrate food sources, to stream.

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 Code of Sustainable Winegrowing Practices, the Rangeland Water Quality Shortcourse, and the Dairy Quality Assurance Program.

3.6.10 URBANIZATION AND URBAN IMPACTS

Within the California range of coho salmon, urban and suburban development occupy 924 square miles or 9.3% of the land base (CDFG unpublished data). Cities and towns with large developed areas within the range of California coho salmon include, from north to south, Crescent City, Arcata, Eureka, Fortuna, Willits, Ukiah, Healdsburg, Sebastopol, Santa Rosa, Petaluma, Sonoma, Napa, Novato, San Francisco Bay Area, and Santa Cruz.

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).

It is impossible to separate the overlapping and interrelated impacts of urbanization; however, the following broad categories are used to frame the following discussion.

3.6.10.1 Alteration of Natural Vegetation

Urbanization can cause severe and permanent alteration of the natural vegetation by its removal or conversion to lawns and ornamental plants. In upland areas this can contribute to erosion and altered drainage, often reducing infiltration and increasing surface runoff. However, impacts are particularly severe in riparian corridors where vegetation is commonly removed to increase the visibility of and access to streams and to allow the installation of landscaping and structures very near the tops of stream banks. Loss of riparian vegetation reduces inputs of nutrients, recruitment of LWD, and stream-bank stability (Booth 1991; Spence et al.1996). It also leads to an increase in stream temperature by removing much of the overhead canopy (Booth 1991).

3.6.10.2 Disrupted Hydrological Processes and Reduced Stream Complexity

Construction and landscaping near streams is often followed by the installation of retaining walls and other hard structures intended to protect or enlarge developed areas. This results in severely constricted streams with disabled or altered hydrological and riparian processes. Furthermore, in developed areas, much of the surface soil is covered by impervious surfaces (buildings, parking lots, roads) which increase peak flows and change channel characteristics. These changes produce measurable effects in the hydrologic response of a drainage basin, particularly an increase in maximum discharge associated with floods and an increase in frequency of flooding (Klein 1979; Booth 1991).

To facilitate the movement of storm runoff, stream channels are often straightened and the banks denuded of vegetation and covered with revetment. In areas where revetments are not installed, channels become less stable because of the increase in bedload transport that accompanies increased water volumes and velocities (Bryan 1972). Both situations lead to loss of bank and instream habitat complexity and an increased uniformity of the channel and bed. The lack of LWD inputs exacerbates channel simplification, causing increased bed scour and fill. Many degraded urban streams have uniform beds with few pools or riffles, exposed near-vertical banks downcut by several feet, chronic high sediment loads due to increased bank erosion, deficient woody debris, and severely reduced aquatic organisms compared to nearby undeveloped streams (Booth 1991). Urbanized streams take on a clean, washed-out look as channel complexity is lost (Lucchetti and Fuerstenberg 1993, as cited in Spence et al. 1996). These highly modified channels generally provide poor habitat for fish (Spence et al. 1996).

Not only do impervious areas increase peak flow, they also block infiltration into the soil (Klein 1979; Booth 1991), thus decreasing the ability of the basin to store precipitation and reducing summer base flows (Spence et al. 1996). These changes occur primarily because of increases in the impervious surface area and the replacement of complex, natural drainage channels with a network of storm pipes and drainage ditches (Lucchetti and Fuerstenberg 1993, as cited in Spence et al. 1996). Clearing of vegetation, compaction of soil, installation of roads and other impervious surfaces, grading of depressions, and direct interception of subsurface flows by drains can lead to irreversible effects to drainage basin hydrology (Booth 1991).

3.6.10.3 Degradation of Soil Function

Significant soil disturbance occurs during the construction phase of urban development, which leads to increased sediment loads (Klein 1979). After construction, buildings, concrete, and asphalt cover much of the surface soil and areas that remain exposed are often altered by irrigation and fertilization necessary to support domestic vegetation. This likely diminishes the ecological functions of the soil (Spence et. al., 1996).

3.6.10.4 Impaired Water Quality

Wanielista (1978, as cited in Spence et al. 1996) identifies numerous types of urban non-point source pollution, including heavy metals, pesticides, bacteria, organics (oil and grease), dirt, and nutrients. In urbanized streams, the type and quantity of nutrients can change significantly: such as LWD and leafy detritus are replaced in importance by nutrient loading from sewage and other sources (Spence et al. 1996). Novitzki (1973, as cited in Spence et al. 1996) reports that high nutrient levels from a small Wisconsin sewage treatment plant effluent significantly degraded brook trout *(Salvelinus fontinalis)* habitat.

The principal effect of nutrients upon a stream is the stimulation of algae and other aquatic plant growth (Klein 1979). As plant growth increases, night-time dissolved oxygen levels can be become critically low due to continuing plant respiration coupled with the cessation of photosynthesis. Novitzki (1973, as cited in Spence et al. 1996) notes that the nutrients greatly stimulated primary and secondary production, which resulted in a high oxygen demand that created critically low dissolved oxygen levels that ultimately resulted in fish kills. Omernik (1977, as cited in Klein 1979) found that total nitrogen exports from urban areas were second only to intensively farmed watersheds.

Water quality impacts from stormwater runoff are well documented. Bryan (1972) found that pesticide concentration in runoff was three times as high as that from a rural area. In industrial areas, runoff may include heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), high pH concrete dust, and other toxic chemicals (Birch et al. 1992, as cited in Spence et al. 1996). Non-point source pollution from agricultural and urban land uses has caused long-term, cumulative harm to stream ecosystems (Jones and Clark 1987;

McDonnell and Pickett 1990; Richards et al. 1996, all cited in Wang et al. 1997). Contaminants associated with sediments can have significant impacts on water quality (Spence et al. 1996).

Several habitat changes caused by urbanization can affect the natural stream temperature regimen (Klein 1979). The effect of reduced shade on maximum temperatures has been well documented. Reduction in shading results from alteration of banks and loss of riparian vegetation. Increase in channel width increases the area of unshaded stream surface area, reduces water depths, and further contributes to heat loss or gain, increasing diurnal temperature fluctuations (Klein 1979). Stream temperatures in urban areas may also be indirectly affected by changes in hydrology, channel morphology, and microclimate (Spence et al. 1996). Lower summer base flows resulting from reduced infiltration can also contribute to higher water temperatures.

3.6.10.5 Barriers to Passage

Urban development is characterized by high road densities and the resulting bridges, culverts, and other structures that constrain channels and impede fish migration (Spence et al. 1996). Areas of high temperature and poor water quality can also present barriers to passage.

3.6.10.6 Degraded Biological Diversity and Habitat Suitability

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

The key to protecting and restoring urban streams appears to be reducing imperviousness and protecting channel integrity and riparian vegetation. Klein (1979) found that stream quality impairment is first observed when watershed imperviousness reaches 15% of the total watershed, and becomes severe at 30%. He recommends that for more sensitive stream ecosystems, such as those containing self-sustaining trout populations, watershed imperviousness should not exceed 10%. Wang et al. (2003) found that even low levels of urban development can damage cold-water stream systems, and State that strategies that protect the riparian area and minimize imperviousness may reduce the damage. Booth (1991) states that the strategy for minimizing or avoiding impacts associated with urban development is to reduce the amount of runoff and minimize landscape disturbance.

3.6.11 FISHING

Retention of coho salmon has been prohibited in ocean commercial fisheries south of Cape Falcon, Oregon since the beginning of the 1993 season. From Cape Falcon to Horse Mountain, California, coho salmon retention has been prohibited in ocean recreational fisheries since the 1994 season, and starting May 1995, the prohibition was extended to include sport fisheries south of Horse Mountain. California's inland waters have been explicitly closed by regulation to coho salmon retention since 1998. Coho salmon are taken incidentally in commercial and recreational fisheries directed toward other salmon species. If large enough numbers are hooked, substantial mortality can be incurred.

The Klamath Basin's Native American tribes (Yurok, Hoopa Valley, and Karuk) currently operate the only existing sanctioned coho salmon fishery. Both the Yurok and Hoopa Valley tribes have Federally recognized fishery rights in the basin, and Tribal subsistence, ceremonial, and minor commercial fisheries operate under the regulatory authority of each tribe. Each tribe determines the extent of fishing opportunities that will be provided its Tribal members based on estimates of preseason abundance. Data for this review are only available for the Yurok Tribe's harvest for subsistence and ceremonial fisheries within the Tribe's reservation on the lower Klamath River (Weitchpec downstream to the ocean); these fisheries have been monitored since 1992. Harvest has ranged from 27 to 1,168 fish caught annually, and based on estimates of upstream escapement (in-river spawners and hatchery returns), is thought to amount to an average harvest rate of 4.4% for the period (D. Hillemeier pers. comm.).

3.6.12 ILLEGAL HARVEST

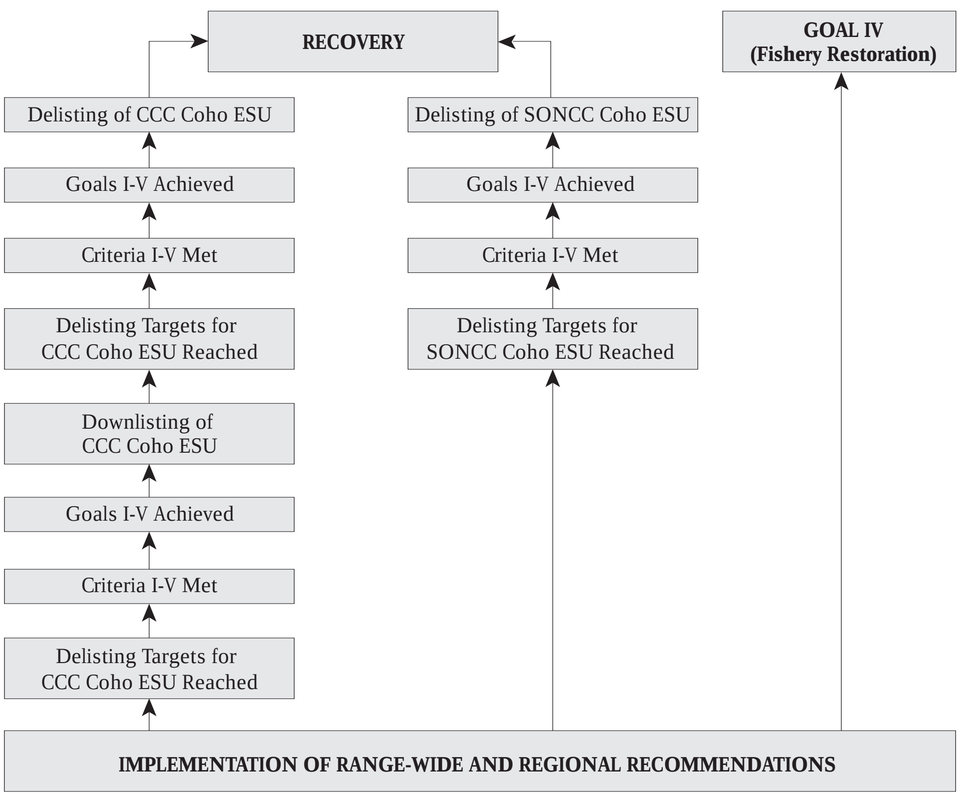
Illegal harvest can have an impact on populations of fishes in certain areas, although this depends on intensity, frequency and species of fish taken. The Wildlife Protection staff of the Department indicates that illegal harvest of both juvenile and adult coho salmon does occur, although most of the illegal take is due to anglers mistaking coho salmon for another species. Most of the violations involving the illegal take of adult coho salmon occur in the offshore sport fishery. Illegal harvest in inland waters is mostly opportunistic, meaning poachers will spear, net, gaff or snag whatever salmonid happens to be in the stream (T. Belt pers. comm.).

4 Recovery Goals and Delisting Criteria

The mandate of the Recovery Strategy is to achieve recovery of California coho salmon to the point where the regulations, or other protections for coho salmon listed under CESA are not necessary (FGC §2105), and the species can be delisted. For the Department to determine that the species has recovered to the point where delisting is warranted, certain "delisting criteria" must be met. For the CCC Coho ESU there are also "downlisting criteria" and their associated quantitative targets, which must be met in order to downlist the species from "Endangered" to "Threatened." This chapter describes the recovery goals, delisting criteria, and quantitative targets for these criteria by watershed recovery unit (see Chapter 6 for a description of recovery units). The Recovery Strategy incorporates an additional goal of restoring viable Tribal, recreational, and commercial coho salmon fisheries in California (see section 4.2).

The frameworks for recovering coho salmon (goals I to V) and restoring coho salmon fisheries (goal VI) are discussed in this chapter (see Figure 4-1). Research, monitoring, and adaptive management of coho salmon populations and recovery activities will be used to both improve the framework and measure progress towards these goals.

FIGURE 4-1: The process of coho salmon recovery and fishery restoration[a, b]



NOTES:
a. Delisting of CCC and SONCC Coho ESUs can occur independently.
b. Goal VI, though an explicit part of this Recovery Strategy, is not required for recovery.

4.1 FRAMEWORK FOR RECOVERY

The mandate of the Recovery Strategy is to achieve recovery of coho salmon populations and their habitat so the species is neither threatened nor endangered with extinction in either of the ESUs. Successful recovery means that the regulations or other protections for coho salmon listed under CESA would no longer be necessary. Achieving this mandate will take a combination of five principle recovery goals. These goals address either coho salmon populations directly or coho salmon habitat. The goals that address coho salmon populations (goals I to III) focus on protecting and increasing the number of coho salmon populations, and maintaining and expanding coho salmon distribution within both ESUs. Goals that address habitat (goals IV to V) focus on protecting existing habitat essential for coho salmon, and enhancing and restoring additional habitat.

The five recovery goals, as well as their downlisting and delisting criteria and associated quantitative targets, are outlined below and discussed in detail in section 4.1.1 (see also Figure 4-1). When recovery of a coho salmon ESU is achieved, that ESU can be delisted, i.e., formally removed from the California Code of Regulations (Title 14, §670.5). Because the CCC Coho ESU will be listed as endangered, it must first achieve downlisting from endangered to threatened before being delisted. The additional goal of restoring coho salmon fisheries (goal VI) is an integral and explicit part of the Recovery Strategy; however, while limited recreational fishing may be possible, goal VI cannot be wholly achieved until goals I to V have been achieved.

Recovery goals I to V were developed with the idea that each goal uniquely contributes to maximizing genetic diversity and population persistence in the face of environmental variation and stochastic events. The recovery goals apply to natural stocks of coho salmon as well as to coho salmon produced from recovery, conservation, and mitigation hatcheries. Achievement of goals I to V at the ESU level will signal the ability to downlist or delist coho salmon under CESA.

Recovery goals I to V and their associated criteria apply to both the CCC and SONCC Coho ESUs. The SONCC Coho ESU will be listed as threatened and so will require only one set of quantitative targets for delisting. Because the CCC Coho ESU will be listed as endangered, there are two sets of quantitative targets for measuring progress. The first set determines when the CCC Coho ESU can be downlisted from endangered to threatened. The second set will be for delisting. The quantitative targets are discussed in section 4.1.2. These targets represent the quantitative components of the otherwise qualitative criteria used to measure progress towards achievement of the recovery goals.

The inherent uncertainty of complex environmental and biological systems precludes the possibility of setting an exact timeline for successful coho salmon recovery. Some goals, such as restoring and enhancing habitat, may be achieved sooner than other goals. In addition, achieving delisting of the CCC Coho ESU is likely to take longer than delisting of the SONCC Coho ESU. The Department believes that, based on an approximate 50-year cycle of the PDO, the 3-year life cycle of coho salmon, and the estimate by the Oregon Department of Fish and Wildlife of needing more than two decades to measure coho salmon recovery in that State, a period of at least 21 years[1] represents a reasonable initial time period for evaluating the status and trend of coho salmon in California.

[1] Twenty-one years would allow for evaluation of 7 complete brood-year complements.

4.1.1 RECOVERY GOALS AND DELISTING CRITERIA

The five recovery goals are stated below and further described, with their accompanying delisting criteria and the methods for measuring each criterion's progress and status, in section 4.1.1.1.

GOAL I	Maintain and improve the number of key populations and increase the number of populations and brood years[2] of coho salmon.
GOAL II	Maintain and increase the number of spawning adults.
GOAL III	Maintain the range and maintain and increase the distribution of coho salmon.
GOAL IV	Maintain existing habitat essential for coho salmon.
GOAL V	Enhance and restore habitat within the range of coho salmon.

The Recovery Strategy includes an additional goal aimed at restoring coho salmon fisheries, although achieving this goal is not a necessary requirement for delisting and recovery. Goal VI addresses the newly adopted §2111(e) of the FGC and is discussed separately in section 4.2.

GOAL VI	Reach and maintain coho salmon population levels that allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.

Each of the recovery goals I to V has one or more criteria to evaluate progress toward delisting and, ultimately, recovery. Specific, quantitative targets have been set, or will be set in the near-future, for evaluating whether a criterion has been met. Although the same qualitative criteria will be used to evaluate progress of both the CCC and SONCC Coho ESUs towards recovery, the quantitative targets for delisting of the CCC and SONCC Coho ESUs differ, as do the targets for downlisting of the CCC Coho ESU as compared to delisting of the CCC Coho ESU (see Figure 4-1).

Preliminary targets set in this Recovery Strategy are based on the best available information. Where there was not sufficient information to set preliminary targets, a timeline to set those targets is substituted and discussed below. Coho salmon are also Federally listed under ESA, and NOAA Fisheries is developing recovery goals and criteria for its Federal recovery plans. The Department's proposed timeline for development of the other quantitative targets in this Recovery Strategy parallels the timelines for each of NOAA Fisheries' two Technical Review Teams (TRTs) working on the coho salmon ESUs in California. The Department is collaborating with both TRTs, and when the TRTs release their public documents, the Department will update its quantitative targets, if appropriate.

Integrating Department and NOAA Fisheries timelines for criteria development will not delay the determination of delisting because a determination that delisting or downlisting is warranted will require a sustained trend over multiple coho salmon generations (at least seven generations, or 21 years), regardless of the metrics used. Updates and possible revisions to the targets will be a key component of the Recovery Strategy's annual progress reports.

[2] See section 2.5 for discussion of coho salmon brood years.

4.1.1.1 Recovery Goals, Delisting Criteria, and Progress Evaluation

GOAL I Maintain and improve the number of key populations and increase the number of populations and brood years of coho salmon.

For the purposes of recovery, key populations are defined as "populations of coho salmon that are thought to constitute biological refugia, source populations, or metapopulations."[3] Generally, key populations are those that occur in coho salmon habitat of relatively high quality, with a full complement of year-classes, or with abundances that are high relative to other populations within the same recovery unit, or that place them at an insignificant risk of extinction. As the Department, NOAA Fisheries, and other population investigations (McElhany et al. 2000) conclude their analyses, the term "identified viable salmonid populations" will replace "key populations."

Criterion 1 *Key coho salmon populations are maintained and improved, at target levels specified for the recovery unit.*

Methods for measuring the progress and status:

- Identify key populations within each ESU;
- Identify appropriate areas where coho salmon could establish populations;
- Apply actions and mechanisms for maintaining and improving key populations and establishing additional populations; and
- Develop and implement population monitoring, both inland and ocean.

Criterion 2 *Additional coho salmon populations are established at target levels specified for the recovery unit.*

Methods for measuring the progress and status are the same as for Criterion 1 above.

Criterion 3 *An increase in the number of brood years present has been attained and sustained, as specified for the recovery units (targets to be reported in 2004 and 2005).*

For both the CCC and SONCC Coho ESUs:

i. Increasing the number of brood years present from two to three (a full brood-year complement), as specified for the recovery unit;

ii. Increasing the number of brood years present from one to two of three brood years, as specified for the recovery unit; and

For the CCC Coho ESU only:

iii. For the CCC Coho ESU, increasing the number of brood years present from zero to one of three brood years, as specified for the recovery unit.

Because of the danger of extinction of the CCC Coho ESU, for the third criterion of this first goal the Department is setting the most basic target, establishing one brood year in streams that currently are believed to have none of the three brood years present. Because of better conditions in the SONCC Coho ESU, the Department is commencing with the higher expectation of increasing brood-year representation.

3 Streams and rivers currently identified as maintaining key populations are listed in Appendix D.

Methods for measuring the progress and status:

- Identify brood-year representation in recovery units;
- Identify appropriate streams for re-establishment of missing brood years;
- Apply actions and mechanisms for re-establishing missing brood years; and
- Conduct brood-year analysis and population monitoring.

GOAL II Maintain and increase the number of spawning adults.

Criterion 1 *The specified number of spawning adults has been attained and sustained for the recovery unit.*

Methods for measuring the progress and status:

- Identify and apply actions and mechanisms for maintaining spawning habitat and other habitat important for adult coho salmon; and
- Monitor adult population status and trends.

GOAL III Maintain the range and maintain and increase the distribution of coho salmon.

This goal speaks to increasing the distribution of the species within its current range by increasing the number of occupied historic streams within each recovery unit. Increasing the distribution of coho salmon is inextricably linked with the success of achieving goals I, II, IV, and V, as well as increasing the percent of potential distribution occupied by coho salmon each year.

Criterion 1 *Current range of coho salmon is maintained.*

Methods for measuring the progress and status:

- Identify and apply actions and mechanisms to maintain current range and distribution; and
- Conduct population monitoring.

Criterion 2 *Current distribution of coho salmon is maintained.*

Methods for measuring the progress and status are the same as for Criterion 1 above.

Criterion 3 *An increase in distribution has been attained and sustained within each ESU, as specified for the recovery unit.*

i. *Coho salmon distribution within the CCC Coho ESU has been increased to at least 60% of historic streams to downlist; and*

ii. *Coho salmon distribution within the CCC and SONCC Coho ESUs has been increased each to at least 75% of historic streams to delist.*

Methods for measuring the progress and status:

- Identify areas feasible and appropriate for increasing distribution;
- Apply actions and mechanisms to increase distribution; and
- Conduct presence/absence monitoring.

GOAL IV Maintain existing habitat essential for coho salmon.

Criterion 1 *Habitat essential for coho salmon has been identified and protected, as specified for the recovery unit.*

Methods for measuring the progress and status:

- Analyze existing watershed assessments and plans;
- Gather necessary field data and conduct necessary mapping;
- Develop and apply a habitat quality index (HQI) based on a standard suite of measurable habitat quality parameters where HQIs currently do not exist;
- Identify and apply actions and mechanisms for protecting existing, essential habitat; and
- Monitor habitat condition.

GOAL V Enhance and restore habitat within the range of coho salmon.

Criterion 1 *Habitat benefiting coho salmon has been restored or enhanced, and then maintained, as specified for the recovery unit.*

Methods for measuring the progress and status:

- Identify areas feasible and appropriate to restore or enhance;
- Apply appropriate restoration or enhancement activities;
- Develop and apply HQIs where HQIs currently do not exist; and
- Monitor (a) coho salmon use of restored and enhanced habitat and effectiveness of restoration activities and (b) habitat condition.

Delisting targets for the SONCC Coho ESU, and downlisting and delisting targets for the CCC Coho ESU are summarized in Tables 4-1, 4-2, and 4-3, respectively.

4.1.1.2 Recovery Units

To facilitate monitoring of progress towards recovery, the Department divided each ESU into recovery units (see Chapter 6). The recovery units are groups of smaller drainages that are related hydrologically, geologically, and ecologically and are believed to function as unique and important components of the ESU.

Measuring progress toward recovery will be done at the recovery unit scale. The SONCC Coho ESU has been divided into 17 recovery units, while the CCC Coho ESU has been divided into six recovery units (Table 4-4). NOAA Fisheries is undergoing a similar process of defining recovery units and has not yet reported its findings. However, the Department has conferred with NOAA Fisheries, and the recovery unit delineations are consistent with its process at this time.

Ultimately, attaining recovery of coho salmon requires many actions and activities, which are contained in the recommendations. Prioritized tasks to achieve the recovery goals are listed in implementation schedules for the entire range as well as the SONCC and CCC Coho ESUs (Chapter 9), and the SSPP (Chapter 10). The Department believes that successful implementation of these tasks will lead to recovery of California coho salmon.

TABLE 4-1: Delisting targets for the SONCC Coho ESU

SONCC COHO ESU RECOVERY UNITS	DELISTING TARGETS								
	GOAL I			GOAL II	GOAL III			GOAL IV	GOAL V
	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1
Rogue/Winchuck rivers	8	TBD	2004	TBD	Maintain current condition.	Maintain current condition.	75	2005	2005
Smith River	27	10	2004	TBD			75	2005	2005
Shasta Valley	1	1	2004	TBD			75	2005	2005
Scott River	14	3	2004	TBD			75	2005	2005
Salmon River	5	4	2004	TBD			75	2005	2005
Middle Klamath River	31	11	2004	TBD			75	2005	2005
Lower Klamath River	33	1	2004	TBD			75	2005	2005
Trinity River	27	4	2004	TBD			75	2005	2005
South Fork Trinity River	5	1	2004	TBD			75	2005	2005
Mad River	15	5	2004	TBD			75	2005	2005
Redwood Creek	12	5	2004	TBD			75	2005	2005
Trinidad	9	TBD	2004	TBD			75	2005	2005
Eureka Plain	24	4	2004	TBD			75	2005	2005
Lower Eel-Van Duzen rivers	14	14	2004	TBD			75	2005	2005
South Fork Eel River	59	18	2004	TBD			75	2005	2005
Middle/Upper and North Fork Eel River	7	3	2004	TBD			75	2005	2005
Cape Mendocino	17	15	2004	TBD			75	2005	2005

NOTES:

TBD: To be determined

GOAL I Criterion 1: Number of streams or rivers currently identified as having populations to maintain or improve (streams listed in Appendix D).

Criterion 2: Number of streams or rivers currently identified as locations where populations could and should be established (Appendix D).

Criterion 3: The Department will report preliminary targets in 2004.

GOAL II The application of this goal to the SONCC Coho ESU is still to be determined (TBD) by the Department.

GOAL III Criteria 1+2: Both criteria require that current conditions (i.e., range and distribution, respectively) be maintained.

Criterion 3: Values are expressed as a percentage of suitable and historic streams with coho salmon presence detected.

GOALS IV+V Linear miles of stream/near-stream habitat targets will be set in 2005.

TABLE 4-2: Downlisting targets for the CCC Coho ESU

CCC COHO ESU RECOVERY UNITS	DOWNLISTING TARGETS								
	GOAL I			GOAL II	GOAL III			GOAL IV	GOAL V
	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1
Mendocino Coast	9	2004	2005	15,000	Maintain current condition.	Maintain current condition.	60	2005	633
Russian River	1	2004	2005	15,000			60	2005	50
Bodega-Marin Coastal	2	2004	2005	1,600			60	2005	26
San Francisco Bay	0	2004	2005	TBD			60	2005	TBD
San Mateo	0	2004	2005	1,350			60	2005	47
Big Basin	1	2004	2005	1,450			60	2005	47

NOTES:

TBD: To be determined

GOAL I Criterion 1: Number of streams or rivers currently identified as having populations to maintain or improve (streams listed in Appendix D).

Criterion 2: Number of streams or rivers currently identified as locations where populations could and should be established (Appendix D). Targets to be determined by 2004.

Criterion 3: The Department will report preliminary targets in 2005.

GOAL II Criterion 1: Numbers of spawning adults.

GOAL III Criterion 3: Percentage of suitable and historic streams with coho salmon presence detected.

GOALS IV Criterion 1: Linear miles of stream/near-stream habitat targets will be set in 2005.

GOALS V Criterion 1: River miles.

TABLE 4-3: Delisting targets for the CCC Coho ESU

CCC COHO ESU RECOVERY UNITS	DELISTING TARGETS								
	GOAL I			GOAL II	GOAL III			GOAL IV	GOAL V
	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1
Mendocino Coast	TBD	TBD	2005	TBD	Maintain current condition.	Maintain current condition.	75	2005	633
Russian River	TBD	TBD	2005	TBD			75	2005	50
Bodega-Marin Coastal	TBD	TBD	2005	TBD			75	2005	26
San Francisco Bay	TBD	TBD	2005	TBD			75	2005	TBD
San Mateo	TBD	TBD	2005	TBD			75	2005	47
Big Basin	TBD	TBD	2005	TBD			75	2005	47

NOTES:

TBD: To be determined

GOAL I Criterion 3: The Department will report preliminary targets in 2005.

GOAL III Criterion 3: Percentage of suitable and historic streams with coho salmon presence detected.

GOALS IV Criterion 1: Linear miles of stream/near-stream habitat targets will be set in 2005.

GOALS V Criterion 1: River miles.

TABLE 4-4: Recovery units within the SONCC and CCC Coho ESUs

SONCC COHO ESU RECOVERY UNITS	CCC COHO ESU RECOVERY UNITS
Rogue/Winchuck rivers	Mendocino Coast
Smith River	Russian River
Shasta Valley	Bodega-Marin Coastal
Scott River	San Francisco Bay
Salmon River	San Mateo
Middle Klamath River	Big Basin
Lower Klamath River	
Trinity River	
South Fork Trinity River	
Mad River	
Redwood Creek	
Trinidad	
Eureka Plain	
Lower Eel/Van Duzen rivers	
South Fork Eel River	
Middle/Upper Fork Eel River	
Cape Mendocino	

4.1.2 DELISTING AND DOWNLISTING TARGETS

The quantitative targets for the various downlisting and delisting criteria are discussed below, although they were introduced earlier and presented in Tables 4-1, 4-2, and 4-3. For all delisting criteria for the CCC Coho ESU, other than increasing distribution (goal III, criterion 3) and enhancing and restoring habitat (goal V), the Department and recovery teams have not developed preliminary targets. The Department believes some level of accomplishment and evaluation of downlisting needs to occur before meaningful delisting targets for most recovery goals can be established. Development of delisting targets for the CCC Coho ESU could begin during the first twenty years of recovery activities within the range of the CCC Coho ESU.

4.1.2.1 Targets for Coho Salmon Populations: Goals I, II, and III

Preliminary targets for maintaining and improving existing populations (goal I, criterion 1) have been established for all 17 watershed units in the SONCC Coho ESU. Preliminary targets for establishing additional populations (goal I, criterion 2) have been set for 15 of the 17 units; the Department still is evaluating appropriate targets for the Rogue/Winchuck rivers and Trinidad recovery units. These targets are shown in Table 4-1, and the streams and rivers are listed in Appendix D. For all but one recovery unit (i.e., San Francisco Bay) of the CCC Coho ESU, preliminary downlisting targets have been set for maintaining and improving existing populations (goal I, criterion 1). Targets have not been set for delisting for this criterion, and targets have not been set for either down- or delisting for establishing additional populations (goal I, criterion 2). The Department and recovery teams anticipate developing the remaining downlisting targets for criteria 1 and 2 in 2004. Downlisting and delisting targets for the CCC Coho ESU are shown in Table 4-2 and Table 4-3, respectively, and key streams and rivers are listed in Appendix D.

The list of rivers and streams in Appendix D is preliminary and does not represent an all-inclusive set of drainages for all recovery units. Therefore, recovery units in which no streams have been identified for maintenance, improvement, or establishment of key populations are not necessarily devoid of such streams. Revisions of these lists will be part of the periodic Recovery Strategy updates to the Commission, beginning in 2004.

Information the Department is gathering through ongoing presence/absence surveys will be used to establish targets for expansion of brood years in each recovery unit (goal I, criterion 3) for both ESUs. The Department will report its brood-year targets for the SONCC Coho ESU in 2004 and for the CCC Coho ESU in 2005.

Preliminary downlisting targets have been established only for attaining and sustaining spawning adults (goal II) for the CCC Coho ESU (Table 4-2). The Department is continuing to evaluate and gather information to refine these targets and will report any revisions in its annual report to the Commission. Based on the need and feasibility, the Department is evaluating whether it will apply goal II to the SONCC Coho ESU. The Department will consult with NOAA Fisheries, other agencies and organizations, and the recovery teams and report its preliminary decision in 2005.

Two of the three criteria under goal III (range and distribution) address maintaining current conditions: criterion 1 (range) and criterion 2 (distribution). As with its brood-year analysis, the Department anticipates reporting more specific information on current distribution in its annual report to the Commission.

Targets for increasing the distribution (goal III, criterion 3) have been established for delisting both ESUs (Tables 4-1 and 4-3) and for downlisting the CCC Coho ESU (Table 4-2). The downlisting target for the CCC Coho ESU (i.e., 60%) corresponds approximately to the current distribution within the SONCC Coho ESU, and the preliminary delisting target (i.e., 75%) currently is identical for both ESUs. The Department does not foresee revising these targets until the initial trends are measurable or until and unless the Federal TRTs develop appreciably different targets in their recovery plans.

4.1.2.2 Targets for Coho Salmon Habitat: Goals IV and V

The data collection and analysis necessary for determining habitat essential for coho salmon have not been completed across the range of either ESU. To set most of the specific targets for habitat protection (goal IV) and enhancement and restoration (goal V), the Department is in the process of compiling existing information on habitat location and condition, identifying past and current habitat restoration, determining where additional field work or analysis is necessary, and identifying habitat essential for coho salmon in each recovery unit.

Each goal has a single criterion to evaluate the achievement of the goal. For both goals, the metric is linear miles of stream/near-stream habitat. Goal IV refers to maintaining existing, suitable to optimum habitat, and goal V refers to enhancing and restoring other coho salmon habitat. For the purpose of delisting the SONCC or CCC Coho ESU, preliminary targets have not been set for either criterion (Table 4-1 and Table 4-3).

For the purpose of downlisting the CCC Coho ESU, the Department and recovery teams have not set the preliminary target of maintaining existing habitat (goal IV) but have established preliminary targets for enhancing and restoring habitat (goal V, Table 4-2) for all but one of the recovery units.

Preliminary delisting targets not yet established for the SONCC Coho ESU (goals IV and V) and downlisting targets for the CCC Coho ESU (goal IV) will be set by 2005. The Department does not anticipate setting preliminary delisting targets for the CCC Coho ESU until status information on the progress of downlisting targets is available.

4.2 FISHERIES RESTORATION GOAL

An additional goal[4] of the Recovery Strategy is to restore coho salmon numbers to the point where viable Tribal, recreational, and commercial fishing (viable coho salmon fishery) can occur. This goal cannot be fully achieved until the prior five goals have been achieved and the species is delisted (see Figure 4-1). To achieve this goal, the Department will collaborate with the appropriate tribes, the Federal government, and stakeholders.

GOAL VI Reach and maintain coho salmon population levels that allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.[5]

Coho salmon population levels allowing for a viable coho salmon fishery will exceed the numbers necessary for recovery. Hence, restoration of a viable coho salmon fishery would occur some time after delisting has been achieved. Restoration of viable recreational and commercial fisheries would be implemented and monitored through fishing regulations governed by the Commission and the Pacific Fisheries Management Council (PFMC) and not by the Department through CESA. The PFMC is an organization composed of representatives from California, Oregon, Washington, the Federal government, affected Tribal governments, the ocean sport and commercial fishing industries, and ocean conservation organizations. Restoration of a viable Tribal fishery would be implemented by Tribal governments and the Federal government, and the Department, other State agencies, and other stakeholders would assist whenever appropriate and requested.

Recovery goal VI meets the new CESA requirement, set forth in 2003, which states that in order to approve a recovery strategy, the Commission must find, among other things, that the Recovery Strategy would recover a formerly commercially valuable species to a level of abundance that would permit commercial use of that species (FGC §2111(e). This requirement does not affect the primary recovery goal of this Recovery Strategy or the delisting criteria.[6]

FGC §2084 allows the Commission to authorize take by hook and line for sport or to authorize incidental take pursuant to FGC §2080 *et seq.* or §2800 *et seq.* The Department and recovery teams discussed the potential for selective recreational and Tribal coho salmon fisheries, specifically hatchery coho salmon in the Klamath and Trinity rivers basin. The feasibility of such fisheries or other selective fisheries could be evaluated in the future, and the Commission's authorization of such a fisheries or incidental take is not based on achieving any of the downlisting or delisting goals.

After delisting is achieved, the Department, appropriate tribes, the Federal government, and stakeholders, including the recovery teams, would determine how to continue implementation of appropriate elements of the Recovery Strategy pursuant to and consistent with other applicable local, State, and Federal law and voluntary measures.

The Department's preliminary timelines for establishing and evaluating coho salmon fisheries are based on initial monitoring of coho salmon inland recovery activities, fishing, man-

4 This additional goal meets the requirements of FGC §2111(e), which was added by SB 216 (Statutes 2003 Chap. 854). This goal does not affect the first objective of the Recovery Strategy or the goals to achieve delisting. The author of SB 216 notes in a letter, dated September 12, 2003 (published in the Senate Journal on September 13, 2003) that FGC § 2111(e) "does not change the primary goal of the Recovery Strategy program as set forth in §2105 of the Fish and Game Code...Therefore, if a species has recovered to the point that the regulatory requirements or other protections for species listed pursuant to CESA are no longer necessary, then no permit pursuant to CESA would be required for incidental take of the species, even if the species has not achieved a level of abundance that would permit resumption of commercial use."

5 A decision by the Commission to authorize take by hook and line for sport pursuant to FGC §2084 or to authorize incidental take pursuant §2080 *et seq.* or §2800 *et seq.* of the FGC, is not predicated upon the attainment of any of the Recovery Strategy goals or criteria.

6 See Footnote 2, Chapter 1, Introduction for more detail on FGC §2111(e).

aging fishing, and potential fisheries issues in response to ocean conditions (see Chapter 3). The Department believes that it will require two decades or more of evaluation to adequately model coho salmon populations in context of salmon population status and trend monitoring and variable ocean conditions. The Department will establish coho salmon assessment and monitoring (see Chapter 5) and base it on the three-year life history of coho salmon. For all of these reasons and the fact that estimating long-term ocean condition cycles can take several decades, the Department believes the minimum timeline for its first evaluation would be 21 years. The steps for re-establishing recreational and commercial fishing are described below.

4.2.1 RECREATIONAL FISHING

Criterion 1 *Limited recreational fishing commences in selected areas and continues for a determined number of years once adult populations have exceeded population levels described in recovery goals I and II.*

Areas will be selected based on the relative health of coho salmon runs and the presence of recreational fishing opportunities and interest.

Methods for measuring the progress and status:

- Select areas, annual timing and duration, and initial number of seasons of coho salmon recreational fisheries;
- Open selected coho salmon recreational fishery;
- Conduct coho salmon population monitoring; and
- Conduct fisheries surveys.

Criterion 2 *The recreational fishery is expanded to the fullest extent feasible for additional years once it is documented that the limited recreational fishery has not significantly reduced levels or compromised the viability of coho salmon in each ESU over initial years of fishing.*

Methods for measuring the progress and status:

- Identify feasible and appropriate areas for extension of fishery;
- Expand coho salmon recreational fishery;
- Conduct coho salmon population monitoring; and
- Conduct fisheries surveys.

Criterion 3 *A permanent recreational fishery is attained when the expanded recreational fisheries have not significantly reduced sustained levels of coho salmon in each ESU over the initial years of fishing.*

Methods for measuring the progress and status:

- Resume permanent coho salmon fishery;
- Conduct coho salmon population monitoring; and
- Conduct fisheries surveys.

4.2.2 COMMERCIAL FISHING

There are two essential issues dealing with coho salmon recovery for the commercial fishing industry. The primary issue is to recover coho salmon so that current regulations on the Chinook salmon fishery to reduce coho salmon by-catch are made less restrictive. A secondary issue is to re-establish a coho salmon commercial fishery.

Criterion 1 *Experimental limited ocean harvesting of coho salmon is established when it has been determined that elimination of by-catch restriction for commercial harvest of other species has not significantly reduced sustained levels of coho salmon in each ESU over the initial years of fishing.*

Methods for measuring the progress and status:

- Evaluate area, timing, duration, and degree of experimental coho salmon commercial fishery;
- Open experimental commercial coho salmon fishery;
- Conduct coho salmon population monitoring;
- Conduct fisheries surveys; and
- Conduct focused, financed, experimental commercial fishing. This might involve financing a limited number of commercial vessels to specifically investigate the ability to and impact of commercial fishing for coho salmon.

Criterion 2 *Commercial harvest of coho salmon is established when it has been determined that the experimental commercial fishery has not significantly reduced sustained levels of coho salmon in each ESU over the initial years of harvest.*

Methods for measuring the progress and status:

- Evaluate feasible expansion of coho salmon commercial fishery;
- Expand coho salmon commercial fishery;
- Conduct coho salmon population monitoring; and
- Conduct fisheries surveys.

5 Elements Necessary for Recovery

The FGC identifies three elements necessary to achieve the goals of the Recovery Strategy: a) availability and use of public lands for the conservation, protection, restoration, and enhancement of the species; b) methods of public and private cooperation[1]; and c) procedures and programs for notice, education, research, monitoring, and strategy modification. An additional element is the regulatory role in recovery. These elements are discussed in the following sections. Strategy management and modification are discussed in Chapter 12.

5.1 ROLE OF PUBLIC LANDS

The range of coho salmon in California is predominantly under private ownership (63%). Public lands encompass the remaining 37% of the species' range, or approximately 8,125 square miles. Approximately 4,375 square miles of these public lands are located within watersheds where coho salmon have been identified as consistently present (Figures 5-1 and 5-2).

Coho salmon recovery is dependent upon the role of private lands, by virtue of the extent of private lands within the range of the species. The Recovery Strategy seeks to achieve species conservation in ways which are consistent with private property rights. Recovery efforts must incorporate maximum use of existing public lands to approach recovery objectives. It is incumbent on the Department to coordinate with other public agencies to promote and implement coho salmon recovery goals and actions on public lands. Below is a summary of the responsibilities of various Federal, State, and local governments.

5.1.1 FEDERAL LANDS

Federal lands within the range of the coho salmon are administered by the U.S. Forest Service (USFS), National Park Service (NPS), Bureau of Land Management (BLM), Department of Defense (DOD), USFWS, Department of Energy, and Bureau of Reclamation (USBR). Under sections 7(a)(1) and 7(a)(2) of the ESA, Federal agencies shall carry out their programs for the conservation of endangered and threatened species and ensure their actions, authorizations, and funding are not likely to jeopardize their continued existence or adversely modify their critical habitat.

5.1.1.1 U.S. Forest Service

USFS lands encompass approximately 6,563 square miles and include the Klamath, Mendocino, Shasta-Trinity, and Six Rivers National forests. These lands represent 81% of the public lands in the SONCC Coho ESU and play a key role in the recovery of coho salmon.

Congress has directed the USFS to manage national forests for multiple uses and benefits, including protection and management of natural resources, forestry and range land management and research, and community assistance and cooperation with State and local govern-

[1] The Department has identified watershed programs, groups, and other resources currently involved in making watershed improvements that may benefit salmonids. Details about this effort are in Appendix E: Watershed Groups and Gap Analysis.

ments. All Forest programs, activities, and projects are reviewed for possible effects on endangered and threatened species, species proposed for listing, and sensitive species. The purpose of the reviews is to ensure that USFS actions do not contribute to the loss of viability for any native or desired non-native plant or animal, and to comply with the ESA.

The USFS has developed an Aquatic Conservation Strategy, a fundamental component of the Northwest Forest Plan (USDA Forest Service 1997), to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands. The strategy was developed to protect salmon and steelhead habitat on Federal lands managed by the USFS and BLM within the range of Pacific Ocean anadromy. This conservation strategy uses several methods to further the goal of maintaining a "natural" disturbance regime.

5.1.1.2 U.S. Bureau of Land Management

BLM lands encompass approximately 516 square miles and include the Headwaters Forest Reserve and the Kings Range Conservation Area.

The Headwaters Forest Reserve is co-managed by the BLM and the State of California to protect the stands of old-growth redwoods that provide habitat for the Federal and State threatened marbled murrelet, and the headwaters that serve as habitat for the coho salmon and other fisheries.

The BLM is responsible for managing the nation's public lands and resources in a combination of ways that balance recreational, commercial, scientific, and cultural interests (i.e., multiple use) and strives for sustained yields of renewable and non-renewable resources, including range, timber, minerals, recreation, watershed, fish and wildlife habitat, wilderness and natural, scenic, and cultural values. The BLM manages the use of these lands to ensure that, wherever possible, the burden of conserving fish, wildlife, and plant species falls on the public lands and not on adjacent private lands.

The BLM administers public lands within a framework of numerous laws. The most comprehensive of these is the Federal Land Policy and Management Act of 1976 (FLPMA). All Bureau policies, procedures and management actions must be consistent with FLPMA and the other laws that govern use of the public lands, including the ESA.

5.1.1.3 U. S. National Park Service

NPS lands encompass approximately 249 square miles and include Redwood National Park, Point Reyes National Seashore, Muir Woods National Monument, and Golden Gate National Recreation Area.

The purpose of the NPS is "...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of future generations" (16 USC 1:1916). This mandate is combined with the NPS mission and responsibilities as a Federal agency to protect, conserve, and contribute to the recovery of candidate, threatened, endangered species.

5.1.1.4 U. S. Department of Defense

DOD lands encompass approximately 86.8 square miles and include various military facilities, the majority of which are located in the San Francisco Bay Area.

The Sikes Act authorizes the DOD to manage natural resources on military lands, and 1997 amendments to the Act provide many opportunities for the DOD to enhance its management. All military installations with significant natural resources are required to develop and implement Integrated Natural Resources Management Plans in cooperation with the USFWS and the appropriate state wildlife agency.

FIGURE 5-1: Land ownership in the SONCC Coho ESU

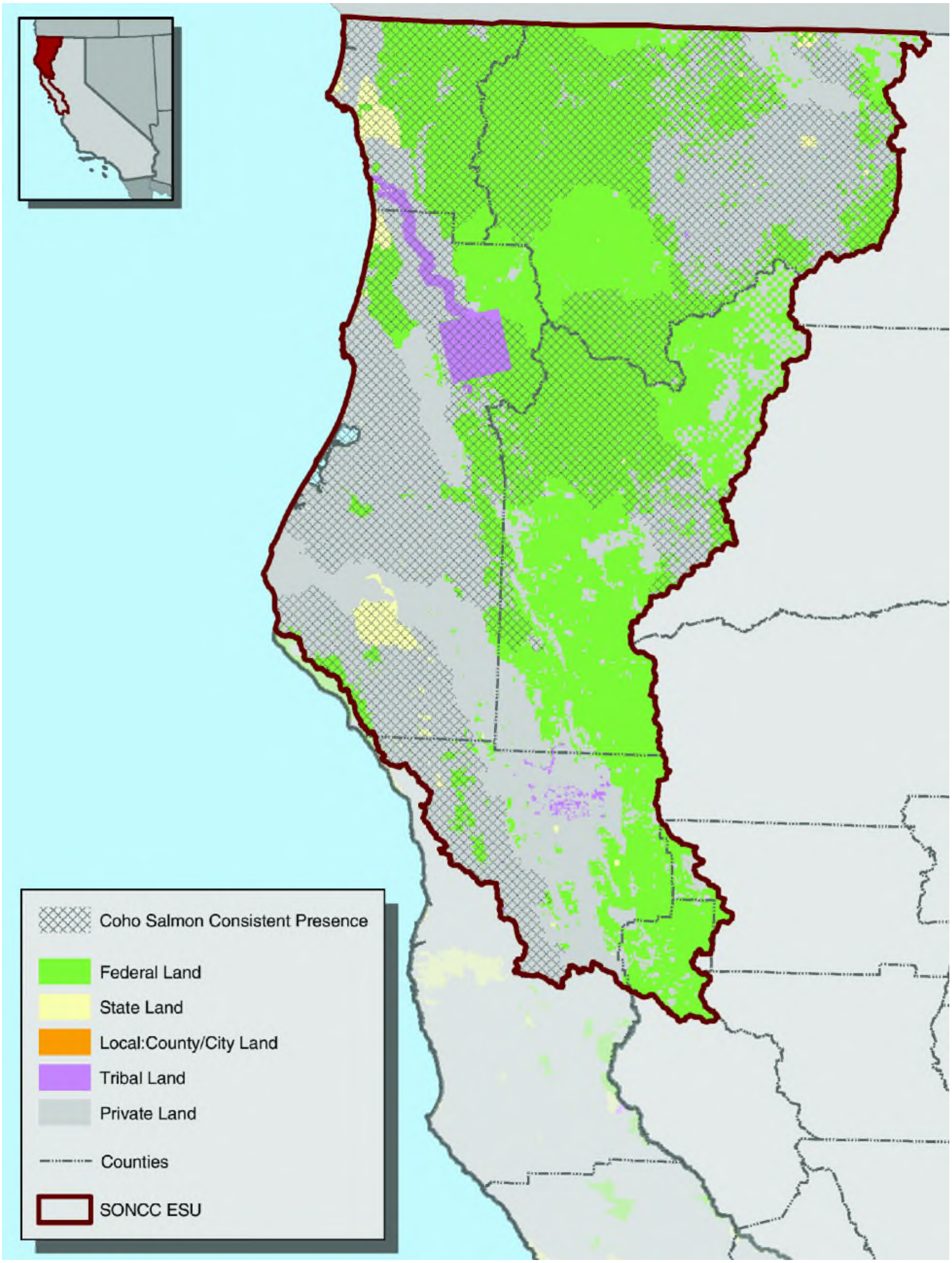
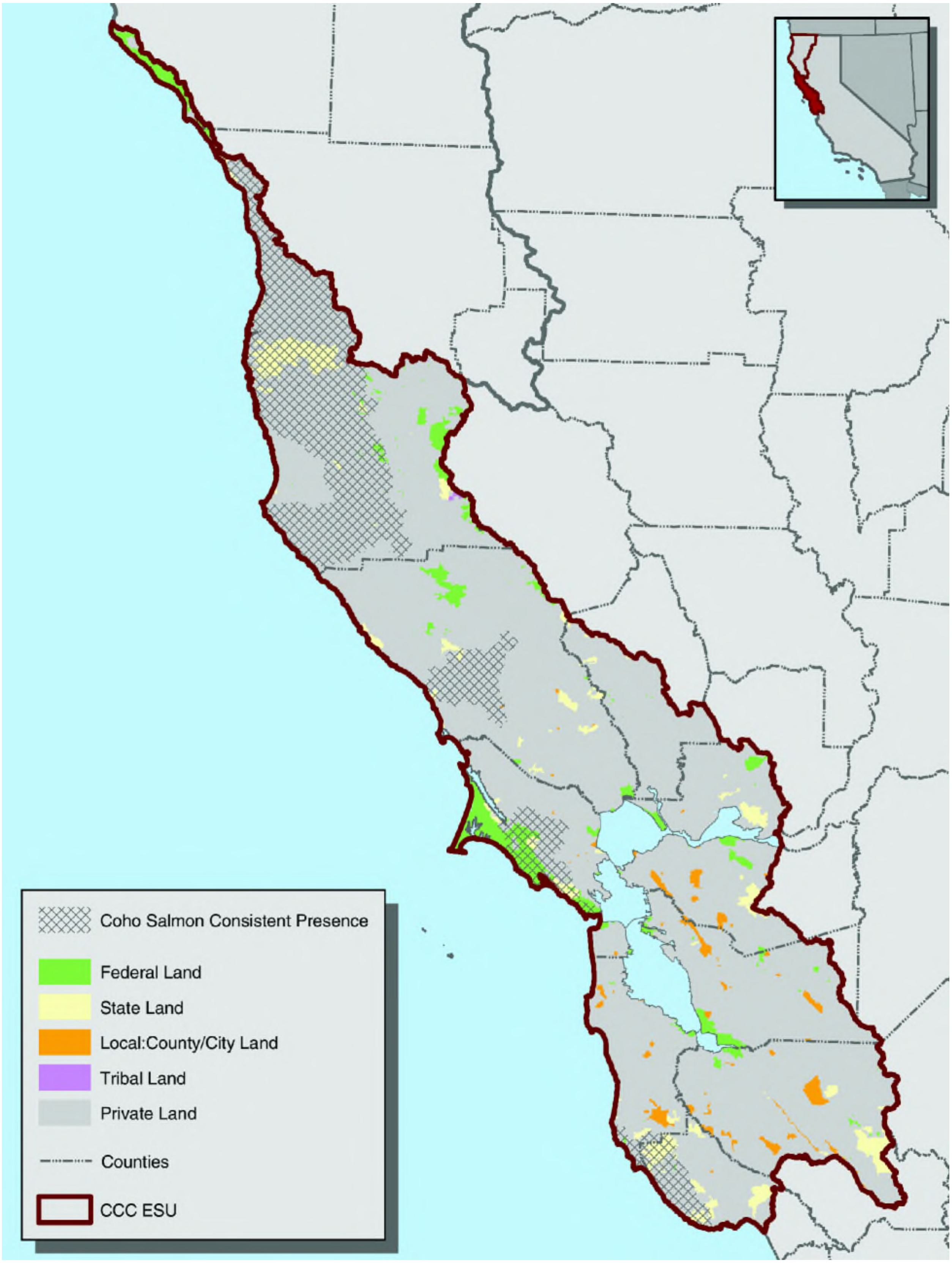


FIGURE 5-2: Land ownership in the CCC Coho ESU



The U. S. Army Corps of Engineers (USACE), which is under the DOD, operates two reservoirs within the range of coho salmon, Lake Mendocino and Lake Sonoma, that are both in the Russian River basin. The USACE also owns, and funds Department operation of, the Don Clausen Hatchery at Lake Sonoma.

5.1.1.5 U.S. Fish and Wildlife Service

USFWS lands encompass 32.0 square miles and include Humboldt Bay National Wildlife Refuge on the north coast and San Pablo Bay, Marin Islands, and Don Edwards San Francisco Bay National Wildlife Refuges in the San Francisco Bay Area.

The USFWS is charged with protecting endangered and threatened species under their jurisdiction and restoring them to a secure status in the wild. Responsibilities of the USFWS Endangered Species program include listing, reclassifying, and delisting species under the ESA; providing biological opinions to Federal agencies on their activities that may affect listed species; overseeing recovery actions; providing for the protection of important habitats in National Wildlife Refuges; providing grants to states to assist with their endangered species conservation programs; and international coordination.

5.1.1.6 U.S. Bureau of Reclamation

USBR lands encompass approximately 0.45 square miles in Siskiyou County and include the Klamath and Trinity River Projects in the range of the SONCC Coho ESU. The mission of the USBR is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. USBR facilities are managed to fulfill water user contracts and protect and enhance conditions for fish, wildlife, land, and cultural resources.

5.1.2 STATE LANDS

The State of California administers approximately 550 square miles of public lands within the range of coho salmon, including lands managed by the Department of Parks and Recreation (DPR), Department of Forestry and Fire Protection (CDF), State Lands Commission (SLC), and the Department.

5.1.2.1 California Department of Parks and Recreation

DPR lands encompass approximately 420 square miles and include more than 270 park units within the range of the coho salmon. DPR lands are managed to provide for the health, inspiration, and education of the people of California, by helping to preserve the State's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation.

5.1.2.2 California Department of Forestry and Fire Protection

CDF lands encompass 79.6 square miles and include the Jackson and Soquel Demonstration State Forests. CDF's responsibilities are to protect the people of California from fires; respond to emergencies; and protect and enhances forest, range, and watershed values providing social, economic, and environmental benefits to rural and urban citizens. CDF's mission emphasizes the management and protection of California's natural resources; a goal that is accomplished through ongoing assessment and study of the State's natural resources and an extensive CDF Resource Management Program. CDF oversees enforcement of the Forest Practice Rules (FPRs), which regulate timber harvesting on private lands.

CDF manages demonstration State forests for commercial timber production, public recreation, and research and demonstration of good forest management practices. Jackson

Demonstration State Forest is managed to prevent "take" of listed species, and to allow aquatic habitat recovery to proceed. Target species include the coho salmon.

5.1.2.3 California State Lands Commission

SLC lands encompass approximately 42.6 square miles located in approximately 54 areas, ranging in size from six to 1,559 acres. They are distributed throughout the coho salmon range. The SLC serves the people of California by providing stewardship of the lands, waterways, and resources entrusted to its care through economic development, protection, preservation, and restoration. The SLC has primary responsibility for the surface management of all sovereign and school lands in California. This responsibility includes the identification, location, and evaluation of the State's interest in these lands and its leasing and management.

Public and private entities may apply to the SLC for leases or permits on State lands for many purposes including marinas, industrial wharves, dredging, sand mining, tanker anchorages, grazing, rights-of-way, bank protection, recreational uses, etc. SLC staff review such applications and make recommendations to the SLC for action.

5.1.2.4 California Department of Fish and Game

Lands owned and/or managed by the Department encompass more than 7.8 square miles and include approximately 150 designated wildlife areas, ecological reserves, conservation easements, and fishing accesses.

The Department is the State agency charged with protecting and managing California's fish, wildlife, and their habitats. Department lands designated as wildlife areas are managed to protect and enhance habitat for wildlife species, and to provide the public with wildlife-related recreational uses. These lands provide habitat for a wide array of plant and animal species, including many listed as threatened or endangered. In contrast, Department lands designated as ecological reserves are managed to provide habitat for threatened or endangered species or species of special concern.

5.1.3 COUNTY AND CITY LANDS

Local government lands total approximately 105 square miles within the range of coho salmon. Local governments set forth the obligations of local projects, both public and private.

5.2 FUNDING FOR PRIVATE AND PUBLIC COOPERATION

Voluntary cooperation between private and public sectors is a critical aspect of coho salmon recovery, because political boundaries and property lines have no bearing on coho salmon occurrence. Private lands comprise approximately 63% of the total land within the range of the coho salmon. Approximately 36% of all lands in coho salmon range are private agricultural and forested lands. Cooperative efforts to maintain and restore coho salmon habitat on private land are usually more effective in watersheds where there are large contiguous parcels of forest and agricultural lands, in comparison to watersheds with multiple small ownerships and a relatively high human population density. This is only one of the benefits of having productive resource and community-based landowners maintaining lands in a contiguous and open landscape.

The Department supports economically and environmentally sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development. In particular, the timely and effective recovery of coho salmon on private lands should include programs to provide appropriate technical and financial assistance to landowners. At present many groups and programs exist to facilitate landowner outreach, education, planning, funding, and implementation of actions aimed at protecting and improving habitat for anadromous salmonids. The CRT report to the Director presented a partial list of voluntary and cooperating groups and activities focused on recovery of coho salmon by watershed.

5.2.1 EXISTING PROGRAMS

A diverse array of existing State and Federal funding programs is available to local watershed groups, individual landowners, and other stakeholders to assist in addressing the needs of California's watersheds. For example, grant programs administered by the Department, local Resource Conservation Districts (RCDs), the SWRCB, NOAA Fisheries, and numerous other groups provide assistance for fish habitat enhancement and water quality improvement projects that are consistent with coho salmon habitat recovery needs. It is extremely important that these grant programs continue to be funded to foster existing partnerships and to restore habitat.

5.2.1.1 Fisheries Restoration Grants Program

The Fisheries Restoration Grants Program (FRGP) is the Department's primary program for funding fisheries improvement projects, education, organizational support and planning in salmon and steelhead watersheds and streams. Public agencies, non-profit organizations, tribes and private entities living and working in watersheds from the Oregon border to the Mexican border are receiving grants to restore salmon and steelhead populations.

Funds for the FRGP come from the Salmon and Steelhead Trout Restoration Account (Proposition 40), Commercial Salmon Stamp Account, Steelhead Catch-Restoration Card sales, and Proposition 13. Additional funding comes from the Federal Pacific Coastal Salmon Recovery Fund, a six-year program established at the request of the governors of the states of California, Oregon, Washington, and Alaska, with the support of the California Congressional Delegation, in the Fiscal Year 2000 Consolidated Appropriation Act Public Law 106-113. This Federal funding is administered through the FRGP in accordance with a Memorandum of Understanding among the California Resources Agency (Resources Agency), the Department, and NOAA Fisheries.

Types of projects eligible for funding by the Fishery Restoration Grants Program include:

- Instream habitat restoration, bank stabilization, barrier modification;
- Fish ladders and screening of diversions;
- Watershed restoration (upslope);
- Riparian restoration;
- Watershed evaluation, assessment, and planning;
- Conservation easements for riparian buffer strips;
- Project maintenance;
- Watershed organization support;
- Education and technical training;
- Project monitoring for completed projects;
- Monitoring to provide baseline and/or trend data;
- Cooperative rearing;
- Water conservation measures; and
- Water measuring devices.

The FRGP is an applicant proposal-driven process. The Department solicits proposals for projects annually. The proposals are evaluated by Department staff. Projects are scored based on several factors, including their merit, the number of anadromous salmonid species benefited, and if those species are endangered, threatened, or candidate species under ESA or CESA. The proposals and staff evaluations are then provided to the California Coastal Salmonid Peer Review Committee, whose members include representatives of county governments, sport and commercial fisheries, Tribal governments, agriculture, forestry, public water agencies, and the academic and research community. The peer review committee considers the proposals and makes funding recommendations to the Director, who makes the final funding decisions.

The FRGP has been in place since 1981 and has invested more than $120 million, supported more than 2000 projects, involved more than 600 partners, and worked in over 2500 coastal streams. Annual funding in the program is currently in the $20 million range.

5.2.1.2 California Department of Conservation Grant Program

Through its Division of Land Resource Protection (DLRP), the Department of Conservation (DOC) plays a major role in protecting California's farmland, open space, and related resources. Financial assistance is offered to local governments and landowners for farmland and open space protection through programs that provide:

- Property tax incentives for retaining agricultural and open space land uses;
- Grants for the purchase of agricultural conservation easements; and
- Funding for conservation projects conducted by RCDs.

DOC's RCD grant program provides financial assistance, administrative education through California Conservation Partnership training programs, and information and technical support through the department's publications and technical assistance program. Additional financial assistance is offered through competitive conservation project grants to RCDs and technical assistance is offered in the form of liaison services, training, and outreach efforts.

5.2.1.3 Environmental Enhancement and Mitigation Program

The Environmental Enhancement and Mitigation Program offers a total of $10 million each year for grants to local, State, and Federal government agencies and to non-profit organizations for projects to mitigate the environmental impacts caused by new or modified State transportation facilities. Individual grants are usually limited to $250,000. State gasoline tax monies fund the Environmental Enhancement and Mitigation Program. Grants are awarded in three categories:

- *Highway Landscape and Urban Forestry*: Projects designed to improve air quality through the planting of trees and other suitable plants;
- *Resource Lands:* Projects for the acquisition, restoration, or enhancement of watersheds, wildlife habitat, wetlands, forests, or other natural areas; and
- *Roadside Recreational:* Projects for the acquisition and/or development of roadside recreational opportunities.

Program Procedures and Criteria, including specific application dates and funding limits, are generally published by the Resources Agency each year in September. The Resources Agency evaluates project proposals and provides a list of recommended projects to the California Transportation Commission by April 15th each year for consideration. The California Department of Transportation (Caltrans) administers the approved grant agreements.

5.2.1.4 Department of Water Resources Grant Program

The Department of Water Resources (DWR) administers grant and loan funding associated with legislation and several general obligation bond laws. Grant and loan funding may be provided for local studies, programs, and projects to better manage California's water resources. These funds are being made available for water conservation and groundwater management purposes through the:

- Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act (Proposition 13);
- Local Water Supply loan program authorized under the Water Conservation Bond Law of 1988 (Proposition 82); and
- Local Groundwater Management Assistance Act of 2000 (AB 303).

5.2.1.5 California Coastal Conservancy Program

The California Coastal Conservancy works with local governments, other public agencies, non-profit organizations, and private landowners to purchase, protect, restore, and enhance coastal resources, and to provide access to the shore. The California Coastal Conservancy has a current annual budget of over $185 million and since 1975, has invested well over $500 million to complete its projects, and has been funded primarily by State general obligation bonds and from the State's general fund. To date, the Coastal Conservancy has undertaken more than 950 projects along the 1,100 mile California coastline and around San Francisco Bay. Coastal Conservancy projects include the following:

- Land acquisition;
- Public access;
- Resource restoration;
- Resource enhancement;
- Urban waterfront improvement and restoration;
- Land use conservation and site reservation;
- Agricultural land preservation; and
- Non-profit support.

5.2.1.6 Watershed and Nonpoint Source Pollution Control Programs

Watershed/Nonpoint Source grants are offered through the SWRCB Division of Financial Assistance, in partnership with CALFED, the EPA, the California Coastal Commission, and the Resources Agency. These grants are made available through funding from Proposition 13, the Federal Clean Water Act section 319, and Proposition 50. Although the specific focus area of some of these programs are outside the range of coho salmon, other programs to improve water quality within the range of coho salmon, especially projects to reduce fine sediment input to streams, will be important for coho salmon recovery.

Nonpoint Source Pollution Control Program (Water Code, Division 25, Chapter 7, Article 2) (Proposition 13): The Nonpoint Source Pollution Control Program provides grant funding to local public agencies and nonprofit organizations formed by landowners for projects that protect the beneficial uses of water throughout the State through the control of nonpoint source pollution.

Coastal Nonpoint Source Pollution Control Program (Water Code, Division 25, Chapter 7, Article 5) (Proposition 13): The program provides grants to municipalities, local public agencies, non-profit organizations, and educational institutions for coastal nonpoint source projects that restore and protect the water quality and environment of coastal waters, estuaries, bays, and near shore waters and groundwater.

N*onpoint Source Implementation Program* (Federal Clean Water Act §319): The 319 Nonpoint Source Implementation Program provides grant funding for projects to implement measures and practices that reduce or prevent nonpoint source pollution to ground and surface waters. In particular, proposals that implement measures to achieve pollutant load reductions and address TMDL implementation are favored in the selection process. Grants are available to municipalities, local public agencies, educational institutions, nonprofit organizations or tribes. Funds cannot be used for activities undertaken pursuant to a NPDES permit (including stormwater).

CALFED Drinking Water Quality Program (Propositions 13 and 50): The Drinking Water Quality Program is focused on improving the quality of Central Valley and Delta water sources used for drinking water. Thus, projects eligible for Drinking Water Quality Program funding will generally be located in the watersheds of the Central Valley Regional Board (Region 5). Projects funded through Proposition 13 must meet the minimum requirements of both the Proposition 13 Nonpoint Source Pollution Control Program and the DWQP, whereas projects funded through Proposition 50 only need to meet the requirements of the Drinking Water Quality Program.

Watershed Protection Program (Water Code, Division 25, Chapter 5, Article 2) (Proposition 13): Grants are available to municipalities, local agencies, or nonprofit organizations to develop and implement local watershed management plans to reduce flooding, control erosion, improve water quality, and improve aquatic and terrestrial species habitats.

CALFED Watershed Program (Propositions 13 and 50): The Watershed Program will support activities that provide benefits to the areas within the CALFED Solution Area. Projects funded through the Proposition 13 allocation must meet the minimum requirements of both the Proposition 13 Watershed Protection and the CALFED Watershed Programs, whereas projects funded through Proposition 50 only need to meet the requirements of the CALFED Watershed Program.

5.2.1.7 Farm Bill Grants

The Farm Security and Rural Investment Act of 2002 (Farm Bill) authorizes $180 billion over seven years, including more than $17 billion for programs to assist landowners protect soil, water, and air quality; support fish and wildlife habitat conservation; purchase conservation easements for agricultural and wildlife purposes; and support improved forest management on non-industrial forestlands. While funding is subject to annual appropriations, Farm Bill grants have the potential to significantly benefit coho salmon. Within the range of coho salmon in California, the various Farm Bill programs allocated $5.45 million in 2002 and $9.60 million in 2003.

The Natural Resources Conservation Service (NRCS) is responsible for providing technical and financial assistance to implement conservation programs in the Farm Bill. In recent years, the Department and other State agencies have played a key partnership role with the NRCS to expand and encourage private land conservation efforts throughout California. Through this working relationship, the ability to leverage Federal and State resources on a landscape level can help facilitate coho salmon recovery efforts. With the active participation and cooperation of RCDs, rural landowners can take advantage of the diverse conservation programs available through the Farm Bill.

Key watershed conservation programs available in the Farm Bill through the NRCS include the following:

Environmental Quality Incentives Program (EQIP): EQIP promotes agricultural production and environmental quality as compatible goals. Through this voluntary program, farmers and ranchers may receive financial and technical help to install or implement structural and management conservation practices on their land. Cost sharing (up to 75 %) or incentive payments can be provided for a wide range of practices, including nutrient management, livestock waste handling, conservation tillage, terraces, and filter strips. EQIP is unique among farm conservation programs in its heavy focus on livestock producers.

Nationwide, EQIP is slated to receive $5.8 billion in funding for fiscal years (FY) 2002-07 and a total of $9 billion over ten years. Funding is phased up to $1.3 billion annually by FY 2007, compared with annual funding of roughly $200 million per year under the 1996 Farm Act.

EQIP's focus is on livestock producers, with 60% of funding earmarked for these producers, up from 50% in the 1996 Farm Act. Limits on the size of participating livestock operations, which excluded operations with more than 1,000 animal units, are eliminated in the 2002 Act. Payments are limited to a total of $450,000 per operation over the six-year life of the Act. Participating livestock operations are required to develop a comprehensive nutrient management plan.

Funding for conservation on working agricultural land is increasing relative to funding for land retirement. Because past conservation funding focused on land retirement, increased funding for working land constitutes a significant change in overall conservation program emphasis. EQIP and the newly initiated CSP are slated to receive new funding of $11 billion over ten years. The Congressional Budget Office estimates that increasing Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP) acreage caps will increase land retirement spending by $3 billion over the same period (from the April 2002 baseline). Expansion of working land programs will make a broader array of conservation options available to a larger group of producers. The increase in the number of programs available may provide the flexibility needed to develop conservation systems that deliver environmental gains at the lowest possible cost.

Changes in EQIP bid assessment procedures, however, may reduce the overall level of environmental benefit per dollar of program expenditure. Although "optimization of environmental benefits" is cited as a purpose of the program, the requirement to maximize environmental benefits per dollar of program expenditure is eliminated. Eliminating priority areas will make it more difficult to target EQIP funds to areas with the greatest environmental need. The ability of producers to enhance prospects for enrollment and reduce program cost by lowering bids (bidding down) is eliminated, increasing the cost of some contracts.

Wetland Reserves Program: WRP restores wetland, upland and riparian complexes to improve habitat for migratory birds. The objectives of this program are to purchase conservation easements from willing sellers, restore and protect wetlands in agricultural settings, and assist landowners with the restoration of wetland hydrology to enhance fish and wildlife habitat.

Conservation Reserve Program: Established in its current form in 1985 and administered by USDA's Farm Services Agency, CRP provides farm owners or operators with an annual per-acre rental payment and half the cost of establishing a permanent land cover, in exchange for retiring environmentally sensitive cropland from production for ten to 15 years. In 1996, Congress re-authorized CRP for an additional round of contracts, limiting enrollment to 36.4 million acres (56,875 square miles) at any time. The 2002 Farm Act increased the enrollment limit to 39 million acres (60,938 square miles). Producers can offer land for competitive bidding based on an Environmental Benefits Index during periodic signups, or can automatically enroll more limited acreages in practices such as riparian buffers, field windbreaks, and grass strips on a continuous basis. CRP is funded through the Commodity Credit Corporation.

To participate in the CRP, producers submit bids that specify practices to be used (e.g., grass, trees, wildlife habitat, filter strips) and the annual rental payment and cost sharing they are willing to accept for establishing these practices. Bids are ranked for selection using the Environmental Benefits Index, which incorporates six environmental factors (including soil erosion, water quality, and wildlife habitat) and contract cost. Contracts are for ten to 15 years.

In addition to the opportunity to enroll in the CRP under the general competitive signups, producers may bypass the competitive bid process and enroll acreage in specific conservation practices under the continuous CRP signup. These practices include:

- Filter strips;
- Riparian buffers;
- Shelter belts;
- Living snow fences;
- Field windbreaks;
- Grass waterways;
- Salt-tolerant vegetation; and
- Shallow water areas for wildlife.

Competitive bidding is not used since the relatively small acreage devoted to one of these practices provides a positive environmental impact for a much larger area. Hence, if the applicant is willing to accept no more than a set per-acre payment for an eligible practice on eligible land, acceptance is automatic and is possible year-round. Payments include a 20% incentive over the Commodity Credit Corporation's maximum rental rates for field windbreaks, grass waterways, filter strips, and riparian buffers, and a 10% incentive for land located within EPA-designated wellhead protection areas. In addition to the enhanced rental rates, 50% cost-sharing and a per-acre maintenance payment are provided.

In April 2000, USDA announced enhanced incentives for continuous signup participation. These include:

- A signing incentive payment of $100 to $150 per acre (depending on the length of contract) for filter strips, riparian buffers, grassed waterways, field windbreaks, shelter belts, and living snow fences;
- A practice incentive payment equal to 40% of cost-sharing for all continuous signup practices;
- Increased maintenance payments for certain practices;
- Updated marginal pastureland rental rates to better reflect the market value of such lands; and
- As of October 2001, about 1.5 million acres (2,343 square miles) had been enrolled in the continuous signup, with filter strips, vegetation to reduce salinity, and riparian buffers as the principal conservation practices. About half of the acreage is enrolled in the Midwest.

Wildlife Habitat Incentives Program: Encourages the voluntary establishment of high quality wildlife habitat on private lands. While some NRCS programs are specifically designed for agricultural lands, the Wildlife Habitat Incentives Program offers technical and financial help for all private landowners or local units of government who wish to plan and develop upland, wetland, riparian, or aquatic habitat on their property.

Farmland Protection Program: Helps farmers keep their productive land in agriculture. This program assists states, tribes, local governments and non-profit organizations by purchasing conservation easements for the purpose of limiting land conversion to non-agricultural uses.

Resource Conservation and Development Program: Assists communities to care for and protect their natural resources in a way that will improve the area's economy, environment and living standards. It provides a way for community members to initiate, sponsor, plan and implement projects that will make their area a better place to live.

Emergency Watershed Protection Program: Provides technical and financial assistance for watersheds ravaged by natural disasters. This program provides funding for work such as clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks.

Conservation Technical Assistance: Provides technical assistance to voluntary participants interested in planning and carrying out conservation activities to address local natural resource issues. NRCS staff works with land-users and communities to provide resource solutions throughout the watershed. Conservation Technical Assistance provides the science-based technical assistance needed to create long-term resource solutions at the local level.

Conservation Security Program: The newly created Conservation Security Program will provide payments to producers for maintaining or adopting structural and/or land management practices that address a wide range of local and/or national resource concerns. As with EQIP, a wide range of practices can be subsidized. But the Conservation Security Program will focus on land-based practices and specifically excludes livestock waste-handling facilities. Producers can participate at one of three tiers; higher tiers require greater conservation effort and offer higher payments. The lowest cost practices that meet conservation standards must be used. By paying producers to maintain practices they have previously found to be profitable to undertake, Conservation Security Program payments are not necessarily intended to internalize environmental externalities but are certainly intended to support agricultural incomes.

5.2.1.8 NOAA Community-based Restoration Program

The Community-based Restoration Program's objective is to bring together citizen groups, public and nonprofit organizations, industry, corporations and businesses, youth conservation corps, students, landowners, and local government, State and Federal agencies to restore fishery habitat around the coastal U.S. The program funds projects directly, and through partnerships with national and regional organizations. Since 1996, the Community-based Restoration Program has funded over 600 restoration projects and has developed national and regional Habitat Restoration Partnerships with 19 organizations. NOAA Community-based Restoration Program has two direct Federal funding opportunities.

NOAA Community-based Restoration Program Individual Project Grants: The Community-based Restoration Program provides funds for individual grass-roots marine habitat restoration projects that will benefit living marine resources including anadromous fish species, commercial and recreational resources, and endangered and threatened species.

NOAA Community-based Habitat Restoration National and Regional Partnership Grants: Partnerships are a key element in community efforts to accomplish significant, on-the ground habitat restoration. Partnerships have significantly leveraged available NOAA funds through cash match and local contributions, including land, volunteer support, and other in-kind services such as technical assistance, earthmoving activities and local knowledge.

NOAA also has a community-based restoration partnership program that periodically announces funding opportunities throughout the year. The funding for these programs are matching funds.

5.2.1.9 A Targeted Incentive Program

For other habitat conservation efforts, State and Federal agencies have created special ventures to provide recovery incentives for Californians. For example, the Central Valley Habitat Joint Venture funds habitat acquisition, conservation easements and management agreements with landowners. The State also purchases easements through the Wetland Easement program and the California Waterfowl Habitat Program. A similar program could be developed for coho salmon recovery.

Another instrument that could be used to create incentives for coho salmon habitat restoration if funds were available would be a tax incentive program. For example, Oregon has a property tax credit available to land owners who maintain riparian buffers. Expanding this tax credit was an element of that State's coho salmon recovery program. A government agency could announce a tax credit that would be available to all landowners undertaking a particular set of conservation activities, perhaps indexed to account for the fact that activities in some watersheds are more valuable than in others. This would relieve some of the informational burden of ranking bids that exists in programs like the Community-based Restoration Program, and transfer risk to the private landowner. Landowners undertake activities before receiving compensation from the government in this scenario.

Incentives might also be provided to public stakeholders. The Oregon conservation plan provides bonuses to local governments that meet or exceed salmon restoration performance standards (State of Oregon 1997).

5.2.1.10 Other Programs

There are a variety of other grant programs that may be available to contribute to coho salmon recovery, including programs administered by NOAA Fisheries and other groups.

5.2.2 MINIMIZING SOCIAL AND ECONOMIC IMPACTS

Solutions to recover coho salmon will be determined and accomplished locally. A guiding principle must be cooperation and coordination to promote partnerships. Landowners must have opportunities available to them that provide flexibility as well as assurances that voluntary participation in coho salmon recovery programs will not create significant new burdens in their use of their land. A balance of options will foster greater cooperation and promote innovation. Solutions will be ecosystem-based and will provide equitable problem-solving at the watershed scale in a comprehensive manner.

5.2.3 VOLUNTARY INCENTIVES

An incentives-based approach will be critical to the success of a timely and effective coho salmon recovery. The voluntary commitment of landowner resources and time that are part of cooperative and incentives-based programs also helps to leverage public funds available for recovery.

This Recovery Strategy contains a description of actions and recommendations, including voluntary incentives and objective criteria for delisting to minimize the adverse social and economic impacts of implementation of the Recovery Strategy. Chapter 4 describes the objective criteria for delisting. Chapters 9 and 10 contain implementation schedules that detail actions and recommendations including voluntary incentives, actions, and programs.

5.3 OUTREACH AND EDUCATION

The awareness and cooperation of public and private landowners, conservation groups, planning agencies, stakeholders, and the general public is essential for coho salmon recovery. Outreach and educational programs detailing the life history and habitat requirements of the species, as well as the goals and objectives for recovery, are an important part of this Recovery Strategy.

The Department will develop and implement educational initiatives or products to complement the biological recovery efforts proposed in this document. Development, prioritization and, ultimately, implementation of these initiatives are dependent on the availability of human and financial resources. The Department will utilize and build upon existing Department educational programs, such as the Mobile Fish Exhibit, Fishing in the City, Project Wild Aquatic, and the Elkhorn Slough National Estuarine Research Reserve. The Mobile Fish Exhibit in the Department's Central Coast Region is uniquely suited to bringing the message of coho salmon recovery to citizens groups and other stakeholders.

5.3.1 RECOVERY STRATEGY RECOMMENDATIONS

Priority will be given to educational activities that help to implement specific range-wide and regional coho salmon recovery recommendations with educational components, including recommendations that focus on water flow and conservation, water quality, sediments, land use, public outreach, and enforcement.

5.3.2 EDUCATION AND OUTREACH PLAN

The Department has a plan for education and outreach that focuses on providing notice to the public about the Recovery Strategy as well as information to interested and affected entities about coho salmon biology, definition and goals of recovery, and how recovery can be achieved. It includes elements outlined in this section below. Public and private landowners will be familiarized with coho salmon and their habitat occurring on their land, significance of the populations, and available conservation measures, including private land incentive programs.

For private lands with potential occurrences of coho salmon (i.e., lands with historic occurrences or otherwise within the range of the species), permission will be sought from landowners to conduct surveys or other recovery activities requiring access to coho salmon habitat. If populations of salmon are identified, landowners will be informed of their significance and encouraged to follow land use guidelines that protect the species and its habitat.

5.3.2.1 School Curricula

The Department will develop and disseminate educational materials for use in public and private schools. These materials would include concepts of coho salmon biology, endangered species, habitat conservation and restoration, and coho salmon recovery efforts in California.

Educational materials should be compatible with current California Science Standards. Grade-specific concepts related to coho salmon that have been identified by the Department's Classroom Aquarium Education Coordination Project to correlate with California Science Standards: physical/behavioral adaptations that affect survival (Life Science grade 3); food webs with producers/consumers (Life Science grade 4); physiology and organ systems (Life Science grade 5); ecology (Life Science grade 6); cell biology, genetics, and evolution (Life Science grade 7); and chemistry (Life Science grade 8). Educational material for use in schools may also include a teacher's information packet listing sources of information and knowledge about the coho salmon recovery process in California.

5.3.2.2 Interpretive Media

The Department may prepare brochures targeted at specific audiences and containing pertinent coho salmon recovery information. Potential target audiences include landowners, consumers of household products, legislators, educators, and watershed restoration groups. The brochures would be made available at appropriate information centers such as public libraries and watershed group headquarters, and in association with suitable outreach efforts such as public appearances or Department demonstrations.

Depending on availability of resources, the Department may prepare a coho salmon recovery video containing a synopsis of the California coho salmon listing history, threats to survival, recovery efforts, and useful contacts. The videotape could be used as a media tool of a range-wide coho salmon public relations campaign and in association with local outreach efforts.

Department grant funds support public educational interpretive exhibits. For example, the development of a comprehensive education and interpretive plan for the Warm Springs Dam and Don Clausen Fish Hatchery describes the management history and restoration/recovery efforts with the Russian River watershed. The work funded under this proposal comprises Phase I of a larger project. Phase II (design, fabrication and installation of the exhibits developed in phase I) will commence if/when funding through the Department grant program has been secured.

5.4 ASSESSMENT, MONITORING, AND RESEARCH

The Recovery Strategy consists of a series of prioritized actions designed to restore coho salmon to their former range at appropriate abundance levels. The coho salmon monitoring program is a framework to: a) track the performance of coho salmon recovery efforts, and b) evaluate the condition of coho salmon populations, habitats and the effects of human activities on them. Both physical and biological elements will be monitored to track the status and trends of fish populations and habitats.

5.4.1 PROGRAM FRAMEWORK

A monitoring program framework will be established and will include the following elements, which are briefly described below. Each is essential for the effective implementation, long-term maintenance, and dependability of a monitoring program.[2]

5.4.1.1 Scientific Planning and Prioritization

Careful and deliberate planning must be the foundation for a monitoring program. The Department and cooperating agencies and organizations have been developing some key components of anadromous salmonid monitoring, including recovery activity implementation and effectiveness, validation, and coastal population monitoring. The monitoring program should be established to ensure an effective and efficient program. Because there are many factors that are in need of monitoring, prioritization is also an essential element requiring early attention.

[2] Based, in part, on the CALFED Science Program's Comprehensive Monitoring, Assessment, and Research Program (2000)

The following components will be established and implemented through the planning and prioritization process:

1. Selection of appropriate metrics;
2. Determination of minimum data sets required to describe baseline conditions;
3. Selection of regional areas and independent populations for monitoring;
4. Development of sampling frameworks and sampling design;
5. Independent scientific review;
6. Standardized monitoring protocols;
7. Preparation and distribution of written protocols; and
8. Training and quality control for monitoring protocols.

The many variables in need of assessment, monitoring, and research (outlined in Table 5-1) will be evaluated and assessed at various spatial and temporal levels to determine the priorities for monitoring. It is likely that some priorities will differ by ESU, watershed, and local levels as well as over the time of coho salmon recovery (see below).

5.4.1.2 Evaluating Current Monitoring

Along with establishing the monitoring framework and scientific protocols, current monitoring efforts will be evaluated for their applicability to coho salmon recovery. Local and regional monitoring efforts already exist. The role and utility of these efforts should be acknowledged, and monitoring efforts beneficial to an overall monitoring program should be integrated. In addition, an inventory is an effective process for identifying the scope and focus of ongoing efforts, the gaps in coverage and data, and differences and applicability of ongoing efforts based on differing objectives of each monitoring effort. Information from historical, baseline, and real-time monitoring will be necessary, especially for establishing the foundation for habitat and population status and trend monitoring.

5.4.1.3 Data Management

Because coho salmon exist without regard to political or property lines, it is important to obtain data about coho salmon and their habitat from both public and private lands. The Department's ability to collect data from private lands is limited in many circumstances by a policy requiring landowner consent (FGC §857). Such consent is often withheld from the Department because of landowner concerns about confidentiality and the risk that if site-specific information is publicly disclosed, it will be misused or misinterpreted by others. A policy regarding data collection and disclosure that addresses these concerns would aid the Department's ability to protect and recover coho salmon. Such a policy is particularly important in that approximately 46% of the land in the SONCC Coho ESU and 86% of the land in the CCC Coho ESU that is privately owned.

The management of monitoring information will be essential. It will require dedicated effort and staff to house, compile, and distribute information to responsible and affected organizations and individuals. Important components to data management will be quality control, assessment, and appropriate application of the monitoring information. Assurances of confidentiality and use, and data reliability, will be important considerations for data management.

5.4.1.4 New Research

There are many uncertainties concerning coho salmon recovery. Evaluation of previous and ongoing assessments and monitoring will not only identify future assessment and monitoring needs, but will also indicate issues and uncertainties that require research. These issues will need to be prioritized. Research into coho salmon biology and ecology, and land use practices

TABLE 5-1: Partial outline of potential ecological and land management variables for coho salmon recovery strategy assessment, monitoring, and research

I. **HYDRODYNAMICS AND SEDIMENT TRANSPORT**

II. **SYSTEM PRODUCTIVITY**
   A. PRIMARY PRODUCTIVITY
   B. INVERTEBRATE
   C. FISH
   D. NUTRIENT CYCLING

III. **FLUVIAL GEOMORPHOLOGY**
   A. SEDIMENT (embeddedness, suspended)
   B. TURBIDITY
   C. SUBSTRATE PARTICLE SIZE
   D. LWD CYCLING
   E. LAND SLIDING AND DEBRIS FLOW

IV. **HYDROLOGY**
   A. FLOW (rate, timing, quantity)
   B. TEMPERATURE
   C. OTHER WATER QUALITY (i.e., DO)

V. **ECOLOGICAL COMMUNITIES**
   A. RIPARIAN COMMUNITY
      1. Vegetation composition
      2. Invertebrate composition
      3. Vegetation condition
      4. LWD recruitment
   B. NEARSHORE OCEAN CONDITION
   C. ESTUARINE
      1. Condition
      2. Fish use

VI. **WATER USE**
   A. EFFICIENCY
   B. TRANSFER
   C. STORAGE

VII. **LAND USE**
   A. EFFECTS ON HABITAT
   B. EFFECTS ON FISH
   C. LAND USE CHANGE TRAJECTORIES
   D. ECONOMIC CONSIDERATIONS
      1. Land use and owners
      2. Local jurisdictions

VIII. **FISHING**

IX. **BARRIERS TO MIGRATION**

X. **FISH POPULATION**
   A. RANGE
   B. DISTRIBUTION
   C. COHORT REPLACEMENT
   D. ABUNDANCE
   E. FISH HEALTH

XI. **RECOVERY EFFORTS**
   A. IMPLEMENTATION
   B. EFFECTIVENESS
   C. VALIDITY (fish response)

XII. **COHO SALMON ECOLOGY**
   A. DISEASE
   B. COMPETITION
   C. GENETICS

XIII. **POLLUTANTS (TYPE AND SOURCE)**

and environmental effects on coho salmon and habitat, will aid the Department in revising and refining both the monitoring program and overall recovery goals.

5.4.1.5 Program Reporting

The Recovery Strategy's monitoring program will have a reporting component by which the general public, landowners, local watershed groups, counties, government agencies, and State legislature can know the status and trend of coho salmon and the results of recovery activities.

Confidence regarding the validity and utility of information resulting from monitoring and research is essential to scientific credibility, public participation, and success in coho salmon recovery. The results and progress of the monitoring program will be subject to scientific review.

5.4.2 ASSESSMENT

In several watersheds, different types and levels of assessment have been done or are ongoing. In many other areas within the range of coho salmon, status information is sparse to non-existent. To evaluate the condition of fish populations, habitat condition, effects from land activity, effects of natural phenomena, and results of recovery efforts, an assessment of these conditions must occur prior to commencing a monitoring program. Baseline information will allow for comparison against changes over the time during the implementation of recovery activities. A baseline condition also will allow for evaluating trend and status. The monitoring program will evaluate historic and current information, identify gaps, and develop a strategy for assessing various conditions in the watersheds. Assessment needs will be prioritized.

5.4.3 MONITORING

The monitoring program for coho salmon will focus on two essential elements: 1) the status and trend of coho salmon and habitat, and 2) the performance of coho salmon recovery efforts. Monitoring will require a long-term commitment as well as annual collection of data on the fish populations, habitat condition, and physical and biological response to recovery actions intended to conserve and restore coho salmon populations and the habitats upon which they depend. An important component to the strategy to establishing a comprehensive monitoring program is to develop and implement standardized, robust field protocols. Monitoring can be divided into several categories, including:

- *Performance measures.* Performance measures are metrics used to track and measure progress of programmatic efforts relative to their goals on an annual basis. Performance measures, if consistently utilized, will begin to identify the long term trends needed to determine the ecological effectiveness of the program and will help ensure that resources are targeted and spent wisely.
- *Trend monitoring.* Trend monitoring evaluates how environmental conditions or populations change over time. The focus of trend monitoring is generally broad in scope, such as an entire ESU or species or extensive, geographic area, such as a large watershed or basin.
- *Implementation monitoring.* Implementation monitoring serves to document what recovery actions are taken and to evaluate whether those recovery actions are being implemented as planned. For habitat restoration, implementation monitoring provides baseline information before and immediately after a project occurs.
- *Effectiveness monitoring.* Effectiveness monitoring evaluates the effects of recovery actions, specifically if the recovery activities are having the desired effects.

This is largely a measure of physical responses to habitat restoration treatments and fisheries management actions. Response should be assessed against pre-established effectiveness criteria and evaluated with respect to the degree which they are obtained.

- *Validation monitoring.* Validation monitoring evaluates how a population, species, or biotic community responds to recovery actions. In the context of the Recovery Strategy, the focus will be on the response of coho salmon at stream reach, watershed, and ESU levels and will focus on each life-stage.

5.4.3.1 Three-tiered Monitoring Framework

Any monitoring program must be able to evaluate conditions at various scales and allow those involved (i.e., State and Federal agencies, counties, watershed organizations, landowners) to participate. In addition, the monitoring itself and the results and information generated must be defensible both scientifically and legally and must be acceptable to the counties and local communities where coho salmon occur. This will require good data on the distribution, abundance, and population health of coho salmon throughout California. A significant monitoring effort sustained over several decades will be required.

The State of Oregon has demonstrated that such a monitoring effort can be successfully initiated through the Oregon Plan for Salmon and Watersheds (Oregon Plan), which includes a three-tiered system for estimating the abundance of adult salmon in coastal watersheds. It also includes targeted studies of juvenile abundances and habitat. In the 1990s, Oregon developed a specific monitoring approach based on stratified random sampling; this method was much more accurate than previous methods based on “index reaches,” and is being used to monitor coho salmon. Oregon has thus demonstrated that a statistically rigorous monitoring approach is possible. The benefit of such an approach is that it delivers unbiased estimates of trends and abundance in salmonid stocks.

The *Oregon Plan* three-tiered framework:

Tier I is a broad-scale (i.e., ESU) assessment of ecosystem health. The intent is for data from Tier I to be used to stratify sampling at the more-detailed Tier II level. Tier I would probably require surveys at a frequency of once every 5 years for each sampling site. Candidate indicators to be measured are:

- *Biological attributes.* Fish presence/absence, distribution, percent of habitat occupied, genetic composition, invertebrate community health (the ones coho salmon need), habitat condition and key habitat elements (spawning and nursery areas, riparian condition).
- *Environmental attributes.* Geology/soils, land cover, digital elevation models, sedimentation/suspended sediment, water temperature, flow, and supply, and LWD recruitment.
- *Threat/Impact attributes.* Land use, roads, stochastic events (e.g., ocean conditions, drought), and barriers to migration.

Tier II is the level at which the status and trends in coho salmon population health are carried out. Annual measures of abundance would be based on a spatially-balanced random-sampling plan. Preliminary data to be collected are:

- *Adults.* Adults, spawners, redds, age structure, sex, hatchery fraction;
- *Juveniles.* Instream or emigrating, age/size class, fish condition; and
- *Habitat.* Macroinvertebrates, fish assemblage, DO, pH, nutrients/pollutants, solids, metals/toxins, temperature, channel form, valley form, valley width, geomorphic channel, channel substrate, canopy cover, LWD, riparian vegetation, land use and land cover, diversions, erosion processes, channel modification, and instream flow.

Data from Tier II would ideally be used as a control for Tier III data, which measures response of environmental conditions and salmonid populations to habitat restoration and other recovery actions (effectiveness and validation monitoring). The overall design of the Tier II portion of the coho salmon recovery plan could be modeled on Oregon's rotating panel design, which distributes sampling effort in time and space in a way that is intended to optimize the dataset's utility for detecting trends and status. It is also possible that a nested hierarchy of basin sampling and subsampling may be desirable.

Tier III is monitoring carried out for individual restoration projects and for a suite of related restoration treatments. It is used to assess and evaluate the effectiveness of restoration actions. The resulting information may then be assessed using comparisons with baseline and/or reference data collected in Tier II.

5.4.3.2 Monitoring of Coho Salmon

To understand the current and potential future condition of coho salmon populations and habitat, there are certain, specific monitoring elements that will be the foundation to the overall monitoring program. These elements will be coordinated with local monitoring efforts and integrated with each other, and will span the entire range and distribution of coho salmon. Status and trend monitoring, implementation and effectiveness monitoring of recovery efforts, and validation monitoring of coho salmon response constitute the core of the State's coho salmon monitoring program. Conceptual models likely will be developed and utilized in the monitoring.

Status and Trend Monitoring. The first essential monitoring requirement for coho salmon will be to understand the status and trend, primarily at the ESU level. To do this, establishing the baseline condition of coho salmon populations and habitat and ongoing monitoring of coho salmon populations will be necessary. This monitoring information will be directly tied to the Department's ability to recommend downlisting, uplisting, or delisting of either ESU.

In 2003, the Department and cooperating agencies began to develop a coastal salmonid monitoring plan. The objective of the plan is to develop statistical sampling designs to estimate status and trends in coastal California salmonid population and habitat conditions at the ESU or other appropriate spatial scale. This plan will be the foundation for population status and trend monitoring for coho salmon.

Implementation and Effectiveness Monitoring. Local and regional restoration activities will be the core to coho salmon recovery efforts. Tracking, measuring, and understanding these activities will be critical to making wise use of limited resources and time and in making improvements in recovery and restoration actions based on past results.

In 2001, through the FRGP, efforts began the Coastal Salmonid Restoration Monitoring and Evaluation Program (CSRMEP). CSRMEP is developing implementation and effectiveness monitoring protocols to evaluate restoration efforts with the goal of improving and conserving coastal anadromous salmonid habitat. Components of this effort currently underway will:

a. Complete monitoring protocol development;

b. Field-test all protocols;

c. Complete a data management support system;

d. Provide training in protocol usage; and

e. Begin testing the implementation of a comprehensive restoration effectiveness monitoring program.

Validation Monitoring. Validation monitoring evaluates whether and to what degree a specific practice accomplishes goals and objectives. In addition, validation monitoring is invaluable for verifying hypotheses regarding coho salmon ecology and recovery, and conceptual models predicting the relationship between different ecological and land management variables. Validation monitoring is indispensable in determining the success of "...actions taken in an attempt to improve the status of salmon (or a specific stock of salmon)..." (Botkin et. al. 2000).

Starting in 2002, the FRGP began to develop validation monitoring protocols for anadromous salmonid recovery activities in California. The goal is to develop standardized validation monitoring protocols to assess and evaluate the response of salmon and steelhead to restoration and management efforts aimed at conserving and restoring anadromous salmonids in coastal California watersheds. These validation monitoring protocols will serve as the foundation for coho salmon Recovery Strategy validation monitoring. It is anticipated that protocols will be developed and ready for field testing by 2005.

5.4.4 NEW RESEARCH

Evaluation of previous and ongoing assessments and monitoring will not only identify future coho salmon assessment and monitoring, it will also indicate biological issues and uncertainties that require research. Like assessment and monitoring needs, coho salmon research will need to be prioritized. Future research into the biology of coho salmon (e.g., genetics, estuary use), effects of land use practices (e.g., urbanization, forestry) and environmental processes (e.g., climatic variation in ocean condition, woody debris cycling) on coho salmon populations and habitat will aid the Department in revising and refining both the monitoring program and overall recovery goals. The CRT identified some priority research issues, and the Department in collaboration with the recovery teams, will continue to identify and prioritize research needs.

5.4.5 ASSESSMENT, MONITORING, AND RESEARCH RECOMMENDATIONS

Assessment, monitoring, and research are important to coho salmon recovery. Recommendations for range-wide monitoring, research and assessment that will contribute to recovery of coho salmon are set forth in the range-wide implementation schedule in Chapter 9.

5.5 REGULATORY ROLE IN RECOVERY

Improving implementation and enforcement of existing laws and regulations (Table 5-2) by and among various State, Federal, and local governments can contribute significantly to the recovery of coho salmon. This was recognized by the CRT. Therefore, many recovery actions call for improved implementation and/or enforcement of specific laws and regulations. Other recovery actions call for improved coordination among government agencies in implementing, enforcing, and streamlining the permit processes to promote activities that will benefit coho salmon.

TABLE 5-2: Existing laws, regulations, and permits that contribute to coho salmon recovery

STATE LAWS AND REGULATIONS

LAWS AND REGULATIONS	GENERAL DESCRIPTION[a]
Recovery Strategy Pilot Program, Fish & Game Code §2105 *et seq.*	Sets forth requirements for Recovery Strategy. Sets forth criteria for Commission approval of Recovery Strategy. Authorizes inclusion of guidelines for issuance of memoranda of understanding under FGC §2081. Provides that the Recovery Strategy itself shall have no regulatory significance, shall not be considered to be a regulation for any purpose, and is not a regulatory action or document.
Fully Protected Species, Fish & Game Code §3511, 4700, 5050, 5515.	Prohibits take and possession of specified fully protected species, except collecting for "necessary scientific research" as authorized by the Commission. No provision of the FGC or any other provision of law shall be construed to authorize the issuance of permits or licenses to take any fully protected species.
California Endangered Species Act (CESA), Fish & Game Code §2080 *et seq.*	Prohibits take of California-listed and candidate species, except as otherwise authorized.
Natural Community Conservation Planning Act, Fish & Game Code §2080 *et seq.*	Authorizes take of any species whose conservation and management is provided for in an approved natural community conservation plan.
Lake and Streambed Alteration Protection, Fish & Game Code §1600 *et seq.*	Prohibits any person from substantially diverting or obstructing the natural flow, or substantially changing the bed, bank, or channel of any river, stream or lake without first notifying the Department of the activity. Prohibits a person from commencing any activity until: 1. The Department has found that it will not substantially adversely affect existing fish and wildlife resources; or 2. The Department's proposals as to measures necessary to protect fish and wildlife resources (as agreed to), or the decision of a panel of arbitrators, have been incorporated into the activity. Where the Department has found the activity will substantially adversely affect existing fish and wildlife resources, prohibits any person from engaging in the activity unless it is conducted in accordance with the department's proposals (as agreed to) or the decisions of the panel of arbitrators. The Department shall not condition a streambed alteration agreement on the receipt of another State or Federal permit.
Water Pollution, Fish & Game Code §5650.	Prohibits anyone from depositing in, permitting to pass into, or placing where it can pass into the waters of the State, specified items and "any substance or material deleterious to fish, plant life, or bird life," except a discharge or release expressly authorized by and in compliance with a WAR or waiver or in compliance with a Federal permit issued a water quality certification issued by the State Water Resources Control Board or regional board after public hearing.
Commission Regulations, Fish & Game Code §316.5.	Authorizes Commission to "prohibit the taking or possessing of salmon in the same manner as the taking or possessing of salmon is prohibited by Federal law or by rules or regulations adopted by the United States Secretary of Commerce, notwithstanding any other provision of this code."
Examination of Dams, Fish & Game Code §5930.	Requires the Department, from time to time, to examine all dams in all rivers and streams in the State naturally frequented by fish.
Fishways, Fish & Game Code §5931.	Provides that if, in the opinion of the Commission, there is not free passage for fish over and around any dam, the Department shall cause to be furnished suitable fishway plans and order the owner in writing to provide the dam, which shall be completed to the Department's satisfaction.
Additional Fishways, Fish & Game Code §5932.	Requires that when article 2 (dams and structures) has been complied with, if in the opinion of the Commission changed conditions make additional structures desirable for free passage of fish, the Department may make such additional structures and necessary expenditures.
Dam Construction and Enlargement, Fish & Game Code §5933.	Requires the Commission to be given a copy of any application to DWR for new dam or enlargement of dam. If the Commission deems fishway necessary for preservation and protection of fish and construction and operation of fishway is practicable, it shall set a date for hearing. Where the Commission finds after hearing fishway is necessary and practicable, prohibits construction without prior written approval of Commission.
Fishway Maintenance, Fish & Game Code §5935.	Requires owner of any dam upon which a fishway has been provided shall keep the fishway in repair and free from obstructions to passage of fish at all times.
Fish Passage, Fish & Game Code §5937.	Requires owner of any dam to allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around, or through the dam, to keep in good condition any fish that may be planted or exist below the dam.

continued

TABLE 5-2: Existing laws, regulations, and permits that contribute to coho salmon recovery (continued)

STATE LAWS AND REGULATIONS (continued)

LAWS AND REGULATIONS	GENERAL DESCRIPTION[a]
Hatchery in Lieu of Fishway, Fish & Game Code §§5938, 5940, 5941.	Provides that when in the opinion of the Commission a fishway is impracticable, Commission may order owner of the dam to equip a hatchery to Department plans and specifications. After the hatchery is constructed, The Department shall operate it without further expense to dam owner. However, dam owner shall permit the use of free water for the hatchery. If dam generates electricity, the dam owner shall permit the use of free electricity for the hatchery.
Fish Planting in Lieu of Fishway, Fish & Game Code §5942.	Authorizes the Commission to order dam owner in lieu of fishway, hatchery, equipment to plant, under Department supervision, young of fish that naturally frequent waters of the stream or river, at such times, in such places, and in such numbers as the Commission may order.
Screening Diversions Deleterious to Salmon and Steelhead, Fish & Game Code §6100.	Requires dam owners to screen any new diversion of water from any stream having populations of salmon and steelhead which is determined by the Department to be deleterious to salmon and steelhead. Authorizes the Department to make onsite investigation prior to proposing measures necessary to protect fishlife. Prohibits commencement of diversion until the Department has determined the protective measures have been incorporated into plans and construction of diversion.
Suction Dredging, Fish & Game Code §5653 *et seq.*	Prohibits suction dredging in rivers, streams, and lakes of the State, except as authorized.
Z'Berg-Nejedly Forest Practice Act, Pub. Res. Code §4511 *et seq.* Forest Practice Rules, CCR Title 14, §895 *et seq.*	Regulates timber operations on industrial and non-industrial timberlands. Sets forth requirements for timber operations and timber harvest plan review.
Surface Mining and Reclamation Act, Pub. Res.Code §2710 *et seq.*	Requires for all mining operations an approved reclamation plan and financial assurances to cover estimated reclamation costs.
Porter-Cologne Water Quality Control Act, Water Code §13000 *et seq.*	Requires persons proposing to discharge waste that could affect the waters of the State to file a Report of Waste Discharge with the appropriate Regional Water Quality Control Board. RWQCB will either issue a Waste Discharge Requirement or waive the requirement.
Streamflow Protection, Pub. Res. Code §10000 *et seq.*	Authorizes the Department to develop, review, and/or propose streamflow requirements or modifications to streamflow requirements, and initiate studies therefore.
California Environmental Quality Act, Pub. Res. Code §21000 *et seq.*	Requires environmental review and public disclosure of environmental impacts.
FEDERAL LAWS AND REGULATIONS	
Endangered Species Act, 16 U.S.C. §1531 *et seq.*	Prohibits take of ESA-listed species, except as authorized under the ESA. Take can be authorized through section 7 and section 10. Section 7 requires Federal agencies to consult whenever any undertaken, permitted, or funded by a Federal agency will result in take of an endangered species or destruction of critical habitat. Section 7 results in an incidental take statement, allowing incidental take, subject to reasonable and prudent measures. Section 10 provides for issuance of permits to persons authorizing incidental take.
U.S. Army Corps 404 Permit, Clean Water Act, 33 U.S.C. §1344.	Regulates discharge of dredged or filled material from a point source into the waters of the US, through: 1. General or individual permit, or 2. Letter of Permission issued by the US Army Corps of Engineers. Exemptions under §404(f)(1) and 33 CFR §323.4 include normal farming, silviculture, ranching, certain construction or maintenance of farm roads or forest roads.
Section 10 Rivers and Harbors Act 33 U.S.C. §403.	Regulates work or structures in, or affecting, the course, condition, or capacity of navigable waters of the US through: 1. General or individual permit, or 2. Letter of Permission issued by the US Army Corps of Engineers.
Section 401 Water Quality Certification, Clean Water Act, 33 U.S.C. §1341.	Requires an applicant for a Federal license or permit to conduct any activity that may result in any discharge into navigable waters to provide the Federal licensing or permitting agency a certification or waiver of certification from the State in which the discharge originates or will originate that the discharge will meet the State's water quality standards. Prohibits granting of any license or permit if the State denies certification.
TMDLs, CWA §303(d) 33 U.S.C. §1313.	Requires establishment of TMDLs for point sources and non-point sources for listed impaired water bodies. TMDLs are not enforceable, except through a State implementation plan (basin plan). To date, the Garcia River TMDL is the only one that has been incorporated into a basin plan.

continued

TABLE 5-2: Existing laws, regulations, and permits that contribute to coho salmon recovery (continued)

FEDERAL LAWS AND REGULATIONS (continued)

LAWS AND REGULATIONS	GENERAL DESCRIPTION[a]
Fish and Wildlife Coordination Act, 16 U.S.C. §661 *et seq.*	Requires Federal agencies to consult with the Fish and Wildlife Service and State fish and game agencies before undertaking or approving projects that control or modify surface water projects.
Data Quality Act, Public Law 106-554.	Pursuant to the Data Quality Act, the Office of Management and Budget (OMB) issued guidelines to Federal agencies providing policy and procedure guidance for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by Federal agencies. The guidelines require procedures for persons who may be affected by such information to request corrections to information that does not conform to the guidelines. OMB directed all Federal agencies to issue implementing guidelines. NOAA and FWS, among other Federal agencies have issued guidelines. Both NOAA's and USFWS's guidelines include objectivity standards. These guidelines apply to third-party information (such as information from states) that the agencies use. The guidelines acknowledge and do not override other compelling interests such as privacy, trade secrets, intellectual property, and other confidentiality protections established by law. Where these considerations preclude full transparency, then "especially rigorous robustness checks" will be applied.
National Environmental Policy Act, 42 U.S.C. §4321 *et seq.*	Requires environmental review and public disclosure.
Santa Cruz County Riparian Corridor Protection Ordinance, County Code Chapter 16.30.	Defines, protects and determines boundaries of riparian corridors for permits and exemptions.

PLANS AND PERMITS PURSUANT TO STATE, FEDERAL AND LOCAL LAWS

PLANS AND PERMITS	GENERAL DESCRIPTION[a]
Pacific Lumber Company Habitat Conservation Plan	Provides mitigation that contributes to recovery of coho salmon.
Water Quality Control Plan for North Coast Region	Provides water quality standards for beneficial uses in North Coast Basin, including Garcia River TMDL. Prohibits unauthorized discharges in violation of the basin plan.
Water Quality Control Plan for San Francisco Bay Region	Provides water quality standards for beneficial uses in San Francisco Bay Region. Prohibits unauthorized discharges in violation of the basin plan.
Humboldt County, USACE Letter of Permission 96-1 for Gravel Mining and Excavation Activities Within Humboldt County	Authorizes gravel mining and excavation activities within Humboldt County subject to specified conditions.
Humboldt County Extraction Review Team (CHERT)	Independently reviews gravel mining and extraction plans and issues recommendations therefore.
Sonoma County Aggregate Resources Management	Authorizes gravel mining in Sonoma County, but defers to the Department concurrence of project conditions through the Streambed Alteration Agreement process under FGC §1600 *et seq.*
Del Norte, US Army Corps of Engineers Letter of Permission 96-2 for Gravel Mining and Excavation Activities within Del Norte County	Authorizes gravel mining and excavation activities within Del Norte County subject to specified conditions.

[a] General descriptions are provided for convenience of the reader. The descriptions are not intended to be exhaustive. For details, the reader should refer to the actual statute, regulation, ordinance, and/or document itself, and any applicable case law.

6 Recovery Units and Watersheds

The Department has subdivided each coho salmon ESU into watershed recovery units (recovery units). The recovery units are groups of smaller drainages related hydrologically, geologically, and ecologically, and that are thought to constitute unique and important components of the ESU. The concept of the recovery unit allows flexibility across the landscape; once a recovery unit has met and sustained recovery targets, more attention can be focused elsewhere.

To provide consistency with existing resource databases, recovery units were aligned with the geographic divisions of the CALWATER 2.2a system, the standard watershed mapping system used by the State of California. The CALWATER classification system includes (from largest to smallest) hydrologic regions, hydrologic units (HUs), hydrologic areas (HAs), hydrologic subareas (HSAs), and planning watersheds.

The HUs, and in some instances the HAs within the recovery units, are described below under each ESU. HSAs are also described where environmental conditions are distinct from the hydrologic unit and specific recovery recommendations are warranted.

6.1 RECOVERY UNITS IN THE SONCC COHO ESU

The SONCC Coho ESU has been divided into 17 recovery units (Figure 6-1). The recovery units generally correspond with CALWATER hydrologic units, with the exception of the Klamath, Trinity, and Eel river systems, which were further refined at the hydrologic area level. These recovery units, and the watershed delineations within each recovery unit, are listed in Table 6-1. Hydrologic subareas are illustrated in Figure 6-2 and watershed conditions are described below.

6.1.1 ROGUE RIVER AND WINCHUCK RIVER HYDROLOGIC UNITS

These two HUs are located mostly in Oregon. Portions of the Illinois River, a tributary to the Rogue River (Figure 6-3), and the Winchuck River (Figure 6-4) are located in California.

6.1.1.1 Illinois River HSA

A very small portion of the Illinois River HSA is located in eastern Del Norte County, California (Figure 6-3). The main drainages of the Illinois River HSA in California are Elk Creek, the East Fork Illinois River, and Dunn Creek. Portions of these drainages are in the Siskiyou National Forest, and the rest is in private ownership. Timber production is the main land-use activity. Coho salmon have been found in the above-listed drainages as well as a few of their main tributaries in recent Department surveys. Problems for coho salmon recovery in these drainages include inadequate pool structure due to insufficient existing and recruitable conifer LWD and excessive fine sediment.

6.1.1.2 Winchuck River HSA

The South Fork Winchuck River is the only portion of the Winchuck River HSA located in California (Figure 6-4). The primary land use in the South Fork drainage is industrial timber production. Coho salmon were found in the South Fork in recent Department surveys.

TABLE 6-1: Recovery units and CALWATER watersheds in the SONCC Coho ESU

RECOVERY UNIT	HYDROLOGIC UNIT (HU)	HYDROLOGIC AREA (HA)	HYDROLOGIC SUBAREA (HSA)
Rogue and Winchuck rivers	Winchuck River	Winchuck River	Winchuck River
	Rogue River	Illinois River	Illinois River
		Applegate River	Applegate River
Smith River	Smith River	Lower Smith River	Smith River Plain
			Rowdy Creek
			Mill Creek
		South Fork Smith River	South Fork Smith River
		Middle Fork Smith River	Middle Fork Smith River
		North Fork Smith River	North Fork Smith River
		Wilson Creek	Wilson Creek
Lower Klamath River	Klamath River	Lower Klamath River	Klamath Glen
			Orleans
Salmon River		Salmon River	Lower Salmon
			Wooley Creek
			Sawyers Bar
			Cecilville
Middle Klamath River		Middle Klamath River	Ukonom
			Happy Camp
			Seiad Valley
			Beaver Creek
			Hornbrook
			Iron Gate
			Copco Lake
Scott River		Scott River	Scott Bar
			Scott Valley
Shasta Valley		Shasta Valley	Shasta Valley
Trinity River	Trinity River	Lower Trinity River	Hoopa
			Willow Creek
			Burnt Ranch
			New River
			Helena
		Middle Trinity River	Douglas City
			Weaver Creek
		Upper Trinity River	Upper Trinity River
South Fork Trinity River		South Fork Trinity River	Grouse Creek
			Hyampom
			Forest Glen
			Corral Creek
			Hayfork Valley

continued

TABLE 6-1: Recovery units and CALWATER watersheds in the SONCC Coho ESU (continued)

RECOVERY UNIT	HYDROLOGIC UNIT (HU)	HYDROLOGIC AREA (HA)	HYDROLOGIC SUBAREA (HSA)
Redwood Creek	Redwood Creek	Orick	Orick
		Beaver	Beaver
		Lake Prairie	Lake Prairie
Trinidad	Trinidad	Big Lagoon	Big Lagoon
		Little River	Little River
Mad River	Mad River	Blue Lake	Blue Lake
		North Fork Mad River	North Fork Mad River
		Butler Valley	Butler Valley
		Ruth	Ruth
Eureka Plain	Eureka Plain	Eureka Plain	Eureka Plain
Lower Eel and Van Duzen rivers	Eel River	Lower Eel River	Ferndale
			Scotia
			Larabee Creek
		Van Duzen River	Hydesville
			Bridgeville
			Yager Creek
South Fork Eel River		South Fork Eel River	Weott
			Benbow
			Laytonville
Middle-Upper Eel River		Middle Main Eel River	Sequoia
			Spy Rock
		Upper Main Eel River	Outlet Creek
			Tomki Creek
			Lake Pillsbury
		Middle Fork Eel River	Eden Valley
			Round Valley
			Black Butte River
			Wilderness
Cape Mendocino	Cape Mendocino	Oil Creek	Oil Creek
		Capetown	Capetown
		Mattole River	Mattole River

Potential problems for coho salmon recovery in this river include inadequate pool structure due to insufficient existing and recruitable conifer LWD and excessive fine sediment.

6.1.2 SMITH RIVER HYDROLOGIC UNIT

The Smith River (Figure 6-4) is California's fourth largest coastal river, with a watershed of approximately 610 square miles in California and 115 square miles in Oregon. At its terminus, the Smith River flows through an agriculturally developed coastal plain and enters the Pacific Ocean four miles south of the Oregon border. The mainstem Smith River is fed by three forks, the North, South, and Middle.

The Smith River estuary is an important rearing habitat for juvenile salmonids. The precipitous upper canyon areas are forested in fir, spruce, cedar, and pine with groves of tall redwoods in Redwood National and State parks. Second and third growth trees inhabit the majority of merchantable timberlands in the basin. A large portion of the Smith River watershed supports a unique flora, which exists on unusual soils derived from ultramafic parent materials.

Historically, salmon were very abundant in the rivers and streams of the Pacific Northwest and the Smith River was no exception. In the late 19th and early years of the 20th century, runs of salmon in the Smith River sustained the operation of a cannery near its mouth. Some cannery records dating from the 1890s documented the processing of 50 tons of salmon per year (Bartson 1997). Coho salmon are currently found throughout the HU, although their numbers are typically small.

Problems facing anadromous salmonids in the Smith River include amount of available habitat, degraded condition of riparian vegetation, poor LWD recruitment, altered estuarine environment, excess sediment, compacted stream gravels, and fish passage.

6.1.2.1 Mill Creek HSA

Mill Creek, which enters the Smith River approximately 15 river miles from the mouth, encompasses 36.9 square miles. The main tributaries to Mill Creek include West Branch Mill, East Fork Mill, and Bummer Lake Creek. Numerous first and second order tributaries feed these streams. Much of the basin was historically managed for timber production, but it is now entirely under public ownership and managed by Redwood National Park and DPR.

Mill Creek is one of the most productive tributaries for salmon and steelhead in the entire Smith River watershed. All species of salmonids present in the Smith River basin can be found in the Mill Creek watershed.

Problems facing anadromous salmonids in the Mill Creek HSA include poor LWD recruitment, barriers to fish passage, degraded riparian vegetation, and sediment input from the existing road network.

6.1.2.2 Wilson Creek HSA

Wilson Creek is a tributary to the Pacific Ocean located approximately four miles north of the Klamath River mouth. The lower section of this coastal watershed lacks an estuary. The creek runs directly into a semi-protected section of coastline where wave action at the creek's entrance is cushioned by exposed rocks. The lower channel is intermittent during the summer, thus emigrating smolts have a discrete window in which to leave the watershed.

Coho salmon juveniles and smolts have been found in appreciable numbers during Wilson Creek dive counts and electrofishing from 1995 to 2000. Their numbers have been highly variable with strong years from 1995 to 1998 and weak years from 1999 to 2000, which may have been related to low observed adult escapement numbers (SRCO 2002).

Problems facing anadromous salmonids include inadequate in-stream habitat complexity, degraded riparian vegetation, and excess sediment input.

FIGURE 6-1: Recovery units in the California portion of the SONCC Coho ESU

FIGURE 6-2: Hydrologic Subareas in the California portion of the SONCC Coho ESU

FIGURE 6-3: Rogue River and Klamath River Hydrologic Units

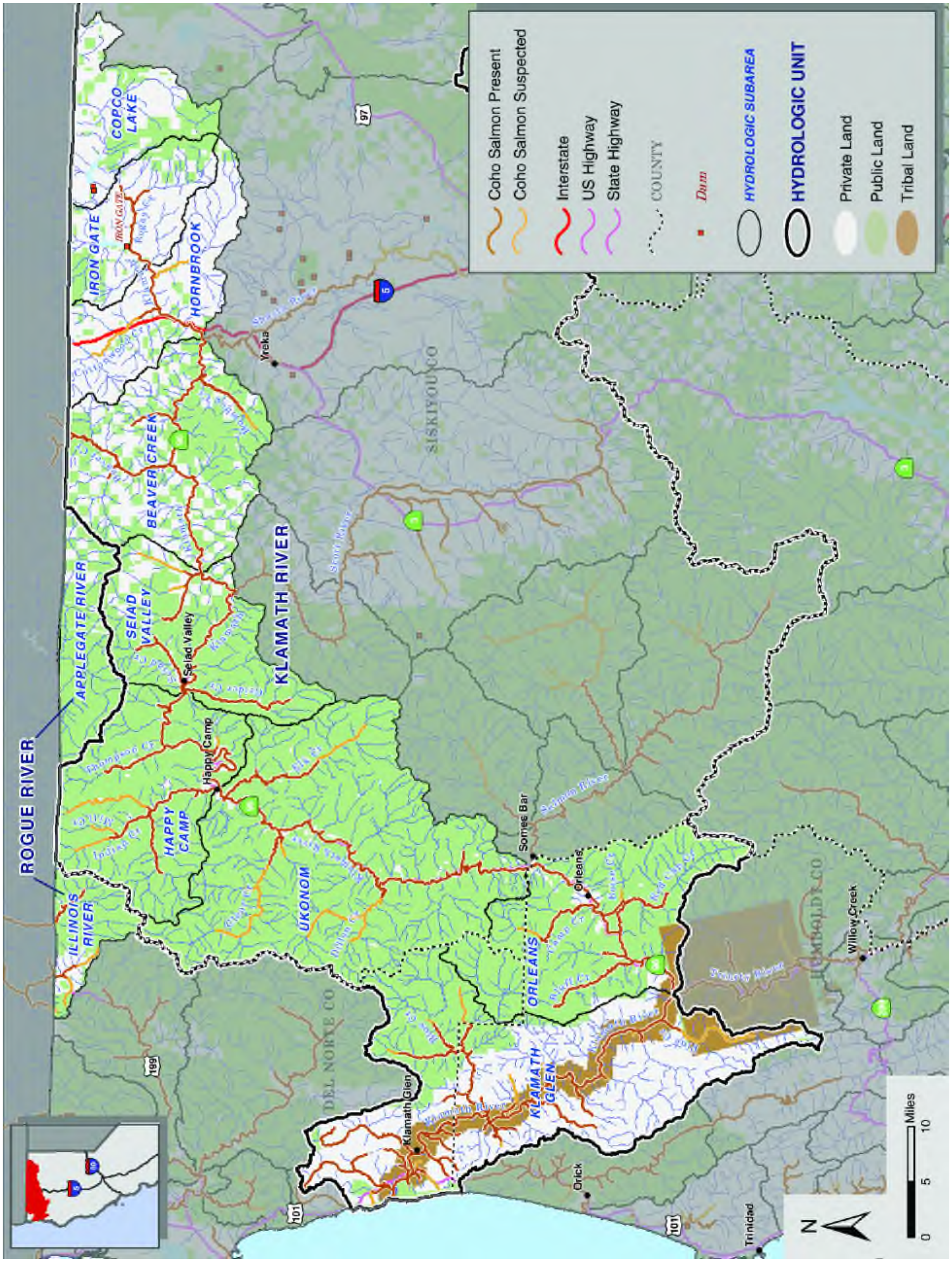
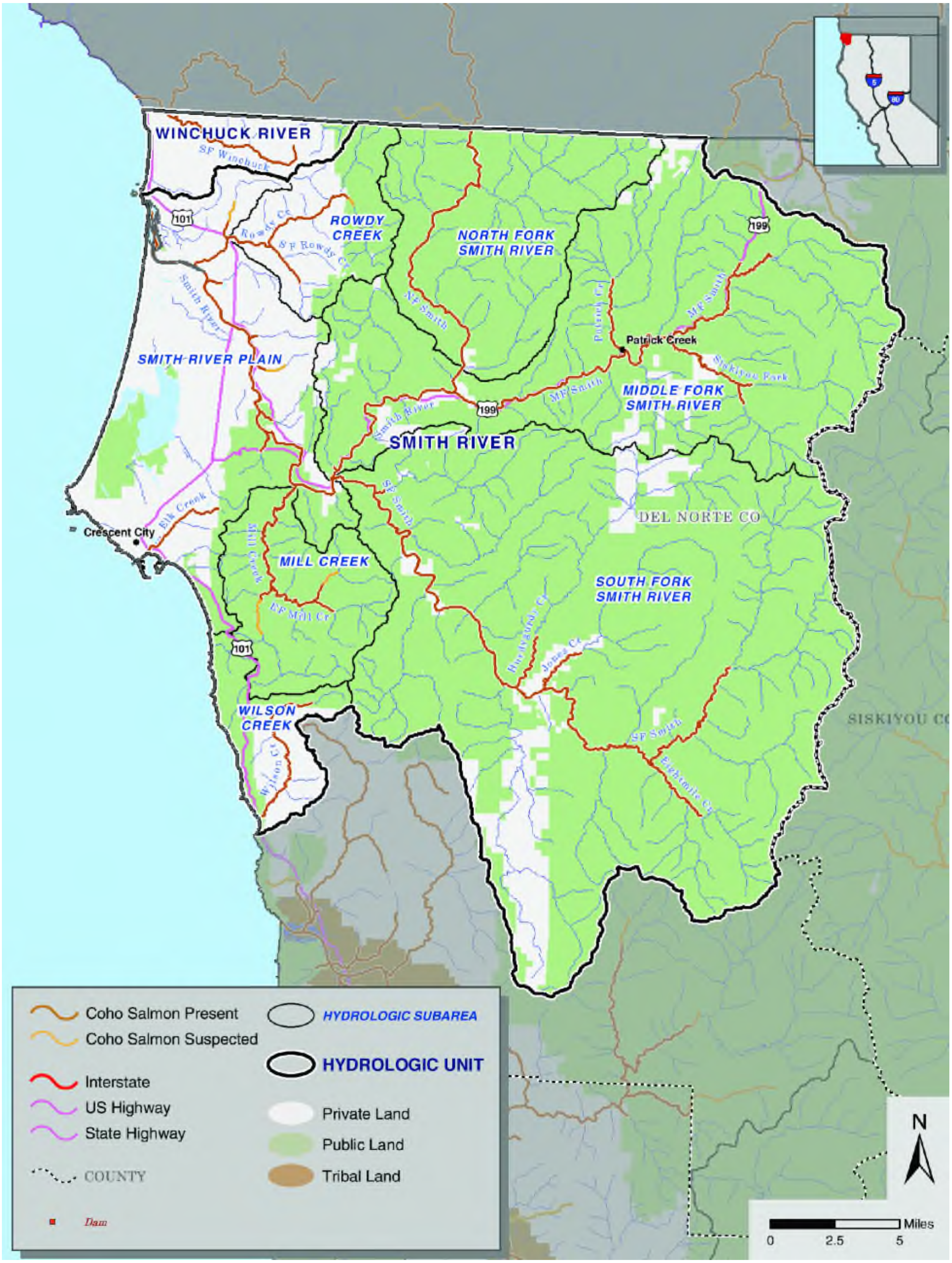


FIGURE 6-4: Winchuck River and Smith River Hydrologic Units



6.1.3 KLAMATH RIVER HYDROLOGIC UNIT

The origin of the Klamath River is at the outflow of Upper Klamath Lake, north of Klamath Falls, Oregon (Figure 6-3). The Upper Klamath River Basin has been highly modified over the past 90 years, with 80-90% of historic wetlands reclaimed for agricultural, urban, and other development. On average, approximately 289,000 acre-feet of water are diverted near the outlet of Upper Klamath Lake and the Klamath River to provide irrigation deliveries to 275 square miles of farmland within the Klamath Project. An additional 44,000 acre-feet of water are diverted to serve 44 square miles of land in the lower Klamath Lake Wildlife Refuge. Approximately 16% of the diverted water is returned to the Klamath River in a slightly more nitrified State during some months of the year. The return water represents approximately 9% of the water passing through the Keno Dam, Oregon.

The Middle Klamath River extends from Iron Gate Dam downstream to the mouth of the Salmon River; the Lower Klamath River is from the mouth of the Salmon River to the mouth of the Klamath River at the Pacific Ocean. It is California's second largest river, draining a watershed of approximately 1,531 square miles. The Klamath River HU has 1,832 miles of waterways. Major tributaries include the Trinity, Salmon, Scott, and Shasta rivers. Numerous other tributaries enter the Klamath River along its length.

Upper Klamath Lake is shallow and hypereutrophic, causing the water of the Klamath River at this point to be poor in quality for much of the year and to be listed by the EPA as impaired for temperature, dissolved oxygen, and nutrients. Anadromous fish have been blocked from the upper basin since 1910 when Copco #1 Dam construction was started. Habitat alteration and water diversions have degraded Klamath River water quality, reduced total annual discharge, and altered the magnitude, timing and duration of flow so that more water runs downstream during winter months and less during the spring and summer than occurred historically.

Information on adult coho salmon returns to the Klamath basin is spotty prior to the construction of Iron Gate and Trinity River hatcheries. Coho salmon were thought to spawn in most tributaries to the Klamath from the mouth to at least Bogus Creek (CDFG 1979). During the 1960s, coho salmon escapement for the mainstem and its minor tributaries (excluding the Shasta, Scott, Salmon and Trinity rivers) was estimated at 8,000.

Problems facing anadromous salmonids in the Klamath River include an altered hydrograph, high summer water temperatures, lack of access to available habitat, erosion and sedimentation, degraded condition of riparian vegetation, depleted LWD, unscreened water diversions, legacy impacts from historical timber operations and mining, and agricultural conversion.

6.1.3.1 Klamath Glen HSA

The Klamath Glen HSA is located between the mouth at the Pacific Ocean and the confluence of the Trinity River. Recent presence/absences survey in this HSA, have indicated that coho salmon are present in much of their historic habitat.

Problems facing coho salmon in the Klamath Glen HSA include feral cattle in lower Blue and Bear creeks impacting riparian vegetation and increasing streamside erosion, excessive sedimentation and erosion due to removal of up to 90% of cover from some tributaries, low habitat diversity, loss of confluence connectivity, and reduced habitat quantity and complexity. Many deep areas of the estuary have been filled by excessive sedimentation, which may affect the mixing zone and impact food availability for juvenile salmonids. Rearing duration may be shorter due to loss of estuary habitat.

6.1.3.2 Orleans HSA

The Orleans HSA is located between the confluence of the Trinity River and the confluence of the Salmon River. Recent present/absence surveys have found coho salmon in many of the main tributaries that enter the Klamath River in this HSA.

The main problems facing coho salmon in the Orleans HSA include potential impacts from timber harvest, water diversions, gravel extraction, stream channelization and excessive sediment input, elevated summer water temperatures, and impaired connectivity to tributaries.

6.1.3.3 Ukonom HSA

The Ukonom HSA is located between the confluence of the Salmon River and the confluence of Indian Creek. Recent presence/absence surveys indicate that coho salmon are no longer found in a number of tributaries that they historically inhabited.

Problems facing anadromous salmonids in this HSA include barriers to migration, elevated water temperatures, undersized culverts in the Elk Creek watershed, unstable spawning gravels, depleted LWD, unscreened water diversions, increased erosion, and discharge of acid, heavy metals, and cyanide from the Siskon Mine in the Dillon Creek watershed.

6.1.3.4 Happy Camp HSA

The Happy Camp HSA is located between the confluence of Indian Creek and the confluence of Grider Creek.

Problems facing anadromous salmonids include increased turbidity, acid and heavy metal contamination from Grey Eagle Mine, elevated water temperatures in some tributaries, degraded quantity and quality of riparian vegetation, depleted LWD, unscreened water diversions, and disrupted natural movement of watershed products (water, LWD, sediment) and fish due to culverts and road crossings in the Thompson Creek Watershed.

6.1.3.5 Seiad Valley HSA

The Seiad Valley HSA is located between the confluence of Grider Creek and the confluence of Horse Creek.

Problems facing anadromous salmonids include increased turbidity in Walker Creek, elevated water temperatures in some tributaries, degraded riparian vegetation in Seiad Creek, depleted LWD, unscreened water diversions, disrupted natural movement of watershed products (water, LWD, sediment) and fish due to road culverts and crossings in Seiad Creek and Grider Creek.

6.1.3.6 Beaver Creek HSA

The Beaver Creek HSA is located between the confluence of Horse Creek and the Shasta River. Problems facing anadromous salmonids in this HSA include high sediment levels in Beaver Creek as a result of the extensive road systems in the watershed, lack of LWD needed for habitat complexity in Beaver Creek, and degraded riparian vegetation.

6.1.3.7 Hornbrook HSA

The Hornbrook HSA is located between the confluence of the Shasta River and the Confluence of Little Bogus Creek. Problems facing coho salmon include a major impoundment on Cottonwood Creek and summer diversions that dry some reaches. In addition, spawning gravels in Cottonwood Creek were depleted during the construction of Interstate 5.

6.1.3.8 Iron Gate HSA

The anadromous portion of the Iron Gate HSA is located between the confluence of Little Bogus Creek and the Iron Gate Dam. Problems facing coho salmon include water diversions, barriers to fish passage, and sedimentation on Bogus Creek.

6.1.3.9 Copco Lake HSA

The Copco Lake HSA is located upstream of Copco Lake and beyond anadromous waters. Therefore the problems facing coho salmon are the inability of migrating salmon to pass Iron Gate Dam.

6.1.4 SALMON RIVER HYDROLOGIC AREA

The Salmon River is located in remote northwestern California in the Klamath Mountains (Figure 6-5). It is a major tributary to the Klamath River and drains an area of 751 square miles. Elevations in the watershed range from about 500 to 9,000 feet above sea level. The area contains steep slopes along much of the river, and tributary streams flow through isolated remote canyons with moderate to high gradients. The riverbed is formed by bedrock and boulder controls, but some alluvial reaches contain gravel and cobble substrates. The headwaters originate in the pristine Marble Mountain, Russian, and Trinity Alps wilderness areas, administered by the Shasta-Trinity and Klamath National Forests. There are approximately 1,414 miles of streams within the watershed, of which 740 miles are perennial in nature. The Salmon River watershed contains one of the most species-diverse temperate forests in the world. There are fourteen different recognized wildlife habitat community types present in the watershed.

Nearly the entire Salmon River watershed is under Federal ownership and administered by the USFS. Management activities are strongly influenced by the Northwest Forest Plan with over 25% of the watershed identified as Late Successional Reserve. The Salmon River has been identified as a Key Watershed under the Klamath River Watershed Assessment.

Historically, coho salmon habitat was estimated to include 105 miles along the Salmon River and its tributaries (CDWR 1965). More recent estimates suggest that coho salmon have access to about 85 miles (CH2M HILL 1985) in this HA. DWR estimated historical coho salmon runs in the Salmon River at 2,000 fish (CDWR 1965). The Department's annual coho salmon spawning escapement estimate for the early 1960s was 800 fish (CDFG 1965). Between 1985 and 1991, the Department operated a weir in the Salmon River near its mouth and recorded a low of two coho salmon in 1985 and a high of 75 coho salmon in 1987.

Problems facing coho salmon in the Salmon River watershed include invasive exotic species, barriers to fish passage, depleted LWD, high sediment loads from the extensive road system, large wildfires, limited riparian function due to mine tailings, unscreened water diversions, and unstable spawning gravels.

6.1.4.1 Lower Salmon HSA

Problems facing coho salmon include excessive sediment from roads and landslides, streambed instability in Nordheimer Creek from aggradation during the flood of 1964, and habitat degradation in Crapo Creek and an upper reach of Nordheimer Creek caused by sediment input following forest fires.

6.1.4.2 Wooly Creek HSA

Wooly Creek is a designated wilderness and provides habitat conditions largely unaffected by human influence.

6.1.4.3 Sawyers Bar HSA

Problems facing coho salmon in the Sawyers Bar HSA include sediment input from roads, marginal summer water temperature resulting from the broad unvegetated flood plain and riparian areas, and waste discharge from mine tailings.

6.1.4.4 Cecilville HSA

Problems facing coho salmon in the Cecilville HSA include lack of deep pools for adult holding and juvenile rearing, marginal summer water temperature resulting from broad, unvegetated flood plain, impacts from past hydraulic mining, and lack of potential winter rearing habitat, particularly cover in slow velocity areas.

6.1.5 SHASTA VALLEY HYDROLOGIC AREA

The Shasta Valley HA is part of the Klamath River HU and consists of one HSA, the Shasta Valley HSA (Figure 6-6), which covers approximately 794.8 square miles.

The Shasta River originates in the higher elevations of the Eddy Mountains, southwest of the town of Weed in Siskiyou County, California. It flows approximately 50 miles in a northerly direction, passing through the Shasta Valley. After leaving the valley, it enters a steep-sided canyon where it flows for seven river miles before emptying into the Klamath River, 176.6 river miles upstream from the Pacific Ocean.

The river drains a portion of the Cascade Province to the east and a portion of the Klamath Province to the west. Numerous springs and a number of small tributaries enter the Shasta River as it passes through the Shasta Valley. Glacial melting from Mt. Shasta and precipitation provide the principle source of recharge for the river. Major tributaries include Parks Creek, Big Springs Creek, Little Shasta River, and Yreka Creek. The highest point in the watershed is Mt. Shasta at an elevation of over 14,000 feet. Where the Shasta River enters the Klamath River, the elevation is just over 2,500 feet.

Seventy-two percent of the watershed is in private ownership. Access to the river and its tributaries is limited to a few miles of the lower Shasta River still in public ownership, at public road crossings, and at locations where few landowners provide access. The portion (approximately three river miles) of the Shasta River that passes through Shasta Canyon is in BLM ownership. It is afforded protected status as an Area of Critical Environmental Concern.

One instream mining permit is located on the Shasta River. Agriculture, silviculture, and timber management are the most prominent land uses. Coho salmon runs in the Shasta Valley HA averaged little more than 1,000 fish annually in the late 1950s (CDFG 1959). In the early 1960s, the runs were estimated to average 600 fish (CDFG 1979). Current counts are lower than these earlier estimates.

Problems facing coho salmon in the Shasta River HSA include reduced summer flows, loss of channel maintenance flows, fish access limitations, high water temperatures, low levels of DO, elevated nutrient levels, turbidity, limitation on spawning gravel quantity, loss of spawning gravel quality, loss of riparian habitat, barriers to fish passage, unscreened water diversions, legal and illegal harvest, lack of funding for planning and studies necessary to precede restoration or fill data gaps, lack of on-the-ground access for studies, and dangerously low population numbers of coho salmon.

6.1.6 SCOTT RIVER HYDROLOGIC AREA

The Scott River is one of four major tributaries of the Klamath River, entering the Klamath at river mile (RM) 143 at an elevation of 1,580 feet (Figure 6-7). The Scott River HA includes two HSAs, the Scott Valley HSA and the Scott Bar HSA. The Scott River watershed is a large area

FIGURE 6-5: Salmon River Hydrologic Area

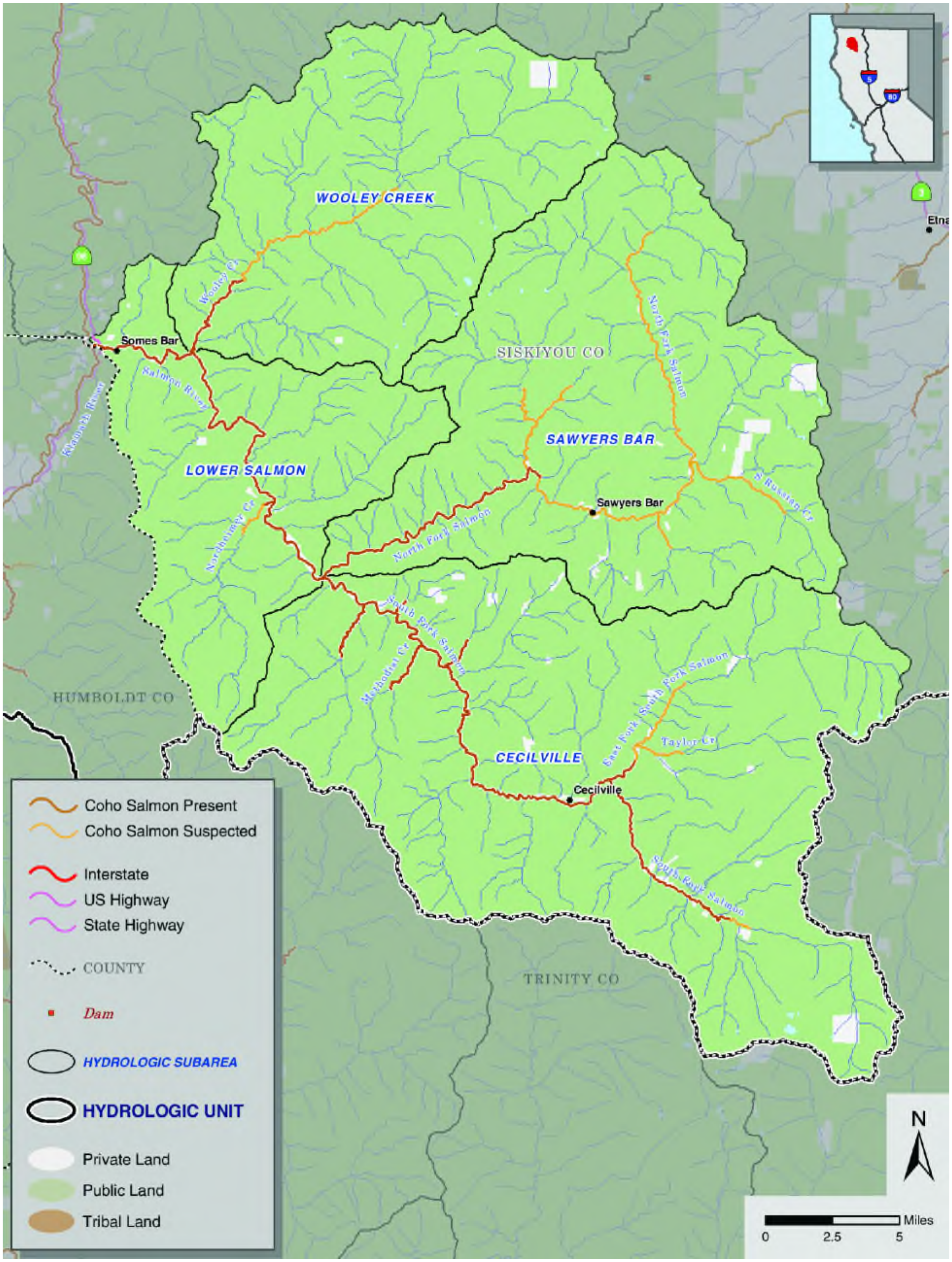
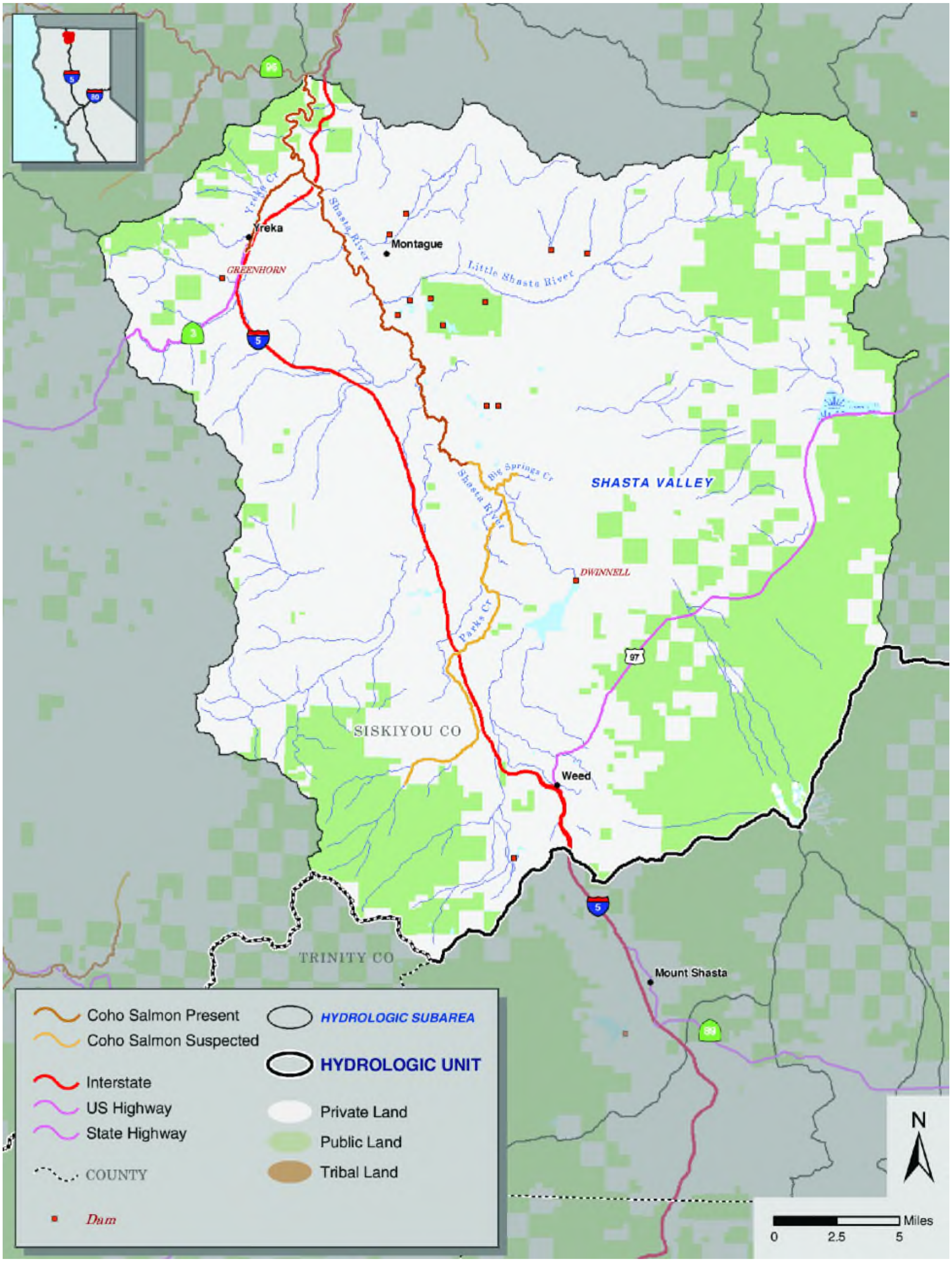


FIGURE 6-6: Shasta Valley Hydrologic Area



with substantial variation in geology, geomorphology, and climate. The watershed drains approximately 813.5 square miles. Major tributaries to the 58-mile-long Scott River are Shackleford/Mill, Kidder, Etna, French, and Moffett creeks and the South and East Forks Scott River. Native vegetation consists of mixed-conifer forest on the western mountain slopes, with scattered meadows and brush, while extensive areas of brush, oaks, western juniper, and annual grasses cover the eastern mountains. The Scott River is part of the Klamath Mountain Province, which encompasses land in both Oregon and California.

The Klamath National Forest manages approximately 35% of the total Scott River watershed area. The remaining 65% is under other public management or private ownership. The mainstem in Scott Valley is predominantly surrounded by irrigated farmland (50 square miles) and rangeland (80 square miles) comprising 16% of the watershed. Remaining areas are predominantly privately owned and Federally managed timberlands.

The Department estimated that during the early 1960s, the Scott River's population of coho salmon was about 800 fish (CDFG 1965).

Problems facing coho salmon in the Scott Valley HSA include reduced stream flows caused by drought and exacerbated by human activities; high water temperatures; limited rearing areas during spring, summer, and fall; restricted access to spawning habitat in extreme drought years; increased disconnect between tributaries and mainstem starting in early July; stranding of juveniles; lack of sufficient summering habitat in tributaries; sedimentation of rearing pools and spawning gravels as a result of the cumulative effects of upslope land management; lack of riparian cover in some tributary reaches; and lack of instream structure for coho salmon rearing.

6.1.7 TRINITY RIVER HYDROLOGIC UNIT

The Trinity River is the largest tributary to the Klamath River, draining approximately 2,037.8 square miles in Humboldt and Trinity counties (Figure 6-8). The headwater streams originate in the pristine wilderness of the Trinity Alps and Trinity Mountains located in eastern Trinity County. From its headwaters, the river flows 172 miles south and west through Trinity County, then north through Humboldt County and the Hoopa Valley and Yurok reservations until it joins the Klamath River at Weitchpec, about 40 river miles from the Pacific Ocean. Anadromous fish passage is blocked by Lewiston Dam approximately RM 112, upstream from the mouth of the Trinity River.

Most of the Trinity River watershed is in public ownership (69% of the land is managed for public multiple uses, 7% as protected lands). Only 24% of the watershed is in private ownership. Two tribes, the Hoopa Valley and Yurok, have reservations located all, or in part, within the Trinity River basin. Both of theses tribes have, and continue to, subsist on anadromous fish runs. Much of their culture is derived from resources found within the basin.

Historically, gold mining was an important economic activity, and today the watershed supports limited suction dredging. A few in-stream mining permits are located on the Trinity River. Commercial timber harvest supports the largest industry within the watershed. The Trinity River supports many recreational uses including fishing, white-water rafting, swimming, sightseeing, birding, and camping. The smaller communities located along the river cater to, and depend on, these activities. Approximately 70% of the Trinity's flow at Lewiston (RM 112) is diverted to the Central Valley Project. This diversion is also used to generate electrical power at several dams, including Lewiston, along its course.

Estimates of coho salmon run-size, spawner escapement and angler harvest have been conducted in the Trinity River since 1977. Estimates are generated using mark-recapture methods. Fish are trapped and tagged at a mainstem trapping weir near the town of Willow Creek

(RM 30). Recoveries occur at Trinity River Hatchery (TRH), the upper-most point of migration. Mean run-size (grilse and adults combined) between 1977 and 1999 was 15,959 coho salmon.

Problems facing coho salmon in the Trinity River HU include degradation of spawning and winter rearing habitat due to sedimentation and past land-use practices, sparse spawning gravel recruitment, high summer water temperatures due to diversion of natural flow of Lewiston Dam, lack of deep pools, water diversions, irregular timing of flows, fragmentation of populations, possible genetic swamping from presumably inferior hatchery strains, migration barriers, water quality problems and unscreened diversions.

6.1.7.1 Douglas City HSA

The Douglas City HSA includes the mainstem of the Trinity River and its tributaries from Browns Creek upstream to Lewiston Dam. Problems facing coho salmon in the Douglas City HSA include unscreened water diversions, barriers to fish passage, reduced riparian function due to agricultural and grazing impacts, and sedimentation from near-stream roads.

6.1.7.2 Grouse Creek HSA

The Grouse Creek HSA includes the South Fork of the Trinity River and its tributaries from the confluence with the Trinity River mainstem up stream to Eltapom Creek. Problems facing coho salmon in the Grouse Creek HSA include impacts from past mining and impacts associated with a large network of forest roads.

6.1.7.3 Hyampom HSA

The Hyampom HSA includes the South Fork of the Trinity River and its tributaries from Eltapom Creek up stream to Hayfork Creek. Historical data show that the South Fork Trinity River and its larger tributaries were once important spawning grounds for coho salmon. The frequency and size of coho salmon runs in the South Fork are not well documented, though they have been reported to migrate as far upstream as Hyampom.

Problems facing coho salmon in the Hyampom HSA include sediment load, unstable stream banks, migration barriers, low flows, lack of pools and cover resulting from large-scale water diversions and other land-use practices, lack of high quality rearing habitat, and a substantial change in channel morphology.

6.1.7.4 Hayfork HSA

The Hayfork Valley HSA includes Hayfork Creek upstream of Little Creek. Coho salmon are thought to have been extirpated in this HSA.

Problems in the Hayfork Valley HSA include mass wasting, erosion caused by fire, excessive stored sediment, migration barriers, low flows, lack of pools and cover due to large-scale water diversions, water pollution, and lack of high quality rearing habitat.

6.1.8 MAD RIVER HYDROLOGIC UNIT

The Mad River HU drains an area of approximately 496.9 square miles (Figure 6-9). The Mad River basin is divided into four hydrologic subareas: Blue Lake HSA, including the estuary; North Fork HSA covering the North Fork Mad River; Butler Valley HSA for the midsection of the mainstem Mad River; and Ruth HSA, for the upper Mad River.

BLM and the USFS manage 39% of the watershed. The remaining 61% is in private ownership with two timber companies owning about half of the privately owned land. Gravel mining operations are located on the lower Mad River near the coastal plain.

There has been an estimated decline in Mad River coho salmon populations of at least 70% over the last 40 years. Returns of adult coho salmon at the Mad River Hatchery indicate a

FIGURE 6-7: Scott River Hydrologic Area

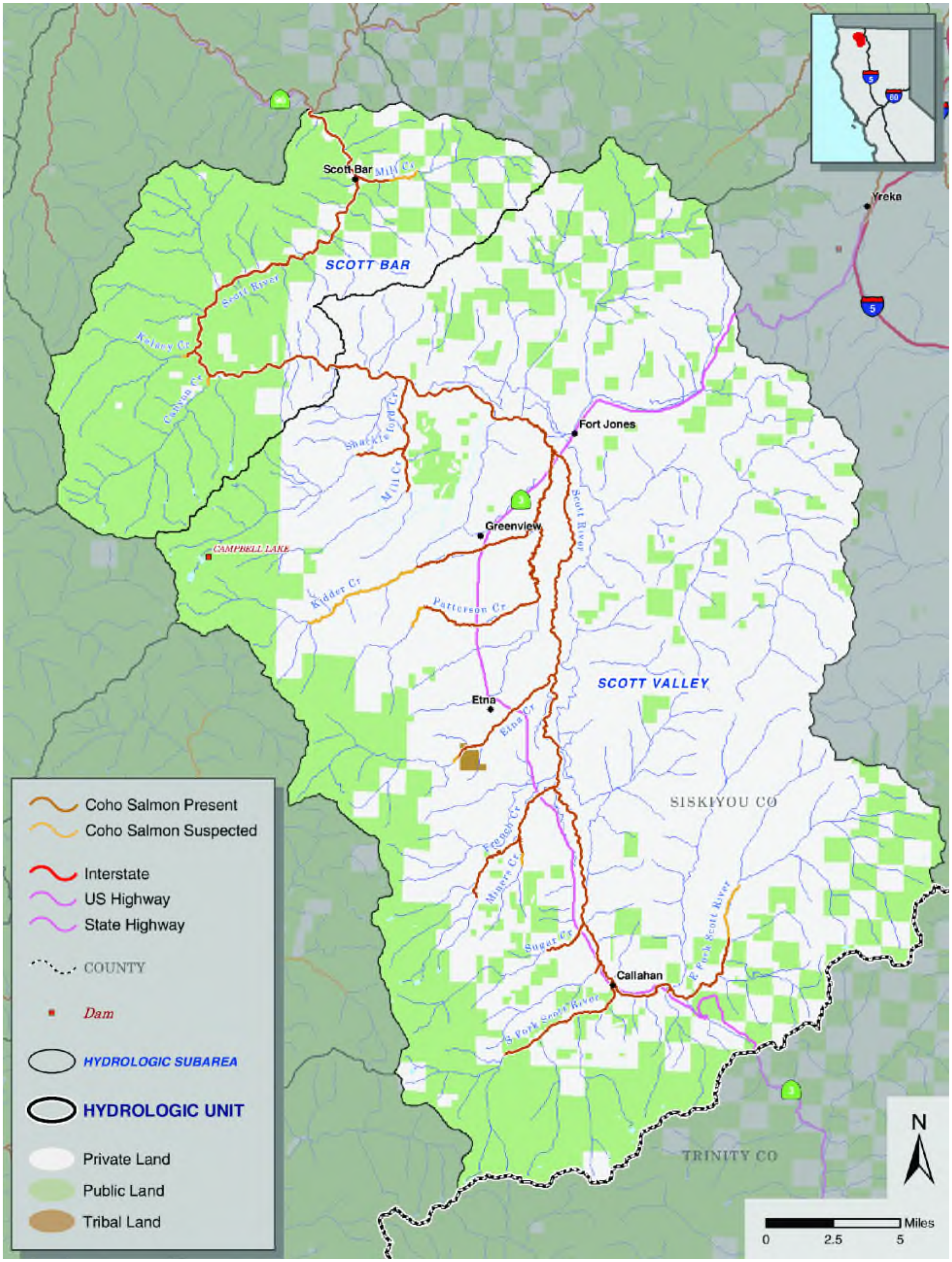
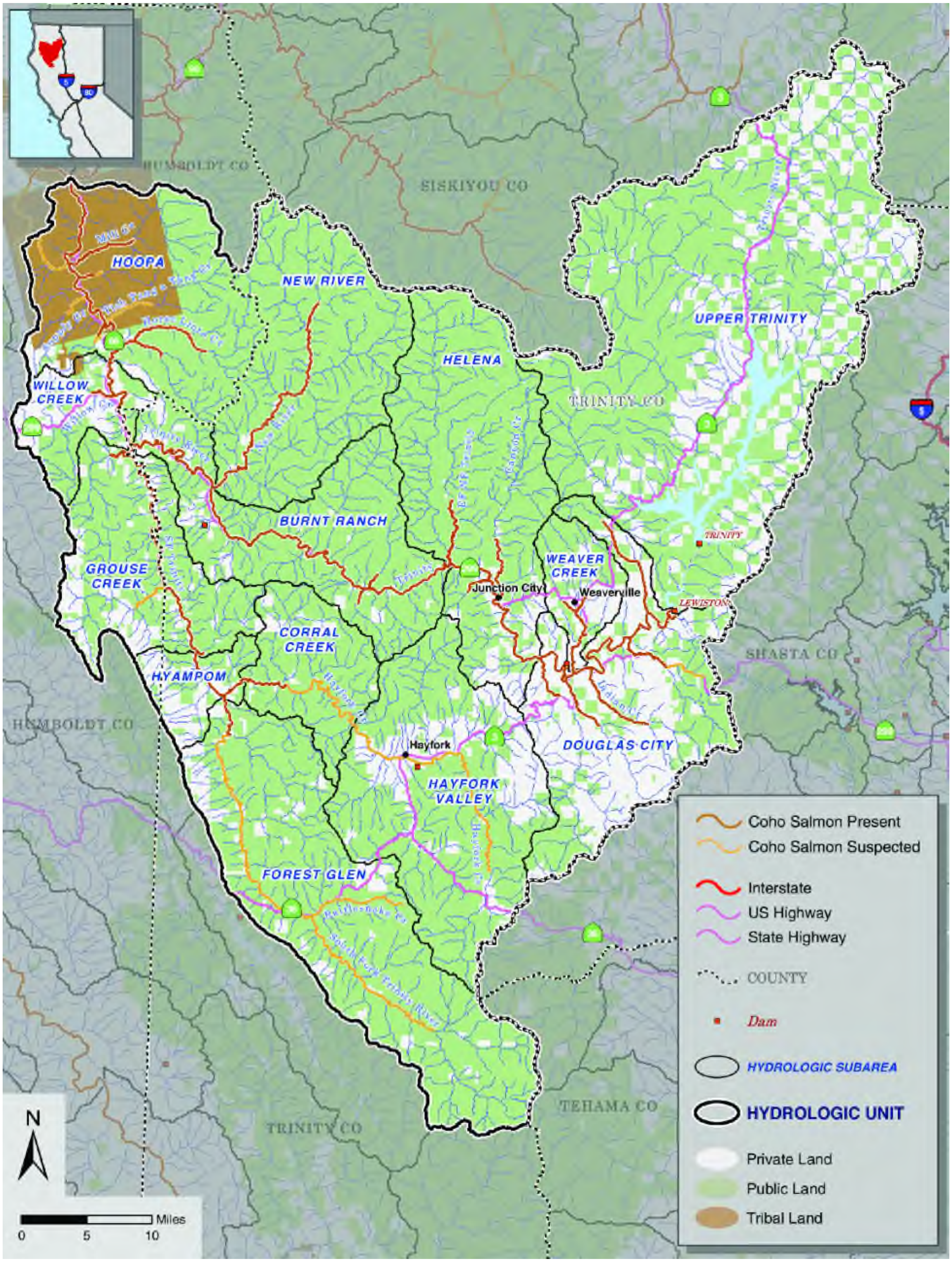


FIGURE 6-8: Trinity River Hydrologic Unit



decline in recent years. Important tributaries to the Mad River that support annual runs of coho salmon include Lindsay Creek in the Blue Lake HSA and Cañon Creek in the Butler Valley HSA. Juvenile coho salmon numbers in Cañon Creek have been highly variable in the recent years. Coho salmon do not appear to have been historically present in the Ruth HSA.

The Mad River is listed under the CWA §303(d) as impaired for sediment, turbidity, and temperature. Problems for coho salmon recovery in the Mad River basin include reduction in habitat diversity by aggradation and lack of conifer LWD, high fine sediment loading (in part from high road concentration in watershed), and high water temperatures throughout the basin.

6.1.9 REDWOOD CREEK HYDROLOGIC UNIT

The Redwood Creek HU (Figure 6-10) covers an area of approximately 282 square miles. The HU is divided into three HSAs: Orick, encompassing the estuary and lower Redwood Creek; Beaver, encompassing middle Redwood Creek from above Devil's Creek to Lupton Creek; and Lake Prairie, encompassing upper Redwood Creek.

The North Coast Watershed Assessment Program completed a basin-wide assessment for Redwood Creek (NCWAP; Henly et al. 2002). The primary private land use in the Redwood Creek HU is timber production, especially in the middle and upper subbasins. In addition, livestock grazing occurs on some private lands. Much of the lower basin is public parkland, managed for protection and restoration of the old-growth redwood forest ecosystem.

Coho salmon principally inhabit the Prairie Creek watershed and tributaries of Redwood Creek located in the Orick HSA. The numbers of coho salmon in the Prairie Creek watershed had been supplemented with hatchery fish until 1992. Five other tributaries with coho salmon present include Elam, Tom McDonald, Bridge, Emerald (a.k.a. Harry Weir) and MacArthur creeks, all within the boundaries of Redwood National Park and Redwood State Park. The historic coho salmon range includes Coyote, Panther, Lacks, Minor, Karen, Strawberry, and Pilchuck creeks in the Beaver Creek HSA, and possibly some of the tributaries in the Lake Prairie HSA (Anderson 1988; Brown 1988; Neillands 1990; PCFWWRA 1995; Department 2001 surveys; and RNSP unpublished data). Historic presence of coho salmon juveniles has also been noted in the mainstem of Redwood Creek.

Electro-fishing conducted in the summer of 2001 did not produce any coho salmon in Bridge, Coyote, Karen, and Pilchuck creeks, nor in any other tributaries in the middle or upper portions of the basin that were sampled. In addition, no coho salmon were captured from the upper one third of the Redwood Creek watershed during a downstream migrant study conducted for the years 2000, 2001, or 2002 (Sparkman 2001 and pers. comm. 2002).

Redwood Creek is listed under CWA §303(d) as impaired for sediment and temperature. Potential problems for coho salmon recovery in the Redwood Creek basin include loss of critical habitat and periodic high temperatures in the estuary, elevated water temperatures in the mainstem and in tributaries due to lack of adequate canopy cover, reduction in habitat diversity by channel aggradation and lack of LWD, high fine sediment loading, and high turbidity levels (in part from high road concentration in watershed). The remaining structure of a small dam that was associated with the former Prairie Creek Hatchery acts as a partial fish barrier at certain flows on Lost Man Creek within the Orick HSA.

6.1.10 TRINIDAD HYDROLOGIC UNIT

The Trinidad HU (Figure 6-10) includes Freshwater, Big, Dry, and Stone coastal lagoons and their tributaries, the Little River drainage, and coastal streams from Strawberry Creek north to Freshwater Lagoon. These drainages extend ten miles inland and crest at an elevation of 2,800 feet at the divide with Redwood Creek. This HU is entirely within the zone of summer fog intrusion, and so, the vegetation reflects the strong coastal influence. Timber production is the main land use in the HU.

Coho salmon have historically occurred in Stone Lagoon, Big Lagoon and their major tributaries as well as Little River and its tributaries and Strawberry Creek. The presence of coho salmon and other anadromous salmonids in coastal lagoon streams depends on the winter timing of lagoon sand bar breaches. In some years flows are not sufficient to breach the sand bars and salmon are prevented from entering their natal streams.

Problems for coho salmon recovery in the Trinidad HU include high levels of instream fine sediment, stream channel aggradation, lack of instream LWD, insufficient levels of recruitable conifer LWD, poor estuary conditions (especially sedimentation), and existence of barriers to anadromy.

6.1.10.1 Big Lagoon HSA

The largest stream of the Big Lagoon HSA is Maple Creek. Coho salmon have been found in lower Maple Creek in years when the sand bar at Big Lagoon is open. Past impacts to the Maple Creek watershed include intensive logging from the 1940s through the 1960s and a large fire in 1945. The effects of historic removal of riparian overstory can still be observed in the dominance of alder canopy in several reaches.

6.1.10.2 Little River HSA

The drainage beyond the estuary is under the ownership of Simpson Resource Company and is undergoing second growth timber harvest through even-aged management practices. Although the current coho salmon population in the Little River drainage is depressed compared to historic estimates, numbers are believed to have been relatively stable over the last decade.

Sand bars rarely, if ever, close the mouth of Little River in the summer. While surveys indicate regular use of the Little River estuary by juvenile salmonids, habitat conditions are those of a heavily modified system. Most of the lower river channel in the estuary is confined between low levees and simplified to accommodate adjacent agricultural activities. The canopy, where present in this lower riparian zone, consists of a narrow strip of willows and some alders.

6.1.11 EUREKA PLAIN HYDROLOGIC UNIT

The Eureka Plain watershed (Figure 6-11), 275 miles north of San Francisco, contains a rare combination of natural and social attributes. Within the basin are the ancient redwoods of the Headwaters Forest, highly productive industrial timberlands, prime agricultural lands, functioning streams and wetlands, all of which are connected to the bay, its eel grass beds, and tidal marshlands. These natural features support some of the best remaining wild salmon runs in northern California, hundreds of aquatic organisms, shorebirds, and waterfowl species, in the midst of several urban and rural communities. At least two-thirds of the total watershed is steep and heavily forested, and is primarily owned by commercial timber companies.

Humboldt Bay is the largest estuary between San Francisco and Coos Bay, Oregon. The watershed is 223 square miles in size. Humboldt Bay, classified as a multi-watershed coastal lagoon, is separated from the ocean by long narrow sand spits and has a centrally channelized mouth to the Pacific Ocean. All of the main streams of the Eureka Plain watershed that flow into Humboldt Bay support wild populations of salmon, steelhead trout, and cutthroat trout.

A number of impairments to salmonid habitat exist in the Humboldt Bay watershed. Identified impairments include high instream sediment levels, stream channel aggradation and widening, lack of stream habitat structure (i.e., deep pools), high water temperatures, and loss of functioning estuary habitat. Observers have seen changes in the occurrence and magnitude of flooding and in the fish-community structure, such as avoidance of degraded tribu-

FIGURE 6-9: Mad River Hydrologic Unit

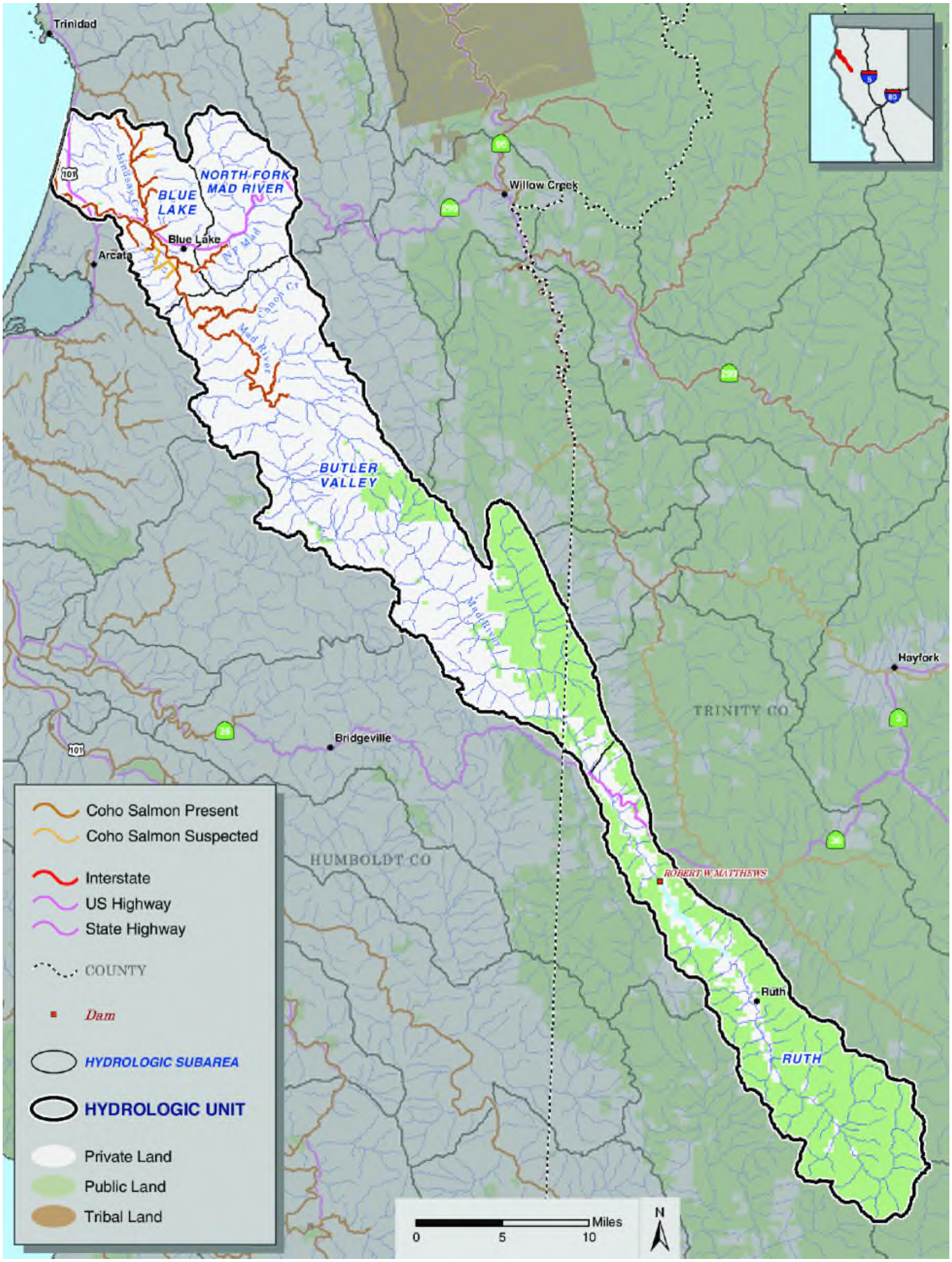
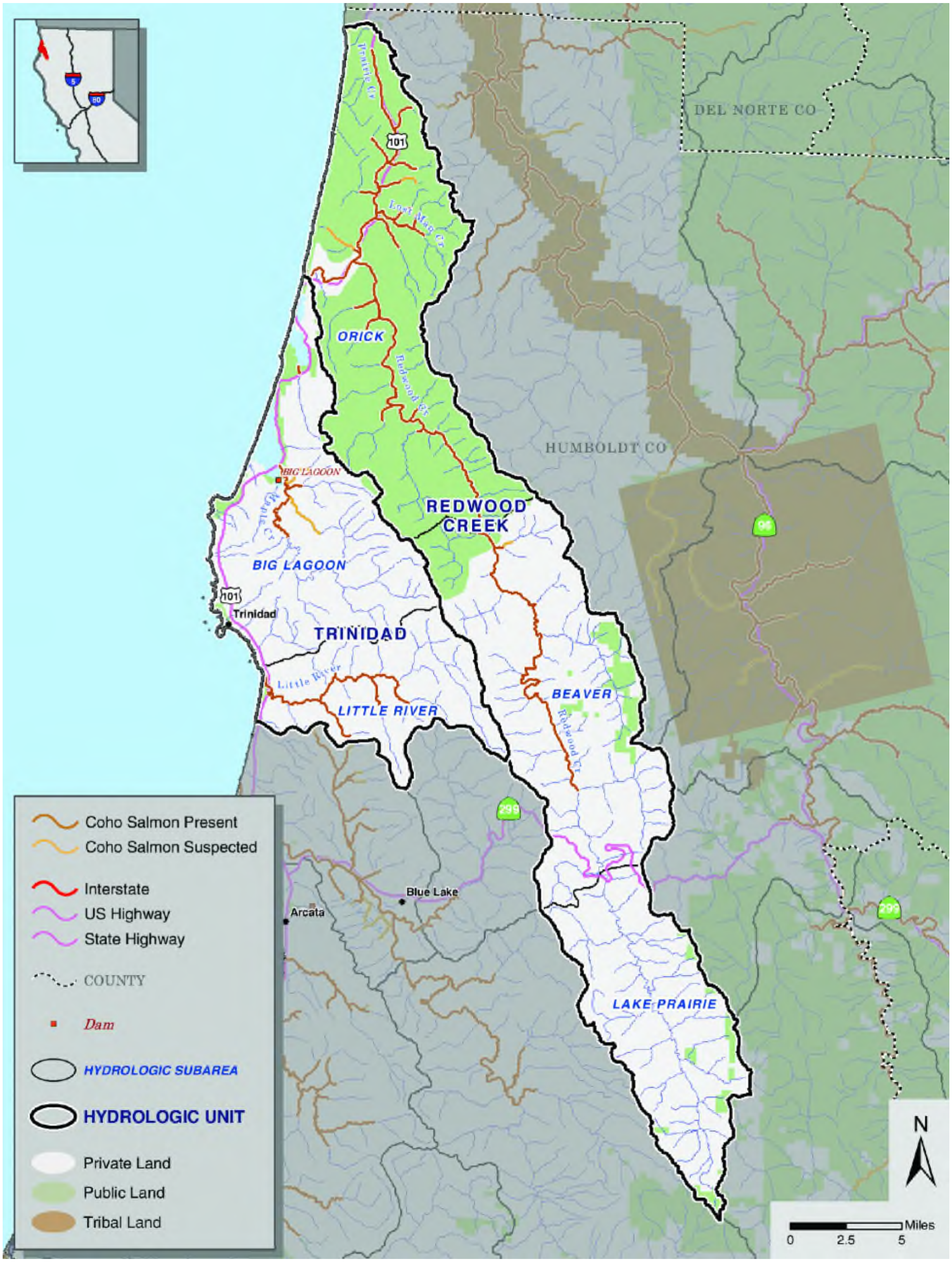


FIGURE 6-10: Redwood Creek and Trinidad Hydrologic Units



taries by spawning adults. Simplification of the stream channels has decreased the quantity and quality of aquatic habitat. Human made obstructions to upstream and downstream migration frequently restrict access of adult and juvenile salmonids to spawning and rearing habitat. Culverts and tide gates have been identified as fish passage barriers.

6.1.12 EEL RIVER HYDROLOGIC UNIT

The Eel River is the third largest river system in California, encompassing approximately 3,684 square miles within Humboldt, Mendocino, Trinity and Lake counties, and small portions of Colusa and Glenn counties (Figure 6-12). There are approximately 3,488 miles of streams within the Eel River watershed that contribute to a mean annual discharge of approximately six million acre-feet. Major subbasins of the Eel River system include the mainstem (1,477 square miles), North Fork (283 square miles), Middle Fork (753 square miles), South Fork (690 square miles), Van Duzen (428 square miles), and the estuary and delta (50 square miles). Other major tributaries include Kekawaka, Outlet, Tomki, Dobbyns, and Larabee creeks.

Principal features of the Eel River watershed are the rugged northwest-southeast trending ridges and canyons. The headwater peaks in the watershed are at elevations of 7,581 feet on Soloman Peak in Trinity County, 7,056 feet on Snow Mountain in Lake County, and 6,739 feet on Bald Mountain in Mendocino County. Three relatively flat valleys (Laytonville, Willits, and Round Valley) are located in the mountainous watershed. Lake Pillsbury is located on the mainstem, approximately 150 miles from the mouth and is 1,818 feet above sea level. Nearly flat alluvial valleys and tidal plains characterize the coastal area. Waters from the Eel River flow through its estuary to the Pacific Ocean approximately 14 miles south of the city of Eureka in Humboldt County.

The majority of the Eel River watershed is rural, with a number of small towns scattered throughout the watershed. Eighty-six percent of the Eel River watershed is held in private ownership. Significant land uses in the watershed are timber harvest, grazing, agriculture, in-channel gravel mining, recreation, and most recently, subdivision and residential development. There are 16 segments of the Eel River that are designated *wild*, *scenic*, or *recreational* in accordance with the Wild and Scenic Rivers Act.

Records indicate coho salmon were more widespread in the Eel River basin in the past. Coho salmon were once present in the North Fork Eel River and its tributary Bluff Creek. They were also present in the Middle Fork Eel River and its tributaries Rattlesnake, Mill, Grist, and Rock creeks (CDFG 1994). Coho salmon in the North Fork and Middle Fork Eel are believed to have been extirpated (Brown and Moyle 1991; CDFG 1994). Coho salmon were noticeably absent during recent surveys of many of the tributaries to the Van Duzen River, in contrast to past surveys conducted in those same streams. Similarly, recent surveys failed to find coho salmon in many of the smaller tributaries to the Eel River where coho salmon had been reported historically. Although coho salmon were recently confirmed in many of the South Fork Eel River tributaries, there were nearly as many streams in which coho salmon were not observed.

Problems facing coho salmon in the Eel River HU include potential impacts from approximately 10,000 miles of roads. Instream mining operations are located at number of sites in the watershed. Hydroelectric power production and water diversions also have a major impact. Scott Dam, built in 1921, is a barrier for all salmonids to the upper 29 miles of the mainstem Eel River and its tributaries. Cape Horn Dam, with a 9,258-foot-long upstream tunnel, is 12 miles below Scott Dam. It was built in 1908. An annual average of 160,000 acre-feet annually has been diverted to the Russian River drainage. Artificial fish passage barriers exist at some road crossings of streams. High summer water temperatures are common in the mainstem and many of the tributaries. The most recent stream habitat surveys conducted by the Department indicate that many of the tributary streams have low stream-habitat diversity and complexity, are lacking stream shade canopy cover, and are devoid of LWD recruitment. Predation by non-native fish such as the Sacramento pikeminnow may have a major impact on salmonids. The pikeminnow has displaced salmonids in summer rearing streams.

6.1.12.1 Ferndale HSA

The Ferndale HSA begins at the river mouth and extends upstream about 20 miles to the town of Rio Dell. This HSA includes the mainstem of the Eel River from the mouth up stream to Scotia. The area includes the communities of Ferndale, Fernbridge, Loleta, Fortuna, Alton, and Rio Dell. Major land uses include dairy ranches, timber, cattle ranches, gravel mining, and residential development. Much of the land is in private ownership with numerous family owned and operated ranches.

Problems facing coho salmon in the Ferndale HSA include sedimentation in the estuary, an increase in the average water temperature, decreased DO and fewer food organisms. In addition, runoff water carrying nutrients from animal waste to the estuary degrades water quality by encouraging the growth of algae, which further reduces the DO levels in the estuary.

6.1.12.2 Scotia HSA

The Scotia HSA includes tributaries to the Eel River from the town of Scotia to Dyerville where the South Fork Eel River enters the mainstem Eel River. This HSA is sparsely populated, although it contains several small towns including Pepperwood, Holmes, Shively and Redcrest. Small farming operations exist in the Eel River flood plain of these communities. Much of this HSA is owned by the Pacific Lumber Company and is managed for timber production under the conditions of their habitat conservation plan. The Scotia HSA also includes streams managed by Humboldt Redwoods State Park.

Problems facing coho salmon in the Scotia HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration.

6.1.12.3 South Fork Eel River HA

The South Fork Eel River HA includes the Weott, Benbow, and Laytonville HSAs.

6.1.12.4 Weott HSA

The Weott HSA includes the lower reaches of the South Fork Eel River and its tributaries. Problems facing coho salmon in the Weott HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration.

6.1.12.5 Benbow HSA

The Benbow HSA includes the middle reaches of the South Fork Eel River and its tributaries. Problems facing coho salmon in the Benbow HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration.

FIGURE 6-11: Eureka Plain Hydrologic Unit

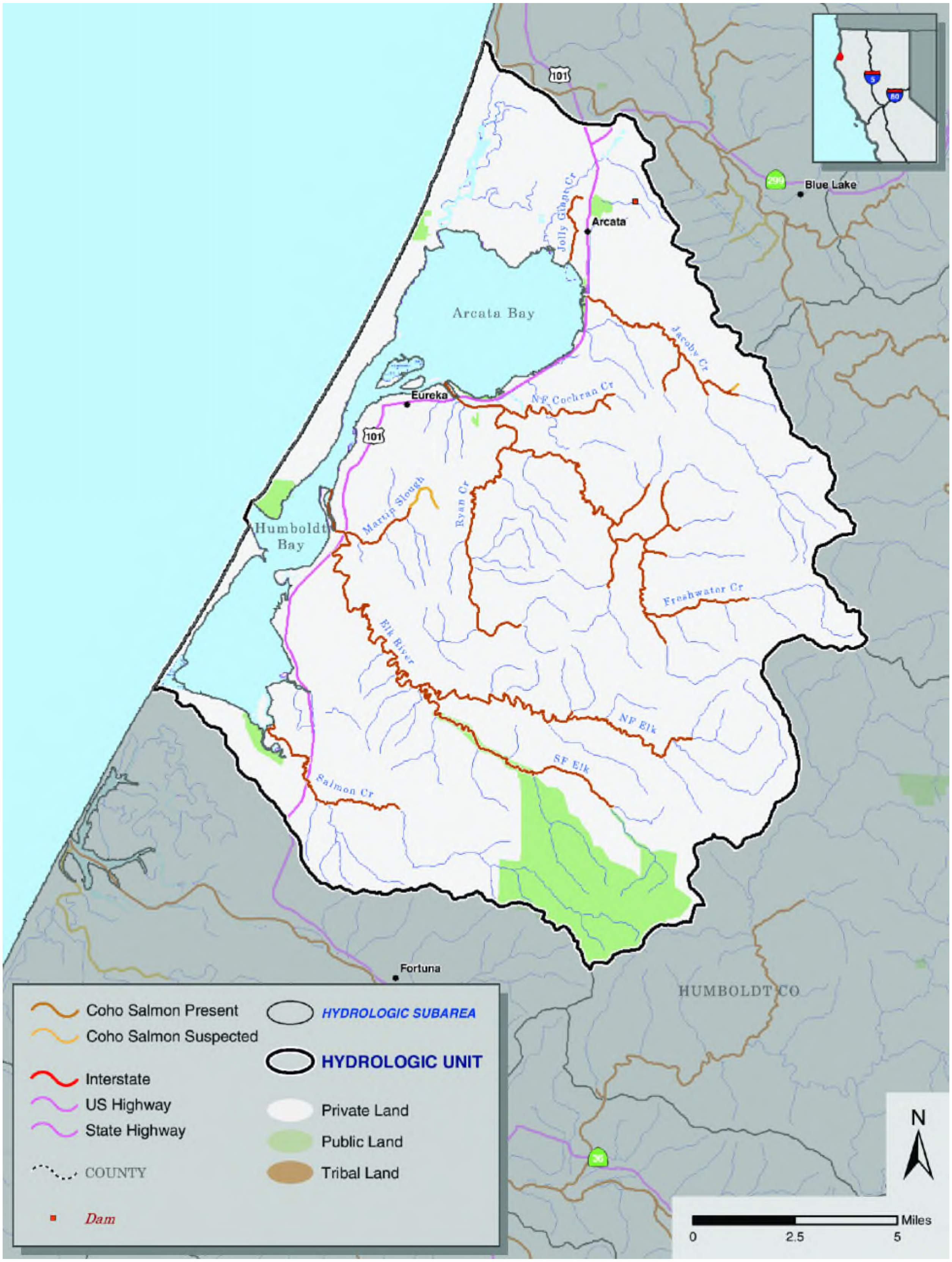
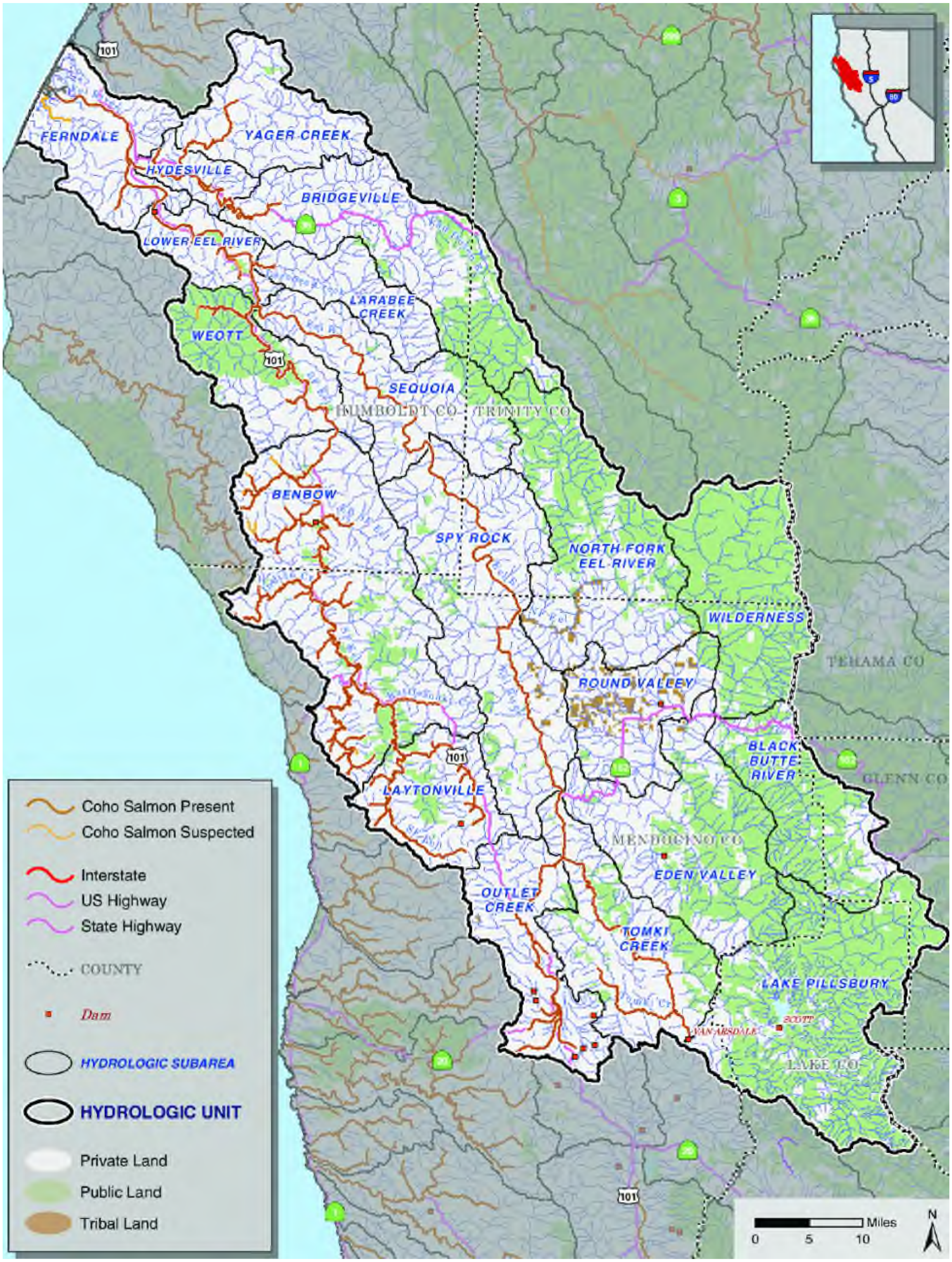


FIGURE 6-12: Eel River Hydrologic Unit



6.1.12.6 Laytonville HSA

The Laytonville HSA includes the upper reaches of the South Fork Eel River and its tributaries. The upper South Fork is primarily redwood forest and has good populations of coho salmon. The Ten Mile Creek watershed is in mixed conifer forest and rangeland managed for cattle production. Coho salmon are found in Ten Mile Creek and many of its tributaries.

Problems facing coho salmon in the Laytonville HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration.

6.1.12.7 Outlet Creek HSA

Outlet Creek HSA includes the Outlet Creek watershed, a tributary to the upper mainstem of the Eel River. One of the longest migrating populations of coho salmon in California is found in the upper tributaries of Outlet Creek. Coho salmon have recently been observed in the tributaries to Little Lake Valley including Ryan, Willits, Baechtel, Broaddus, and Mill creeks. Many of these tributaries run through the City of Willits.

Problems facing coho salmon in the Outlet Creek HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration. During 2003 surveys in Outlet Creek, no coho salmon were observed

6.1.13 CAPE MENDOCINO HYDROLOGIC UNIT

The Cape Mendocino HU (Figure 6-13) encompasses approximately 387 square miles of the northern California Coast Range and includes three watersheds: the Mattole River in the Mattole River HSA, Bear River in the Capetown HSA, and Oil Creek in the Oil Creek HSA.

The information regarding land use and coho salmon presence for the Mattole River HSA is presented in section 6.1.13.1 below. The Bear River and Oil Creek watersheds are entirely privately owned and are managed for timber production and rangeland. In 1996 and 2000, the Department surveyed most tributaries to Bear River. These surveys have documented suitable coho salmon habitat within several portions of the Bear River including portions of the South Fork Bear River, but presence of coho salmon has not been documented. The Department documented the presence of steelhead and Chinook salmon in the Bear River watershed as recently as June 13, 2001. There was one record of a young-of-the-year coho salmon in Oil Creek in 1994 (D. Halligan pers. comm.), but the drainage has not been surveyed regularly.

Problems for coho salmon recovery in the Cape Mendocino HU are deleterious summer water temperatures; high levels of fine sediment; and lack of deep pools, cover, other elements of habitat complexity, and suitable spawning gravels.

A small portion of the Mattole River's southern-most headwaters originates in Mendocino County, but the vast majority of the basin is within Humboldt County. The mainstem Mattole is approximately 62 miles long, and receives water from over 74 tributary streams. There are over 600 perennial stream miles in these watersheds.

Land uses in the Mattole River HSA include timber production, ranching, crop farming, and residential subdivision. Human activities such as road construction, grazing of livestock, and timber management, have interacted with natural geologic instability and sediment production, and major storm events (e.g., the 1964 flood) to impact aquatic habitats. Disturbances from an increasing human population include water diversions, conversion of near-stream areas to residential usage, removal of mature vegetation, widespread soil disturbance, construction of levees or armored banks, and the installation of dams and reservoirs that disrupt normal flow regimes and prevent free movement of salmonids and other fish.

NCWAP completed a basin-wide assessment for the Mattole River that divided the watershed into five subbasins: northern, eastern, southern, western and the estuary (Downie et al. 2002). For the sake of consistency, this Recovery Strategy uses the same organization.

6.1.13.1 Northern Subbasin of the Mattole River HSA

The *northern subbasin* of the Mattole River is located between the estuary and Honeydew Creek (RM 26.5) along the northeastern side of the Mattole mainstem. Eighteen perennial streams drain a watershed area of 98 square miles. The watershed is largely managed for timber production and cattle ranching. The town of Petrolia is located in this subbasin at the confluence of the North Fork Mattole River and the Mattole River. Several back-to-land homesteads are located near Petrolia. Controversies concerning old-growth timber harvest issues are focused on Rainbow and Long ridges in this subbasin. The Northern Subbasin appears to be the most impacted of the Mattole subbasins from a combination of land uses and naturally occurring geological processes. Although historical accounts indicate stream conditions were favorable for salmonid populations in the past, coho salmon were not found in the eight tributaries surveyed by the Department in 2001 or 2002.

6.1.13.2 Eastern Subbasin of the Mattole River HSA

The *eastern subbasin* of the Mattole River is located between Honeydew Creek (RM 26.5) and Bridge Creek (RM 52.1) along the eastern side of Wilder Ridge, and the Mattole mainstem above Bear Creek, for a distance of about 25.6 river miles. The watershed is largely managed for timber production and cattle ranching. Recent stream surveys indicate the presence of coho salmon in a few tributaries and steelhead throughout the eastern subbasin.

6.1.13.3 Southern Subbasin of the Mattole River HSA

The *southern subbasin* of the Mattole River is located south of Bridge Creek (RM 52.1) and McKee Creek (RM 52.8), near Thorn Junction, and continues upstream to the Mattole headwaters near Four Corners (RM 61.5), a distance along the mainstem Mattole of about 9.4 river miles. Much of the subbasin is subdivided into small parcels of rural development or managed for timber production. Domestic and agricultural water consumption has contributed to reduced summer flows. Recent stream surveys indicate the presence of coho salmon and steelhead trout throughout the southern subbasin. This subbasin supports coho salmon in more tributaries than the other Mattole River subbasins.

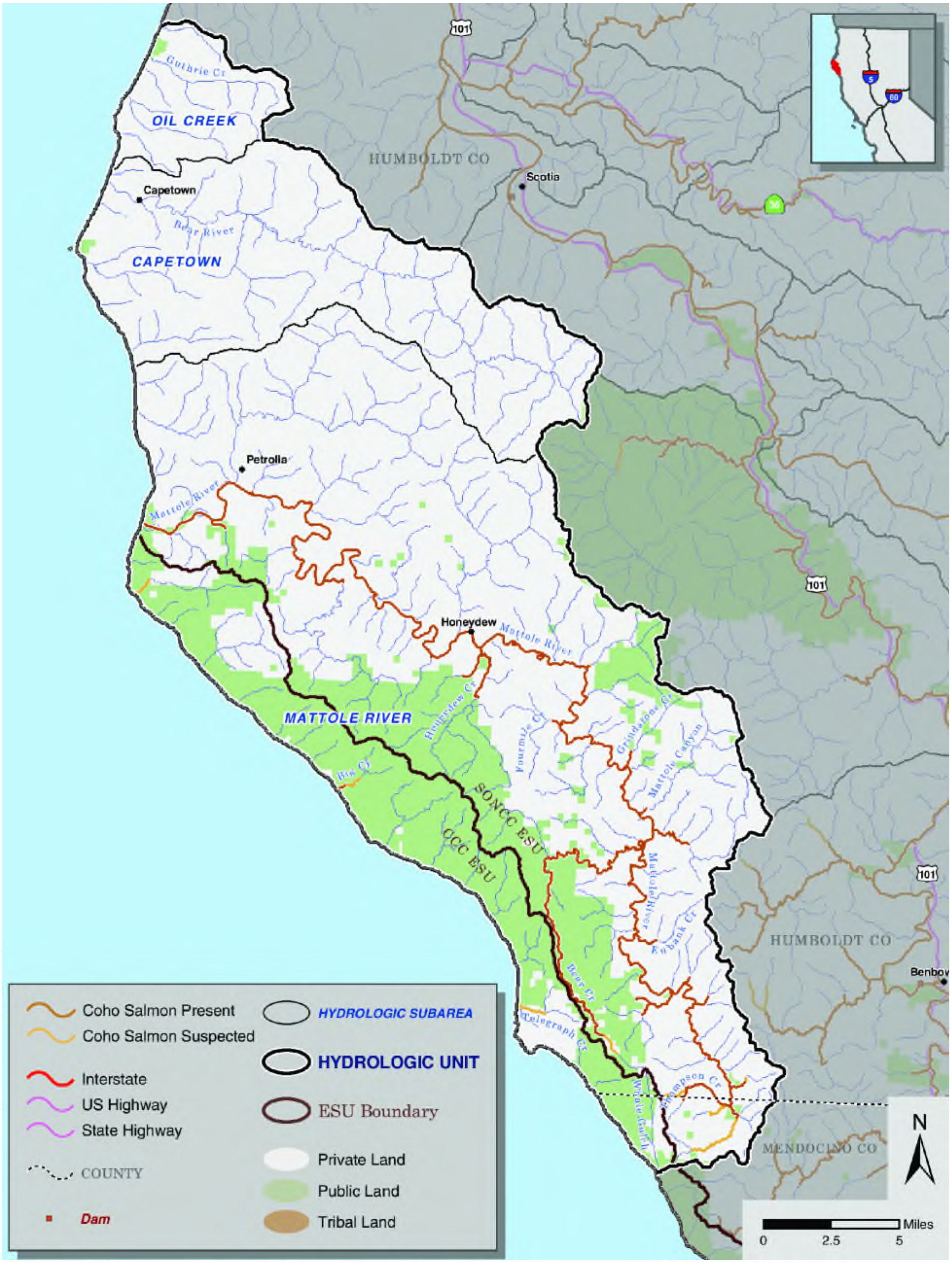
6.1.13.4 Western Subbasin of the Mattole River HSA

The *western subbasin* of the Mattole River is located between the Little Bear Creek in the estuary (RM 0.3) and the headwaters of the South Fork of Bear Creek (RM 50) along the western side of the Mattole mainstem and Wilder Ridge for a distance of about sixty miles. The watershed is largely managed for conservation and recreation in the King Range National Conservation Area. Recent surveys indicate the presence of coho salmon in a few tributaries and the presence of steelhead throughout. Instream habitat is showing signs of improvement due, in part, to the efforts of local stewardship.

6.1.13.5 Estuary Subbasin of the Mattole River HSA

The *estuary subbasin* located at the mouth of the Mattole River in comparison to the other subbasins is quite small, but important to salmonids throughout the summer months, being a vital

FIGURE 6-13: Cape Mendocino Hydrologic Unit



6 RECOVERY UNITS AND WATERSHEDS

FIGURE 6-14: Recovery units in the CCC Coho ESU

transition step on the seaward migration of juveniles and the returning adult spawners. Although no specific recommendations were made for the estuary subbasin, estuary sedimentation problems would be improved by continuing the basin-wide road and erosion assessments and implementation of the resulting recommendations.

Problems for coho salmon recovery in all subbasins in the Mattole River HSA include high instream sediment levels; stream channel aggradation and widening; low-flow conditions, lack of habitat complexity such as deep pools; excessive water temperatures; and loss of functioning estuarine habitat.

6.2 RECOVERY UNITS IN THE CCC COHO ESU

The CCC Coho ESU has been divided into six recovery units (Figure 6-14) that are aligned with CALWATER HUs. These recovery units, and the watershed delineations within each recovery unit, are listed in Table 6-2. HSAs are shown in Figure 6-15 and watershed conditions are described below.

6.2.1 MENDOCINO COAST HYDROLOGIC UNIT

The Mendocino Coast HU (Figures 6-16 and 6-17) lies entirely within the CCC Coho ESU and is comprised of coastal watersheds in Mendocino and Sonoma counties that are west and south of the Eel and Mattole river basins, and west and north of the Russian River basin. The larger river basins in the HU include Ten Mile, Noyo, Big, Albion, Navarro, Garcia, and Gualala rivers. Numerous smaller streams drain directly to the Pacific Ocean. Total area of the HU is about 1,590 square miles. On the coast, air temperatures generally range from the high 30s to high 50s (°F) in winter, and from the low 50s to high 60s (°F) in summer. Average annual precipitation is about 40 inches on the coast and can be significantly higher on inland hill slopes.

The most common land use in this HU is timber production, although livestock grazing, irrigated agriculture (orchards, vineyards), parks (mainly California State parks), rural subdivisions, and urban areas also occupy smaller portions of the area. The Department operates the Noyo River Salmon Egg Collecting Station on the South Fork Noyo River. Adult coho salmon are trapped and spawned and the resulting eggs and young fish are reared at Mad River Hatchery in Humboldt County.

Coho salmon populations in the main river systems within this HU, such as the Albion, Ten Mile, Big, Noyo (including hatchery supplementation), Navarro, Garcia, and Gualala rivers, were estimated by the Department to be in the thousands during the 1960s. Recent presence surveys have been undertaken in an effort to determine where coho salmon may still persist.

Though water quality characteristics in the HU are generally adequate for salmonids, there are several problems potentially limiting salmonid survival. Several major stream systems in the Mendocino Coast region are on the CWA §303(d) list for sedimentation or siltation. High summer water temperatures are the most identifiable problem limiting distribution of coho salmon in some streams. None of the major streams have mainstem dams blocking large portions of salmonid habitat; however, man-made barriers to migration do exist, caused mainly by culverts designed and placed with insufficient consideration of fish passage. The lack of instream shelter (especially LWD), as well as water diversions and illegal harvest, may also limit production of coho salmon within the HU.

6.2.1.1 Albion River HSA

The Albion River HSA consists of the Albion River, all its tributary streams and several adjacent streams draining directly to the Pacific Ocean. The watershed area is 68.4 square miles.

TABLE 6-2: Recovery units and CALWATER watersheds in the CCC Coho ESU

RECOVERY UNIT	HYDROLOGIC UNIT (HU)	HYDROLOGIC AREA (HA)	HYDROLOGIC SUBAREA (HSA)
MENDOCINO COAST	Mendocino Coast	Rockport	Usal Creek
			Wages Creek
			Ten Mile River
		Noyo River	Noyo River
		Big River	Big River
		Albion River	Albion River
		Navarro River	Navarro River
			Greenwood Creek
			Elk Creek
			Alder Creek
		Point Arena	Brush Creek
		Garcia River	Garcia River
		Gualala River	North Fork
			Rockpile Creek
			Buckeye Creek
			Wheatfield Fork
			Gualala
		Russian Gulch	Russian Gulch
RUSSIAN RIVER	Russian River	Lower Russian River	Guerneville
			Austin Creek
		Middle Russian River	Laguna
			Santa Rosa
			Mark West
			Warm Springs
			Geyserville
			Sulphur Creek
		Upper Russian River	Ukiah
			Coyote Valley
			Forsythe Creek
BODEGA-MARIN COASTAL	Bodega	Salmon Creek	Salmon Creek
		Estero Americano	Estero Americano
		Estero San Antonio	Estero San Antonio
		Bodega Harbor	Bodega Bay
	Marin Coastal	Tomales Bay	Walker Creek
			Lagunitas Creek
			Inverness
		Point Reyes	Drakes Estero
		Bolinas	Bolinas

continued

TABLE 6-2: Recovery units and CALWATER watersheds in the CCC Coho ESU (continued)

RECOVERY UNIT	HYDROLOGIC UNIT (HU)	HYDROLOGIC AREA (HA)	HYDROLOGIC SUBAREA (HSA)
SAN FRANCISCO BAY	Bay Bridges	San Rafael	San Rafael
		Berkeley	Berkeley
		San Francisco Bayside	San Francisco Bayside
	South Bay	East Bay Cities	East Bay Cities
		Alameda Creek	Alameda Creek
		San Mateo Bayside	San Mateo Bayside
	Santa Clara	Fremont Bayside	Fremont Bayside
		Coyote Creek	Coyote Creek
		Guadalupe River	Guadalupe River
		Palo Alto	Palo Alto
	San Pablo	Novato	Novato
		Petaluma River	Petaluma River
		Sonoma Creek	Sonoma Creek
		Napa River	Napa River
		Pinole	Pinole
	Suisun	Fairfield	Benicia
			Suisun Creek
			Suisun Slough
			Grizzly Island
			Grizzly Island – in Delta
			Suisun Slough – in Delta
		Concord	Pittsburg
			Walnut Creek
			Martinez
			Pittsburg – in Delta
SAN MATEO	San Mateo	San Francisco Coastal	San Francisco Coastal
		San Mateo Coastal	Pacifica
			Half Moon Bay
			Tunitas Creek
		San Gregorio Creek	San Gregorio Creek
		Pescadero Creek	Pescadero Creek
		Año Nuevo	Año Nuevo
BIG BASIN	Big Basin	Santa Cruz	Davenport
			San Lorenzo
			Aptos-Soquel

Main Albion River tributary streams include Railroad Gulch, South Fork Albion River, and Marsh Creek. Important adjacent streams include Little River and Salmon Creek. During recent surveys (2000 to 2002), coho salmon were found consistently in the Albion River and many of its tributaries, as well as the Little River, Little Salmon Creek, and Big Salmon Creek.

6.2.1.2 Big River HSA

The Big River HSA consists of Big River, all its tributary streams, and several adjacent streams draining directly to the Pacific Ocean. The watershed area is 200.7 square miles. Main Big River tributaries include Two Log Creek, North Fork Big River, Martin Creek, Rice Creek, South Fork Big River, and Daugherty Creek. Important adjacent streams include Caspar Creek and Russian Gulch. During recent surveys (2000 to 2002), coho salmon have shown consistent presence in Caspar Creek and have been found less consistently in Doyle Creek, Russian Gulch, and the Big River and its tributaries.

6.2.1.3 Garcia River HSA

The Garcia River HSA consists of the Garcia River, all its tributary streams, and several smaller streams west of the Garcia basin that drain directly to the Pacific Ocean. The watershed area is 146.4 square miles. The main Garcia River tributaries include Hathaway Creek, North Fork Garcia River, South Fork Garcia River, Signal Creek, and Inman Creek. Streams draining directly to the Pacific Ocean include Schooner Gulch and Fish Rock Gulch. During recent surveys (2000 to 2002), coho salmon were found only in 2002 in the North Fork Garcia River as well as the South Fork Garcia River and its tributary, Fleming Creek.

6.2.1.4 Navarro River HSA

The Navarro River HSA consists of the Navarro River and all its tributary streams. The watershed area is 315.8 square miles. Main tributaries include North Fork Navarro River, Mill Creek, Indian Creek, Rancheria Creek, and Anderson Creek. The Navarro is the largest and most diverse basin in the HU.

Land uses include timber production near the coast, irrigated agriculture in Anderson Valley, and grazing on hill slopes of the eastern area. Melange geology in the eastern areas makes them less stable than coastal areas dominated by coastal belt geology. Coho salmon have recently been found in the Navarro River (2002 and 2003) and in some of its tributaries, including Marsh Gulch, Murray Gulch, Flume Gulch, Flynn Creek, and North Branch North Fork Navarro River (2000 to 2002).

6.2.1.5 Noyo River HSA

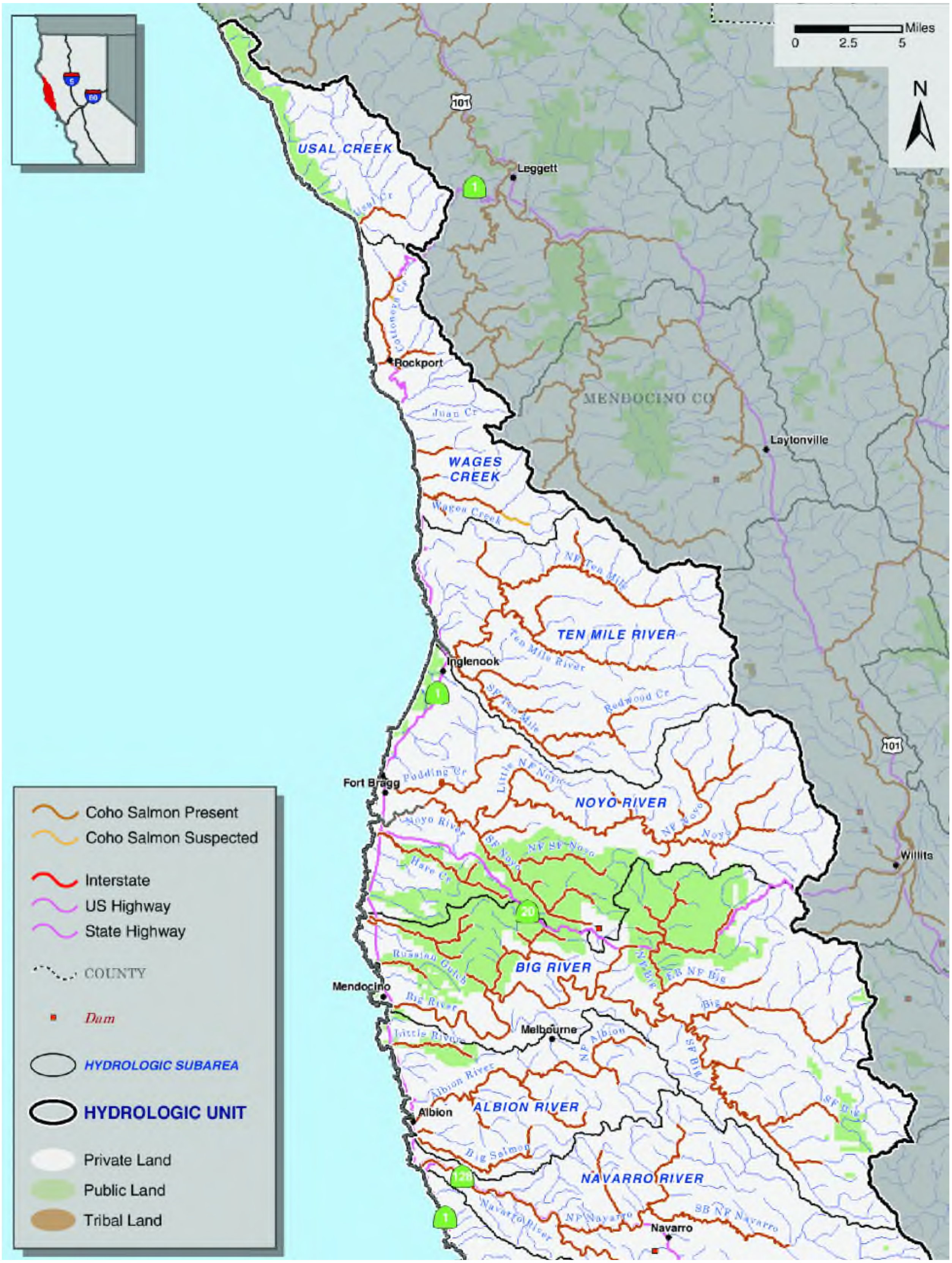
The Noyo River HSA consists of the Noyo River, all its tributary streams, and several adjacent smaller streams draining directly to the Pacific Ocean. The watershed area is 166 square miles. The main Noyo River tributaries include South Fork Noyo and North Fork Noyo. The more important adjacent streams include Pudding and Hare creeks. During recent surveys (2000 to 2002), the Noyo River and many of its tributaries, as well as Pudding and Hare creeks have shown consistent presence of coho salmon.

6.2.1.6 Ten Mile River HSA

The Ten Mile River HSA consists of the Ten Mile River, all its tributary streams, and several small adjacent streams draining directly to the Pacific Ocean. The watershed area is 129 square miles. The main tributaries include North Fork Ten Mile, Middle Fork (also known as Clark Fork) Ten Mile, and South Fork Ten Mile. The Ten Mile River originates in the Coast Range of Mendocino County and enters the ocean about nine miles north of Fort Bragg. Its main tributaries are the North and South Forks.

FIGURE 6-15: Hydrologic Subareas in the CCC Coho ESU

FIGURE 6-16: Mendocino Coast Hydrologic Unit (North)



The Ten Mile River flows mainly through coastal forests and grasslands. During recent surveys (2000 to 2002), coho salmon were found only in 2001 and 2002 in the Ten Mile River and most of its tributaries, although coho salmon were found all three years in Little North Fork Ten Mile River and Bear Haven Creek.

6.2.1.7 Gualala River HA

This HA consists of the Gualala River, all its tributary streams, and coastal streams south to Russian Gulch. The Gualala River watershed area is 298.4 square miles. The main Gualala River tributaries include North Fork Gualala River, Little North Fork Gualala River, Little North Fork Gualala River, Rockpile Creek, South Fork Gualala River, Buckeye Creek, and Wheatfield Fork Gualala River. The Gualala River begins on the western slope of the coastal ranges of Mendocino and Sonoma counties; the lower 3.5 miles of the mainstem form the common boundary of these counties. The South Fork Gualala River flows northwest along a rift valley formed by the San Andreas Fault, which parallels the coast for about 25 miles.

The surrounding topography is generally steep ridges and hills, covered with dense stands of redwood and Douglas-fir forest. Scattered along both forks of the river are sand and gravel bars, as well as stands of willow and alder. The river valley broadens at its mouth, south of the Highway 1 Bridge. In the vicinity of the bridge on both sides of the river are a few scattered freshwater marshes. The lower mile of the river is bordered by a broad grassland-covered bluff to the south and bluffs to the north.

On December 20, 2001, the USEPA established a sediment TMDL for the Gualala River based on the information contained in the Gualala Technical Support Document, prepared by Regional Board staff and their consultants. The purpose of the Technical Support Document, was to estimate current discharges of sediments to the surface waters of the Gualala River watershed, and to identify the reduction in discharges necessary for achieving water quality standards contained in the North Coast Region Water Quality Control Plan.

During recent surveys (2000 to 2002), coho salmon were found only in 2002 in some of the Gualala River tributaries, including the Little North Fork Gualala River, Dry Creek, and McGann Gulch.

6.2.2 RUSSIAN RIVER HYDROLOGIC UNIT

The Russian River HU (Figure 6-18) covers an area of approximately 1,485 square miles and includes about 240 named and numerous unnamed tributaries. The Russian River HU has been described extensively within the context of a fisheries restoration plan (CDFG 2002). In keeping with the format of that plan, the mainstem of the Russian River is described here as a separate entity, although this is not done for any of the other watersheds included in this Recovery Strategy.

Approximately 95% of the river's natural runoff, about 1,600,000 acre-feet, occurs between November and April. Summer flows are regulated by releases from Lake Mendocino (impounded by Coyote Dam) and Lake Sonoma (impounded by Warm Springs Dam). The Potter Valley Project also contributes up to 300 cfs to the river above Lake Mendocino. Mean daily temperatures can exceed 73°F in some sections of the river, causing stress to salmonids and promoting proliferation and persistence of predatory, warm-water fish species. Natural and man-made physical barriers such as bedrock constrictions and falls, debris jams, dams, road crossings, and culverts adversely affect fish migration.

Urban and industrial uses are concentrated around cities in Mendocino and Sonoma counties. Uses include high-technology industries, petroleum distribution plants, light manufacturing, wrecking and salvage yards, and industries related to construction. Santa Rosa is the chief commercial distribution center for the north coast of California. Other land uses such as timber harvest, agricultural production, livestock grazing, and gravel mining, have been present in the Russian River watershed for decades and continue today. Agriculture is still the dominant land use within the basin, with a recent trend of conversion of historic croplands, pasture for livestock, dairy lands, and forestlands to vineyards.

Coho salmon historically occurred in six of the 11 Russian River HSAs (Guerneville, Austin Creek, Geyserville, Mark West, Warm Springs, and Santa Rosa Creek HSAs). Of the four salmonid species that historically occurred in the watershed (Chinook salmon, pink salmon, coho salmon, and steelhead trout), pink salmon have been extinct since 1955, while the other three species are currently listed as threatened under the Federal ESA. Natural coho salmon production in the Russian River system was augmented through annual releases of about 70,000 yearlings produced at the Warm Springs Hatchery (WSH) between 1980 and 1998. The Department, NOAA Fisheries, and USACE initiated a captive coho salmon broodstock program at WSH in 2001. Using conservation hatchery principles, their goal is to restock selected streams within the Russian River basin with juvenile coho salmon derived from local natural spawning populations.

Potential problems for coho salmon recovery in the Russian River basin include barriers to migration, poor gravel quality, inadequate gravel quantity, lack of riparian stability, loss of native plant species, invasion of non-native plants, inappropriate water temperature, poor water quality, and an altered hydrologic regime. The river is listed as impaired for sediment on the 303(d) list of the CWA.

6.2.2.1 Russian River Mainstem

The mainstem of the Russian River extends for about 96 miles from the mouth to the headwaters of the river above Lake Mendocino. It is dominated by alluvial stretches in the lower, middle, and upper reaches, separated by bedrock sections of variable lengths. Factors specific to the mainstem that limit coho salmon production include barriers to upstream migration and other life-history stages posed by permanent and seasonal dams, stream crossings and culverts, inadequate gravel quantity, insufficient riparian stability, inadequate water quality, and seasonally unsuitable water quantity due to artificial breaching of the barrier beach for flood-control purposes.

6.2.2.2 Guerneville HSA

The Guerneville HSA occupies the southwest end of the Russian River basin in Sonoma County and has an area of 159.8 square miles. It extends from the mouth of the river at the Pacific Ocean upstream to Healdsburg and east to the outskirts of Sebastopol. Major tributaries include Green Valley, Fife, Hulbert, Dutchbill, and Willow creeks.

The lower reaches of the near-coast streams within the basin contain marsh-like environments, which are subject to daily tidal influence. Most of the subbasin is privately owned, but it also contains Armstrong Woods State Park, consisting of about 1.26 square miles in the Fife Creek watershed and 0.57 square miles in the Willow Creek watershed. No watershed plans have been adopted for these watersheds, although considerable resource assessment work has been completed and community watershed groups have been organized in both.

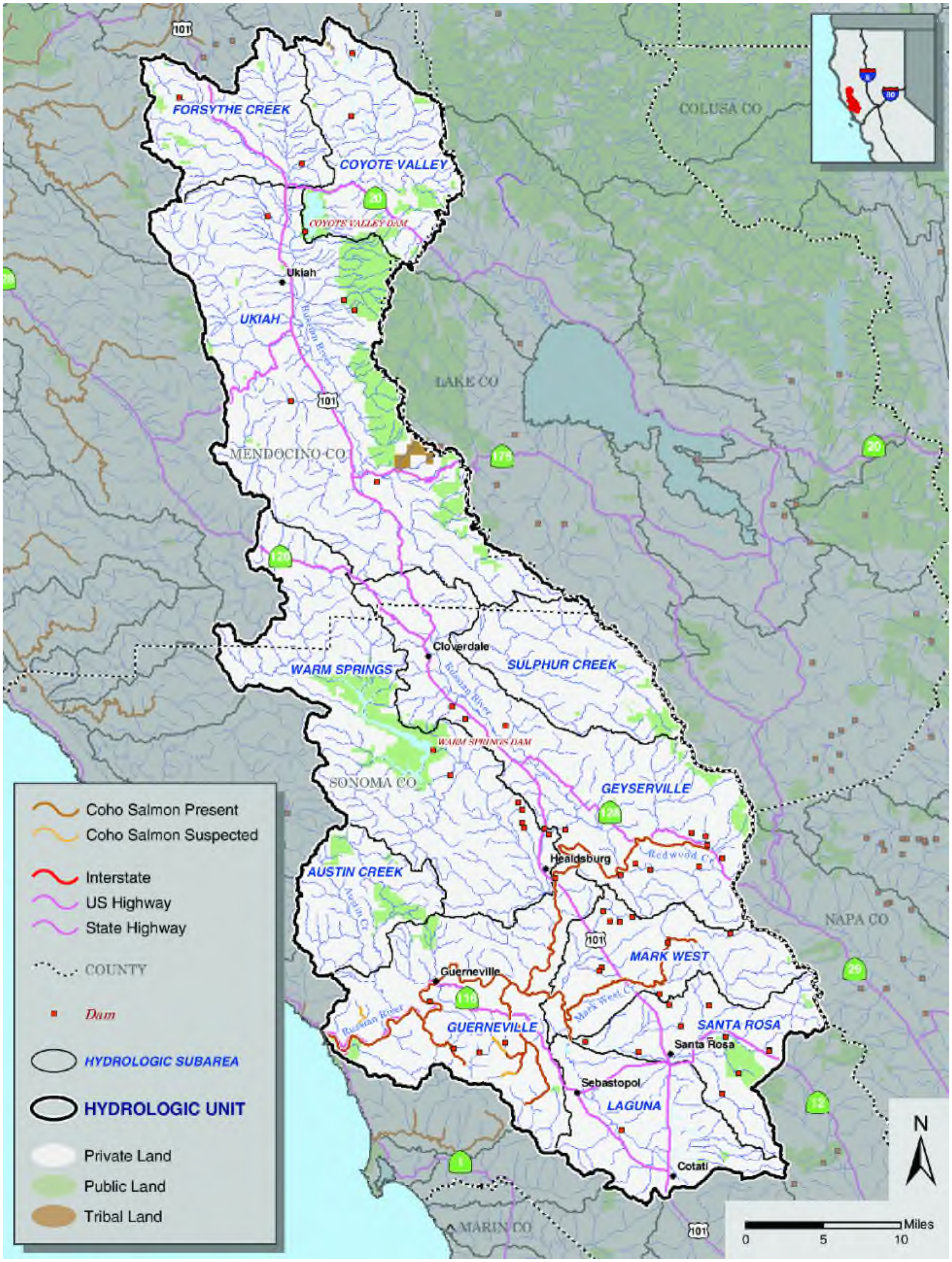
During recent surveys (2000 to 2002), coho salmon were found only in three Russian River tributaries: Green Valley, Dutchbill, and Mark West creeks. Coho salmon were found in each of the last ten years, except 2001. They were found in Dutch Bill Creek in 2002 but not in 2001, and in Mark West Creek in 2001 but not in 2002.

6.2.2.3 Austin Creek HSA

The Austin Creek HSA consists of the Austin Creek watershed and includes the major watersheds of Big Austin, East Austin, and Ward creeks. It drains an area of 62.3 square miles.

FIGURE 6-17: Mendocino Coast Hydrologic Unit (South)

FIGURE 6-18: Russian River Hydrologic Unit



Numerous perennial and intermittent streams feed both the mainstem of Austin Creek and the larger tributary systems.

Many of the headwater areas are geologically unstable, and the basin has the highest average annual rainfall of any area within the Russian River region. Major land uses in the Austin Creek subbasin include timber production, gravel mining and rural development. The watershed is primarily privately owned, except for portions under DPR ownership. Parts of the watershed are now protected from development as a part of Armstrong Woods State Park and Austin Creek State Recreation Areas, together covering 8.9 square miles. During recent surveys (2000 to 2002), coho salmon were not found in Austin Creek or any of its tributaries.

6.2.2.4 Warm Springs HSA

The Warm Springs HSA runs along the western edge of the Russian River basin in Sonoma County and contains the Dry Creek watershed and Lake Sonoma. This subbasin is named after Warm Springs Dam, constructed in 1982, which impounds Lake Sonoma. The subbasin drains an area of 218 square miles. Approximately 130 square miles of the watershed are above the lake and completely inaccessible to anadromous species. Major tributary watersheds within the Dry Creek watershed below the dam include Pena and Mill creeks, as well as numerous perennial and intermittent tributaries. Cherry, Warm Springs, and Gallaway creeks are major tributary watersheds above the dam.

Warm Springs Hatchery, operated by the Department, was built as mitigation for lost habitat and fish runs on Dry Creek above the dam. Ownership within the subbasin is primarily private, although USACE owns Lake Sonoma. The Dry Creek watershed has been the site of intense agricultural development since the turn of the twentieth century. Conifer forest dominates the upper HSA, but there are zones of grassland and oak-woodland in the lower watersheds and flood plain areas. Primary land uses today are vineyard cultivation, scattered rural development and grazing, and recreation within the boundaries of Lake Sonoma. Some timber is still harvested within the basin, and is often followed by conversion of uplands to agricultural use.

During recent surveys (2000 to 2002), coho salmon were not found in Dry Creek or any of its tributaries, although coho salmon were detected inconsistently in some tributaries during the 1990s.

6.2.2.5 Mark West Creek HSA

The Mark West HSA contains Mark West Creek and its tributaries. Mark West Creek traverses Sonoma County in a general east-west direction, meets the Laguna de Santa Rosa, and flows into the Russian River at Mirabel Park, about eight miles east of Guerneville. The subbasin covers an area of 86.3 square miles, and includes the major tributary watersheds of Windsor, Humbug, and Porter creeks. Mark West Creek and its tributaries drain a basin of approximately 40 square miles.

Cultivated fields and housing developments border most of the stream in the middle section. Where the Mark West Creek subbasin meets the Russian River, vegetation is dominated by typical redwood forest. Oaks, bay, redwood, Douglas-fir, maples, madrone, and manzanita characterize the vegetation near the headwaters. Riparian vegetation is composed of willows, oaks, bay, alder, maples, blackberry, and a limited number of redwoods. During recent surveys (2000 to 2002), coho salmon were found in Mark West Creek only in 2001, although they were detected in 1993 and 1994.

6.2.2.6 Santa Rosa Creek HSA

The Santa Rosa Creek HSA is located in the southeastern portion of the Russian River watershed, and contains Santa Rosa Creek and its major tributaries, Matanzas Creek and the North and South Forks of Santa Rosa Creek. It covers an area of 77.4 square miles. Santa Rosa Creek is a tributary to Laguna de Santa Rosa, which flows into Mark West Creek.

The upper watershed consists of mixed evergreen forest grading to oak woodland. The primary land use today is urban development, although livestock grazing and vineyard development also exist. The Santa Rosa Creek watershed is primarily in private landownership, with some portions owned by the City of Santa Rosa and the Sonoma County Regional Parks Department.

The City of Santa Rosa, located at the intersection of Highway 101 and Highway 12, is the most urbanized and densely populated community within the Russian River basin. The creek is channelized for about seven miles from the Santa Rosa City Hall downstream to Laguna de Santa Rosa. The discharge from the Santa Rosa Wastewater Treatment Facility is released into the Russian River via Santa Rosa Creek and Laguna de Santa Rosa.

The Santa Rosa Plain contains a large number of confined animal operations, including almost 100 dairies. Conversion of pasture and orchards to vineyards has increased significantly in the past decade. The upper basin, incorporated into Hood Mountain Regional Park and the McCormick Sanctuary, is now protected from further development.

During recent surveys (2000 to 2002), coho salmon were not found in Santa Rosa Creek, although they had been detected in 1993 and 1994.

6.2.2.7 Forsythe Creek HSA

The Forsythe Creek HSA, in the northwestern portion of the Russian River watershed in Mendocino County, contains the Forsythe Creek watershed and the West Fork drainage of the Russian River. The Forsythe Creek subbasin drains 84.3 square miles. The Forsythe Creek watershed and its tributaries drain a basin of approximately 47.7 square miles. Major tributaries within Forsythe watershed are Mill, Jack Smith, and Eldridge creeks. Many artificial and several natural lakes occur throughout the basin. The West Fork has its headwaters in a mountain forest but predominantly flows through hills of rangeland and pastureland for sheep and cattle, with scattered oak trees. Major tributaries include Mariposa, Corral, Fisher, and Salt Hollow creeks.

The streams flow predominantly through oak-, bay-, and maple-covered rangelands with second-growth redwoods in the upper headwaters of the drainage. Much of the central basin area is cultivated as vineyards or used for livestock grazing. Timber harvest is also a predominant land use with scattered rural homesteads. The majority of the Forsythe Creek subbasin is privately owned, with much of the watershed managed for timber production and livestock for the past century. During recent surveys (2000 to 2002), coho salmon were not found in any of the creeks or their tributaries in this HSA.

6.2.2.8 Geyserville HSA

The Geyserville HSA drains 207.8 square miles, and includes the Alexander Valley reach of the Russian River, the Maacama Creek watershed, and many smaller tributaries.

The watershed is dominated by oak grasslands except in the headwaters, where vegetation consists mostly of gray pine and oaks. Riparian vegetation generally has abundant alders and willows. Major land uses within the Maacama watershed are vineyard cultivation, cattle grazing, and urban development. The Briggs Creek watershed and its tributaries occupy the northeastern side of the upper subbasin, draining approximately 12.3 square miles. The mixed hardwood forests here are in excellent condition in this pristine sub-watershed. Much of the upper Maacama watershed remains in large parcels and is now under protection from further development under Sonoma County Open Space easements.

Coho salmon were detected in Maacama and Redwood creeks in 1993 and 1994. In addition, the Department collected juvenile coho salmon from the Maacama Creek watershed (Redwood Creek) in 2001 for the coho salmon broodstock program.

6.2.3 BODEGA AND MARIN COASTAL HYDROLOGIC UNITS

The Bodega and Marin Coastal HUs (Figure 6-19) consist of nine HSAs, four of which have documented historical coho salmon presence to Salmon Creek, Walker Creek, Lagunitas Creek, and Bolinas. Together, they drain an area of about 265 square miles. In this typical coastal region of California, the climate is highly variable, with basin-wide average rainfall of over 30 inches per year.

Approximately 95% of the Salmon Creek and Walker Creek watersheds are in private ownership, whereas about 50% of Lagunitas Creek basin and only 5% of the Redwood Creek watershed in the Bolinas HSA are privately owned. Land uses include protected open space; buffer lands for domestic drinking water; recreation, natural resource protection and management areas; organic farming, and moderately dense residential development.

Three major reservoirs form barriers to coho salmon distribution in the HUs: Soulajule Reservoir on Arroyo Sausal in the Walker Creek watershed, and the reservoirs formed behind Nicasio Dam on Nicasio Creek and Peters Dam on Lagunitas Creek, both in the Lagunitas Creek watershed. There are no fish hatcheries or fish facilities currently operated in the HUs, although the Department operated a trapping facility on Nicasio Creek during the 1960s to move coho salmon above Nicasio Reservoir.

Watersheds within the HUs have a variety of water quality impairments, including excess sediment, high temperature, low DO, and excessive nutrients. Chronic erosion and sedimentation is the primary water quality challenge throughout the HU. Tomales Bay is listed on the CWA §303(d) list as an impaired water body for high concentrations of bacteria, nutrients, pathogens, metals (mercury), and sediment. Walker, Lagunitas, and Olema creeks have been listed as impaired for sedimentation, nutrients, and fecal coliform bacteria.

Current knowledge indicates that the primary problems facing coho salmon in the HUs are the permanent loss of access to spawning and rearing habitat above Peters Dam on Lagunitas Creek and above Nicasio Dam on Nicasio Creek, fish passage barriers at road crossings, high fine sediment loads, low summer streamflow, high summer water temperature, a shortage of cover in the form of LWD, and loss of riparian vegetation. The Lagunitas and Bolinas HSAs have recent documented occurrences of coho salmon, while the Salmon and Walker creek HSAs historically supported the species.

6.2.3.1 Salmon Creek HSA

The Salmon Creek HSA is located in Sonoma County and consists of two watersheds, Salmon and Scotty creeks. Salmon Creek drains 34.5 square miles into a tidal estuary located just north of Bodega Harbor along the Sonoma coast. The six major tributaries to Salmon Creek are Finley, Coleman Valley, Tannery, Fay, Nolan, and Thurston creeks. Scotty Creek is a small drainage that flows into the Pacific Ocean just north of the Salmon Creek estuary.

Salmon Creek is characterized by a deeply incised channel and highly active bank erosion due to steep topography and livestock grazing. Instream flow data for the Salmon Creek watershed are lacking. Water temperatures in parts of the Salmon Creek watershed during the summer rearing season are mostly acceptable due the basin's close proximity to the coast. During recent surveys (2000 to 2002), no coho salmon were found in any of the creeks of this HSA.

6.2.3.2 Walker Creek HSA

The Walker Creek HSA consists of the 76 square-mile Walker Creek drainage. It is located primarily in northwestern Marin County, except for a small portion in Sonoma County. Walker Creek is the second largest tributary to Tomales Bay, draining into the northern end of the bay. The four main tributaries to Walker Creek are Keys, Chileno, Salmon and Arroyo Sausal creeks. Lagunitas Creek and Walker Creek provide 75% of the freshwater into Tomales Bay. Since 1979, releases from Soulajule Reservoir have maintained perennial flow in Walker Creek. Prior to 1985, flow in Walker Creek was intermittent in some reaches, although it is reported that in the early 1900s, Walker Creek was a perennial stream (Haible 1976).

Soulajule Reservoir sits high in the watershed on Arroyo Sausal Creek, which flows directly into Walker Creek. The reservoir was constructed in 1968 and is currently managed by Marin Municipal Water District (MMWD). This reservoir is far enough upstream to allow for salmonid access to a majority of the historic habitat.

The Walker Creek watershed has been listed as impaired for sediment, high nutrients, and high fecal coliform bacteria on the CWA §303(d) List by the San Francisco RWCB. During recent surveys (2000 to 2002), no coho salmon were found in Walker Creek or any of its tributaries.

6.2.3.3 Lagunitas Creek HSA

The Lagunitas HSA consists of the 103-square-mile Lagunitas Creek basin. This is the largest watershed in Marin County, draining a large portion of the central part of West Marin. Flowing from its headwaters on the north slope of Mt. Tamalpais, it traverses northwesterly 25 miles through four reservoirs to the southern end of Tomales Bay.

Lagunitas Dam (built in 1872), Alpine Dam (built in 1918), Bon Tempe Dam (built in 1948), and Peters Dam (built in 1954), which provide water for domestic use to central and west Marin communities, are all located on Lagunitas Creek. A fifth dam in the basin is Seeger Dam (Nicasio Dam), built in 1961, which forms Nicasio Reservoir on Nicasio Creek one mile upstream from its confluence with Lagunitas Creek. The four major tributaries to Lagunitas Creek are San Geronimo, Devil's Gulch, Olema, and Nicasio creeks. San Geronimo Creek flows through San Geronimo Valley and into Lagunitas Creek one-quarter mile downstream of Peters Dam. Devil's Gulch flows through a steep, narrow canyon into Lagunitas in Samuel P. Taylor State Park. Olema Creek flows along Highway 1, joining Lagunitas just downstream of Pt. Reyes Station.

Sub-watersheds that provide spawning habitat include Cheda and McIsaac creeks, which flow directly into Lagunitas Creek, and Woodacre, Larsen, and Arroyo Road creeks, which flow into San Geronimo Creek. During recent surveys (1997 to 2002), coho salmon were found consistently in Lagunitas Creek, as well as in Olema Creek, Devil's Gulch, and San Geronimo Creek and its tributaries, but only in one or two years in two other smaller tributaries to Lagunitas Creek.

6.2.3.4 Bolinas HSA

Coho salmon have been identified in three watersheds in the Bolinas HAS; Redwood, Pine Gulch and Easkoot creeks.

Redwood Creek drains an 8.9-square-mile watershed from the west peak of Mt. Tamalpais to its mouth at Muir Beach. Approximately seven miles of Redwood Creek provide accessible habitat for anadromous salmonids and this basin is considered one of the most productive and restorable basins for anadromous salmonid habitat in Marin County. It is largely undeveloped and its resources are protected as State and Federal parklands. Major watersheds include Fern, Bootjack, Rattlesnake, Spike Buck, Kent Canyon, and Green Gulch creeks. During recent surveys (2000 to 2002), coho salmon were found consistently in Redwood Creek.

Pine Gulch Creek, a 7.6-square-mile watershed in coastal Marin County, is the primary freshwater source to Bolinas Lagoon. Seventy percent of the water draining into Pine Gulch Creek flows off of Inverness Ridge, providing perennial flow. Currently, the watershed supports a native self-sustaining population of steelhead trout, and up until the 1970s, a native population of coho salmon. Although the Department and the NPS considered coho salmon extirpated, 538 juveniles were found in August 2001, and data suggest they originated from more than one redd. Known factors that may limit coho salmon in Pine Gulch Creek are sedimentation/erosion, lack of pool shelter, and water quantity. Because of the lack of published information, Pine Gulch Creek is not discussed in detail in the watershed summary. During recent surveys (2000 to 2002), coho salmon were found in Pine Gulch Creek only in 2002.

Easkoot Creek, a small perennial tributary with a 1.7-square-mile watershed, flows into Bolinas Lagoon at Stinson Beach. Easkoot Creek is accessible to anadromous fish in its lower reaches, for a short distance upstream of Highway 1 in the town of Stinson Beach. Lower Easkoot Creek has been highly modified and provides relatively limited potential habitat; however, juvenile coho salmon were observed there in 2002. During recent surveys (2000 to 2002), coho salmon were found in Easkoot Creek only in 2002.

6.2.4 SAN FRANCISCO BAY HYDROLOGIC UNITS

San Francisco Bay encompasses San Pablo, Suisun, Central, and South bays and covers an area of about 400 square miles (Figure 6-20). It extends for approximately 85 miles from the east end of Chips Island in Suisun Bay westward and southward to the mouth of Coyote Creek near the City of San Jose. Most of the bay's shoreline has a flat slope, which causes the intertidal zone to be relatively large. San Francisco Bay is surrounded by about 130 square miles of tidal flats and marshes. The watershed of San Francisco Bay drains an area of approximately 3,475 square miles (Leidy 1984).

San Francisco Bay Area watersheds are largely urbanized, with some areas in agriculture, grazing, and parkland. Most San Francisco Bay watersheds are currently listed as impaired for sediment, nutrients, and pathogens under CWA § 303(d). Many creeks have intermittent flow during the dry season and can be completely dry for one or more months. Many creeks contain obstructions to salmonid migration in the form of grade-control structures, road crossings, flood-control channels, permanent and seasonal dams, and seasonally dry sections. Summer and fall water temperatures in Bay Area creeks tend to be relatively high.

Several creeks and rivers of the San Francisco Bay historically supported coho salmon runs, including Alameda, San Pablo, Walnut, San Anselmo, Corte Madera, and Mill Valley (Arroyo Corte Madera Del Presidio) creeks (Leidy, 1984). No coho salmon have been observed in waters draining to San Francisco Bay since 1981.

Historically, coho salmon occurred in the San Rafael HSA in the Corte Madera Creek and Arroyo Corte Madera Del Presidio (Mill Valley) drainages (Fry 1936; Hallock and Fry 1967). The last record of coho salmon in this HSA was on September 18, 1981 when Leidy (1984) reported collecting two juveniles from Corte Madera Creek and two from Old Mill Creek (tributary to Arroyo Corte Madera Del Presidio). NOAA Fisheries has identified both Corte Madera Creek and Arroyo Corte Madera Del Presidio as critical habitat for coho salmon. Rich (1995) reported that existing habitat in the Arroyo Corte Madera Del Presidio watershed is not suitable for coho salmon.

6.2.5 SAN MATEO HYDROLOGIC UNIT

The San Mateo HU (Figure 6-21) is near the southern end of the coho salmon range and has been significantly impacted by water diversion, urbanization, road building, riparian development, land-use practices, and fire suppression. This HU includes the San Gregorio Creek, Pescadero Creek, and Año Nuevo (Gazos Creek) HSAs. Four other HSAs, San Francisco Coastal, Half Moon Bay, Pacifica, and Tunitas Creek also fall in the San Mateo HU; however, none of these has any known current or historical information that they are or were coho salmon-bearing streams, and they are not discussed further in this report.

Streams in this HU originate in the Santa Cruz Mountains and flow west or southwest to the Pacific Ocean. They are generally well shaded and summer water temperatures seldom exceed the high 60s°F, although temperatures may be higher in the lagoons and the lower stream reaches. Coho salmon distribution is generally limited to the relatively high-order, low-gradient streams and reaches. The San Gregorio subbasin is entirely within San Mateo County and covers approximately 61 square miles. Most of the watersheds for Pescadero and Gazos creeks are within San Mateo County, with a small part of the headwaters located in Santa Cruz County. The Pescadero Creek watershed is approximately 100 square miles while the Gazos Creek watershed is approximately 20 square miles.

San Gregorio, Pescadero, and Gazos creeks all have estuaries whose mouths are frequently blocked by sandbars, forming lagoons. The alteration of the lagoons, in conjunction with increased sediment loads from land-use activities, lower stream flows due to water diversions, and other watershed changes have reduced and degraded rearing habitat for juvenile coho salmon and created a poor freshwater-saltwater transition zone for smolts.

There are few definitive data on historical coho salmon abundance in this HU. Most brood-year lineages appear to be extirpated or very weak in all three watersheds, although surveys found coho salmon in the Año Nuevo HSA in 2002. Erosion and landslides are significant natural factors shaping habitat in this HU. Reduced flow and water depth during dry months and periods of drought may impede migration of adult and juvenile coho salmon between storms, and limit the distribution of rearing juveniles. Recorded water rights, unregistered riparian diversions, and wells affecting underflow contribute to reduced flow. The use of wells to extract flow from mapped and unmapped groundwater flow is a significant and growing issue in this HU.

Effective maintenance and restoration of stream flow and LWD are key challenges to coho salmon recovery in an increasingly urban setting. Comprehensive water storage and distribution is required to provide the habitat necessary for coho salmon recovery.

6.2.5.1 San Gregorio Creek HSA

The San Gregorio watershed is located approximately 11 miles south of Half Moon Bay in San Mateo County and covers approximately 61 square miles. The mainstem of San Gregorio Creek is 11.8 miles in length, and has about 33 miles of perennial tributaries. The mainstem of San Gregorio Creek, in combination with its tributaries of La Honda, Alpine, Harrington, El Corte de Madera and Bogess creeks, contains approximately 33 miles of potentially usable rearing habitat.

Most of the San Gregorio watershed is in private ownership. Land use includes agriculture, developments (residential, minor commercial, and a road infrastructure), cattle grazing, timber harvest, and recreational trails. Because of the large private ownership and development potential, water diversions and low base flows are an important issue in this HSA. In 1993, water rights in the San Gregorio watershed were adjudicated and a minimum stream bypass flow was established. However, the prescribed bypass flows are too low to assure viable coho salmon populations.

Pescadero Creek is located approximately 16 miles south of Half Moon Bay in San Mateo County. The watershed area has an area of approximately 100 square miles. The mainstem of Pescadero Creek is approximately 26 miles in length, with an additional 44 miles of perennial tributaries. Approximately 21 miles of mainstem Pescadero Creek and Peters, Slate, Oil and Butano creeks are potential coho salmon rearing habitat. Approximately 30% of the watershed is in public ownership (DPR and the County of San Mateo) and 70% is in private ownership. Land use includes agriculture, timber harvest, grazing, development (e.g., residential, commercial, road infrastructure) and recreation.

FIGURE 6-19: Bodega and Marin Coastal Hydrologic Units

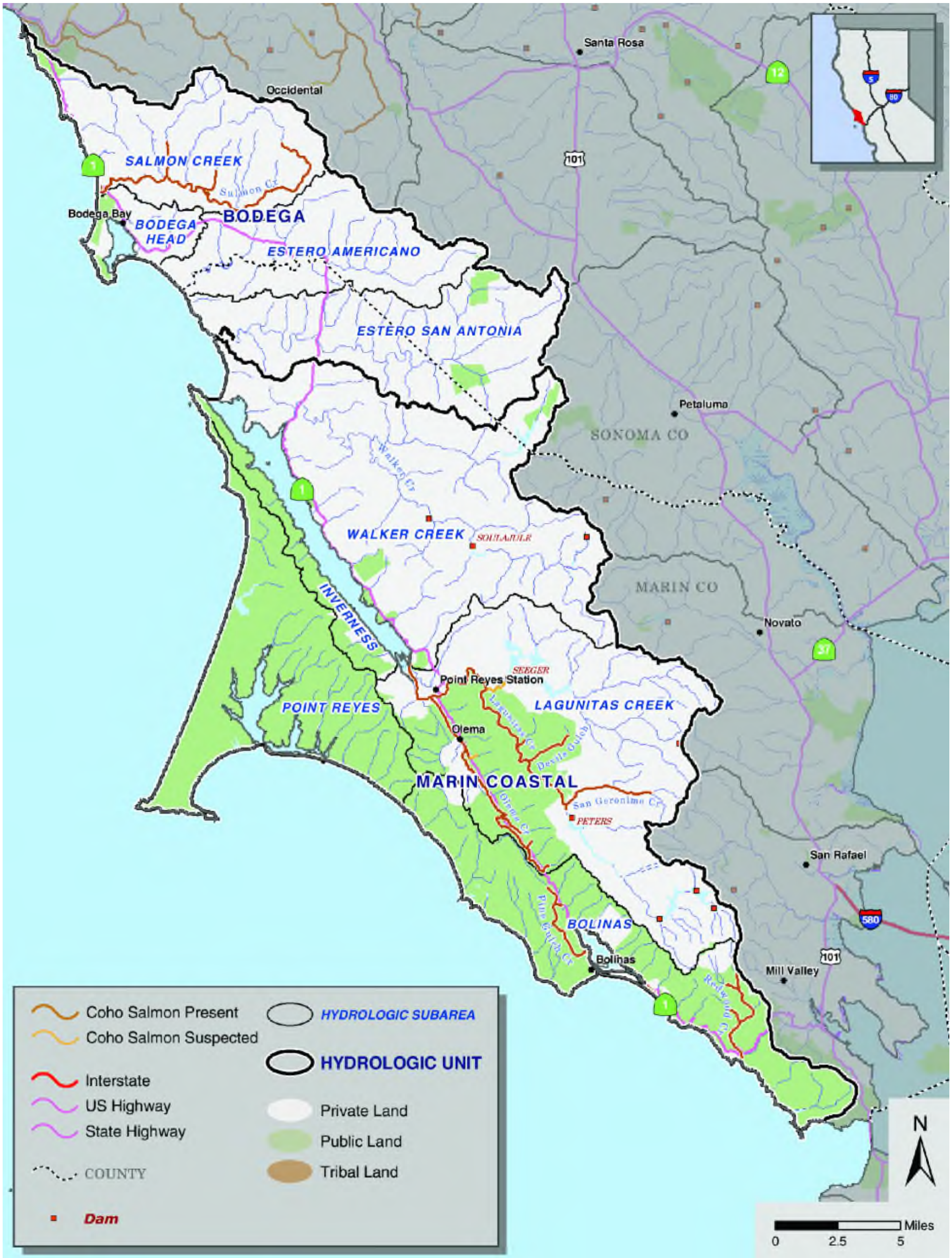
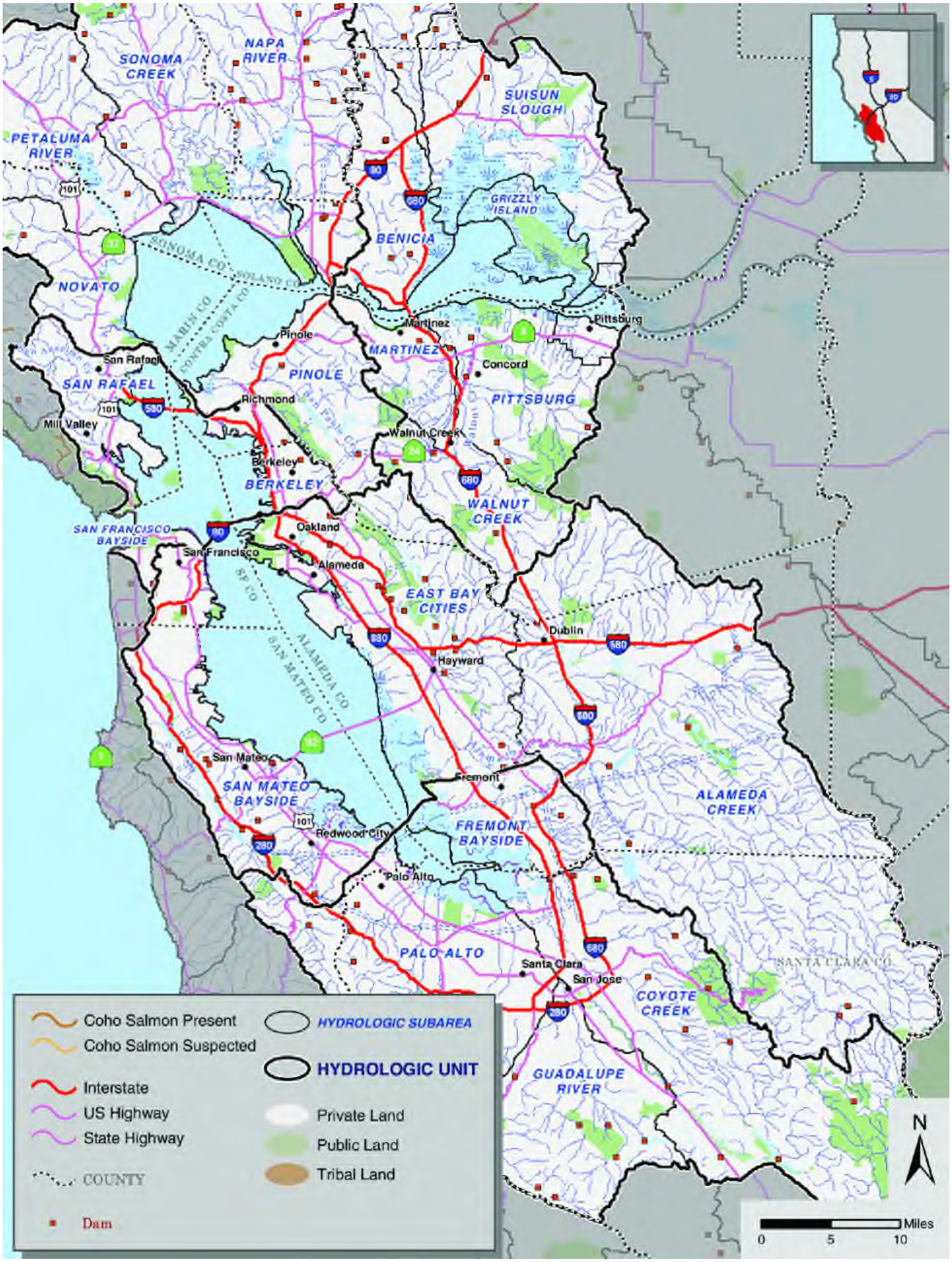


FIGURE 6-20: San Francisco Bay Hydrologic Units



6.2.5.2 Año Nuevo (Gazos Creek) HSA

Gazos Creek is located approximately 26 miles south of Half Moon Bay in the southern part of San Mateo County. The watershed is approximately 20 square miles. There is just one year of stream flow data for Gazos Creek and the data have not been completely summarized. The mainstem of Gazos Creek is approximately 6.7 miles in length and has an additional 9.2 miles of perennial tributaries, the most significant of which are Old Womans Creek and two unnamed headwater tributaries.

Approximately six miles of Gazos Creek and one half mile of Old Womans Creek are potential coho salmon rearing habitat. DPR owns the headwater section of Gazos Creek and a small in holding of Gazos Creek at the confluence of Old Womans Creek. The remainder of the watershed is privately owned or owned by land-trusts. Land uses include agriculture, timber harvest, developments (residential and a road infrastructure), and recreation. During recent surveys (2000 to 2002), coho salmon were found inconsistently in Gazos Creek. Gazos Creek also had inconsistent presence of coho salmon during the 1990s.

6.2.6 BIG BASIN HYDROLOGIC UNIT

The Big Basin Hydrologic HU (Figure 6-22) is the southern end of the coho salmon range and has been significantly impacted by water diversion, urbanization, road building, riparian encroachment, timber harvest, fire suppression, and other land use practices. This HU includes the following watersheds where coho salmon are or have been historically present: Waddell Creek (20 square miles), Scott Creek (27 square miles), San Vicente Creek (11 square miles), San Lorenzo River (138 square miles), Soquel Creek (23 square miles), and Aptos Creek (25 square miles). All are located entirely within Santa Cruz County. Streams in this HU originate in the Santa Cruz Mountains and flow west or southwest to the Pacific Ocean. They are generally well shaded and summer water temperatures seldom exceed the high 60s (°F); however, some streams or stream sections are too warm for coho salmon rearing.

Because rain and run-off are extremely rare in this HU during summer and fall months and watershed areas are relatively small, stream flows during summer and fall are a critical issue for the survival of coho salmon. Most channel-forming flows and flows necessary for migration of adult coho salmon occur from December to April. These flows breach the sandbars that are common at the mouth of most local streams. Reduced flow and depth due to water diversions may impede migration of adult and juvenile coho salmon between storms, and the range of rearing juveniles is severely limited by water depth during dry months and drought. Reduction of surface flow by pumping of underflow is particularly problematic, because the structures and their effects are relatively difficult to identify and because de-watering is often related to the cumulative effects of many structures and diversions. There are recorded water rights within the Big Basin HU, in addition to unregistered riparian diversions and wells affecting underflow. The use of wells to extract flow from mapped and un-mapped subterranean streams is a significant and growing issue in this HU.

The Monterey Bay Salmon and Trout Project, a cooperative salmonid rearing project under permit from the Department, operates the Kingfisher Flat Fish Hatchery, located on Big Creek (tributary to Scott Creek). Coho salmon production at the Kingfisher Flat Fish Hatchery, utilizing Scott Creek and San Lorenzo River fish, began in the winter of 1986/87. Hatchery operations have been sporadic since then, dependent on the availability of returning broodstock. The hatchery now operates under the principles of a conservation hatchery. There are few definitive data on historical coho salmon abundance in this HU. Coho salmon distribution is generally limited to the relatively high-order, low-gradient streams and stream sections. Most brood-year lineages appear to be extirpated or weak in most watersheds, although Waddell and Scott creeks appear to have one or two relatively strong brood-year lineages, respectively. Significant problems for coho salmon in the Big Basin HU include low stream flow, high sediment loads, and lack of LWD.

6.2.6.1 Davenport HSA

This HSA is comprised of the watersheds of Waddell, Scott, and San Vicente creeks. Together, they cover an area of about 150 square miles (Waddell and Scott creeks are located a few miles north of the town of Davenport in the northern part of Santa Cruz County). San Vicente Creek flows through Davenport. The mainstem of Waddell Creek is approximately 4.8 miles in length and has several perennial tributaries, the most significant of which are east and west branches of Waddell and Henry creeks. All 4.8 miles of the mainstem and six miles of the tributaries are potentially usable rearing habitat. Approximately 90% of the watershed is in Big Basin Redwoods State Park, with the remainder in private holdings. Land uses include recreation, minor residential development and road infrastructure, timber harvest, and agriculture.

The mainstem of Scott Creek is 11 miles in length with an additional 29 miles of perennial tributaries, the most significant of which are Little, Big and Mill creeks and Bettencourt Gulch. Approximately eight miles of the mainstem and 5.6 miles of the tributaries are considered potentially suitable rearing habitat. DPR has small in-holdings in the headwaters; however, the majority of Scott Creek watershed is privately owned. Land use in the watershed includes timber harvest, agriculture, residential development and a road infrastructure, equestrian trails and cattle grazing. Water use is variable and includes storage reservoirs in the headwaters of Big and Mill creeks, wells and surface diversions for domestic uses throughout the watershed, and wells and surface diversions for agricultural purposes in the lowermost portion of the watershed.

The mainstem of San Vicente Creek is approximately 9.3 miles in length and has an additional 11.3 miles in perennial tributaries, the most significant of which is Mill Creek. However, only 2.5 miles of the mainstem and less than one-quarter mile of the tributaries are estimated to be potentially usable coho salmon rearing habitat. At stream mile 3.4, the creek discharges from a mining tunnel. This prevents anadromous salmonids from ascending the upper portion of the watershed. Water diversion dams located at stream miles 0.5 and 0.75 on Mill Creek prohibit fish from utilizing the upper four miles of this tributary. San Vicente Creek does not have a lagoon; instead, the creek flows through a bedrock tunnel before discharging directly onto a beach and into the Pacific Ocean.

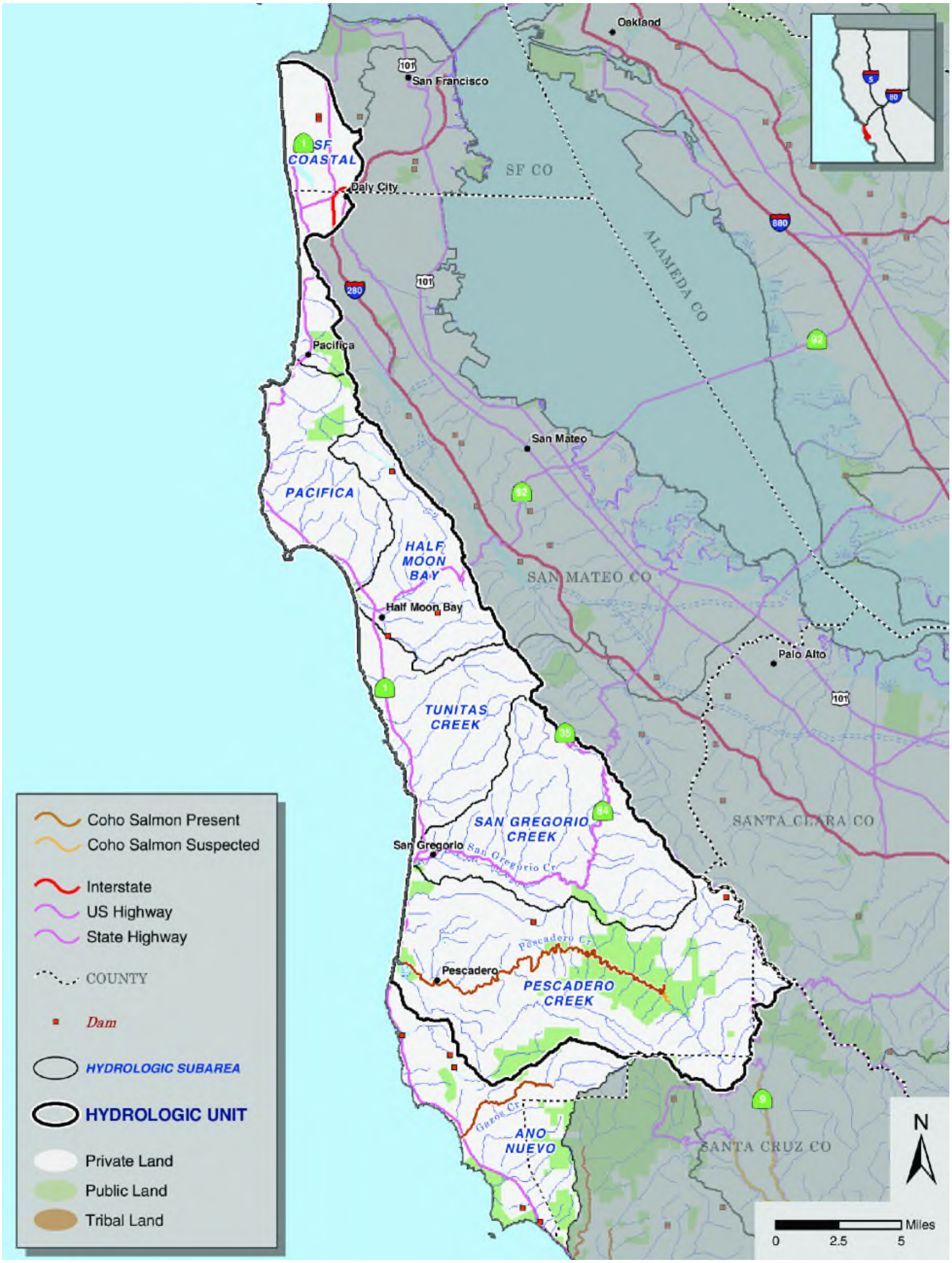
There are few definitive data on historical coho salmon abundance in this HSA due to limited field sampling. However, it is clear that coho salmon have been extirpated from many tributaries and all brood-year lineages have too few individuals to be self-sustaining. During recent surveys (2000 to 2002), coho salmon were found consistently in Scott Creek and some of its tributaries, but less consistently in Waddell Creek.

6.2.6.2 San Lorenzo River HSA

The San Lorenzo River originates in the Santa Cruz Mountains, and flows in a southerly direction before entering the Pacific Ocean in the City of Santa Cruz. The watershed encompasses an area of 138 square miles. The San Lorenzo River is approximately 26.3 miles in length and has several additional miles of perennial tributaries, the most significant of which are Boulder, Newell, Zayante, Fall, Kings, Bean, Carbonera, and Branciforte creeks. Approximately six miles of mainstem and 20.8 miles of tributary streams are considered potential coho salmon rearing habitat.

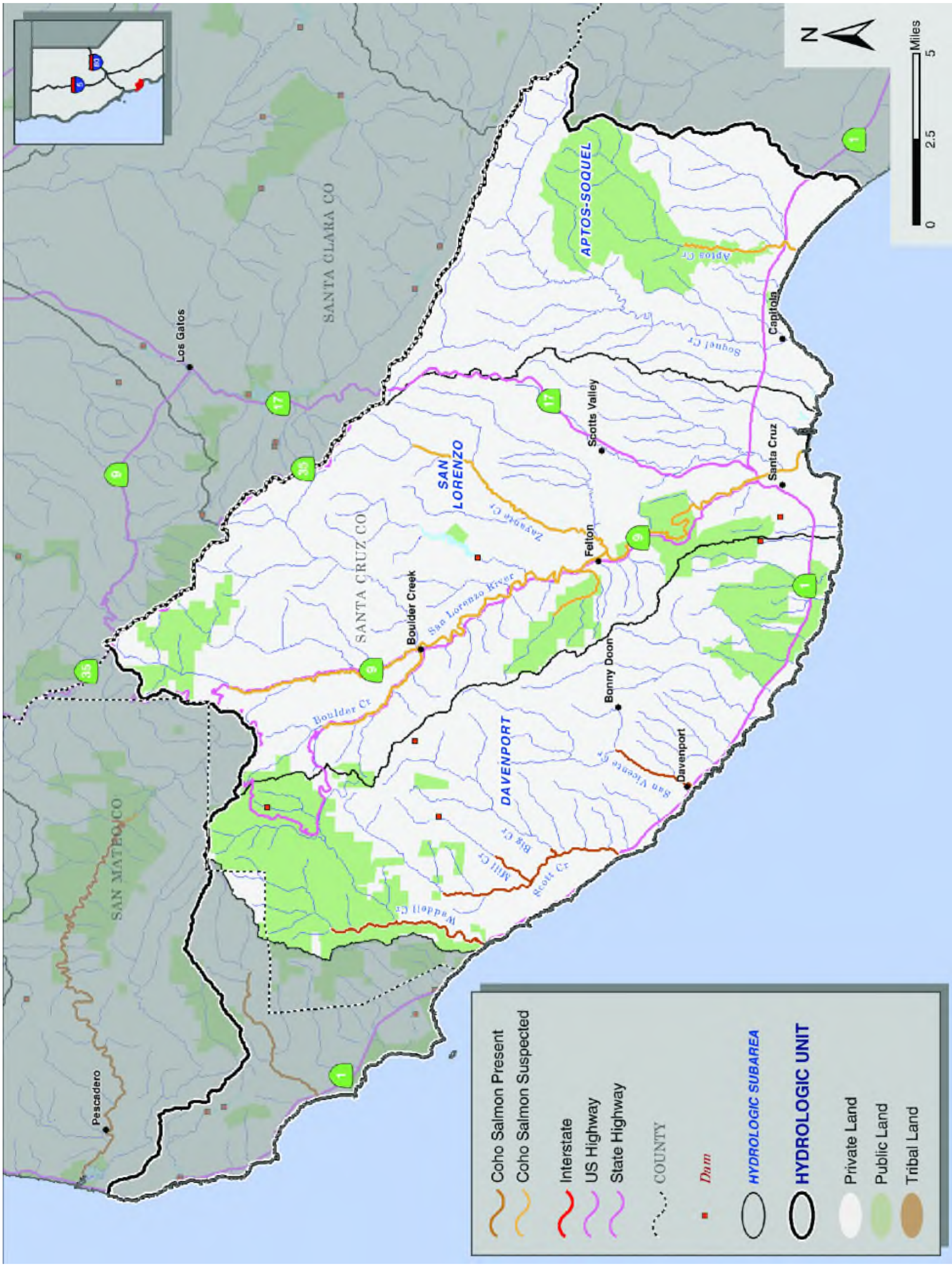
The majority of the watershed is privately owned. Land use in the watershed includes residential and commercial development, an extensive road infrastructure, timber harvest, agriculture, limited cattle grazing, recreation, equestrian facilities, and quarry operations. The San

FIGURE 6-21: San Mateo Hydrologic Unit



6 RECOVERY UNITS AND WATERSHEDS

FIGURE 6-22: Big Basin Hydrologic Unit



Lorenzo River watershed provides water to the communities of San Lorenzo Valley and Santa Cruz, thus stream flows are a critical issue in this watershed. During recent surveys (2000 to 2002), no coho salmon were found in the San Lorenzo River or any of its tributaries.

6.2.6.3 Aptos-Soquel HSA

This HSA is comprised of the watersheds of Soquel and Aptos creeks. Together, they cover an area of about 48 square miles. Soquel Creek is located approximately 2.5 miles south of the City of Santa Cruz in Santa Cruz County. Its mainstem is approximately 19 miles in length and has an additional 28 miles of perennial tributaries, the most significant of which are the West Branch Soquel Creek, and Hinckley, Hester, Bates, and Moores creeks. Approximately nine miles of the mainstem and tributaries are considered potentially usable coho salmon rearing habitat.

The Soquel Demonstration State Forest is approximately 4.2 square miles and essentially all other property in the watershed is privately owned. Land uses include residential and commercial development, an extensive road infrastructure, timber harvest, agriculture, recreation, quarry operations, limited cattle grazing, and equestrian activities. The City of Capitola actively manages the lagoon by building the sandbar and using a concrete flume. Because of extensive private ownership and water diversions, the resulting low summer and fall streamflows are a significant issue in the Soquel Creek watershed. In the 1970s, water rights in the Soquel watershed were adjudicated by court decree. The adjudication established relative priorities among diverters in the watershed, but did not specifically consider instream flow needs for fish protection and did not call for the appointment of a watermaster.

Aptos Creek is located approximately 8.5 miles south of the city of Santa Cruz in Santa Cruz County and enters the Pacific Ocean at Seacliff State Beach in the town of Aptos. Its mainstem is approximately 11.5 miles in length, but a 16-foot-high waterfall located at approximately stream mile 9.4 precludes anadromous salmonids from utilizing the headwaters. There are eight additional miles of perennial tributaries, the most significant of which are Bridge and Valencia creeks.

About 8.5 miles of Aptos Creek mainstem and approximately five miles of tributaries are considered potential coho salmon rearing habitat. To facilitate beach access, DPR manipulates the mouth of Aptos Creek each summer so that it discharges directly to the ocean. Most of Aptos Creek is owned by DPR (i.e., Nisene Marks State Park) or is privately owned; however, a small portion is owned by Santa Cruz County. Bridge Creek lies entirely within the State Park and Valencia Creek is entirely in private ownership. Land uses include residential and commercial development, a road infrastructure, recreation, agriculture, equestrian stables, and timber harvest. During recent surveys (2000 to 2002), no coho salmon were found in Aptos or Soquel creeks.

6.3 WATERSHED PRIORITIZATION

The Recovery Strategy incorporates a three-tiered process to prioritize watersheds for coho salmon recovery. This approach:

a. Identifies for maintenance and recovery those watersheds supporting key coho salmon populations in California and identifies those populations that are currently at risk of extinction;

b. Provides a ranking system for guiding recovery planning actions among watersheds; and

c. Identifies those watersheds with barriers to migration that could be corrected with ease, relative to other solutions.

This process was developed from a review of data available for coho salmon and their watersheds throughout California, as well as CRT discussions. Maps developed to guide recovery actions are provided below (Figures 6-23 through 6-30). Appendix F describes how these maps were developed and defines terms used in the following discussion. The maps, and criteria used to develop them, should be considered general guidelines for watershed recovery planning and restoration actions rather than absolute.[1]

6.3.1 GENERAL PRINCIPLES

In HSAs considered refugia for coho salmon, the Recovery Strategy will include actions that preserve, protect, and enhance these key populations and their habitats. These HSAs, identified in Figures 6-23 and 6-24 (Consistent presence of coho salmon in the SONCC and CCC Coho ESUs, respectively), are top priorities for Department resources and other resources available for habitat restoration.

Each population of coho salmon potentially represents unique genetic and life history attributes. Some populations of coho salmon are at greater risk of extinction than others, particularly those in the central coast of California. Identifying these populations will enable resource managers and others to guide actions to avoid extinction and begin recovery. HSAs in which populations of coho salmon are at high risk of extinction, identified in Figures 6-25 and 6-26 (Risk of extinction in watersheds of the SONCC and CCC Coho ESUs, respectively), will receive special consideration for maintenance and recovery actions.

Ranking of HSAs relative to their potential for coho salmon recovery is intended to guide recovery strategy actions that may improve habitat within these watersheds. This ranking incorporated information on coho salmon populations, HSA condition, and risks to coho salmon within these HSAs. HSAs scoring higher in this ranking should be given priority in the expenditure of resources available for restoration, other considerations being equal. HSA rankings for maintenance and recovery actions are presented in Figures 6-27 and 6-28 (Restoration and management potential in the SONCC and CCC Coho ESUs, respectively).

Recovery strategy actions in HSAs with barriers to migration will include providing passage for both juvenile and adult coho salmon. The distribution of barriers is illustrated in Figures 6-29 and 6-30 (disconnected habitat in the SONCC and CCC Coho ESUs, respectively). HSAs with quality habitats and few barriers should be viewed as cost-effective opportunities to provide increased habitat, relative to other recovery strategy actions.

The databases used to generate the maps and support this prioritization should be updated periodically, perhaps at three- to five-year intervals. This would allow review and modification, if warranted, of the HSA rankings.

Finally, the prioritization criteria proposed is for recovery of coho salmon, as per CESA and FGC, and may or may not apply to other salmonid species such as Chinook salmon, steelhead, and coastal cutthroat trout.

[1] Some situations may override or alter recommended priorities. Examples include, but are not limited to, willing landowners, high cost shares, unique funding opportunities or partnerships, multi-species projects, etc. Cost effectiveness must be considered regardless of priorities.

6.3.2 PRIORITIZATION PROCESS

The three steps followed to prioritize the watersheds are described in this section.

6.3.2.1 Identify Refugia Watersheds (Figures 6-23 and 6-24) and Risk of Extinction (Figures 6-25 and 6-26)

Rationale: Those HSAs in the SONCC Coho ESU with consistent presence of greater than 50% should be considered refugia watersheds. HSAs in the CCC Coho ESU having consistent presence of greater than 10% should also be considered refugia watersheds. However, even these watersheds have problems that could reduce productivity and these problems should be addressed.

Risk of extinction to coho salmon is ranked on watershed risks and coho salmon population parameters, since population abundance and genetic data are not available range-wide. The ranking combines risk (human density, water diversions, road density) and population parameters (consistent presence of coho salmon, isolation index for coho salmon populations, and run length of coho salmon populations). Those HSAs in which risk of extinction is high should be given equal priority as refugia watersheds.

Anticipated Actions:

a. On public lands, consider full maintenance and recovery of instream and riparian areas.

b. On private lands, provide incentives for riparian maintenance and recovery strategy activities that maintain and enhance coho salmon habitat.

c. Identify any problems within these watersheds and recommend actions (for example; restoring estuarine habitats in Eureka Plain, Redwood Creek and Smith River).

d. Prioritize biological refugia watersheds in the application of California coho salmon range-wide recommendations.

6.3.2.2 Identify Restoration Potential (Figures 6-27 and 6-28)

Rationale: HSAs with high scores for recovery strategy actions are known to support populations of coho salmon and have potential habitat that has been compromised. Coho salmon populations in HSAs ranking high (4-5) in the combined population, risk and habitat potential categories should have potential to respond when restoration actions are taken.

Anticipated Actions:

a. Determine if near-term (< 9 years) actions are adequate to maintain these populations at their current level.

b. Determine if near-term and long-term actions will allow for expansion of these populations in all brood years.

c. If identified recovery strategy actions satisfy categories (a) and (b) above, use the prioritization scheme to guide watershed restoration and other identified recovery strategy actions. If identified recovery strategy actions do not satisfy categories (a) and (b) above, then recommendations must be upgraded.

d. Develop recommendations specific enough to direct restoration actions.

e. Work with existing watershed groups in priority HSAs and with willing landowners on watershed assessments to develop specific actions to restore coho salmon habitat.

6.3.2.3 Identify Disconnected Habitats (Figures 6-29 and 6-30)

Rationale: Eliminating barriers to migration is among the most effective restoration actions that can be taken. Barriers to migration limit the distribution of coho salmon and limit recovery potential. Removing barriers, including but not limited to those created by Federal, State, county or private road culverts, rail crossings, tide gates and small impoundments are high priorities. Addressing levees for flood control, access over larger impoundments, or other hydraulic or thermal barriers may present greater challenges, but must also be considered important components of disconnected habitats.

Anticipated Actions:

a. Identify and map the specific locations of barriers and score barriers using two criteria: 1) the amount of coho salmon habitat made accessible by their removal and 2) the relative ease or cost of their removal (culverts, tide gates and small impoundments = 3, levees and large impoundments = 2, thermal and hydraulic barriers, and other barriers requiring site-specific evaluation = 1).

b. Where appropriate, implement existing recommendations that are specific enough to direct barrier elimination.

c. Develop additional, needed recommendations for barrier elimination.

FIGURE 6-23: Consistent presence of coho salmon in the SONCC Coho ESU

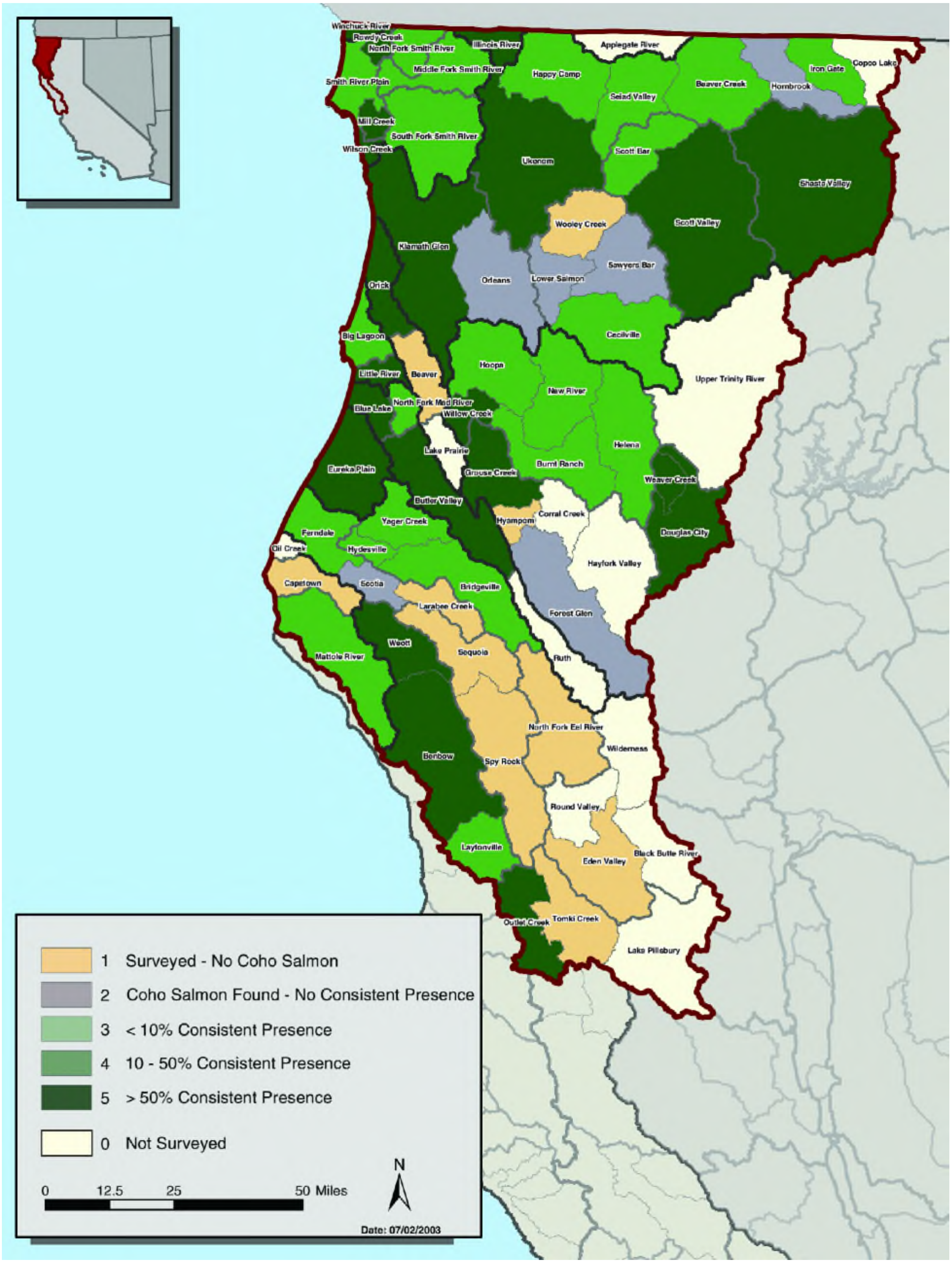


FIGURE 6-24: Consistent presence of coho salmon in the CCC Coho ESU

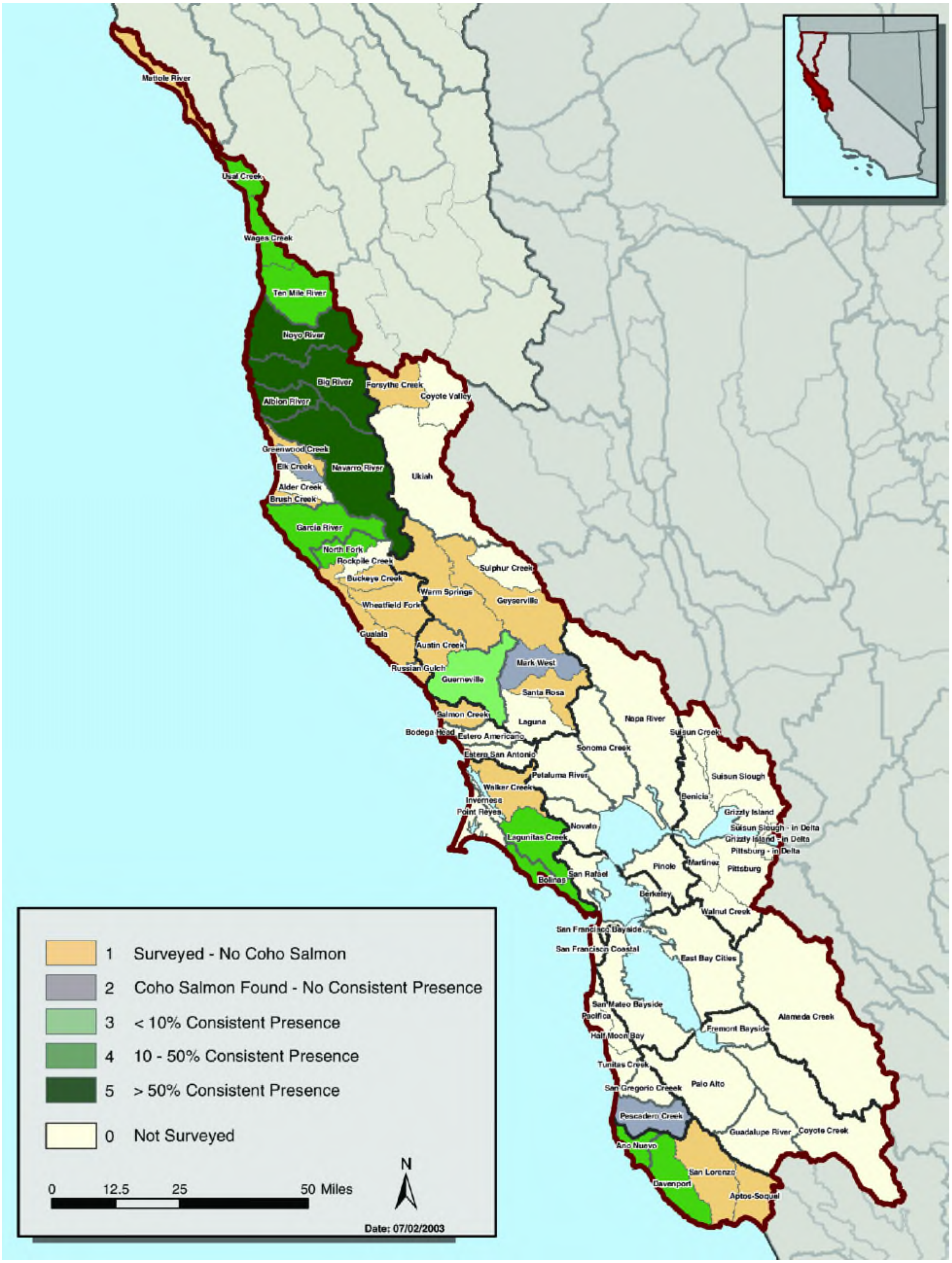


FIGURE 6-25: Risk of extinction in watersheds in the SONCC Coho ESU

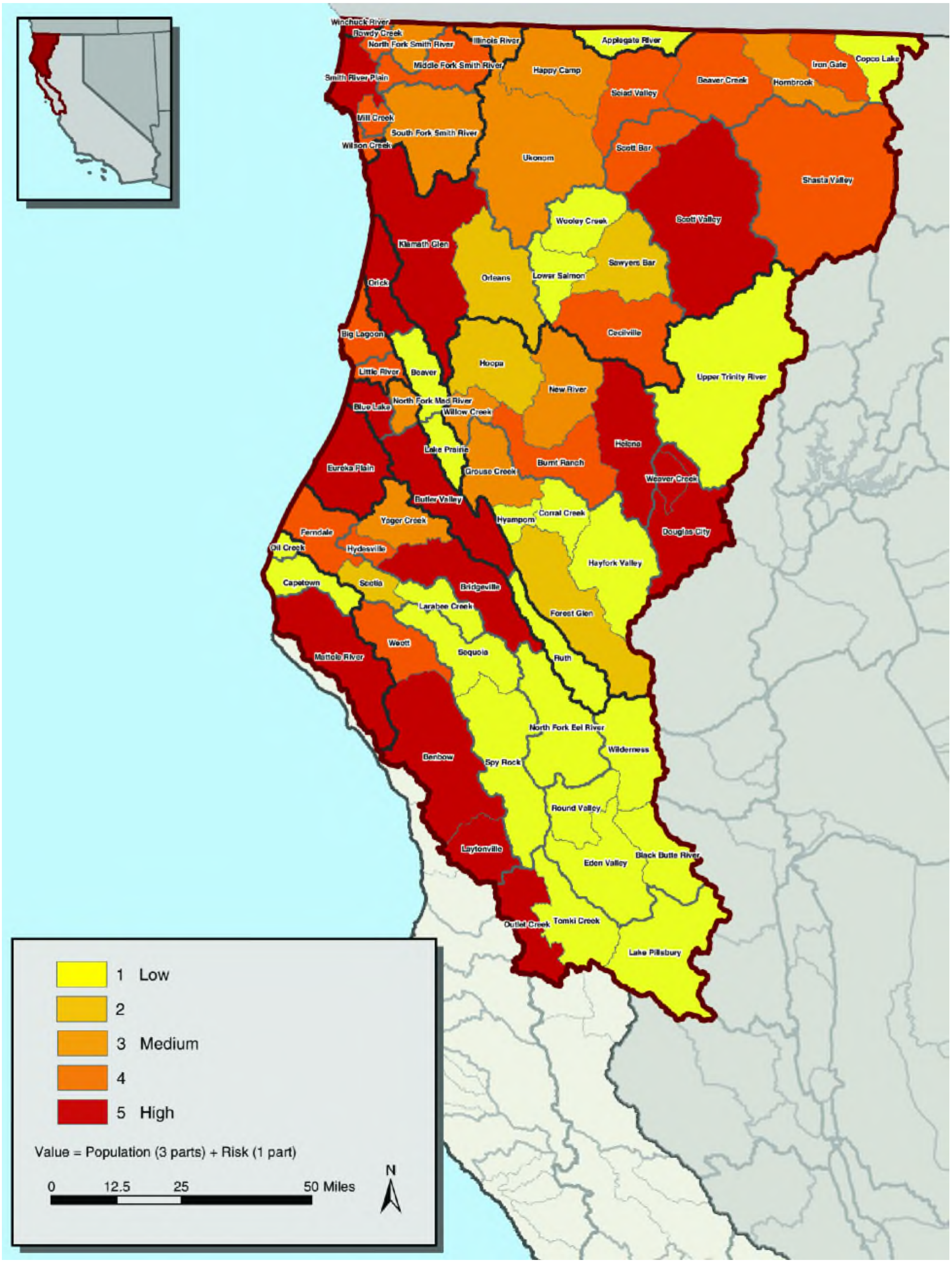


FIGURE 6-26: Risk of extinction in watersheds in the CCC Coho ESU

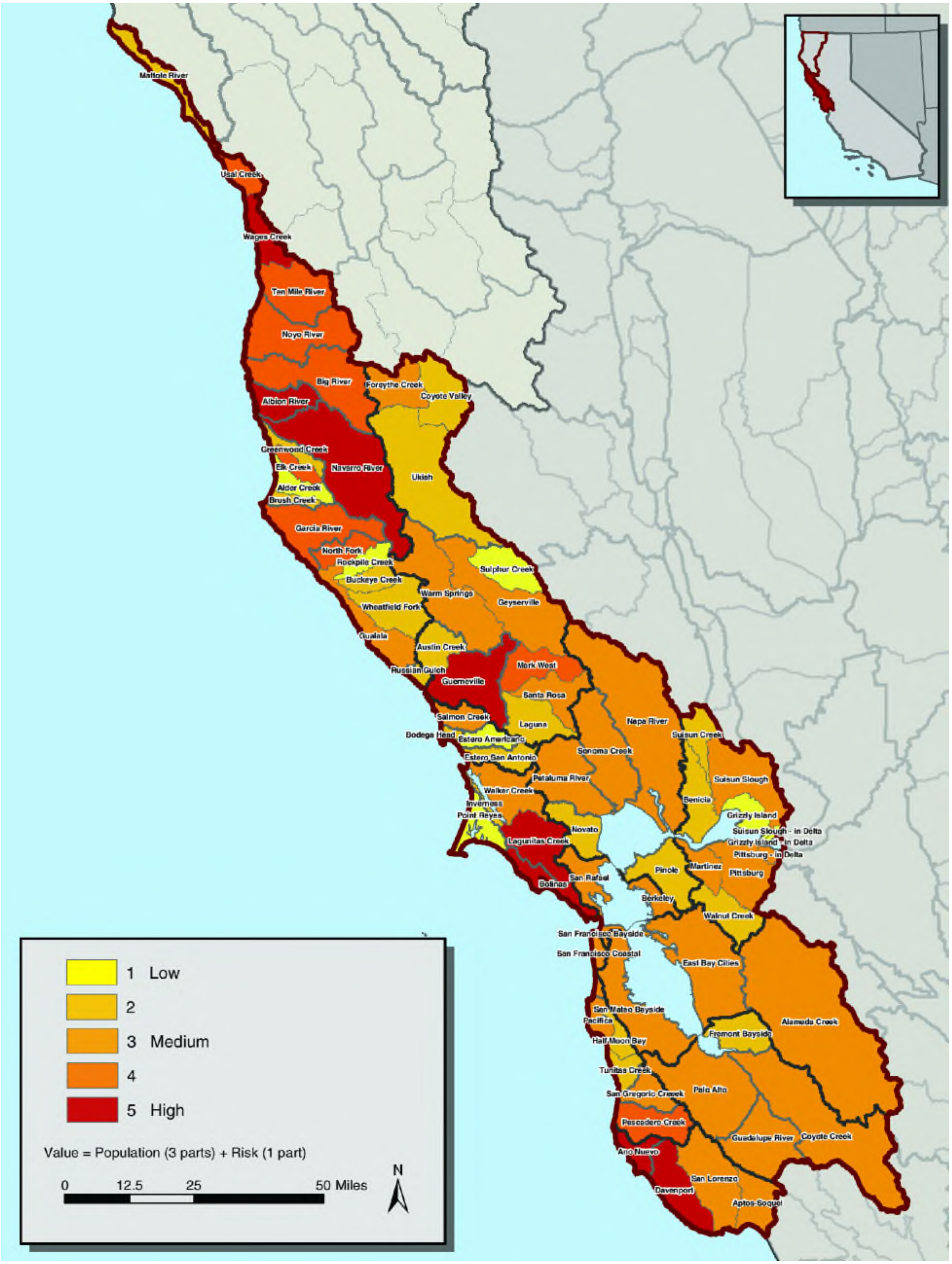


FIGURE 6-27: Restoration and management potential in the SONCC Coho ESU

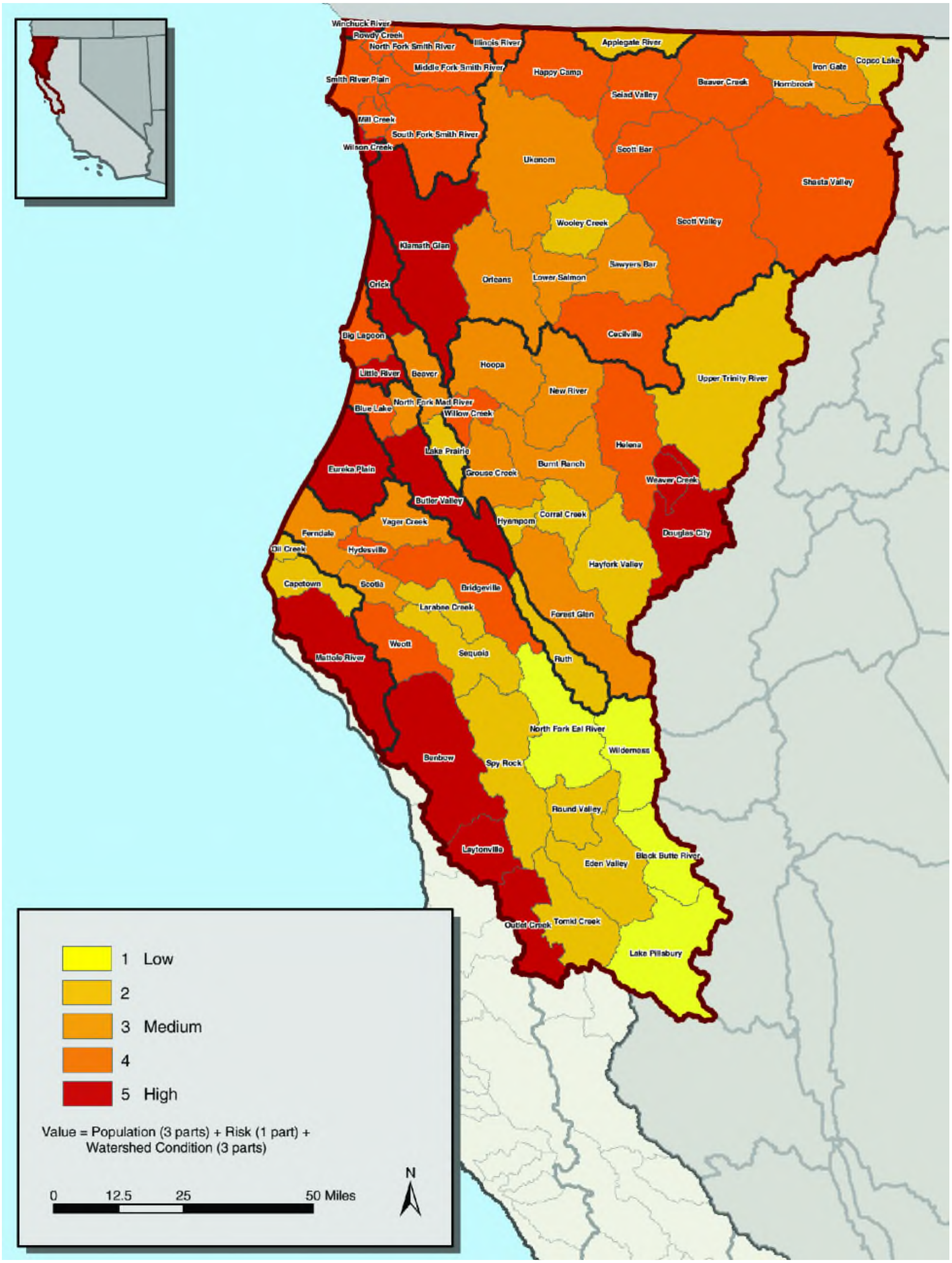


FIGURE 6-28: Restoration and management potential in the CCC Coho ESU

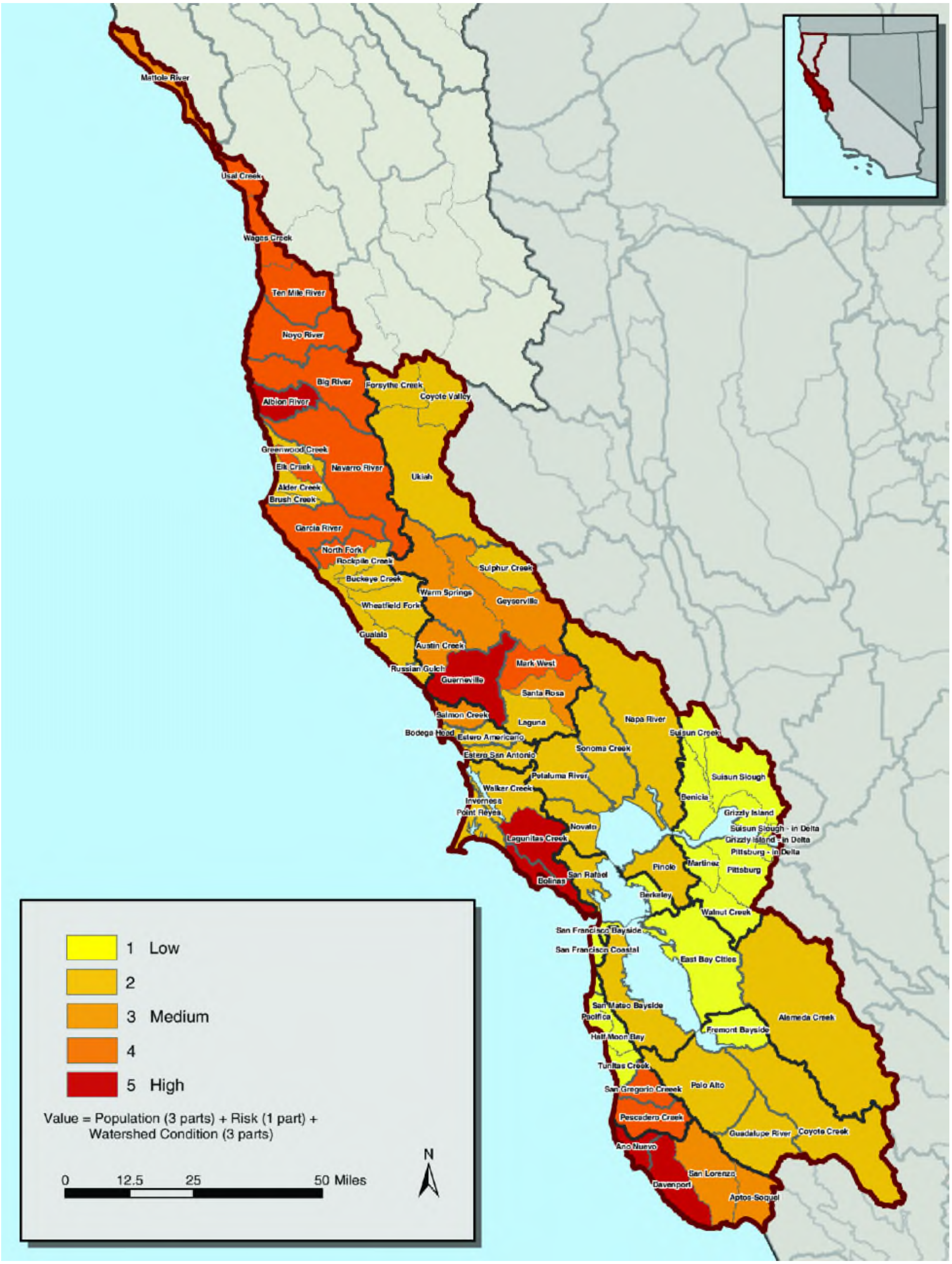


FIGURE 6-29: Disconnected habitat in the SONCC Coho ESU

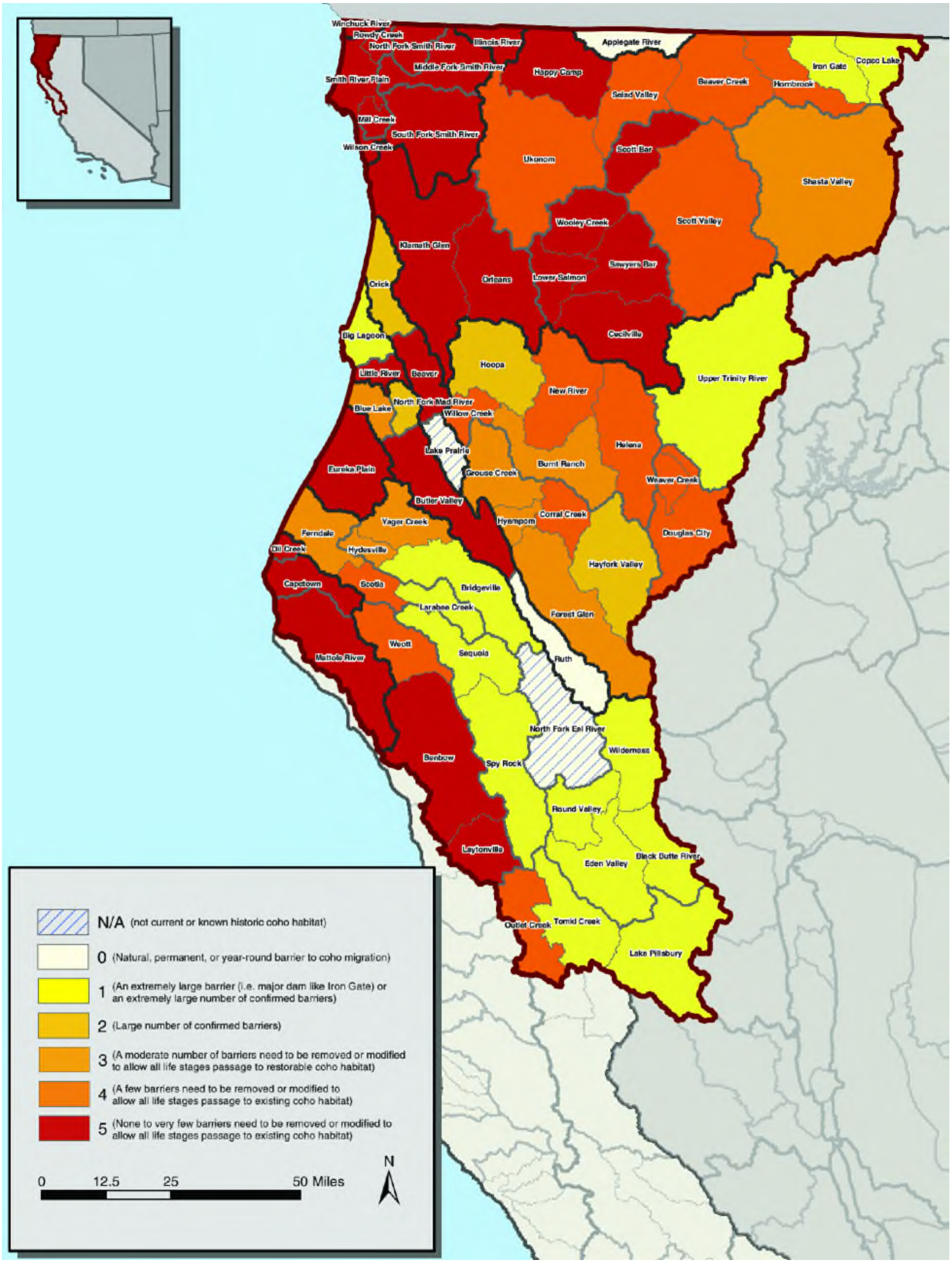
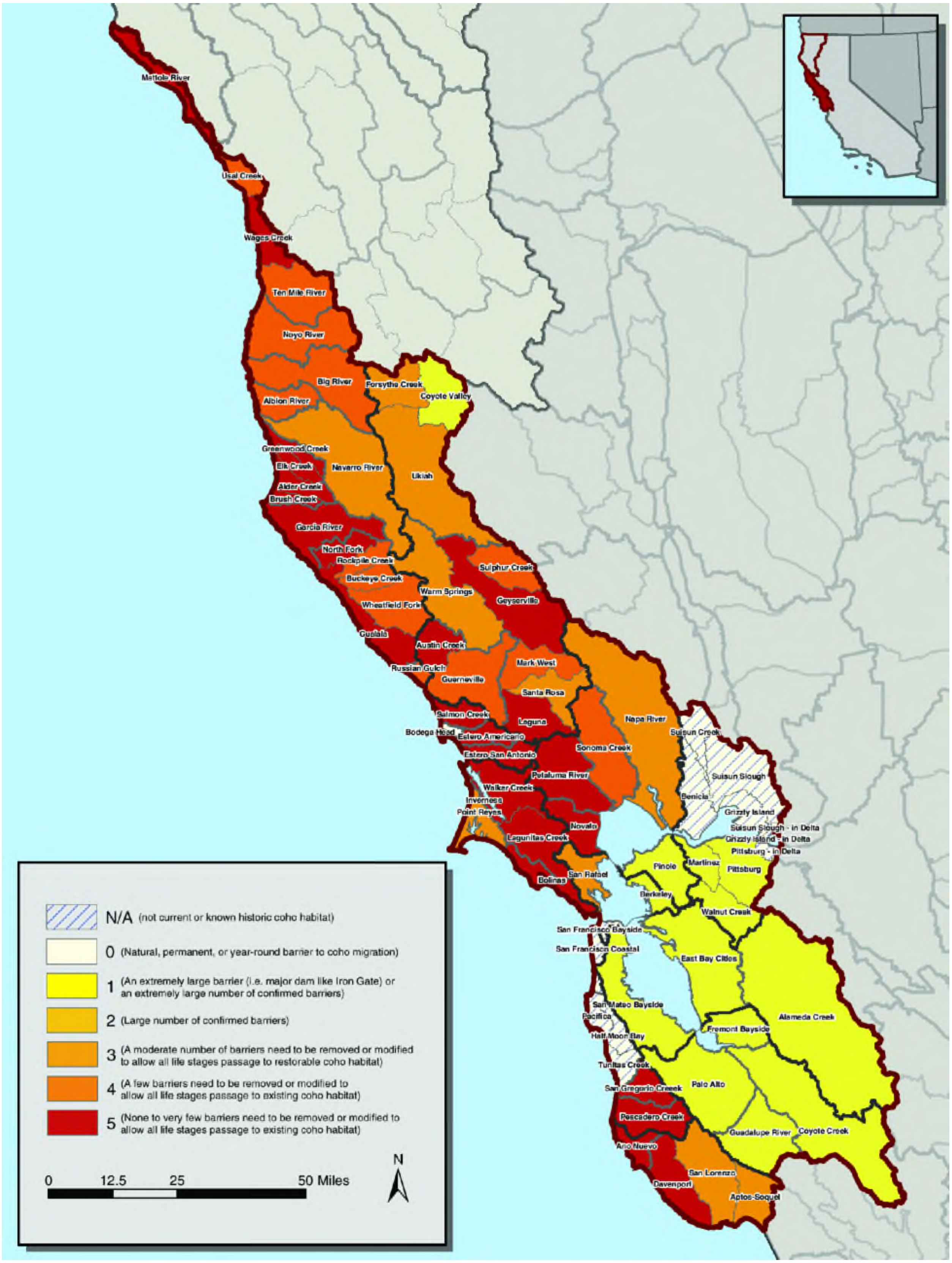


FIGURE 6-30: Disconnected habitat in the CCC Coho ESU



7 Range-wide Recommendations

Many of the potential recovery actions to address the threats and issues discussed in Chapter 3 have application across most, if not all, of the range of coho salmon in California. These issues do not necessarily threaten or impact coho salmon everywhere or to the same degree across the range. The CRT developed the following recommendations with the exception of numbers RW-LW-07, RW-LW-08, RW-IN-18, and RW-EN-24, which were developed by the Department. In a few cases, the Department has modified recommendations that were developed by the CRT. The Timber Management Recommendations (section 7.24) are a hybrid of various alternatives crafted by a subgroup of the CRT. In February 2004, the Commission approved the Timber Management Recommendations for inclusion in this Recovery Strategy. An implementation schedule, which includes identified action entities and timelines, is provided for these recommendations in Table 9-1.

Recommendation numbers presented below were used during CRT discussions and are not sequential. They are presented here only as unique identifiers for reference to individual recommendations and to maintain a permanent record of the CRT process.

7.1 STREAMFLOW

RW-I-B-01	Encourage the use of passive diversion devices designed to allow diversion of water only when minimum flow requirements are met or exceeded. Identify and develop adequate passive diversion structure designs.
RW-I-C-01	Encourage cooperative effort to plan water supply development and growth that are not harmful to coho salmon habitat. Work in coordination with the California Department of Housing and Community Development, Association of Bay Area Governments, counties, cities, water districts, and others. Provide funding and education to accomplish this.
RW-I-D-01	Encourage elimination of unnecessary and wasteful use of water from coho salmon habitat, through education components of this strategy. Encourage water conservation for existing uses.
RW-I-D-02	Improve coordination between agencies to avoid and minimize the adverse effects of future or reopened permits and licenses for water diversions on coho salmon. Promote consistency and pool limited resources to implement a regional interagency task force for regional project review (water rights, 1600, CESA). Include staff that represent the Department, SWRCB, RWQCB, NOAA Fisheries and, where applicable, other agencies. Where feasible, use programmatic, cost-efficient approaches and incentives to working with landowners to permit off-channel storage ponds. For the CCC Coho ESU, the SWRCB shall consider the June 23, 2002 Draft Guidelines developed by NOAA Fisheries and the Department in the water rights proceedings for

streams with coho salmon including season of diversion and off-stream storage, and maintenance of the natural hydrograph, where appropriate. Encourage NOAA Fisheries and the Department to work with SWRCB to modify the guidelines to be appropriate to the SONCC Coho ESU as needed.

RW-I-D-03 Provide conservation incentives to minimize negative effects of water drafting for roads and fire suppression, including, but not limited to:

a. Streamline permitting for actions that result in an improvement of instream flows;

b. Support multiple uses of water storage systems (e.g., USFS, CDF, counties, landowners); and

c. Cost-share funding where low-flow, trickle recharge water storage is used to avoid adversely affecting streamflow or coho salmon habitat.

RW-I-D-04 Evaluate the rate and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon. When feasible, use alternatives to water as a dust palliative (including EPA-certified compounds) that are consistent with maintaining or improving water quality.

RW-I-D-05 Explore ways to improve implementation of the Department's Lake or Stream Alteration Notification and Agreement process to protect coho salmon from the adverse affects of projects that would alter the bed, banks, channel, or natural flow streams.

RW-I-D-06 Pursue funding for the assessment, cataloging, and compliance monitoring of water diversions within the range of coho salmon. Upgrade the existing water rights information system so that water allocations can be readily quantified by watershed.

RW-I-D-08 Support a comprehensive streamflow evaluation program to determine instream flow needs for coho salmon in priority watersheds.

7.2 WATER RIGHTS

RW-II-A-01 Review authorized diversions that have no provisions to protect coho salmon. Review should be conducted in order of priority for streams with coho salmon habitat.

RW-II-A-02 Identify unauthorized diversions.

RW-II-A-04 Where flows are a limiting factor in priority coho salmon habitat, petition the SWRCB to add streams to the Declaration of Fully Appropriated Streams.

RW-II-A-05 Inventory water use and water availability in streams with coho salmon habitat. Ensure that water availability analyses on priority coho salmon habitat accurately reflect existing water use and availability. Require streamflow gauging devices on priority coho salmon streams when approving water development projects. Continue to require riparian and pre-1914 water users to file annual statements of diversion and use.

RW-II-B-01	Pursue opportunities to acquire or lease water, or acquire water rights from willing sellers for coho salmon recovery purposes. Develop incentives for water right holders to dedicate instream flows for the protection of coho salmon (Water Code §1707).
RW-II-B-02	Evaluate the cumulative effects to coho salmon from the creation of new riparian water rights associated with land subdivisions and rezonings. Where cumulative impacts on flows will be detrimental to coho salmon, consider mitigations or conditions that would protect coho salmon or avoid adverse effects to coho salmon. Conditions could include requirements that would not allow riparian water rights for new parcels at the time subdivision approvals are made.
RW-II-B-03	Within the range and distribution of coho salmon, diversion screens should be constructed, repaired, upgraded, reconstructed, and maintained in accordance with Department/NOAA Fisheries Screening Criteria.

7.3 FISH PASSAGE

RW-III-A-01	Continue and complete assessments and prioritizations for correction of fish passage barriers.
RW-III-A-02	Develop and maintain a database of barriers to fish passage.
RW-III-C-01	Encourage funding authorities to allocate adequate resources to construct new crossings and upgrade existing crossings (bridges, culvert and fills, other crossings) within the range of coho salmon to accommodate 100-year flows and associated bedload and debris. Priority for upgrading should be based upon the potential impact to coho salmon habitat.
RW-III-C-02	Evaluate NOAA Fisheries standards for passage at summer dams, and if necessary, develop additional policies and guidelines for passage at summer dams. Implement appropriate recommendations resulting from this process.
RW-III-C-04	Encourage the Federal Emergency Management Agency (FEMA) to fund upgrades to flood-damaged facilities to meet the requirements of the ESA.
RW-III-C-06	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies for fish passage projects. This includes, but is not limited to, funding for road maintenance programs and capital project activities.

7.4 POLLUTANTS

RW-V-B-01	Improve water quality by reducing or minimizing point and non-point sources of nutrient input (i.e. sewage treatment plant discharge, septic system discharge, storm drain runoff, and agricultural runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.
RW-V-E-01	Continue outreach, education, and enforcement related to hazardous materials spills, illegal dumping, and household hazardous waste and hazardous materials spills in creeks. Provide education on the CalTIP program.

RW-V-E-03 Continue to fund and support the CalTIP program. Provide additional training for Wardens to identify water pollution problems and promote coordination with other responsible agencies. Coordinate water rights training for resource agency personnel.

7.5 SEDIMENTS

RW-VI-A-02 Identify and prioritize specific sediment source locations for treatment that may deliver sediment to coho salmon streams. Encourage the use of protocols, such as the California Stream Habitat Restoration Manual Guidelines. Work with others to educate and provide technical assistance to landowners to implement upgrades.

RW-VI-B-01 Encourage agencies and landowners to restore natural drainage patterns and minimize hydrologic connectivity of roads, where feasible. Encourage funding agencies to provide annual funding for implementation of the program.

RW-VI-B-02 Continue to fund and provide technical support to local government and private landowner actions to reduce identified sediment input from upslope sources. Basin-wide assessments should prioritize remediation activities, which would include slope stabilization and minimizing sediment production.

RW-VI-D-01 Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems. Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses. Support activities to:

a. Reduce road densities where necessary and appropriate;
b. Upgrade roads and road-maintenance practices to eliminate or reduce the potential for concentrating run-off to streams during rainfall events. Employ best available technology when appropriate;
c. Encourage measures to reduce sediment delivery from unpaved roads;
d. Decrease potential for streamflow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations;
e. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams;
f. Minimize alteration of natural hill slope drainage patterns; and
g. Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for fish passage projects.

7.6 WATER TEMPERATURE

RW-X-B-01 Identify and implement actions to maintain and restore water temperatures to meet habitat requirements for coho salmon in specific streams.

RW-X-B-02 Offer funding and permit incentives to restore stream habitat where lack of LWD, riparian cover, simplified stream morphology and other conditions have been determined to be limiting factors to coho salmon habitat.

7.7 LARGE WOODY DEBRIS

RW-XII-B-01a Identify those riparian vegetation communities that provide good opportunities for conifer LWD recruitment to coho salmon habitat. Communicate the importance of these riparian communities to appropriate agencies, restoration funding groups, and landowners, and work to maintain them in a healthy condition. Address and identify possible solutions to potential conflicts between flood management activities and maintenance of riparian vegetation and large woody debris.

RW-XII-B-01b Prioritize riparian vegetation communities for the purposes of restoring conifer LWD recruitment.

RW-XII-B-02 Funding authorities should provide funding and technical support for riparian restoration.

RW-LW-07 Encourage management practices that promote conifer recruitment to provide short-term and long-term restoration of LWD and stream shade.

RW-LW-08 Encourage Federal, State, and county agencies and private landowners to protect instream LWD to the greatest extent practicable without endangering public safety, life or property.

7.8 STREAM COMPLEXITY

RW-XIII-C-01 Modify channel or flood control maintenance manuals for consistency with habitat requirements and protection for coho salmon.

RW-XIII-C-02 Where appropriate and feasible, work with all parties, including landowners, to reconfigure levees and channelized streams to benefit coho salmon.

7.9 REFUGIA

RW-XV-A-01 Identify key coho salmon refugia and inform land managers and other agencies of their locations and characteristics.

RW-XV-A-02 Identify core coho salmon populations, inform land managers and other agencies of their locations, and implement measures to maintain those populations.

RW-XV-B-01 Maintain or re-establish geographic distribution of coho salmon by continuing to allocate substantial improvement efforts towards identified key refugia with substantial coho salmon populations and/or otherwise suitable conditions.

7.10 HABITAT FRAGMENTATION

RW-XVI-B-01	Restore habitat connectivity between coho salmon populations in coastal and low-gradient inland streams to promote the long-term viability of coho salmon.
RW-XVI-B-02	Reduce habitat fragmentation by restoring fish passage between high quality habitat channels to allow for gene flow between breeding populations within targeted coho salmon watersheds.

7.11 COMPETITION

RW-XVIII-A-01	Develop a rapid-response eradication plan that can be implemented when invasive non-native species that negatively affect coho salmon are newly detected.
RW-XVIII-A-02	Develop management guidelines to mitigate the impacts of non-native fish species on coho salmon.
RW-XVIII-A-03	Encourage removal of non-native fish species from stock ponds where these fish pose a threat to coho salmon.

7.12 HATCHERY OPERATIONS, GENETICS, AND RELOCATION

RW-XX-B-01	Promote recovery actions that maintain the local genetic diversity of coho salmon populations to maximize fitness and long-term viability of coho salmon populations.
RW-III-C-03	Evaluate the desirability and feasibility of relocating stranded juvenile coho salmon to nearby underutilized high quality habitat. Develop a policy addressing this issue, and implement recommendations arising from the evaluation.
RW-XXI-A-01	Adopt draft policy for recovery hatcheries (Appendix G).
RW-XXI-A-02	Adopt draft guidelines for recovery hatcheries (Appendix H).

7.13 RIPARIAN VEGETATION

RW-XXII-A-02	Where necessary, provide riparian protection from livestock while providing off-stream watering.
RW-XXII-A-04	Encourage restoration of LWD and shade by improvement of existing riparian zones through planting, release of conifers or other appropriate native species, and control of blackberries and other competitors. The Department and others should provide incentives to landowners, such as technical support.
RW-XXII-A-05	Inventory and evaluate on a site-specific basis the adequacy of stream buffer zones and riparian and wetland habitat on public and private lands. This review should be coordinated between all agencies with regulatory jurisdiction.
RW-XXII-A-06	Develop and implement initiatives, including funding where appropriate, to improve stream buffers that have been determined to be inadequate.

7.14 ESTUARIES

RW-XXIII-E-01 Restore estuarine habitat and the associated wetlands and sloughs by providing fully functioning habitat. Fully functioning habitat includes:

a. Restoration of historic estuarine areas to maximize available estuarine habitats and tidal prisms;
b. Free passage for adult and juvenile coho salmon to all estuarine areas;
c. Adequate instream structure (cover and complexity);
d. Adequate riparian habitat;
e. Eradication of invasive exotic flora and fauna;
f. Protection of habitat quality by providing suitable water quality and quantity input to estuaries;
g. Protection and restoration of coho salmon prey habitat; and
h. Minimizing artificial breaching and associated potential negative impacts.

7.15 LAND USE

RW-XXV-A-01 Continue providing subvention funds to counties for Williamson Act contracts to help preserve a rural landscape for more effective recovery of coho salmon.

RW-XXV-B-03 Where necessary, revise General Plans, Local Coastal Plans, and/or Community Development Plans to direct development away from riparian habitats on coho salmon streams or tributaries. Establish incentives and standards to protect riparian and wetland areas on private lands, based on flexible subdivision design and other cooperative land development mechanisms.

RW-XXV-B-04 Encourage continued economically sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development.

RW-XXV-B-05 Evaluate range-wide the adequacy of riparian buffers and development setbacks where needed for protecting riparian and wetland habitat on county, city, and private lands adjacent to coho salmon streams.

RW-XXV-B-07 Develop and implement county, city, and landowner initiatives to expand inadequate stream buffers and protect riparian and wetland habitat for coho salmon recovery.

RW-XXV-C-01 Acquire conservation easements or land in fee title from willing landowners to protect coho salmon habitat.

7.16 PUBLIC OUTREACH

RW-XXVIII-A-01	Develop and provide informative programs for Registered Professional Foresters, Licensed Timber Operators, and other natural resource professionals regarding coho salmon and their habitat.
RW-XXVIII-A-03	The Department and the Commission should set up a periodic recognition program for watershed groups and stakeholders that are helping to implement the coho salmon recovery strategy.
RW-XXVIII-B-01	Support local governments, interested parties, and property owners in the development of incentives for landowners who participate in activities that exceed legal requirements or timelines to protect and/or restore coho salmon habitat and watershed processes.
RW-XXVIII-B-03	Encourage local governments to incorporate protection of coho salmon in flood management activities consistent with Department, RWQCB, NOAA Fisheries, and USACE requirements.
RW-XXVIII-B-04	Provide information to staff of counties and incorporated areas about the importance and requirements to develop and implement performance standards in Stormwater Management Plans.
RW-XXXIII-A-23	Provide educational materials, outreach and training for issues such as sport fishing (inadvertent incidental take), poaching (direct take) and habitat destruction (LWD removal, riparian destruction, illegal stream crossings, pollution, illegal water withdrawal, etc.).
RW-XXVIII-C-01	Educate and train restoration specialists and watershed restoration groups on the coho salmon recovery strategy.

7.17 INTEGRATION WITH OTHER PLANS AND PROGRAMS

RW-XXX-A-01	The California Board of Forestry should continue to support the Threatened and Impaired Watersheds Rules.
RW-XXX-A-02	Recommend that CDF amend FPRs to require that Registered Professional Foresters certify in timber harvesting plans that they have followed the California Licensed Foresters Association Guide to Determining the Need for Input from a Licensed Geologist during THP Preparation.
RW-XXX-A-03	Recommend that CDF use statistical analysis of land failure and sediment yield to strengthen protection in geologically unstable areas.
RW-XXX-A-04	Conduct implementation and effectiveness monitoring for Nonindustrial Timber Management Plans.
RW-XXX-B-01	As feasible, prepare and implement TMDL plans on a schedule that gives priority to key coho salmon watersheds.
RW-XXX-B-02	Request that RWQCBs' TMDL process quantify and allocate increased sediment loads that might result from restoration activities.
RW-XXX-B-05	Ensure that TMDL standards provide protection for coho salmon.

RW-XXX-B-06	Conduct outreach to State agencies and local governments to encourage their participation in the TMDL process to ensure the standards provide protection of coho salmon.
RW-XXX-D-01	Implement Fire Safe Councils' recommendations promoting the reduction of fuel near residences, while addressing impacts to other listed species, to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.
RW-XXX-D-03	Encourage agencies and stakeholders to work together on a long-term basis to develop a process to incorporate coho salmon recovery considerations in fire reduction and fuel management strategies.
RW-XXX-D-04	Establish fire regimes to promote watershed function and health and to reduce the risk and impact of extensive, high severity fire on coho salmon and habitat.
RW-XXX-D-05	Identify areas within coho salmon range that are susceptible to extensive, high severity fires.
RW-XXX-D-06	Identify State of perturbation (=disturbance regime) in watersheds within coho salmon range to determine potential, deleterious shifts from ecological functioning regimes.
RW-XXX-D-07	Restore aquatic habitat structure and life history complexity of coho salmon populations in areas susceptible to extensive, high severity fires.
RW-XXX-E-01	Continue to implement FishNet 4C and Five County Salmon Restoration goals, including adopting and implementing written Operations and Maintenance Guidelines, training staff on guidelines, addressing fish passage and road sedimentation issues, developing riparian protections, promoting alternatives to conventional bank stabilization, and developing land use policies favorable for coho salmon.
RW-XXX-E-02	Incorporate the FishNet 4C and Five County adopted Roads Operations and Maintenance Guidelines within incidental take authorizations under CESA and as part of the coho salmon recovery strategy.
RW-XXX-F-01	Encourage NOAA Fisheries to work with USACE to reduce the impacts to coho salmon of USACE projects.
RW-XXX-J-01	After delisting is achieved, review the Recovery Strategy to determine how to continue implementation of appropriate elements of the Recovery Strategy, pursuant to and consistent with other applicable local, State, and Federal law and voluntary measures, to achieve restoration of Tribal, recreational, and commercial fisheries and avoid relisting of the species.
RW-IN-18	Encourage USFS implementation of the Aquatic Conservation Strategy as outlined in the Northwest Forest Plan, and specific Standards and Guidelines identified in the Land and Resource Management Plan for each National Forest in the range of California coho salmon.

7.18 PERMITTING

RW-XXXI-A-01 Federal, State, local governments and other interested parties should cooperate to develop regulatory assurance mechanisms to encourage land managers, local governments, and landowners to implement coho salmon habitat restoration and/or enhancement projects.

RW-XXXI-A-02 Coordinate with the SWRCB and appropriate RWCBs to implement water quality monitoring and streamline permitting of coho salmon habitat enhancement and/or restoration projects (RWQCB 401, USACE 404, NOAA Fisheries, and USFWS permitting).

RW-XXXI-A-03 Encourage State, Federal, and local governmental agencies to work with stakeholders in identifying ways to remove regulatory barriers (e.g., permitting and environmental review) to expedite activities that will contribute to the recovery of coho salmon. Examples of ideas to consider may be:

a. The creation of local permit assistance centers;

b. Seeking categorical exemptions from CEQA; and

c. Seeking a certified regulatory program under CEQA for certain activities.

RW-XXXI-A-04 Encourage the Department, NOAA Fisheries, USFWS, and USACE to coordinate and develop programmatic incidental take authorizations (e.g., 404 permits, section 7 consultations, 4(d) rules) for activities that will contribute to the recovery of coho salmon, including but not limited to the Department's Fisheries Restoration Grants Program.

RW-XXXI-A-05 Support the Department in seeking new funding to pay for environmental review and permitting of voluntary projects that will contribute to the recovery of coho salmon.

RW-XXXI-A-06 Develop and issue management memoranda of understanding under §2081(a) to participants as an incentive for voluntary activities that will contribute to the recovery of coho salmon.

RW-XXXI-A-07 Consider whether the Task Force on Removing Barriers to Restoration (Resources Agency) recommendation suggesting counties adopt ordinances to exempt restoration and/or enhancement projects from indemnification requirements is appropriate and/or desirable in the context of coho salmon recovery.

RW-XXXI-A-09 Instream restoration (structures, crossings, road decommissioning, etc.) should be allowed to begin the same time as THP activities (that require similar 1600 agreements). This would allow for an extra month in the beginning of the restoration season.

RW-XXXI-A-10 Amend grading ordinances to exempt restoration and/or enhancement activities approved by the Department fishery grants program within certain categories (specified by the county or others).

RW-XXXI-A-11 Support adequate staffing and funding for the Department restoration program to complete contracts in a timely manner (including review, site visits, etc.).

RW-XXXI-A-12 Seek a small restoration projects categorical exemption.

RW-XXXI-A-13 Create a new CEQA Categorical Exemption for barrier removals that meet the Department and NOAA Fisheries natural stream simulation criteria for passage.

RW-XXXI-B-02 Encourage State, Federal, and local governmental agencies to place greater emphasis on coordinating:

a. The permitting process (including environmental review) while ensuring protection of coho salmon and their habitat; and

b. Implementation of programs affecting coho salmon.

RW-XXXI-B-06 Where mitigation for otherwise lawful activities would mitigate for authorized take of coho salmon and contribute to recovery of coho salmon, encourage the Department to streamline the incidental take permitting process by developing guidelines for allowable take and for the issuance of incidental take permits under §2081(b).

RW-XXXI-B-07 To minimize and reduce the effects of water diversions, direct the Department to work with the SWRCB, present supportive evidence, and actively participate in making recommendations needed to implement provisions of the FGC. This may include:

a. Identifying and implementing actions to improve coordination between the agencies and others to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion;

b. Funding of assessment and geographic information system (GIS) mapping of water diversions and determination and monitoring of FGC §1600 program compliance related to water diversions; and

c. Evaluating requests for on-stream dams on coho salmon streams above migratory reaches for the effects on the natural hydrograph and the effects on the supply of spawning gravel for recruitment downstream.

7.19 WATERSHED PLANNING

RW-XXXII-B-02 Provide adequate funding to the agencies to coordinate and support preparation of comprehensive watershed assessments and restoration plans that:

a. Include a professional fisheries scientist;

b. Assess streamflow, water diversions, water quality, sediment sources, fish barriers, riparian corridors, instream habitat, estuarine habitat, and land use, as necessary; and

c. Identify, prioritize, and implement site-specific restoration projects to benefit coho salmon.

RW-XXXII-B-03 Review existing, approved watershed management or restoration plans within the range of coho salmon and implement actions consistent with priority recommendations of the coho salmon recovery strategy.

7.20 ENFORCEMENT OF EXISTING LAWS

RW-XXX-C-01 Request that the Coastal Commission require landowners to fund restoration of impacted coho salmon habitat resulting from project construction without proper review and approvals.

RW-XXXIII-A-01 Support enforcement of existing laws, codes, regulations, and ordinances that address the protection of coho salmon and their habitat. Habitat includes but is not limited to water (quality and quantity), pools, riffles, instream LWD, riparian vegetation and estuaries. Existing laws, codes, regulations, and ordinances include, but are not limited to FGC §§1600, 5650, 5900 through 6100 (with an emphasis on 5901, 5937, and 6100), PRC §§ 10000-10005, CESA, and the ESA. The term "enforcement" includes, but is not limited to, education, issuing warnings, issuing citations, developing cases for referral to district attorneys offices and/or the Office of the Attorney General.

RW-XXXIII-A-02 Provide adequate budgetary funding and positions for agencies with enforcement authority to enforce laws and codes relevant to coho salmon protection.

RW-XXXIII-A-03 Review diversions and use of water in priority coho salmon streams to determine which permits and/or licenses need modification for the protection of coho salmon. Where necessary, formally request that the terms of water rights permits/licenses be modified for protection of coho salmon. This will require field studies to evaluate impacts and develop supportive evidence and formal hearings to consider proposed changes. This program must be adequately funded to be implemented.

RW-XXXIII-A-04 Agencies with the primary authority for fish and water should lead enforcement efforts and coordinate with all local, State and Federal agencies with regulatory authority affecting coho salmon.

RW-XXXIII-A-05 Request that enforcement to prevent unauthorized diversion and use of water and water permit processing a high priority. Enforcement of existing codes including Water Code §§1052 Trespass and 1831 *et seq.*, Cease and Desist. Adequate funding should be provided for enforcement and permit processing staff.

RW-XXXIII-A-06 Support continued funding for the California District Attorneys' Association's Environmental Circuit Prosecutors program and/or Environmental Project for applicable district attorney offices in the range of coho salmon.

RW-XXXIII-A-07 Dedicate fines from violations affecting coho salmon or coho salmon habitat to coho salmon recovery and restoration activities consistent with the Department's Coho Salmon Recovery Strategy, including but not limited to education and outreach. Emphasis should be placed on keeping fine money in watersheds where the violation occurred to address existing coho salmon restoration plans and projects. This recommendation applies to fines that are not otherwise mandated by law to be directed to other purposes.

RW-XXXIII-A-08 Examine penalty schedules and, if necessary, explore ways to adjust penalty schedules to reflect the impact of violations to coho salmon, taking into account other penalties that may be enforced in association with the same activity.

RW-XXXIII-A-10 Develop an outreach/information and education program that targets agency personnel, judges, district attorneys, the Attorney General's Office, municipalities, and other affected or interested parties concerning the status of coho salmon and the value and importance of coho salmon resources and coho salmon recovery. Provide educational materials, outreach and training for issues such as sport fishing (inadvertent incidental take), poaching (directed take) and habitat destruction (LWD removal, riparian destruction, illegal stream crossings, pollution, illegal water withdrawal, etc.).

RW-XXXIII-A-11 Discourage illegal dumping, poaching, and other illegal activities by promoting "neighborhood watch" programs for streams and/or watersheds.

RW-XXXIII-A-14 Support funding for increased enforcement of existing laws against dumping of toxic substances.

RW-XXXIII-A-18 Require adequate review, as staffing allows, of all applications for proposed projects that may impact coho salmon

RW-XXXIII-A-27 Establish environmental task forces made up of State, local, and Federal enforcement agencies that operate in the range of coho salmon.

RW-XXXIII-A-28 Increase funding for the Department's CalTIP program.

RW-XXXIII-A-29 Seek programmatic incidental take authority with respect to screen design and installation that conforms to Department/NOAA Fisheries screening criteria.

RW-EN-24 Encourage Federal, State, and county agencies and private landowners to protect instream LWD to the greatest extent practicable without endangering public safety, life or property.

7.21 IMPLEMENTATION

RW-XXXIV-A-01 Provide funding and incentives for projects that exceed requirements of existing law and/or expedite timelines required by law. All commitments of State and local agencies are subject to availability of funding. Funding and incentives provided by State fishery restoration accounts should be prioritized as follows:

a. Projects that exceed requirements of existing law and/or expedite timelines required by current law;

b. Projects that were installed in accordance with laws and standards in effect at the time the work was done;

c. Projects that contain elements of a. and b. above; and

d. Projects that do not meet elements of a. and b. above, but which are not a part of new development or under enforcement actions.

Projects that are mitigation for new development or activities under enforcement actions are not fundable.

RW-XXXIV-A-02 Support continued and increased funding for the California Conservation Corps to implement coho salmon restoration projects throughout the entire range of California coho salmon.

7.22 INSTREAM GRAVEL EXTRACTION

RW-XXXV-A-01 Within known or historic coho salmon habitat, permits for instream gravel extraction should require:

a. A total yearly extraction volume proportionally based on the long term mean average recruitment of gravel into the mining reach;

b. An extraction strategy that will promote species recovery by retaining sufficient gravel to preserve and restore the alluvial structure necessary for forming and maintaining critical physical habitat in, up- and downstream of the mined reach; and

c. A monitoring plan capable of demonstrating that the extraction strategy is successful.

These conditions may not be necessary if it can be determined that the extraction volume and method protect coho salmon and their habitat (including, but not limited to, protection of habitat attributes such as water quality, riparian vegetation, and the geomorphic features that control local hydraulics and safeguard the physical processes that create and maintain habitat).

7.23 ASSESSMENT, MONITORING, AND RESEARCH

RW-XXIX-B-03 Support research necessary to better understand crucial uncertainties regarding coho salmon ecology. Four important issues area:

a. Genetic relatedness and health;

b. Potential of local adaptive differences to environmental factors;

c. Identifying specific refugia, including non-natal rearing areas; and

d. Stream nutrient enrichment and cycling needs for coho salmon.

RW-XXIX-C-01 Evaluate and prioritize coho salmon issues and questions in need of research.

RW-XXIX-C-01a Develop and maintain a coho salmon species and recovery data/information system for compiling, analyzing, and distributing information on the status and trend of coho salmon and the status of coho salmon recovery.

RW-XXIX-D-04 The Department, NOAA-Fisheries, CDF, California Geological Survey (CGS), in cooperation with the landowners and representatives of the CRT, should develop a comprehensive system to gather, evaluate and manage monitoring information associated with the elements set forth in the Assessment, Monitoring, and Research section of the Recovery Strategy.

RW-XXIX-E-01 Coho salmon restoration activities should consistently use field tested implementation, effectiveness, and validation monitoring protocols.

RW-XXIX-F-01 Support immediately needed assessments necessary to better understand population and life-history uncertainties, such as:

a. Relative abundance;

b. Spawning sites/success;

c. Estuary use;

d. Barriers to juveniles;

e. Over-wintering growth and survival; and

f. Ocean condition effects on coho salmon populations.

RW-XXIX-G-01 Coho salmon recovery shall be guided by the strategic, long-term monitoring program being developed as a California coastal salmonid assessment and monitoring program.

RW-XXIX-G-02 Assessment and prioritization of actions within a watershed should precede implementation of comprehensive restoration plans in a subbasin or basin to ascertain the most crucial factors for coho salmon and habitat. This should not preclude prompt implementation of specific, obvious beneficial projects or measures already recommended in the Recovery Strategy.

RW-XXIX-H-01 Support the expenditure of restoration dollars, including Fisheries Grant Restoration funding, to research, monitor, and evaluate the effectiveness of restoration. This may require amending the PRC to allow research as an eligible project type.

RW-XXX-C-02 The Recovery Team recognizes that the Department has authority to collect data on navigable waterways. In addition, the CRT recommends the Department develop a data collection and sharing policy that:

a. Requires permission of private landowners for access across private lands to collect data where such access is desired;

b. Disclosure of data collected from private lands in a form or by a means that protects landowner privacy (i.e., disclosure of data at stream-reach level or other appropriate scale that protects landowner privacy, but also shows the relationship to the nearest tributary confluences);

c. Disclosed data must be quality assured and quality controlled;

d. Disclosure should include metadata files indicating who collected the data, and how and for what purposes the data were collected;

e. If requested, disclosed data should be in electronic form if it already exists in that form.

f. Data requests should be responded to in a timely manner, recognizing limitations of staff and budgets can affect processing requests.

7.24 TIMBER MANAGEMENT

ALT-C-01 CRT recommends government commitment of adequate financial, material, and personnel support for the life of the Recovery Strategy for on-the-ground recovery actions, identified in the Recovery Strategy. Possible funding mechanisms may include:

a. Legislation specifically identifying funding for recovery;

b. Cost-share programs with private landowners, stakeholder groups and local governments; and

c. Endowment and/or grant programs cooperatively with private sources.

ALT-C-02 The Department should provide technical expertise to support appropriate cooperatively undertaken recovery actions, which may include:

a. Technical advisors to assist in the development of restoration proposals;

b. Technical expertise to assist in the implementation of recovery activities on-the-ground; and

c. Technical expertise to assist in training and education on coho restoration projects.

ALT-C-03 The Department should develop and implement a program to design and implement a coho salmon recovery plan for individual CALWATER Planning Watersheds. The program should promote and enable cooperative working relationships between agencies, landowners and residents. This program should include:

a. Federal and State funding to assist landowners in performing watershed analysis in a manner usable by the Department;

b. A systematic evaluation at the watershed level to identify key limiting factors for the recovery of coho salmon;

c. Identification of site-specific sources and locations of the key limiting factors;

d. Identification of restoration projects for watershed transportation systems, fish passage, slope stabilization measures, erosion control measures and drainage structures;

e. Identification of beneficial management practices to protect existing values; and

f. Use of these plans and the data that support them as the principle reference document, which would save landowners and/or project proponents additional costs associated with repetitive analysis and paperwork for each project.

ALT-C-04 The Department should develop an information repository system for individual Planning Watersheds that utilizes and builds upon existing information, adding new information as it becomes available, while ensuring adequate confidentiality for information specifically pertaining to an individual's private property.

ALT-C-05 The Department should promote and support programmatic approaches to address key limiting factors in each CALWATER Planning Watershed with a watershed plan. Include these components:

a. Where appropriate and where costs to landowners are offset by monetary assistance, technical assistance or regulatory incentives, encourage landowners to develop and implement Road Management Plans that contribute to the restoration of coho salmon habitat;

b. Where appropriate and where the costs to landowners are offset by incentives, encourage the use of a licensed engineer to assist in the design and construction of watercourse crossings;

c. Continuing education and training (classroom and field) to ensure watercourse crossings are appropriately designed, constructed and maintained;

d. Cooperative habitat restoration projects that extend across ownerships to address habitat restoration efforts in a coordinated and cost effective manner; and

e. State funding to assist landowners to implement coordinated watershed riparian vegetation improvement programs that:

   i. Identify areas within the riparian zone where planting of riparian vegetation, including conifers, to improve coho salmon habitat is appropriate and

   ii. Promote vegetation modification (e.g., thinning, removal of undesired competitive vegetation) to accelerate riparian vegetation recovery and enhancement for coho salmon habitat.

ALT-C-06 The Department should set up a long term monitoring system that measures the implementation and effectiveness of FPR in effect at the time of the monitoring. The monitoring shall measure the effectiveness of the rules for maintenance and recovery of coho salmon habitat.

ALT-C-07 Encourage CDF and California Geological Survey in concert with the Board of Forestry (through the Monitoring Study Group) to develop a monitoring program to evaluate whether mitigation measures implemented by Registered Professional Foresters as part of THPs are effectively reducing the risk of mass soil movement associated with harvesting operations, including road and landing construction. Any monitoring system should be designed to compare harvested areas to non-harvested areas so it can be determined whether harvesting, road and landing construction activities increase the likelihood of mass soil movement. The THP work completion report and the Monitoring Study Group's Hillslope Monitoring Program, as well as periodic air photo flights and photo interpretation, could provide the basis for monitoring and evaluation.

ALT-C-08 CDF document voluntary efforts taken by forest landowners beneficial to coho salmon that:

a. Provide mitigation measures that exceed FPRs requirements; and/or

b. Are identified in specific CALWATER Watershed Recovery Plans.

ALT-C-09 The Department should develop a system to evaluate implementation and effectiveness of voluntary efforts to recover coho salmon populations.

ALT-C-10 The Department should develop, with appropriate peer review, a long-term consolidation and analysis of resource assessments and monitoring data.

ALT-C-11 The Department should collaborate with CDF and appropriate industry groups to provide watercourse training and roads assessment watershed academy.

ALT-C-12 Acquire conservation easements or land in fee title from willing landowners to protect coho salmon habitat.

ALT-C-13 The Department should seek funding for staff to improve effectiveness of the Department timberland conservation program.

ALT-C-14 Continue participation in full review of THPs and participation and other timberland conservation activities associated with managing timberlands.

ALT-C-15 In watersheds with coho salmon, the Department will prepare a "coho salmon biological assessment" when acting as a Lead or Responsible agency under the California Environmental Quality Act (CEQA) for timberland conservation activities, including but not limited to the review of timber harvesting plans. A "coho salmon biological assessment" is an assessment by the Department of project effects, if any, on coho salmon. The biological assessment will include conclusions by the Department regarding potential for the project to "jeopardize" the long-term survival of or "take" coho salmon. It will also include the Department's assessment of the significance of project impacts for purposes of "mandatory findings of significance" under 14 CCR §15065 (a), (b), and (c).

ALT-C-16 In conjunction with CDF, qualified landowners representatives and experts, and qualified independent scientists with appropriate expertise, and consistent with the availability of staff, the Department will monitor for five years (or more if necessary to develop an adequate sampling regime) the implementation of the FPR in effect at the time to determine whether these rules are consistent with the long-term survival of coho salmon.

ALT-C-17 If results of monitoring, based on substantial evidence as the term is defined by 14 CCR §15384, conclude that the implementation of the FPR s are not providing adequate protection for the long-term survival of coho salmon, the Department in cooperation with CDF and interested stakeholders will develop recommendations to ensure adequate protection for the long-term survival of coho salmon.

ALT-B-19 Recommend that a "proof of concept" pilot program be developed and implemented to test a mathematical or scientific method of cumulative effects analysis as was suggested in the 2001 report, "A Scientific Basis for the Prediction of Cumulative Watershed Effects" (otherwise known as the "Dunne Report"), by the U.C. Committee on Cumulative Watershed Effects. The pilot program would be developed and implemented by a panel of experts such as those at U.C. in cooperation with the Department, CDF, and SWRCB.

ALT-B-20 Recommend that CDF and the Board of Forestry work with the Department and other interested agencies and stakeholders to establish a procedure for THPs to document and evaluate the implementation and effectiveness of coho-related mitigation measures prior to the official completion inspection by CDF and other agencies.

8 Watershed Recommendations

Range-wide recommendations for recovering coho salmon in California are presented in Chapter 7. While some issues and risks facing coho salmon are constant across the entire range, others are unique to an ESU. Additionally, issues and risks for coho salmon populations and their associated habitat (both current and historic) vary substantially by recovery unit watersheds. Accordingly, the Recovery Strategy emphasizes recovery recommendations and activities at various hydrologic levels.

To aid the Department in the development of the Recovery Strategy, the CRT identified issues and developed recommendations, the vast majority of which are included in the Recovery Strategy. Several recommendations were developed after the last CRT meeting, and therefore, the CRT did not have the opportunity to review these recommendations. In a few cases, the Department has modified some of the recommendations that were developed by the CRT. Implementation schedules for the SONCC and CCC Coho ESUs are provided in Chapter 9, with additional implementation for the SSPP in Chapter 10.

The recommendations were developed for two geographic levels, the HU, which generally corresponds to major watersheds or sub-regions within the range of coho salmon, and within each HU by HSA, which generally corresponds to major tributary watersheds. In a few cases recommendations are presented for the HA, a unit intermediate in scale between the HU and the HSA. In some cases where adjacent HUs have similar characteristics and issues they are presented in a combined section (e.g., Bodega and Marin Coastal HUs, and the multiple HUs tributary to San Francisco Bay).

Recommendation numbers presented below were used during CRT discussions. They are presented here only as unique identifiers for reference to individual recommendations and to maintain a permanent record of the CRT process.

8.1 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS ESU

Recommendations for the SONCC Coho ESU in California are presented in this section.

8.1.1 ROGUE RIVER AND WINCHUCK RIVER HYDROLOGIC UNITS

8.1.1.1 Illinois River HSA

RO-IR-01	Develop a long-term plan to promote retention of LWD.
RO-IR-02	Support continued control of sediment.
RO-IR-03	Monitor impacts of suction dredge activities for deleterious affects on coho salmon, taking corrective measures when needed.
RO-IR-04	Develop a cooperative management strategy with Oregon Department Fish and Wildlife to improve downstream habitat conditions.

8.1.1.2 Winchuck River Hydrologic Unit/Winchuck River HSA

WR-SF-01 Develop a short-term plan to increase LWD until natural recruitment can be restored.

WR-SF-02 Develop a long-term plan to restore a mature coniferous riparian zone to South Fork Winchuck River.

WR-SF-03 Support the assessment, prioritization, and treatment of sources of sediment.

8.1.2 SMITH RIVER HYDROLOGIC UNIT

SR-HU-01 Develop and implement a program to control exotic vegetation, particularly canary grass, which impedes access to and use of tributaries by coho salmon.

SR-HU-02 Assess, prioritize and treat barriers to passage and other impediments to use (including water diversion), especially those blocking access to and use of smaller tributaries, including Cedar, Clarks, Morrison, Peacock, Sultan and Little Mill creeks.

SR-HU-03 Develop and implement a plan to restore the effectiveness and use of off-channel areas, sloughs, and wetlands. Yontocket, Tillas and Tryon sloughs should be given immediate attention. Since a portion of Yontocket Slough is State property, the restoration of connectivity and functionality of this slough should be given priority.

SR-HU-04 Investigate the feasibility of restoring channelized reaches of streams to natural meander belts (e.g., Lower Rowdy and Dominie creeks) that would allow recruitment of stored spawning gravel, re-establish scour pools, recruit woody debris from banks, and ultimately restore fluvial processes that maintain coho salmon habitat.

SR-HU-05 Improve the quality and quantity of deep pools, spawning gravels, and cover by measures to:

a. Protect existing LWD recruitment potential through the retention of mature coniferous trees in the riparian zone;
b. Establish adequate streamside buffer areas that are protected from vegetation removal;
c. Increase the amount of in-channel LWD;
d. Continue to review THPs; and
e. Continue riparian management projects with ranchers.

SR-HU-06 Assess the impacts of steelhead outplanting by the Rowdy Creek Hatchery.

SR-HU-07 Adequately treat legacy sources of sediment and provide for minimization of new sediment input.

SR-HU-08 Support the use of the existing watershed coordinator to aid in implementing recommendations.

8.1.2.1 Mill Creek HSA

SR-MC-01 Assess, prioritize, and treat sediment sources (mostly legacy roads).

SR-MC-02 Develop and implement a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.

SR-MC-03 Develop and implement a revegetation plan for the riparian zone that includes planting of coniferous species, along with the release of conifers from competitors, such as alders and blackberries.

8.1.2.2 Wilson Creek HSA

SR-WC-01 Work with landowners to determine the amount of LWD necessary for improved flushing, pooling and habitat conditions for coho salmon, facilitate immediate placement, and develop a plan for long-term recruitment.

SR-WC-02 Develop a plan to increase connectivity of riparian habitat through fencing and planting.

SR-WC-03 Support the assessment, prioritization, and treatment of sources of sediment.

8.1.2.3 Smith River Plain HSA

SR-PL-01P Support the assessment, prioritization, and treatment of barriers to passage.

8.1.3 KLAMATH RIVER HYDROLOGIC UNIT[1]

KR-HU-01 Facilitate development of an adaptive management plan in preparation for low-flow emergencies in cooperation with the USBR, NOAA Fisheries, the USFWS, the Department of the Interior (DOI), tribes, the SWQCB and other stakeholders.

KR-HU-03 Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.

KR-HU-04 Develop a plan, including a feasibility analysis, for coho salmon passage over and above Iron Gate and Copco dams to restore access to historic habitat.

KR-HU-07 Analyze the feasibility and appropriateness of site-specific 2084 authorization for sport fishing for hatchery coho salmon.

KR-HU-08 Complete comprehensive flow study activities (e.g., Hardy Phase II), and use them to educate water managers on how to reduce impacts to coho salmon.

KR-HU-09 Apply protective down-ramp rates at Iron Gate Dam to minimize stranding of coho salmon fry.

KR-HU-10 Support efforts to improve quality of water entering the Klamath River mainstem from the upper Klamath River basin.

KR-HU-11 Perform cost/benefit analysis of full or partial hydroelectric project removal for the purposes of improving water quality, coho salmon passage, and sediment transport.

KR-HU-13 Ensure that uplands in key cold-water tributaries are managed in a way that preserves their cold-water thermal regime.

1 Recommendations for Klamath River HU do not include the Salmon River HA, Shasta Valley HA, Scott River HA, or the Trinity River HU, all of which are listed below.

KR-HU-14 Investigate coho salmon non-natal rearing and refugia use in lower reaches of tributaries and mainstem confluences. Protect and enhance tributary reaches identified as providing refugia to coho salmon juveniles.

KR-HU-15 Address water quality and quantity problems in Klamath River tributaries that exacerbate mainstem water quality problems.

KR-HU-16 Assess hatchery operations in terms of coho salmon recovery in accordance with the policies and guidelines included in this recovery strategy.

KR-HU-17 Continue disease monitoring of juvenile coho salmon emigration in the Klamath River mainstem so that major disease outbreaks can be identified and their causes evaluated.

KR-HU-18 Conduct disease monitoring of migrating adult Chinook and coho salmon during fall migration.

KR-HU-19 Conduct studies in and around the Klamath River Hydroelectric Project to see if the project is contributing to habitat for the ceratomyxosis intermediate host.

KR-HU-20 Restore appropriate coarse sediment supply and transport near Iron Gate Dam. Means to achieve this could include full or partial removal of the Klamath River Project, or gravel introduction such as is done below other major dams (e.g., Trinity Dam).

KR-HU-22 Where lack of flows is a limiting factor, acquire additional water through conservation easements, purchases and/or transfers of water and water rights from willing sellers, where appropriate. Dedicate these flows to instream coho salmon needs. Water transfers would be used as an interim, emergency measure, with easements and purchases for the long-term.

KR-HU-24 Encourage water master service for all diversions by assisting with funding from the State and/or Federal government.

KR-HU-25 Promote public interest in the Klamath River Basin's coho salmon, their beneficial use and habitat requirements.

8.1.3.1 Klamath Glen HSA

KR-KG-01 Support the continuation of long-term estuary investigations to better understand the estuary's role in the survival of Klamath River basin coho salmon.

KR-KG-02 Develop a plan to restore off-channel estuarine, wetland, and slough habitat in lower Hunter and Salt creeks:

a. Determining if key properties, conservation easements, or development rights should be purchased from willing sellers; and
b. Encouraging the installation of livestock exclusion fencing to protect restored areas.

KR-KG-03 Develop a plan to maintain Blue Creek watershed tributaries as key thermal refugia and for their cool water contributions to the mainstem Klamath River. The plan should emphasize that:

a. Sediments from upslope activities do not impact the refugia;

b. Upslope stabilization and restoration activities (including road assessment and treatment) continue;

c. In-channel and riparian restoration efforts (target riparian retention efforts) continue; and

d. Feral cattle are removed.

KR-KG-04 Finalize and implement the Lower Klamath Sub-Basin Watershed Restoration Plan (Dale and Randolph 2000) to protect and restore Klamath River mainstem tributaries, even those that do not support populations of coho salmon but that provide cool water and which improve mainstem Klamath River water quality, particularly during warm summer months. Actions should:

a. Protect and/or restore riparian habitat;

b. Stabilize upslope areas to prevent sedimentation and aggradation at the mouth of tributaries; and

c. Work with Federal land managers to reduce impacts to riparian corridors and sediment loads.

KR-KG-05 Support actions to reduce sediment input from upslope sources, such as to:

a. Decommission roads and skid trails;

b. Upgrade roads and maintenance practices;

c. Ensure adequate coho salmon migration is provided for at stream/road crossings;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and

e. Minimize alteration of natural hill slope drainage patterns.

KR-KG-06 Review existing inventory and assessment of barriers (Gale 2003) and prioritize barriers impeding migration of adult and juvenile coho salmon throughout the Lower Klamath River tributaries.

KR-KG-06b Investigate temporal and spatial magnitude of tributary deltas and seasonal subsurface flow reaches to determine impacts to juvenile and adult coho salmon migration and to quantify seasonal loss of lower tributary habitat. Investigation should include assessment of long-term delta size trends, annual variation in coho salmon access periodicity by tributary, quantification of seasonal habitat loss and fish stranding, and the relation of delta and subsurface flow formation to upslope erosion, river and tributary flow, mainstem bed load deposition and other causative factors.

KR-KG-06c Conduct feasibility study to re-establish adult coho salmon passage above major barriers in lower Roaches and Tully creeks and the Middle and North Forks of Ah Pah Creek.

KR-KG-07 Support treating sediment sources and improving riparian and instream habitat conditions to provide adequate and stable spawning and rearing areas for coho salmon.

KR-KG-08 Develop a plan to restore in-channel and riparian habitat in tributaries:

a. Revegetate riparian zones with native species (e.g., conifers) to stabilize stream banks and promote a long-term supply of LWD;
b. Provide adequate protection from development, grazing, etc. for riparian areas; and
c. Relocate roads out of riparian areas where feasible.

KR-KG-09 Develop a plan to provide suitable accumulations of woody cover in slow-velocity habitats for coho salmon winter rearing on a short-term basis by placing wood in needed areas until natural supplies become available.

KR-KG-10a Construct livestock exclusionary fencing and corresponding riparian restoration as necessary in Salt, lower High Prairie, lower Hunter and lower Terwer creeks. Provide funding and incentives to landowners and/or restoration groups where necessary to achieve this goal.

KR-KG-10b Develop a plan to remove feral cattle from lower Blue and Bear creeks.

KR-KG-11a Work with Humboldt County, NOAA Fisheries and existing and future gravel-mining operators to restrict gravel-mining operations to appropriate mainstem Klamath River locations. Gravel mining should not be conducted within lower Klamath River tributary watersheds until a scientifically valid and peer-reviewed geomorphic analysis is conducted to determine existing channel stability, causes of excess aggradation, and identifies gravel mining as an appropriate restorative measure, as outlined in task RW-XXXV-A-1. (See Table 9-1).

KR-KG-12 Encourage cooperation between industrial timber land managers and the tribes to restore coho salmon habitat. Use the successful Tribal/Simpson Resource Company program as an example.

KR-KG-13 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;
b. Management to promote conifer recruitment;
c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and
d. Incentives to landowners, such as technical support.

KR-KG-14 Provide technical and financial support to implement riparian restoration throughout alluvial reaches in lower Blue, Terwer, Hunter and Salt creeks.

KR-KG-15 Investigate straying and impacts of exotic fish (e.g., bass and bullhead) populations in an abandoned mill pond in lower Richardson Creek to coho salmon in the adjoining Klamath River estuary.

KR-KG-17 Continue funding and technical support for the California Conservation Corps Del Norte Center to continue their collaborative participation with the Yurok Tribe and Simpson Resource Company to implement watershed restoration throughout the lower Klamath River subbasin.

KR-KG-18 Support continued implementation of the Coho Salmon Regional Abundance Inventory throughout the lower Klamath River subbasin.

KR-KG-19 Develop a plan to restore the historic flood plain on Hoppaw Creek, in cooperation with landowners and Caltrans.

8.1.3.2 Orleans HSA

KR-OR-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon that provide cool water and which improve mainstem Klamath River water quality and which provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Include improved land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;
b. Request that the SWRCB review existing water appropriations for compliance;
c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and
d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-OR-02 Support activities to maintain connectivity (i.e., flow) between mainstem habitat and tributary habitat in Slate and Red Cap creeks.

KR-OR-03 Develop a plan to protect and enhance spawning and rearing habitats in Boise and Camp creeks.

KR-OR-04 Develop a plan to protect and enhance Bluff and Red Cap Creek watersheds, which are classified as *Key Watersheds* in the Northwest Forest Plan, and are biological refugia for coho salmon. Key watersheds serve as biological refugia for maintaining and recovering habitat for stocks of anadromous fish at risk, such as coho salmon.

KR-OR-05 Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.

KR-OR-06 Support efforts to provide livestock exclusion fencing where feasible and appropriate, while providing off-site watering.

KR-OR-07 Support actions to reduce sediment input from upslope sources, including measures to:

a. Decommission roads and skid trails;
b. Upgrade roads and maintenance practices;
c. Ensure adequate coho salmon migration is provided for at stream/road crossings;
d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and
e. Minimize alteration of natural hill slope drainage patterns.

8.1.3.3 Ukonom HSA

KR-UK-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Include improved land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;
b. Request that the SWRCB review existing water appropriations for compliance;
c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and
d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-UK-02 Support actions to reduce sediment input from upslope sources, including measures to:

a. Decommission roads and skid trails;
b. Upgrade roads and maintenance practices;
c. Ensure adequate coho salmon migration is provided for at stream/road crossings;
d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and
e. Minimize alteration of natural hill slope drainage patterns.

KR-UK-03 Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. Implement highest priority barrier repairs as identified in the Caltrans inventory. USFS and the Karuk Tribe have identified culverts on Highway 96 at Stanshaw, Sandy Bar, and Coon creeks as needing treatment.

KR-UK-04 Develop a plan to ensure continued yields of high quality water and the maintenance the ecological function of tributary riparian systems, including measures to:

a. Conduct riparian revegetation and stream-bank restoration;
b. Encourage, where feasible, the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas);
c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and
d. Revegetate flood plain areas using native species.

KR-UK-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

KR-UK-06 Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.

KR-UK-07 Where necessary, provide riparian protection from livestock through exclusion fencing while providing off-site watering.

KR-UK-08 Encourage installation of screens on diversions to Department-NOAA Fisheries standards. Provide funding incentives to landowners where necessary to achieve this goal.

KR-UK-09 Improve water diversion and delivery system efficiency.

KR-UK-10 Continue restoration and monitoring of Siskon Mine to prevent further degradation of the riparian resource.

KR-UK-11 Request that the SWRCB to investigate diversions and use of water on Stanshaw Creek.

8.1.3.4 Happy Camp HSA

KR-HC-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-HC-02 Support actions to reduce sediment input from upslope sources, including measures to:

a. Decommission roads and skid trails;

b. Upgrade roads and maintenance practices;

c. Ensure adequate coho salmon migration is provided for at stream/road crossings;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and

e. Minimize alteration of natural hill slope drainage patterns.

KR-HC-03 Develop a plan to improve coho salmon passage at stream and road crossings, including measures to:

a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage. The USFS and Karuk Tribe have identified culverts under Highway 96 at Cade, Portuguese, and Fort Goff creeks as needing treatment;

b. Prioritize and upgrade crossings to accommodate 100-year storm flows and associated bedload and debris; and

c. Encourage the USFS, County and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-HC-04 Develop a plan to ensure continued yields of high quality water and maintenance the ecological function of tributary riparian systems, including measures to:

a. Conduct riparian revegetation and stream-bank restoration;

b. Encourage, where feasible, the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas);

c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and

d. Revegetate flood plain areas using native species.

KR-HC-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

KR-HC-06 Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.

KR-HC-07 Where necessary, provide riparian protection from livestock through exclusion fencing while providing off-site watering.

KR-HC-08 Encourage installation of screens on diversions to Department-NOAA Fisheries standards. Provide funding incentives to landowners where necessary to achieve this goal.

KR-HC-09 Increase water diversion and delivery system efficiency where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet this goal.

KR-HC-10 Encourage the NCRWQCB to continue monitoring Grey Eagle Mine and tailings as a follow-up to remediation that has already been done. Encourage EPA Region 9 to consider coho salmon when dealing with both emergency and remedial actions.

8.1.3.5 Seiad Valley HSA

KR-SV-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-SV-02 Support actions to reduce sediment input from upslope sources:

a. Decommission roads and skid trails;

b. Upgrade roads and maintenance practices;

c. Ensure adequate coho salmon migration is provided for at stream/road crossings;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and

e. Minimize alteration of natural hill slope drainage patterns.

KR-SV-03 Support efforts to improve coho salmon passage at stream and road crossings, including measures to:

a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage;

b. Treat coho salmon passage problems associated with the USFS roads;

c. Prioritize and upgrade crossings to accommodate 100-year storm flows and associated bedload and debris; and

d. Encourage the USFS, County, and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-SV-04 Develop a plan to ensure continued yields of high quality water and to maintain the ecological function of tributary riparian systems, including measures to:

a. Conduct riparian revegetation and stream-bank restoration;

b. Encourage the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas);

c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and

d. Revegetate flood plain areas using native species.

KR-SV-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

KR-SV-06 Manage roadless areas within the Seiad Valley HSA to be consistent with land use allocations under the Northwest Forest Plan to reduce the risk of large, severe fires by re-establishing the natural fire regimes.

KR-SV-07 Where necessary, provide riparian protection from livestock through exclusion fencing while providing off-site watering.

KR-SV-08 Encourage installation of screens on diversions to Department-NOAA Fisheries standards. Provide funding incentives to landowners where necessary to achieve this goal.

KR-SV-09 Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.

KR-SV-10 Identify illegal water diverters; request that the SWRCB take appropriate action and review and/or modify water use based on the needs of coho salmon and authorized diverters.

KR-SV-11 Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.

KR-SV-12 Assess potential coho salmon passage problem associated with private water diversion at the mouth of Middle Creek (tributary to Horse Creek). If problem exists, design and implement remediation project.

8.1.3.6 Beaver Creek HSA

KR-BC-01 Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.

KR-BC-02 Encourage landowners to manage fuels to prevent large, severe fires and to evaluate the application of the Watershed Evaluation Mitigation Addendum.

KR-BC-03 Assess fine sediment production and delivery from the USFS road adjacent to the West Fork of Beaver Creek and implement appropriate remediation.

KR-BC-04 Hydrologically disconnect the USFS Beaver Creek road, north of West Beaver Creek.

KR-BC-05 Support actions to reduce sediment from upslope sources:

a. Decommission roads and skid trails;

b. Upgrade roads and maintenance practices;

c. Ensure adequate coho salmon migration is provided for at stream/road crossings;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams;

e. Minimize alteration of natural hill slope drainage patterns; and

f. Encourage the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas).

KR-BC-06 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-BC-07 Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.

KR-BC-08 Improve coho salmon passage at stream and road crossings, by measures to:

a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage;

b. Treat coho salmon passage problems associated with the USFS roads;

c. Prioritize and upgrade crossings to accommodate 100-year storm flows and associated bedload and debris; and

d. Encourage the USFS, County, and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-BC-09 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment; and

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors.

KR-BC-10 Provide technical support as an incentive to landowners for ongoing efforts of restoring LWD and shade to the watershed.

KR-BC-11 Where necessary, provide riparian protection from livestock while providing off-site watering.

8.1.3.7 Hornbrook HSA

KR-HB-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-HB-02 Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.

KR-HB-03 Improve coho salmon passage at stream and road crossings, including measures to:

a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage;

b. Treat coho salmon passage problems associated with the USFS roads; and

c. Encourage the USFS, County, and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-HB-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, including technical support.

KR-HB-09 Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.

KR-HB-10 Identify water diverters; request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.

KR-HB-11 Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.

8.1.3.8 Iron Gate HSA

KR-IG-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;
b. Request that the SWRCB review existing water appropriations for compliance;
c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and
d. Provide measures that reduce hydrologic connectivity between streams and roads, where feasible.

KR-IG-02 Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.

KR-IG-03 Improve coho salmon passage at stream and road crossings, including measures to:

a. Prioritize and upgrade crossings to accommodate 100-year storm flows and associated bedload and debris;
b. Treat coho salmon passage problems associated with the USFS roads; and
c. Encourage the USFS, County, and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-IG-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;
b. Management to promote conifer recruitment;
c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and
d. Incentives to landowners, including technical support.

KR-IG-09 Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.

KR-IG-10 Identify water diverters; request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.

KR-IG-11 Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.

8.1.4 SALMON RIVER HYDROLOGIC AREA

SA-HA-01 With the goal of reducing sediment and providing coho salmon passage at all life history stages where roads affect coho salmon habitat:

a. Implement Forest Roads Analysis, private and county roads assessment recommendations;
b. Complete road sediment source inventory on all roads within the Salmon River HSA; and
c. Correct identified passage barriers on all roads.

SA-HA-02 Foster the multi-agency task force to identify and prioritize barrier to fish passage and implement corrective treatments. This task force would include at a minimum, representatives from Salmon River Restoration Council, Karuk Tribe, the USFS, NOAA Fisheries, the USFWS, and the Department.

SA-HA-03 Educate landowners, restoration specialists, and watershed restoration groups to reduce the impacts of private roads on coho salmon.

SA-HA-04 Encourage collaborative efforts among agencies and stakeholders to control or remove invasive exotics using integrated pest management techniques.

SA-HA-05 Reduce the risk of large, severe fires through fuels management around residential structures, homes, and escape routes. Implement Salmon River Fire Safe Council recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.

SA-HA-06 Re-establish fire regimes consistent with Northwest Forest Plan objectives to reduce the risk and impact of large, severe fire on coho salmon.

SA-HA-09 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade, primarily in tributaries and key refugia areas, through:

a. LWD placement;
b. Management to promote conifer recruitment;
d. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and
e. Incentives to landowners, such as technical support.

SA-HA-10 Develop a plan to prioritize and remediate mine tailings.

8.1.4.1 Lower Salmon River HSA

SA-LS-01 Restore and maintain habitat connectivity between the Salmon River and Nordheimer Creek where low flow or sediment aggradation has been known to restrict coho salmon passage.

SA-LS-02 Support ongoing maintenance and operations for the Nordheimer Creek Fish Ladder.

8.1.4.2 Sawyers Bar HSA

SA-SB-01 Reduce current and future sediment inputs to Specimen Creek, North Russian and South Russian creeks by the following actions:

a. Upgrade, improve, maintain, and/or storm proof (out sloping roads, reducing hydrologic connectivity) roads;
b. Stabilize slopes where feasible;
c. Reduce or avoid alteration of natural hill slope drainage patterns; and
d. Upgrade stream/road crossings and ensure coho salmon passage.

SA-SB-02 Conduct riparian revegetation and stream-bank stabilization along entire North Fork by the following actions:

a. Control vegetation removal in the streamside zone;
b. Increase the number of conifers and deciduous trees to provide stable stream shading and which will eventually become a source for LWD; and
c. Revegetate flood plain areas using native species.

8.1.5 SHASTA VALLEY AND SCOTT RIVER HYDROLOGIC AREAS

SS-HA-01 Reduce the risk of large, severe fires through fuels management (especially in the Scott) around residential structures and homes. Implement Fire Safe Council recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.

SS-HA-02 Support actions to reduce human-caused sediment input from upslope sources identified through public and private inventories. Prioritize remediation activities, which would include slope stabilization, minimizing sediment production, and eliminating coho salmon passage barriers.

SS-HA-03 Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems. Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses. Support activities to:

a. Reduce road densities where necessary and appropriate;
b. Upgrade roads and road maintenance practices to eliminate or reduce the potential for concentrating run-off to streams during rainfall events. Employ best available technology when appropriate;
c. Decrease potential for stream flow to become diverted at road crossings during high flow events resulting in flow along the road that returns to the channel at undesirable locations;
d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams;
e. Minimize alteration of natural hill slope drainage patterns; and
f. Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for coho salmon passage projects.

SS-HA-04	Encourage funding authorities to allocate adequate resources to prioritize and upgrade crossings to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g., LWD that might be mobilized).
SS-HA-05	Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies' needs.
SS-HA-06	Design and implement a reclamation plan to remediate effects of historical mining (i.e., tailings near Callahan) with the goal of enhancing the production and survival of coho salmon. Identify locations, costs, and restoration potential of intensively mined areas. (Carry out the same kind of planning for Trinity River and Indian Creek.)
SS-HA-07	Improve water quality by reducing or minimizing both domestic and municipal sources of nutrient input (i.e., sewage treatment plant discharge and storm drain runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.
SS-HA-08	Minimize impacts of cattle grazing on watercourses through exclusionary fencing as necessary and appropriate (i.e., providing off-site watering, preventing overgrazing, etc.).
SS-HA-09	Support cooperative State and local efforts to redirect Big Mill Creek into its historic channel under State Route 3, thereby restoring adult and juvenile coho salmon access to approximately 1.25 miles of quality spawning and rearing habitat.
SS-HA-10	Assess the potential benefits and technical feasibility of increasing stream flows in the Scott River for fish and wildlife within the Klamath National Forest. This should be dealt with during the verification described in SSRT water management recommendations.
SS-HA-11	Request the USBR to study the potential benefits of adjusting Iron Gate flows to better meet the needs of adult and juvenile life stages to enhance Scott/Shasta coho salmon production, consistent with the flow needs of the Klamath and Trinity rivers.
SS-HA-18	Support ongoing watershed planning and complete comprehensive, peer-reviewed watershed restoration plans for the Shasta and Scott rivers that include identification and prioritization of all restorative needs in each basin. When restoration funds are limited, implementation should occur on the highest priority issues most likely to effectively address coho salmon needs within each basin.
SS-HA-24	Investigate incentive-based alternatives with willing participants for preserving water quality, quantity and coho salmon habitat in the Big Springs area in the Shasta River.
SS-HA-25	Maintain and revegetate, where appropriate, riparian trees in headwaters and along creeks that provide shade habitat essential for coho salmon.
SS-HA-26	Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement; and

b. Management to promote conifer recruitment.

8.1.6 TRINITY RIVER HYDROLOGIC UNIT

TR-HU-01 Implement the Trinity River Record of Decision (ROD), which would provide:

a. Variable annual instream flows for the Trinity River from the Trinity River Dam (TRD) based on forecasted hydrology for the Trinity River Basin as of April 1st of each year, ranging from 369,000 acre-feet (af) in critically dry years to 815,000 af in extremely wet years;

b. Physical channel rehabilitation, including the removal of riparian berms and the establishment of side-channel habitat;

c. Sediment management, including the supplementation of spawning gravels below the TRD and reduction in fine sediments which degrade coho salmon habitat;

d. Watershed restoration efforts, addressing negative impacts which have resulted from land use practices in the basin; and

e. Infrastructure improvements or modifications, including rebuilding or fortifying bridges and addressing other structures affected by the peak instream flows provided by the ROD.

TR-HU-02 Recommend to the NCRWQCB that the TMDL process consider alterations in the sediment load allocations and targets due to implementation of the ROD.

TR-HU-06 Recommend that the USBR implement the Trinity River TMDL instream flushing flows without affecting ROD allocations.

TR-HU-07 Encourage the NCRWQCB to establish TMDL implementation plans for the Main Stem and South Fork using the upslope indicators and targets established in the Mainstem Load Allocation.

TR-HU-08 Support development of a County grading ordinance based on exemption, certification, and permitting criteria.

TR-HU-09 Encourage Trinity County to implement the Five Counties *Water Quality and Stream Habitat Protection Manual for County Road Maintenance* in Northwestern California Watersheds.

TR-HU-10 Support continued State and Federal funding for the implementation of sediment reduction programs for private lands and the implementation of DIRT-prioritized sediment source sites treatment funding on County roads.

TR-HU-11 Encourage Trinity County to establish incentives and standards for private riparian and wetlands area protection based on flexible subdivision design; road, curb and gutter requirements; minimum lot size and density; clustering and other techniques.

TR-HU-12 Encourage Trinity County to establish riparian setbacks for grading activities on private lands, based on the Department's 1994 recommendations to District I counties.

TR-HU-13 Evaluate the impacts of non-native fish species on coho salmon and develop management guidelines to reduce impacts.

TR-HU-14 Encourage Trinity County to develop or amend existing County Conservation, Open Space and Land Use Elements and Community plans to focus development away from riparian habitats, wetland habitats, or steep slopes. Consider all species habitats, wildland-urban fire hazard and other land uses factors in making allocations.

TR-HU-15 Analyze the feasibility and appropriateness of site-specific §2084 authorization for sport fishing for hatchery coho salmon.

8.1.6.1 Douglas City HSA

TR-DC-01 Evaluate water diversions on Reading, Indian, and Browns creeks. Restore coho salmon passage and encourage instillation of screens to Department-NOAA Fisheries standards. Provide incentives to landowners when necessary to reach this goal.

TR-DC-02 Increase riparian function in lower Reading, Indian, and Browns creeks with conservation easements or landowner incentives that reduce agricultural and grazing impacts.

TR-DC-03 Implement sediment reduction plans consistent with County plans and policies.

8.1.6.2 Grouse Creek HSA

TR-GC-01 Support continued implementation of habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.

8.1.6.3 Hyampom HSA

TR-HY-01 Request that the USFS develop a management plan for Big Slide to reduce human contributions to mobilization of sediments, including evaluating relocation of the county road that crosses Big Slide.

TR-HY-02 Request that the USFS reduce fuel loading in stands that could be susceptible to large, severe fire. Where appropriate, this management should include actions to accelerate the growth of conifers for LWD recruitment, develop mature shade canopy in the riparian zone, and to provide for other multiple use goals.

TR-HY-03 Continued implementation of habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.

8.1.6.4 Hayfork HSA

TR-HA-01 Encourage agricultural/residential water conservation programs through incentive programs.

TR-HA-02 Recommend that Trinity County amend its Critical Water Resources Overlay zone to address new riparian water rights development resulting from parcel subdivision. The amendment should include expanding the overlay zoning to additional watersheds where summer surface flows are limiting factors for residents and for coho salmon fisheries habitat.

TR-HA-03 Support continued implementation of riparian improvements through restoration activities, land use planning, and conservation easements.

TR-HA-04 Support efforts to provide livestock exclusion fencing where feasible and appropriate, while providing off-site watering.

TR-HA-05 Continue to implement habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.

8.1.7 MAD RIVER HYDROLOGIC UNIT

MR-HU-01 Work with landowners and other entities to reduce coho salmon tributary stream temperature through the development of mature coniferous overstory within the riparian zone by continuing:

a. Planting programs in stream corridors barren of mature conifers;

b. THP review; and

c. Riparian management projects with cattle ranchers.

MR-HU-02 Recommend that the SWRCB make a high priority in this HU of the:

a. Review of authorized diversions that have no provisions to protect coho salmon; and

b. Identification of unauthorized diversions and enforcement actions to stop them.

MR-HU-03 Work with landowners and other entities to improve the quality and quantity of deep pools, spawning gravels, and cover by measures to:

a. Protect existing LWD recruitment potential through the retention of mature coniferous trees in the riparian zone;

b. Establish adequate streamside buffer areas;

c. Increase the amount of in-channel LWD;

d. Continue to review THPs; and

e. Continue riparian management projects with ranchers.

MR-HU-04 Conduct pre-project geological surveys where needed. Develop permit conditions to limit activities within unstable areas and identify mitigation measures for restoration and enhancement.

MR-HU-05 Adopt measures to protect riparian vegetation for all development over which they have jurisdiction.

MR-HU-07 Assess barriers to passage, prioritize barriers for removal, and develop a plan to treat the barriers, with Warren Creek given a high priority for treatment.

MR-HU-08 Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. This is a known problem at Cañon Creek, Dry Creek, and North Fork Mad River.

MR-HU-09 Consider the mouths of Cañon Creek, Dry Creek, and North Fork Mad River as locations to:

a. Identify causes of loss of connectivity;

b. Evaluate management techniques;

c. Implement the identified strategy; and

d. Address permitting complexity for identified implementation measures.

MR-HU-10 Continue stream management activities with landowners in Lower Lindsay Creek.

MR-HU-11 Develop programs to control exotic vegetation, especially canary grass.

MR-HU-12 Evaluate the impact of the Mad River Hatchery steelhead production on coho salmon.

MR-HU-13 Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems.

MR-HU-14 Continue road and watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.

MR-HU-15 Reduce road densities where necessary and appropriate.

MR-HU-16 Decrease potential for stream flow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.

MR-HU-17 Stabilize slopes along roadways to minimize or prevent erosion and to minimize future risk of eroded material entering streams.

MR-HU-18 Minimize alteration of natural hill slope drainage patterns to decrease erosion and sediment input into the streams.

MR-HU-19 Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for coho salmon passage projects.

MR-HU-20 Encourage CHERT to incorporate coho salmon friendly measures.

8.1.7.1 Blue Lake HSA and North Fork Mad HSA

MR-BL-01 Encourage landowners, municipalities, and Tribal interests to work together to develop a watershed restoration plan.

MR-BL-02 Encourage agencies and land managers to work with qualified watershed groups. Develop and support well informed watershed communities with regards to coho salmon habitat issues. Ensure that there are adequate incentives for landowners who participate in activities to protect and/or restore coho salmon habitat and watershed processes. Implement an outreach program regarding issues of parity and obligations of stakeholder groups.

8.1.7.2 Butler Valley HSA

MR-BV-01 Reduce temperature impacts through establishment of adequate streamside buffer areas that are protected from vegetation removal; with emphasis on maintaining a significant number of large conifers within the riparian zone.

MR-BV-02 Reduce input of fine and coarse sediments into streams through priority road related sediment reduction assessment and implementation, and reducing management activities within unstable areas.

MR-BV-03 Establish access for both adult and juvenile coho salmon to suitable habitat by upgrading prioritization of culverts identified as passage barriers on both private and public lands.

8.1.8 REDWOOD CREEK HYDROLOGIC UNIT

RC-HU-01 Work with Redwood National and State parks, private landowners, and interested parties to improve coho salmon habitat conditions of the estuary while protecting Highway 101 and the Town of Orick. These plans should aim toward restoring the historic form and function of the estuary/lagoon and slough channels, riparian forests, and adjacent wetlands. This includes providing for:

a. Unconfined channels;
b. Restoration of riparian vegetation, tree cover, wetlands, and off-channel and rearing habitat;
c. Increased sediment transport, pool depth, and LWD;
d. Work to restore natural drainage patterns from adjacent wetlands; and
e. Improving the conditions of sloughs and tributaries to the estuary (Strawberry, Dorrance and Sand Cache creeks).

RC-HU-02 Work with USACE, Redwood National and State parks, and Humboldt County Planning Department to modify levee maintenance manuals to be consistent with habitat requirements of coho salmon while maintaining flood control.

RC-HU-03 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;
b. Management to promote conifer recruitment;
c. Improvement of existing riparian zones through plantings, release of small, suppressed conifers, and control of alders, blackberries, and other competitors (RW-XXII-A-04); and
d. Incentives to landowners, such as funding and technical support.

RC-HU-04 Encourage completion of assessments of sediment sources and upgrade deficient assessments; then encourage implementation of the recommendations contained in the assessment, paying particular attention to road assessment and implementation of road improvement projects; and the incorporation of measures to preclude sediment delivery to stream systems in near stream land use planning (especially on slopes greater than 35%).

RC-HU-05 Develop and implement measures to reduce water temperatures, improve the quality and quantity of deep pools, spawning gravels, and cover by protecting existing LWD recruitment potential through retention of mature trees in the riparian zone, establishing adequate near stream buffer areas protected from vegetation removal, and increasing the amount of in-channel LWD. Root wads should be left on LWD.

RC-HU-06 Coordinate a long-term, concerted effort between landowners, interested parties, and responsible agencies to determine the current population size and trends of coho salmon of Redwood Creek.

RC-HU-07 Conduct pre-project geological surveys where needed.

RC-HU-08 Continue to review and improve THPs with regard to protection of coho salmon and their habitat.

8.1.9 TRINIDAD HYDROLOGIC UNIT

TP-HU-01 Support the assessment, prioritization, and treatment of sediment sources, particularly roads, which have not been assessed and acknowledge progress that has been made in addressing sediment sources.

TP-HU-02 Work with Humboldt County and landowners to maintain flood plain capacity and prevent future encroachment on the flood plain.

8.1.9.1 Big Lagoon HSA

TP-BL-01 Continue to work with private landowners to develop riparian buffers with an adequate conifer component and canopy closure to reduce temperatures, increase LWD, and provide sediment filtration.

TP-BL-02 Develop a plan to restore the historic flood plain on Mill Creek (a.k.a. Pitcher Creek), in cooperation with landowners.

8.1.9.2 Little River HSA

TP-LR-01 Develop a plan to improve the functioning of the lower river estuary. Re-establish conifers and a functional flood plain and riparian zone on the lower river channel. Re-establish more complex instream habitat. The plan should include the release of conifers, exclusion fencing where necessary, and riparian planting.

TP-LR-02 Work with landowners to minimize the impacts of agricultural activities on the estuary.

TP-LR-04 Work with Humboldt County and landowners to maintain current flood plain capacity and prevent future encroachment on the flood plain.

8.1.10 EUREKA PLAIN HYDROLOGICAL UNIT

EP-HU-02 Support implementation of Humboldt County's provisions to protect Stream Management Areas and evaluate their effectiveness; recommend revisions as necessary.

EP-HU-03 Work with agencies and landowners, to re-establish estuarine function.

EP-HU-04	Acknowledge the Arcata City Sewage Treatment Project and encourage implementation of similar projects elsewhere, where possible.
EP-HU-05	Assess sources of sediment input, prioritize and implement remediation projects.
EP-HU-06a	Review recent habitat surveys and identify gaps in data; conduct habitat surveys in areas identified as lacking data.
EP-HU-06b	Identify and prioritize rearing habitat reaches for protection.
EP-HU-06c	Improve quality and quantity of deep pools and spawning gravels.
EP-HU-06d	In cooperation with willing landowners, restore and maintain historical tidal areas, backwater channels and salt marsh.
EP-HU-06e	Maintain, protect and restore channel conditions important to all life stages of coho salmon (e.g., spawning gravels, pool depth, rearing gravels, food) as it relates to bed load.
EP-HU-06f	Identify reaches where naturally functioning channel and flood plain conditions exist. Maintain and restore a functioning flood plain and natural channel processes where practicable.
EP-HU-06g	Identify impacted reaches where a functioning flood plain could be re-established: a. Prioritize areas that are not naturally functioning for restoration potential; and b. Develop site specific project objectives to protect and restore naturally functioning channel and flood plain conditions where feasible.
EP-HU-06h	Conduct hydrologic analysis for all Humboldt Bay tributaries.
EP-HU-06i	Establish access for both adult and juvenile coho salmon to suitable habitat where practicable.
EP-HU-06j	Upgrade all county culverts already identified as passage barriers and prioritized for repair.
EP-HU-06k	Conduct an inventory and prioritize for treatment migration barriers other than county culverts (private roads, tide gates) including Rocky and Washington gulches.
EP-HU-06m	Conduct LWD survey, identify location and areas for potential recruitment and/or placement of LWD structures: a. Map areas where large conifer riparian habitat exists; b. Increase the canopy by planting appropriate conifer and hardwood species composition along the stream where the canopy is not at acceptable levels. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects; c. Protect existing LWD structure; d. Increase the amount of large wood debris in rearing reaches; e. Provide additional LWD for rearing habitat;

f. Ensure retention of mature trees in the riparian corridor;

g. Establish adequate streamside buffer areas that are protected from vegetation removal; and

h. Protect and maintain habitat associated with instream LWD.

EP-HU-06n Maintain functional riparian habitat. Conduct assessment of historic and present riparian conditions.

EP-HU-06o Develop site specific riparian restoration plans:

a. Restore degraded riparian habitat; and

b. Establish a monitoring program to evaluate success of restoration projects.

EP-HU-06p Maintain and/or attain turbidity and suspended sediment levels beneficial to coho salmon during all life stages. Establish a coordinated turbidity monitoring plan.

EP-HU-06q Reduce input of fine sediments into the stream system by the following actions:

a. Conduct comprehensive road inventory;

b. Carry out priority road related sediment reduction;

c. Implement priorities for road-related sediment reduction projects identified in existing road inventories projects;

d. Identify areas still needing road/erosion inventories;

e. Identify ongoing road maintenance needs;

f. Identify landslide hazard areas such as steep unstable slopes, stream crossings,(other than those identified in the road inventory) and inner gorge area;

g. Conduct pre-project geological surveys and/or reducing management activities within these areas, especially road construction, grading, intensive timber harvests; and

h. Identify and treat bank erosion sites.

EP-HU-06r Assess and establish temperatures beneficial to coho salmon during all life stages by:

a. Evaluating temperature ranges in all tributaries;

b. Reviewing existing temperature data;

c. Identifying data gaps and establish watershed-wide temperature monitoring program; and

d. Determining if temperatures are a concern for coho salmon.

EP-HU-06t Prevent point and non-point source pollution (i.e. septic systems, livestock, household chemicals, petrol-chemicals, herbicides, fertilizer and other pollutants) by actions to:

a. Where necessary, limit direct livestock access to stream, and runoff impacts from livestock pens; and

b. Identify any pollutants that are potentially affecting coho salmon, identify priorities for pollution reduction and strategy to be pursued.

EP-HU-06v Determine and maintain adequate flows for migrating juvenile and adult coho salmon. Develop an inventory of current water rights, and conduct a field survey of water withdrawals in main-stem and tributaries.

EP-HU-06w Maintain open space lands (e.g., agriculture, forestland) for water retention and limit addition of impervious surfaces in the watershed.

EP-HU-06x Identify socioeconomic impacts of watershed management and future possible solutions.

EP-HU-06y Facilitate and sustain a well informed watershed community with regards to coho habitat issues.

EP-HU-06z Ensure that there are adequate incentives for landowners who choose to protect and/or restore watershed processes.

EP-HU-28 Support and encourage urban stream day-lighting efforts in Arcata and Eureka to reconnect and restore coho salmon habitat.

8.1.11 EEL RIVER HYDROLOGIC UNIT

ER-HU-01 Support the existing watershed cooperative working groups and the formation of new groups where necessary.

ER-HU-02 Acknowledge that the pike minnow is a problem and support efforts to control it.

ER-HU-03 Continue ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD through:

a. LWD placement;
b. Management to promote conifer recruitment; and
c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and incentives to landowners, such as technical support.

ER-HU-05 Recommend that the SWRCB make a high priority the identification of unauthorized diversions and enforcement actions to stop them in the Eel River HU.

ER-HU-07 Encourage the CHERT to incorporate coho salmon friendly measures.

ER-HU-08 Develop a plan to restore an adequate migration corridor in the mainstem Eel River.

ER-HU-09 Assess and prioritize sediment sources, including roads.

ER-HU-10 Treat prioritized sediment sources, including roads.

ER-HU-11 Identify coho salmon rearing impacts from Van Arsdale outplanting site.

ER-HU-12 In cooperation with agencies and landowners, plan to re-establish estuarine function, restore and maintain historical tidal areas, backwater channels and salt marsh.

ER-HU-13 Request that Caltrans assess, prioritize, and treat culverts that are barriers to passage on Highway 101. Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies.

8.1.11.1 Ferndale HSA

ER-FE-01 Encourage the Salt River Local Implementation Plan to incorporate coho salmon-friendly measures, in cooperation with the agencies. For the Salt River Local Implementation Plan to be effective, assessment prioritization and treatment of sediment sources in the watershed must be completed.

ER-FE-02 Support the acquisition of conservation easements as an incentive for landowners to conserve and enhance habitat.

8.1.11.2 Van Duzen River HSA

ER-VD-01 Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. The plan should

a. Evaluate management techniques;

b. Implement the identified strategy; and

c. Address permitting complexity for identifying implementation measures.

ER-VD-02 Implement the plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.

ER-VD-03 Recommend that the CHERT incorporate coho salmon-friendly measures.

ER-VD-04 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement; and

b. Improvement of existing riparian zones through plantings, release and recruitment of conifers, and control of alders, blackberries, and other competitors.

ER-VD-05 Assess and prioritize excess sediment sources including roads.

ER-VD-06 Treat excess sediment sources including roads.

8.1.11.3 Scotia HSA

ER-SC-02 Evaluate the benefits to coho salmon of removing the barrier on Bridge Creek.

8.1.11.4 South Fork Eel River HA

ER-SF-01 Explore opportunities to acquire conservation easements with conditions that provide for benefits to coho salmon.

8.1.11.5 Weott HSA

ER-WE-01 Support the DPR's efforts to complete the storm proofing of Bull Creek watershed.

ER-WE-02 Support the DPR and private property owners planting of trees and implement other habitat enhancement as necessary in the Bull and Salmon Creek watersheds.

ER-WE-03 Request that Caltrans assess, prioritize, and treat culverts that are barriers to passage along Avenue of the Giants and Highway 101. Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies.

8.1.11.6 Benbow HSA

ER-BE-01 Support assessment of the entire watershed.

ER-BE-04 Request that the CDF monitor Non-industrial Timber Management Plans to ensure that they are properly implemented.

8.1.11.7 Laytonville HSA

ER-LA-01 Support continued watershed restoration efforts, including measures to reduce temperatures in Ten Mile Creek.

ER-LA-02 Support efforts to prioritize and treat culverts on county roads that are barriers.

ER-LA-03 Encourage the county to coordinate with landowners on the removal of barriers on private property.

ER-LA-04 Support efforts by the county sheriff to enforce laws against dumping and the Department of Health to clean up dumped materials.

ER-LA-06 Encourage cities, counties, and Caltrans to adopt maintenance manuals that protect coho salmon habitat (e.g., standards for sidecasting of spoils and identification of spoils disposal sites).

ER-LA-07 To minimize and reduce the effects of water diversions, take actions to improve SWRCB coordination with other agencies to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and other anadromous salmonids and natural hydrograph, and avoidance of adverse impacts caused by water diversion.

8.1.11.8 Outlet Creek HSA

ER-OC-01 Prepare a technical assessment of Outlet Creek watershed, develop recommendations to restore long-term function, and prioritize implementation.

ER-OC-02 Encourage the City of Willits to become involved in planning for coho salmon recovery and to:

a. Assess, prioritize, and treat barriers to passage;

b. Address water quality issues;

c. Modify facility maintenance practices as necessary; and

d. Evaluate land use planning and revise plans as appropriate.

ER-OC-03 Encourage the NCRWQCB to upgrade the basin plan to benefit coho salmon.

8.1.12 CAPE MENDOCINO HYDROLOGIC UNIT

CM-HU-01	Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade by the placement of LWD in stream channels to improve channel structure and function
CM-HU-02	Assess and prioritize of sources of excess sediment including roads.
CM-HU-03	Treat of sources of excess sediment, including roads.
CM-HU-04	Investigate the feasibility of restoring estuarine function to maximize habitat for coho salmon.
CM-HU-05	Prioritize and upgrade all county culverts identified as passage barriers.
CM-HU-06	Conduct an inventory and prioritize for treatment migration coho salmon barriers other than county culverts.

Recommendations are presented separately for the four subbasins of the Mattole River HSA.

8.1.12.1 Southern Subbasin Mattole River HSA

CM-MS-01	Encourage elimination of unnecessary and wasteful use of water to improve stream surface flows and coho salmon habitat through outreach and education of water and conservation practices.
CM-MS-02a	Ensure protection of the high quality habitat found in the Mattole River headwaters and historic coho salmon streams.
CM-MS-02b	Protect high quality habitat found in the South Fork of Vanauken, Mill, Stanley, Thompson, Yew, and Lost Man creeks through recognition of current land management practices and encourage private landowners to continue land stewardship.
CM-MS-03	Promote a cooperative effort to establish monitoring stations at appropriate locations to monitor in-channel sediment (or turbidity) both in the lower basin and in the lower reaches of major tributaries.
CM-MS-04	Support the assessment, prioritization, and treatment of sources of excess sediment.
CM-MS-05	Study herbicide use with respect to impacts on coho salmon. Encourage lead agencies to consider herbicide application in CEQA and NEPA review.
CM-MS-06	Follow the NCRWQCB suggested best management practices (BMPs) to protect water quality from the ground application of pesticides.
CM-MS-07	Work with University of California Cooperative Extension (UCCE) specialists to monitor summer water and air temperatures and flow in cooperation with landowners using Department-accepted protocols.
CM-MS-08	Request that Mendocino County evaluate all parcels (new and existing) for their impacts to coho salmon habitat.
CM-MS-09	Request that Mendocino County investigate promoting cluster development away from streams to protect coho salmon.
CM-MS-10	Provide incentives to landowners to protect habitat and reduce water use.

CM-MS-11 Develop educational materials for landowners explaining how they can protect coho salmon.

CM-MS-12 Request that the SWRCB begin the process of declaring the southern subbasin to be fully appropriated in the spring and summer.

CM-MS-13 Request that the SWRCB make the enforcement of water rights in this watershed a priority.

CM-MS-14 Pursue opportunities to acquire fee title, easement, and water rights from willing sellers.

CM-MS-15 Encourage the planting of trees in riparian areas when appropriate and where conditions are suitable.

8.1.12.2 Western Subbasin Mattole River HSA

CM-MW-01 Assess current levels of LWD, determine amount necessary for improved flushing, pooling and habitat conditions for coho salmon, facilitate immediate placement and develop a plan for long-term recruitment.

CM-MW-02 Cooperate in establishing monitoring stations at appropriate locations (e.g., Squaw, Honeydew, and Bear creeks) to monitor in-channel sediment and track aggraded reaches in the lower basin and in the lower reaches of major tributaries.

CM-MW-03 Support the assessment, prioritization, and treatment of sources of excess sediment.

CM-MW-04 Encourage the monitoring of summer water and air temperatures using Department-accepted protocols. Continue temperature monitoring efforts in Stansberry, Mill (RM 2.8) Clear, Squaw, Woods, Honeydew Bear, North Fork Bear, South Fork Bear, Little Finley, Big Finley, and Nooning creeks, and expand efforts into other subbasin tributaries.

CM-MW-05 Develop a plan to manage near-stream buffers to reduce the effects of solar radiation and to moderate air temperatures.

CM-MW-06 Encourage the assessment, prioritization, reclamation and enhancement of riparian habitat.

CM-MW-07 Recognize and support ongoing efforts of landowners, the BLM, and others to improve habitat conditions for coho salmon.

CM-MW-08 Recommend coordinated, expedited processing of SWRCB and 1600 agreements for projects that are intended to reduce summer diversions.

CM-MW-09 Develop a public education program to raise awareness of the habitat needs of coho salmon and how the community, especially landowners, can improve coho salmon habitat.

CM-MW-10 Develop incentives for landowners and communities to reduce summer water withdrawals and enhance habitat.

CM-MW-11 Develop programs to support continued land-use patterns and discourage conversions and subdivisions.

CM-MW-12 Support a plan for mapping unstable soils and use of the information to guide land-use decisions, road design, and other activities that can increase erosion.

8.1.12.3 Northern Subbasin Mattole River HSA

CM-MN-01 Encourage tree planting and other vegetation management to improve canopy cover, especially in Conklin, Oil, Green Ridge, Devils, and Rattlesnake creeks.

CM-MN-02 Encourage cooperative efforts for treatment of stream-bank erosion sites to reduce sediment yield to streams, especially in Sulphur, Conklin, and Oil creeks and the lower reaches of the North Fork Mattole River.

CM-MN-03 Due to high incidence of unstable slopes in this subbasin, any permitting of future sub-division development proposals should be based on existing county-imposed forty acre minimum parcel sub-division ordinances.

8.1.12.4 Eastern Subbasin Mattole River HSA

CM-ME-01 Continue to conduct and implement road and erosion assessments, especially in Middle, Westlund, Gilham, Sholes, Blue Slide, and Fire creeks.

CM-ME-02 Encourage tree planting and other vegetation management to improve canopy cover, especially in Dry and Blue Slide creeks.

CM-ME-03 Encourage cooperation at stream-bank erosion sites to reduce sediment yield to streams, especially in Middle, Westlund, Gilham, North Fork Fourmile, Sholes, Harrow, Little Grindstone, Grindstone, Eubank, and McKee creeks.

8.2 CENTRAL CALIFORNIA COAST ESU

Recommendations for the CCC Coho ESU are presented in this section.

8.2.1 MENDOCINO COAST HYDROLOGIC UNIT

MC-HU-01 Encourage local jurisdictions to update general plans to include measures to protect coho salmon.

MC-HU-03 Encourage the County to limit development in the 100-year flood plain where the development would adversely affect coho salmon or their habitat.

MC-HU-04 Encourage Mendocino and Sonoma counties to adopt county grading ordinances.

MC-HU-05 Encourage the County to expand the CEQA checklist for Mendocino County to include coho salmon.

MC-HU-06 Increase stream complexity by actions to:

a. Retain current limited supply of LWD, boulders, and other structure-providing features;

b. Install new LWD, boulders, and other features immediately; and

c. Restore riparian vegetation to provide for future recruitment of LWD.

MC-HU-07 Support the assessment, prioritization, and treatment of sediment sources at an HSA level.

MC-HU-08 Determine site-specific recommendations, including incentives, to remedy high temperatures. Depending on the terrain and aspect, examples could include riparian planting to increase shade to reduce high ambient temperature and raise humidity along streams.

MC-HU-09 Map unstable soils and use that information to guide land-use decisions, road design, THPs, and other activities that can promote erosion.

MC-HU-10 Provide education and training on water diversion practices and facilitate compliance with pertinent regulations (e.g., FGC §1600 *et seq.*, CFPR 916.9, California water rights law).

MC-HU-11 Improve pool frequency and depth by actions to:

a. Continue to treat existing upslope sediment sources; and

b. Avoid or minimize land ownership fragmentation/conversion to more intensive uses.

MC-HU-12 Discourage poaching of coho salmon by measures to:

a. Cooperate with and provide incentives to landowners to maintain road and trail closures to be effective against trespass;

b. Encourage monitoring of road closures and timely repair of defective or damaged road closure systems;

c. Promote CalTIP, especially how it might apply to spawning coho salmon; and

d. Report un-permitted road use to local, State, and Federal enforcement personnel during periods when coho salmon are running.

MC-HU-13 To promote channel complexity and provide rearing habitat, investigate the desirability and feasibility of reintroduction of beavers.

MC-HU-14 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. Management to promote conifer recruitment; and

b. Incentives to landowners, such as technical support.

MC-HU-15 Maintain or improve instream flows by actions to:

a. Avoid or minimize increases in water use; and

b. Provide incentives to remove or convert direct diversions to off-stream storage and restrict the season of diversion to December through March.

MC-HU-16 The Department, the SWRCB, the RWQCB, the CDF, Caltrans, and counties, in cooperation with NOAA Fisheries, should evaluate the rate and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon. These agencies should consider existing regulations or other mechanisms when evaluating alternatives to water as a dust palliative (including EPA-certified compounds) that are consistent with maintaining or improving water quality.

MC-HU-17 Maintain or re-establish geographic distribution of coho salmon by continuing to allocate substantial improvement efforts towards identified biological refugia spawning coho salmon populations, and/or otherwise suitable habitat conditions accessible to coho salmon.

MC-HU-18 Coordinate with the NCRWQCB to implement water quality monitoring and streamline permitting of coho salmon habitat restoration projects (RWQCB 401, USACE 404, NOAA Fisheries, and USFWS permitting).

MC-HU-19 Encourage funding authorities to allocate adequate resources to prioritize and upgrade culverts to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g. LWD that might be mobilized).

MC-HU-20 Decrease coarse sediment delivery by implementing actions to work with:

a. Landowners, other resource professionals, and agencies to identify areas of increased risk of mass wasting to enable avoidance or mitigation of triggering activities; and

b. Transportation system (State, county, and private road and rail) construction and maintenance personnel to identify risks and mitigation measures for mass wasting such as replacing culverts with bridges, minimizing fill volumes on culverts, and constructing critical dips at culverts.

MC-HU-21 Decrease fine sediment loads by actions to:

a. Abandon riparian road systems and/or upgrade roads and skid trails that deliver sediment to adjacent water courses;

b. Limit winter use of unsurfaced roads and recreational trails by unauthorized and impacting uses;

c. Minimize the density of road and trail crossings of water courses;

d. Encourage out-sloping roads with rolling dips as the standard, wherever feasible, for all roads, and especially unsurfaced roads; and

e. Work with landowners to identify and modify practices such as road maintenance that generate fine sediment.

MC-HU-22 Develop erosion control projects similar to the North Fork Ten Mile River erosion control plan.

8.2.1.1 Albion River HSA

MC-AR-01 Place instream structures to improve gravel retention and habitat complexity.

MC-AR-02 Provide technical assistance and incentives to landowners in developing and implementing sediment reduction plans to meet requirements of the CWA TMDL, making watersheds with an implementation schedule the highest priority.

MC-AR-03 Conduct collaborative evaluations of priorities for treatment of barriers such as Fish Passage Forum.

MC-AR-04 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

MC-AR-07 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-AR-10 Encourage coordination of large wood placement in streams as part of logging operations and road upgrades to maximize size, quality, and efficiency of effort.

MC-AR-11 Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricted access is not feasible, encourage measures such as rocking to prevent sediment from reaching streams with coho salmon.

MC-AR-12 Conduct comprehensive subbasin erosion control “storm proofing” combined with installation of LWD into streams.

MC-AR-13 Modify stream barriers to allow coho salmon passage while maintaining LWD.

8.2.1.2 Big River HSA

MC-BR-01 To minimize and reduce the effects of water diversions, take actions to improve SWRCB coordination with other agencies to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and other anadromous salmonids and natural hydrograph, and avoidance of adverse impacts caused by water diversion.

MC-BR-02 Target Big River for enhancement of instream habitat by installation of LWD.

8.2.1.3 Garcia River HSA

MC-GA-02 Re-establish connectivity of North Fork Garcia River to the mainstem.

MC-GA-05 Provide technical assistance and incentives to Garcia River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.

MC-GA-06 Utilize as a model for erosion reduction and LWD placement the comprehensive approach practiced in the South Fork of the Garcia River.

MC-GA-07 Investigate stream nutrient enrichment and cycling needs for coho salmon.

MC-GA-08 Study the Garcia River estuary using the Garcia River Estuary Enhancement Feasibility Study, as well as new information, to consider restoring estuary functions that would benefit coho salmon.

MC-GA-09 Encourage coordination of LWD in streams as part of logging operations and road upgrades to maximize size, quality, and efficiency of effort.

MC-GA-11 Maintain the following tributaries to provide coldwater input to the Garcia River mainstem: Hathaway, North Fork, Rolling Brook, Mill Creek (lower Garcia River), South Fork, Signal, Mill Creek (upper Garcia River).

MC-GA-12 Work with landowners to plant riparian zones of Blue Waterhole, Inman Creek, and Pardaloe Creek with the goal of reducing instream temperatures and inputs into the Garcia River mainstem, and providing a long-term source of conifer LWD.

MC-GA-13 Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricted access is not feasible, encourage measures such as rocking to prevent sediment from reaching streams with coho salmon.

MC-GA-14 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-GA-16 Excavate a geomorphically designed channel in the lower North Fork Garcia River, which currently goes subsurface in the summer months, stranding thousands of salmonids. Juvenile coho salmon should be rescued until restoration project is undertaken and completed.

MC-GA-17 Work with landowners to plant conifers in the lower mainstem Garcia River from Eureka Hill road Bridge to Windy Hollow road with the goal of reducing stream temperature, providing bank stability and long-term LWD. Note the lower mainstem is currently seeing a reemergence of steelhead spawning and rearing life history. Reductions of mainstem temperature to a suitable range for coho salmon would be a very favorable development.

MC-GA-18 Consider projects to open logjam migration barriers while maintaining LWD in the North Fork, South Fork, and Fleming Creek.

MC-GA-19 Complete the remaining 25% of erosion control sites, identified in the South Fork Garcia River by the Trout Unlimited North Coast Coho Project.

MC-GA-21 Place large woody debris in Inman Creek, South Fork Garcia River, Signal Creek, and North Fork Garcia River, where necessary and with willing landowners.

MC-GA-22 Plant redwood trees in the lower seven miles of the Garcia River mainstem between Eureka Hill road and Windy Hollow road for long term LWD and bank stability and reduction of instream temperatures (which are now close to being suitable for coho salmon).

8.2.1.4 Navarro River HSA

MC-NA-03 Investigate stream nutrient enrichment and cycling needs for coho salmon.

MC-NA-04 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

MC-NA-06 The SWRCB, the Department, and NOAA Fisheries should make enforcement of pertinent laws and codes concerning illegal and unpermitted dams and diversions a high priority for action. Ongoing education and incentives and assistance with water conservation are called for.

MC-NA-07 Comprehensive, subbasin wide, erosion control and LWD installation is being implemented by Mendocino Redwood Company in partnership with the Department through the North Coast Coho Project in the Little North Fork. This approach of "storm proofing" key subbasins needs to be fully implemented in the key subbasins of Flynn, Dutch Henry, John Smith, Minnie, Horse Camp and German creeks. These tributaries have been identified as high priority in the Navarro River Restoration Plan.

MC-NA-08 Provide technical assistance and incentives to Navarro River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.

MC-NA-09 Encourage coordination of large wood placement in streams as part of logging operations and road upgrades to maximize size, quality, and efficiency of effort.

MC-NA-10 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-NA-11 Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricted access is not feasible, encourage measures such as rocking to prevent sediment from reaching streams with coho salmon.

8.2.1.5 Noyo River HSA

MC-NO-02 Investigate the role of the Pudding Creek Dam impoundment in coho salmon migration and freshwater survival rate; repair dam as appropriate.

MC-NO-04 Request that Mendocino County implement a sediment reduction plan related to water quality.

MC-NO-05 Support funding to address barriers to passage on the California Western Railway right-of-way.

MC-NO-06 Evaluate the biological justification for the egg-taking station on the South Fork Noyo River.

8.2.1.6 Ten Mile River HSA

MC-TM-01 Complete implementation of erosion control sites identified in Hawthorne Campbell, Department, and TU North Coast Coho Project on North Fork Ten Mile. Encourage development of similar projects in other coho salmon subbasins.

MC-TM-02 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-TM-03 Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricted access is not feasible, encourage measures such as rocking to prevent sediment from reaching streams with coho salmon.

MC-TM-05 Provide technical assistance and incentives to Ten Mile River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.

MC-TM-06 Evaluate the biological justification for the egg-taking station on the South Fork Noyo River.

8.2.1.7 Gualala River HSA

MC-GU-02 Complete comprehensive assessment/implementation of erosion control measures in entire North Fork basin.

MC-GU-03 Enforce existing bypass flow permit conditions of the SWRCB and the Department for the North Gualala Water Company diversion on North Fork Gualala River.

MC-GU-04 Investigate expanding North Fork riparian zone through acquisition/easement from willing participants where necessary.

MC-GU-05 Encourage coordination of large wood placement in streams as part of logging operations and road upgrades to maximize size, quality, and efficiency of effort.

MC-GU-07 Consider Haupt Creek for acquisition/easement of old growth redwood sections from willing participants.

MC-GU-09 Recovery goal should be to restore conditions in all tributaries that historically contained coho salmon.

MC-GU-11 Enforce all pertinent laws relating to summer dams and diversions to provide adequate year round flows and coho salmon passage. Baseline flow (i.e., hydrograph) studies are needed.

MC-GU-12 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-GU-13 Take a critical look at emerging conversion of timberland and oak woodlands in the Gualala River.

8.2.2 RUSSIAN RIVER HYDROLOGIC UNIT

RR-HU-02 Encourage the RWQCB to upgrade the Basin Plan to benefit salmonids (revisions have been proposed by the RWQCB).

RR-HU-03 Identify water diverters; request that SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.

RR-HU-04 Assess, prioritize, and develop plans to treat barriers to passage in all HSAs.

RR-HU-06 Assess riparian canopy and impacts of exotic vegetation (especially *Arundo donax*), prioritize, and plan riparian habitat reclamation and enhancement programs.

RR-HU-07 Implement the Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties.

RR-HU-08 Implement Coho Salmon Captive Broodstock Program:

a. Continue genetic analysis of source stocks for coho salmon broodstock. Recent genetic data produced by the Bodega Marine Laboratory and the NOAA Fisheries laboratory at Santa Cruz identifies that source populations in the Russian River and Marin County are genetically distinct. Further analysis of other broodstock year classes needs to be completed by NOAA Fisheries to weigh the risks of inbreeding and outbreeding depression in the captive broodstock program. A review of stocking history may help determine how locally adapted stocks can be utilized to enhance variability and reduce risk of extirpation. This review should be completed before mating protocols are finalized and implemented. The Department has completed this review in the Russian River HU, and the review for Bodega-Marin Coastal HU is underway;

b. Stock first priority barren streams. First priority streams are streams the Department has identified with good habitat condition resulting from complete restoration or unimpaired functions include Felta and Mill creeks (tributary to Dry Creek west of Healdsburg), Freezeout, Willow and Sheephouse creeks (near Duncans Mills), and Ward Creek (tributary to Austin Creek). Identify additional streams that may be suitable for stocking as restoration occurs;

c. Develop and implement a monitoring and evaluation program to adaptively manage the coho salmon broodstock program. Coordinate and implement a monitoring and evaluation program that would meet high and medium priority monitoring objectives as outlined in the coho salmon hatchery genetic management plan;

d. Develop, implement, and evaluate experimental release protocols for the captive broodstock program;

e. Review and revise long-term hatchery program goals based on results of the monitoring and evaluation program implemented in the experimental captive broodstock program; and

f. Develop and implement a long-term monitoring program for coho salmon abundance trends in suitable index streams that have recent (within eight years) coho salmon presence or that will be supplemented with the captive broodstock program. The Department has contracted Humboldt State University to develop these protocols in coordination with NOAA Fisheries.

RR-HU-09 Review and develop preferred protocols for Pierce's Disease Control that would maintain a native riparian corridor and develop an outreach program.

RR-HU-10 Throughout the HU, advise Sonoma County to consider recommendations to offset impacts from county policies and operations, as developed by the FishNet program in their report, Effects of County Land Use Policies and Management Practices on Anadromous Salmonids and Their Habitat (Harris et al, 2001). Advise Mendocino County to consider recommendations to offset impacts from county policies and operations, as developed by the Five County effort.

RR-HU-11 Sonoma and Mendocino counties should develop grading and erosion control standards supported by a grading ordinance, to minimize sediment impacts to coho salmon habitat.

RR-HU-12 Restore coho salmon passage at county structures on all streams inhabited by coho salmon, as identified in the Russian River Fish Passage Assessment report (Taylor, March 2003). Encourage expansion of coho salmon passage inventories as needed to use a comprehensive watershed approach to coho salmon passage. Integrate coho salmon passage projects at county facilities with coho salmon passage improvements involving other landowners, throughout targeted coho salmon watersheds.

RR-HU-13 Sonoma County Public Works and Parks departments should adopt and implement the best management practices in Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004) after review and approval by State regulatory agencies is completed. Mendocino County Public Works should adopt the Five County Roads manual after review and approval by State regulatory agencies is completed.

RR-HU-14 Sonoma and Mendocino County's Public Works, Water Agencies and Flood Control District's should reduce native riparian vegetation clearing and sediment removal adjacent to and in streams with coho salmon. Retain LWD within streams to the extent possible. When woody material is removed it should be stored and made available for stream enhancement projects.

RR-HU-15 Sonoma and Mendocino County planning and public works should promote alternatives to conventional bank stabilization for public and private projects, including bioengineering techniques.

RR-HU-16 Sonoma and Mendocino counties and incorporated areas should review development set-backs for adequacy in protecting critical streams inhabited by coho salmon, and revise as needed. Promote streamside conservation measures, including conservation easements, setbacks, and riparian buffers.

RR-HU-17 Sonoma and Mendocino County Public Works, Transportation Departments, Parks and Open Space Districts, should inventory, evaluate and fix problem roads which systematically contribute sediment to streams inhabited by coho salmon.

RR-HU-18 Support efforts and develop county, city, and other local programs to protect and increase instream flows for coho salmon. Sonoma and Mendocino counties should have policies to minimize impervious surfaces and promote surface water retention. The counties should participate in regional water management planning through the general plan process and in other venues as appropriate.

8.2.2.1 Russian River Mainstem

RR-MS-01 Manage summer flows in the mainstem of the Russian River to the benefit of rearing coho salmon and the estuary, while ensuring that all existing legal water uses and rights are accounted for.

RR-MS-02 Investigate the opportunity to operate the estuary as a natural system, allowing periods of closure to benefit coho salmon rearing, and appropriate timing of opening to benefit coho salmon migration/emigration.

RR-MS-03 Explore adjusting the operation of Mirabel Dam within confines of existing water rights and legal uses to improve passage of downstream migrants.

RR-MS-04 Evaluate the feasibility of bypassing large dams.

RR-MS-05 Update temperature analyses below Coyote Dam and Warm Springs Dam and review dam management.

RR-MS-06 In upper mainstem, prioritize and plan habitat restoration programs and projects.

8.2.2.2 Guerneville HSA

RR-GU-01 Encourage local agencies to implement recommendations of completed non-point source sediment assessments.

RR-GU-02 Assess, prioritize, and treat sources of excess sediment.

RR-GU-03 Supplement first priority barren streams as part of the coho salmon broodstock program. Within the Guerneville HSA, these streams include Willow, Sheephouse, Freezeout, Dutchbill and Green Valley creeks.

RR-GU-04 Acquire from willing sellers conservation easements or land in fee title in habitat essential for coho salmon.

RR-GU-06 Identify water diverters; request that SWRCB review or modify water use based on the needs of coho salmon and authorized diverters. Monitor and identify problems and prioritize needs in terms of changes to water diversion, in particular Green Valley and Dutchbill creeks, which have been identified as current or potential streams inhabited by coho salmon that go dry in some years.

8.2.2.3 Austin Creek HSA

RR-AC-01 Encourage Sonoma County to implement recommendations of completed non-point source sediment assessments.

RR-AC-02 Assess, prioritize, and treat sources of excess sediment.

RR-AC-03 Supplement first priority barren streams with the coho salmon broodstock program, such as Ward Creek. Identify additional streams that may be suitable for stocking as restoration occurs.

8.2.2.4 Warm Springs HSA

RR-WS-01	Develop plans to improve riparian vegetation in Dry Creek and its tributaries. Develop and implement riparian improvements through land-use planning, use of conservation easements, and implementation of the Sotoyome Resource Conservation District's Fish Friendly Farming Program.
RR-WS-02	Support implementation of measures to modify flows in Dry Creek to provide summer rearing habitat for coho salmon.
RR-WS-03	Supplement first priority barren streams as part of the coho salmon broodstock program, such as Mill and Felta creeks. Identify additional streams that may be suitable for stocking as restoration occurs.
RR-WS-04	Review and develop preferred protocols for Pierce's Disease Control that would maintain a native riparian corridor and develop an outreach program.
RR-WS-06	Assess, prioritize, and develop plans to treat sources of excess sediment.
RR-WS-07	Increase habitat structure and complexity in Dry Creek to enhance habitat diversity, and provide depositional areas for spawning gravels for coho salmon (i.e., place LWD or large boulder structures).

8.2.2.5 Mark West Creek HSA

RR-MW-01	Reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements from willing landowners.
RR-MW-02	Develop plans to improve instream habitat conditions.
RR-MW-04	Assess, prioritize, and develop plans to treat sources of excess sediment.

8.2.2.6 Santa Rosa Creek HSA

RR-SR-01	Encourage Sonoma County and the City of Santa Rosa to reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements from willing landowners.
RR-SR-02	Evaluate and develop solutions to problems caused by channelization.
RR-SR-03	Assess, prioritize, and develop plans to treat sources of excess sediment.

8.2.2.7 Forsythe Creek HSA

RR-FO-01	Improve migration and summer/overwintering habitat through riparian restoration and erosion control.
RR-FO-02	Assess, prioritize, and develop plans to treat sources of excess sediment.

8.2.2.8 Geyserville HSA

RR-GE-01	Maintain and improve riparian condition and water temperature through land use planning and conservation easements from willing landowners.
RR-GE-03	Assess, prioritize, and develop plans to treat sources of excess sediment.

8.2.3 BODEGA AND MARIN COASTAL HYDROLOGIC UNITS

BM-HU-01	Implement BMPs for road projects. Support Sonoma and Marin County Departments of Public Works, Caltrans, and other appropriate agencies to implement and maintain environmentally sound upgrades, modifications, and new construction of road projects, including culverts and stream crossings.
BM-HU-02	Continue to implement erosion control projects that were assessed and inventoried in sediment assessment plans throughout watersheds of the HU.
BM-HU-03	To avoid and minimize the adverse effects of water diversion on coho salmon, improve coordination between the SWRCB, the Department, and other agencies, to promote flows that will provide for a natural hydrograph, and to address protective conditions, such as by-pass flows, season of diversion, and off-stream storage.
BM-HU-04	Encourage local governments to incorporate protection of coho salmon in any flood management activities.
BM-HU-05	Encourage counties to implement performance standards in stormwater management plans.
BM-HU-06	On private and public lands, address issues of low flow by increasing riparian protection restoration, sediment control, and employing BMPs that encourage permeability and infiltration.
BM-HU-07	Continue outreach, education, and enforcement related to household hazardous waste and hazardous materials spills in creeks.
BM-HU-08	Encourage the cultivation and availability of locally indigenous native plants for use in restoration and bank stabilization.
BM-HU-09	Investigate opportunities for restoring historic runs in identified watersheds.
BM-HU-10	Continue to support landowners and the Marin RCD to restore riparian zones and manage livestock to increase stream protection and soil retention. Encourage sustainable land management practices and control of sediment sources in agricultural zones.
BM-HU-11	Continue to support the many active watershed groups in the HU, encouraging a focus on coho salmon restoration where appropriate.
BM-HU-12	Implement coho salmon passage improvements as identified in inventories conducted by the Salmon Protection and Watershed Network (SPAWN), Taylor and Associates, Trout Unlimited and the NPS. Expand inventories as needed for a comprehensive watershed approach for coho salmon passage.
BM-HU-13	County planning, public works, open space, and fire departments should continue to implement FishNet 4C priority goals for this region, which include: a. Enact and enforce Marin County Streamside Conservation Area Ordinance; b. Adopt and implement Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004);

c. Systematically work to restore coho salmon passage at county facilities; and

d. Address issues of sediment from roads through restoration and education.

BM-HU-14 Monitor the effectiveness and maintenance of watershed restoration projects (e.g., Sonoma County Coastal Wetland Enhancement Plan; Walker Creek Watershed Enhancement Plan; San Geronimo Creek Watershed Sediment Source Sites Assessment and Evaluation; Lagunitas Creek Final Sediment and Riparian Management Plan; and Watershed Assessment and Erosion Prevention Planning Project for the Redwood Creek Watershed). Augment inventories as needed.

8.2.3.1 Salmon Creek HSA

BM-SA-01 Coordinate efforts of involved agencies in review of plans for timber harvest and vineyard conversion. Support appropriate entities in the development and implementation of standards and BMPs for agriculture to reduce pathogen, nutrient, and sediment loadings to creeks.

BM-SA-02 Continue to implement erosion control projects that were assessed and inventoried in sediment assessment plans, and monitor effectiveness and maintenance of past and current watershed restoration projects. Augment surveys as necessary.

BM-SA-03 Continue to fund and support landowners to restore riparian zones and manage livestock to increase stream protection and soil retention. Encourage sustainable land management practices and control sediment sources in agricultural zones.

BM-SA-04 Implement recommendations of watershed plans consistent with the coho salmon recovery strategy. Review existing, approved watershed management or restoration plans within the range of coho salmon and implement actions consistent with priority recommendations of the coho salmon recovery strategy.

BM-SA-05 Encourage the design of vineyard operations to ensure adequate protection of coho salmon habitat attributes, including riparian corridors, instream flow, and water quality.

BM-SA-06 Support a coho salmon limiting factors assessment of the Salmon Creek estuary.

8.2.3.2 Walker Creek HSA

BM-WA-01 Continue to fund and support landowners and the Marin RCD to restore riparian zones and manage livestock to increase stream protection and soil retention. Address water quality and nutrient loading issues by encouraging sustainable land management practices, controlling sediment sources, protecting riparian zones and employing BMPs that encourage permeability and infiltration.

BM-WA-02 Continue to support active watershed groups, encouraging a focus on coho salmon restoration where appropriate.

BM-WA-03	Assess the water temperature regime during the summer season for three to five years to determine the role of water temperature as a limiting factor in coho salmon production.
BM-WA-04	Support landowners and the Marin RCD in projects to improve channel conditions and restore natural channel geomorphology, including side channels and dense contiguous riparian vegetation.
BM-WA-05	Implement high priority fishery enhancement projects for the reduction of sediment delivery and the restoration of riparian corridors as listed in the Walker Creek Enhancement Plan (2001).
BM-WA-06	Look for opportunities to increase woody debris retention and recruitment.
BM-WA-07	Continue to assess the release of water from Soulajule Reservoir to develop the optimum release for coho salmon.
BM-WA-08	Support a coho salmon limiting factors assessment in Keys Estero and Tomales Bay.

8.2.3.3 Lagunitas Creek HSA

BM-LA-01	Use recommendations of existing sediment source surveys to restore habitat of coho salmon. Augment surveys as necessary. Expand inventories as needed for a comprehensive watershed approach for coho salmon passage.
BM-LA-03	Coordinate with appropriate agencies to restore coho salmon passage at barriers identified by Ross Taylor, SPAWN, and others. Complete any needed surveys of migration barriers.
BM-LA-04	Investigate opportunities for restoring historic runs of coho salmon.
BM-LA-05	Commit ongoing resources and support of stewardship in the basin to include riparian enhancement and protection, sediment source reduction, habitat typing and surveying, coho salmon surveys and counts, water conservation, outreach and education, effectiveness monitoring of projects, and planning and assessment of potential restoration projects to benefit coho salmon.
BM-LA-06	Provide incentives for septic inspection, repair, and replacement to reduce aquatic pollution.
BM-LA-07	Assess, evaluate, and implement habitat restoration actions in Nicasio Creek.
BM-LA-08	Develop a monitoring and assessment program for the estuarine reaches of Lagunitas Creek and inter-tidal reaches of Tomales Bay, looking at impacts to coho salmon rearing and emigration.
BM-LA-09	Consider restoration of Olema Marsh, Bear Valley Creek, and the mouth of Olema Creek, to benefit coho salmon. The restoration should provide rearing habitat refuge during high flows, habitat protection, and food production. Hydrologic connectivity between marshes should be restored.
BM-LA-11	Throughout the Lagunitas Creek drainage, work with private landowners to encourage biotechnical bank stabilization, riparian protections, woody debris retention, and timing of water withdrawals to help protect coho salmon.

BM-LA-12 In the San Geronimo Creek sub-watershed, continue public outreach and education for private landowners, residents, commercial, public utility and county workers regarding best management practices to control erosion, protect riparian vegetation, retain LWD, and minimize disturbance to coho salmon from pets.

BM-LA-13 In the San Geronimo Creek sub-watershed, encourage removal of non-native fish species from stock ponds where they are a threat to coho salmon.

BM-LA-14 In the San Geronimo Creek sub-watershed, Marin County should determine a policy for reviewing new development projects and impacts to the creek from new well construction. The County should consider adopting recommendations for well developments from the local coastal plan.

BM-LA-15 Encourage the NPS to continue practices to benefit coho salmon, including restoration projects, sediment control projects, locating well constructed fences out of riparian zones, repairing headcut gullies as possible, and implementing rotational grazing in locations to minimize erosion and impacts to the creek.

BM-LA-16 Encourage the County of Marin to continue to implement and coordinate the Watershed Protection Agreement Program for additional water hook-ups in Nicasio and San Geronimo creek watersheds.

BM-LA-17 Look for opportunities to restore natural channel form and function in upper watershed to protect summer flows into San Geronimo Creek.

BM-LA-18 Encourage continuation of riparian protection and sediment control projects. Focus on working with landowners to manage livestock to protect riparian areas, and to implement erosion control projects on State and Federal parkland and on private lands (e.g., Devil's Gulch).

BM-LA-21 Continue public outreach and education for private landowners, residents, commercial, public utility and county workers regarding best management practices to control erosion, protect riparian vegetation, retain LWD, and minimize disturbance to coho salmon from pets.

BM-LA-23 Determine policy for reviewing new development projects and well construction. Consider adopting recommendations for well developments from the coastal plan.

8.2.3.4 Bolinas HSA

BM-BO-01 Implement recommendations of completed sediment source surveys. Supplement surveys as necessary.

BM-BO-02 Continue to support restoration efforts on Bolinas and Big lagoons to benefit coho salmon during all life phases and seasons.

BM-BO-03 Work with landowners and appropriate agencies to manage low summer flows for coho salmon, on a watershed basis. Provide support and incentives to protect both fisheries flows and agriculture, including timing of withdrawals, construction of off-site storage facilities, water conservation practices and riparian zone protections. Conduct outreach and education for landowners on these practices.

BM-BO-04 Look for opportunities to increase LWD recruitment and retention.

BM-BO-05 Provide incentives for septic inspection, repair and replacement to improve water quality in both streams and lagoons.

BM-BO-06 Encourage the NPS to provide additional space for Stinson Beach Water District for off-stream storage to protect coho salmon in Easkoot Creek.

BM-BO-07 Identify, prioritize, and treat coho salmon passage barriers in the Redwood Creek drainage.

BM-BO-08 Identify and resolve problems related to trails in these watersheds, including location of trails and access for construction and maintenance of roads and trails.

8.2.4 SAN FRANCISCO BAY HYDROLOGIC UNITS

SF-HU-01 Habitat suitability evaluations in the San Francisco Bay Area should include coho salmon.

SF-HU-02 Where appropriate, apply range-wide recommendations to suitable streams in the San Francisco Bay.

SF-SR-01 Work to restore coho salmon habitat, especially in Arroyo Corte Madera del Presidio and Corte Madera Creek.

8.2.5 SAN MATEO HYDROLOGIC UNIT

SM-HU-02 To minimize and reduce the effects of water diversions, take actions to improve SWRCB coordination with other agencies to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and natural hydrograph, and avoidance of adverse impacts caused by water diversion.

SM-HU-03 Develop legislation that will fund county planning for environmentally sound growth and water supply. Work in coordination with the California Department of Housing and Community Development, Association of Bay Area Governments, and other government associations.

SM-HU-04 Implement FishNet 4C priority actions that protect coho salmon.

a. Continue to protect riparian zones on streams inhabited by coho salmon within the coastal zone according to local coastal plan and THP prescriptions. Evaluate the need to apply coastal zone protections to streams inhabited by coho salmon that are not in the coastal zone;

b. Develop, adopt and implement written standards for routine operations and maintenance. Train staff in BMPs;

c. Conduct coho salmon passage assessments and restore coho salmon passage to coho salmon habitat;

d. Conduct road assessments and address issues of sedimentation from county public works and parks roads and trails;

e. Promote alternatives to conventional bank stabilization for public and private projects;

f. Establish adequate spoils storage sites throughout the counties so that material from landslides and road maintenance can be stored safely away from anadromous streams. Coordinate these efforts with Caltrans; and

g. Work to increase county enforcement of permit conditions and erosion control plans on development.

SM-HU-05 Support continued economically sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development.

8.2.5.1 San Gregorio Creek HSA and Pescadero Creek HSA

SM-SG-01 Minimize take attributable to diversion of stream flow. Potential take results from three primary impacts to habitat: 1) reduced rearing habitat for juveniles, 2) reduced flows necessary for smolt emigration, and 3) reduced flows necessary for adult immigration. This recommendation would develop and support alternatives to diversion of stream flow, where the alternatives may include operation of off-stream reservoirs, development of infrastructure necessary for conjunctive use of stream flow, and use of desalinated ocean water.

SM-SG-02 Conduct a watershed assessment in San Gregorio Creek that addresses impacts to coho salmon.

SM-SG-03 Conduct a comprehensive assessment of watershed processes (e.g., hydrology, geology, fluvial-geomorphology, water quality, vegetation), instream habitat, and factors limiting coho salmon production. Use the assessment results to develop a plan for restoration of coho salmon passage, instream habitat, and upslope erosion control, for implementation by cooperating landowners/managers.

SM-SG-04 Implement BMPs designed to reduce erosion of soil and consequential sedimentation of instream habitat attributable to roads (e.g., practices described in the California Salmonid Stream Habitat Restoration Manual).

SM-SG-05 Implement BMPs designed to reduce bank erosion, water temperature, and removal of LWD by improving the form and function of the riparian forest. These BMPs include livestock exclusion fencing, reclamation and reconstruction of flood plain, and active revegetation.

SM-SG-07 Request that the SWRCB declare critical tributaries to San Gregorio and Pescadero creeks fully appropriated during summer and fall months.

8.2.5.2 Año Nuevo (Gazos Creek) HSA

SM-AN-01 Implement the projects recommended as high priority for coho salmon in the Gazos Creek watershed restoration plan.

8.2.6 BIG BASIN HYDROLOGIC UNIT

BB-HU-02 Provide education and training on coho salmon-friendly water diversion practices to facilitate compliance with pertinent regulation (e.g., FGC §1600 *et seq.*, CFPR 916.9, California Water Code, the Department – NOAA Fisheries guidelines).

BB-HU-03 Encourage funding authorities to allocate adequate resources to prioritize and upgrade culverts to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g. LWD that might be mobilized).

BB-HU-04 Develop, facilitate, and support by-pass stream-flow requirements on all streams inhabited by coho salmon. Evaluate existing structures and apply to all future structures.

BB-HU-05 Implement the highest priority restoration projects in the watershed plans that address coho salmon habitat. Adjust ongoing efforts based on results.

BB-HU-06 Complete a broad conjunctive-use feasibility study to focus on creative ways to better manage existing surface and groundwater resources in Santa Cruz County, including all cities and water districts, to better utilize groundwater storage and increase baseflow at critical times. This would involve water sources under the control of Scotts Valley Water District, City of Santa Cruz, Soquel Water District, and San Lorenzo Water District.

BB-HU-07 Develop a lagoon management plan that addresses the needs of coho salmon.

8.2.6.1 Davenport HSA

BB-DA-01 Work with the SWRCB to develop and enforce stream flow bypass requirements for diversions from the alluvial reaches of Waddell, mainstem Scott, Big, Mill, and San Vicente creeks.

BB-DA-02 Petition the SWRCB to declare Scott and San Vicente creeks fully appropriated during summer and fall months.

BB-DA-03 Improve the form and function of riparian vegetation in alluvial reaches by implementing established BMPs designed to reduce bank erosion, temperature, and removal of LWD. These BMPs include, but are not limited to, livestock fencing where needed, reclamation or reconstruction of flood plains, and active revegetation. This recommendation applies especially to Scott Creek.

BB-DA-04 Reduce erosion from roads and resulting sedimentation of instream habitat. Implement established BMPs that account for public safety standards, including, but not limited to, assessment procedures and a suite of road reconstruction prescriptions. This recommendation applies especially to Scott Creek.

BB-DA-05 Encourage the DPR to develop a logjam management plan for Waddell Creek. Log jams should be closely examined for coho salmon passage and conservatively modified if absolutely necessary for coho salmon passage.

BB-DA-07 Develop and enforce stream flow bypass requirements for diversions from the alluvial reaches of mainstem San Vicente and Mill creeks.

8.2.6.2 San Lorenzo River HSA

BB-SL-01 Reduce soil erosion and resulting sedimentation of in-stream habitat that is attributable to roads. Implement adopted BMPs, accounting for public safety standards, including, but not limited to, assessment procedures and a suite of road reconstruction prescriptions. This recommendation applies especially to San Lorenzo River.

BB-SL-02 Develop and enforce stream flow bypass requirements for diversions from the alluvial reaches of San Lorenzo River and its tributaries, Zayante, Fall, Bear, Boulder, and Branciforte creeks.

BB-SL-03 Evaluate the Felton Diversion Dam for impacts to coho salmon.

BB-SL-04 Improve adult coho salmon passage at locations named in the San Lorenzo River Enhancement Plan, the Santa Cruz Road Crossing and Salmonid Passage Assessment (Taylor 2003) and other locations identified by the Department as being problematic. Implement the portions of these plans that are consistent with recovery strategy.

8.2.6.3 Aptos-Soquel HSA

BB-AP-01 Implement elements of the Soquel Creek Watershed Assessment and Enhancement Project Plan consistent with the recommendations of recovery strategy. Specifically focus on projects recommended as high-priority in this coho salmon-centric plan. These projects include preservation of base flow, restoration of flood plains, improvements to coho salmon passage, BMPs to reduce sedimentation of instream habitat.

BB-AP-02 Explore and promote opportunities to assure diversion of streamflow (directly or indirectly) is consistent with perpetuation of Soquel Creek coho salmon. Among others, these opportunities include amendments to the adjudication, water conservation, shallow recharge opportunities, shallow-well gauging, deep-well gauging, stream-gauging, self-monitoring of diversions, and conjunctive water management for recovery of groundwater levels.

9 Implementation

Several hundred range-wide and watershed-specific recommendations for recovering coho salmon in California are listed in Chapter 7 (Range-wide Recommendations) and Chapter 8 (Watershed Recommendations). The majority of these recommendations were developed by the CRT. The Department further subdivided and refined some recommendations to facilitate successful implementation. The implementation schedules are intended to reflect the substance and intent of the recommendations. To successfully implement these recommendations, they must be both feasible and funded. Several elements necessary for implementation are described below. Implementation schedules for the range-wide and watershed recommendations follow.

The Recovery Strategy and implementation schedule must be capable of being carried out in a scientifically, technologically, and economically reasonable manner [FGC §2111(b)]. In addition, they must be carried out in a legal manner. Therefore, all of the processes and activities within this strategy are subject to these considerations.

9.1 AVAILABILITY OF FUNDS

Implementation of the Recovery Strategy by the Department is subject to the availability of adequate funding and staffing resources. It is also subject to the availability of adequate funds of other action entities and participants to support and implement recovery strategy actions.

9.2 WATERSHED PRIORITY

Each watershed in the coho salmon range was prioritized as described in Section 6.3 and Appendix G. The resulting rankings for restoration and management potential, as depicted in Figures 6-27 and 6-28, were assigned to each HSA in the implementation schedule.

9.3 TASK LEVEL

Each recovery recommendation is assigned a Task Level, denoting its relative importance or priority for implementation. There are three task levels:

- E Task Level E is the highest level. These tasks must be implemented rapidly or early in the coho salmon recovery process because they are critical to coho salmon recovery or they must precede tasks included in levels D and C.
- D Task Level D includes tasks that contribute directly to the stated recovery criteria or goals or must be implemented if recovery criteria or goals are to be achieved.
- C Tasks included in Task Level C contribute to stated recovery criteria or goals or will likely result in the delay of recovery if not implemented.

Task levels for recommendations were assigned by CDFG technical staff with watershed-specific expertise and with input from some CRT members. Task levels for SSPP recommendations were assigned by consensus of SSRT members based on specific knowledge of the Shasta Valley and Scott River watersheds.

9.4 TASK NUMBER

Recovery recommendations (Chapters 7 and 8) were, in many instances, refined and subdivided into multiple tasks by the Department to facilitate successful implementation. Hence, new numbers were assigned to tasks in the implementation schedules (Tables 9-1 and 9-2). Original recommendation numbers (or original identifiers) are also provided for reference.

9.5 ACTION ENTITIES

Action entities, including governments, organizations, and other parties that are either responsible for recovery actions or will be instrumental in recovery of coho salmon in California have been identified. They include, but are not limited to:

- Federal agencies
  - Bureau of Reclamation (USBR)
  - National Marine Fisheries Service (NOAA Fisheries)
  - National Park Service (NPS)
  - United States Army Corps of Engineers (USACE)
  - United States Fish and Wildlife Service (USFWS)
  - United States Forest Service (USFS)
- State agencies
  - California Conservation Corps (CCC)
  - California Department of Fish and Game (DFG)
  - California Department of Forestry and Fire Protection (CDF)
  - California Department of Parks and Recreation (DPR)
  - California Fish and Game Commission (FGC)
  - California Geological Survey (CGS)
  - Regional Water Quality Control Board (RWQCB)
  - Resources Agency
  - State Water Quality Control Board (SWQCB)
  - California Department of Transportation (Caltrans)
  - Board of Forestry and Fire Protection (BOF)
- County governments
- City governments
- Resource Conservation Districts
- Tribal governments
- Private industry (including forestry, agriculture, livestock, mining)
- Private landowners
- Conservation organization
- Watershed councils and groups
- Academic institutions

9.6 ESTIMATED TIME

Some recovery actions are already occurring (ongoing), but most actions have yet to be initiated. Some of those actions can commence immediately or within the first five years of the strategy (interim), while others require other actions to occur before they, themselves, can be undertaken (long-term). Some actions will be immediate and temporary (short-term), while others will continue indefinitely and at constant intervals (continual).

9.7 IMPLEMENTATION SCHEDULES

The Department has organized the range-wide and watershed recommendations into schedules for implementation, which include the Department's identification of watershed priority, task level, action entity(ies), and estimated time. Table 9-1 sets forth the implementation schedule for range-wide recommendations. Table 9-2 (SONCC) and Table 9-3 (CCC) set forth the implementation schedules for the watershed recommendations.

TABLE 9-1: Implementation schedule for range-wide recommendations

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
STREAMFLOW					
E	RW-SF-01	Design passive diversion devices for water diversions.	**Potential Lead:** CDFG	Interim	*RW-I-B-01b*
C	RW-SF-02	Use passive diversion devices designed to allow diversion of water only when minimum flow requirements are met or exceeded.	**Potential Lead:** Landowners	Long-term	*RW-I-B-01*
C	RW-SF-03	Plan water supply development and growth that are not harmful to coho salmon habitat.	**Potential Lead:** Department of Housing and Development, Counties and Cities, Water Districts, ABAG	Long-term	*RW-I-C-01*
C	RW-SF-04	Increase agency coordination in planning water supply development and growth that are not harmful to coho salmon habitat.	**Potential Lead:** Department of Housing and Development, Counties and Cities, Water Districts, ABAG	Long-term	*RW-I-C-01b*
C	RW-SF-05	Fund planning and education to accomplish water supply development and growth that is not harmful to coho salmon habitat.	**Potential Lead:** Department of Housing and Development, Counties and Cities, Water Districts, ABAG, CDFG, NOAA Fisheries	Long-term	*RW-I-C-01c*
C	RW-SF-06	Educate public on unnecessary and wasteful use of water from coho salmon streams.	**Potential Lead:** SWRCB, RWQCBs, DWR, CDFG	Interim/ Continual	*RW-I-D-01*
C	RW-SF-07	Create interagency task force to improve coordination and promote consistency between agencies to avoid and minimize the adverse effects of future or reopened permits and licenses for water diversions on coho salmon.	**Potential Lead:** CDFG, SWRCB, RWQCB, NOAA Fisheries	Long-term	*RW-I-D-02*
C	RW-SF-08	Encourage NOAA Fisheries and CDFG to work with SWRCB to validate and modify the guidelines *(Guidelines for Maintaining Instream Flows to Protect Fisheries Resources Downstream of Water Diversions in Mid-California Coastal Streams, 2002)* to be appropriate to the SONCC Coho ESU as needed.	**Potential Lead:** NOAA Fisheries, CDFG	Long-term	*RW-I-D-02b*
C	RW-SF-09	Use programmatic, cost-efficient approaches and incentives to work with landowners to remove or convert direct diversions to off-channel storage ponds or tanks.	**Potential Lead:** CDFG, SWRCB, RWQCB, NOAA Fisheries, Landowners	Long-term	*RW-I-D-03*
D	RW-SF-10	Restrict the season of diversion to December through March to provide sufficient flows for coho salmon while ensuring the permitted use need is met.	**Potential Lead:** SWRCB, RWQCB	Long-term	*RW-I-D-03b*
E	RW-SF-11	Evaluate the rate, location, and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon.	**Potential Lead:** CDF, USFS, CDFG, Landowners	Long-term/ Continual	*RW-I-D-04*
D	RW-SF-12	When feasible, use alternatives to water as a dust palliative that are consistent with maintaining or improving water quality.	**Potential Lead:** Counties, Landowners	Long-term/ Continual	*RW-I-D-04b*
C	RW-SF-13	Improve implementation of the Lake or Stream Alteration Notification and Agreement process to protect coho salmon from the adverse affects of projects that would alter the bed, banks, channel, or natural flow streams.	**Potential Lead:** CDFG	Interim/ Continual	*RW-I-D-05*
E	RW-SF-14	Pursue funding for assessing, cataloging, and monitoring water diversions within the range of coho salmon.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Long-term	*RW-I-D-06*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
STREAMFLOW (continued)					
C	RW-SF-15	Assess, catalog, and monitor water diversions within the range of coho salmon.	**Potential Lead:** RWQCBs **Others:** CDFG, Counties	Long-term	*RW-I-D-06b*
C	RW-SF-16	Upgrade the existing water rights information system so that water allocations can be readily quantified by watershed.	**Potential Lead:** SWRCB	Interim/ Continual	*RW-I-D-06c*
C	RW-SF-17	Provide conservation incentives to minimize negative effects on coho salmon of water drafting for roads and fire suppression, including, but not limited to: a. Streamline permitting for actions that result in an improvement of instream flows; b. Support multiple uses of water storage systems; and c. Cost-share funding where low-flow, trickle recharge water storage is used to avoid adversely affecting streamflow or coho salmon habitat.	**Potential Lead:** Counties, CDF, USFS	Long-term/ Continual	*RW-I-D-07*
E	RW-SF-18	Establish a comprehensive streamflow evaluation program to determine instream flow needs for coho salmon in priority watersheds.	**Potential Lead:** CDFG	Long-term	*RW-I-D-08*
WATER RIGHTS					
E	RW-WR-01	Review authorized diversions that have no provisions to protect coho salmon in areas with high priority coho salmon habitat.	**Potential Lead:** SWRCB, RWQCBs	Interim/ Continual	*RW-II-A-01*
E	RW-WR-02	Identify unauthorized diversions.	**Potential Lead:** SWRCB, RWQCBs	Interim/ Continual	*RW-II-A-02*
C	RW-WR-03	Petition the SWRCB to add streams to the Declaration of Fully Appropriated Streams where flows are a limiting factor for coho salmon.	**Potential Lead:** CDFG	Interim	*RW-II-A-04*
E	RW-WR-04	Inventory water use and water availability in streams with coho salmon habitat.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG	Long-term	*RW-II-A-05*
D	RW-WR-05	Ensure that water availability analyses on priority coho salmon habitat accurately reflect existing water use and availability.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG	Long-term	*RW-II-A-05b*
E	RW-WR-06	Require streamflow-gauging devices on priority coho salmon streams when approving water development projects.	**Potential Lead:** Local Government, RWQCBs	Long-term	*RW-II-A-05c*
C	RW-WR-07	Continue to require riparian and pre-1914 water users to file annual statements of diversion and use.	**Potential Lead:** SWRCB	Interim/ Ongoing	*RW-II-A-05d*
D	RW-WR-08	For coho salmon recovery purposes, acquire or lease water, or acquire water rights from willing sellers.	**Potential Lead:** Wildlife Conservation Board	Interim/ Continual	*RW-II-B-01*
D	RW-WR-09	Develop incentives for water right holders to dedicate instream flows for the protection of coho salmon (Water Code §1707).	**Potential Lead:** CDFG, SWRCB	Long-term	*RW-II-B-01b*
C	RW-WR-10	For new riparian water rights created by subdivisions and rezonings, consider mitigation or conditions to protect coho salmon or avoid adverse effects where cumulative impacts on flows will be detrimental to coho salmon.	**Potential Lead:** Local Government **Other:** CDFG, NOAA Fisheries	Long-term	*RW-II-B-02*
E	RW-WR-11	Follow CDFG-NOAA Fisheries screening criteria when constructing, repairing, upgrading, reconstructing, and maintaining diversion screens within the range and distribution of coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Counties, Landowners	Interim/ Continual	*RW-II-B-03*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
FISH PASSAGE					
E	RW-FP-01	Continue and complete assessments and prioritizations for correction of fish passage barriers.	**Potential Lead:** CDFG, NOAA Fisheries, CCC	Interim/ Ongoing	*RW-III-A-01*
C	RW-FP-02	Continue to refine, update, and maintain the Coastal Conservancy database of barriers to fish passage.	**Potential Lead:** Coastal Conservancy, Fish Passage Forum, CDFG, Counties	Interim/ Ongoing	*RW-III-A-02*
E	RW-FP-03	Encourage funding authorities to provide adequate resources to construct new crossings and upgrade existing crossings (bridges, culverts and fills, other crossings) within the range of coho salmon to accommodate100-year flows flood and associated bedload and debris. Priority for upgrading should be based upon the potential impact to coho salmon habitat.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Long-term	*RW-III-C-01*
C	RW-FP-04	Allocate adequate resources to prioritize and upgrade culverts within the range of coho salmon to pass 100-year flows and associated debris loads (e.g. LWD that might be mobilized).	**Potential Lead:** CDFG, NOAA Fisheries, CDF, USFS, Caltrans, RWQCBs, Counties	Long-term	*RW-III-C-01b*
C	RW-FP-05	Evaluate NOAA Fisheries standards for passage at summer dams, and if necessary, develop additional policies and guidelines for passage at summer dams. Implement any recommendations resulting from this process.	**Potential Lead:** NOAA Fisheries, CDFG	Interim	*RW-III-C-02*
C	RW-FP-06	Fund upgrades to flood-damaged fish passage facilities to meet the requirements of Department/NOAA Fisheries fish passage criteria, and CESA.	**Potential Lead:** FEMA **Other:** CDFG, NOAA Fisheries, Counties	Ongoing/ Continual	*RW-III-C-04b*
E	RW-FP-07	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies for identifying, designing, and implementing fish passage projects. This includes, but is not limited to, funding for road maintenance programs and capital project activities.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Long-term/ Continual	*RW-III-C-06*
D	RW-FP-08	Allocate adequate budgets to Federal, State, and local agencies for identifying, designing, and implementing fish passage projects.	**Potential Lead:** NOAA Fisheries, CDFG, DWR, SWRCB	Long-term	*RW-III-C-06b*
POLLUTANTS					
D	RW-PL-01	Improve water quality by reducing or minimizing point and non-point sources of nutrient input (e.g., sewage treatment plant discharge, septic system discharge, storm drain runoff, and agricultural runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.	**Potential Lead:** SWRCB, RWQCBs	Interim/ Continual	*RW-V-B-01*
D	RW-PL-02	Within range of coho salmon, support efforts to complete system upgrades to cities and rural communities to achieve Clean Water Act compliance.	**Potential Lead:** Local Government **Other:** Federal and State Agencies	Long-term	*RW-V-B-01b*
C	RW-PL-03	Continue outreach, education, and enforcement related to hazardous materials spills, illegal dumping, and household hazardous waste dumping in creeks.	**Potential Lead:** SWRCB, CDFG	Interim/ Ongoing	*RW-V-E-01*
C	RW-PL-04	Continue to fund and support the CalTIP program.	**Potential Lead:** CDFG	Interim/ Ongoing	*RW-V-E-03*
C	RW-PL-05	Provide additional training for wardens to identify water pollution problems and promote coordination with other responsible agencies.	**Potential Lead:** CDFG	Interim/ Continual	*RW-V-E-03b*
C	RW-PL-06	Coordinate water rights training for resource agency personnel.	**Potential Lead:** Federal and State Agencies, SWRCB	Long-term/ Continual	*RW-V-E-03c*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SEDIMENTS					
E	RW-SD-01	Identify and prioritize specific sediment source locations for treatment that may deliver sediment to coho salmon streams.	**Potential Lead:** CGS	Long-term	*RW-VI-A-02*
C	RW-SD-02	Use protocols, such as the *California Stream Habitat Restoration Manual Guidelines* for upgrading areas of sediment delivery.	**Potential Lead:** CDFG, Landowners, Counties	Interim/ Continual	*RW-VI-A-02b*
C	RW-SD-03	Educate and provide technical assistance to landowners to upgrade areas of sediment delivery.	**Potential Lead:** CDFG, CGS	Interim/ Continual	*RW-VI-A-02c*
D	RW-SD-04	Restore natural drainage patterns and minimize hydrologic connectivity of roads, where feasible. Provide annual funding for restoring natural drainage patterns.	**Potential Lead:** USFS, BLM, NPS, DPR, Counties, Caltrans, Landowners	Long-term	*RW-VI-B-01*
D	RW-SD-05	Continue to fund and provide technical support to local government and private landowner actions to reduce identified sediment input from upslope sources. Basin-wide assessments should prioritize remediation activities, which would include slope stabilization and minimizing sediment production.	**Potential Lead:** CDFG, Counties, Watershed Groups	Interim/ Ongoing	*RW-VI-B-02*
E	RW-SD-06	Prioritize basin-wide assessments for remediation activities, including slope stabilization and minimizing sediment production.	**Potential Lead:** CDF, CDFG, NOAA Fisheries, CGS	Interim	*RW-VI-B-02b*
D	RW-SD-07	Continue road and watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.	**Potential Lead:** Counties, Watershed Groups, Landowners, USFS	Interim/ Ongoing	*RW-VI-D-01b*
D	RW-SD-08	Where sediment has been identified as impacting water quality and habitat condition, reduce road densities where necessary and appropriate.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01*
D	RW-SD-09	Where sediment has been identified as impacting water quality and habitat condition, upgrade roads and road-maintenance practices to eliminate or reduce the potential for concentrating run-off to streams during rainfall events. Employ best available technology when appropriate.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01c*
D	RW-SD-10	Where sediment has been identified as impacting water quality and habitat condition, decrease potential for streamflow to become diverted at road cross-ings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01d*
D	RW-SD-11	Where sediment has been identified as impacting water quality and habitat condition, stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01e*
D	RW-SD-12	Where sediment has been identified as impacting water quality and habitat condition, minimize alteration of natural hill slope drainage patterns.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01f*
D	RW-SD-13	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, Conservation Stakeholders	Interim/ Continual	*RW-VI-D-01g*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
WATER TEMPERATURE					
E	RW-WT-01	Identify actions to maintain and restore water temperatures to meet habitat requirements for coho salmon in specific streams.	**Potential Lead:** CDFG, CDF, USFS, Academia, Counties, Landowners	Interim/ Continual	*RW-X-B-01*
D	RW-WT-02	Implement actions to maintain and restore water temperatures to meet habitat requirements for coho salmon in specific streams.	**Potential Lead:** Counties, Landowners, USFS CDFG, NOAA Fisheries, CDF	Long-term	*RW-X-B-01b*
C	RW-WT-03	Provide funding and permit incentives to restore stream habitat where lack of LWD, riparian cover, simplified stream morphology and other conditions have been determined to be limiting factors to coho salmon habitat.	**Potential Lead:** CDFG, NOAA Fisheries, USFWS, USFS, Counties	Interim/ Continual	*RW-X-B-02*
LARGE WOODY DEBRIS					
E	RW-LW-01	Identify near stream vegetation communities that provide good opportunities for conifer LWD recruitment to coho salmon habitat. Address and identify possible solutions to potential conflicts between flood management activities and maintenance of riparian vegetation and LWD.	**Potential Lead:** CDF, USFS, DPR, NPS, CDFG, Watershed Groups, Landowners	Long-term	*RW-XIII-B-01a*
C	RW-LW-02	Provide education and information on the importance of these near stream communities to appropriate agencies, restoration funding groups, and landowners, and work to maintain them in a healthy condition.	**Potential Lead:** CDFG, NOAA Fisheries, USFS, Academia	Long-term	*RW-XIII-B-01a.ii*
E	RW-LW-03	Prioritize near stream vegetation communities for the purposes of restoring conifer LWD recruitment.	**Potential Lead:** CDF, USFS, DPR, NPS, CDFG, Watershed Groups, Landowners	Long-term/ Continual	*RW-XIII-B-01b*
E	RW-LW-04	Prioritize near stream vegetation communities for the purposes of restoring conifer LWD recruitment.	**Potential Lead:** CDF, USFS, DPR, NPS, CDFG, Watershed Groups, Landowners	Long-term/ Continual	*RW-XIII-B-01b*
E	RW-LW-05	Encourage funding authorities to provide funding and technical support for riparian restoration.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Long-term/ Continual	*RW-XII-B-02*
D	RW-LW-06	Allocate funding and technical support for riparian restoration.	**Potential Lead:** CDFG, CDF, NOAA Fisheries, USFS, Watershed Groups	Long-term	*RW-XII-B-02b*
D	RW-LW-07	Encourage management practices that promote conifer recruitment to provide short-term and long-term restoration of LWD and stream shade.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** RCDs, Watershed Groups, CDF, USFS, Counties	Ongoing/ Continual	*None*
D	RW-LW-08	Encourage Federal, State, and county agencies and private landowners to protect instream LWD to the greatest extent practicable without endangering public safety, life or property.	**Potential Lead:** Counties, Landowners, USFS **Other:** CDFG, CDF, NOAA Fisheries	Interim/ Continual	*None*
STREAM COMPLEXITY					
C	RW-SC-01	Modify channel, flood control, and road maintenance manuals for consistency with habitat requirements and protection for coho salmon.	**Potential Lead:** Caltrans, USFS, Counties	Long-term	*RW-XIII-C-01*
D	RW-SC-02	Where appropriate and feasible, reconfigure levees and channelized streams to benefit coho salmon.	**Potential Lead:** USACE, Counties, Landowners, CDFG, NOAA Fisheries	Long-term/ Continual	*RW-XIII-C-02*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ECOLOGICAL REFUGIA					
E	RW-ER-01	Identify and characterize coho salmon refugia.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** USFS, Watershed Groups, Academia, Landowners	Long-term	*RW-XV-A-01*
D	RW-ER-02	Provide information to land managers, agencies, and landowners of the location and characteristics of coho salmon refugia.	**Potential Lead:** CDFG, NOAA Fisheries	Long-term	*RW-XV-A-01b*
E	RW-ER-03	Identify key coho salmon populations.	**Potential Lead:** CDFG and NOAA Fisheries **Others:** USFS, Watershed Councils, Landowners	Interim/ Continual	*RW-XV-A-02*
D	RW-ER-04	Inform land managers, agencies, and landowners of locations of key coho salmon populations.	**Potential Lead:** CDFG, NOAA Fisheries	Interim/ Continual	*RW-XV-A-02b*
D	RW-ER-05	Implement measures to maintain key coho salmon populations.	**Potential Lead:** Landowners, USFS	Interim/ Continual	*RW-XV-A-02c*
D	RW-ER-06	Allocate substantial improvement efforts towards identified biological refugia, spawning coho salmon populations, suitable habitat accessible to coho salmon.	**Potential Lead:** All Local, State, Federal Agencies; Landowners	Long-term	*RW-XV-B-01*
HABITAT FRAGMENTATION					
D	RW-HF-01	Restore habitat connectivity between coho salmon populations in coastal and low-gradient inland streams.	**Potential Lead:** CDFG, Counties, Watershed Groups	Interim/ Continual	*RW-XVI-B-01*
D	RW-HF-02	Within prioritized watersheds, reduce habitat fragmentation by restoring fish passage to high quality habitat.	**Potential Lead:** CDFG, Counties, Watershed Groups	Interim/ Ongoing	*RW-XVI-B-02*
COMPETITION					
C	RW-CM-01	Develop a rapid-response eradication plan for invasive, non-native fish species that negatively affect coho salmon.	**Potential Lead:** CDFG and NOAA Fisheries	Long-term	*RW-XVIII-A-01*
C	RW-CM-02	Develop management guidelines to mitigate the impacts of non-native fish species on coho salmon.	**Potential Lead:** CDFG and NOAA Fisheries	Long-term	*RW-XVIII-A-02*
D	RW-CM-03	Remove non-native fish species from stock ponds where these fish pose a threat to coho salmon.	**Potential Lead:** Landowners, Counties **Other:** CDFG, Watershed Groups, NOAA Fisheries	Interim/ Continual	*RW-XVIII-A-03*
HATCHERY OPERATIONS, GENETICS, AND RELOCATION					
D	RW-HO-01	Maintain the local genetic diversity of coho salmon populations.	**Potential Lead:** NOAA Fisheries, CDFG, Academia **Other:** landowners, Counties, USFS	Long-term/ Continual	*RW-XXI-B-01*
E	RW-HO-02	Adopt draft policies for recovery hatcheries (see Appendix G).	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties	Interim	*RW-XXI-B-04*
E	RW-HO-03	Adopt draft guidelines for recovery hatcheries (see Appendix H).	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties	Interim	*RW-XXI-B-05*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
HATCHERY OPERATIONS, GENETICS, AND RELOCATION (continued)					
D	RW-HO-04	Implement guidelines for recovery hatcheries (see Appendix H)	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties	Interim	*RW-B-05b*
C	RW-HO-05	Evaluate the desirability and feasibility of relocating stranded juvenile coho salmon to nearby underutilized high quality habitat.	**Potential Lead:** CDFG, NOAA Fisheries, Academia	Interim/ Ongoing	*RW-III-C-03*
C	RW-HO-06	Develop a policy for relocation of stranded juvenile coho salmon, especially for under-utilized, high quality habitat.	**Potential Lead:** CDFG, NOAA Fisheries, Academia	Long-term	*RW-III-C-03b*
RIPARIAN VEGETATION					
D	RW-RV-01	Where necessary to protect coho salmon habitat, protect riparian communities from livestock while providing off-stream watering.	**Potential Lead:** Landowners, NOAA Fisheries, CDFG **Other:** USFS, Counties	Interim/ Continual	*RW-XXII-A-02*
C	RW-RV-02	Plant and release conifers or other appropriate native species, and control blackberries and other competitors, to restore short term and long term LWD and shade.	**Potential Lead:** CDFG, RCDs, NOAA Fisheries, USFS, Landowners, Counties, **Other:** Watershed Groups, CDF	Interim/ Continual	*RW-XXII-A-04*
C	RW-RV-03	Provide incentives to landowners, including technical support, to plant conifers and control competing plant species.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners, USFS, Counties **Other:** RCDs, Watershed Groups, CDF	Long-term	*RW-XXII-A-04b*
E	RW-RV-04	Inventory and evaluate the adequacy of buffer zones around riparian and wetland habitat on public and private lands.	**Potential Lead:** CDFG, NOAA Fisheries, USFWS, USFS, USACE, Counties, Landowners	Interim/ Continual	*RW-XXII-A-05*
E	RW-RV-05	Develop initiatives, including funding, to improve stream buffers that have been determined to be inadequate to protect coho salmon habitat.	**Potential Lead:** Counties **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXII-A-06*
D	RW-RV-06	Implement initiatives, including funding where appropriate, to improve stream buffers that have been determined to be inadequate to protect coho salmon habitat.	**Potential Lead:** Counties **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXII-A-06b*
ESTUARIES					
E	RW-ES-01	Adopt a policy of restoring estuarine habitat and the associated wetlands to provide fully functioning habitat. The policy should address: a. Restoration of historic estuarine areas; b. Maximizing available estuarine and tidal prism habitat; c. Free passage of all coho salmon life-stages to estuaries; d. Adequate instream cover and complexity; e. Eradication of exotic flora and fauna; f. Protection of habitat quality by providing suitable water quality and quantity input to estuaries; g. Protection/restoration of coho salmon prey habitat; and h. Minimizing artificial breaching and associated potential negative impacts.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties, Coastal Commission, Academia, Landowners	Long-term	*RW-XXIII-E-01*
D	RW-ES-02	Restore estuarine and associated wetland ecosystems.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties, Coastal Commission, Academia, Landowners	Long-term	*RW-XXIII-E-01b*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
LAND USE					
D	RW-LU-01	Continue providing subvention funds to counties for Williamson Act contracts to help preserve a rural landscape.	**Potential Lead:** State Government	Interim/ Continual	*RW-XXV-A-01*
D	RW-LU-02	Where necessary, revise General Plans, Local Coastal Plans, and/or Community Development Plans to direct development away from riparian habitats on coho salmon streams or tributaries, include setbacks for development, restrictions on grading activities, and setbacks for septic system development.	**Potential Lead:** Counties, Coastal Commission **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXV-B-03*
D	RW-LU-03	Establish incentives and standards to protect riparian and wetland areas on private lands.	**Potential Lead:** Counties	Interim	*RW-XXV-B-03b*
C	RW-LU-04	Encourage continued economically sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development.	**Potential Lead:** CDF, CDFG, Counties	Long-term	*RW-XXV-B-04*
D	RW-LU-05	Evaluate the adequacy of riparian buffers and development setbacks where needed for protecting riparian and wetland habitat on county, city, and private lands adjacent to coho salmon streams.	**Potential Lead:** CDFG, Counties	Long-term	*RW-XXV-B-05*
E	RW-LU-06	Develop county, city, and landowner initiatives to expand inadequate stream buffers and protect riparian and wetland habitat for coho salmon recovery.	**Potential Lead:** Counties and cities, Landowners **Other:** CDFG, NOAA Fisheries	Interim	*RW-XXV-B-07*
D	RW-LU-07	Implement county, city, and landowner initiatives to expand inadequate stream buffers and protect riparian and wetland habitat for coho salmon recovery.	**Potential Lead:** Counties and cities, Landowners	Long-term	*RW-XXV-B-07b*
D	RW-LU-08	Acquire conservation easements or land in fee title from willing landowners to protect habitat essential to coho salmon.	**Potential Lead:** Wildlife Conservation Board **Other:** USFS, BLM, Counties, Land Conservancies	Long-term	*RW-XXV-C-01*
PUBLIC OUTREACH					
C	RW-PO-01	Develop and provide informative programs to Registered Professional Foresters, Licensed Timber Operators, and other natural resource professionals regarding coho salmon and their habitat.	**Potential Lead:** CDFG, CDF	Interim/ Continual	*RW-XXVIII-A-01*
C	RW-PO-02	Establish a recognition program for periodically identifying the efforts of Watershed Groups and stakeholders that are helping to implement the coho salmon recovery strategy.	**Potential Lead:** FGC, CDFG	Long-term	*RW-XXVIII-A-03*
C	RW-PO-03	Develop incentives for landowners who participate in activities that exceed legal requirements or timelines to protect and/or restore coho salmon habitat and watershed processes.	**Potential Lead:** CDFG, NOAA Fisheries, Watershed Groups, Local Governments	Long-term	*RW-XXVIII-B-01*
D	RW-PO-04	Educate local governments on how to incorporate protection of coho salmon in flood management activities consistent with CDFG, RWQCB, NOAA Fisheries, and USACE requirements.	**Potential Lead:** Local Governments	Interim/ Continual	*RW-XXVIII-B-03*
D	RW-PO-05	Provide information to staff of counties and incorporated areas about the importance and requirements to develop and implement performance standards in Stormwater Management Plans.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG, NOAA Fisheries, Watershed Groups, Education Extension Programs	Interim/ Continual	*RW-XXVIII-B-04*
D	RW-PO-06	Educate and train restoration specialists and watershed restoration groups on the coho salmon recovery strategy.	**Potential Lead:** CDFG, NOAA Fisheries, Education Extension Programs	Interim/ Continual	*RW-XXVIII-C-01*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
PUBLIC OUTREACH (continued)					
C	RW-PO-07	Provide educational materials, outreach and training for issues such as sport fishing (inadvertent incidental take), poaching (directed take) and habitat destruction (LWD removal, riparian destruction, illegal stream crossings, pollution, illegal water withdrawal, etc.).	**Potential Lead:** CDFG	Long-term	*RW-XXXIII-A-23*
INTEGRATION WITH OTHER PLANS AND PROGRAMS					
D	RW-IN-01	Continue to support the Threatened and Impaired Watersheds rules.	**Potential Lead:** BOF	Interim/ Potentially Continual	*RW-XXX-A-01*
D	RW-IN-02	Amend Forest Practice Rules to require that Registered Professional Foresters certify in timber harvesting plans that they have followed the California Licensed Foresters Association *Guide to Determining the Need for Input From a Licensed Geologist During THP Preparation*.	**Potential Lead:** BOF	Long-term	*RW-XXX-A-02*
D	RW-IN-03	Use statistical analysis of land failure and sediment yield to strengthen protection in geologically unstable areas.	**Potential Lead:** CDF **Other:** CGS	Long-term	*RW-XXX-A-03*
C	RW-IN-04	Conduct implementation and effectiveness monitoring for Nonindustrial Timber Management Plans.	**Potential Lead:** CDF	Long-term	*RW-XXX-A-04*
C	RW-IN-05	As feasible, prepare and implement TMDL plans on a schedule that gives priority to priority coho salmon watersheds.	**Potential Lead:** SWRCB	Long-term	*RW-XXX-B-01*
C	RW-IN-06	Consider necessary coho salmon restoration projects within the sediment allocation of TMDL or watershed basin restoration plan implementation.	**Potential Lead:** RWQCBs, Counties, Landowners **Other:** SWRCB, CDFG, NOAA Fisheries	Long-term	*RW-XXX-B-02*
E	RW-IN-07	Ensure that TMDL standards provide protection for coho salmon.	**Potential Lead:** CDFG, SWRCB	Long-term	*RW-XXX-B-05*
C	RW-IN-08	Conduct outreach to State agencies and local governments to encourage their participation in the TMDL process to ensure the standards provide protection of coho salmon.	**Potential Lead:** SWRCB, RWQCBs	Long-term	*RW-XXX-B-06*
C	RW-IN-09	Implement Fire Safe Councils' recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.	**Potential Lead:** CDF, State Fire Safe Council, local FSCs **Other:** CDFG, NOAA Fisheries, USFS	Interim/ Continual	*RW-XXX-D-01*
C	RW-IN-10	Develop a process to incorporate coho recovery considerations in fire reduction and fuel management strategies, including identification of drafting sites in advance of wildland fire incident response.	**Potential Lead:** CDF, USFS, BLM, USGS, CDFG, CFSC, local FSCs, Landowners	Long-term	*RW-XXX-D-03*
D	RW-IN-11	Establish fire regimes to promote watershed function and health and to reduce the risk and impact of extensive, high severity fire on coho salmon and habitat.	**Potential Lead:** California Fire Alliance, CFSC, Counties, Academia, USGS, Landowners	Long-term	*RW-XXX-D-04*
E	RW-IN-12	Identify areas within coho salmon range that are susceptible to extensive, high severity fires.	**Potential Lead:** CDF, USFS	Interim	*RW-XXX-D-05*
E	RW-IN-13	Identify state of perturbation (=disturbance regime) in watersheds within coho salmon range to determine potential, deleterious shifts from ecological functioning regimes.	**Potential Lead:** USFS, USGS	Long-term	*RW-XXX-D-06*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
INTEGRATION WITH OTHER PLANS AND PROGRAMS (continued)					
D	RW-IN-14	Restore aquatic habitat structure and life history complexity of coho salmon populations in areas susceptible to extensive, high severity fires.	**Potential Lead:** USFS, CDFG, NOAA Fisheries, Landowners	Long-term	*RW-XXX-D-07*
D	RW-IN-15	Continue to implement FishNet 4C and Five County salmon restoration goals, including adopting and implementing Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004), training staff on guidelines, addressing fish passage and road sedimentation issues, developing riparian protections, promoting alternatives to conventional bank stabilization, and developing land-use policies beneficial to coho salmon.	**Potential Lead:** Counties	Interim/ Ongoing	*RW-XXX-E-01*
D	RW-IN-16	Incorporate the Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004) within incidental take authorizations.	**Potential Lead:** CDFG	Interim/ Continual	*RW-XXX-E-02*
D	RW-IN-17	Work with USACE to reduce the impacts to coho salmon of USACE projects.	**Potential Lead:** NOAA Fisheries	Interim	*RW-XXX-F-01*
C	RW-IN-18	After delisting is achieved, review the recovery strategy to determine how to continue implementation of appropriate elements of the recovery strategy.	**Potential Lead:** CDFG	Long-term	*RW-XXX-J-01*
D	RW-IN-19	Implement the Aquatic Conservation Strategy as outlined in the Northwest Forest Plan, and specific Standards and Guidelines identified in the Land and Resource Management Plan for each National Forest in the range of California coho salmon.	**Potential Lead:** USFS **Other:** USFWS, CDFG, CDF, NOAA Fisheries	Long-term	*None*
PERMITTING					
C	RW-PR-01	Develop regulatory assurance mechanisms to encourage land managers, local governments, and landowners to implement coho salmon habitat restoration and/or enhancement projects.	**Potential Lead:** Federal, State, and Local Governments	Long-term	*RW-XXXI-A-01*
C	RW-PR-02	Coordinate with the State Water Resources Control Board and appropriate Regional Water Quality Control Boards to implement water quality monitoring and streamline permitting of coho habitat enhancement and/or restoration projects.	**Potential Lead:** NOAA Fisheries, CDFG	Long-term	*RW-XXXI-A-02*
E	RW-PR-03	Identify ways to remove regulatory barriers (e.g., permitting and environmental review) to expedite activities that will contribute to the recovery of coho salmon. Examples of ideas to consider may be: (1) the creation of local permit assistance centers; (2) seeking categorical exemptions from CEQA; and (3) seeking a certified regulatory program under CEQA for certain activities.	**Potential Lead:** Federal, State, and Local Governments; Landowners	Interim	*RW-XXXI-A-03*
D	RW-PR-04	Remove regulatory barriers (e.g., permitting and environmental review) to expedite activities that will contribute to the recovery of coho salmon.	**Potential Lead:** Federal, State, and Local Governments	Long-term	*RW-XXXI-A-03b*
E	RW-PR-05	Encourage the Department, NOAA Fisheries, U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers to coordinate and develop programmatic incidental take authorizations (e.g., 404 permits, Section 7 consultations, 4(d) rules) for activities that will contribute to the recovery of coho salmon, including but not limited to the Department's Fisheries Restoration Grants Program.	**Potential Lead:** USACE, CDFG, NOAA Fisheries, USFWS	Long-term	*RW-XXXI-A-04*
C	RW-PR-06	Obtain funding to pay for environmental review and permitting of voluntary projects that will contribute to the recovery of coho salmon.	**Potential Lead:** CDFG, FGC	Long-term	*RW-XXXI-A-05*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
PERMITTING (continued)					
E	RW-PR-07	Develop management memoranda of understanding under §2081(a) to participants as an incentive for voluntary activities that will contribute to the recovery of coho salmon.	**Potential Lead:** CDFG	Interim	*RW-XXXI-A-06*
E	RW-PR-08	Issue management memoranda of understanding under §2081(a) to participants as an incentive for voluntary activities that will contribute to the recovery of coho salmon.	**Potential Lead:** CDFG	Long-term	*RW-XXXI-A-06b*
E	RW-PR-09	Evaluate the merit of counties adopting ordinances to exempt restoration and/or enhancement projects from indemnification requirements in context of coho salmon recovery.	**Potential Lead:** Counties, CDFG, NOAA Fisheries	Interim	*RW-XXXI-A-07*
C	RW-PR-10	If found to be of merit, adopt ordinances to exempt restoration and/or enhancement projects from indemnification requirements in context of coho salmon recovery.	**Potential Lead:** Counties	Long-term	*RW-XXXI-A-07b*
D	RW-PR-11	Bring into line the timing of instream restoration with THP activities (that require similar §1600 agreements; this will allow for add an addition month at the beginning of the restoration season).	**Potential Lead:** CDFG	Interim	*RW-XXXI-A-09*
D	RW-PR-12	Amend grading ordinances to exempt habitat restoration and enhancement activities within certain categories.	**Potential Lead:** Counties, Caltrans **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXXI-A-010*
C	RW-PR-13	Support adequate staffing and funding for the CDFG restoration program to complete contracts in a timely manner.	**Potential Lead:** Congress, State Legislature, Governor	Long-term/ Continual	*RW-XXXI-A-11*
C	RW-PR-14	Support the Small Restoration Projects Categorical Exemption.	**Potential Lead:** Resources Agency, CDFG	Interim	*RW-XXXI-A-12*
C	RW-PR-15	Establish a new categorical exemption under CEQA for fish passage barrier removal projects that meet Department and NOAA Fisheries natural stream simulation criteria.	**Potential Lead:** State Legislature, Resources Agency **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXXI-A-13*
C	RW-PR-16	Increase interagency coordination on environmental review, permitting, and implementation of programs when coho salmon and habitat can be affected.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Federal, State, and Local Agencies	Interim/ Continual	*RW-XXXI-B-02*
C	RW-PR-17	Where mitigation for otherwise lawful activities would mitigate for authorized take of coho and contribute to recovery of coho salmon, streamline the incidental take permitting process by developing guidelines for allowable take and for the issuance of incidental take permits under §2081(b).	**Potential Lead:** CDFG	Long-term	*RW-XXXI-B-06*
E	RW-PR-18	Coordinate and make recommendations needed to implement provisions of FGC §1600.	**Potential Lead:** CDFG, SWRCB	Interim/ Ongoing	*RW-XXXI-B-07*
C	RW-PR-19	Implement recommendations on provisions of the FGC §1600.	**Potential Lead:** CDFG	Long-term	*RW-XXXI-B-07b*
E	RW-PR-20	Identify actions to improve coordination between the agencies and others to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion.	**Potential Lead:** CDFG, NOAA Fisheries, USGS	Interim	*RW-XXXI-B-07c*
D	RW-PR-21	Implement actions to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion.	**Potential Lead:** CDFG, NOAA Fisheries, USGS, USFS, Counties, Landowners	Long-term	*RW-XXXI-B-07d*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
PERMITTING (continued)					
D	RW-PR-22	Determine and monitor §1600 compliance related to water diversions.	**Potential Lead:** CDFG, Counties, RCDs	Long-term	*RW-XXXI-B-07f*
C	RW-PR-23	Evaluate requests for on-stream dams on coho streams above coho migratory reaches for the effects on the natural hydrograph and the effects on the supply of spawning gravel for recruitment downstream.	**Potential Lead:** CDFG	Interim/ Continual	*RW-XXXI-B-07g*
C	RW-PR-24	Develop incidental take guidelines that state that those diversion screens that comply with the Department/NOAA Fisheries Screening Criteria should be assumed by the Department to not take coho salmon with respect to the screens.	**Potential Lead:** CDFG	Interim	*RW-II-B-03*
WATERSHED PLANNING					
D	RW-WP-01	Provide adequate funding to the agencies to coordinate and support preparation of comprehensive watershed assessments and restoration plans: a. Include a professional fisheries scientist; b. Assess streamflow, water diversions, water quality, sediment sources, fish barriers, riparian corridors, instream habitat, estuarine habitat, and land use, as necessary; and, c. Identify and prioritize site-specific restoration to benefit coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Counties, CDF, USFS, RCDs, Watershed Groups	Interim/ Ongoing	*RW-XXXII-B-02*
E	RW-WP-02	Review existing, approved watershed management or restoration plans within the range of coho.	**Potential Lead:** Watershed Groups, CDFG, NOAA Fisheries	Interim/ Continual	*RW-XXXII-B-03*
D	RW-WP-03	Implement actions from watershed plans consistent with priority recommendations of the coho salmon recovery strategy.	**Potential Lead:** Landowners, Counties, Watershed Groups, USFS **Other:** CDFG, NOAA Fisheries	Long-term/ Continual	*RW-XXXII-B-03b*
ENFORCEMENT OF EXISTING LAWS					
D	RW-EN-01	Restore impacted coho salmon habitat resulting from project construction without proper review and approvals.	**Potential Lead:** Coastal Commission, Landowners	Interim/ Continual	*RW-XXX-C-01*
C	RW-EN-02	Fully enforce existing laws, codes, regulations, and ordinances that address the protection of coho salmon and their habitat. Habitat includes but is not limited to water (quality and quantity), pools, riffles, instream LWD, riparian vegetation, and estuaries.	**Potential Lead:** CDFG, NOAA Fisheries, District Attorneys	Interim/ Ongoing	*RW-XXXIII-A-01*
C	RW-EN-03	Provide adequate funding and positions for agencies with enforcement authority to enforce laws and codes relevant to coho salmon protection.	**Potential Lead:** CDFG, NOAA Fisheries, District Attorneys	Long-term/ Ongoing	*RW-XXXIII-A-02*
E	RW-EN-04	Review diversions and use of water in priority coho salmon streams to determine which permits and/or licenses need modification for the protection of coho salmon.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG, NOAA Fisheries, Counties	Long-term/ Continual	*RW-XXXIII-A-03*
D	RW-EN-05	Where necessary, formally request that the terms of water rights permits/ licenses be modified for protection of coho salmon.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG, NOAA Fisheries, Counties	Long-term/ Continual	*RW-XXXIII-A-03b*
D	RW-EN-06	Conduct field studies to evaluate impacts of water use on coho salmon.	**Potential Lead:** RWQCBs, CDFG, NOAA Fisheries **Others:** Watershed Groups, Counties, Landowners, Academia	Long-term/ Continual	*RW-XXXIII-A-03c*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ENFORCEMENT OF EXISTING LAWS (continued)					
C	RW-EN-07	Develop supportive evidence and formal hearings to consider proposed changes to water use or permits.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG, NOAA Fisheries, Counties	Long-term/ Continual	*RW-XXXIII-A-03d*
C	RW-EN-08	Fund water permit and use review program.	**Potential Lead:** SWRCB	Long-term/ Continual	*RW-XXXIII-A-03e*
C	RW-EN-09	Coordinate enforcement efforts with local, State and Federal agencies with regulatory authority affecting coho salmon.	**Potential Lead:** SWRCB, RWQCBs, EPA, NOAA Fisheries, CDFG, USFWS	Interim/ Continual	*RW-XXXIII-A-04*
C	RW-EN-10	Make a high priority of efforts to prevent unauthorized diversion and use of water and water permit processing.	**Potential Lead:** CDFG, DWR, SWRCB, District Attorneys	Long-term	*RW-XXXIII-A-05*
C	RW-EN-11	Adequately fund water diversion enforcement and permit programs.	**Potential Lead:** CDFG, DWR, SWRCB, Counties	Long-term	*RW-XXXIII-A-05b*
C	RW-EN-12	Support continued funding for the California District Attorneys' Association's Environmental Circuit Prosecutors program and/or Environmental Project for applicable district attorney offices in the range of coho salmon.	**Potential Lead:** CDFG, CalEPA, Counties	Long-term	*RW-XXXIII-A-06*
C	RW-EN-13	Dedicate fines from violations affecting coho salmon or coho salmon habitat to coho salmon recovery and restoration activities consistent with the Recovery Strategy, including but not limited to education and outreach. Emphasis should be placed on keeping fine money in watersheds where the violation occurred to address existing coho salmon restoration plans and projects. This recommendation applies to fines that are not otherwise mandated by law to be directed to other purposes.	**Potential Lead:** Counties	Long-term	*RW-XXXIII-A-07*
C	RW-EN-14	Examine penalty schedules with regard to the impact of violations to coho salmon.	**Potential Lead:** CDFG, Counties, District Attorneys	Long-term	*RW-XXXIII-A-08*
C	RW-EN-15	If necessary, adjust penalty schedules to reflect the impact that violations have on coho salmon, taking into account other penalties that may be enforced in association with the same activity.	**Potential Lead:** Counties	Long-term	*RW-XXXIII-A-08b*
E	RW-EN-16	Develop an outreach/information and education program that targets agency personnel, judges, district attorneys, the Attorney General's Office, municipalities, and other affected or interested parties concerning the status of coho salmon and the value and importance of coho salmon resources and coho salmon recovery.	**Potential Lead:** CDFG, NOAA Fisheries, USFS **Other:** Academia	Long-term	*RW-XXXIII-A-10*
C	RW-EN-17	Provide educational materials, outreach and training for issues such as sport fishing, poaching, and habitat destruction to counties, district attorneys, municipalities, and affected and interested parties.	**Potential Lead:** CDFG, NOAA Fisheries, USFS **Other:** Academia	Long-term	*RW-XXXIII-A-10b*
C	RW-EN-18	Support existing and promote, if necessary, new neighborhood watch programs that discourage illegal dumping, poaching, and other illegal activities in streams and watersheds.	**Potential Lead:** CDFG, CalEPA, SWRQB, Counties **Other:** Landowners, Watershed Groups	Interim/ Continual	*RW- XXXIII-A-11*
C	RW-EN-19	Support funding for increased enforcement of existing laws against dumping of toxic substances.	**Potential Lead:** CDFG, CalEPA, SWRQB, Counties	Long-term/ Continual	*RW-XXXIII-A-14*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ENFORCEMENT OF EXISTING LAWS (continued)					
D	RW-EN-20	As staffing allows, review all applications for proposed projects that may impact coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, RWQCBs, Counties **Other:** USFWS, USFS, CDF, SWRCB, CalEPA, FEMA	Interim/ Continual	*RW-XXXIII-A-18*
C	RW-EN-21	Establish environmental task force comprised of State, local, and Federal enforcement agencies that operate in the range of coho salmon.	**Potential Lead:** NOAA Fisheries, EPA, USFWS, CDFG, CalEPA, District Attorneys, CHP, CDF	Long-term	*RW-XXXIII-A-27*
C	RW-EN-22	Increase funding for the Department's CalTIP program.	**Potential Lead:** CDFG, State Legislature	Long-term	*RW-XXXIII-A-28*
C	RW-EN-23	Seek programmatic incidental take authority with respect to screen design and installation that conforms to Department/NOAA Fisheries screening criteria.	**Potential Lead:** Counties, Landowners, project proponents **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXXIII-A-29*
D	RW-EN-24	Encourage Federal, State, and county agencies and private landowners to protect instream LWD to the greatest extent practicable without endangering public safety, life or property.	**Potential Lead:** Counties, Landowners, USFS **Other:** CDFG, CDF, NOAA Fisheries	Interim/ Continual	*None*
IMPLEMENTATION					
C	RW-IM-01	Provide funding and incentives for projects that exceed requirements of existing law or expedite timelines required by law.	**Potential Lead:** CDFG, NOAA Fisheries, USFS, USFWS, EPA, SWRCB	Long-term/ Continual	*RW-XXXIV-A-01*
D	RW-IM-02	Support continued and increased funding for the California Conservation Corps to implement coho salmon restoration projects throughout the coho salmon range in California.	**Potential Lead:** CCC, CDFG	Interim/ Ongoing	*RW-XXXIV-A-02*
INSTREAM GRAVEL EXTRACTION					
C	RW-IG-01	Within known or historic coho salmon habitat, require permits for instream gravel extraction to include: a. A total yearly extraction volume proportionally based on the long-term mean average recruitment of gravel into the mining reach; b. An extraction strategy that will promote species recovery by retaining sufficient gravel to preserve and restore the alluvial structure necessary for forming and maintaining critical physical habitat in, up- and downstream of the mined reach; and c. A monitoring plan capable of demonstrating that the extraction strategy successfully promotes species recovery.	**Potential Lead:** Counties	Interim/ Ongoing	*RW-XXXV-A-01*
ASSESSMENT, MONITORING, AND RESEARCH					
E	RW-AM-01	Support research necessary to understand crucial aspects and uncertainties regarding coho salmon ecology. Three important issues are: a. Genetic relatedness and health; b. Potential of local adaptive differences to environmental factors, specifically water temperature; c. Biological refugia, including non-natal rearing areas.	**Potential Lead:** NOAA Fisheries, CDFG, USFS, Academia	Interim/ Continual	*RW-XXIX-B-03*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ASSESSMENT, MONITORING, AND RESEARCH (continued)					
E	RW-AM-02	Evaluate and prioritize coho salmon issues and questions in need of research.	**Potential Lead:** NOAA Fisheries, CDFG, Academia	Long-term	*RW-XXIX-C-01*
D	RW-AM-03	Develop and maintain data/information system for compiling, analyzing, and distributing information on the status and trend of coho salmon and the status of coho salmon recovery.	**Potential Lead:** CDFG **Other:** NOAA Fisheries, Academia, USFS, Landowners	Interim/ Ongoing	*RW-XXIX-C-01a*
C	RW-AM-04	Develop a data collection and sharing policy that: a. Requires permission of private landowners for access across private lands to collect data where such access is desired; b. Disclosure of data collected from private lands in a form or by a means that protects landowner privacy (i.e., disclosure of data at stream-reach level or other appropriate scale that protects landowner privacy, but also shows the relationship to the nearest tributary confluences); c. Disclosed data must be quality assured and quality controlled; d. Disclosure should include metadata files indicating who collected the data, and how and for what purposes the data were collected; e. If requested, disclosed data should be in electronic form it if already exists in that form; and f. Data requests should be responded to in a timely manner, recognizing limitations of staff and budgets can affect processing requests.	**Potential Lead:** CDFG	Interim	*RW-XXX-C-02*
D	RW-AM-05	Use field-tested implementation, effectiveness, and validation monitoring protocols for coho salmon restoration activities.	**Potential Lead:** Landowners, CDFG, NOAA Fisheries, USFS, Counties	Interim/ Ongoing	*RW-XXIX-E-01*
E	RW-AM-06	Conduct key assessments to understand essential aspects of coho salmon populations and life-history, including: a. Relative abundance; b. Spawning sites/success; c. Estuary use; d. Barriers to juveniles; e. Over-wintering growth and survival; and f. Ocean condition effects on coho salmon populations.	**Potential Lead:** CDFG, NOAA Fisheries, Academia, Counties, Watershed Groups	Interim/ Continual	*RW- XXIX-F-01*
E	RW-AM-07	Develop and implement a strategic, long-term population assessment and monitoring program for coho salmon.	**Potential Lead:** NOAA Fisheries, CDFG	Interim/ Ongoing	*RW-XXIX-G-01*
C	RW-AM-08	Recommend to agencies and organizations that they assess and prioritize actions within a watershed prior to implementation of comprehensive restoration plans.	**Potential Lead:** Watershed Groups, Landowners, Counties	Interim/ Continual	*RW-XXIX-G-02*
C	RW-AM-09	Fund research, monitoring, and evaluation of the effectiveness of restoration.	**Potential Lead:** CDFG, NOAA Fisheries, USFWS, USFS, CDF, Academia	Interim/ Continual	*RW-XXIX-H-01*
C	RW-AM-10	Develop a comprehensive system to gather, evaluate and manage monitoring information associated with coho salmon recovery.	**Potential Lead:** CDFG, NOAA Fisheries, CDF, CGS, Landowners	Interim/ Ongoing	*RW-XXIX-D-04*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TIMBER MANAGEMENT					
E	RW-TM-01	Appropriate adequate State and Federal financial, material, and personnel support for on-the-ground recovery actions, identified in the Recovery Strategy. Possible funding mechanisms include but are not limited to: a. Legislation specifically identifying funding for coho salmon recovery; b. Cost-share programs with private landowners, stakeholder groups and local governments; and c. Endowment and/or grant programs cooperatively with private sources.	**Potential Lead:** State Legislature, Congress **Others:** Member organizations of CRT and SSRT	Long-term/ Continual	*ALT-C-1-a*
D	RW-TM-02	Provide adequate financial, material, and personnel support for on-the-ground recovery actions, identified in the Recovery Strategy.	**Potential Lead:** California and Federal Legislature **Others:** CDFG, CDF, SWRCB, Caltrans, NOAA Fisheries, USFS, USFWS	Long-term/ Continual	*ALT-C-1-b*
C	RW-TM-03	Provide technical expertise to support cooperative recovery actions, including but not limited to: a. Technical advisors to assist in the development of restoration proposals; b. Technical expertise to assist in the implementation of recovery activities on-the-ground; and c. Technical expertise to assist in training and education on coho salmon restoration projects.	**Potential Lead:** CDFG, CDF, SWRCB, NOAA Fisheries **Others:** USFS, USFWS, Academic Institutions Tribes, RWQCB, Caltrans	Interim/ Continual	*ALT-C-2*
E	RW-TM-04	Develop a program to design and implement coho recovery plans for individual CALWATER Planning Watersheds. The program should promote and enable cooperative working relationships between agencies, landowners and residents.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** USFS, Tribes, Counties, Landowners, Academic Institutions	Interim	*ALT-C-3*
C	RW-TM-05	Implement a program to design and implement coho recovery plans for individual CALWATER Planning. Watersheds.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** FGC, Planning Watershed Recovery Teams	Long-term	*ALT-C-3*
E	RW-TM-06	Provide Federal and State funding to assist landowners in performing watershed analysis in a manner usable by the Department.	**Potential Lead:** CDFG, CDF, SWRCB, CGS, Caltrans, NOAA Fisheries, USFS, USFWS	Long-term	*ALT-C-3-a*
E	RW-TM-07	Conduct systematic watershed analyses at the watershed level to identify key limiting factors, their sources, and locations affecting coho salmon.	**Potential Lead:** Watershed Groups, Environmental Consulting Companies, Counties, Agency Teams, Landowners **Other:** CDFG, NOAA Fisheries	Long-term	*ALT-C-3-b,c*
D	RW-TM-08	Remedy the sources of key limiting factors.	**Potential Lead:** Watershed Groups, Environmental Consulting Companies, Counties, Agency Teams, Landowners **Others:** CDFG, NOAA Fisheries	Long-term	*ALT-C-3-c*
E	RW-TM-09	Identify restoration projects for watershed transportation systems, fish passage, slope stabilization measures, erosion control measures and drainage structures.	**Potential Lead:** Caltrans, CDFG, CDF, RWQCB, Counties, Watershed Groups, Landowners, NOAA Fisheries **Other:** Academic Institutions, Environmental Consulting Companies	Ongoing/ Continual	*ALT-C-3-d*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TIMBER MANAGEMENT (continued)					
D	RW-TM-10	Implement restoration projects for watershed transportation systems, fish passage, slope stabilization measures, erosion control measures and drainage structures.	**Potential Lead:** Caltrans, CDFG, CDF, Counties, Watershed Groups, Landowners **Others:** Environmental Consulting Companies	Ongoing/ Continual	*ALT-C-3-d*
E	RW-TM-11	Identify beneficial management practices to protect existing values.	**Potential Lead:** CDF, CDFG, USFS, Landowners **Others:** NOAA Fisheries, SWRCB, RWQCB, CGS	Interim	*ALT-C-3-e*
C	RW-TM-12	Implement beneficial management practices to protect existing values.	**Potential Lead:** CDF, CDFG, USFS, Landowners **Others:** NOAA Fisheries, SWRCB, RWQCB, CGS	Long-term	*ALT-C-3-e*
C	RW-TM-13	Monitor effectiveness of beneficial management practices in protecting existing values.	**Potential Lead:** CDF, CDFG, USFS, Landowners **Others:** NOAA Fisheries, SWRCB, RWQCB, CGS	Long-term	*ALT-C-3-e*
C	RW-TM-14	Where necessary, revise beneficial management practices to improve protection of existing values.	**Potential Lead:** CDF, CDFG, USFS, Landowners **Others:** NOAA Fisheries, SWRCB, RWQCB, CGS	Long-term	*ALT-C-3-e*
C	RW-TM-15	Use CALWATER coho salmon recovery plans, and data that support them as principle reference documents, to avoid costs to landowners and/or project proponents associated with repetitive analysis and paperwork for each project.	**Potential Lead:** Counties, Landowners, CDFG, NOAA Fisheries **Others:** Affected Local, State, and Federal Agencies	Long-term	*ALT-C-3-f*
C	RW-TM-16	Develop an information repository system for individual Planning Watersheds that compiles and integrates existing information.	**Potential Lead:** CDFG	Long-term	*ALT-C-4*
C	RW-TM-17	Add new information as it becomes available to Planning Watershed information system.	**Potential Lead:** CDFG	Long-term	*ALT-C-4*
C	RW-TM-18	Ensure that the Planning Watershed information system provides adequate confidentiality for information specifically pertaining to private property.	**Potential Lead:** CDFG	Long-term	*ALT-C-4E*
E	RW-TM-19	Where appropriate and where costs to landowners are offset, develop Road Management Plans that contribute to the restoration of coho salmon habitat.	**Potential Lead:** Caltrans, CDF, Counties, Landowners, CDFG, NOAA Fisheries, USFS **Others:** Watershed Groups, Academic Institutions	Long-term	*ALT-C-5-a*
D	RW-TM-20	Where appropriate and where costs to landowners are offset, implement Road Management Plans that contribute to the restoration of coho salmon habitat.	**Potential Lead:** Landowners, Counties, USFS, Caltrans, CDF **Others:** CDFG, NOAA Fisheries	Interim	*ALT-C-5-a*
C	RW-TM-21	Where appropriate and where costs to landowners are offset, encourage the use of a licensed engineer to assist in the design and construction of watercourse crossings.	**Potential Lead:** Caltrans, Counties, CDF **Others:** CDFG, SWRCB, CGS, NOAA Fisheries, BOF	Interim/ Continual	*ALT-C-5-b*
C	RW-TM-22	Provide continuing education and training (classroom and field) to ensure watercourse crossings are appropriately designed, constructed and maintained.	**Potential Lead:** CDF, CDFG, NOAA Fisheries, Caltrans, DWR **Others:** Environmental Consulting Companies, Academic Institutions	Long-term	*ALT-C-5-c*
D	RW-TM-23	Conduct cooperative coho salmon habitat restoration projects that extend across ownerships to address habitat restoration efforts in a coordinated and cost effective manner.	**Potential Lead:** Counties, Watershed Groups **Others:** CDFG, NOAA Fisheries, USFS, Landowners	Ongoing/ Continual	*ALT-C-5-d*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TIMBER MANAGEMENT (continued)					
E	RW-TM-24	Appropriate State funding to assist landowners to implement coordinated watershed riparian vegetation improvement programs, in the range of coho salmon, that: a. Identify appropriate areas within the riparian zone where planting of riparian vegetation, including conifers, is likely to improve coho salmon habitat; and b. Promote vegetation modification (e.g., thinning, removal of undesired competitive vegetation) to accelerate riparian vegetation recovery and enhancement in coho salmon habitat.	**Potential Lead:** State Legislature **Others:** Member Organizations of CRT and SSRT	Interim	*ALT-C-5-e*
C	RW-TM-25	Provide State funding to assist landowners in implementing coordinated watershed riparian vegetation improvement programs in the range of coho salmon.	**Potential Lead:** CDFG, CDF, SWRCB, Caltrans, Counties **Others:** Tribes, USFS, NOAA Fisheries	Long-term	*ALT-C-5-e*
E	RW-TM-26	Conduct long-term monitoring to evaluate the effectiveness of FPRs in maintaining and recovering coho salmon habitat.	**Potential Lead:** CDF, CDFG **Others:** SWRCB, CGS, NOAA Fisheries, USFS, Landowners	Long-term/ Continual	*ALT-C-6*
E	RW-TM-27	Through the CDF Monitoring Study Group, develop a monitoring project to evaluate whether mitigation measures implemented by Registered Professional Foresters as part of THPs are effectively reducing the risk of mass soil movement associated with harvesting operations, including road and landing construction.	**Potential Lead:** BOF, CDF, CGS **Others:** CDFG, NOAA Fisheries, Landowners	Interim	*ALT-C-7*
E	RW-TM-28	Document voluntary efforts by forest landowners beneficial to coho salmon that: a. Exceed FPRs requirements; and/or b. Are recommendations included in the Recovery Strategy.	**Potential Lead:** CDF, BOR **Others:** CDFG, CGS, SWRCB, NOAA Fisheries, Landowners	Interim	*ALT-C-8*
C	RW-TM-29	Evaluate the effectiveness of voluntary efforts to recover coho salmon populations.	**Potential Lead:** CDFG	Long-term	*ALT-C-9*
E	RW-TM-30	Consolidate existing resource assessments and monitoring data.	**Potential Lead:** CDFG	Long-term	*ALT-C-10*
C	RW-TM-31	Analyze resource assessments and monitoring data.	**Potential Lead:** CDFG	Long-term	*ALT-C-10*
C	RW-TM-32	Provide a collaborative watercourse and roads assessment training and watershed academy.	**Potential Lead:** CDFG, CDF, Forestry Industry **Others:** SWRCB, CGS, NOAA Fisheries, USFS	Long-term	*ALT-C-11*
D	RW-TM-33	Acquire conservation easements or land in fee title from willing landowners to protect coho salmon habitat.	**Potential Lead:** WCB **Others:** CDFG, Landowners, Counties, NOAA Fisheries, USFS	Interim/ Continual	*ALT-C-12*
C	RW-TM-34	Seek additional funding for staff to improve the effectiveness of the Department's timberland conservation program.	**Potential Lead:** Resources Agency, CDFG, CDF **Others:** CRT Member Organizations	Long-term	*ALT-C-13*
	RW-TM-35	Appropriate funding for staff to improve effectiveness of the Department timberland conservation program.	**Potential Lead:** State Legislature **Others:** Resource Agency, CDFG	Long-term	*ALT-C-13*
C	RW-TM-36	To the extent staff is available, conduct full review of THPs and other timberland conservation activities associated with managing timberlands in the range of coho salmon.	**Potential Lead:** CDFG **Others:** Resources Agency	Ongoing/ Continual	*ALT-C-14*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TIMBER MANAGEMENT (continued)					
C	RW-TM-37	To the extent staff is available, prepare coho salmon biological assessments as a Lead or Responsible agency under CEQA for timberland conservation activities, including preharvest inspection reports but not limited to the review of timber harvesting plans.	**Potential Lead:** CDFG **Others:** Counties, Landowners, CDF, CGS, SWRCB	Long-term	*ALT-C-15*
D	RW-TM-38	To the extent staff is available, monitor for five years or more, if necessary to develop an adequate sampling regime, the implementation of the FPRs to determine whether these rules are consistent with the long-term survival of coho salmon.	**Potential Lead:** CDFG, CDF, NOAA Fisheries, Landowners **Others:** Academic Institutions	Interim/ Continual	*ALT-C-16*
D	RW-TM-39	If FPRs are found to be inconsistent with the long-term viability of coho salmon, revise FPRs to ensure adequate protection for the long-term survival of coho salmon.	**Potential Lead:** BOF **Others:** CDF, CDFG, FGC, NOAA Fisheries, Landowners, Forest Industry, Academic Institutions	Long-term	*ALT-C-17*
E	RW-TM-40	Develop a “proof of concept” pilot program to test mathematical or scientific methods of cumulative effects analysis as was suggested in A Scientific Basis for the Prediction of Cumulative Watershed Effects (University of California Committee on Cumulative Watershed Effects, Report No. 46, June 2001 or the “Dunne Report”).	**Potential Lead:** CDFG, CDF, SWRCB, CGS, Academic Institutions	Long-term	*ALT-B-19*
C	RW-TM-41	Implement a “proof of concept” pilot program to test mathematical or scientific methods of cumulative effects analysis.	**Potential Lead:** CDFG	Long-term	*ALT-B-19*
C	RW-TM-42	Establish a THP procedure to document and evaluate the implementation and effectiveness of coho salmon mitigation measures prior to completion inspections.	**Potential Lead:** BOF, CDF **Others:** FGC, CDFG, SWRCB, CGS, Landowners	Long-term	*ALT-B-20e*

TABLE 9-2: Implementation schedule for the SONCC Coho ESU

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ROGUE RIVER AND WINCHUCK RIVER HUs						
Illinois River HSA						
4	E	RO-IR-01	Develop a long-term plan to promote retention of LWD.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, CCC, Landowners, USFS, County, Watershed Groups	Interim	*RO-IR-01*
4	D	RO-IR-02	Implement the long-term plan to promote retention of LWD.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, CCC, Landowners, USFS, County, Watershed Groups	Long-term	*RO-IR-01b*
4	E	RO-IR-03	Continue to control the input of sediment into the watershed.	**Potential Lead:** CDFG, NCRWQCB **Others:** CDF, Landowners, CCC, USFS, Watershed Groups, NOAA Fisheries, County	Interim/ Continual	*RO-IR-02*
4	D	RO-IR-04	Monitor impacts of suction dredge activities for deleterious effects on coho salmon, taking corrective measures when needed.	**Potential Lead:** CDFG, NCRWQCB **Others:** NOAA Fisheries	Interim/ Continual	*RO-IR-03*
4	E	RO-IR-05	Develop a cooperative management strategy with Oregon Department of Fish and Wildlife to improve habitat conditions for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Oregon Department of Fish and Wildlife	Interim	*RO-IR-04*
4	D	RO-IR-06	Implement the cooperative management strategy with Oregon Department of Fish and Wildlife.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Oregon Department of Fish and Wildlife	Long-term	*RO-IR-04b*
Winchuck River HSA						
5	E	WR-SF-01	Develop a short-term plan to increase LWD until natural recruitment can be restored.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, USFS, County, Watershed Groups	Interim	*WR-SF-01*
5	D	WR-SF-02	Implement the short-term plan to increase LWD.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, USFS, County, Watershed Groups	Interim/ Continual	*WR-SF-01b*
5	E	WR-SF-03	Develop a long-term plan to restore a mature coniferous riparian zone to South Fork Winchuck River.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, County, Watershed Groups	Interim	*WR-SF-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Winchuck River HSA (continued)						
5	D	WR-SF-04	Implement the long-term plan to restore a mature coniferous riparian zone to South Fork Winchuck River.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, County, Watershed Groups	Long-term	*WR-SF-02b*
5	E	WR-SF-05	Assess sources of sediment and prioritize treatment areas.	**Potential Lead:** CDFG, NCRWQCB **Others:** CDF, CCC, NOAA Fisheries, Landowners, County, Watershed Groups	Interim/ Continual	*WR-SF-03*
5	D	WR-SF-06	Prioritize and treat sources of sediment.	**Potential Lead:** CDFG, NCRWQCB **Others:** CDF, CCC, NOAA Fisheries, Landowners, County, Watershed Groups	Long-term	*WR-SF-03b*
5	D	WR-SF-07	Develop a cooperative management strategy with Oregon Department of Fish and Wildlife to improve habitat conditions for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	*WR-SF-04*
5	D	WR-SF-08	Implement a cooperative management strategy with Oregon Department of Fish and Wildlife to improve habitat conditions for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	*WR-SF-05*
SMITH RIVER HU						
	D	SR-HU-01	Develop a program to control exotic vegetation which impedes access to and use of tributaries by coho salmon.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, Private Landowners	Interim/ Continual	*SR-HU-01*
	D	SR-HU-02	Implement a program to control exotic vegetation which impedes access to and use of tributaries by coho salmon.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, Private Landowners	Interim/ Continual	*SR-HU-01b*
	E	SR-HU-03	Assess and prioritize barriers and impediments to passage (including water diversions), especially those on smaller tributaries, including Cedar, Clarks, Morrison, Peacock, Sultan, and Little Mill creeks.	**Potential Lead:** USFS, DPR, RNSP **Others:** NOAA Fisheries, Caltrans, County, CDFG, CDF, Private Landowners	Interim/ Ongoing	*SR-HU-02*
	D	SR-HU-04	Treat barriers and impediments to passage (including water diversions), especially those on smaller tributaries, including Yontocket, Tillas, and Tyron sloughs.	**Potential Lead:** USFS **Others:** NOAA Fisheries, Caltrans, County, CDFG, CDF, Landowners	Interim/ Ongoing	*SR-HU-02b*
	E	SR-HU-05	Develop a plan to restore the effectiveness and use of off-channel areas, sloughs, and wetlands.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USACE, California Coastal Commission, DPR, County	Interim	*SR-HU-03*
	D	SR-HU-06	Implement the plan to restore the effectiveness and use of off-channel areas, sloughs, and wetlands.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USACE, California Coastal Commission, County	Interim/ Continual	*SR-HU-03b*
	C	SR-HU-07	Investigate the feasibility of restoring channelized reaches of streams to natural meander belts (e.g., Lower Rowdy Creek and Dominie Creek) that would allow recruitment of stored spawning gravel, re-establish scour pools, recruit woody debris from banks, and ultimately restore fluvial processes that maintain coho salmon habitat.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Landowners	Long-term	*SR-HU-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SMITH RIVER HU (continued)						
	C	SR-HU-08	Where feasible, restore channelized reaches back to more natural fluvial processes (e.g. meander belts that recruit stored spawning gravel, re-establish scour pools, recruit woody debris from banks).	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Landowners	Long-term	*SR-HU-04b*
	D	SR-HU-09	Protect existing LWD recruitment potential through the retention of mature coniferous trees in the riparian zone.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, RNSP, DPR, Landowners	Interim/ Ongoing	*SR-HU-05*
	D	SR-HU-10	Establish adequate streamside buffer areas that are protected from vegetation removal.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, Landowners	Interim/ Ongoing	*SR-HU-05b*
	D	SR-HU-11	Increase the amount of in-channel LWD.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, Landowners	Interim/ Ongoing	*SR-HU-05c*
	D	SR-HU-12	Continue to review THPs with regard to potential impacts to coho salmon and their habitat.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, Landowners	Interim/ Ongoing	*SR-HU-05d*
	D	SR-HU-13	Continue riparian management projects with landowners.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, Landowners	Interim/ Ongoing	*SR-HU-05e*
	C	SR-HU-14	Assess the impacts of steelhead outplanting by the Rowdy Creek Hatchery.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*SR-HU-06*
	C	SR-HU-15	If impacts of steelhead outplanting are found, adjust the outplanting of steelhead by the Rowdy Creek Hatchery to minimize any identified impacts to coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim/ Continual	*SR-HU-06*
	D	SR-HU-16	Treat legacy sources of sediment and minimization the input from new sediment sources.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners, Counties	Interim/ Ongoing	*SR-HU-07*
	C	SR-HU-17	Support and work with the watershed coordinator to aid in implementing recommendations.	**Potential Lead:** CDFG **Others:** Watershed Coordinator	Interim/ Ongoing	*SR-HU-08*
Mill Creek HSA						
4	E	SR-MC-01	Assess and prioritize sediment sources.	**Potential Lead:** DPR **Others:** NPS, NOAA Fisheries, CDFG, CDF	Interim/ Ongoing	*SR-MC-01*
4	D	SR-MC-02	Treat sediment sources.	**Potential Lead:** DPR **Others:** NPS, NOAA Fisheries, CDFG, CDF	Interim/ Ongoing	*SR-MC-01b*
4	E	SR-MC-03	Develop a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.	**Potential Lead:** DPR **Others:** NPS, NOAA Fisheries, CDFG, CDF	Interim/ Ongoing	*SR-MC-02*
4	D	SR-MC-04	Implement the short-term plan to add LWD and a long-term plan to promote recruitment of LWD.	**Potential Lead:** CDFG **Others:** NPS, NOAA Fisheries, CDF	Interim/ Ongoing	*SR-MC-02b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Mill Creek HSA (continued)						
4	D	SR-MC-05	Develop a revegetation plan for the riparian zone which includes planting of coniferous species, along with the release of conifers from competitors, such as alders and blackberries.	**Potential Lead:** CDFG **Others:** NPS, NOAA Fisheries, CDF	Interim/ Ongoing	*SR-MC-03*
4	D	SR-MC-06	Implement the revegetation plan for the riparian zone.	**Potential Lead:** DFG **Others:** NPS, NOAA Fisheries, CDFG, CDF	Interim/ Ongoing	*SR-MC-03b*
Wilson Creek HSA						
5	E	SR-WC-01	Develop a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG, NPS, NOAA Fisheries	Interim/ Ongoing	*SR-WC-01*
5	D	SR-WC-02	Implement a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG, NPS, NOAA Fisheries	Interim/ Continual	*SR-WC-01b*
5	D	SR-WC-03	Increase connectivity of riparian habitat through fencing and planting.	**Potential Lead:** Landowners **Others:** CDF, CDFG, Caltrans	Interim	*SR-WC-02*
5	D	SR-WC-04	Implement the plan to increase connectivity of riparian habitat through fencing and planting.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG	Interim	*SR-WC-02b*
5	D	SR-WC-05	Assess and prioritize the sources of sediment.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG	Interim/ Ongoing	*SR-WC-03*
5	D	SR-WC-06	Treat the sources of sediment.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG	Interim/ Ongoing	*SR-WC-03b*
Smith River Plain HSA						
4	E	SR-PL-01	Assess and prioritize barriers to coho salmon passage.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Caltrans, County, Private Landowners	Interim/ Ongoing	*SR-PL-01*
4	D	SR-PL-02	Treat the barriers to coho salmon passage.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Caltrans, County, Private Landowners	Interim/ Ongoing	*SR-PL-01b*
4	D	SR-PL-03	Implement the plan developed at the HU-level that speaks to restoring the effectiveness and use of off-channel areas, sloughs, and wetlands; and specifically give immediate attention to Yontocket (partially State-owned), Tillas and Tryon sloughs.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USACE, California Coastal Commission, Department of Parks and Recreation, County	Interim	*SR-HU-03*
KLAMATH RIVER HU						
	E	KR-HU-01	Facilitate development of a cooperative adaptive management plan in preparation for low-flow emergencies.	**Potential Lead:** CDFG, PacifiCorp **Others:** USBR, NOAA Fisheries, USFWS, DOI, Tribes, SWQCB, other stakeholders	Interim	*KR-HU-01*
	E	KR-HU-02	Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.	**Potential Lead:** CDFG **Others:** RWQCB, NOAA Fisheries, USFS, Yurok Tribe, CDF, Caltrans, Private Landowners	Interim	*KR-HU-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
KLAMATH RIVER HU (continued)						
	C	KR-HU-03	Develop a plan (including a feasibility analysis) for coho salmon passage over and above Iron Gate and Copco dams to restore access to historic habitat.	**Potential Lead:** FERC, PacifiCorp **Others:** USFWS, USBR, NOAA Fisheries, CDFG	Interim	*KR-HU-04*
	C	KR-HU-04	Analyze the feasibility and appropriateness of site-specific FGC §2084 permits for sport fishing for hatchery coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*KR-HU-07*
	E	KR-HU-05	Complete comprehensive flow study activities (e.g. Hardy Phase II) and use them to educate water managers on how to reduce impacts to coho salmon.	**Potential Lead:** BIA, USFWS **Others:** NOAA Fisheries, CDFG	Interim	*KR-HU-08*
	D	KR-HU-06	Implement the comprehensive flow study in a manner that will restore natural stream processes.	**Potential Lead:** USBR **Others:** USFWS, NOAA Fisheries, CDFG	Interim	*KR-HU-08b*
	E	KR-HU-07	Apply protective down-ramp rates at Iron Gate Dam to minimize stranding of coho salmon fry.	**Potential Lead:** CDFG, USBR, FERC, PacifiCorp **Others:** USFWS	Interim	*KR-HU-09*
	E	KR-HU-08	Improve water quality coming into the Klamath River mainstem from the Upper Klamath Basin through ongoing efforts.	**Potential Lead:** CDFG **Others:** USBR, USFWS, NOAA Fisheries	Interim/ Ongoing	*KR-HU-10*
	D	KR-HU-09	Perform cost/benefit analysis of full or partial Hydroelectric Project removal for the purposes of improving water quality, fish passage, and sediment transport.	**Potential Lead:** PacifiCorp, FERC **Others:** USBR, USFWS, NOAA Fisheries, CDFG	Interim	*KR-HU-11*
	D	KR-HU-10	Manage the streams and uplands in key cold-water tributaries, to preserve their cold-water thermal regime.	**Potential Lead:** USFS **Others:** Tribes, NOAA Fisheries, USFWS, CDFG, Landowners, Counties, Watershed Groups	Interim/ Continual	*KR-HU-13*
	D	KR-HU-11	Investigate coho salmon non-natal rearing and refugia use in lower reaches of tributaries and mainstem confluences.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS	Interim	*KR-HU-14*
	D	KR-HU-12	Protect and enhance tributary reaches identified as providing refugia to juvenile coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS	Interim	*KR-HU-14b*
	E	KR-HU-13	Develop a plan to address water quality and quantity in Klamath River tributaries that exacerbate mainstem water quality problems.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Private Landowners	Interim/ Ongoing	*KR-HU-15*
	D	KR-HU-14	Implement the plan that addresses water quality and quantity in the Klamath River tributaries that exacerbate mainstem water quality problems.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Private Landowners	Interim/ Ongoing	*KR-HU-15*
	E	KR-HU-15	Assess hatchery operations in terms of coho salmon recovery in accordance with the policies and guidelines included in this document.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS, USBR	Interim	*KR-HU-16*
	E	KR-HU-16	Continue disease monitoring of juvenile salmon emigration in the Klamath River mainstem so that major disease outbreaks can be identified and their causes evaluated.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS	Interim/ Ongoing	*KR-HU-17*
	E	KR-HU-17	Conduct disease monitoring of migrating adult Chinook and coho salmon during fall migration.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS, USBR	Interim/ Continual	*KR-HU-18*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
KLAMATH RIVER HU (continued)						
	D	KR-HU-18	Conduct studies in and around the Klamath River Hydroelectric Project to see if the Project is contributing to habitat for the ceratomyxosis intermediate host.	**Potential Lead:** PacifiCorp **Others:** USBR, CDFG, NOAA Fisheries, USFWS	Interim	*KR-HU-19*
	C	KR-HU-19	Restore appropriate coarse sediment supply and transport near Iron Gate Dam. Means to achieve this could include full or partial removal of the Klamath Project, or gravel introduction such as is done below other major dams (e.g., Trinity Dam).	**Potential Lead:** FERC, PacifiCorp **Others:** USFWS, NOAA Fisheries, CDFG	Long-term	*KR-HU-20*
	E	KR-HU-20	Acquire additional water through conservation easements and purchases of water and water rights from willing sellers, where lack of flows is a limiting factors and dedicate these flows to instream coho salmon needs	**Potential Lead:** CDFG **Others:** USBR, NOAA Fisheries, USFWS	Long-term/ Continual	*KR-HU-22*
	E	KR-HU-21	Acquire interim, emergency water through transfers of water and water rights from willing sellers, when necessary to meet critical instream coho salmon needs.	**Potential Lead:** CDFG **Others:** USBR, NOAA Fisheries, USFWS	Interim	*KR-HU-22b*
	D	KR-HU-22	Provide watermaster service for all diversions with partial funding provided by the State or Federal governments.	**Potential Lead:** DWR **Others:** SWRCB, CDFG, USBR	Interim/ Continual	*KR-HU-24*
	C	KR-HU-23	Promote public interest in the Klamath River Basin's coho salmon, their beneficial use and habitat requirements.	**Potential Lead:** CDFG **Others:** USFWS, RCDs, Watershed Groups	Interim/ Continual	*KR-HU-25*
Klamath Glen HSA						
5	E	KR-KG-01	Resume estuary investigations to better understand the estuary's role in the survival of Klamath Basin River coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Yurok Tribe, Coastal Commission, NPS	Interim/ Ongoing	*KR-KG-01*
5	D	KR-KG-02	Develop a plan to restore off-channel estuarine, wetland, and slough habitat in the Klamath River estuary and adjoining lower tributary reaches that includes: a. Determining if key properties, conservation easements, or development rights need to be purchased and the work with wiling landowners; and b. Determining the need and installation of livestock exclusion fencing to protect restored areas.	**Potential Lead:** CDFG **Others:** Yurok Tribe, Private Landowners	Interim	*KR-KG-02*
5	D	KR-KG-03	Implement the plan to restore off-channel estuarine, wetland, and slough habitat in the Klamath River estuary and adjoining lower tributary reaches.	**Potential Lead:** CDFG **Others:** Yurok Tribe, Private Landowners	Interim	*KR-KG-02*
5	D	KR-KG-04	Develop a plan to maintain Blue Creek watershed tributaries as key thermal refugia for their cool water contributions to the mainstem Klamath River. The plan should emphasize that: a. Sediments from upslope activities do not impact the refugia; b. Upslope stabilization and restoration activities continue, including road assessment and treatment; c. In-channel and riparian restoration efforts (target riparian retention efforts) continue; and d. Feral cattle are removed.	**Potential Lead:** Yurok Tribe **Others:** Simpson, USFS, NOAA Fisheries, CDFG, USFWS	Interim/ Ongoing	*KR-KG-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Klamath Glen HSA (continued)						
5	D	KR-KG-05	Implement the plan to maintain Blue creek watershed tributaries as key thermal refugia for their cool water contributions to the mainstem Klamath River.	**Potential Lead:** Yurok Tribe, Simpson **Others:** USFS, CDFG, CCC, SCC	Interim/ Ongoing	*KR-KG-03b*
5	D	KR-KG-06	Develop a plan to protect and restore Klamath River mainstem tributaries, even those that do not support populations of coho salmon but that provide cool water and which improve mainstem Klamath water quality, particularly during warm summer months. Plan should emphasize the: a. Protection and/or restoration of riparian habitat; b. Stabilization of upslope areas to prevent sedimentation and aggradation of tributaries at their mouths; c. Improvement of Federal land management activities to reduce impacts to riparian corridors and decrease sediment loads; and d. Finalize and/or refine the Lower Klamath Sub-Basin Watershed Restoration Plan (Gale and Randolph 2000) that focuses on the tributaries to the Lower Klamath within the Klamath Glen HSA.	**Potential Lead:** Yurok Tribe **Others:** Simpson, USFS, NOAA Fisheries, RWQCB, Yurok Tribe, Hoopa Valley Tribe, USFWS	Interim/ Ongoing	*KR-KG-04*
5	D	KR-KG-07	Finalize and Implement the Lower Klamath Sub-Basin Watershed Restoration Plan (Gale and Randolph 2000) to protect and restore Klamath River mainstem tributaries.	**Potential Lead:** Yurok Tribe, Simpson **Others:** USFS, CDFG, CCC, SCC	Interim/ Ongoing	*KR-KG-04b*
5	D	KR-KG-08	Reduce sediment input from upslope sources, including activities such as: a. Decommissioning skidtrails and unmaintained roads, where possible; b. Upgrading roads and maintenance practices; c. Stabilizing slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams, and d. Minimizing alteration of natural hillslope drainage patterns.	**Potential Lead:** Yurok Tribe, Simpson **Others:** USFS, CDFG, CCC, SCC	Interim/ Ongoing	*KR-KG-05*
5	E	KR-KG-09	Review existing inventory and assessment of barriers (Gale 2003) and prioritize barriers impeding migration of adult and juvenile coho salmon throughout the Lower Klamath River tributaries.	**Potential Lead:** Yurok Tribe **Others:** Simpson, Del Norte County, Caltrans, CDFG, CCC, SCC	Interim/ Ongoing	*KR-KG-06*
5	D	KR-KG-10	Treat prioritized barriers impeding migration of adult and juvenile coho salmon throughout the Lower Klamath River tributaries.	**Potential Lead:** CDFG **Others:** County, Tribes, NOAA Fisheries, USFWS, Landowners, Caltrans	Interim/ Ongoing	*KR-KG-06a*
5	D	KR-KG-11	Investigate temporal and spatial magnitude of tributary deltas and seasonal subsurface flow reaches to determine impacts to juvenile and adult coho migration and to quantify seasonal loss of lower tributary habitat. Investigation should include assessment of long-term delta size trends, annual variation in coho salmon access periodicity by tributary, quantification of seasonal habitat loss and fish stranding, and the relation of delta and subsurface flow formation to upslope erosion, river and tributary flow, mainstem bedload deposition and other causative factors.	**Potential Lead:** Yurok Tribe **Others:** Simpson, CDFG, CCC	Long-term	*KR-KG-06b*
5	D	KR-KG-12	Conduct feasibility study to re-establish adult coho salmon passage above major barriers in lower Roaches and Tully creeks and the Middle and North Forks of Ah Pah Creek.	**Potential Lead:** CDFG, Yurok Tribe **Others:** Simpson, CCC, NOAA Fisheries	Interim	*KR-KG-06c*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Klamath Glen HSA (continued)						
5	D	KR-KG-13	Treat sediment sources and improve riparian and instream habitat conditions to provide adequate and stable spawning and rearing areas for coho salmon.	**Potential Lead:** Yurok Tribe, Simpson, CCC **Others:** USFS, CDFG, SCC	Interim/ Ongoing	*KR-KG-07*
5	D	KR-KG-14	Develop a plan to restore in-channel and riparian habitat in tributaries to address: a. Revegetating riparian zones with native species (e.g., conifers) to stabilize stream banks and promote a long-term supply of LWD; b. Providing adequate protection from development, grazing, etc; and c. Relocating roads out of riparian areas when feasible.	**Potential Lead:** Yurok Tribe, CDFG **Others:** Landowners, CCC, CDF, SCC, NOAA Fisheries	Interim/ Continual	*KR-KG-08*
5	D	KR-KG-15	Implement the plan to restore in-channel and riparian habitat in tributaries.	**Potential Lead:** Yurok Tribe, Simpson, CCC **Others:** NOAA Fisheries, CDFG, CDF, SCC, Landowners	Interim/ Continual	*KR-KG-08b*
5	D	KR-KG-16	Develop a plan to provide suitable accumulations of woody cover in slow-velocity habitats for coho salmon winter rearing on a short-term basis by placing wood in needed areas until natural supplies become available.	**Potential Lead:** CDFG **Others:** Tribes, Landowners, USFS	Interim	*KR-KG-09*
5	D	KR-KG-17	Implement the plan to provide suitable accumulations of woody cover in slow-velocity habitats for coho salmon winter rearing on a short-term basis by placing wood in needed areas until natural supplies become available.	**Potential Lead:** CDFG **Others:** Tribes, Landowners, USFS	Interim	*KR-KG-09b*
5	C	KR-KG-18	Construct livestock exclusionary fencing and corresponding riparian restoration as necessary in Salt, lower High Prairie, lower Hunter and lower Terwer creeks. Provide funding and incentives to landowners and/or restoration groups where necessary to achieve this goal.	**Potential Lead:** CCC, Yurok Tribe **Others:** Landowners, CDFG	Interim	*KR-KG-10a*
5	C	KR-KG-19	Develop a plan to remove feral cattle from lower Blue and Bear Creeks.	**Potential Lead:** Yurok Tribe **Others:** Simpson	Interim	*KR-KG-10b*
5	C	KR-KG-20	Implement the plan to remove feral cattle from lower Blue and Bear creeks.	**Potential Lead:** Landowners	Interim/ Continual	*KR-KG-10b*
5	D	KR-KG-21	Work with Humboldt County, NOAA Fisheries and existing and future gravel-mining operators to restrict gravel-mining operations to appropriate mainstem Klamath locations. Gravel mining should not be conducted within Lower Klamath tributary watersheds until a scientifically valid and peer-reviewed geomorphic analysis is conducted to determine existing channel stability, causes of excess aggradation, and identifies gravel mining as an appropriate restorative measure, as outlined in task RW-IG-01.	**Potential Lead:** CDFG **Others:** County, NOAA Fisheries, existing and future gravel mining operators	Interim/ Continual	*KR-KG-11a*
5	C	KR-KG-22	Encourage cooperation between industrial timber land managers and tribes to restore coho salmon habitat Use the successful Tribal/Simpson Resource Company program as an example.	**Potential Lead:** CDFG **Others:** Tribes, Simpson Timber	Interim	*KR-KG-12*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Klamath Glen HSA (continued)						
5	D	KR-KG-23	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through planting and release of conifers, and control of alders, blackberries, and other competitors; and d. Provide technical support as an incentive for landowners.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, Yurok Tribe, CDF, Landowners	Interim/ Ongoing	*KR-KG-13*
5	D	KR-KG-24	Provide technical and financial support to implement riparian restoration throughout alluvial reaches in lower Blue, Terwer, Hunter and Salt creeks.	**Potential Lead:** CDFG **Others:** Landowners, CCC, Yurok Tribe	Interim/ Continual	*KR-KG-14*
5	C	KR-KG-25	Investigate straying and impacts of exotic fish (bass and bullhead) populations in an abandoned mill pond in lower Richardson Creek to coho salmon in the adjoining Klamath River estuary.	**Potential Lead:** CDFG **Others:** Yurok Tribe, RNSP, NOAA Fisheries	Interim/ Continual	*KR-KG-15*
5	C	KR-KG-26	Continue funding and technical support for the California Conservation Corps to continue their collaborative participation with the Yurok Tribe and Simpson Resource Company to implement watershed restoration throughout the lower Klamath River subbasin.	**Potential Lead:** CDFG **Others:** Yurok Tribe, Simpson Resource Company	Interim/ Ongoing	*KR-KG-17*
5	E	KR-KG-27	Support continued implementation of the Coho Salmon Regional Abundance Inventory throughout the lower Klamath River subbasin.	**Potential Lead:** CDFG	Interim/ Ongoing	*KR-KG-18*
5	C	KR-KG-28	Develop a plan to restore the historic flood plain on Hoppaw Creek, in cooperation with landowners and Caltrans.	**Potential Lead:** CDFG **Others:** Simpson, Yurok Tribe, Caltrans	Interim	*KR-KG-19*
5	C	KR-KG-29	Implement the plan to restore the historic flood plain on Hoppaw Creek.	**Potential Lead:** CDFG **Others:** Landowners, Caltrans	Interim	*KR-KG-19b*
Orleans HSA						
3	D	KR-OR-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon that provide cool water and which improve mainstem Klamath River water quality and which provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Include improved land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request SWRCB to review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-OR-01*
3	D	KR-OR-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, but which provide cool water and which improve mainstem Klamath River water quality and/or provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-OR-01b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Orleans HSA						
3	D	KR-OR-03	Continue activities that maintain connectivity (flow) between mainstem habitat and tributary habitat in Slate and Red Cap creeks.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG	Interim/ Continual	*KR-OR-02*
3	C	KR-OR-04	Develop a plan to protect and enhance spawning and rearing habitats in Boise and Camp creeks.	**Potential Lead:** USFS	Interim	*KR-OR-03*
3	C	KR-OR-05	Implement the plan to protect and enhance spawning and rearing habitats in Boise and Camp creeks.	**Potential Lead:** USFS	Interim	*KR-OR-03b*
3	E	KR-OR-06	Develop a plan to protect and enhance Bluff and Red Cap creek watersheds, which are classified as Key Watersheds in the Northwest Forest Plan, and are refugia for coho salmon.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG	Interim/ Ongoing	*KR-OR-04*
3	D	KR-OR-07	Implement the plan to protect and enhance Bluff and Red Cap creek watersheds	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG	Interim/ Ongoing	*KR-OR-04b*
3	C	KR-OR-08	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.	**Potential Lead:** USFS, BLM **Others:** CDF, Landowners	Interim	*KR-OR-05*
3	C	KR-OR-09	Support efforts to provide livestock exclusion fencing where feasible and appropriate, while providing off-site watering.	**Potential Lead:** USFS **Others:** Landowners	Interim/ Ongoing	*KR-OR-06*
3	D	KR-OR-10	Reduce sediment input from upslope sources, including measures to: a. Decommission skid trails and unmaintained roads where possible; b. Upgrade roads and maintenance practices; c. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and d. Minimize alteration of natural hillslope drainage patterns.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-OR-07*
Ukonom HSA						
3	D	KR-UK-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, but which provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Include improved land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-01*
3	D	KR-UK-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, but which provide cool water, improve mainstem Klamath water River quality, and provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-01b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Ukonom HSA (continued)						
3	D	KR-UK-03	Reduce sediment input from upslope sources, including measures to: a. Decommission skid trails and unmaintained roads where possible; b. Upgrade roads and maintenance practices; c. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and d. Minimize alteration of natural hillslope drainage patterns.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-02*
3	D	KR-UK-04	Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.	**Potential Lead:** CDFG **Others:** Caltrans, USFS, Karuk Tribe, USFS	Interim	*KR-UK-03*
3	D	KR-UK-05	Implement the plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.	**Potential Lead:** CDFG **Others:** Caltrans, USFS, Karuk Tribe, USFS	Interim/ Ongoing	*KR-UK-03b*
3	D	KR-UK-06	Implement highest priority barrier repairs as identified in the Caltrans, USFS, and the Karuk Tribe inventories, specifically the identified culverts on Highway 96 at Stanshaw, Sandy Bar, and Coon.	**Potential Lead:** CDFG **Others:** Caltrans, USFS, Karuk Tribe, USFS	Interim/ Ongoing	*KR-UK-3c*
3	D	KR-UK-07	Develop a plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems, including measures to: a. Conduct riparian revegetation and stream-bank restoration; b. Where feasible, relocate roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas); c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and d. Revegetate flood plain areas using native species.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-04*
3	D	KR-UK-08	Implement the plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-04b*
3	D	KR-UK-09	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Planting conifers in riparian zones; and d. Release of conifers by controlling alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-05*
3	D	KR-UK-10	Provide technical support as an incentive to landowners for ongoing efforts of restoring LWD and shade to the watershed.	**Potential Lead:** USFS **Others:** Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-05b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Ukonom HSA (continued)						
3	C	KR-UK-11	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.	**Potential Lead:** USFS, BLM **Others:** CDF, Landowners	Interim/ Ongoing	*KR-UK-06*
3	C	KR-UK-12	Where necessary, provide riparian protection from livestock through exclusion fencing, while establishing off-site watering.	**Potential Lead:** RCDs **Others:** Landowners	Interim/ Continual	*KR-UK-07*
3	E	KR-UK-13	Install screens on diversions to Department-NOAA Fisheries standards and provide funding, or other incentives to landowners where necessary to achieve this goal.	**Potential Lead:** CDFG **Others:** DWR, NOAA Fisheries	Interim	*KR-UK-08*
3	E	KR-UK-14	Increase efficiency of water diversions and delivery systems.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-UK-09*
3	D	KR-UK-15	Continue restoration and monitoring of Siskon Mine to prevent further degradation of the riparian resource.	**Potential Lead:** CGS **Others:** RWQCB, EPA	Interim/ Ongoing	*KR-UK-10*
3	D	KR-UK-16	Request SWRCB to investigate the legality of diversions and use of water on Stanshaw Creek.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-UK-11*
Happy Camp HSA						
4	D	KR-HC-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath water River quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-HC-01*
4	D	KR-HC-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-HC-01b*
4	D	KR-HC-03	Reduce sediment input from upslope sources, including measures to: a. Decommission skid trails and unmaintained roads where possible; b. Upgrade roads and maintenance practices; c. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and d. Minimize alteration of natural hillslope drainage patterns.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HC-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Happy Camp HSA (continued)						
4	E	KR-HC-04	Develop a plan to improve coho salmon passage at stream and road crossings, including measures to: a. Replace culverts on both USFS and Caltrans roads with structures allowing fish passage (USFS and Karuk Tribe have identified culverts under Highway 96 at Cade, Portuguese, and Fort Goff creeks as needing treatment); b. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and c. Establish an adequate funding source basin-wide for road maintenance and upgrades (possible funding sources are USFS, County and State agencies).	**Potential Lead:** CDFG **Others:** USFS, Caltrans, Karuk Tribe , Counties	Interim	*KR-HC-03*
4	D	KC-HC-05	Implement the plan to improve coho salmon passage at stream and road crossings.	**Potential Lead:** CDFG **Others:** USFS, Caltrans, Karuk Tribe, Counties	Long-term	*KC-HC-03b*
4	D	KR-HC-06	Develop a plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems, including measures to: a. Conduct riparian revegetation and stream-bank restoration; b. If feasible, relocate roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas); c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and d. Revegetate flood plain areas using native species.	**Potential Lead:** CDFG **Others:** USFS, Tribes, Landowners	Interim	*KR-HC-04*
4	D	KR-HC-07	Implement the plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems.	**Potential Lead:** CDFG **Others:** USFS, Tribes, Landowners	Interim/ Continual	*KR-HC-04b*
4	D	KR-HC-08	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Planting conifers in riparian zones; and d. Release of conifers by controlling alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HC-05*
4	C	KR-HC-09	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fires on coho salmon.	**Potential Lead:** USFS, BLM **Others:** CDF, Landowners	Interim	*KR-HC-06*
4	C	KR-HC-10	Where necessary, provide riparian protection from livestock through exclusion fencing, while establishing off-site watering.	**Potential Lead:** USFS **Others:** Landowners	Interim	*KR-HC-07*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Happy Camp HSA (continued)						
4	E	KR-HC-11	Install screens on diversions to Department-NOAA Fisheries standards and provide funding, or other incentives to landowners where necessary to achieve this goal.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Landowners	Interim	*KR-HC-08*
4	E	KR-HC-12	Increase efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet this goal.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-HC-09*
4	D	KR-HC-13	Request the NCRWQCB to continue monitoring Grey Eagle Mine and tailings as a follow-up to remediation that has already been done.	**Potential Lead:** CDFG **Others:** RWQCB	Interim	*KR-HC-10*
	D	KR-HC-14	Request that EPA Region 9 consider coho salmon when dealing with both emergency and remedial actions.	**Potential Lead:** CDFG **Others:** EPA	Interim	*KR-HC-10b*
Seiad Valley HSA						
4	D	KR-SV-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-SV-01*
4	D	KR-SV-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for fish, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-SV-01b4*
4	D	KR-SV-03	Reduce sediment input from upslope sources by: a. Decommissioning unmaintained roads (where possible) and skid trails; b. Upgrade roads and maintenance practices; c. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and d. Minimize alteration of natural hill slope drainage patterns.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-SV-02E*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Seiad Valley HSA (continued)						
4	E	KR-SV-04	Improve fish passage at stream and road crossings, including measures to: a. Replace culverts on both USFS and Caltrans roads with structures allowing coho salmon passage; b. Treat coho salmon passage problems associated with the USFS roads; c. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and d. Establish an adequate funding source basin-wide for road maintenance and upgrades (possible funding sources are USFS, County and State agencies).	**Potential Lead:** CDFG **Others:** USFS, Caltrans	Interim/ Ongoing	*KR-SV-03*
4	D	KR-SV-05	Develop a plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems, including measures to: a. Conduct riparian revegetation and stream-bank restoration; b. Relocate roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, seep areas); c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and d. Revegetate flood plain areas using native species.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-SV-04*
4	D	KR-SV-06	Implement the plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-SV-04b*
4	D	KR-SV-07	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Planting conifers in riparian zones; and d. Release of conifers by controlling alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-SV-05*
4	D	KR-SV-08	Provide technical support as an incentive to landowners for ongoing efforts of restoring LWD and shade to the watershed.	**Potential Lead:** USFS, NOAA Fisheries, CDFG **Others:** CDF, Landowners	Interim	*KR-SV-05b*
4	C	KR-SV-09	Manage roadless areas to be consistent with land use allocations under the Northwest Forest Plan to reduce the risk of large, severe fires by re-establishing the natural fire regimes.	**Potential Lead:** USFS	Interim	*KR-SV-06*
4	C	KR-SV-10	Where necessary, provide riparian protection from livestock through exclusion fencing, while establishing off-site watering.	**Potential Lead:** USFS **Others:** Landowners	Interim	*KR-SV-07*
4	E	KR-SV-11	Install screens on diversions to Department-NOAA Fisheries standards and provide funding, or other incentives to landowners where necessary to achieve this goal.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Landowners	Interim	*KR-SV-08*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Seiad Valley HSA (continued)						
4	E	KR-SV-12	Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-SV-09*
4	E	KR-SV-13	Identify illegal water diverters and request that the SWRCB take appropriate action.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-SV-10*
4	E	KR-SV-14	Request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-SV-10b*
4	D	KR-SV-15	Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.	**Potential Lead:** CDFG **Others:** Landowners, RCDs	Interim	*KR-SV-11*
4	D	KR-SV-16	Assess potential coho salmon passage problem associated with private water diversion at the mouth of Middle Creek (tributary to Horse Creek).	**Potential Lead:** CDFG **Others:** Landowners	Interim	*KR-SV-12*
4	D	KR-SV-17	If necessary, design and implement a remediation project for coho salmon fish passage at the mouth of Middle Creek.	**Potential Lead:** CDFG **Others:** Landowners	Interim	*KR-SV-12b*
Beaver Creek HSA						
4	C	KR-BC-01	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of a large, severe fire on coho salmon.	**Potential Lead:** USFS **Others:** BLM, CDF	Long-term	*KR-BC-01*
4	C	KR-BC-02	Encourage landowners to manage fuels to prevent large, severe fires and to evaluate the application of the Watershed Evaluation Mitigation Addendum.	**Potential Lead:** USFS **Others:** CDF, County, Landowners, CDFG	Interim/ Ongoing	*KR-BC-02*
4	D	KR-BC-03	Assess fine sediment production and delivery from the USFS road adjacent to the West Fork of Beaver Creek.	**Potential Lead:** USFS	Interim	*KR-BC-03*
4	D	KR-BC-04	Implement appropriate remediation for the sediment from the USFS road adjacent to the West Fork of Beaver Creek.	**Potential Lead:** USFS	Interim	*KR-BC-03b*
4	C	KR-BC-05	Hydrologically disconnect the USFS Beaver Creek Road north of West Beaver Creek.	**Potential Lead:** USFS	Interim	*KR-BC-04*
4	D	KR-BC-06	Support actions to reduce sediment from upslope sources such as: a. Decommission roads and skid trails; b. Upgrade roads and maintenance practices; c. Ensure adequate coho salmon migration is provided for at stream/road crossings; d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; e. Minimize alteration of natural hillslope drainage patterns; and f. Encourage the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, seep areas).	**Potential Lead:** USFS, NOAA Fisheries **Others:** CDFG, CDF, Landowners	Interim/ Ongoing	*KR-BC-05*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Beaver Creek HSA (continued)						
4	D	KR-BC-07	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-BC-06*
4	D	KR-BC-08	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for fish, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-BC-07*
4	E	KR-BC-09	Improve coho salmon passage at stream and road crossings, including measures to: a. Replace culverts on both USFS and Caltrans roads with structures allowing coho salmon passage; b. Treat coho salmon passage problems associated with the USFS roads; c. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and d. Encourage the USFS and County and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.	**Potential Lead:** CDFG **Others:** USFS, Caltrans	Interim/ Ongoing	*KR-BC-08*
4	D	KR-BC-10	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; and c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-BC-09*
4	D	KR-BC-11	Provide technical support as an incentive to landowners for ongoing efforts of restoring LWD and shade to the watershed.	**Potential Lead:** USFS, NOAA Fisheries, CDFG **Others:** CDF, Landowners	Interim	*KR-BC-10*
4	C	KR-BC-12	Where necessary, provide riparian protection from livestock while providing off-site watering.	**Potential Lead:** USFS **Others:** Landowners	Interim	*KR-BC-11*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SALMON RIVER HA						
	D	SA-HA-01	Reduce sediment and provide coho salmon passage for all life history stages where roads affect streams inhabited by coho salmon.	**Potential Lead:** Road Management and Fisheries Barrier Work Group Task Force, USFS **Others:** Landowners, County, CDFG	Interim	*SA-HA-01*
	D	SA-HA-02	Reduce sediment by accelerating the Northwest Forest Plan road assessment schedule.	**Potential Lead:** USFS **Others:** County, CDFG	Interim	*SA-HA-01b*
	D	SA-HA-03	Reduce sediment where roads affect streams inhabited by coho salmon by completing the road sediment inventory assessment of County roads.	**Potential Lead:** County **Others:** USFS, CDFG	Interim/ Ongoing	*SA-HA-01c*
	D	SA-HA-04	Reduce sediment where roads affect streams inhabited by coho salmon by implementing the treatment of the road sediment inventory of county roads.	**Potential Lead:** County **Others:** USFS, CDFG	Interim	*SA-HA-01d*
	D	SA-HA-05	Provide coho salmon passage to all life history stages where roads affect streams inhabited by coho salmon implement the recommendations for the completed assessment of barriers.	**Potential Lead:** County, Road Management and Fisheries Barrier Work Group Task Force **Others:** USFS, CDFG, Landowners	Interim	*SA-HA-01e*
	E	SA-HA-06	Foster the multi-agency task force to identify and prioritize barriers to fish passage, and implement corrective treatments. This task force would include at a minimum, representatives from the Salmon River Restoration Council, Karuk Tribe, USFS, NOAA Fisheries, USFWS, and the Department.	**Potential Lead:** Road Management and Fisheries Barrier Work Group Task Force (Salmon River Restoration Council, Karuk Tribe, USFS, NOAA Fisheries, USFWS, County, and CDFG)	Interim/ Ongoing	*SA-HA-02*
	D	SA-HA-07	Educate landowners, restoration specialist, and watershed groups to reduce the impacts of private roads on coho salmon.	**Potential Lead:** CDFG, Road Management and Fisheries Barrier Work Group Task Force **Others:** Salmon River Restoration Council, Landowners	Interim/ Ongoing	*SA-HA-03*
	C	SA-HA-08	Encourage collaborative efforts among agencies and stakeholders to control or remove invasive exotics using integrated pest management techniques, emphasizing manual treatments.	**Potential Lead:** CDFG, Salmon River Noxious Weed Management Area Groups **Others:** Landowners, Academia, Native Plant Advocates	Interim/ Ongoing	*SA-HA-04*
	C	SA-HA-09	Reduce the risk of large, severe fires through fuels management around residential structures, homes, and fire escape routes. Implement Salmon River Fire Safe Council recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.	**Potential Lead:** Salmon River Fire Safe Council **Others:** County, CDFG, CDF, USFS	Interim/ Ongoing	*SA-HA-05*
	C	SA-HA-10	Re-establish fire regimes consistent with Northwest Forest Plan objectives to reduce the risk and impact of large, severe fire on coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Salmon River Fire Safe Council **Others:** USFS	Interim	*SA-HA-06*
	C	SA-HA-11	If necessary, integrate coho salmon conservation into the Northwest Forest Plan regarding fire suppression and overall fuel management plan.	**Potential Lead:** USFS	Interim	*SA-HA-06b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SALMON RIVER HA (continued)						
	D	SA-HA-12	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade, primarily in tributaries and key refugia areas, through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as technical support.	**Potential Lead:** USFS, CDFG **Others:** NOAA Fisheries, Watershed Groups, County, USFWS, Karuk Tribe, Salmon River Restoration Council, Landowners	Interim/ Ongoing	*SA-HA-09*
	C	SA-HA-13	Develop a plan to prioritize and remediate mine tailings.	**Potential Lead:** CDFG, CGS, North Coast RWQCB, USFS **Others:** NOAA Fisheries, Karuk Tribe, USFWS, Salmon River Restoration Council, Landowners	Interim/ Ongoing	*SA-HA-10*
	C	SA-HA-14	Implement the plan to remediate prioritized mine tailings, focusing on tributaries and key area of the Salmon River.	**Potential Lead:** CGS, USFS, North Coast RWQCB **Others:** NOAA Fisheries, CDFG, USFWS, Karuk Tribe, Salmon River Restoration Council	Interim/ Ongoing	*SA-HA-10b*
Lower Salmon HSA						
3	D	SA-LS-01	Restore and maintain habitat connectivity between the Salmon River and Nordheimer Creek where low flow or sediment aggradation has been known to restrict coho salmon passage.	**Potential Lead:** USFS, Watershed Group **Others:** Karuk Tribe	Interim/ Ongoing	*SA-LS-01*
		SA-LS-02	Support ongoing maintenance and operations for the Nordheimer Creek Fish Ladder.	**Potential Lead:** USFS, Watershed Group **Others:** Karuk Tribe		*SA-LS-02*
Sawyers Bar HSA						
3	D	SA-SB-01	Reduce current and future sediment inputs to Specimen, North Russian, and South Russian creeks: a. Do road upgrade/improvement/maintenance/storm proofing (out sloping roads, reducing hydrologic connectivity); b. Provide slope stabilization where feasible; c. Reduce or avoid alteration of natural hill slope drainage patterns: and d. Upgrade stream/road crossings and ensure coho salmon passage.	**Potential Lead:** USFS, Watershed Group **Others:** Karuk Tribe	Interim/ Ongoing	*SA-SB-01*
3	D	SA-SB-02	Conduct riparian revegetation and stream-bank stabilization along entire North Fork: a. Control vegetation removal in the streamside zone; b. Increase the number of conifers and deciduous trees to provide stable stream shading and which will eventually become a source for LWD; and c. Revegetate flood plain areas using native species.	**Potential Lead:** USFS, Watershed Group **Others:** Karuk Tribe	Interim/ Ongoing	*SA-SB-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SHASTA VALLEY AND SCOTT RIVER HAs —Shasta Valley, Scott Bar, and Scott Valley HSAs						
4	C	SS-HA-01	Reduce the risk of large, severe fires (especially in the Scott) by implementing the Fire Safe Council's recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.	**Potential Lead:** CDF, USFS **Others:** County, Landowners, CDFG	Interim/ Ongoing	*SS-HA-01*
4	D	SS-HA-02	Reduce human-caused sediment input from upslope sources identified through public and private inventories.	**Potential Lead:** USFS, CDF, Landowners **Others:** Caltrans, County, CDFG	Interim/ Ongoing	*SS-HA-02*
4	D	SS-HA-03	Prioritize and implement remediation activities for human-caused sediment, which would include slope stabilization, minimizing sediment production, and eliminating coho salmon passage barriers.	**Potential Lead:** USFS, CDF, Landowners **Others:** Caltrans, County, CDFG	Interim/ Ongoing	*SS-HA-02b*
4	D	SS-HA-04	Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems.	**Potential Lead:** CDFG **Others:** USFS, CDF, Caltrans, County, Landowners	Interim	*SS-HA-03*
4	D	SS-HA-05	Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim/ Ongoing	*SS-HA-03b*
4	D	SS-HA-06	Reduce road densities where necessary and appropriate.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*SS-HA-03c*
4	D	SS-HA-07	Decrease potential for stream flow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim/ Ongoing	*SS-HA-03d*
4	D	SS-HA-08	Stabilize slopes along roadways to minimize or prevent erosion and to minimize future risk of eroded material entering streams.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*SS-HA-03e*
4	D	SS-HA-09	Minimize alteration of natural hill slope drainage patterns to decrease erosion and sediment input into the streams.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*SS-HA-03f*
4	D	SS-HA-10	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for coho salmon passage projects.	**Potential Lead:** CDFG, Counties, USFS, NOAA Fisheries **Others:** CDF, Caltrans, Landowners	Interim	*SS-HA-03g*
4	E	SS-HA-11	Encourage funding authorities to allocate adequate resources to prioritize and upgrade crossings to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g., LWD that might be mobilized).	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFS, CDF, Landowners	Interim/ Ongoing	*SS-HA-04*
4	E	SS-HA-12	Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFS, Caltrans, CDF, County, Landowners	Interim/ Ongoing	*SS-HA-05*
4	C	SS-HA-13	Design a reclamation plan to remediate effects of historical mining (e.g., tailings near Callahan) with the goal of enhancing the production and survival of coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, County, CGS, Landowners	Interim	*SS-HA-06*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SHASTA VALLEY AND SCOTT RIVER HAs —Shasta Valley, Scott Bar, and Scott Valley HSAs (continued)						
4	C	SS-HA-14	Implement the reclamation plan that remedies effects of historical mining (e.g., tailings near Callahan) with the goal of enhancing the production and survival of coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, County, CGS, Landowners	Interim	*SS-HA-06b*
4	C	SS-HA-15	Identify locations, costs, and restoration potential of intensively mined areas.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, County, CGS, Landowners	Interim	*SS-HA-06c*
4	D	SS-HA-16	Improve water quality by reducing or minimizing both domestic and municipal sources of nutrient input (i.e., sewage treatment plant discharge and storm drain runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.	**Potential Lead:** RWQCB **Others:** County, Landowners, CDFG	Interim/ Ongoing	*SS-HA-07*
4	D	SS-HA-17	Minimize impacts of cattle grazing on watercourses though exclusion fencing as necessary and appropriate (e.g., providing off-site watering, preventing overgrazing, etc.).	**Potential Lead:** RCDs **Others:** Landowners, CDFG, NOAA Fisheries	Interim, Ongoing	*SS-HA-08*
4	D	SS-HA-18	Support cooperative State and local efforts to redirect Big Mill Creek into its historic channel under State Route 3, thereby restoring adult and juvenile coho salmon access to approximately 1.25 miles of quality spawning and rearing habitat.	**Potential Lead:** CDFG **Others:** Caltrans, Landowners	Interim	*SS-HA-09*
4	E	SS-HA-19	Assess the potential benefits and technical feasibility of increasing stream flows in the Scott River for fish and wildlife within the Klamath National Forest.	**Potential Lead:** CDFG **Others:** SWRCB, DWR, Landowners	Interim	*SS-HA-10*
4	D	SS-HA-20	Request the USBR to study the potential benefits of adjusting Iron Gate flows to better meet the needs of adult and juvenile life stages to enhance Scott/Shasta coho salmon production, consistent with the flow needs of the Klamath and Trinity rivers.	**Potential Lead:** CDFG **Others:** USBR	Interim	*SS-HA-11*
4	D	SS-HA-21	Complete the comprehensive, peer-reviewed watershed restoration plans for the Shasta and Scott rivers that include identification and prioritization of all restorative needs in each basin. When restoration funds are limited, implementation should occur on the highest priority issues most likely to effectively address coho salmon needs within each basin.	**Potential Lead:** RCDs, Watershed Council **Others:** CDFG, NOAA Fisheries, USFWS	Interim/ Ongoing	*SS-HA-18*
	C	SS-HA-22	Financially support ongoing watershed planning.	**Potential Lead:** RCDs, Watershed Council **Others:** CDFG, NOAA Fisheries, USFWS	Interim/ Ongoing	*SS-HA-18b*
4	E	SS-HA-23	Preserve water quality, quantity and coho salmon habitat in the Big Springs area in the Shasta River by possibly using incentive-based alternatives with willing participants.	**Potential Lead:** CDFG **Others:** Landowners, RCD	Interim/ Continual	*SS-HA-24*
4	E	SS-HA-24	Maintain and revegetate, where appropriate, riparian trees in headwaters and along creeks that provide shade habitat essential for coho salmon.	**Potential Lead:** CDFG **Others:** Landowners, RCD	Interim/ Continual	*SS-HA-25*
4	D	SS-HA-25	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; and b. Management to promote conifer recruitment.	**Potential Lead:** CDFG **Others:** Landowners, RCD	Interim/ Ongoing	*SS-HA-26*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
KLAMATH RIVER HU — Hornbrook HSA						
4	D	KR-HB-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB,CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HB-01*
4	D	KR-HB-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB,CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HB-02*
4	E	KR-HB-03	Improve coho salmon passage at stream and road crossings, including measures to: a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage; b. Treat coho salmon passage problems associated with the USFS roads; c. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and d. Encourage the USFS, County and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.	**Potential Lead:** CDFG **Others:** USFS, Caltrans	Interim/ Ongoing	*KR-HB-03*
4	D	KR-HB-04	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as technical support.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HB-05*
4	E	KR-HB-05	Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-HB-09*
4	E	KR-HB-06	Identify water diverters; request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-HB-10*
4	D	KR-HB-07	Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.	**Potential Lead:** CDFG **Others:** Landowners, RCDs	Interim	*KR-HB-11*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
KLAMATH RIVER HU — Irongate HSA						
4	D	KR-IG-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB,CDFG, CDF, Landowners	Interim/ Ongoing	*KR-IG-01*
4	D	KR-IG-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB,CDFG, CDF, Landowners	Interim/ Ongoing	*KR-IG-02*
4	E	KR-IG-03	Improve coho salmon passage at stream and road crossings, including measures to: a. Replace culverts on both USFS and Caltrans roads with structures allowing coho salmon passage; b. Treat coho salmon passage problems associated with the USFS roads; c. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and d. Encourage the USFS, County and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.	**Potential Lead:** USFS, Caltrans **Others:** CDFG	Interim/ Ongoing	*KR-IG-03*
4	D	KR-IG-04	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as technical support.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-IG-05*
4	E	KR-IG-05	Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-IG-09*
4	E	KR-IG-06	Identify water diverters and request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-IG-10*
4	D	KR-IG-07	Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.	**Potential Lead:** CDFG **Others:** Landowners, RCDs	Interim	*KR-IG-11*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TRINITY RIVER HU						
	E	TR-HU-01	Implement the Trinity River Record of Decision (ROD), which would provide: a. Variable annual instream flows for the Trinity River from the Trinity River Dam (TRD) based on forecasted hydrology for the Trinity River basin as of April 1st of each year, ranging from 369,000 acre-feet in critically dry years to 815,000 af in extremely wet years; b. Physical channel rehabilitation, including the removal of riparian berms and the establishment of side-channel habitat; c. Sediment management, including the supplementation of spawning gravels below the TRD and reduction in fine sediments which degrade coho salmon habitats; d. Watershed restoration efforts, addressing negative impacts which have resulted from land use practices in the Basin; and e. Infrastructure improvements or modifications, including rebuilding or fortifying bridges and addressing other structures affected by the peak instream flows provided by the ROD.	**Potential Lead:** USBR **Others:** USFS, NOAA Fisheries, USFWS, CDFG	Interim	*TR-HU-01*
	C	TR-HU-02	Recommend to the NCRWQCB that the TMDL process consider alterations in the sediment load allocations and targets due to implementation of the ROD.	**Potential Lead:** CDFG **Others:** RWQCB	Interim	*TR-HU-02*
	D	TR-HU-03	Implement the Trinity River TMDL instream flushing flows without affecting ROD allocations.	**Potential Lead:** CDFG, USBR **Others:**, RWQCB	Interim	*TR-HU-06*
	D	TR-HU-04	Establish TMDL implementation plans for the mainstem and South Fork using the upslope indicators and targets established in the Main Stem Load Allocation.	**Potential Lead:** CDFG, RWQCB **Others:** USBR	Interim	*TR-HU-07*
	E	TR-HU-05	Develop a County grading ordinance based on exemption, certification, and permitting criteria.	**Potential Lead:** County **Others:** CDFG	Long-term	*TR-HU-08*
	C	TR-HU-06	Implement county grading ordinance based on exemption, certification, and permitting criteria.	**Potential Lead:** County **Others:** CDFG	Long-term/ Continual	*TR-HU-08b*
	C	TR-HU-07	Implement the Five Counties Water Quality and Stream Habitat Protection Manual for County Road Maintenance in Northwestern California Watersheds.	**Potential Lead:** Trinity County **Others:** CDFG	Interim/ Continual	*TR-HU-09*
	D	TR-HU-08	Support continued State and Federal funding for the implementation of sediment reduction programs for private lands and the implementation and funding of treatment of sediment source sites on County roads using the prioritization of the Direct Inventory of Roads and Their Treatment (DIRT).	**Potential Lead:** County **Others:** Landowners, CDFG	Interim/ Ongoing	*TR-HU-10*
	C	TR-HU-09	Establish incentives and standards for private riparian and wetland areas protection based on flexible subdivision design; road, curb and gutter requirements; minimum lot size and density; clustering and other techniques.	**Potential Lead:** CDFG **Others:** County	Interim	*TR-HU-11*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TRINITY RIVER HU (continued)						
	C	TR-HU-10	Establish riparian setbacks for grading activities on private lands, based on Department 1994 recommendations to District I counties.	**Potential Lead:** CDFG **Others:** County	Interim	*TR-HU-12*
	D	TR-HU-11	Evaluate the impacts of non-native fish species on coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*TR-HU-13*
	D	TR-HU-12	Develop management guidelines to reduce impacts from non-native fish species.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*TR-HU-13*
	C	TR-HU-13	Develop or amend existing County Conservation, Open Space and Land Use Elements and Community Plans to focus development away from riparian habitats, wetland habitats, or steep slopes. Consider all species habitats, wildland-urban fire hazard, and other land uses factors in making allocations.	**Potential Lead:** CDFG **Others:** Trinity County	Interim	*TR-HU-14*
	C	TR-HU-14	Analyze the feasibility and appropriateness of site-specific 2084 authorization for sport fishing for hatchery coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*TR-HU-15*
Douglas City HSA						
5	E	TR-DC-01	Investigate all water diversions on Reading Creek, Indian Creek, and Browns Creek.	**Potential Lead:** CDFG **Others:** SWRCB, NOAA Fisheries	Interim	*TR-DC-01*
5	E	TR-DC-02	Restore coho salmon passage and instillation of screens to Department-NOAA Fisheries standards. Provide incentives to landowners when necessary to reach this goal.	**Potential Lead:** CDFG **Others:** SWRCB, NOAA Fisheries	Interim	*TR-DC-01*
5	D	TR-DC-03	Increase riparian function in lower Reading, Indian, Browns creeks with conservation easements or landowner incentives that reduce agricultural and grazing impacts.	**Potential Lead:** CDFG **Others:** RCD, Landowners	Interim/ Ongoing	*TR-DC-02*
5	D	TR-DC-04	Implement sediment reduction plans consistent with County plans and policies.	**Potential Lead:** CDFG **Others:** RCD, County, Landowners	Interim/ Ongoing	*TR-DC-03*
Grouse Creek HSA						
3	D	TR-GC-01	Continue implementation of habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.	**Potential Lead:** USFS **Others:** NOAA Fisheries, County, RCD, CDFG, CDF, Landowners	Interim/ Ongoing	*TR-GC-01*
Hyampom HSA						
2	D	TR-HY-01	Develop a management plan for Big Slide to reduce human contributions to mobilization of sediments, including evaluating relocation of the county road that crosses Big Slide.	**Potential Lead:** USFS **Others:** CDFG, County	Interim	*TR-HY-01*
2	D	TR-HY-02	Implement the management plan for Big Slide to reduce human contributions to mobilization of sediments, including evaluating relocation of the county road that crosses Big Slide.	**Potential Lead:** USFS, County **Others:** CDFG	Interim	*TR-HY-01b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Hyampom HSA (continued)						
2	C	TR-HY-03	Manage forest stands to reduce their susceptibility to large, severe fires. Where appropriate, this should include actions to accelerate the growth of conifers for LWD recruitment, develop mature shade canopy in the riparian zone, and provide for other multiple use goals.	**Potential Lead:** CDFG **Others:** USFS	Interim/ Ongoing	*TR-HY-02*
2	D	TR-HY-04	Continued implementation of habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.	**Potential Lead:** USFS **Others:** NOAA Fisheries, County, RCD, CDFG, CDF, Landowners	Interim/ Ongoing	*TR-HY-03*
Hayfork HSA						
2	E	TR-HA-01	Establish agricultural/residential water conservation programs using incentive programs if necessary.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim/ Ongoing	*TR-HA-01*
2	D	TR-HA-02	Amend Trinity County's Critical Water Resources Overlay zone to address new riparian water rights developed as a result from parcel subdivision. The amendment should include expanding the overlay zoning to additional watersheds where summer surface flows are limiting factors for residents and coho salmon.	**Potential Lead:** CDFG **Others:** County	Interim	*TR-HA-02*
2	C	TR-HA-03	Continue implementation of riparian improvements through restoration activities, land use planning, and conservation easements.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Private Landowners	Interim/ Ongoing	*TR-HA-03*
2	D	TR-HA-04	Support efforts to provide livestock exclusion fencing where feasible and appropriate, while providing off-site watering.	**Potential Lead:** Landowners, RCDs **Others:** NRCS	Interim/ Continual	*TR-HA-04*
2	D	TR-HA-05	Continue to implement habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.	**Potential Lead:** USFS **Others:** NOAA Fisheries, County, RCD, CDFG, CDF, Landowners	Interim/ Ongoing	*TR-HA-05*
MAD RIVER HU						
	D	MR-HU-01	Work with landowners and other entities to reduce coho salmon tributary stream temperature through the development of mature coniferous stream-side over-story within the riparian zone by continuing: a. Planting programs in stream corridors barren of mature conifers; b. THP review; and c. Riparian management with cattle ranchers.	**Potential Lead:** CDFG , NCRWQCB, CDF **Others:** Landowners, CCC, Watershed Groups, NOAA Fisheries, USFS, RCD	Interim/ Continual	*MR-HU-01*
	C	MR-HU-02	Recommend the SWRCB make a high priority the: a. Review of authorized diversions that have no provisions to protect coho salmon; and b. Identification of unauthorized diversions and enforcement actions to stop them.	**Potential Lead:** NCRWQCB, SWQCB **Others:** DWR, CDFG	Long-term	*MR-HU-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MAD RIVER HU (continued)						
	E	MR-HU-03	Work with landowners and other entities to: a. Protect existing LWD recruitment potential through the retention of mature coniferous trees in the riparian zone; b. Establish adequate streamside buffer areas; c. Increase the amount of in-channel LWD; d Continue to review THPs; and e. Continue riparian management projects.	**Potential Lead:** CDFG **Others:** CCC, CDF, Landowners, NOAA Fisheries, County, Watershed Groups	Interim/ Continual	*MR-HU-03*
	E	MR-HU-04	Conduct pre-project geological surveys where needed.	**Potential Lead:** NCRWQCB, CDF, CDFG, County, CGS	Interim/ Continual	*MR-HU-04*
	D	MR-HU-05	Develop permit conditions to limit activities within unstable areas, identifying appropriate mitigation measures.	**Potential Lead:** NCRWQCB, CDF,CDFG, County, CGS	Interim/ Continual	*MR-HU-04b*
	D	MR-HU-06	Adopt measures to protect riparian vegetation for all development over which counties and incorporated areas have jurisdiction.	**Potential Lead:** Counties and Incorporated Areas **Others:** CDFG, NOAA Fisheries	Long-term	*MR-HU-05*
	E	MR-HU-07	Assess barriers to coho salmon passage, prioritize barriers for removal, and develop a plan to treat the barriers, with Warren Creek given a high priority for treatment.	**Potential Lead:** CDFG **Others:** Caltrans, Landowner, County, NOAA Fisheries	Interim	*MR-HU-07*
	E	MR-HU-08	Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. This is a known problem at Cañon Creek, Dry Creek, and North Fork Mad River. The plan should: a. Evaluate management techniques; b. Implement the identified strategy; and c. Address permitting complexity for identified implementation measures.	**Potential Lead:** CDFG , NOAA Fisheries, Landowners	Long-term	*MR-HU-08*
	D	MR-HU-09	Consider the mouths of Cañon Creek, Dry Creek, and North Fork Mad River as locations to: a. Identify causes of loss of connectivity; b. Evaluate management techniques; c. Implement the identified strategy; and d. Address permitting complexity for identified implementation measures.	**Potential Lead:** CDFG **Others:** County	Long-term	*MR-HU-09*
	C	MR-HU-10	Continue stream management activities with landowners in Lindsay Creek.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups	Interim/ Continual	*MR-HU-10*
	C	MR-HU-11	Develop programs to control exotic and invasive vegetation, especially reed canary grass, where necessary to protect coho salmon habitat.	**Potential Lead:** CDFG, UCCE **Others:** Redwood Science Lab, HSU	Interim	*MR-HU-11*
	C	MR-HU-12	Evaluate the impact of the Mad River Hatchery steelhead production on coho salmon.	**Potential Lead:** CDFG **Others:** USFWS	Long-term	*MR-HU-12*
	E	MR-HU-13	Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems.	**Potential Lead:** CDFG **Others:** USFS, CDF, Caltrans, County, Landowners	Interim	*MR-HU-13*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MAD RIVER HU (continued)						
	D	MR-HU-14	Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim/ Ongoing	*MR-HU-14*
	D	MR-HU-15	Reduce road densities where necessary and appropriate.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*MR-HU-15*
	D	MR-HU-16	Decrease potential for stream flow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim/ Ongoing	*MR-HU-16*
	D	MR-HU-17	Stabilize slopes along roadways to minimize or prevent erosion and to minimize future risk of eroded material entering streams.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*MR-HU-17*
	D	MR-HU-18	Minimize alteration of natural hill slope drainage patterns to decrease erosion and sediment input into the streams.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*MR-HU-18*
	D	MR-HU-19	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for fish passage projects.	**Potential Lead:** CDFG, Counties, USFS, NOAA Fisheries **Others:** CDF, Caltrans, Landowners	Interim	*MR-HU-19*
	D	MR-HU-20	Encourage CHERT to incorporate coho salmon friendly measures.	**Potential Lead:** CDFG **Others:** CHERT, NOAA Fisheries, USACE	Interim/ Continual	*MR-HU-20*
Blue Lake HSA						
4	C	MR-BL-01	Develop a watershed restoration plan in conjunction with landowners, municipalities, and Tribal interests.	**Potential Lead:** Watershed Groups **Others:** Landowners, County, Tribes, Municipalities, CDFG	Long-term	*MR-BL-01*
4	C	MR-BL-02	Implement the watershed restoration plan.	**Potential Lead:** Watershed Groups **Others:** Landowners, County, Tribes, Municipalities, CDFG	Long-term	*MR-BL-01*
4	C	MR-BL-03	Agencies and land managers should work with qualified Watershed Groups to develop and support well-informed watershed communities with regards to coho salmon habitat issues.	**Potential Lead:** Watershed Groups	Long-term	*MR-BL-02*
4	C	MR-BL-04	Develop and implement an outreach program regarding activities that protect and/or restore coho salmon habitat, and the public's responsibility for protecting and restoring coho salmon habitat.	**Potential Lead:** Watershed Groups, CDFG	Long-term	*MR-BL-02*
Butler Valley HSA						
5	D	MR-BV-01	Establish adequate streamside buffer areas to promote appropriate water temperatures for coho salmon.	**Potential Lead:** Humboldt County, Landowners CDF, CDFG, NOAA Fisheries	Long-term	*MR-BV-01*
5	C	MR-BV-02	Protect streamside vegetation from unnecessary vegetation removal.	**Potential Lead:** Humboldt County, Landowners CDF, CDFG, NOAA Fisheries	Long-term	*MR-BV-01b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Butler Valley HSA (continued)						
5	C	MR-BV-03	Maintain large conifers within the riparian zone.	**Potential Lead:** Humboldt County, Landowners, **Others:** CDF, CDFG, NOAA Fisheries	Interim/ Continual	*MR-BV-01c*
5	E	MR-BV-04	Assess and prioritize the road-related sources of input of fine and coarse sediments into streams.	**Potential Lead:** Humboldt County, Landowners, CDFG, NOAA Fisheries, CDF	Interim	*MR-BV-02*
5	D	MR-BV-05	Address priority sources of fine and coarse sediments into streams.	**Potential Lead:** Humboldt County, Landowners **Others:** CDF, CDFG, NOAA Fisheries	Long-term	*MR-BV-02b*
5	C	MR-BV-06	Where appropriate, reduce management activities within unstable areas.	**Potential Lead:** Humboldt County, Landowners **Others:** CDF, CDFG, NOAA Fisheries	Interim/ Continual	*MR-BV-02c*
5	E	MR-BV-07	Identify and prioritize culverts that are passage barriers to suitable habitat for juvenile or adult coho salmon.	**Potential Lead:** Humboldt County, Caltrans, Landowners **Others:** CDF, CDFG, NOAA Fisheries	Interim	*MR-BV-03*
5	D	MR-BV-08	Upgrade prioritized culverts that to allow access to suitable habitat for juvenile or adult coho salmon.	**Potential Lead:** Humboldt County, Caltrans, Landowners **Others:** CDF, CDFG, NOAA Fisheries	Long-term	*MR-BV-03b*
REDWOOD CREEK HU						
	E	RC-HU-01	Work with Redwood National and State Parks (RNSP), private landowners, and interested parties to improve habitat conditions of the estuary while protecting Highway 101 and the Town of Orick. These plans should aim toward restoring the historic form and function of the estuary/lagoon and slough channels, riparian forests, and adjacent wetlands. This includes providing for: a. Unconfined channels by modifying levees; b. Restoration of riparian vegetation, tree cover, wetlands, and off-channel and rearing habitat; c. Increased sediment transport, pool depth, and LWD; d. Restoring natural drainage patterns from adjacent wetlands; and e. Improving the conditions of sloughs and tributaries to the estuary (Strawberry, Dorrance, and Sand Cache creeks).	**Potential Lead:** RNSP, USACE, County **Others:** RNSP, CDF, NOAA Fisheries, Landowners, County, CCC, Watershed Groups, Coastal Conservancy, CDFG	Interim	*RC-HU-01*
	E	RC-HU-02	Modify levee requirements to maintain habitat for coho salmon while maintaining flood control, including modifying maintenance manuals to be consistent with habitat requirements of coho salmon.	**Potential Lead:** USACE, RNSP, DPR, and Humboldt County Public Works Department, NOAA Fisheries **Others:** CDFG	Long-term	*RC-HU-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
REDWOOD CREEK HU (continued)						
	E	RC-HU-03	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of small, suppressed conifers, and where appropriate, control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as funding and technical support.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, RNSP, County, Watershed Groups	Interim	*RC-HU-03*
	C	RC-HU-04	Complete the assessments of sediment sources and road upgrade assessments.	**Potential Lead:** CDFG, **Others:** NCRWQCB, CDF, Landowners, CCC, RNSP, Watershed Groups, NOAA Fisheries, County	Interim/ Ongoing	*RC-HU-04*
	C	RC-HU-05	Implement the recommendations contained in the assessments for sediment paying particular attention to road assessment and improvement projects; also incorporate measures to preclude sediment delivery to stream systems in near-stream land use planning (especially on slopes greater than 35%).	**Potential Lead:** CDFG **Others:** NCRWQCB, CDF, Landowners, CCC, RNSP, Watershed Groups, NOAA Fisheries, County	Interim/ Ongoing	*RC-HU-04b*
	E	RC-HU-06	Develop measures to protect existing LWD recruitment potential through retention of mature trees in the riparian zone, establishing adequate near stream buffer areas protected from vegetation removal, and increasing the amount of in-channel LWD (Root wads should be left on LWD).	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, RNSP, County, Watershed Groups	Interim	*RC-HU-05*
	D	RC-HU-07	Implement measures to protect existing LWD recruitment potential through retention of mature trees in the riparian zone, establish adequate near stream buffer areas protected from vegetation removal, and increase the amount of in-channel LWD.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, RNSP, County, Watershed Groups	Interim/ Continual	*RC-HU-05b*
	E	RC-HU-08	Coordinate a long-term, concerted effort between land owners, interested parties, and responsible agencies to determine the current population size and trends of coho salmon of Redwood Creek.	**Potential Lead:** RNSP, CDFG **Others:** NOAA Fisheries, USFWS, Landowners	Interim/ Ongoing	*RC-HU-06*
	E	MR-HU-09	Conduct pre-project geological surveys where needed.	**Potential Lead:** NCRWQCB, CDF,CDFG, County, CGS	Interim/ Continual	*MR-HU-04*
	C	RC-HU-10	Continue to review and improve THPs with regard to protection of coho salmon and their habitat.	**Potential Lead:** CDFG	Ongoing/ Continual	*RC-HU-08*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TRINIDAD HU						
	E	TP-HU-01	Assess and prioritize sediment sources, particularly roads that have not been assessed, and acknowledge progress that has been made in addressing sediment sources.	**Potential Lead:** County, Landowners, Caltrans **Others:** CDF, CDFG, CCC, NCRWQCB, Watershed Groups, NOAA Fisheries	Interim	*TP-HU-01*
	D	TP-HU-02	Prioritize and treat sediment sources.	**Potential Lead:** County, Landowners, Caltrans **Others:** CDF, CDFG, CCC, NCRWQCB, Watershed Groups, NOAA Fisheries	Interim	*TP-HU-01b*
	D	TP-HU-3	Work with Humboldt County and landowners to maintain flood plain capacity and prevent future encroachment on the flood plain.	**Potential Lead:** County, Army Corps **Others:** Caltrans, CDFG, NOAA Fisheries, Landowners	Long-term	*TP-HU-02*
Big Lagoon HSA						
4	E	TP-BL-01	Continue to work with private landowners to develop riparian buffers with an adequate conifer component and canopy closure to reduce temperatures, increase LWD, and provide sediment filtration.	**Potential Lead:** CDFG **Others:** Landowners, CDF, County, CCC, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*TP-BL-01*
4	C	TP-BL-02	Develop a plan to restore the historic flood plain on Mill Creek (a.k.a. Pitcher Creek), in cooperation with landowners.	**Potential Lead:** CDFG **Others:** Landowners	Long-term	*TP-BL-02*
4	C	TP-BL-03	Implement the plan to restore the historic flood plain on Mill Creek (a.k.a. Pitcher Creek), in cooperation with landowners.	**Potential Lead:** CDFG **Others:** Landowners	Long-term	*TP-BL-02b*
Little River HSA						
5	E	TP-LR-01	Develop a plan to improve the functioning of the lower river and estuary by re-establishing a functional flood plain and a more complex instream habitat and riparian zone. The plan should include the release of conifers, exclusion fencing where necessary, and riparian planting.	**Potential Lead:** Landowners, Watershed Groups **Others:** CDFG, CCC, NOAA Fisheries, County	Interim	*TP-LR-01*
5	D	TP-LR-02	Implement the plan to improve the functioning of the lower river and estuary.	**Potential Lead:** Landowners, Watershed Groups **Others:** CDFG, CCC, NOAA Fisheries, County	Interim	*TP-LR-01b*
5	C	TP-LR-03	Work with landowners to minimize the impacts of agricultural activities on the estuary.	**Potential Lead:** Watershed Groups, CDFG **Others:** County, NOAA Fisheries	Interim/ Continual	*TP-LR-02*
5	E	TP-LR-04	Appropriate agencies should enforce any violation of law that occurred from construction of cranberry bogs in the Little River; completion of appropriate mitigation should also be enforced.	**Potential Lead:** USACE, CDFG, NOAA Fisheries	Interim	*TP-LR-03*
5	C	TP-LR-05	Work with Humboldt County and landowners to maintain current flood plain capacity and prevent future encroachment on the flood plain.	**Potential Lead:** County, USACE **Others:** CDFG, NOAA Fisheries, Landowners	Long-term	*TP-LR-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EUREKA PLAIN HU — Eureka Plain HSA						
5	D	EP-HU-01	Support implementation of Humboldt County's provisions to protect Stream Management Areas and evaluate their effectiveness; recommend revisions as necessary.	**Potential Lead:** CDFG **Others:** Humboldt County	Interim/ Continual	*EP-HU-02*
5	E	EP-HU-02	Work with agencies and landowners, to re-establish estuarine function.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Coastal Commission, USACE, U.S. Coast Guard, City of Eureka, City of Arcata, Landowners	Interim	*EP-HU-03*
5	C	EP-HU-03	Acknowledge the Arcata City Sewage Treatment Project and encourage similar projects elsewhere where possible.	**Potential Lead:** CDFG **Others:** City of Arcata, California State University	Interim	*EP-HU-04*
5	E	EP-HU-04	Assess and prioritize sources of sediment and implement remediation projects.	**Potential Lead:** CDF **Others:** County, CDFG, Landowners, California Conservation Corps	Interim/ Ongoing	*EP-HU-05*
5	D	EP-HU-05	Implement the prioritized remediation projects for the sources of sediment.	**Potential Lead:** CDF **Others:** County, CDFG, Landowners, California Conservation Corps	Interim/ Ongoing	*EP-HU-05b*
5	E	EP-HU-06	Identify gaps in recent coho salmon habitat survey data.	**Potential Lead:** CDFG	Interim	*EP-HU-06a*
5	E	EP-HU-07	Conduct coho salmon habitat surveys in identified areas lacking data.	**Potential Lead:** CDFG	Interim	*EP-HU-06a*
5	E	EP-HU-08	Identify and prioritize rearing habitat reaches for protection.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06b*
5	D	EP-HU-09	Improve quality and quantity of deep pools and spawning gravels.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06c*
5	D	EP-HU-10	In cooperation with willing landowners, restore and maintain historical tidal areas, backwater channels and salt marsh.	**Potential Lead:** CDFG **Others:** Coastal Commission, Landowners	Interim/ Continual	*EP-HU-06d*
5	D	EP-HU-11	Maintain and protect channel conditions important for all life stages of coho salmon.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06e*
5	D	EP-HU-12	Restore channel conditions important for all life stages of coho salmon.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06e*
5	D	EP-HU-13	Identify and maintain reaches where naturally functioning channel and flood plain conditions exist.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06f*
5	D	EP-HU-14	Restore a functioning flood plain and natural channel processes where practicable.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06f*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EUREKA PLAIN HU — Eureka Plain HSA (continued)						
5	E	EP-HU-15	Identify impacted reaches where a functioning flood plain could be re-established: a. Prioritize areas that are not naturally functioning for restoration potential; and b. Develop site specific project objectives to protect and restore naturally functioning channel and flood plain conditions where feasible.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06g*
5	E	EP-HU-16	Conduct hydrologic analysis for all Humboldt Bay tributaries.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*EP-HU-06h*
5	E	EP-HU-17	Establish access for both adult and juvenile coho salmon to suitable habitat where practicable.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Ongoing	*EP-HU-06i*
5	E	EP-HU-18	Prioritize and upgrade for repair all county culverts already identified as coho salmon passage barriers.	**Potential Lead:** CDFG **Others:** County, Landowners	Interim/ Ongoing	*EP-HU-06j*
5	E	EP-HU-19	Conduct an inventory and prioritize for treatment migration barriers other than county culverts (private roads, tide gates), including Rocky and Washington gulches.	**Potential Lead:** CDFG **Others:** Landowners, Coastal Commission, NOAA Fisheries	Interim	*EP-HU-06k*
5	D	EP-HU-20	Conduct LWD surveys and identify locations of existing LWD structures and areas for potential recruitment and/or placement of LWD structures.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-21	Protect and maintain habitat associated with instream LWD.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-22	Increase the amount of LWD in rearing reaches.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-23	Establish adequate streamside buffer areas that are protected from vegetation removal ensuring retention of mature trees in the riparian corridor	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-24	Increase canopy by planting appropriate conifer and hardwood species composition along the stream where the canopy is not at acceptable levels. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-25	Map areas where large conifer riparian habitat exists for future recruitment.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-26	Maintain functional riparian habitat.	**Potential Lead:** CDFG **Others:** CDF, County, Landowners	Interim/ Ongoing	*EP-HU-06n*
5	D	EP-HU-27	Conduct assessment of historic and present riparian conditions	**Potential Lead:** CDFG **Others:** CDF, County, Landowners	Interim/ Ongoing	*EP-HU-06n*
5	E	EP-HU-28	Develop site specific riparian restoration plans to: a. Restore degraded riparian habitat; and b. Establish a monitoring program to evaluate success of restoration projects.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EUREKA PLAIN HU — Eureka Plain HSA (continued)						
5	D	EP-HU-29	Prioritize and implement the site specific riparian restoration plans.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06o*
5	D	EP-HU-30	Establish a monitoring program to identify turbidity and suspended sediment levels outside the beneficial range for all life stages of coho salmon.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06p*
5	E	EP-HU-31	Reduce input of fine sediments into stream systems by: a. Conducting comprehensive road inventory; b. Carry out priority road related sediment reduction; c. Implement priorities for road-related sediment reduction projects identified in existing road inventories projects; d. Identify areas still needing road/erosion inventories; e. Identify on-going road maintenance needs; f. Identify landslide hazard areas such as steep unstable slopes, stream crossings,(other than those identified in the road inventory) and inner gorge area; g. Implement pre-project geological surveys and/or reducing management activities within these areas, especially road construction, grading, intensive timber harvests; and h. Identify and treat bank erosion sites.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06q*
5	D	EP-HU-32	Establish temperature parameters beneficial to coho salmon during all life stages by: a. Evaluating temperature ranges in all tributaries; b. Review of existing temperature data; c. Identifying data gaps and establish a watershed-wide temperature monitoring program; and d. Determining if temperatures are a concern for coho salmon.	**Potential Lead:** CDFG **Others:** Landowners	Interim	*EP-HU-06r*
5	D	EP-HU-33	Prevent point and non-point source pollution (e.g., septic systems, livestock, household chemicals, petrol-chemicals, herbicides, fertilizer and other pollutants); identify priorities for pollution reduction and strategy to be pursued.	**Potential Lead:** RWCQB **Others:** Landowners, CDFG	Interim/ Continual	*EP-HU-06t*
5	E	EP-HU-34	Determine and maintain adequate flows for migrating juvenile and adult coho salmon by developing an inventory of current water rights, and conduct a field survey of water withdrawals in main-stem and tributaries.	**Potential Lead:** CDFG **Others:** SWRCB	Interim	*EP-HU-06v*
5	C	EP-HU-35	Maintain open space lands (e.g., agriculture, forestland) for water retention and limiting addition of impervious surfaces in the watershed.	**Potential Lead:** County **Others:** Coastal Commission, Landowners, CDFG	Interim/ Ongoing	*EP-HU-06w*
5	C	EP-HU-36	Identify socioeconomic impacts of watershed management and future possible solutions.	**Potential Lead:** County **Others:** Coastal Commission, CDF, Landowners	Interim	*EP-HU-06x*
5	D	EP-HU-37	Facilitate and sustain a well informed watershed community with regards to coho salmon habitat issues.	**Potential Lead:** RCDs, Watershed Groups **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*EP-HU-06y*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EUREKA PLAIN HU — Eureka Plain HSA (continued)						
5	C	EP-HU-38	Ensure that there are adequate incentives for landowners who choose to protect and/or restore watershed processes.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim/ Continual	*EP-HU-06z*
5	C	EP-HU-39	Continue urban stream day-lighting efforts in Arcata and Eureka to reconnect and restore coho salmon habitat.	**Potential Lead:** City of Arcata, City of Eureka **Others:** NOAA Fisheries, CDFG	Interim/ Ongoing	*EP-HU-28*
EEL RIVER HU						
	C	ER-HU-01	Support the existing watershed cooperative working groups and the formation of new groups where necessary.	**Potential Lead:** CDFG **Others:** RCDs, Watershed Groups	Interim/ Ongoing	*ER-HU-01*
	E	ER-HU-02	Acknowledge that the pike minnow is a problem and support efforts to control it.	**Potential Lead:** CDFG, NOAA Fisheries	Interim/ Ongoing	*ER-HU-02*
	D	ER-HU-03	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Improvement of existing riparian zones through plantings, release of conifers, and manage alders, blackberries, and other competitors; and c. Bank stabilization and fencing projects.	**Potential Lead:** CDFG **Others:** California Conservation Corps, CDF, USFS, DPR, Landowners	Ongoing	*ER-HU-03*
	E	ER-HU-04	Recommend that the SWRCB make a high priority the identification of unauthorized diversions and enforcement actions to stop them.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim/ Continual	*ER-HU-05*
	D	ER-HU-05	Encourage CHERT to incorporate coho salmon-friendly measures.	**Potential Lead:** CDFG **Others:** CHERT, NOAA Fisheries, USACE	Interim/ Continual	*ER-HU-07*
	E	ER-HU-06	Develop a plan to restore an adequate migration corridor in the mainstem Eel River.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, State Lands Commission	Interim	*ER-HU-08*
	D	ER-HU-07	Implement the plan to restore an adequate migration corridor in the mainstem Eel River.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, State Lands Commission	Interim	*ER-HU-08b*
	E	ER-HU-08	Assess and prioritize sediment sources, including roads.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups, RCD, NOAA Fisheries	Interim/ Ongoing	*ER-HU-09*
	D	ER-HU-09	Treat prioritized sediment sources, including roads.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups, RCD, NOAA Fisheries	Interim/ Ongoing	*ER-HU-10*
	C	ER-HU-10	Identify coho salmon rearing impacts from Van Arsdale out-planting site.	**Potential Lead:** CDFG	Interim/ Ongoing	*ER-HU-11*
	D	ER-HU-11	In cooperation with agencies and landowners, plan to re-establish estuarine function, restore and maintain historical tidal areas, backwater channels and salt marsh.	**Potential Lead:** CDFG **Others:** Coastal Commission, Landowners	Interim/ Continual	*ER-HU-12*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EEL RIVER HU (continued)						
	E	ER-HU-12	Request that Caltrans assess, prioritize, and treat culverts that are barriers to passage on Highway 101. Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies.	**Potential Lead:** Caltrans **Others:** County, Landowners, California Conservation Corps, CDFG	Interim	*ER-HU-13*
Ferndale HSA						
3	E	ER-FE-01	Develop the Salt River Local Implementation Plan to incorporate coho salmon-friendly measures, in cooperation with the agencies.	**Potential Lead:** USACE, CDFG **Others:** RCD, Watershed Group, City of Ferndale NOAA Fisheries, Humboldt County, NRCS	Interim	*ER-FE-01*
3	E	ER-FE-02	Complete the assessment and prioritization of the sediment sources in the watershed.	**Potential Lead:** USACE, CDFG **Others:** RCD, Watershed Group, City of Ferndale NOAA Fisheries, Humboldt County, NRCS	Interim	*ER-FE-01b*
3	D	ER-FE-03	Treat the sediment sources in the watershed.	**Potential Lead:** USACE, CDFG **Others:** RCD, Watershed Group, City of Ferndale NOAA Fisheries, Humboldt County, NRCS	Interim	*ER-FE-01c*
3	C	ER-FE -04	Acquire conservation easements as an incentive for landowners to conserve and enhance habitat.	**Potential Lead:** CDFG **Others:** Land Conservancies, Landowners	Interim/ Ongoing	*ER-FE -02*
Van Duzen River HSA						
3	E	ER-VD-01	Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. The plan should a. Evaluate management techniques; b. Implement the identified strategy; and c. Address permitting complexity for identified implementation measures.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners	Long-term	*ER-VD-01*
3	D	ER-VD-02	Implement the plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners	Long-term	*ER-VD-02*
3	D	ER-VD-03	Recommend that CHERT incorporate coho salmon-friendly measures.	**Potential Lead:** CDFG **Others:** CHERT, NOAA Fisheries, USACE	Interim/ Continual	*ER-VD-03*
3	D	ER-VD-04	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; and b. Improvement of existing riparian zones through plantings, release and recruitment of conifers, and control of alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*ER-VD-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Van Duzen River HSA (continued)						
3	E	ER-VD-05	Assess and prioritize sediment sources including roads.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups, RCD, NOAA Fisheries	Interim/ Ongoing	*ER-VD-05*
3	D	ER-VD-06	Treat sediment sources including roads.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups, RCD, NOAA Fisheries	Interim/ Ongoing	*ER-VD-06*
Scotia HSA						
3	C	ER-SC-01	Evaluate the benefits to coho salmon of removing the barrier on Bridge Creek.	**Potential Lead:** CDFG	Interim	*ER-SC-02*
South Fork Eel River HA						
	C	ER-SF-01	Explore opportunities to acquire conservation easements with conditions that provide benefits to coho salmon.	**Potential Lead:** CDFG	Interim/ Ongoing	*ER-SF-01*
Weott HSA						
5	C	ER-WE-01	Complete storm proofing of the Bull Creek watershed.	**Potential Lead:** DPR **Others:** CDFG	Interim/ Ongoing	*ER-WE-01*
5	C	ER-WE-02	Continue to implement the planting of trees and other habitat enhancement as necessary in the Bull and Salmon creek watersheds.	**Potential Lead:** DPR, Landowners **Others:** CDFG	Interim/ Ongoing	*ER-WE-02*
5	E	ER-WE-03	Assess and prioritize culverts that are barriers to coho salmon passage along Avenue of the Giants through collaborative efforts with other agencies.	**Potential Lead:** Caltrans **Others:** CDFG, County, Landowners, California Conservation Corps	Interim	*ER-WE-03*
5	D	ER-WE-04	Treat the prioritized culverts that are barriers to coho salmon passage along Avenue of the Giants, through collaborative efforts with other agencies.	**Potential Lead:** Caltrans **Others:** CDFG, County, Landowners, California Conservation Corps	Interim	*ER-WE-03b*
Benbow HSA						
5	D	ER-BE-01	Support a watershed assessment.	**Potential Lead:** CDFG **Others:** CDF, Counties, Landowners, NOAA Fisheries	Interim	*ER-BE-01*
5	C	ER-BE-02	Request that the CDF monitor Non-industrial Timber Management Plans to ensure that they are properly implemented.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*ER-BE-04*
Laytonville HSA						
5	D	ER-LA-01	Continue watershed restoration efforts, including measures to reduce temperatures in Ten-mile Creek.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners, California Conservation Corps	Interim/ Ongoing	*ER-LA-01*
5	E	ER-LA-02	Prioritize culverts on county roads that are coho salmon barriers.	**Potential Lead:** County **Others:** CDFG	Interim/ Ongoing	*ER-LA-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Laytonville HSA (continued)						
5	D	ER-LA-03	Treat culverts on county roads that are coho salmon barriers.	**Potential Lead:** County **Others:** CDFG	Interim/ Ongoing	*ER-LA-02b*
5	E	ER-LA-04	Work with the county to coordinate with landowners on the removal of coho salmon barriers on private property.	**Potential Lead:** CDFG **Others:** County, CDF, Landowners	Interim/ Ongoing	*ER-LA-03*
5	C	ER-LA-05	Support efforts by the county sheriff to enforce laws against illegal dumping and the Department of Health to clean up dumped materials.	**Potential Lead:** CDFG **Others:** County Sheriff, Department of Health	Interim/ Ongoing	*ER-LA-04*
5	D	ER-LA-06	Recommend that cities, counties, and Caltrans adopt maintenance manuals that protect coho salmon habitat (e.g., standards for side-casting of spoils and identification of spoils disposal sites).	**Potential Lead:** CDFG **Others:** Cities, Counties, Caltrans	Interim/ Ongoing	*ER-LA-06*
5	E	ER-LA-07	Minimize and reduce the effects of water diversions by addressing the season of diversion, installing off-stream reservoirs, requiring bypass flows protective of coho and natural hydrograph, and avoiding adverse impacts caused by water diversion.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*ER-LA-07*
Outlet Creek HSA						
5	E	ER-OC-01	Prepare a technical assessment and prioritization of the Outlet Creek watershed, developing recommendations to restore long-term function.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, RCD	Interim/ Ongoing	*ER-OC-01*
5	D	ER-OC-02	Work with the City of Willits in coho salmon recovery planning to: a. Assess, prioritize, and treat barriers to passage; b. Address water quality issues; c. Modify facility maintenance practices as necessary; and d. Evaluate land use planning and revise plans as appropriate.	**Potential Lead:** CDFG **Others:** City of Willits	Interim/ Ongoing	*ER-OC-02*
5	D	ER-OC-03	Upgrade the NCRWQCB basin plan to benefit coho salmon.	**Potential Lead:** NCRWQCB **Others:** CDFG	Interim	*ER-OC-03*
CAPE MENDOCINO HU						
	E	CM-HU-01	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Improvement of existing riparian zones through plantings, release of conifers, and manage of alders, blackberries, and other competitors; and c. Bank stabilization and fencing projects.	**Potential Lead:** CDFG **Others:** California Conservation Corps, CDF, USFS, DPR, Landowners	Ongoing	*CM-HU-01*
	E	CM-HU-02	Assessment and prioritization of sources of sediment including roads.	**Potential Lead:** CDFG, **Others:** CDF, Landowners, CCC, NCRWQCB, County, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*CM-HU-02*
	D	CM-HU-03	Treat sources of sediment, including roads.	**Potential Lead:** CDFG, **Others:** CDF, Landowners, CCC, NCRWQCB, County, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*CM-HU-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
CAPE MENDOCINO HU (continued)						
	E	CM-HU-04	Investigate feasibility of restoring estuarine function to maximize habitat for coho salmon.	**Potential Lead:** CDFG **Others:** Coastal Conservancy, NOAA Fisheries, Landowners	Interim/ Ongoing	*CM-HU-04*
	E	CM-HU-05	Prioritize and upgrade all county culverts identified as passage barriers.	**Potential Lead:** CDFG, County **Others:** Landowners	Interim/ Ongoing	*CM-HU-05*
	E	CM-HU-06	Conduct an inventory and prioritize for treatment coho salmon barriers other than county culverts.	**Potential Lead:** CDFG **Others:** Landowners, Coastal Commission, NOAA Fisheries	Interim	*CM-HU-06*
Mattole River HSA — Southern Subbasin						
5	C	CM-MS-01	Promote outreach and education of water and conservation practices to improve stream surface flows and coho salmon habitat.	**Potential Lead:** Watershed Groups, Counties **Others:** CDFG, Landowners, NCRWQCB	Long-term	*CM-MS-01*
5	C	CM-MS-02	Protect the high quality habitat found in the Mattole River Headwaters and historic coho streams.	**Potential Lead:** CDFG **Others:** Landowners, CDF	Interim/ Continual	*CM-MS-02a*
5	C	CM-MS-03	Protect high quality habitat found in the South Fork of Vanauken, Mill, Stanley, Thompson, Yew, and Lost Man creeks, recognizing current and continued land management practices by private landowners.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim/ Continual	*CM-MS-02b*
5	C	CM-MS-04	Promote a cooperative effort to establish monitoring stations at appropriate locations to monitor in-channel sediment (or turbidity) both in the lower basin and in the lower reaches of major tributaries.	**Potential Lead:** NCRWQCB, CDFG **Others:** CDF, Landowners, Watershed Groups, NOAA Fisheries, Counties	Long-term	*CM-MS-03*
5	C	CM-MS-05	Assess and prioritize sources of excess sediment.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim/ Continual	*CM-MS-04*
5	C	CM-MS-06	Treat sources of excess sediment.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim/ Continual	*CM-MS-04b*
5	D	CM-MS-07	Study herbicide use with respect to impacts on coho salmon.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Caltrans, County	Interim	*CM-MS-05*
5	D	CM-MS-08	Urge lead agencies to consider herbicide application in CEQA and NEPA review.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Caltrans, County	Interim	*CM-MS-05b*
5	D	CM-MS-09	Protect water quality from the ground application of pesticides following the NCRWQCB suggested BMPs.	**Potential Lead:** NCRWQCB **Others:** CDF, Watershed Groups, Landowners, Counties	Interim	*CM-MS-06*
5	D	CM-MS-10	Work with University of California Cooperative Extension (UCCE) specialists to monitor summer water and air temperatures and flow in cooperation with landowners using Department-accepted protocols.	**Potential Lead:** CDFG **Others:** UCCE, Landowners, Watershed Groups	Interim/ Ongoing	*CM-MS-07*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Mattole River HSA — Southern Subbasin (continued)						
5	D	CM-MS-11	Continue and expand on-going temperature monitoring efforts.	**Potential Lead:** CDFG **Others:** UCCE, Landowners, Watershed Groups	Interim/ Ongoing	*CM-MS-07b*
5	C	CM-MS-12	Request that Mendocino County evaluate new and existing for their impacts to coho salmon habitat.	**Potential Lead:** CDFG **Others:** Mendocino County, Landowners	Interim	*CM-MS-08*
5	C	CM-MS-13	Promote cluster development away from streams to protect coho salmon.	**Potential Lead:** Watershed Groups, Counties **Others:** NCRWQCB	Long-term	*CM-MS-09*
5	C	CM-MS-14	Provide incentives to landowners to protect coho salmon habitat and reduce water use.	**Potential Lead:** Watershed Groups, Counties, NCRWQCB, CDFG	Long-term	*CM-MS-10*
5	C	CM-MS-15	Develop educational materials for landowners explaining how they can protect coho salmon.	**Potential Lead:** Watershed Groups **Others:** CDFG, Counties, NCRWQCB, NOAA Fisheries	Long-term	*CM-MS-11*
5	E	CM-MS-16	Begin the process of declaring the southern subbasin to be fully appropriated in the spring and summer.	**Potential Lead:** SWRCB **Others:** DWR, CDFG	Interim	*CM-MS-12*
5	D	CM-MS-17	Request that the SWRCB make the enforcement of water rights in this watershed a priority.	**Potential Lead:** CDFG **Others:** SWRCB	Interim	*CM-MS-13*
5	D	CM-MS-18	Pursue opportunities to acquire fee title, easement, and water rights from willing sellers.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*CM-MS-14*
5	C	CM-MS-19	Plant trees appropriate to the location in riparian areas where conditions are suitable.	**Potential Lead:** Watershed Groups, Landowners, County **Others:** CDFG, CCC, NOAA Fisheries, CDF	Long-term	*CM-MS-15*
Mattole River HSA — Western Subbasin						
5	D	CM-MW-01	Assess current levels of LWD in the western subbasin, and determine amount necessary for improved flushing, pooling and habitat conditions for coho salmon.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim	*CM-MW-01*
5	D	CM-MW-02	Facilitate immediate placement of LWD in areas where lacking.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim	*CM-MW-01b*
5	D	CM-MW-03	Develop and implement a plan for long-term recruitment of LWD.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim	*CM-MW-01c*
5	D	CM-MW-04	Cooperate in establishing monitoring stations at appropriate locations (e.g., Squaw, Honeydew, and Bear creeks) to monitor in-channel sediment and track aggraded reaches in the lower basin and in the lower reaches of major tributaries.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim/ Ongoing	*CM-MW-02*
5	C	CM-MW-05	Support the assessment, prioritization, and treatment of sources of excess sediment.	**Potential Lead:** CDFG, NOAA Fisheries Landowners, CDF, Watershed Groups	Interim/ Continual	*CM-MW-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Mattole River HSA — Western Subbasin (continued)						
5	C	CM-MW-06	Monitor summer water and air temperatures using Department-accepted protocols. Continue temperature monitoring efforts in Stansberry, Mill (RM 2.8) Clear, Squaw, Woods, Honeydew Bear, North Fork Bear, South Fork Bear, Little Finley, Big Finley, and Nooning creeks, and expand efforts into other subbasin tributaries.	**Potential Lead:** Watershed Groups, CDFG **Others:** NCRWQCB	Interim/ Ongoing	*CM-MW-04*
5	C	CM-MW-07	Develop a plan to manage near-stream buffers to reduce the effects of solar radiation and to moderate air temperatures.	**Potential Lead:** CDFG **Others:** Landowners, RWQCB, Watershed Groups	Interim	*CM-MW-05*
5	C	CM-MW-08	Implement the plan to manage near-stream buffers to reduce the effects of solar radiation and to moderate air temperatures.	**Potential Lead:** CDFG **Others:** Landowners, RWQCB, Watershed Groups	Interim	*CM-MW-05b*
5	C	CM-MW-09	Assess and prioritize the actions needed for restoration and enhancement of riparian habitat.	**Potential Lead:** CDFG, Watershed Groups **Others:** Landowners, NOAA Fisheries	Interim	*CM-MW-06*
5	C	CM-MW-10	Implement the prioritized actions needed for restoration and enhancement of riparian habitat.	**Potential Lead:** CDFG, Watershed Groups **Others:** Landowners, NOAA Fisheries	Interim	*CM-MW-06b*
5	C	CM-MW-11	Recognize and support on-going efforts of landowners, BLM, and others to improve habitat conditions for coho salmon.	**Potential Lead:** Watershed Groups **Others:** CDFG, NOAA Fisheries	Interim/ Ongoing	*CM-MW-07*
5	D	CM-MW-12	Work with the SWRCB to expedite the processing of projects, including 1600 agreements, that are intended to reduce summer diversions.	**Potential Lead:** CDFG, NCRWQCB	Interim	*CM-MW-08*
5	C	CM-MW-13	Develop a public education program to raise awareness of the habitat needs of coho salmon and how the community, especially landowners, can improve coho salmon habitat.	**Potential Lead:** Watershed Groups **Others:** Landowners, CDFG, CCC, NOAA Fisheries, County	Interim/ Continual	*CM-MW-09*
5	D	CM-MW-14	Develop incentives for landowners and communities to reduce summer water withdrawals and enhance habitat.	**Potential Lead:** Watershed Groups **Others:** NCRWQCB, Counties, NOAA Fisheries	Interim	*CM-MW-10*
5	C	CM-MW-15	Develop programs to support continued land-use patterns and discourage conversions and subdivisions.	**Potential Lead:** Counties, NCRWQCB **Others:** CDFG, NOAA Fisheries	Long-term	*CM-MW-11*
5	E	CM-MW-16	Support a plan for mapping unstable soils and use of the information to guide land-use decisions, road design, and other activities that can increase erosion.	**Potential Lead:** NCRWQCB **Others:** CDF, CDFG, CGS, Watershed Groups, NOAA Fisheries	Interim	*CM-MW-12*
Mattole River HSA — Northern Subbasin						
5	C	CM-MN-01	Use tree planting and other vegetation management to improve canopy cover, especially in Conklin, Oil, Green Ridge, Devils, and Rattlesnake creeks.	**Potential Lead:** Watershed Groups **Others:** Landowners, CDFG,CCC, NOAA Fisheries, County	Long-term	*CM-MN-01*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Mattole River HSA — Northern Subbasin (continued)						
5	C	CM-MN-02	Through cooperative efforts, treat stream-bank erosion sites to reduce sediment yield, especially in Sulphur, Conklin, and Oil creeks and the lower reaches of the North Fork Mattole River.	**Potential Lead:** Watershed Groups **Others:** Landowners, NCRWQCB, CDFG, CDF	Long-term	*CM-MN-02*
5	D	CM-MN-03	Due to high incidence of unstable slopes in the northern subbasin, base future permitting of sub-division development proposals on existing county-imposed forty-acre minimum parcel sub-division ordinances.	**Potential Lead:** County **Others:** NCRWQCB	Interim	*CM-MN-03*
Mattole River HSA — Eastern Subbasin						
5	E	CM-ME-01	Continue to conduct road and erosion assessments, especially in Middle, Westlund, Gilham, Sholes, Blue Slide, and Fire creeks.	**Potential Lead:** CDFG **Others:** CDF, Landowners, CCC, NCRWQCB, County, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*CM-ME-01*
5	D	CM-ME-02	Continue to implement road and erosion assessments, especially in Middle, Westlund, Gilham, Sholes, Blue Slide, and Fire creeks.	**Potential Lead:** CDFG **Others:** CDF, Landowners, CCC, NCRWQCB, County, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*CM-ME-01b*
5	C	CM-ME-03	Use tree planting and other vegetation management to improve canopy cover, especially in Dry and Blue Slide creeks.	**Potential Lead:** CDFG **Others:** Landowners, CCC, Watershed Groups, NOAA Fisheries, CDF, County	Long-term	*CM-ME-02*
5	C	CM-ME-04	Through cooperative efforts, reduce sediment yield at stream-bank erosion sites, especially in Middle, Westlund, Gilham, North Fork Fourmile, Sholes, Harrow, Little Grindstone, Grindstone, Eubank, and McKee creeks.	**Potential Lead:** Watershed Groups **Others:** Landowners, NCRWQCB, CDFG, CDF	Long-term	*CM-ME-03*

TABLE 9-3: Implementation schedule for the CCC Coho ESU

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MENDOCINO COAST HU						
	E	MC-HU-01	Update general plans to include measures to protect coho salmon.	**Potential Lead:** Counties **Others:** Watershed Groups, CDFG, NOAA Fisheries	Long-term	*MC-HU-01*
	C	MC-HU-02	Provide technical and staff support to update general plans to include measures to protect coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, SWRCB, RWQCBs	Long-term	*MU-HU-01b*
	D	MC-HU-03	Where development would adversely affect coho salmon, limit development in the 100-year flood plain.	**Potential Lead:** Counties **Others:** CDFG, NOAA Fisheries, USACE	Interim/ Continual	*MC-HU-03*
	C	MC-HU-04	Recommend Mendocino and Sonoma counties to adopt county grading ordinances.	**Potential Lead:** CDFG	Long-term	*MC-HU-04*
	C	MC-HU-05	Adopt county grading ordinances.	**Potential Lead:** Mendocino and Sonoma Counties	Long-term	*MC-HU-04b*
	C	MC-HU-06	Recommend to Mendocino County to expand the CEQA checklist to include coho salmon.	**Potential Lead:** CDFG	Interim	*MC-HU-05*
	C	MC-HU-07	Include coho salmon in CEQA checklist.	**Potential Lead:** Mendocino County	Interim	*MC-HU-05b*
	E	MC-HU-08	Maintain current LWD, boulders, and other structure-providing features to maintain current stream complexity and pool frequency and depth.	**Potential Lead:** Landowners, Counties **Others:** CDFG, NOAA Fisheries, Watershed Groups	Interim/ Continual	*MC-HU-06*
	D	MC-HU-09	Install LWD, boulders, and other features to increase stream complexity and improve pool frequency and depth.	**Potential Lead:** Landowners, Counties, CDFG, NOAA Fisheries, Watershed Groups	Interim/ Continual	*MC-HU-06b*
	D	MC-HU-10	Restore riparian vegetation and promote conifer recruitment for shade and for LWD recruitment to increase stream complexity.	**Potential Lead:** Landowners, Counties, CDFG, NOAA Fisheries, Watershed Groups	Interim/ Continual	*MC-HU-06c*
	E	MC-HU-11	Assess, prioritize, and treat sediment sources at an HSA level.	**Potential Lead:** CDFG, **Others:** Watershed Groups, Landowners, NOAA Fisheries, NCRWQCB, CDF, Counties. BLM, DPR, RCDs, CCC	Interim/ Ongoing	*MC-HU-07*
	E	MC-HU-12	Determine site-specific recommendations, including incentives, to remedy high temperatures.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Landowners, Watershed Groups, Counties	Long-term	*MC-HU-08*
	D	MC-HU-13	Implement recommendations to remedy high temperature.	**Potential Lead:** Landowners, Counties, Watershed Groups **Others:** CDFG, NOAA Fisheries	Long-term	*MC-HU-08b*
	E	MC-HU-14	Map unstable soils.	**Potential Lead:** Counties, CDFG **Others:** Watershed Groups, Landowners, NOAA Fisheries, NCRWQCB, CDF, BLM, RCDs	Long-term	*MC-HU-09*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MENDOCINO COAST HU (continued)						
	C	MC-HU-15	Use soil mapping to guide land-use decisions, road design, THPs, and other activities that can promote erosion.	**Potential Lead:** Counties, Counties, CDF, RWQCB, CDFG, NOAA Fisheries, Landowners **Others:** Watershed Groups, BLM, RCDs	Long-term	*MC-HU-09b*
	C	MC-HU-16	Provide education and training on water diversion practices.	**Potential Lead:** SWRCB **Others:** CDFG	Interim/ Continual	*MC-HU-10*
	C	MC-HU-17	Ensure compliance with pertinent regulations on water diversion practices (e.g., FGC §1600 *et seq.*, FPR §916.9, California water rights law).	**Potential Lead:** SWRCB **Others:** CDFG	Interim/ Continual	*MC-HU-10b*
	E	MC-HU-18	Continue to treat existing upslope sediment to improve pool frequency and depth and decrease sediment load.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners, NOAA Fisheries, NCRWQCB, CDF, Counties BLM, DPR, RCDs, CCC	Interim/ Ongoing	*MC-HU-11*
	E	MC-HU-19	Avoid or minimize land fragmentation or conversion to more intensive uses to maintain pool frequency and depth.	**Potential Lead:** Counties, CDFG **Others:** Watershed Groups, Landowners, CDFG	Long-term/ Continual	*MC-HU-11b*
	C	MC-HU-20	Cooperate with and provide incentives to Landowners to maintain road and trail closures to be effective against trespass and discourage poaching of coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Counties, Landowners, DPR, Public	Interim/ Continual	*MC-HU-12*
	C	MC-HU-21	Monitor road closures to discourage poaching of coho salmon.	**Potential Lead:** County law enforcement, CHP, CDFG, NOAA Fisheries **Others:** Counties, Landowners, DPR, Watershed Groups, Public	Interim/ Continual	*MC-HU-12b*
	C	MC-HU-22	Repair defective or damaged roads to discourage poaching of coho salmon.	**Potential Lead:** Counties, Landowners, DPR **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*MC-HU-12c*
	D	MC-HU-23	Promote CalTIP, especially with regard to coho salmon spawning sites, to discourage poaching of coho salmon.	**Potential Lead:** County law enforcement, CHP, CDFG, NOAA Fisheries **Others:** Counties, Landowners, DPR, Watershed Groups, Public	Interim/ Continual	*MC-HU-12d*
	E	MC-HU-24	Investigate the desirability and feasibility of beaver reintroductions to promote channel complexity and provide rearing habitat.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Academia	Long-term	*MC-HU-13*
	C	MC-HU-25	If appropriate, reintroduce beavers to promote channel complexity and provide rearing habitat.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Counties, Landowners, Watershed Groups	Long-term/ Continual	*MC-HU-13b*
	C	MC-HU-26	Increase efforts to control alders, blackberries, and other competitors to restore LWD recruitment and shade.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, Counties, Landowners, DPR, RCDs, CCC, Watershed Groups	Interim/ Ongoing	*MC-HU-14*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MENDOCINO COAST HU (continued)						
	C	MC-HU-27	Provide incentives to landowners, such as technical support, to increase efforts to restore LWD recruitment and shade.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, Counties, Landowners, DPR, RCDs, CCC, Watershed Groups	Interim/ Ongoing	*MC-HU-14b*
	D	MC-HU-28	Avoid or minimize increases in water use to maintain or improve instream flows.	**Potential Lead:** SWRCB, Counties, Landowners **Others:** CDFG, NOAA Fisheries, RCDs	Interim/ Continual	*MC-HU-15*
	D	MC-HU-29	Provide incentives to remove or convert direct diversions to off-stream storage to maintain or improve instream flow.	**Potential Lead:** SWRCB, CDFG, NOAA Fisheries, Counties **Others:** RCDs, Watershed Groups	Interim/ Continual	*MC-HU-15b*
	C	MC-HU-30	Restrict the season of diversion to December through March to maintain or improve instream flows.	**Potential Lead:** SWRCB, Counties, Landowners, CDFG **Others:** NOAA Fisheries, RCDs	Interim/ Continual	*MC-HU-15c*
	E	MC-HU-31	Cooperatively evaluate the rate, location, and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon.	**Potential Lead:** CDF, SWRCB, CDFG **Others:** Landowners, NOAA Fisheries, Caltrans, RWQCBs	Long-term/ Continual	*MC-HU-16*
	D	MC-HU-32	When feasible, use alternatives to water as a dust palliative that are consistent with maintaining or improving water quality. Consider existing regulations or other mechanisms when evaluating alternative to water as a dust palliative (including EPA certified compounds) that are consistent with maintaining or improving water quality.	**Potential Lead:** Counties, Landowners	Long-term/ Continual	*MC-HU-16b*
	D	MC-HU-33	Maintain or re-establish geographic distribution of coho salmon by allocating substantial improvement efforts towards identified biological refugia, spawning coho salmon populations, suitable habitat accessible to coho salmon.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, Counties, Landowners, DPR, RCDs, CCC, Watershed Groups	Long-term	*MC-HU-17*
	C	MC-HU-34	Coordinate with RWQCB to implement water quality monitoring of coho salmon habitat restoration projects (RWQCB 401, USACE 404, NOAA Fisheries, and USFWS permitting).	**Potential Lead:** CDFG **Others:** SWQCB, USACE, NOAA Fisheries, USFWS	Interim (Spring 2003-Spring 2004)	*MC-HU-18*
	C	MC-HU-35	Streamline permitting of coho salmon habitat restoration projects (RWQCB 401, USACE 404, NOAA Fisheries, and USFWS permitting).	**Potential Lead:** CDFG **Others:** SWQCB, USACE, NOAA Fisheries, USFWS	Interim (Spring 2003-Spring 2004)	*MC-HU-18b*
	E	MC-HU-36	Encourage funding authorities to allocate adequate resources to prioritize and upgrade culverts to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads.	**Potential Lead:** Federal, State, Local, and Tribal Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Interim	*MC-HU-19*
	E	MC-HU-37	Adequately fund prioritization and upgrading of culverts to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads.	**Potential Lead:** CDFG, NOAA Fisheries, Counties	Interim/ Continual	*MC-HU-19b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MENDOCINO COAST HU (continued)						
	E	MC-HU-38	Identify areas of increased risk of mass wasting and fine sediment loads to decrease sediment from transportation projects and land management activities.	**Potential Lead:** CDFG, NCRWCB, Caltrans, Counties, Landowners **Others:** Watershed Groups, CDF, CCC	Interim/ Continual	*MC-HU-20*
	D	MC-HU-39	Implement appropriate measures or mitigation for mass wasting.	**Potential Lead:** CDFG, NCRWCB, Caltrans, Counties, Landowners **Others:** Watershed Groups, CDF, CCC	Interim/ Continual	*MC-HU-20b*
	E	MC-HU-40	Abandon riparian road systems and/or upgrade roads and skid trails that deliver sediment to adjacent watercourses to decrease fine sediment loads.	**Potential Lead:** Counties, NCRWQB, CDFG **Others:** Landowners, Counties, Caltrans, Watershed Groups, RCDs, CDF, CCC, DPR	Interim/ Continual	*MC-HU-21*
	E	MC-HU-41	Limit winter use of unsurfaced roads and recreational trails by unautho-rized and impacting uses to decrease fine sediment loads.	**Potential Lead:** Counties, NCRWQB, CDFG **Others:** Landowners, Counties, Caltrans, Watershed Groups, RCDs, CDF, CCC, DPR	Interim/ Continual	*MC-HU-21b*
	E	MC-HU-42	Minimize the density of road and trail crossings of watercourses.	**Potential Lead:** Counties, Landowners, Caltrans, CDF **Others:** CDFG, NCRWQCB, Watershed Groups, RCDs, CCC, DPR	Interim/ Continual	*MC-HU-21c*
	E	MC-HU-43	Wherever feasible, out-slope roads with rolling dips to decrease fine sediment loads.	**Potential Lead:** Counties, Landowners, Caltrans, CDF **Others:** CDFG, NCRWQCB, Watershed Groups, RCDs, CCC, DPR	Interim/ Continual	*MC-HU-21d*
	E	MC-HU-44	Identify and modify road maintenance activities that generate fine sediment to decrease fine sediment loads.	**Potential Lead:** Counties, Landowners, Caltrans, CDF **Others:** CDFG, NCRWQCB, Watershed Groups, RCDs, CDF, CCC, DPR	Interim/ Continual	*MC-HU-21e*
	C	MC-HU-45	Develop erosion control projects similar to the North Fork Ten Mile River erosion control plan.	**Potential Lead:** CDFG, Trout Unlimited, NCRWQCB, NOAA Fisheries, Mendocino County, Landowners	Interim	*MC-HU-22*
Albion River HSA						
5	C	MC-AR-01	Place instream structures to improve gravel retention and habitat complexity.	**Potential Lead:** CDFG **Others:** Landowners, CCC, CDF, Watershed Groups, Mendocino County, RCDs	Interim/ Continual	*MC-AR-01*
5	C	MC-AR-02	Provide technical assistance and incentives to landowners in developing and implementing sediment reduction plans to meet requirements of the CWA TMDL, making watersheds with an implementation schedule the highest priority.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF, DPR	Interim	*MC-AR-02*
5	C	MC-AR-03	Conduct collaborative evaluations of priorities for treatment of coho salmon passage barriers, such as the Fish Passage Forum.	**Potential Lead:** CDFG, NOAA Fisheries, Caltrans, Mendocino County Landowners, Watershed Groups.	Interim/ Continual	*MC-AR-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Albion River HSA (continued)						
5	C	MC-AR-04	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-AR-7*
5	C	MC-AR-05	Encourage when necessary and appropriate restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricting winter access to unpaved roads is not feasible, encourage measures such as rocking to prevent sediment from reaching coho salmon streams.	**Potential Lead:** CDF, CDFG, USFS, Counties, Landowners	Interim/ Continual	*MC-AR-11*
5	D	MC-AR-06	Conduct comprehensive subbasin erosion control "storm proofing," combined with installation of LWD into streams.	**Potential Lead:** CDFG, Mendocino County, RCD, Landowners **Others:** CDF, CCC, DPR	Interim	*MC-AR-12*
5	E	MC-AR-07	Modify stream barriers to allow coho salmon passage while maintaining LWD.	**Potential Lead:** CDFG, Landowners, RCD **Others:** Mendocino County, CCC, DPR	Interim	*MC-AR-13*
Big River HSA						
5	E	MC-BR-01	Coordinate and make recommendations needed to implement provisions of the FGC §1600.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01*
5	E	MC-BR-02	Implement recommendations on provisions of the FGC §1600.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01b*
5	E	MC-BR-03	Identify actions to improve coordination between the agencies and others to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01c*
5	E	MC-BR-04	Implement actions to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01d*
5	E	MC-BR-05	Assess and map water diversions.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01e*
5	E	MC-BR-06	Determine and monitor 1600 compliance related to water diversions.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01f*
5	E	MC-BR-07	Evaluate requests for on-stream dams on streams with coho salmon above coho salmon migratory reaches for the effects on the natural hydrograph and the effects on the supply of spawning gravel for recruitment downstream.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01g*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Garcia River HSA						
4	D	MC-GA-01	Establish connectivity of North Fork Garcia River to the mainstem.	**Potential Lead:** CDFG, Counties, Landowners **Others:** NOAA Fisheries	Long-term	*MC-GA-02*
4	C	MC-GA-02	Provide technical assistance and incentives to Garcia River Landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF	Interim	*MC-GA-05*
4	C	MC-GA-03	Utilize as a model for erosion reduction and LWD placement the comprehensive approach practiced in the South Fork of the Garcia River.	**Potential Lead:** CDF, NCRQCB, CDFG	Interim	*MC-GA-06*
4	C	MC-GA-04	Investigate stream nutrient enrichment and cycling needs for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Academia **Others:** Counties, Landowners, Watershed Groups	Interim	*MC-GA-07*
4	E	MC-GA-05	Apply the Garcia River Estuary Enhancement Feasibility Study Report to investigate coho salmon in the Garcia River estuary, as well as new information, to consider restoring estuary functions that would benefit coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Mendocino County, Landowners, RCD, Academia	Interim	*MC-GA-08*
4	D	MC-GA-06	If appropriate, restore estuary function to benefit coho salmon.	**Potential Lead:** Mendocino County, CDFG	Long-term	*MC-GA-08b*
4	C	MC-GA-07	Coordinate LWD placement in streams with logging operations and road upgrades to maximize size, quality, and efficiency of effort.	**Potential Lead:** CDF **Others:** Landowners, CDFG, NOAA Fisheries, Counties, Caltrans	Interim	*MC-GA-09*
4	D	MC-GA-08	Maintain Hathaway Creek, North Fork Garcia, Rolling Brook, Mill Creek (lower Garcia River), South Fork Garcia, Signal, Mill Creek (upper Garcia River) to continue to provide coldwater input to the mainstem Garcia.	**Potential Lead:** CDF **Others:** Landowners, CDFG, NOAA Fisheries, Counties, Caltrans	Interim/ Continual	*MC-GA-11*
4	C	MC-GA-09	Plant conifers in riparian zone of Blue Waterhole, Inman and Pardaloe creeks to reduce instream temperatures and inputs into the mainstem and conifer LWD recruitment.	**Potential Lead:** Landowners **Others:** CDF, CDFG, RCD	Interim	*MC-GA-12*
4	C	MC-GA-10	Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricting winter access to unpaved roads is not feasible, encourage measures such as rocking to prevent sediment from reaching coho salmon streams.	**Potential Lead:** Mendocino County, CDF	Interim/ Continual	*MC-GA-13*
4	D	MC-GA-11	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-GA-14*
4	D	MC-GA-12	Excavate a geomorphically designed stream channel in the lower North Fork Garcia River to rectify subsurface flow during summer months and prevent coho salmon stranding.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Mendocino County, Watershed Groups	Long-term	*MC-GA-16*
4	E	MC-GA-13	Rescue juvenile coho salmon until subsurface summer flows are rectified.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Mendocino County, Watershed Groups	Interim	*MC-GA-16b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Garcia River HSA (continued)						
4	C	MC-GA-14	Work with landowners to plant conifers in the lower mainstem Garcia River from Eureka Hill road Bridge to Windy Hollow road with the goal of reducing stream temperature, providing bank stability and long-term LWD.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners **Others:** Mendocino County, Watershed Groups	Interim/ Continual	*MC-GA-17*
4	E	MC-GA-15	Evaluate the value to coho salmon of projects to open logjam migration barriers in the North Fork, South Fork, and Fleming Creek.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups	Interim	*MC-GA-18*
4	D	MC-GA-16	If appropriate, open logjam barriers to coho salmon migration in the North Fork, South Fork, and Fleming Creek.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups	Interim	*MC-GA-18b*
4	C	MC-GA-17	Complete the remaining 25% of erosion control sites, identified in the South Fork Garcia River by the Trout Unlimited North Coast Coho Salmon Project.	**Potential Lead:** CDFG, Landowners, Watershed Groups	Long-term	*MC-GA-19*
4	C	MC-GA-18	Where appropriate and with willing landowners, place LWD in Inman Creek, South Fork Garcia River, Signal Creek, and North Fork Garcia River.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners, Watershed Groups **Others:** Counties	Interim/ Continual	*MC-GA-21*
4	C	MC-GA-19	Where appropriate and with willing landowners, plant redwood trees in the lower seven miles of the Garcia River mainstem between Eureka Hill road and Windy Hollow road to provide for LWD recruitment and bank stability and to reduce instream temperatures.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners, Watershed Groups **Others:** Counties	Interim/ Continual	*MC-GA-22*
Navarro River HSA						
4	C	MC-NA-01	Investigate stream nutrient enrichment and cycling needs for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Academia	Interim	*MC-NA-03*
4	D	MC-NA-02	Pay particular attention to Implementing actions regarding LWD and shade that are suggested at the HU level.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, Mendocino County, Landowners, CCC, RCDs	Interim	*MC-NA-04*
4	C	MC-NA-03	Prioritize enforcement of pertinent laws concerning illegal and unpermitted dams and diversions.	**Potential Lead:** SWRCB, CDFG, NOAA Fisheries	Interim/ Continual	*MC-NA-06*
4	C	MC-NA-04	Conserve water by providing land-owners education, incentives, and technical assistance.	**Potential Lead:** SWRCB, CDFG, NOAA Fisheries **Others:** RWQCBs, Watershed Groups, RCDs, UCCE	Ongoing/ Continual	*MC-NA-06b*
4	E	MC-NA-05	Implement comprehensive, subbasin-wide erosion control and LWD installation for Flynn, Dutch Henry, John Smith, Minnie, Horse Camp and German creeks such as is being implemented on Little North Fork.	**Potential Lead:** MRC, CDFG **Others:** NOAA Fisheries, CDF, NCRWQCB	Interim	*MC-NA-07*
4	C	MC-NA-06	Provide technical assistance and incentives to Navarro River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF	Interim	*MC-NA-08*
4	C	MC-NA-07	Coordinate LWD placement in streams with logging operations and road upgrades to maximize size, quality, and efficiency of effort.	**Potential Lead:** CDF **Others:** CDFG, Landowners, NOAA Fisheries, Mendocino County, Caltrans	Interim/ Continual	*MC-NA-09*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Navarro River HSA (continued)						
4	C	MC-NA-08	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-NA-10*
4	C	MC-NA-09	Where restricting winter access to unpaved roads is not feasible, encourage measures such as rocking to prevent sediment from reaching coho salmon streams.	**Potential Lead:** CDF, CDFG, USFS, Counties, Landowners	Interim/ Continual	*MC-NA-11*
Noyo River HSA						
4	E	MC-NO-01	Investigate the role of the Pudding Creek Dam impoundment in coho migration and freshwater survival rate.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia, Landowners	Interim	*MC-NO-02*
4	C	MC-NO-02	If appropriate, repair the Pudding Creek Dam.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia, Landowner	Long-term	*MC-NO-02b*
4	C	MC-NO-03	Implement actions of a sediment reduction plan to improve water quality.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Mendocino County, NCRWCB	Interim	*MC-NO-04*
4	E	MC-NO-04	Fund activities to address barriers to coho salmon passage on the California Western Railway right-of-way.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Mendocino County	Interim	*MC-NO-05*
4	D	MC-NO-05	Remove barriers to coho salmon passage on the California Western Railway right-of-way.	**Potential Lead:** CDFG, NOAA Fisheries, Mendocino County	Interim	*MC-NO-05b*
4	C	MC-NO-06	Evaluate the biological justification for the egg-taking station on the South Fork Noyo River.	**Potential Lead:** CDFG NOAA Fisheries **Others:** Academia	Interim	*MC-NO-06*
Ten Mile River HSA						
4	E	MC-TM-01	Complete erosion control on the North Fork Ten Mile River.	**Potential Lead:** Hawthorne-Campbell Company, CDFG **Others:** Trout Unlimited, NCRWQCB, NOAA Fisheries, Mendocino County, Landowners	Interim	*MC-TM-01*
4	C	MC-TM-02	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-TM-02*
4	C	MC-TM-03	Where restricting winter access to unpaved roads is not feasible, encourage measures such as rocking to prevent sediment from reaching coho salmon streams.	**Potential Lead:** CDF, CDFG, USFS, Counties, Landowners	Interim/ Continual	*MC-TM-03*
4	C	MC-TM-04	Provide technical assistance and incentives to Ten Mile River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF	Interim	*MC-TM-05*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Ten Mile River HSA (continued)						
4	C	MC-TM-05	Coordinate LWD placement in streams with logging operations and road upgrades to maximize the size, quality, and efficiency of effort.	**Potential Lead:** CDF **Others:** Landowners, CDFG, NOAA Fisheries, Counties	Interim/ Continual	*MC-TM-06*
Gualala River HSA						
2	E	MC-GU-01	Complete comprehensive assessment/implementation of erosion control measures in the entire North Fork River basin.	**Potential Lead:** CDFG, NCRWQCB **Others:** Watershed Groups, Landowners	Interim/ Ongoing	*MC-GU-02*
2	E	MC-GU-02	Enforce existing by-pass flow permit conditions of water diversions on the North Fork Gualala River to protect coldwater input to lower mainstem and estuary.	**Potential Lead:** SWRCB, CDFG	Interim	*MC-GU-03*
2	C	MC-GU-03	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-GU-04*
2	C	MC-GU-04	Coordinate LWD placement in streams with logging operations and road upgrades to maximize size, quality, and efficiency of effort.	**Potential Lead:** CDF **Others:** CDFG, NOAA Fisheries, Counties, Caltrans	Interim/ Continual	*MC-GU-05*
2	C	MC-GU-05	Explore acquisition or conservation easements from willing land-owners of sections of stands of old-growth Redwood along Haupt Creek.	**Potential Lead:** WCB, CDFG **Others:** Mendocino County, Sonoma County	Interim	*MC-GU-07*
2	C	MC-GU-06	If appropriate and from willing land-owners, acquire fee-title or conservation easement to sections of stands of old-growth Redwood along Haupt Creek.	**Potential Lead:** WCB **Others:** Landowners, CDFG, Mendocino County, Sonoma County	Long-term	*MC-GU-07b*
2	D	MC-GU-07	Restore all tributaries that historically contained coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners **Others:** Mendocino County, Sonoma County	Interim/ Continual	*MC-GU-09*
2	C	MC-GU-08	Enforce all pertinent laws relating to summer dams and water diversions to provide adequate year round flows and coho salmon passage.	**Potential Lead:** SWRCB, CDFG **Others:** NOAA Fisheries, RWQCB, Mendocino County, Sonoma County	Interim	*MC-GU-11*
2	C	MC-GU-09	Study baseline flow of Gualala River basin.	**Potential Lead:** SWRCB, CDFG **Others:** NOAA Fisheries, RWQCB, Mendocino County, Sonoma County Watershed Groups	Interim	*MC-GU-11b*
2	C	MC-GU-10	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-GU-12*
2	E	MC-GU-11	Investigate effects to coho salmon of conversion of timberland and oak woodlands in the Gualala River.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** CDF, Mendocino County, Sonoma County Watershed Groups	Interim	*MC-GU-13*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
RUSSIAN RIVER HU						
	C	RR-HU-01	Upgrade the Russian River Basin Plan to benefit coho salmon.	**Potential Lead:** RWQCB **Others:** CDFG, NOAA Fisheries	Interim	*RR-HU-02*
	E	RR-HU-02	Identify water diverters.	**Potential Lead:** RWQCB **Others:** SWRCB, Counties	Interim	*RR-HU-03*
	C	RR-HU-03	Review, and modify if necessary, water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** RWQCB, SWRCB **Others:** CDFG, NOAA Fisheries, Counties, Landowners	Long-term	*RR-HU-03b*
	E	RR-HU-04	Assess, prioritize, and develop plans to treat barriers to coho salmon passage in all HSAs.	**Potential Lead:** CDFG, Counties **Others:** NOAA Fisheries, USFWS, Landowners	Interim	*RR-HU-04*
	D	RR-HU-05	Treat barriers to coho salmon passage.	**Potential Lead:** CDFG, Counties **Others:** NOAA Fisheries, USFWS, Landowners	Long-term	*RR-HU-04b*
	E	RR-HU-06	Assess riparian canopy and impacts of exotic vegetation (e.g., *Arundo donax*), prioritize, and develop riparian habitat reclamation and enhancement programs.	**Potential Lead:** RCDs, CDFG **Others:** Landowners, Counties	Interim/ Continual	*RR-HU-06*
	C	RR-HU-07	If appropriate, control exotic vegetation (especially *Arundo donax*).	**Potential Lead:** RCDs, CDFG **Others:** Landowners, Counties	Long-term	*RR-HU-06b*
	C	RR-HU-08	Restore and enhance priority riparian habitat.	**Potential Lead:** RCDs, CDFG **Others:** Landowners, Counties	Long-term	*RR-HU-06c*
	C	RR-HU-09	Implement the Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties.	**Potential Lead:** Sotoyome RCD **Others:** Landowners, CDFG, Counties	Interim/ Continual	*RR-HU-07*
	E	RR-HU-10	Continue genetic analysis of source stocks for coho salmon broodstock.	**Potential Lead:** Bodega Marine Lab, CDFG **Others:** NOAA Fisheries	Interim/ Ongoing	*RR-HU-08*
	D	RR-HU-11	Stock first priority streams missing coho salmon, including Felta and Mill creeks (tributary to Dry Creek west of Healdsburg), Freezeout, Willow and Sheephouse creeks (near Duncans Mills), and Ward Creek (tributary to Austin Creek). Identify additional streams that may be suitable for stocking as restoration occurs	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Watershed Groups	Interim	*RR-HU-08b*
	E	RR-HU-12	Identify additional streams that may be suitable for stocking coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia	Interim	*RR-HU-08c*
	C	RR-HU-13	Develop and implement a monitoring and evaluation program to adaptively manage the coho salmon broodstock program and meet high and medium priority monitoring objectives as outlined in the coho salmon HGMP.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia	Interim/ Continual	*RR-HU-08d*
	C	RR-HU-14	Develop, implement, and evaluate experimental release protocols for the captive broodstock program.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia	Interim/ Continual	*RR-HU-08e*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
RUSSIAN RIVER HU (continued)						
	C	RR-HU-15	Review and revise long-term hatchery program goals based on results of the monitoring and evaluation program implemented in the experimental captive broodstock program.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia	Long-term	*RR-HU-08f*
	C	RR-HU-16	Develop and implement protocols for controlling Pierce's Disease to maintain a native riparian corridor.	**Potential Lead:** RCDs, Counties **Others:** Landowners, CDFG, NCRWQCB, NOAA Fisheries, USFWS	Interim/ Continual	*RR-HU-09*
	C	RR-HU-17	Develop an outreach program for controlling Pierce's Disease.	**Potential Lead:** RCDs, Counties **Others:** Landowners, CDFG, NCRWQCB, NOAA Fisheries, USFWS	Interim/ Continual	*RR-HU-09b*
	E	RR-HU-18	Evaluate recommendations to offset impacts from county policies and operations, as developed by the FishNet 4C program in their report, Effects of County Land Use Policies and Management Practices on Anadromous Salmonids and Their Habitat.	**Potential Lead:** Sonoma County **Others:** CDFG, NCRWQCB, NOAA Fisheries, Landowners	Interim	*RR-HU-10*
	C	RR-HU-19	Implement appropriate recommendations to offset impacts from county policies and operations, as developed by the FishNet program.	**Potential Lead:** Sonoma County, Landowners **Others:** CDFG, NCRWQCB, NOAA Fisheries	Long-term	*RR-HU-10b*
	E	RR-HU-20	Evaluate recommendations to offset impacts from county policies and operations, as developed by the Five County effort.	**Potential Lead:** Mendocino County **Others:** CDFG, NCRWQCB, NOAA Fisheries, Landowners	Interim	*RR-HU-10c*
	C	RR-HU-21	Implement appropriate recommendations to offset impacts from county policies and operations, as developed by the Five County effort.	**Potential Lead:** Mendocino County, Landowners **Others:** CDFG, NCRWQCB, NOAA Fisheries	Long-term	*RR-HU-10d*
	C	RR-HU-22	Develop a grading ordinance and grading and erosion control standards to minimize sediment impacts to coho salmon habitat.	**Potential Lead:** Sonoma and Mendocino Counties **Others:** Caltrans, CDF, CDFG, NOAA Fisheries	Long-term	*RR-HU-11*
	E	RR-HU-23	Restore coho salmon passage at county structures on all streams inhabited by coho salmon, as identified in the Russian River Fish Passage Assessment report.	**Potential Lead:** Counties **Others:** CDFG, NOAA Fisheries, Landowners	Interim	*RR-HU-12*
	E	RR-HU-24	Expand coho salmon passage barrier inventories as needed to use a comprehensive watershed approach improving coho salmon passage.	**Potential Lead:** Counties **Others:** CDFG, NOAA Fisheries, Landowners	Interim	*RR-HU-12b*
	C	RR-HU-25	Integrate coho salmon passage projects at county facilities with coho salmon passage improvements involving other Landowners, throughout targeted coho salmon watersheds.	**Potential Lead:** Counties, CDFG, NOAA Fisheries, Watershed Groups **Others:** Landowners	Interim	*RR-HU-12c*
	E	RR-HU-26	Review and, if appropriate, approve Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004).	**Potential Lead:** State Agencies	Interim	*RR-HU-13*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
RUSSIAN RIVER HU (continued)						
	C	RR-HU-27	Implement any best management practices pertinent to coho salmon recovery in Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004).	**Potential Lead:** Sonoma County Public Works and Parks	Long-term	*RR-HU-13b*
	E	RR-HU-28	Review the Five County Roads manual.	**Potential Lead:** State agencies	Interim	*RR-HU-13c*
	C	RR-HU-29	Implement any practices pertinent to coho salmon recovery in the Five County Roads manual.	**Potential Lead:** Mendocino County	Long-term	*RR-HU-13d*
	D	RR-HU-30	Reduce native riparian vegetation clearing and sediment removal adjacent to and in anadromous coho streams.	**Potential Lead:** Sonoma and Mendocino County Public Works, Water Agencies, Flood Control Districts **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*RR-HU-14*
	D	RR-HU-31	Retain LWD within streams to the extent possible.	**Potential Lead:** Sonoma and Mendocino County Public Works, Water Agencies, Flood Control Districts **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*RR-HU-14b*
	C	RR-HU-32	Store and make available woody material removed from streams for stream enhancement projects benefiting coho salmon.	**Potential Lead:** Sonoma and Mendocino County Public Works, Water Agencies, Flood Control Districts **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*RR-HU-14c*
	C	RR-HU-33	Promote alternatives to conventional bank stabilization for public and private projects, including bioengineering techniques.	**Potential Lead:** Sonoma and Mendocino County Planning and Public Works Departments **Others:** Landowners, CDFG, NCRWQCB, RCDs	Interim/ Continual	*RR-HU-15*
	E	RR-HU-34	Review development set-backs for adequacy in protecting key streams inhabited by coho salmon.	**Potential Lead:** Sonoma and Mendocino Counties, Incorporated Areas **Others:** CDFG, NOAA Fisheries, Landowners, NCRWQCB	Interim	*RR-HU-16*
	E	RR-HU-35	If appropriate, revise development set-backs to adequately protect key streams inhabited by coho salmon.	**Potential Lead:** Sonoma and Mendocino Counties, Incorporated Areas **Others:** CDFG, NOAA Fisheries, Landowners, NCRWQCB	Interim	*RR-HU-16b*
	E	RR-HU-36	Promote streamside conservation measures, including conservation easements, setbacks, and riparian buffers.	**Potential Lead:** Sonoma and Mendocino Counties, Incorporated Areas **Others:** CDFG, NOAA Fisheries, Landowners, NCRWQCB	Interim/ Continual	*RR-HU-16c*
	D	RR-HU-37	Implement streamside conservation measures, including conservation easements, setbacks, and riparian buffers.	**Potential Lead:** Landowners, Sonoma and Mendocino Counties, Incorporated Areas **Others:** CDFG, NOAA Fisheries, NCRWQCB	Interim/ Continual	*RR-HU-16d*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
RUSSIAN RIVER HU (continued)						
	E	RR-HU-38	Inventory, evaluate, and prioritize problem roads which contribute sediment to streams inhabited by coho salmon.	**Potential Lead:** Sonoma and Mendocino County Public Works Departments, Caltrans, Open Space Districts **Others:** CDFG, NCRWQB, Landowners, RCDs, NOAA Fisheries	Interim	*RR-HU-17*
	D	RR-HU-39	Fix problem roads which contribute sediment to streams inhabited by coho salmon.	**Potential Lead:** Counties, Caltrans **Others:** CDFG, NCRWQB, Landowners, RCDs, NOAA Fisheries	Long-term	*RR-HU-17b*
	E	RR-HU-40	Support efforts and develop county, city, and other local programs to protect and increase instream flows for coho salmon.	**Potential Lead:** SWRCB, CDFG, NCRWQCB **Others:** Counties, Landowners, RCDs	Interim	*RR-HU-18*
	D	RR-HU-41	Develop and implement programs to protect and increase instream flows for coho salmon.	**Potential Lead:** Sonoma and Mendocino Counties, RCDs, Landowners **Others:** SWRCB, CDFG, NCRWQCB	Long-term	*RR-HU-18b*
	C	RR-HU-42	Participate in regional water management planning through the general plan process and in other venues as appropriate.	**Potential Lead:** Sonoma and Mendocino Counties, SWRCB, NCRWQCB	Interim	*RR-HU-18c*
Russian River Mainstem (various HSAs)						
	E	RR-MS-01	Manage summer flows in the mainstem Russian River to benefit rearing coho salmon and the estuary, while ensuring that all existing legal water uses and rights are accounted for.	**Potential Lead:** Sonoma County Water Agency (SCWA), USACE, NOAA Fisheries, SWRCB **Others:** CDFG, Landowners, Sonoma County	Interim/ Continual	*RR-MS-01*
	E	RR-MS-02	Evaluate operating the estuary as a natural system to benefit coho salmon rearing and migration.	**Potential Lead:** SCWA, USACE, NOAA Fisheries, CDFG **Others:** Academia, Landowners, Sonoma County, SWRCB	Interim	*RR-MS-02*
	C	RR-MS-03	If appropriate, operate the estuary as a natural system to benefit coho salmon rearing and migration.	**Potential Lead:** SCWA, USACE, NOAA Fisheries **Others:** CDFG, Landowners, Counties, SWRCB	Long-term/ Continual	*RR-MS-02b*
	D	RR-MS-04	Evaluate adjusting the operation of Mirabel Dam, within existing water rights and legal uses, to improve passage of downstream migrants.	**Potential Lead:** SCWA, SWRCB **Others:** CDFG, NOAA Fisheries	Interim	*RR-MS-03*
	C	RR-MS-05	If appropriate, adjust the operation of Mirabel Dam, within existing water rights and legal uses, to improve passage of downstream coho salmon migrants.	**Potential Lead:** SCWA, SWRCB **Others:** CDFG, NOAA Fisheries	Long-term	*RR-MS-03b*
	E	RR-MS-06	Evaluate the feasibility of bypassing large dams.	**Potential Lead:** SCWA, USACE, NOAA Fisheries, CDFG **Others:** Landowners, Counties, Watershed Groups	Interim	*RR-MS-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Russian River Mainstem (various HSAs) (continued)						
	C	RR-MS-07	If feasible, bypass large dams.	**Potential Lead:** SCWA, USACE, Counties, Watershed Groups **Others:** CDFG, Landowners, Counties, NOAA Fisheries	Long-term	*RR-MS-04b*
	E	RR-MS-08	Update temperature analyses below Coyote Dam and Warm Springs Dam and review dam management.	**Potential Lead:** SCWA, USACE, NOAA Fisheries **Others:** CDFG, Landowners, Counties	Interim	*RR-MS-05*
	C	RR-MS-09	If appropriate, revise management of Coyote and Warm Springs dams to benefit coho salmon recovery.	**Potential Lead:** SCWA, USACE, NOAA Fisheries **Others:** CDFG, Landowners, Counties	Long-term	*RR-MS-05b*
	E	RR-MS-10	In upper mainstem, prioritize and plan coho salmon habitat restoration programs and projects.	**Potential Lead:** CDFG, SCWA, Mendocino County, NOAA Fisheries **Others:** Landowners, USACE, RCDs	Interim	*RR-MS-06*
	C	RR-MS-11	Implement high-priority coho salmon habitat restoration programs and projects.	**Potential Lead:** CDFG, SCWA, Mendocino County, NOAA Fisheries, Landowners **Others:** USACE, RCDs	Long-term	*RR-MS-06b*
Guerneville HSA						
5	C	RR-GU-01	Encourage local agencies to implement recommendations of completed non-point source sediment assessments.	**Potential Lead:** EPA, SWRCB, RWQCB, NOAA Fisheries, CDFG	Interim	*RR-GU-01*
5	C	RR-GU-02	Implement recommendations of completed non-point source sediment assessments.	**Potential Lead:** Sonoma County **Others:** EPA, SWRCB, NCRWQCB, NOAA Fisheries, CDFG	Interim/ Continual	*RR-GU-01a*
5	E	RR-GU-03	Assess and prioritize sources of excess sediment.	**Potential Lead:** CDFG, RCDs, NCRWQCB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-GU-02*
5	C	RR-GU-04	Treat priority sources of excess sediment.	**Potential Lead:** Landowners, Sonoma County, RCDs, NCRWQB **Others:** CDFG, USFWS, NOAA Fisheries	Long-term	*RR-GU-02b*
5	C	RR-GU-05	Stock Willow, Sheephouse, Freezeout, Dutchbill and Green Valley creeks as part of the coho salmon broodstock program.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** SCWA, Landowners, Sonoma County	Interim	*RR-GU-03*
5	C	RR-GU-06	From willing Landowners, acquire conservation easements or fee-title of habitat essential for coho salmon.	**Potential Lead:** WCB, CDFG, NOAA Fisheries, **Others:** RCDs, Landowners, Sonoma County	Interim/ Continual	*RR-GU-04*
5	E	RR-GU-07	Identify water diverters.	**Potential Lead:** SWRCB, NCRWQCB **Others:** Sonoma County, RCDs, Landowners	Interim	*RR-GU-06*
5	E	RR-GU-08	Request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** SWRCB, NCRWQCB **Others:** SWRCB, NCRWQCB, Sonoma County, RCDs, Landowners	Interim	*RR-GU-06b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Guerneville HSA (continued)						
5	E	RR-GU-09	Monitor, identify problems, and prioritize needs for changes to water diversion on current or potential coho streams that go dry in some years, in particular Green Valley and Dutchbill creeks.	**Potential Lead:** SWRCB, NCRWQCB, CDFG, NOAA Fisheries, **Others:** Sonoma County, RCDs, Landowners	Interim	*RR-GU-06c*
5	C	RR-GU-10	Remedy priority water diversion problems for current or potential coho streams that go dry in some years.	**Potential Lead:** SWRCB, NCRWQCB, CDFG, NOAA Fisheries **Others:** Sonoma County, RCDs, Landowners	Long-term	*RR-GU-06d*
Austin Creek HSA						
3	C	RR-AC-01	Encourage local agencies to implement recommendations of completed non-point source sediment assessments.	**Potential Lead:** EPA, SWRCB, RWQCB, NOAA Fisheries, CDFG	Interim	*RR-AC-01*
3	C	RR-AC-02	Implement recommendations of completed non-point source sediment assessments.	**Potential Lead:** Sonoma County **Others:** EPA, SWRCB, NCRWQCB, NOAA Fisheries, CDFG	Interim/ Continual	*RR-AC-01a*
3	E	RR-AC-03	Assess and prioritize sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-AC-02*
3	E	RR-AC-04	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Long-term	*RR-AC-02a*
3	E	RR-AC-05	Stock high-priority barren streams, including Ward Creek, with the coho salmon broodstock program.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** SCWA, Landowners, Sonoma County	Long-term	*RR-AC-03*
Warm Springs HSA						
3	E	RR-WS-01	Develop plans to improve riparian vegetation in Dry Creek and its tributaries.	**Potential Lead:** CDFG, Sotoyome RCD **Others:** Landowners, SCWA, USACE	Interim	*RR-WS-01*
3	C	RR-WS-02	Implement riparian vegetation improvement plans.	**Potential Lead:** Landowners, SCWA, Sotoyome RCD **Others:** CDFG, USACE	Long-term/ Continual	*RR-WS-01b*
3	C	RR-WS-03	Implement Sotoyome Resource Conservation District's Fish Friendly Farming Program.	**Potential Lead:** Landowners, SCWA, Sotoyome RCD **Others:** USACE	Interim/ Continual	*RR-WS-01c*
3	C	RR-WS-04	Use land-use planning and conservation easements with willing landowners, to protect riparian vegetation.	**Potential Lead:** CDFG, Sotoyome RCD **Others:** Landowners, SCWA, USACE	Interim/ Continual	*RR-WS-01d*
3	C	RR-WS-05	Support implementation of measures to modify flows in Dry Creek to provide summer rearing habitat for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, SWRCB, NCRWQCB	Interim	*RR-WS-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Warm Springs HSA (continued)						
3	D	RR-WS-06	Modify flows in Dry Creek to provide summer rearing habitat for coho salmon.	**Potential Lead:** Mendocino and Sonoma Counties, SWRCB, NCRWQCB **Others:** CDFG, NOAA Fisheries, Landowners, RCDs	Long-term	*RR-WS-02b*
3	C	RR-WS-07	Stock high-priority barren streams, such as Mill and Felta creeks, as part of the coho salmon broodstock program.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** SCWA, Landowners, Sonoma County	Long-term	*RR-WS-03*
3	C	RR-WS-08	Review and develop preferred protocols for Pierce's Disease Control that would maintain a native riparian corridor and develop an outreach program.	**Potential Lead:** RCDs, Counties **Others:** Landowners, CDFG, NCRWQCB, NOAA Fisheries, USFWS	Interim/ Continual	*RR-WS-04*
3	E	RR-WS-09	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-WS-06*
3	C	RR-WS-10	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Long-term	*RR-WS-06b*
3	D	RR-WS-11	Increase habitat structure and complexity in Dry Creek to enhance habitat diversity, including depositional areas for spawning gravels for coho salmon (e.g., place LWD or large boulders).	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County	Interim	*RR-WS-07*
Mark West HSA						
4	C	RR-MW-01	Use land-use planning and conservation easements, from willing landowners, to reduce habitat fragmentation and improve riparian vegetation.	**Potential Lead:** Sonoma County **Others:** Landowners, CDFG, NOAA Fisheries, Watershed Groups	Interim/ Continual	*RR-MW-01*
4	E	RR-MW-02	Develop plans to improve instream coho salmon habitat conditions.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Landowners, Sotoyome RCD, Sonoma County	Long-term	*RR-MW-02*
4	D	RR-MW-03	Implement measures to improve instream coho salmon habitat conditions.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Landowners, Sotoyome RCD, Sonoma County	Long-term	*RR-MW-02b*
4	E	RR-MW-04	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-MW-04*
4	C	RR-MW-05	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Long-term	*RR-MW-04b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Santa Rosa Creek HSA						
3	C	RR-SR-01	Encourage Sonoma County and the City of Santa Rosa to reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	RR-SR-01
3	C	RR-SR-02	Use land-use planning and conservation easements, from willing landowners, to reduce habitat fragmentation and improve riparian vegetation.	**Potential Lead:** Sonoma County, City of Santa Rosa **Others:** CDFG, NOAA Fisheries, Watershed Groups	Long-term/ Continual	RR-SR-01b
3	E	RR-SR-03	Evaluate, and develop solutions, to problems for coho salmon caused by channelization.	**Potential Lead:** SCWA, USACE, Sonoma County, UCCE **Others:** CDFG, NOAA Fisheries	Interim	RR-SR-02
3	D	RR-SR-04	Implement solutions to problems for coho salmon caused by channelization.	**Potential Lead:** SCWA, USACE, Sonoma County **Others:** CDFG, NOAA Fisheries, UCCE	Interim	RR-SR-02b
3	E	RR-SR-05	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	RR-SR-03
3	C	RR-SR-06	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCDs, NCRWQB, Landowners, Sonoma County **Others:** CDFG, USFWS, NOAA Fisheries	Long-term	RR-SR-03b
Forsythe Creek HSA						
2	C	RR-FO-01	Restore riparian vegetation to improve migration and summer/overwintering habitat for coho salmon.	**Potential Lead:** CDFG, Mendocino RCD, NCRWQB **Others:** Landowners, Mendocino County, USFWS, NOAA Fisheries	Interim/ Continual	RR-FO-01
2	C	RR-FO-02	Control erosion to improve migration and summer/over-wintering habitat for coho salmon.	**Potential Lead:** CDFG, Mendocino RCD, NCRWQB **Others:** Landowners, Mendocino County, USFWS, NOAA Fisheries	Interim/ Continual	RR-FO-01b
2	E	RR-FO-03	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Mendocino RCD, NCRWQB **Others:** Landowners, Mendocino County, USFWS, NOAA Fisheries	Interim	RR-FO-02
2	D	RR-FO-04	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Mendocino RCD, NCRWQB **Others:** Landowners, Mendocino County, USFWS, NOAA Fisheries	Long-term	RR-FO-02b

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Geyserville HSA						
3	C	RR-GE-01	Use land-use planning and conservation easements, from willing landowners, to maintain and improve riparian vegetation condition and water temperature.	**Potential Lead:** WCD, CDFG, Sonoma County **Others:** NOAA Fisheries, Landowners, Watershed Groups	Interim/ Continual	*RR-GE-01*
3	E	RR-GE-02	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-GE-03*
3	D	RR-GE-03	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Long-term	*RR-GE-03b*
BODEGA/MARIN COASTAL HUs						
	E	BM-HU-01	Implement BMPs for road projects maintaining environmentally sound upgrades, modifications, and new construction of road projects, including culverts and stream crossings.	**Potential Lead:** Counties, Caltrans **Others:** CDFG, NOAA Fisheries	Interim	*BM-HU-01*
	C	BM-HU-02	Support local agencies, Caltrans, and others in implementing and maintaining environmentally sound upgrades, modifications, and new construction of road projects, including culverts and stream crossings.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Counties, Caltrans	Interim	*BM-HU-01b*
	E	BM-HU-03	Continue to implement erosion control projects that were assessed and inventoried in sediment assessment plans.	**Potential Lead:** CDFG **Others:** Landowners, RCDs, Counties, NCRWQCB, NPS, DPR, CCC, USFWS, NOAA Fisheries	Interim/ Continual	*BM-HU-02*
	E	BM-HU-04	Avoid and/or minimize the adverse effects of water diversion on coho salmon by establishing: a more natural hydrograph, by-pass flows, season of diversion, and off-stream storage.	**Potential Lead:** CDFG, SWRCB **Others:** Landowners, NOAA Fisheries, USFWS	Interim	*BM-HU-03*
	C	BM-HU-05	Work with local governments to incorporate protection of coho salmon in any flood management activities.	**Potential Lead:** CDFG **Others:** Counties	Interim	*BM-HU-04*
	C	BM-HU-06	Implement performance standards in Stormwater Management Plans.	**Potential Lead:** NCRWQCB, Counties	Long-term	*BM-HU-05*
	C	BM-HU-07	Address issues of low flow on private and public lands by increasing riparian protection, restoration, and sediment control, and employing BMPs for permeability and infiltration.	**Potential Lead:** Counties, NPS, DPR, RCDs **Others:** Landowners, CDFG, NCRWQCB	Long-term	*BM-HU-06*
	C	BM-HU-08	Continue outreach, education, and enforcement related to household hazardous waste and hazardous materials spills in creeks.	**Potential Lead:** NCRWQCB, Counties	Long-term	*BM-HU-07*
	C	BM-HU-09	Encourage the cultivation and availability of locally indigenous native plants for use in restoration and bank stabilization.	**Potential Lead:** CDFG, Counties **Others:** CCC, RCDs, Watershed Groups, NPS, DPR	Long-term	*BM-HU-08*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
BODEGA/MARIN COASTAL HUs (continued)						
	E	BM-HU-10	Investigate opportunities for restoring historic runs in identified watersheds.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	*BM-HU-09*
	E	BM-HU-11	Continue to support landowners and the Marin RCD to restore riparian zones and manage livestock to increase stream protection and soil retention.	**Potential Lead:** CDFG, County **Others:** Marin RCD, Landowners	Interim/ Ongoing	*BM-HU-10*
	E	BM-HU-12	Continue sustainable land management practices and control of sediment sources in agricultural zones.	**Potential Lead:** CDFG, County **Others:** Marin RCD, Landowners	Interim/ Ongoing	*BM-HU-10a*
	C	BM-HU-13	Continue to support the active watershed groups, encouraging a focus on coho salmon restoration where appropriate.	**Potential Lead:** CDFG, RCDs, Counties	Interim/ Ongoing	*BM-HU-11*
	E	BM-HU-14	Implement coho salmon passage improvements as identified in inventories conducted by the Salmon Protection and Watershed Network (SPAWN), Taylor and Associates, Trout Unlimited and the NPS. Expand inventories as needed for a comprehensive watershed approach for coho salmon passage.	**Potential Lead:** CDFG, NOAA Fisheries, Counties **Others:** NPS, DPR, Landowners, Caltrans, USFWS, NOAA Fisheries	Interim	*BM-HU-12*
	D	BM-HU-15	County planning, public works, open space, and fire departments should continue to implement FishNet 4C priority goals for this region.	**Potential Lead:** Counties **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Interim/ Ongoing	*BM-HU-13*
	D	BM-HU-16	Enact and enforce the Marin County Streamside Conservation Area Ordinance.	**Potential Lead:** Counties **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Long-Term/ Continual	*BM-HU-13a*
	D	BM-HU-17	Adopt and implement Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004).	**Potential Lead:** Counties **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Long-Term	*BM-HU-13b*
	E	BM-HU-18	Systematically work to restore coho salmon passage at county facilities.	**Potential Lead:** Counties **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Interim	*BM-HU-13c*
	E	BM-HU-19	Address issues of sediment from roads through restoration and education.	**Potential Lead:** Counties, Caltrans **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Interim	*BM-HU-13d*
	C	BM-HU-20	Monitor the effectiveness and maintenance of watershed restoration projects and augment inventories as needed.	**Potential Lead:** CDFG, Watershed Groups, RCDs, NPS, DPR **Others:** NOAA Fisheries, NCRWCB, Landowners	Interim/ Continual	*BM-HU-14*
Salmon Creek HSA						
3	C	BM-SA-01	Coordinate efforts of involved agencies in review of plans for timber harvest and vineyard conversion.	**Potential Lead:** CDF, Sonoma County, NCRWQCB **Others:** CDFG, Landowners, Gold Ridge RCD	Interim	*BM-SA-01*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Salmon Creek HSA (continued)						
3	C	BM-SA-02	Develop standards and BMPs for agriculture to reduce pathogen, nutrient, and sediment loadings to creeks.	**Potential Lead:** CDF, Sonoma County, NCRWQCB **Others:** CDFG, Landowners, Gold Ridge RCD	Interim	*BM-SA-01b*
3	C	BM-SA-03	Implement standards and BMPs for agriculture to reduce pathogen, nutrient, and sediment loadings to creeks.	**Potential Lead:** CDF, Sonoma County, NCRWQCB **Others:** CDFG, Landowners, Gold Ridge RCD	Interim/ Continual	*BM-SA-01c*
3	E	BM-SA-04	Monitor effectiveness and maintenance of past and current watershed restoration projects. Augment surveys as necessary.	**Potential Lead:** CDFG, Gold Ridge RCD **Others:** Landowners, Sonoma County, NCRWQCB, NOAA Fisheries, USFWS	Interim/ Continual	*BM-SA-02*
3	C	BM-SA-05	Continue to fund and support landowners to restore riparian zones and manage livestock to increase stream protection and soil retention. Encourage sustainable land management practices and control sediment sources in agricultural zones.	**Potential Lead:** CDFG, CDF, Sonoma County, NCRWQCB **Others:** Landowners, Gold Ridge RCD	Interim/ Continual	*BM-SA-03*
3	E	BM-SA-06	Implement recommendations of watershed or restoration plans within the range of coho salmon and implement actions consistent with priority recommendations of the coho salmon recovery strategy.	**Potential Lead:** CDFG, Gold Ridge RCD **Others:** Landowners, Sonoma County, NCRWQCB, NOAA Fisheries, USFWS	Interim	*BM-SA-04*
3	C	BM-SA-07	Design vineyard operations to ensure adequate protection of coho salmon habitat attributes, including riparian corridors, instream flow, and water quality.	**Potential Lead:** Sonoma County **Others:** CDFG, Gold Ridge RCD, Landowners, NCRWQCB, NOAA Fisheries, USFWS	Interim	*BM-SA-05*
3	C	BM-SA-08	Assess limiting factors on coho salmon in the Salmon Creek estuary.	**Potential Lead:** CDFG, NOAA Fisheries, DPR **Others:** Sonoma County, Academia	Interim	*BM-SA-06*
Walker Creek HSA						
2	C	BM-WA-01	Address water quality and nutrient loading issues by encouraging sustainable land management practices, controlling sediment sources, protecting riparian zones and employing BMPs that encourage permeability and infiltration.	**Potential Lead:** CDFG, NCRWQCB **Others:** Marin RCD, NOAA Fisheries, Landowners, Marin County	Interim	*BM-WA-01*
2	C	BM-WA-02	Assess the water temperature regime during the summer season for three to five years to determine the role of water temperature as a limiting factor in coho salmon production.	**Potential Lead:** Marin County, Marin RCD, NCRWCB **Others:** CDFG, Landowners, Watershed Groups, NOAA Fisheries	Interim	*BM-WA-03*
2	C	BM-WA-03	Support landowners and the Marin RCD in projects to improve channel conditions and restore natural channel geomorphology, including side channels and dense contiguous riparian vegetation.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups, Marin RCD, Landowners, NCRWQCB, Marin County	Interim/ Continual	*BM-WA-04*
2	C	BM-WA-04	Implement high priority coho salmon enhancement projects for the reduction of sediment delivery and the restoration of riparian corridors as listed in the Walker Creek Enhancement Plan (2001).	**Potential Lead:** CDFG, NCRWQCB **Others:** Watershed Groups, Marin RCD, NOAA Fisheries, Landowners, Marin County	Interim	*BM-WA-05*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Walker Creek HSA (continued)						
2	c	BM-WA-05	Look for opportunities to increase LWD retention and recruitment.	**Potential Lead:** Marin RCD, Watershed Groups, CDFG **Others:** NOAA Fisheries, Landowners, NCRWQCB, Marin County/MMWD	Interim	*BM-WA-07*
2	C	BM-WA-06	Continue to assess the release of water from Soulejule Reservoir to develop the optimum release for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, NCRWCB, **Others:** CDFG, Marin County/MMWD	Interim/ Ongoing	*BM-WA-07*
2	C	BM-WA-07	Support a coho salmon limiting factors assessment in Keys Estero and Tomales Bay.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD	Interim	*BM-WA-08*
Lagunitas Creek HSA						
5	E	BM-LA-01	Use recommendations of existing sediment source surveys to restore habitat of coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD **Others:** NPS, DPR, Landowners, Marin RCD	Interim	*BM-LA-01*
5	E	BM-LA-02	Expand inventories as needed for a comprehensive watershed approach for coho salmon passage.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD **Others:** NPS, DPR, Landowners, Marin RCD	Interim	*BM-LA-01a*
5	D	BM-LA-03	Coordinate with appropriate agencies to restore coho salmon passage at barriers identified by Ross Taylor, SPAWN, and others.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD **Others:** Landowners, Marin RCD, SPAWN, NPS, DPR, Caltrans	Interim	*BM-LA-03*
5	D	BM-LA-04	Complete any needed surveys of migration barriers that were not Identified by Ross Taylor, SPAWN, and others.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD **Others:** Landowners, Marin RCD, SPAWN, NPS, DPR, Caltrans	Interim	*BM-LA-03b*
5	C	BM-LA-05	Investigate opportunities for restoring historic runs of coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	*BM-LA-04*
5	C	BM-LA-06	Continue ongoing efforts and support of stewardship in the basin to include riparian enhancement and protection, sediment source reduction, habitat typing and surveying, coho salmon surveys and counts, water conservation, outreach and education, effectiveness monitoring of projects, and planning and assessment of potential restoration projects to benefit coho salmon.	**Potential Lead:** CDFG, SWRCB **Others:** MMWD	Interim	*BM-LA-05*
5	C	BM-LA-07	Provide incentives for septic inspection, repair, and replacement to reduce aquatic pollution.	**Potential Lead:** Marin County, NCRWQCB **Others:** Landowners, CDFG	Interim	*BM-LA-06*
5	C	BM-LA-08	Assess and evaluate habitat restoration actions in Nicasio Creek.	**Potential Lead:** CDFG, SWRCB, Marin County/MMWD **Others:** Landowners, Marin RCD	Interim	*BM-LA-07*
5	C	BM-LA-09	Implement habitat restoration actions in Nicasio Creek.	**Potential Lead:** CDFG, SWRCB, Marin County/MMWD **Others:** Landowners, Marin RCD	Interim	*BM-LA-07a*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Lagunitas Creek HSA (continued)						
5	C	BM-LA-10	Develop a monitoring and assessment program for the estuarine reaches of Lagunitas Creek and inter-tidal reaches of Tomales Bay, looking at impacts to coho salmon rearing and emigration.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Landowners, NPS, DPR, Academia	Interim/ Continual	*BM-LA-08*
5	C	BM-LA-11	Restore Olema Marsh, Bear Valley Creek, and the mouth of Olema Creek, to benefit coho salmon. The restoration should provide rearing habitat refuge during high flows, habitat protection, and hydrologic connectivity between marshes.	**Potential Lead:** NPS, CDFG **Others:** Landowners, Marin RCD	Long-term	*BM-LA-09*
5	D	BM-LA-12	Work with private landowners to encourage biotechnical bank stabilization, riparian protections, woody debris retention, and timing of water withdrawals to help protect coho salmon.	**Potential Lead:** Marin RCD, Marin County, CDFG **Others:** Landowners, NPS, DPR	Long-term/ Continual	*BM-LA-11*
5	C	BM-LA-13	In the San Geronimo Creek sub-watershed, continue public outreach and education for private landowners, residents, commercial, public utility and county workers regarding best management practices to control erosion, protect riparian vegetation, retain LWD, and minimize disturbance to coho salmon from domestic animals.	**Potential Lead:** Marin RCD, Marin County, Watershed Groups **Others:** SPAWN, Landowners	Long-term	*BM-LA-12*
5	D	BM-LA-14	In the San Geronimo Creek sub-watershed, work with stock pond owners to remove non-native fish species where they are a threat to coho salmon.	**Potential Lead:** Watershed Groups, CDFG, Marin RCD	Long-term/ Continual	*BM-LA-13*
5	D	BM-LA-15	Marin County should develop a policy for reviewing the impacts of new development projects and how new well construction effects the streams. The County should consider adopting recommendations for well developments from the local coastal plan.	**Potential Lead:** Marin County **Others:** Landowners, CDFG, SWRCB	Interim	*BM-LA-14*
5	C	BM-LA-16	Recommend the NPS continue practices to benefit coho salmon, which include restoration projects, sediment control projects, locating fences out of riparian zones, repairing headcut gullies as possible, and implementing rotational grazing in locations to minimize erosion and impacts to the creek.	**Potential Lead:** NOAA Fisheries **Others:** CDFG, NPS	Interim/ Ongoing	*BM-LA-15*
5	C	BM-LA-17	Continue to implement and coordinate the the Watershed Protection Agreement Program for additional water hook-ups in Nicasio and San Geronimo creek watersheds.	**Potential Lead:** Marin MMWD, County **Others:** NOAA Fisheries, CDFG	Interim	*BM-LA-16*
5	C	BM-LA-18	Look for opportunities to restore natural channel form and function in the upper watershed to protect summer flows into San Geronimo Creek.	**Potential Lead:** Marin County, CDFG **Others:** Landowners, NPS, DPR, NOAA Fisheries, USFWS	Interim	*BM-LA-17*
5	C	BM-LA-19	Continue riparian protection and sediment control projects with a focus on working with landowners to manage livestock to protect riparian areas, and to implement erosion control projects on State and Federal park and private lands (e.g., Devil's Gulch).	**Potential Lead:** DPR, NPS **Others:** Landowners, CDFG, NOAA Fisheries	Interim/ Ongoing	*BM-LA-18*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Lagunitas Creek HSA (continued)						
5	C	BM-LA-20	Continue public outreach and education for private landowners, residents, commercial, public utility and county workers regarding best management practices to control erosion, protect riparian vegetation, retain woody debris, and minimize disturbance to coho salmon from pets.	**Potential Lead:** CDFG, Watershed Groups **Others:** County	Interim/ Continual	*BM-LA-21*
5	C	BM-LA-21	Determine policy for reviewing new development projects and well construction. Consider adopting recommendations for well developments from the Coastal Plan.	**Potential Lead:** CDFG, County, Watershed Groups	Interim	*BM-LA-23*
Bolinas HSA						
5	E	BM-BO-01	Implement recommendations of completed sediment source surveys and supplement surveys as necessary.	**Potential Lead:** Marin County, CDFG, Marin RCD **Others:** NPS, DPR, Landowners, USFWS, NOAA Fisheries	Long-term	*BM-BO-01*
5	D	BM-BO-02	Continue restoration efforts on Bolinas and Big lagoons to benefit coho salmon during all life phases and seasons.	**Potential Lead:** NPS **Others:** CDFG, Marin County, Landowners, NOAA Fisheries, USFWS	Interim/ Ongoing	*BM-BO-02*
5	E	BM-BO-03	Work with landowners through outreach and education and appropriate agencies to manage summer flows for coho salmon, on a watershed basis. Provide support and incentives to protect both fisheries flows and agriculture by timing of withdrawals, construction of off-site storage facilities, water conservation practices, and riparian zone protections. Conduct outreach and education for landowners on these practices.	**Potential Lead:** SWRCB, CDFG, NOAA Fisheries **Others:** Watershed Groups	Interim	*BM-BO-03*
5	C	BM-BO-04	Look for opportunities to increase LWD recruitment and retention.	**Potential Lead:** CDFG	Long-term	*BM-BO-04*
5	C	BM-BO-05	Provide incentives for septic inspection, repair and replacement to improve water quality in both streams and lagoons.	**Potential Lead:** Marin County, NCRWQCB	Long-term	*BM-BO-05*
5	C	BM-BO-06	Encourage the National Park Service to provide additional space for Stinson Beach Water District for off-stream storage to protect coho salmon in Easkoot Creek.	**Potential Lead:** NOAA Fisheries, Stinson Beach Water District **Others:** CDFG, SWRCB, Marin County, USFWS	Interim	*BM-BO-06*
5	D	BM-BO-07	Identify and prioritize coho salmon passage barriers in the Redwood Creek drainage.	**Potential Lead:** DPR, County **Others:** CDFG	Interim	*BM-BO-07*
5	D	BM-BO-08	Treat coho salmon passage barriers in the Redwood Creek drainage.	**Potential Lead:** DPR, County **Others:** CDFG	Interim	*BM-BO-07b*
5	C	BM-BO-09	Identify and prioritize problems related to roads and trails in these watersheds, including location of trails and access for construction and maintenance of roads and trails.	**Potential Lead:** NPS **Others:** DPR, CDFG, NOAA Fisheries, USFWS	Long-term	*BM-BO-08*
5	C	BM-BO-10	Treat problems related to roads and trails in these watersheds, including location of trails and access for construction and maintenance of roads and trails.	**Potential Lead:** NPS **Others:** DPR, CDFG, NOAA Fisheries, USFWS	Long-term	*BM-BO-08b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SAN FRANCISCO BAY AREA HU						
	C	SF-HU-01	Include coho salmon in habitat suitability evaluations in the San Francisco Bay Area.	**Potential Lead:** CDFG **Others:** Counties, Watershed Groups, NOAA Fisheries, Landowners	Long-term	*SF-HU-01*
	C	SF-HU-02	Where appropriate, apply range-wide recommendations to suitable streams in the San Francisco Bay.	**Potential Lead:** CDFG, Counties, NOAA Fisheries	Long-term	*SF-HU-02*
San Rafael HSA						
2	C	SF-SR-01	Work to restore coho salmon habitat, especially in Arroyo Corte Madera del Presidio and Corte Madera Creek.	**Potential Lead:** Marin County, Watershed Groups, CDFG **Others:** Landowners, NOAA Fisheries, USACE	Long-term	*SF-SR-01*
SAN MATEO HU						
	E	SM-HU-01	Reduce the effects of water diversions, by assisting the SWRCB's coordination with other agencies in addressing season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and natural hydrograph.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners, USFS, RWQCB, Watershed Groups	Interim	*SM-HU-02*
	D	SM-HU-02	Develop legislation that will fund county planning for environmentally sound growth and water supply. Work in coordination with the California Department of Housing and Community Development (CDHCD), Association of Bay Area Governments (ABAG), and other government associations.	**Potential Lead:** CDFG **Others:** Counties, CDHCD, ABAG, RWQCB, Landowners, Watershed Groups, NOAA Fisheries	Long-term	*SM-HU-03*
	C	SM-HU-03	Continue to protect riparian zones on streams inhabited by coho salmon within the coastal zone according to the local coastal plan and THP prescriptions.	**Potential Lead:** Counties **Others:** CDFG, CDF, Landowners, Watershed Groups, Caltrans, NOAA Fisheries, RWQCB	Interim	*SM-HU-04*
	C	SM-HU-04	Evaluate the need to apply coastal zone protections to streams inhabited by coho salmon that are not in the coastal zone.	**Potential Lead:** Counties **Others:** CDFG, CDF	Interim	*SM-HU-04b*
	C	SM-HU-05	Develop written standards for routine operations and maintenance.	**Potential Lead:** Counties **Others:** CDFG, CDF	Interim	*SM-HU-04c*
	C	SM-HU-06	Implement written standards for routine operations and maintenance, and train staff in best management practices.	**Potential Lead:** Counties **Others:** CDFG, CDF	Interim	*SM-HU-04d*
	D	SM-HU-07	Assess and prioritize coho salmon passage barriers to coho salmon habitat.	**Potential Lead:** Counties, CDFG	Interim	*SM-HU-04e*
	D	SM-HU-08	Restore coho salmon passage to coho salmon habitat by using the prioritized list.	**Potential Lead:** Counties, CDFG	Interim	*SM-HU-04f*
	D	SM-HU-09	Conduct road assessments and address issues of sedimentation from county public works and parks roads and trails.	**Potential Lead:** Counties, DPR **Others:** CDFG	Interim	*SM-HU-04g*
	C	SM-HU-10	Promote alternatives to conventional bank stabilization for public and private projects.	**Potential Lead:** Counties, CDFG **Others:** Landowners	Interim	*SM-HU-04h*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SAN MATEO HU (continued)						
	C	SM-HU-11	Establish adequate spoils storage sites throughout the counties so that material from landslides and road maintenance can be stored safely away from streams inhabited by coho salmon. Coordinate these efforts with Caltrans.	**Potential Lead:** Caltrans, Counties **Others:** CDFG	Interim	*SM-HU-04i*
	C	SM-HU-12	Work to increase county enforcement of permit conditions and erosion control plans on development.	**Potential Lead:** Counties, CDFG **Others:** NOAA Fisheries	Interim	*SM-HU-04j*
	C	SM-HU-13	Support continued economically sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development.	**Potential Lead:** CDF, Landowners **Others:** CDFG, BLM NPS, Watershed Groups	Interim	*SM-HU-05*
San Gregorio Creek and Pescadero Creek HSAs						
4	E	SM-SG-01	Minimize take attributable to diversion of stream flow through alternatives, such as the operation of off-stream reservoirs, development of infrastructure necessary for conjunctive use of stream flow, and use of desalinated ocean water.	**Potential Lead:** RWQCB **Others:** CDFG, Landowners, Watershed Groups, Counties	Interim	*SM-SG-01*
4	D	SM-SG-02	Conduct a watershed assessment in San Gregorio Creek that addresses impacts to coho salmon.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners	Interim	*SM-SG-02*
4	E	SM-SG-03	Conduct a comprehensive assessment of watershed processes (e.g., hydrology, geology, fluvial-geomorphology, water quality, and vegetation), instream habitat, and factors limiting coho salmon production.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners	Interim	*SM-SG-03*
4	D	SM-SG-04	Use the assessment results to develop a plan for restoration of coho salmon passage, instream habitat, and upslope erosion control, for implementation by cooperating landowners/managers.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners	Interim	*SM-SG-03b*
4	C	SM-SG-05	Implement BMPs designed to reduce erosion and sediment from roads into instream habitat (e.g., practices described in the California Salmonid Stream Habitat Restoration Manual).	**Potential Lead:** Landowners, County **Others:** CDFG, Caltrans, Watershed Groups	Interim	*SM-SG-04*
4	D	SM-SG-06	Improve riparian areas by implementing BMPs designed to reduce bank erosion, water temperature, and the removal of LWD. These BMPs should include livestock exclusion fencing, reclamation and reconstruction of flood plain, and active revegetation.	**Potential Lead:** CDFG **Others:** Cattlemen's Association, Farm Bureau, Landowners, Watershed Groups, Counties, RWQCB	Interim	*SM-SG-05*
4	E	SM-SG-07	Encourage funding authorities to allocate adequate resources to prioritize and upgrade culverts to provide fish passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g. LWD that might be mobilized).	**Potential Lead:** Federal, State, Local, and Tribal Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Interim	*SM-SG-06*
4	E	SM-SG-08	Request that the SWRCB declare critical tributaries to San Gregorio and Pescadero creeks fully appropriated during summer and fall months.	**Potential Lead:** CDFG **Others:** SWRCB, RWQCB	Interim	*SM-SG-07*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
A o Nuevo (Gazos Creek) HSA						
5	D	SM-AN-01	Implement the projects recommended as high priority for coho salmon in the Gazos Creek watershed restoration plan.	**Potential Lead:** CDFG, Watershed Groups, Counties	Interim	*SM-AN-01*
BIG BASIN HU						
	E	BB-HU-01	Continue to operate MBSTP Kingfisher Flat Hatchery as a conservation hatchery, following the guidelines of the Department and NOAA Fisheries.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups, Counties, Landowners	Interim/ Ongoing	*BB-HU-01*
	C	BB-HU-02	Provide education and training on water diversion practices to facilitate compliance.	**Potential Lead:** CDFG **Others:** Watershed Groups	Interim/ Continual	*BB-HU-02*
	E	BB-HU-03	Assess and prioritize culverts to provide coho salmon passage within the range of coho salmon, and to pass expected high flow debris loads (e.g. mobilized LWD).	**Potential Lead:** County **Others:** CDFG	Interim	*BB-HU-03*
	D	BB-HU-04	Allocate adequate resources to prioritize and upgrade culverts providing coho salmon passage within the range of coho salmon and to pass expected high flow debris loads (e.g. mobilized LWD).	**Potential Lead:** County, CDFG **Others:** NOAA Fisheries	Interim	*BB-HU-03b*
	E	BB-HU-05	Develop and apply bypass stream flow requirements on all existing and future structures in streams inhabited by coho salmon.	**Potential Lead:** CDFG **Others:** SWQCB, Landowners, CDF, Caltrans, Watershed Groups	Interim/ Continual	*BB-HU-04*
	D	BB-HU-06	Implement the highest priority restoration projects in the watershed plans that address coho salmon habitat. Adjust on-going efforts based on results.	**Others:** CDFG, Watershed Groups, Counties, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim/ Continual	*BB-HU-05*
	D	BB-HU-07	Complete a broad conjunctive use feasibility study focusing on creative ways of managing existing surface and groundwater resources in Santa Cruz County, with the intent to increase base flow at critical times.	**Potential Lead:** CDFG, SWQCB **Others:** Water Districts, Counties, Landowners, Watershed Groups	Interim	*BB-HU-06*
	C	BB-HU-08	Develop a lagoon management plan that addresses the needs of coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, SWQCB, Academia, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim	*BB-HU-07*
	C	BB-HU-09	Implement the lagoon management plan that addresses the needs of coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, RWQCB, Academia, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim	*BB-HU-07b*
Davenport HSA						
5	E	BB-DA-01	Work with the SWRCB to develop and enforce stream flow bypass requirements for diversions in Waddell Creek, mainstem Scott Creek, Big Creek, Mill Creek, and San Vicente Creek.	**Potential Lead:** CDFG, SWRCB **Others:** Watershed Groups, Landowners	Interim/ Long-term	*BB-DA-01*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Davenport HSA (continued)						
5	E	BB-DA-02	Petition the SWRCB to declare Scott Creek and San Vicente Creek fully appropriated during summer and fall months.	**Potential Lead:** CDFG **Others:** SWRCB	Interim	*BB-DA-02*
5	D	BB-DA-03	Improve riparian vegetation by implementing established BMPs designed to reduce bank erosion, temperature, and removal of LWD; also include livestock fencing where needed, reclamation or reconstruction of flood plains, and active revegetation (this recommendation applies especially to Scott Creek).	**Potential Lead:** CDFG **Others:** Cattlemen, Farm Bureau, Landowners, Watershed Groups, Counties, RWQCB, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim/ Continual	*BB-DA-03*
5	C	BB-DA-04	Reduce sediment from road erosion using established BMPs (this recommendation applies especially to Scott Creek).	**Potential Lead:** Counties, Caltrans **Others:** CDFG, Watershed Groups, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim/ Continual	*BB-DA-04*
5	C	BB-DA-05	Investigate suspect log jams in Waddell Creek to determine if passage issues for coho salmon exist and should be modified if absolutely necessary.	**Potential Lead:** CDFG, DPR **Others:** Watershed Groups, CCC, Counties, Landowners	Interim	*BB-DA-05*
5	C	BB-DA-06	Develop a log-jam management plan.	**Potential Lead:** DPR	Interim	*BB-DA-05b*
5	D	BB-DA-07	Develop stream flow bypass requirements for diversions on the mainstem San Vicente and Mill creeks.	**Potential Lead:** CDFG, SWQCB **Others:** Watershed Groups	Interim	*BB-DA-07*
5	D	BB-DA-08	Implement stream flow bypass requirements for diversions on the mainstem San Vicente and Mill creeks.	**Potential Lead:** CDFG, SWQCB **Others:** Watershed Groups	Interim	*BB-DA-07b*
5	D	BB-DA-09	Enforce stream flow bypass requirements for diversions on the mainstem San Vicente and Mill creeks.	**Potential Lead:** SWQCB, CDFG **Others:** Landowners	Interim	*BB-DA-07c*
San Lorenzo River HSA						
3	C	BB-SL-01	Reduce sediment from road erosion using established BMPs accounting for public safety standards; this applies especially to San Lorenzo River.	**Potential Lead:** Counties, Caltrans **Others:** CDFG, Watershed Groups, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim	*BB-SL-01*
3	E	BB-SL-02	Develop and enforce stream flow bypass requirements for diversions in the San Lorenzo River and its tributaries Zayante, Fall, Bear, Boulder, and Branciforte creeks.	**Potential Lead:** CDFG, SWRCB **Others:** Watershed Groups, Landowners	Interim	*BB-SL-02*
3	D	BB-SL-03	Evaluate the Felton Diversion Dam for impacts to coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups	Interim	*BB-SL-03*
3	C	BB-SL-04	Improve adult coho salmon passage at locations named in the San Lorenzo River Enhancement Plan, the Santa Cruz Road Crossing and Salmonid Passage Assessment (Taylor 2003) and those identified by the Department as being problematic.	**Potential Lead:** CDFG, Counties, FishNet 4C, Watershed Groups, Landowners, Caltrans	Interim	*BB-SL-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
San Lorenzo River HSA (continued)						
3	C	BB-SL-05	Implement the portions of the San Lorenzo River Enhancement Plan, and the areas identified as problematic by the Department that are consistent with the coho salmon recovery strategy.	**Potential Lead:** CDFG, Counties, FishNet 4C, Watershed Groups, Landowners, Caltrans	Interim	*BB-SL-04b*
Aptos-Soquel HSA						
3	E	BB-AP-01	Implement elements of the Soquel Creek Watershed Assessment and Enhancement Project Plan that are consistent with the coho salmon recovery strategy. Specifically focusing on preservation of base flow, restoration of flood plains, improvements to coho salmon passage, BMPs to reduce sedimentation of instream habitat.	**Potential Lead:** Counties, Landowners, Santa Cruz County RCD, Coastal Conservancy **Others:** CDFG, FishNet 4C, Watershed Groups, Caltrans,	Interim/ Continual	*BB-AP-01*
3	E	BB-AP-02	Maintain year round instream flows for coho salmon by amendments to the adjudication, water conservation, shallow recharge opportunities, shallow-well gauging, deep-well gauging, stream-gauging, self-monitoring of diversions, and conjunctive water management for recovery of groundwater levels.	**Potential Lead:** CDFG **Others:** SWQCB, Watershed Groups, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim/ Continual	*BB-AP-02*

10 Shasta-Scott Pilot Program

In accordance with the direction of the Commission, the Department established the Shasta-Scott Pilot Program (SSPP) to address coho salmon recovery issues associated with agriculture and agricultural water use in the Shasta and Scott river valleys in Siskiyou County (i.e., Shasta Valley and Scott River recovery units), and established the Shasta-Scott Recovery Team (SSRT) to advise the Department on these issues. All other issues within these two recovery units were addressed by the CRT. Both the SSRT and CRT aided the Department in the development of the Pilot Program.

10.1 FRAMEWORK FOR AGRICULTURAL ISSUES

The SSRT has reached preliminary agreement on the recommendations included in the Pilot Program. However, the SSRT intends to consider the recommendations in another round of review before finalizing the recommendations. The SSRT also intends to establish the framework for an implementation and permitting strategy (including appropriate Streambed Alteration Agreements and Incidental Take Permits).

Recommendations addressing agriculture and agricultural water use in the Shasta and Scott river valleys were developed in eight action categories. Recommendations for implementation and administration are introduced in Section 10.2. Recommendations for the following seven categories are presented in Section 10.3:

1. *Water Management.* Recommendations in this category include the following topics: preparation of a Dry Year Water Plan, verification of water use and water rights, ramped flows for diversions, pulse flows, interim instream flows, irrigation rotation, installation and maintenance of headgates and measuring devices for diversions, better water forecasting, groundwater studies, and instream flow/habitat/temperature modeling studies.
2. *Water Augmentation.* Recommendation topics are formation of water trusts, development of additional surface water storage, small storage opportunities, conjunctive groundwater use, conveyance from the main Klamath, as well as buying or leasing water rights.
3. *Habitat Management.* These recommendations are presented separately for the two watersheds.
   a. Scott River. Recommendations for habitat management focus on improvement of rearing habitat (habitat restoration, flow connectivity, temperature), valley and low-gradient tributary channel structure and function, fish passage (low flow, structures at private road crossings, remediation of mine tailings), and spawning gravels.
   b. Shasta Valley. Recommendations address rearing habitat (identification of current rearing habitat and efforts to maintain it; enhancement of rearing habitat; identification and remediation of various dams and impoundments, high temperatures, and structures at road crossings that are barriers to fish passage), management of spawning gravel, management of riparian vegetation, and water temperatures.

4. *Water Use Efficiency.* Topics in this category include development of alternative stock water systems, workshops in water use efficiency for landowners, ditch lining and piping, ditch repair and cleaning, irrigation system efficiency, cropping changes, tailwater reclamation, BMPs, and implementing the California Irrigation Management Information System (CIMIS) program in the two watersheds.
5. *Protection.* This category includes screening diversions and screen maintenance, protection of riparian zones, fish rescue, and barrier removal.
6. *Assessment and Monitoring.* The recommendations are presented in two categories: habitat monitoring and fish population monitoring. The goals are to collect data that will be needed for both the Federal and State recovery programs as they evaluate progress toward recovery and to support an adaptive management program for the measures in the other categories. One key issue is obtaining access from landowners.
7. *Education and Outreach.* Education efforts will target not only landowners, but also legislators (Federal, State, and local), and local schools. Handbooks, newsletters, a website, active engagement with the local press, demonstration projects, and special events are proposed.

10.2 ADMINISTRATION AND IMPLEMENTATION

Acceptance of the SSPP by the local agricultural community is inextricably linked to development of a programmatic implementation framework which covers normal ranching and farming activities consistent with the Pilot Program. The Department is committed to working with the SSRT to develop this framework. This framework should include necessary Streambed Alteration Agreements for water diversion and other instream work, as well as coverage for any unavoidable incidental take of coho salmon or other listed species.

The implementation schedule is dependent on funding. Quantitative estimates of both the fiscal cost and socioeconomic impacts of implementing the SSPP have been developed in conjunction with the economic analysis presented in Chapter 11. For a more detailed analysis, refer to the complete economic report in Appendix I.

Historically, funding for salmon restoration has been available from a variety of sources including State and Federal agencies and from various restoration grant opportunities with cost sharing by local landowners. The current economic downturn and State budget crisis could jeopardize funding from one or more of these sources. The Department recognizes that adequate funding is essential to successful implementation of the Pilot Program.

The Department is committed to working with the SSRT, other State and Federal agencies, and with various interest groups to ensure the SSPP is implemented in an economically reasonable manner with an equitable apportionment of public and private obligations. The Department continues to believe that an incentive-based approach to implementation is the most viable option for agricultural areas of the Shasta and Scott valleys.

10.3 SHASTA-SCOTT RECOMMENDATIONS AND IMPLEMENTATION SCHEDULE

The recommendations developed by the SSRT[1] to deal with agricultural water and land-use issues are presented in seven solution categories. They are water management, water augmentation, habitat management, water use efficiency, protection, assessment and monitoring, and education and outreach (Table 10-1). Brief issue and solution statements that provide context are provided within the list of recommendations.

[1] The SSRT has reached conceptual agreement (termed "preliminary favorable regard") on the recommendations within the first seven action areas. This is a status short of "final approval." The SSRT intends to continue its work following approval of the Recovery Strategy and pursue the establishment of an implementation and permitting framework necessary to allow their final approval of the recommendations.

TABLE 10-1: Recovery recommendations and implementation schedule for the Shasta-Scott Pilot Program

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT — SHASTA VALLEY HSA, SCOTT BAR HSA, AND SCOTT VALLEY HSA						
WATER MANAGEMENT: DRY YEAR WATER PLAN						
ISSUES:	Low instream flows, especially in drought and dry years, limit habitat for coho salmon and other salmonids. There are no comprehensive plans to deal with supplying instream flows for coho salmon.					
SOLUTIONS:	Develop a comprehensive, community-based plan that identifies progressive steps to take to obtain, manage, or deal with low water conditions in advance of the event.					
4	E	WM-1a	Ask Scott River Watershed Council (SRWC) to develop a Dry Year Water Plan for the Scott. Components would include predetermined funding and prioritized actions for implementation, with identification of who, what, where, when, and how. **Short-term:** Seek funding and proceed with plan development. **Long-term:** Use plan to coordinate actions during low-water periods. Plan will define "low-water."	SRWC, Siskiyou RCD, CDFG, DWR	Interim	$40,000.
4	E	WM-1b	Ask the Shasta Coordinated Resources Management Planning (CRMP) to develop a Dry Year Water Plan for the Shasta. Components would include predetermined funding and prioritized actions for implementation, with identification of who, what, where, when, and how. **Short-term:** Seek funding and proceed with plan development. **Long-term:** Use plan to coordinate actions during low water periods. Plan will define "low-water."	CRMP, Shasta Valley RCD, CDFG, DWR	Interim	$40,000.
WATER MANAGEMENT: VERIFICATION OF WATER DIVERSIONS WITH WATER RIGHTS						
ISSUES:	Currently the Shasta River and five creeks in the Scott Watershed are under State Watermaster Service. The main Scott River and other tributaries, while under decree, are not under either State or private watermaster service. Watermasters allocate and manage water diversions so that each diverter receives water according to his or her right as defined in the decree. In the non-watermastered areas, diverters may not be diverting their correct allotment and there is no verification that diverters are correctly following their adjudicated right; if diverters are taking more than their right, it may be impacting instream flows, coho salmon habitat, and water-right holders.					
SOLUTIONS:	Careful management and verification of diversion amounts according to existing decrees may increase flows. Recent DWR efforts to more precisely manage diversions on the watermastered streams have produced prolonged higher instream flows in the summer season. Watermasters also are able to manage volunteered or dedicated instream flows.					
4	E	WM-2a	Add additional oversight and provide more people to verify water use and better manage water in current watermaster service areas (Shasta and Scott). **Short-term:** Seek and support additional funding and authorization to add one additional person to work in the area already watermastered by DWR. Include verification data in the annual report. **Long-term:** Continue oversight and verification and improve as necessary.	DWR, RCDs	Interim/ Continual	$350,000- $500,000 per yr.
4	D	WM-2b	Work with diverters covered by the Scott River Decree to confirm they know exactly their rights. **Short-term:** Hold voluntary one-on-one meetings with diverters and conduct a diverters' workshop for each schedule. **Long-term:** Continue periodic diverters' workshops.	DWR, SWRCB	Interim/ Continual	$20,000.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: VERIFICATION OF WATER DIVERSIONS WITH WATER RIGHTS (continued)						
ISSUES:	Lack of prediction of water-year type limits opportunities for water management. Lack of short-term predictions similarly constrains planning for mid-season water use.					
SOLUTIONS:	Forecasting stream flows for the water year based on snow surveys, precipitation, and aquifer condition within the season could aid water management techniques, such as irrigation rotation and harvesting, and thereby provide additional instream flows and habitat.					
4	E	WM-2c	Provide assistance for voluntary flow measurement of current non-watermastered diversions on the Scott. **Short-term:** DWR staff can continue to provide service as needed. DWR can train others (SRWC, RCD staff) on flow measuring techniques. **Long-term:** Continue to provide service and training as needed.	DWR, SRWC, Siskiyou RCD	Interim/ Ongoing	$20,000.
4	E	WM-2d	Verify compliance with water rights as contained in the Scott River Decree using a phased implementation period for currently un-watermastered areas. 100 percent verification is the goal. **Short-term:** 1. During 2003 and early 2004, diverters on a given reach will choose to have usage verified under one of the following options: a. Independent and accountable private watermaster, who coordinates with DWR; b. Allow DWR to access sites for compliance (individual); c. Watermaster by DWR with no fee; or d. Other mechanisms to be determined. 2. After 7/1/04, DWR will assess and report on the adequacy of the verification efforts. If sufficient, continue. If not sufficient (not enough volunteers or inadequate results), solicit water users for adoption of Watermaster Service. (Fifteen percent of the diverters within the decree can request State Watermaster Service.)	DWR, Siskiyou County, SRWC, Siskiyou RCD	Interim/ Continual	$250,000/yr (approximate cost of two additional watermasters).
WATER MANAGEMENT: RAMPED FLOWS FOR DIVERSIONS						
ISSUES:	Especially at the beginning of the irrigation season, a significant number of irrigators often begin diverting at the same time. This action may severely lower water levels almost instantaneously, causing fish stranding or other impacts.					
SOLUTIONS:	Institute a cooperative agreement between diverters to stage their irrigation starts and completions to gradually change flows over several days.					
4	D	WM-3a	On the Shasta River, through Shasta CRMP, DWR and irrigators' cooperation, establish a voluntary program to stagger or rotate irrigation starts and completions (ramped flows). Monitor success. **Short-term:** Continue and expand this effort. **Long-term:** Continue appropriate implementation, monitor and adaptively manage. Develop a long-term plan for implementation.	DWR, CDFG, Shasta Valley RCD, CRMP	Interim/ Ongoing	Little or no incremental cost.
4	C	WM-3b	On the Scott River, investigate if ramping would be beneficial or necessary. **Short-term:** Survey water users, CDFG, and watermaster staff. Publish results. Begin implementation if appropriate. **Long-term:** Continue appropriate implementation. Monitor and adaptively manage. Develop a long-term plan for implementation.	SRWC, Siskiyou RCD, DWR, CDFG	Interim/ Continual	$20,000.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: PULSE FLOWS						
ISSUES: Juvenile outmigrants or other life stages may have difficulty migrating during some periods.						
SOLUTIONS: Produce a pulse of flow, which will aid in migration.						
4	D	WM-4a	On the Shasta River, the CRMP and CDFG, through voluntary participation and compensation, develop an agreement under which landowners pull diversions for a limited period to allow a resulting pulse flow to travel downstream. **Short-term:** On the Shasta River, implement voluntary program among diverters to create pulse flows; augment with cost funding as needed. Monitor both flow and fish distribution results. Integrate findings of flow-temperature model in planning. Establish a monitoring protocol. **Long-term:** Reduce and eliminate barriers and water quality problems that create need for it in the first place. Integrate this effort with TMDL process.	CRMP, Shasta Valley RCD, DWR, CDFG, NCRWQCB	Interim/ Ongoing	$3,000/yr.
4	C	WM-4b	On the Scott River, CDFG should research with the SRWC and RCD to determine if some streams could benefit from a pulse flow. **Short-term:** Implement research recommendations.	CDFG, SRWC, Siskiyou RCD	Interim/ Ongoing	$20,000.
WATER MANAGEMENT: USING UNUSED WATER AND WATER RIGHTS FOR INSTREAM FISH FLOWS						
ISSUES: Low instream flows limit habitat for coho salmon and other salmonids.						
SOLUTIONS: Some water rights are currently not being exercised under existing decrees. Work within the water rights process to allow water rights holders to temporarily dedicate currently unused rights to instream flow.						
4	E	WM-5a	DWR and SWRCB should outline the procedure for developing instream flow dedications and develop incentives for acquiring instream flow. **Short-term:** Watermasters will continue and expand opportunities to help manage flows on some streams; develop an informational report to describe the process and incentives; identify potential for future measures; and develop guidelines to protect water users, inform funders, and ensure that water is used for instream flows.	DWR, SWRCB	Interim/ Continual	See text regarding instream flow.
4	D	WM-5b	On the Scott River, SRWC and DWR should determine unused diversion rights and approach those diverters about providing flows for instream use without affecting the water rights of others. **Short-term:** Once agreements are reached, work to inform other downstream users as to water amounts to be left in the stream. Oversee and shepherd those flows. **Long-term:** Acquire flows for permanent dedication.	SRWC, Siskiyou RCD, DWR, CDFG	Interim/ Ongoing	Little or no incremental cost.
4	D	WM-5c	On the Shasta River, the CRMP and DWR should determine unused diversion rights and approach those diverters about providing flows for instream use without affecting the water rights of others. **Short-term:** Once agreements are reached, work to inform other downstream users as to water amounts to be left in the stream. Oversee and shepherd those flows. **Long-term:** Acquire flow for permanent dedication. Include options for Dwinnell, Greenhorn, and other storage reservoirs.	CRMP, DWR, CDFG	Interim/ Ongoing	$50,000 for study. See text regarding instream flow.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: IRRIGATION ROTATION PROGRAM						
ISSUES: Low instream flows limit habitat for coho salmon and other salmonids and inhibit movement of coho salmon juveniles to secure rearing habitat.						
SOLUTIONS: For certain stream and river reaches, diverters could rotate irrigations so not all users are on line at the same time when flows are critical for fish. This would leave additional flow in the stream to maintain or enhance habitat at critical times.						
4	D	WM-6a	Within watermastered areas, DWR watermasters could work closely with irrigators to develop creative water management techniques to benefit coho salmon. Develop incentives. Focus on key areas. **Short-term:** CDFG should identify critical habitat reaches and times that might benefit from this activity. DWR should continue pilot program. On the Shasta River, demand on river is variable and coordination among users might help avoid accidental problems.	DWR, Shasta Valley RCD	Interim/ Ongoing	Little or no incremental cost.
4	D	WM-6b	On non-watermastered reaches of the Scott River HA, develop a test rotation program with tributary groups. **Short-term:** Contact various tributary or ditch groups to assess willingness and difficulty. Execute pilot program. Write up results. **Long-term:** Continue to work with groups on irrigation coordination and other water management; expand as warranted.	SRWC, Siskiyou RCD, DWR	Interim/ Continual	$50,000.
WATER MANAGEMENT: INSTALL HEAD GATES AND MEASURING DEVICES ON DIVERSIONS						
ISSUES: Low instream flows limit habitat for coho salmon and other salmonids and inhibit movement of coho salmon juveniles to secure rearing habitat. Many diversions do not have flow control devices or ways to measure discharges into the diversion. Without control structures and accurate measurements, diversions cannot be managed easily for changing stream flows and some users could be diverting more than their proper allotments. (See also WM-2 for verification.)						
SOLUTIONS: Provide head gates and measuring devices for diversions.						
4	E	WM-7a	Within watermastered areas, continue DWR's program of constructing head gates and measuring devices on diversions. **Short-term:** Seek additional funding for these structures to help encourage timely installation. Install on all watermastered diversions by 2006.	DWR, RCDs	Interim/ Ongoing	Installing 50 devices will cost approximately $300,000/yr for 2 yrs, or $600,000.
4	D	WM-7b	Seek additional funds to provide structures for willing irrigators in non-water-mastered areas; CDFG, DWR, SRWC or RCD could participate. **Short-term:** Seek funding to provide measuring weirs and devices to willing irrigators. Install weirs and measuring devices as requested. (See recommendation WM-7a.) **Long-term:** Continue program until all diversions have gates and are measurable.	DWR, CDFG, SRWC, Siskiyou RCD	Interim	Little or no incremental cost.
4	D	WM-7c	On Shasta River, riparian users should participate. **Short-term:** Provide devices to riparian users. Set up voluntary diversion reporting process so the Watermaster knows what riparian users are doing.	DWR, CRMP, Shasta Valley RCD	Interim	Little or no incremental cost.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated)**, Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: WATER AVAILABILITY PROJECTIONS AND FORECASTS						
ISSUES:	Lack of prediction of water-year type limits opportunities for water management. Lack of short-term predictions similarly constrains planning for mid-season water use.					
SOLUTIONS:	Forecasting stream flows for the water year based on snow surveys, precipitation, and aquifer condition within the season could aid water management techniques, such as irrigation rotation and harvesting, and thereby provide additional instream flows and habitat.					
4	D	WM-8a	On the Scott River, DWR, SRWC, USFS, and other partners should study the correlation of stream flow with other parameters to closely predict weekly flow rates (cfs). **Short-term:** Develop work/study plan. Collect additional data. Hire consultant /team. Implement. Seek additional funding to initiate and implement a predictive program. **Long-term:** Continue implementation.	DWR, SRWC, Siskiyou RCD, USFWS	Interim	$176,000 (see text).
4	D	WM-8b	On the Shasta River, DWR, USFS, CRMP and other partners should study the correlation of stream flow with other parameters to closely predict weekly flow rates (cfs). **Short-term:** Develop a work/study plan. Collect additional data. Hire consultant or team. Implement. Seek additional funding to initiate and implement a predictive program. **Long-term:** Continue implementation.	DWR, USFWS, Shasta Valley RCD, CRMP, NCRWQCB	Interim	$176,000 (see text).
WATER MANAGEMENT: INSTREAM FLOW STUDIES AND RECOMMENDATIONS						
ISSUES:	Flow-habitat relationships for coho salmon have not been established and the amount of habitat required for coho salmon recovery has not yet been identified.					
SOLUTIONS:	Conduct an instream flow study to develop the relationship between flows and habitat. Develop the relationship between flow and habitat availability for the different life stages of coho salmon.					
4	E	WM-9	CDFG and USFWS in cooperation with the community should seek funding to conduct instream flow studies on the Scott River and Shasta River to determine flow-habitat relationships. Establish a broad-based technical advisory group. Quantify how much, where, and when stream flow is needed for coho salmon rearing life stages. **Short-term:** As an interim measure and in coordination with the Emergency Water Plan and other recommended water management measures, identify target minimum instream flows for the tributaries that provide coho salmon summer rearing habitat. Use the best, scientifically valid method suitable for the analysis. Seek funding and carry out study. Explore different instream flow assessment methods including, 1D and 2D modeling, microhabitat mapping, hydrologic modeling and others. Use Water Balance information, including feasibility aspects. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Integrate findings into watershed planning processes.	CDFG, NOAA Fisheries, USFWS, USFS, RCDs, CRMP, SRWC, NCRWQCB	Interim	$2,075,250 for Shasta, $2,132,250 for Scott, or $4,207,500 for both rivers.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated)**, Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: GROUNDWATER STUDIES						
ISSUES:	Low instream flows limit habitat for coho salmon and other salmonids and inhibit movement of coho salmon juveniles to secure rearing habitat. Some groundwater withdrawals appear to be linked to surface flows, but effects are not conclusive given other factors (climate change, precipitation variations, upland vegetation changes and removed barriers).					
SOLUTIONS:	Study groundwater availability in the Scott and Shasta Valley to determine groundwater status and potential needs and opportunities regarding groundwater management.					
4	E	WM-10a	DWR, the CRMP, and other partners should seek funding and cooperators to conduct a comprehensive groundwater study of the Shasta Valley. **Short-term:** Seek funding; conduct the study; make recommendations that would help preserve or enhance instream flows. Look at using groundwater from wells not connected with the river during low-flow periods and effect of infiltration from unlined ditches. Lead agencies will apply for funds for 2-year study by May 2004. **Long-term:** Implement recommendations as applicable. Coordinate results with water supply augmentation options.	DWR, CDFG, CRMP, NCRWQCB Shasta Valley RCD, Siskiyou County	Interim	$176,000 (see text).
4	E	WM-10b	Prepare a comprehensive study updating previous work by USGS (Seymour Mack 1958) and DWR to determine the current status of groundwater in the Scott Valley and its relationship to surface flows. Studies should include factors such as climate change, adjudications/decree verification, precipitation variability, changes in upland vegetation and removal of diversions and natural dams (e.g. beaver dam) that would have elevated groundwater levels. **Short-term:** Obtain funding to update the study. Find additional wells and cooperative landowners to measure monthly groundwater levels and develop current groundwater contours. Analyze data to assess management options. Look at using groundwater from wells not connected with the river during low flow periods. Lead agencies will apply for funds for 2-year study by May 2004. **Long-term:** Coordinate results with water supply augmentation options.	DWR, Siskiyou County, SRWC, NCRWQCB, Siskiyou RCD	Interim	$176,000 (see text).
4	D	WM-10c	Prior to groundwater study completion, recommend County establish process for developing groundwater management plans. If the comprehensive groundwater study shows the necessity, the County should initiate a basin-specific groundwater plan to protect the resource of groundwater for all users, including fish. **Short-term:** Review results of groundwater study and previous county work. Recommend that by 2005, the County appoint a broadly representative, community based steering committee to develop the idea. Formalize the process for preparing basin-wide plans using groundwater study results. Implement plan. Beginning in 2006, review and analyze study results and determine thresholds and actions to protect resource for all users.	Siskiyou County, RCDs, SRWC, NCRWQCB, CRMP, DWR, CDFG	Interim	$200,000 (see text).

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: WATER BALANCE STUDY						
ISSUES:			The connection between surface water and groundwater and the sources and sinks of water are poorly understood. This lack of knowledge limits the ability to take actions to increase instream flow and maintain the groundwater levels necessary to support riparian vegetation.			
SOLUTIONS:			Conduct studies that will provide the missing information and use that information to guide water management, water augmentation, and habitat enhancement.			
4	D	WM-11a	Support completion of the Scott River Water Balance Study to learn how water behaves in the river; in particular establish the fate of water added to the Scott River to increase instream flow. The study should identify the best locations to augment flow and predict the impact of the additional water at downstream locations. Apply the results of the completed Water Balance Study to water management, water augmentation, and habitat enhancement recommendations. **Short-term:** Obtain funds to complete Water Balance Study. Use results to guide projects that will support improvement to coho salmon habitat. **Long-term:** Continue implementation.	SRWC, Siskiyou RCD, DWR, NCRWQCB	Interim/ Ongoing	$60,000 for study.
4	D	WM-11b	Support preparation of a water balance study for the Shasta River to learn how water behaves in the river, in particular establish the fate of water added to the river to increase instream flow. The study should identify the best locations to augment flow and predict the impact of the additional water at downstream locations. Apply the results of the completed study to water management, water augmentation, and habitat enhancement recommendations. **Short-term:** Obtain funds to prepare Water Balance Study. Use results to guide projects that will support improvement to coho salmon habitat.	CRMP, Shasta Valley RCD, DWR, NCRWQCB	Interim	$100,000 for study.
WATER AUGMENTATION — SHASTA VALLEY HSA, SCOTT BAR HSA AND SCOTT VALLEY HSA						
WATER AUGMENTATION: WATER TRUST (WATER LEASING)						
ISSUES:			Low stream survival and growth during some coho salmon life stages.			
SOLUTIONS:			Provide a structured process for willing participants to donate, sell, or lease water or water rights to provide improved stream flow for coho salmon and habitat at critical periods.			
4	E	WA-1a	Support the ongoing efforts of the Scott River Water Trust to create an endowment that will support the Trust as a non-permanent agent for buying water to augment instream flows. **Short-term:** Complete the Phase 1 study funded by CDFG grant; Phase 2, implementation of the Water Trust, will occur no later than 2006 if Phase 1 supports feasibility of the process. Verification of the adjudication should be a concurrent activity to use of the Water Trust to ensure that legal use of water is addressed and that flows reflect this. **Long-term:** Continue as needed with the expectation that instream flow issues will be addressed and remedied, making this function less important.	SRWC, Siskiyou RCD, DWR, CDFG	Interim/ Ongoing	Little or no incremental cost.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated)**, Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER AUGMENTATION: WATER TRUST (WATER LEASING) (continued)						
4	E	WA-1b	Promote the establishment of a Shasta River Water Trust. **Short-term:** Explore options to create the Shasta River Water Trust and implement as applicable. Identify willing participants in the short term until longer-range solutions are available or in place. **Long-term:** Continue as needed with the expectation that instream flow issues will be addressed and remedied, making this function less important.	CRMP, Shasta Valley RCD, DWR, CDFG	Interim	Little or no incremental cost.
4	D	WA-1c	Create an endowment to provide funding for water leasing and purchase. **Short-term:** Find commitment for funding a water leasing or purchase program. Solicit agency support. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project.	SRWC, CRMP, RCDs, CDFG	Interim	See text regarding instream flow.
4	D	WA-1d	Initiate measures to create or enhance instream flows by reducing irrigation starting in September to promote access and connectivity of existing spawning areas; capitalize on available adult returns. Where this applies to rearing areas, it would also benefit juveniles. **Short-term:** (1) Prioritize streams where benefit will be greatest; (2) Solicit cooperation from water users; (3) Develop a contact list; (4) Acquire funding; (5) Form a water management group to manage the money and develop an implementation strategy, including long-range planning for growers. Implementation in Summer 2004. Investigate option for participators to not irrigate after September 1 (e.g., a fourth alfalfa crop) with this water dedicated to instream flows in exchange for appropriate reimbursement. **Long-term:** Continue as necessary.	DWR, RCDs, SRWC, CRMP	Interim	$30,000 for study. Other costs addressed in WA-1. See text regarding instream flow.
WATER AUGMENTATION: STUDY ADDITIONAL LARGE SURFACE WATER STORAGE						
ISSUES:	Low instream flows limit survival and growth during some coho salmon life stages. Winter runoff once out of the system cannot be recovered to provide year round flows at critical times to benefit coho salmon.					
SOLUTIONS:	Study the feasibility of building storage reservoirs to capture excess winter runoff and manage stream flows more for the benefit of coho salmon. Implement if feasible and acceptable. The intent of the stored water would be to benefit coho salmon, not to increase the irrigation acreage or volume.					
4	C	WA-2a	Initiate reconnaissance level studies to identify possible surface storage opportunities and possible fatal flaws for those alternatives in the Shasta River watershed. Off-stream reservoirs may provide storage yet maintain current or improved fish habitat. The study should identify management alternatives. **Short-term:** Identify environmental concerns for additional water storage, including those on steelhead and Chinook and develop proposal to alleviate. Initiate reconnaissance level study of increasing storage at Lake Shastina and opportunities for use of water from Greenhorn Reservoir. **Long-term:** Seek funding for and implement feasible projects.	DWR, CRMP, Shasta Valley RCD, USFS	Interim	$176,000 for study.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER AUGMENTATION: STUDY ADDITIONAL LARGE SURFACE WATER STORAGE (continued)						
4	D	WA-2b	Initiate reconnaissance level studies to identify possible surface storage opportunities and possible fatal flaws for those alternatives in the Scott River watershed. Off-stream reservoirs may provide storage yet maintain current or improved fish habitat. The study should identify management alternatives. **Short-term:** Look into historical and proposed water storage reservoirs; expedite the process at the elected official and agency levels. Consider potential impacts on Chinook and steelhead. Consider Noyes Valley, Wildcat Creek, Kidder Valley off-stream and other off-stream and upslope sites. Consider option of ditching or pumping water to storage area. Determine how to avoid usual problems with water storage, such as infilling of the storage structure with sediment, address channel maintenance flows, etc. **Long-term:** Seek funding for and implement feasible projects.	DWR, USFS, SRWC, Siskiyou RCD		$176,000 for study.
WATER AUGMENTATION: SMALL STORAGE OPPORTUNITIES (OFF-STREAM OR HIGH MOUNTAIN LAKES)						
ISSUES:	Low instream flows limit survival and growth during some coho salmon life stages. Winter runoff once out of the system cannot be recovered to provide year round flows at critical times to benefit coho salmon.					
SOLUTIONS:	Raise the levels of existing small lakes or create storage using small off-stream reservoirs rather than one large reservoir.					
4	D	WA-3a	Study raising additional mountain lakes in a reconnaissance level effort. **Short-term:** Support current partnership effort to rehabilitate Cliff Lake to provide 150 acre-feet of water for coho salmon rearing and migration; Identify USFS small storage locations that have not been maintained. **Long-term:** Seek funding for and implement feasible projects.	DWR, USFS, CDFG	Interim/ Ongoing	$176,000 for study. Approximately $300,000 to implement.
4	D	WA-3b	Study using small, off-stream ponds for increased storage. **Short-term:** Identify options for off-stream storage on public and private lands. **Long-term:** Seek funding for and implement feasible projects.	DWR, CDFG, SRWC, CRMP	Interim	$176,000 for study. Approximately $1,750,000 to create 10 ponds.
WATER AUGMENTATION: STORE WATER WITH A CONJUNCTIVE GROUNDWATER USE PROGRAM AND GROUNDWATER RECHARGE PONDS						
ISSUES:	Low instream flows limit survival and growth during some coho salmon life stages.					
SOLUTIONS:	Initiate reconnaissance level study of operating surface storage in conjunction with groundwater storage. Establish groundwater recharge ponds that receive and capture high winter river and stream flows and allow that water to percolate and recharge the aquifer. Recharging/maintaining the groundwater may be used to increase stream flows (e.g., recharging groundwater that is connected to the surface flows or using the groundwater to replace surface diversions).					
4	D	WA-4a	Along with general groundwater investigation on the Shasta (see WM-10a), include coordinating groundwater storage with operation of Lake Shastina. **Short-term:** Conduct Shasta River Groundwater Study to obtain basic data. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Look at options for conjunctive use in specific study.	DWR, Shasta Valley RCD, Siskiyou County, CRMP	Interim	$176,000 for study.

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WATER AUGMENTATION: STORE WATER WITH A CONJUNCTIVE GROUNDWATER USE PROGRAM AND GROUNDWATER RECHARGE PONDS (continued)						
4	D	WA-4b	On the Scott River, as part of both the general groundwater investigation and the surface reservoir investigation (see WM-10b), include conjunctive groundwater operation. **Short-term:** Find funding and implement reconnaissance level study. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Pursue feasibility study and implement if warranted.	DWR, Siskiyou RCD, Siskiyou County, SRWC	Interim	$176,000 for study.
4	D	WA-4c	On both the Scott and Shasta, investigate the most efficient ways to recharge groundwater. Mechanisms could include recharge ponds, unlined ditches, or others. Evaluate pre-season flooding of agricultural land for groundwater recharge. **Short-term:** Find funding and initiate groundwater and hydrologic studies, develop groundwater management criteria (yield and withdrawal criteria), identify possible recharge locations, and conduct reconnaissance level studies, which include legal aspects. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Pursue feasibility study and implement if warranted.	DWR, UC Davis Cooperative Extension, Siskiyou County, SRWC, CRMP, NRCS, RCDs	Interim	$300,000 for study. Approximately $1,000,000 to implement.
WATER AUGMENTATION: SCOTT VALLEY TAILINGS WATER STORAGE						
ISSUES:	Low instream flows limit survival and growth during some coho salmon life stages.					
SOLUTIONS:	On the Scott River, reshape dredge tailings to provide additional water storage within the remaining tailings.					
4	D	WA-5	Initiate reconnaissance-level study on options for a tailings rehabilitation and water storage project. Pursue viable options; coordinate water storage with restoration. **Short-term:** Find funding and implement reconnaissance level study. **Long-term:** Pursue feasibility study and implement if warranted.	SRWC, USFWS, CDFG, Siskiyou County	Interim	$250,000 for study. Long-term costs covered by other recovery actions.
WATER AUGMENTATION: WATER CONVEYANCE TO SHASTA VALLEY FROM MAIN KLAMATH						
ISSUES:	High water temperatures and low instream flows limit survival and growth during some coho salmon life stages.					
SOLUTIONS:	A water diversion of between 100 and 200 cfs from the mainstem Klamath River above Iron Gate Reservoir could provide irrigation water to the Shasta Valley greatly reducing the need for water diversions and ground water pumping for agricultural purposes. The majority of the low temperature, high quality water from the Shasta River would then be left instream to the benefit of spawning and rearing coho salmon.					
4	E	WA-6a	Study the legality of a Klamath-to-Shasta diversion. **Short-term:** Verify the legal status of the several reserved water rights for the Shasta Valley, and map out the best strategy to exercise them. Coordinate with the relicensing before FERC.	Siskiyou County, USBR, SWRCB, CRMP, DWR	Interim	$6,000-$7,000.

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WATER AUGMENTATION: WATER CONVEYANCE TO SHASTA VALLEY FROM MAIN KLAMATH (continued)						
4	D	WA-6b	Conduct Feasibility Study **Short-term:** Study engineering and environmental considerations of the various point-of-diversion possibilities, including capital and operation costs and biological and ecological considerations. Select most promising approach. Determine how much water is needed in Shasta Valley with Dwinnell Dam intact and without Dwinnell Dam.	DWR, Siskiyou County, USBR, SWRCB, CRMP	Interim	$200,000.
WATER AUGMENTATION: ACQUIRING WATER RIGHTS						
ISSUES:	Low instream flows limit survival and growth during some coho salmon life stages					
SOLUTIONS:	Acquire water rights that shall be dedicated to instream flow.					
4	E	WA-7a	Conduct reconnaissance-level investigations. **Short-term:** Conduct cost-benefit analysis that includes socioeconomic effects to community and legal considerations; Present options and survey public support. Proceed as warranted.	DWR, CDFG, SRWC, CRMP	Interim	$200,000.
4	D	WA-7b	Depending upon study, engage and support projects **Short-term:** Solicit interest from willing participants. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Continue short-term actions.	DWR, CDFG, SRWC, CRMP	Interim/ Continual	See text regarding instream flow.
4	D	WA-7c	Apply the results of appropriate studies (e.g., water balance, instream flow, coho salmon population surveys) to prioritize the purchase of water rights. **Short-term:** Complete and synthesize studies; fund implementation.	DWR, CDFG, SRWC, CRMP	Interim/ Continual	See text regarding instream flow.
HABITAT MANAGEMENT AND RESTORATION — SCOTT BAR HSA AND SCOTT VALLEY HSA						
HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT						
ISSUES:	Lack of Habitat Complexity. The Scott River watershed has experienced a loss of summer and winter rearing habitat for juvenile coho salmon. Juvenile coho salmon naturally move throughout the year looking for suitable temperature, cover, flow velocity, and food supply. Large logs, small woody debris, boulders, pools, side channels, beaver ponds, springs, and accessible wetlands provide habitat complexity and are "safe havens" for coho salmon juveniles. Protection from high flows, such as can be found around large structures in the stream or in backwaters connected to the stream, is necessary for over-wintering survival of juvenile coho salmon. Riparian vegetation provides habitat complexity and is an important element supporting juvenile rearing habitat for coho salmon. Riparian vegetation has been reduced for a variety of reasons, including lowering of the water table and channel destabilization. Current information shows a positive relationship between coho salmon presence and beaver ponds. The valley was historically heavily populated with beaver until mid-1800s. Today small populations exist. The rather stable ponds created by these animals, especially on valley tributaries, likely created year round fish rearing habitat, including the period of low stream flow. Changes in stream channel form and function may have limited riparian restoration potential. Changes in hydrologic conditions, such as changes in groundwater and water use may also limit riparian restoration potential. The loss of off-channel habitat results in a loss of productive rearing and over-wintering areas, often favored by species such as the coho salmon.					
SOLUTIONS:	Identify and conserve existing rearing habitat. Restore lost rearing habitat where possible. In locations where there are problems, increase habitat complexity. Find new ways to increase riparian vegetation in addition to continuing current efforts.					

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HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT (continued)						
4	E	Scott HM-1-1a	Study the habitat needs of rearing coho salmon in the Scott River watershed. Identify critical existing coho salmon rearing habitat. For the protection of riparian habitat, see recommendation P-2. **Short-term:** Secure funding; work with landowners to gain access; explore methods to obtain the necessary data to implement the appropriate coho salmon recovery projects; develop an action plan to prioritize projects. Coordinate with other ongoing agreements and scheduling. **Long-term:** Implement and evaluate projects.	CDFG, Siskiyou RCD, SRWC, USFS, NOAA Fisheries	Interim	$300,000 for study. See text regarding habitat restoration.
4	D	Scott HM-1-1b	Identify methods for increasing habitat complexity and appropriate locations for instream habitat structures to create pools, increase habitat complexity, and improve bank stabilization. All bank stabilization projects should be done in a fish-friendly manner. **Short-term:** Research and quantify locations and develop restoration plans for them. Define what constitutes fish-friendly bank stabilization. Evaluate existing alternative bank stabilization methods. Continue to seek funding and carry out specific projects. **Long-term:** Assess and monitor activities to determine whether or not instream structures are working properly and doing no harm. There should be a decreasing need to install instream structures as natural river channel processes (channel meander, riparian vegetation recruitment, reduced sedimentations, etc.) are improved.	CDFG, Siskiyou RCD, SRWC, USFS, NOAA Fisheries	Interim	See text regarding habitat restoration.
4	D	Scott HM-1-1c	Encourage riparian restoration projects using locally native vegetation. Project implementation should consider if: 1) the site previously supported riparian vegetation and still has the soil and hydrologic characteristics to support it; 2) the native plants selected are likely to flourish; 3) the width of the planted riparian zone is appropriate for the hydrologic regime at the site; and 4) the plan includes effectiveness monitoring using approved protocols. Establish procedures for recommending appropriate plant materials where natural conditions are significantly compromised. **Short-term:** Support ongoing riparian restoration efforts and continue to seek funding and carry out projects with an emphasis on the tributaries, especially those identified as potentially major coho salmon streams. Evaluate outcomes of replanting and research causes of riparian planting outcomes, appropriate width of planted areas, and new strategies for restoration. Monitor past projects to secure updated information on most effective techniques. **Long-term:** Assure implementation monitoring with emphasis on protecting the coho salmon refugia.	Siskiyou RCD, SRWC, NCRWQCB, CDFG	Interim/ Ongoing	See text regarding habitat restoration.
4	D	Scott HM-1-1d	Continue riparian easement programs. **Short-term:** Seek cooperation from local landowners. Compensate land-owners for short- or long-term protection of their riparian property.	NRCS, Landowners, RCDs	Interim/ Ongoing	See text regarding habitat restoration.

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HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT (continued)						
4	D	Scott HM-1-1e	Evaluate the use of beaver ponds and other efforts that contain similar benefits to increase habitat complexity. **Short-term:** Review literature (studies done in Washington and Oregon). Hold workshops and publish newsletters as appropriate. Investigate projects in prioritized areas to support beaver activity if appropriate. Coordinate with related projects to improve stream complexity and habitat. If projects are planned, ensure that riparian growth is adequate or provide materials for beaver needs, so that appropriate riparian cover is maintained. **Long-term:** Include implementation monitoring. If beaver reintroduction fails or is found to be inappropriate, consider analogous habitat attribute efforts.	RCDs, CDFG, NOAA Fisheries	Interim	$200,000 for study.

HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT

ISSUES: High Water Temperatures. Water temperatures are influenced by amount of river flow, and river structure (W/D ratios, etc.), air temperature, shading from terrain and vegetation, influx of groundwater, tributary flow and runoff, and other factors, including aggraded streambeds and sedimentation. High water temperatures can stress coho salmon, increasing disease and mortality. Water temperature is listed as a significant problem for the Scott River (303d impaired) and the condition is associated with current summer flow regime and the valley structure of the river (high width to depth ratios). Water temperature influences the development and survival of coho salmon by affecting different physiological processes such as growth and smoltification. Water temperature affects migration timing and the fishes' ability to cope with predation and disease and exposure to contaminants. High water temperatures also create thermal barriers to migration.

SOLUTIONS: Identify and remedy conditions that contribute to high water temperatures. Restore structure of river. Modeling water temperature and flow relationships in the mainstem will help guide the timing of water additions to the river and selecting the best locations for restoration of water table, meander pattern, and slope.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
4	E	Scott HM-1-2a	Identify location, timing, frequency and duration of thermal barriers to migration for adult and juvenile coho salmon. Develop habitat improvement measures that address temperature. **Short-term:** Identify and map locations and timing of thermal barriers. Coordinate information and projects to address appropriate solutions in prioritized areas with the most benefit to coho salmon. **Long-term:** Implement projects or measures in coordination with over-all habitat recovery process and monitor for improvements in an adaptive fashion.	CDFG, NOAA Fisheries, Siskiyou RCD, SRWC, NCRWQCB	Interim	$176,000 for study. See text regarding habitat restoration.
4	C	Scott HM-1-2b	Investigate the contribution to stream cooling of the flow of cool water through gravel. Investigate the interference of fine sediment in that process. **Short-term:** Seek funding and carry out study using agreed-upon scientists identified by the Technical Committee of the SRWC. **Long-term:** Use results to plan projects and drive adaptive management.	SWRC, NCRWQCB, Siskiyou RCD	Interim	Little or no incremental cost.
4	D	Scott HM-1-2c	Install systems that treat warm water or percolate it through the ground to cool it. (See also WUE-7b) **Short-term:** Seek funding and carry out projects where appropriate.	Siskiyou RCD, SRWC, NRCS	Interim	$200,000 for approximately two projects.

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HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT (continued)						
4	D	Scott HM-1-2d	Model the relationship of temperature and flow and use the results to plan the timing and locations of water additions to the river. **Short-term:** Fund and implement temperature studies. Coordinate with the NCRWQCB TMDL process in data collection. **Long-term:** Monitor projects to determine optimum benefits are achieved with implementation of habitat improvement actions.	Siskiyou RCD, CDFG, SRWC, NCRWQCB	Interim	$176,000 for study.
HABITAT MANAGEMENT AND RESTORATION: IMPROVE VALLEY AND LOW-GRADIENT TRIBUTARY CHANNEL STRUCTURE AND FUNCTION						
ISSUES:	Degraded Channel Structure and Function. Historical accounts indicate that in the early 1900s the Scott River in the valley was narrow and deep (with more of a meander pattern) and was more in contact with its flood plain. Today the river is currently a mix of reaches, some are narrow and riprapped, while others are broad and wide. Channel recovery is impeded. Most reaches illustrate large width to depth ratios. This fact, combined with summer low flows and minimal riparian shading, lead to very warm stream temperatures during the summer months. In other reaches, down-cut channel conditions, loss of meander pattern, and increased stream gradient all translate to increased amounts of stream flow (stream power) held within the channel during larger flows resulting in increases stream-bank erosion and the need for riprap. Down-cut channels also act as drains to surrounding land resulting in a lowering of the water table. This has ramifications on water storage, riparian vegetation and stream-bank stabilization.					
SOLUTIONS:	Restore valley river structure to an appropriate meander pattern, decreased channel slope, decreased width-to-depth ratios, proper connections with the flood plain and side channels, where feasible.					
4	D	Scott HM-2a	Evaluate the geomorphology of the Scott River system. Identify all areas of high width-to-depth ratios, with entrenched channels, or other compromised areas. Implement projects that improve stream geomorphology at specific locations in conjunction with system-wide stream channel improvement. Identify and apply consistently a system of stream classification. **Short-term:** Need expert input – understand fluvial processes and formulate plan of recovery. Map areas of unstable banks, high width-to-depth ratios, or entrenched channels. Develop a Request for Proposals for stream channel restoration projects that are based in natural process restoration. **Long-term:** Implement a long-term monitoring program to assess responses to implemented restoration projects, with monitoring sites established to measure, for example, cross-sectional channel profile, substrate composition, stream-bank condition (including riparian vegetation), and photo points.	CDFG, Siskiyou RCD, SRWC, NCRWQCB, NOAA Fisheries	Interim/ Continual	$176,000 for initial study. Approximately $160,000 for monitoring/yr.
4	D	Scott HM-2b	Identify locations where the main channel can be reconnected to its flood plain and historic sloughs to allow formation of side channels without negative impacts to the community. Implementation of this recommendation should be done after remediation of the Callahan Dredger Tailings. **Short-term:** Assess the feasibility of setback levees to restore channel function. Survey with funding. Prioritize projects and solicit buy-in. Utilize information from habitat studies above to select locations for the best cost/benefit to coho salmon. **Long-term:** Implement projects as appropriate. Include appropriate monitoring of this effort.	SRWC, Siskiyou RCD, Landowners, CDFG, NOAA Fisheries	Interim	$200,000 for study. Incremental restoration costs uncertain.

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HABITAT MANAGEMENT AND RESTORATION: IMPROVE VALLEY AND LOW-GRADIENT TRIBUTARY CHANNEL STRUCTURE AND FUNCTION (continued)						
4	E	Scott HM-2c	Restore the Scott River flood plain in the Callahan Dredger Tailings reach, through a community-driven process supported by the SRWC. **Short-term:** Review Tom Hesseldenz and Associates report to USFWS. Secure funding to establish a stakeholder group (including agencies and design consultants) to formulate a process and plan to restore the tailings. **Long-term:** Secure funding and implement tailings restoration.	SRWC, Siskiyou RCD, CDFG, Siskiyou County, USFWS	Interim	$30,000,000.
HABITAT MANAGEMENT AND RESTORATION: BARRIERS TO FISH PASSAGE						
ISSUES:	Juvenile coho salmon need access to rearing habitat that is suitable at different times of the year, however natural and other barriers may prevent them from moving freely. Barriers to juvenile fish movement are found where streamflow goes sub-surface and where impediments in the channel block fish passage. Coho salmon return to the Scott River in November, making their way up through the canyon to spawning grounds. Particularly in drought years, natural and other barriers may delay or prevent coho salmon from reaching spawning areas. Barriers to movement are found where streamflow goes sub-surface and where impediments in the channel block fish passage. Some barriers are the result of human activity and have the potential to be remedied.					
SOLUTIONS:	Continue to investigate and implement fish passage improvement projects and promote the surface connectivity of streams that provide coho salmon habitat.					
4	E	Scott HM-3a	Identify location, timing, duration and frequency of low flows that prevent juvenile access to rearing habitats and adult access to spawning habitats. **Short-term:** Compile information and incorporate into a GIS. **Long-term:** Implement actions to remediate barriers.	CDFG, Siskiyou RCD, SRWC, DWR	Interim/ Ongoing	Little or no incremental cost.
4	C	Scott HM-3b	Identify, prioritize, and treat barriers on private roads, consistent with the Five Counties process for road assessments. Comply with CDFG-NOAA Fisheries passage criteria. **Short-term:** Prioritize projects for benefit to coho salmon and implement with completion dates in the near term (1-3 years). **Long-term:** Implement actions to remediate barriers.	Siskiyou RCD, CDFG, SRWC, Landowners	Interim	See text regarding treatment of barriers to passage.
4	D	Scott HM-3c	Investigate opportunities to construct low-flow channels through alluvial fans to improve fish passage (short- and long-term) in all tributaries from French Creek north. **Short-term:** Compile data describing where barriers are found. Secure funding to formulate a process and plan to restore the aggraded reaches. **Long-term:** Secure funding and implement restoration.	CDFG, Siskiyou RCD, SRWC, NOAA Fisheries	Interim	$1,800,000 assuming treatment of six sites.

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HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SPAWNING HABITAT						
ISSUES:	Spawning coho salmon require gravel with rocks within a particular size range. They prefer spawning locations with adequate habitat complexity to prevent redds from washing out in floods and provide cover nearby for emerging fry. Moffett Creek has a high sediment load, can run turbid, and contributes a large amount of fine-grained sediment to the Scott River. Large pools in the Canyon Area are reduced in volume due to granitic sand loading. In other locations, aggradations of larger cobbles and boulders have covered or replaced spawning gravels. Erosion from mining tailings affects many tributaries from the South Fork to Scott Bar.					
SOLUTIONS:	Identify and conserve existing spawning habitat. Restore lost spawning habitat where possible. In locations where there are problems, increase habitat complexity and gravel quality.					
4	E	Scott HM-4a	Identify existing coho salmon spawning habitat. Study the habitat needs of spawning coho salmon in the Scott River watershed. Protect and maintain spawning habitat to prevent further loss of the species. **Short-term:** Secure funding. Continue and expand existing surveys. Quantify spawning habitat. Use this information to prioritize projects for habitat restoration and enhancement **Long-term:** Continue to use results to plan projects and drive adaptive management.	SRWC, NCRWQCB, Siskiyou RCD, CDFG, NOAA Fisheries	Interim/ Ongoing	$176,000 for study. See text regarding habitat restoration.
4	D	Scott HM-4b	Improve spawning gravel quantity and quality. **Short-term:** Develop a sediment budget; identify locations with an action plan for desired future conditions; and determine and remediate causes of aggradation. Identify locations that have poor quality or lack adequate spawning gravels but in other respects meet coho salmon spawning requirements. Remove fine sediment from gravels in locations that otherwise meet coho salmon spawning requirements but where gravels are buried. Remove large, aggraded rock from locations that otherwise meet coho salmon spawning requirements but where gravels are buried. Assess gravel recruitment and augmentation locations. **Long-term:** Design, secure funding, and implement projects.	SRWC, NCRWQCB, Siskiyou RCD, CDFG, NOAA Fisheries	Interim	See text regarding habitat restoration.
4	C	Scott HM-4c	Identify and remedy sources of fine sediment within the SSRT area. **Short-term:** Secure funding and conduct surveys. Use this information to implement projects to reduce sediment input. **Long-term:** Continue as needed.	Siskiyou RCD, SRWC, CDFG, NCRWQCB, NRCS, Landowners	Interim	See text regarding treatment of barriers to passage.

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HABITAT MANAGEMENT AND RESTORATION — SHASTA VALLEY HSA						
HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF REARING HABITAT						
ISSUES	Inaccessibility to tributaries, high stream temperatures, low dissolved oxygen levels, and lack of habitat complexity limit coho salmon production within the Shasta River.					
SOLUTIONS	In the short-term identify and maintain existing spawning and rearing habitats. In the long term, create multiple refugia areas, and/or re-link those no longer accessible. Establish recovery goals.					
4	E	Shasta HM-1a	Identify existing areas successfully used for rearing and potential rearing areas by conducting entire mainstem channel-length survey: 1) water temperature/refugia; and 2) habitat suitability based on slope and water velocity. Estimate carrying capacity and fish utilization of rearing habitat. Identify spawning areas and determine accessibility to rearing areas. **Short-term:** Secure funding, conduct habitat, spawning, and rearing surveys, and prepare analysis. **Long-term:** Use results to guide and prioritize projects to insure best benefit to coho salmon and overall restoration of the river.	CDFG, NCRWQCB, Shasta Valley RCD, CRMP, Landowners	Interim	$176,000.
4	D	Shasta HM-1b	Implement habitat protection, restoration, and improvement projects that enhance rearing habitat in high priority areas. **Short-term:** Focus on areas currently accessible to coho salmon or potentially accessible (e.g. below Greenhorn and Dwinnell Dams). Conduct habitat suitability studies (see also Shasta HM-1a) on other streams to guide future actions. Coordinate with long-range planning effort for addressing barriers (Shasta HM-2). Possible projects to include are livestock control or exclusion fencing, tree and emergent planting, bioengineered bank stabilization, and irrigation tailwater reduction. **Long-term:** Continue projects. Monitor for effectiveness over the long term, utilizing adaptive management to fine-tune projects for best benefit to coho salmon.	Shasta Valley RCD, CRMP, CDFG, Landowners	Interim	See text regarding habitat restoration.
HABITAT MANAGEMENT AND RESTORATION: BARRIERS TO FISH PASSAGE						
ISSUES	Juvenile coho salmon need access to rearing habitat that is suitable at different times of the year, however natural and other barriers may prevent them from moving freely. Barriers to juvenile fish movement are found where streamflow goes sub-surface and where impediments in the channel block fish passage. Coho salmon return to the Shasta River in November, making their way up through the canyon to spawning grounds. Particularly in drought years, natural and other barriers may delay or prevent coho salmon from reaching spawning areas. Barriers to movement are found where streamflow goes sub-surface and where impediments in the channel block fish passage. Some barriers are the result of human activity and have the potential to be remedied.					
SOLUTIONS	Continue to investigate and implement fish passage improvement projects and promote the surface connectivity of streams that provide coho salmon habitat.					
4	E	Shasta HM-2a	Identify barriers to fish passage throughout the watershed for adults and juveniles, and work to implement solutions to these barriers. **Short-term:** At each site assess impacts on water quality and assess importance for coho salmon passage at each site. Assign each dam/impoundment a priority for reduction or removal. Work with users to select workable management measures. Implement short term solutions and work towards removal or remediation of passage problems at flashboard dams as soon as possible where feasible; otherwise develop temporary modifications to minimize passage and water quality problems. **Long-term:** Implement removal or remediation of passage problems at flashboard dams where feasible, otherwise modify to minimize passage and water quality problems. Continue to work with affected landowners and implement workable solution. Refine and Implement long-term solutions.	CDFG, NCRWQCB, Shasta Valley RCD, CRMP, Landowners	Interim	See text regarding treatment of barriers to fish passage.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: BARRIERS TO FISH PASSAGE (continued)						
4	D	Shasta HM-2b	Develop a long-term strategy for improving passage at Greenhorn and Dwinnell dams. **Short-term:** Develop working group to create long-range strategy for Greenhorn and Dwinnell, including assessment of suitability of habitat upstream, options for passage or modification/removal. **Long-term:** Develop a long-term solution and implement that if it is different from short-term outcome.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim	See Shasta HM-2a.
4	E	Shasta HM-2c	Develop solutions for water quality barrier caused by impoundment at Highway 3. **Short-term:** Provide for passage at Highway 3 as soon as possible; determine impacts on water quality, if any, at all sites. **Long-term:** Develop a plan for complete removal if possible. Implement TMDL plans.	CDFG, NCRWQCB, Shasta Valley RCD, CRMP, Landowners	Interim	See Shasta HM-2a.
4	E	Shasta HM-2d	Provide for passage at impoundment above County Road A-12. **Short-term:** Provide for passage above A-12 to Big Springs refugia area as soon as possible. Determine impacts on water quality, if any. **Long-term:** Develop a plan for complete removal if possible.	CDFG, NCRWQCB, Shasta Valley RCD, CRMP, Landowners	Interim	See Shasta HM-2a.
4	D	Shasta HM-2e	Eliminate barriers caused by high water temperatures throughout the river. **Short-term:** Work with Shasta Temperature model and through TMDL process to establish appropriate targets based on system capability. Provide for passage to safe areas in the short term.	CDFG, Shasta Valley RCD, CRMP, Landowners, RWQCB, NCRWQCB	Interim/ Ongoing	Little or no incremental cost.
4	E	Shasta HM-2f	Eliminate barriers on Parks Creek caused by low water drainage at Interstate 5 and diversion downstream. **Short-term:** Studies/repairs underway. Continue to completion. **Long-term:** Monitor for management, maintenance and effectiveness.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim/ Ongoing	Little or no incremental cost.
4	E	Shasta HM-2g	Remediate barriers on Parks Creek caused by de-watering. (See WM-9 for flow recommendations.) **Short-term:** Develop target initial instream flows to re-water channel year-round. **Long-term:** Purchase or lease water. Assess appropriateness of flow tested. Adjust.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim	Little or no incremental cost.
4	E	Shasta HM-2h	Provide fish passage at remaining diversion dam on Little Shasta River. **Short-term:** Develop a plan for the second and seek funding. **Long-term:** Implement barrier modification on second barrier.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim/ Ongoing	See Shasta HM-2a.
4	D	Shasta HM-2i	Correct fish passage problems associated with road crossings. **Short-term:** Implement results of ongoing study of road barriers on Parks Creek.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim/ Ongoing	Little or no incremental cost.

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HABITAT MANAGEMENT AND RESTORATION: SPAWNING GRAVEL MANAGEMENT						
ISSUES:	In the Shasta River, severe limits on spawning gravel exist below Dwinnell Dam due to natural geological conditions. Historic in-channel gravel mining in the main-stem, gold mining in Yreka Creek and its subsequent channelization, and the construction of Greenhorn Dam exacerbated that shortage. Greenhorn Dam also blocks the input of gravel to Yreka Creek and Shasta Canyon. Those natural geologic conditions (the filling of the Shasta Valley with volcanic debris approximately 300,000 years ago) make coarse-sediment supply in the Shasta extremely limited and present coarse-sediment transport conditions that probably exist nowhere else on earth. Under current conditions, existing spawning gravel has essentially no way of cleansing or replacing itself, leading to higher mortality of eggs in gravels. Presence of Dwinnell Dam limits peak flows that historically cleaned gravels. Remnant gravels may have substantially less capacity for fine sediment than natural conditions once allowed, due to lack of periodic removal of fines.					
SOLUTIONS:	Improve spawning gravel quality and quantity and reduce input of fine sediment.					
4	E	Shasta HM-3a	Prepare a gravel budget for the watershed. **Short-term:** Continue to submit funding request for study. The gravel budget study will guide implementation of all recommendations in this section. Use this information to develop projects to benefit coho salmon spawning, secure funding, and implement. **Long-term:** Monitor. Continue implementation of plan as hydrologic conditions dictate.	Shasta Valley RCD, CRMP	Interim	$200,000 for study.
4	D	Shasta HM-3b	Determine natural processes that historically maintained spawning gravel. Identify methods of restoring quantity and quality of gravel. **Short-term:** Conduct gravel budget study and apply results of study to needs of coho salmon. **Long-term:** Re-create historic process if feasible; mitigate if not. Artificial supplementation may be necessary due to loss of natural processes and historic removal.	Shasta Valley RCD, CRMP	Interim	$176,000 for study.
4	D	Shasta HM-3c	Identify and map existing and potential spawning gravel locations and sources of gravel. Evaluate suitability for spawning and access to rearing areas for emergent fry. **Short-term:** Conduct Gravel Budget study and apply results of study to needs of coho salmon. **Long-term:** Monitor condition over time and continue to apply results of the study.	Shasta Valley RCD, CRMP	Interim	Little or no incremental cost.
4	D	Shasta HM-3d	Identify and quantify sources of fine sediment and mitigate their effect on spawning gravel quality. **Short-term:** Accelerate restoration measures, especially livestock exclusion fencing and emergent plantings. Investigate role and importance of spawning salmon in maintaining gravel cleanliness under the unique conditions found in the Shasta River. **Long-term:** Establish basin-wide monitoring program to chart changes over time in fine sediment. Develop fine sediment budget for the river. Assess status. Integrate fine sediment problem into long-range planning for Dwinnell Dam, potential use of flushing flows to maintain habitat, and establishing instream flow needs.	Shasta Valley RCD, CRMP	Interim	Little or no incremental cost.

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HABITAT MANAGEMENT AND RESTORATION: RIPARIAN VEGETATION MANAGEMENT						
ISSUES:	Riparian vegetation is an important element supporting juvenile rearing habitat for coho salmon. Riparian trees shade streams, reducing solar heating of the water, provide bank stabilization, woody debris, and drop insects and debris that contribute to the food supply. In the Shasta River vegetation has been reduced for a variety of reasons. Substantial restoration efforts have focused on livestock exclusion fencing and riparian planting, and much has been accomplished in those areas, but significant problems have been discovered that limit the ability to re-create riparian cover.					
SOLUTIONS:	Increase riparian vegetation.					
4	D	Shasta HM-4a	Encourage riparian restoration projects using locally native vegetation including both woody and herbaceous stocks. Project implementation should consider if: 1) the site previously supported riparian vegetation and still has the soil and hydrologic characteristics to support it; 2) the native plants selected are likely to flourish; 3) the width of the planted riparian zone is appropriate for the hydrologic regime at the site; and 4) the plan includes effectiveness monitoring using approved protocols. **Short-term:** Continue riparian planting efforts. Identify natural processes that encourage riparian vegetation recruitment. Establish working relationship/MOU with entities such as U.C. Davis, Humboldt State University, USFS, NRCS, Society for Ecological Restoration, etc. to investigate specifics, test alternatives, and develop broad adaptive management approach. Evaluate outcomes of replanting and research causes of riparian planting outcomes, appropriate width of planted areas, and new strategies for restoration. **Long-term:** Continue.	Shasta Valley RCD, CRMP	Interim/ Ongoing	See text regarding habitat restoration.
4	D	Shasta HM-4b	Establish procedures for recommending appropriate plant materials where natural conditions are significantly compromised and local species are not likely to thrive. **Short-term:** Do search for information on similar conditions elsewhere. Where undocumented, or where realistic remediation does not exist, prepare presentation materials for publication and discussion at restoration conferences (See EO-8). Seek to establish a working group from industry, academia and government to identify specific problem conditions, determine if they can be reduced, or suggest alternative species compatible with local conditions if they cannot be remediated. **Long-term:** Coordinate this discussion with considerations on instream flows, future role of Dwinnell Dam, TMDL temperature targets, fine sediment monitoring in spawning gravels.	CDFG, CRMP, Shasta Valley RCD	Interim	Little or no incremental cost.
4	C	Shasta HM-4c (See also EO-9)	Educate non-agricultural landowners on the importance of not removing riparian vegetation. **Short-term:** Prepare presentation materials with photos, illustrating desired future condition. Create awards and recognition. Since this is primarily an urban problem, work closely with Yreka Creek Committee to develop approach. **Long-term:** Secure ongoing funding for periodic reminders and recognition.	CRMP, Shasta Valley RCD, CDFG	Interim	$60,000/yr.
4	D	Shasta HM-4d	Investigate the establishment of a riparian easement or lease program to compensate landowners for short-term or long-term protection of their riparian property. **Short-term:** Create opportunity, and then gauge acceptability of program from local landowners' response. Review the Buckhorn Conservancy. Find or develop a local entity or process to implement program. **Long-term:** Monitor; utilize adaptive management of program.	Shasta Valley RCD	Interim	See text regarding habitat restoration.

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HABITAT MANAGEMENT AND RESTORATION: WATER TEMPERATURE						
ISSUES:			Water temperatures are influenced by amount of river flow, and river structure (W/D ratios, etc.) air temperature, shading from terrain and vegetation, influx of groundwater, tributary flow and runoff, and other factors. Water temperature is listed as a significant problem for the Shasta River (303d impaired). High water temperatures can stress coho salmon, increasing disease and mortality.			
SOLUTIONS:			Address factors that contribute to high water temperatures. Modeling water temperature and flow relationships in the mainstem will help plan for water management and habitat restoration in the river.			
4	E	Shasta HM-5a	Continue to model the relationship of temperature and flow. Use that information and other habitat variables to plan for water management and habitat restoration in the river. **Short-term:** Fund development of more scenarios to cover a broader array of flows to run through the model. Coordinate with the NCRWQCB in TMDL process. **Long-term:** Use model result to target restoration projects. Expand model to include the rest of the watershed.	CDFG, Shasta Valley RCD, CRMP, NCRWQCB	Interim/ Ongoing	$176,000.
4	D	Shasta HM-5b	Identify location, timing, frequency and duration of thermal barriers to migration for adult and juvenile coho salmon. Develop habitat improvement measures that address temperature. **Short-term:** Identify and map locations and timing of thermal barriers. Coordinate information and projects to address appropriate solutions in prioritized areas with the most benefit to coho salmon. **Long-term:** Implement projects or measures in coordination with over-all habitat recovery process and monitor for improvements in an adaptive fashion.	CDFG, NCRWQCB	Interim	Little or no incremental cost.
WATER USE EFFICIENCY[1] —SHASTA VALLEY HSA, SCOTT BAR HSA AND SCOTT VALLEY HSA						
WATER USE EFFICIENCY: STOCK WATER ALTERNATIVES						
ISSUES:			Active surface diversion for livestock watering in the post-irrigation season may reduce instream flows at a critical time for migrating adult coho salmon.			
SOLUTIONS:			Provide and maintain alternate stock watering facilities through voluntary, incentive-based programs.			
4	C	WUE-1a	Develop the cost and potential stream-flow enhancement if all relevant diversions participated. **Short-term:** Coordinate with implementation of WUE-1b.	SRWC, CRMP, DWR, RCDs	Interim	Little or no incremental cost.
4	D	WUE-1b	Where water losses appear to be significant or where associated benefits can be demonstrated for coho salmon (e.g., fencing of riparian areas), identify and provide alternative stock water systems. **Short-term:** Identify and reprioritize systems needed by Dec 31, 2003. Design approach to individual systems; seek funding. **Long-term:** Install selected systems by Sept. 30, 2007.	SRWC, CRMP, RCDs	Interim	$320,000 for 40 systems.

[1] The following overall goals apply to the entire Water Use Efficiency category:
- Promote water conservation by all water users (both for irrigation and stock water), particularly during low-flow years.
- Promote and assure leaving water savings in the streams.
- Prioritize projects by recognized benefit to coho salmon; conduct cost-benefit analyses, including analysis of watershed volume and the effectiveness of the efficiency program for benefits to coho salmon.
- Research and promote incentives for the efficient use of water, including tax incentives.

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WATER USE EFFICIENCY: STOCK WATER ALTERNATIVES (continued)						
4	C	WUE-1c	Provide improved awareness of needs for fish protection through the non-irrigation season and provide information about costs and benefits of stock-watering alternatives.[2] **Short-term:** Provide education about management changes under ESA.	SRWC, CRMP, RCDs	Interim	$60,000/yr.
WATER USE EFFICIENCY: LANDOWNERS WORKSHOPS						
ISSUES: Water users may lack awareness about the advantages and methods of water use efficiency, including alternate stock-watering methods.						
SOLUTIONS: Educate water users and develop incentives for their participation in water-use efficiency programs.						
4	D	WUE-2	Promote and provide landowner workshops. Work with landowners to develop a method to prioritize efficiency improvements that will yield either increased instream flows or improved water quality. Use to avoid funding projects that would not benefit coho salmon. (See also EO-2.) **Short-term:** Evaluate and provide education as appropriate.	SRWC, CRMP, RCDs	Interim	Little or no incremental cost to WUE-1c.
WATER USE EFFICIENCY: DITCH LINING AND PIPING						
ISSUES: Water losses from surface ditch systems may lead to more water being diverted than is needed at the point of use.[3]						
SOLUTIONS: Identify the advantages and water savings of lining and or piping surface ditch systems. Identify and prioritize ditch systems that have potential water saving benefits to coho salmon. Research possible negative effects to habitat, wildlife, and aquifer recharge from lining and or piping ditches.						
4	D	WUE-3	Identify water savings from lining and/or piping surface ditch systems. Identify and prioritize ditch systems that have potential water-saving benefits to coho salmon. Develop locally specific policies and provide guidance to entities that fund and review these projects. Evaluate potential negative impacts to groundwater, wildlife, and other resources that could result from lining or piping ditch systems. If appropriate, concurrently implement companion planned winter recharge program to maintain system balance. **Short-term:** Map all existing ditches, show season of use, quantity, and determine ditch loss. Prioritize potential ditch lining projects. Collect field data if needed. Consider opportunity for assured, measurable increase in quantity and duration instream flows in spring and fall relative to coho salmon needs for passage, other criteria as developed. Utilize outreach funds to develop appropriate lining projects, especially on shared ditches. Implement where costs, benefits and overall basin priorities coincide. **Long-term:** Continue implementation of high priority projects.	SRWC, RCDs, CRMP, NRCS	Ongoing	$2.2 million See text regarding ditch lining.

2 Realization that fish screens must operate at all times when diverting water (paddle wheel and screens ice up in winter and self destruct) will make efficient livestock watering systems look good. Biggest failure is frost damage and ill thought out tank placement. Once valve freezes or pipe splits, they don't get fixed. This has driven the cost way up. Might be worth documenting causes of failure in order to either upgrade or avoid in future designs. Over the years this problem became in part a justification for removing screens when they would do the most good—when newly emerged fish are in the water column, but also when the risk of damage is greatest (a typical mechanics response to a biological problem—protect the machine) and as a result no effort was made to solve it. There may be a need for a little innovation to take advantage of the fact that liquid water contains a great deal of heat, and that something as simple as an insulated cover might be sufficient to reduce evaporation and trap heat to keep the temperature above freezing, or if not that alone possibly in combination with cups to carry up more water and dump it over the wheel and/or screen to facilitate the heat transfer.

3 Additional Considerations: One or more ditches in the Shasta run continuously all summer, even though the demand doesn't seem to be continuous. Turning them off takes too long (driving time), especially when combined with the time required to re-fill the ditch.

Some ditches in the Scott continue to divert water even though it is not getting to point of use. Users don't take out diversion dams as they are waiting for flows to increase in the fall for stock water. This is not a beneficial use of water and flows should be returned to the stream. It may be possible to return 5-7 cfs to the streams under this scenario for no cost. This is where water verification system is needed.

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WATER USE EFFICIENCY: DITCH REPAIR AND CLEANING						
ISSUES:	Lack of ditch maintenance can cause sustained high diversion rates and resulting flow impacts to coho salmon.					
SOLUTIONS:	Promote routine and ongoing ditch maintenance. Research funding opportunities and incentives for ditch repair and cleaning.					
4	C	WUE-4	Promote routine and ongoing ditch maintenance for ditches in active use.[4](See also EO-2.) **Short-term:** Educate landowners about the importance of maintaining ditch in active use and the possible need for access for maintenance activities. **Long-term:** Continue education. Discuss purchase of water right if its beneficial use will not support the cost of maintaining its delivery system.	DWR, Landowners	Interim	$60,000/yr.
WATER USE EFFICIENCY: IRRIGATION SYSTEM EFFICIENCY						
ISSUES:	Inefficient irrigation systems cause loss of water and potential impacts to both flow and water quality.					
SOLUTIONS:	Promote incentives for irrigators to upgrade and maintain the efficiency of existing irrigation systems where there is a benefit to coho salmon.					
4	D	WUE-5a	Evaluate irrigation systems for water use efficiency with assistance from UC Extension Service, NRCS Farm Irrigation Rating Index Model (FIRI) or other available resources. (Flood vs. wheel lines vs. pivots and conversion to low-pressure sprinkler systems.) **Short-term:** Develop prioritization approach for possible projects. Consider soil type, impacts on water quantity and quality, measurable benefits to coho salmon in terms of instream flow or water quality improvement. **Long-term:** Implement projects only where benefits to coho salmon can be demonstrated and secured.	RCDs, NRCS, NCRWQCB, SRWC, CRMP, UC Davis Cooperative Extension	Ongoing	$200,000 for study.
4	C	WUE-5b	Promote maintenance of existing sprinkler systems, such as: replacing gaskets and drains; replacing nozzles and/or heads with crop-specific equipment. **Short-term:** Implement education program through UC Extension.	SRWC, CRMP, RCDs, UC Davis Cooperative Extension, NRCS	Ongoing	$60,000/yr.
4	C	WUE-5c	Develop/disseminate BMPs for each irrigation type (including land leveling) and a corresponding on-farm monitoring system that is easily useable by farmer (e.g. moisture sensors to verify BMP). Encourage UC Extension to serve as a clearinghouse for the data and to evaluate success of the program.	UC Davis Cooperative Extension, NRCS	Ongoing	$200,000 for development $60,000 for outreach.
4	D	WUE-5d	Review existing water delivery pricing arrangements within irrigation districts to see if they are as effective as possible at encouraging efficient use of water. **Short-term:** Conduct an economic study to look at current pricing systems, suggest revenue neutral changes that would enhance conservation and/or dedication to instream flows. Present to each district for consideration and possible action.	UC Davis Cooperative Extension, NRCS	Interim	$200,000.
4	C	WUE-5e	Support DWR in implementing the CIMIS stations that measure evapotranspiration information and make it available over the internet to aid farmers in efficiently irrigating. **Short-term:** Site and install stations, take steps to make information available to irrigators. Hold training programs to show utility.	DWR	Ongoing	$10,000.

[4] Cleaning an unmanaged ditch that gains riparian and aquatic values may require a 1600 agreement. A well maintained ditch will not develop such values and no agreement is likely to be required. The maintenance of a ditch is up to the user. This should not be a burden of the State unless there is mutual benefit through a material change (lining or piping coupled with dedication of portion of the net water to the stream). This may be the most effective way to retire water rights in the future. Certainly a poor cost-benefit ratio has had that effect in the past.

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WATER USE EFFICIENCY: CROPPING CHANGES						
ISSUES: Lack of stream flows influenced by diversion can impact coho salmon habitat. Certain crops or practices may not be the most efficient use of water.						
SOLUTIONS: Research and suggest voluntary changes in cropping or practices that reduce water consumption and/or improve yield.						
4	D	WUE-6a	Research and suggest voluntary cropping changes that reduce water consumption and/or improve yield. **Short-term:** Prepare a document reviewing all known crops capable of being grown commercially in this area, showing yield/acre likely, current market price, water requirements, growing season. For any that look promising in terms of water consumption, do further assessment of barriers to their use, including difference in return per acre vs. existing crops, marketing hurdles, processing hurdles, equipment processing and storage hurdles, and market limitations. **Long-term:** Implement if feasible. Periodically review and update crop review document. If deemed feasible, partner with other producers throughout the watershed as appropriate, to establish guidelines for verification and marketing processes. If mechanical barriers are identified to otherwise promising potential changes, develop plans to address those hurdles if local producers can be encouraged to show interest. Where barriers are primarily economic, develop an approach that could subsidize conversion by willing producers.	UC Davis Cooperative Extension, NRCS	Interim	See qualitative discussion of payments for environmental services.
4	D	WUE-6b	Seek more marketing assistance and begin investigation of promoting local processing plants, thereby allowing people to transition to lower water use crops and to gain more income from value added options. Investigate opportunities to embark on strategy of salmon-safe product marketing as a way to boost value of otherwise economically non-competitive crops or growing procedures. **Short-term:** Seek needed assistance; develop a plan to promote project; implement with County support; investigate RAC funding for processing plant options. If deemed feasible, partner with other producers throughout the watershed as appropriate; establish guidelines verification and marketing processes.	Siskiyou County, Siskiyou County EDC, Farm Bureau, Farm Extension	Interim	See qualitative discussion of payments for environmental services.
4	D	WUE-6c	Launch a project to take advantage of changing opportunities in the beef industry for niche markets, which can provide greater financial returns and possible water savings as a result of the value-added option. **Short-term:** Develop a workshop model that addresses risk involved in starting a niche-oriented business; production flow and related issues; product marketing; pricing; applicable State and federal regulations. Proceed with implementing workshops and making available marketing and other support to carry out the program. **Long-term:** Implement this project concurrently with efforts to establish local processing plants.	UC Davis Cooperative Extension, USDA field personnel, RCDs, CRMP, Siskiyou County EDC	Interim	See qualitative discussion of payments for environmental services.

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WATER USE EFFICIENCY: TAILWATER RECLAMATION						
ISSUES:	Tailwater (agricultural runoff) may negatively impact coho salmon and coho salmon habitat by returning water that is nutrient rich and/or high temperature.					
SOLUTIONS:	Tailwater return systems can provide beneficial impacts and water conservation opportunities.[5]					
4	E	WUE-7a	Conduct basin-wide assessment of irrigation practices to identify opportunities to improve water use efficiency in order to reduce tailwater creation. Identify areas of tailwater inputs that cannot be reduced by improved irrigation practices. **Short-term:** Conduct assessment. Coordinate with TMDL process. **Long-term:** Prioritize remedial measures identified in assessment.	RCDs, SRWC, NCRWQCB, CRMP	Interim	$176,000 for study.
4	D	WUE-7b	Research and promote methods and opportunities to first minimize and then reclaim tailwater where it can be justified and is legally permissible. Priority should be given to shared systems. **Short-term:** Provide agricultural engineering assistance to evaluate irrigation practices, soil depth, costs, and other factors that affect creation of tailwater on a ranch-by-ranch basis. Provide an agricultural waiver to eliminate red tape and permitting hurdles that currently block construction of tailwater systems, while retaining assurances that conditions will not be made worse by system proposed. Formalize local review group and process to assure cost effectiveness and prevent collateral damage **Long-term:** Develop more comprehensive plans to capture and re-use tailwater as efficiently as possible, e.g., possibly build larger systems addressing multiple owners, rather than a cascade of individual ponds.	NRCS, RCDs, NCRWQCB	Interim/ Ongoing	See WUE-7a.
4	C	WUE-7c	Develop a comprehensive evaluation and ranking process to be adopted by funding sources to maximize benefits to coho salmon while minimizing negative impacts possible with tailwater management projects. **Short-term:** Educate funders to understand complexity of this issue via coho salmon process. Strongly advocate the development of a range-wide evaluation process to achieve positive cost/benefit ratio with adequate understanding of effects on instream flows before State or Federal funds are allocated. Implement. **Long-term:** Refine and adaptively manage.	CRMP, DWR, NRCS, Farm Bureau	Interim	See WUE-7a.
WATER USE EFFICIENCY: AGRICULTURAL WATER CONSERVATION BEST MANAGEMENT PRACTICES						
ISSUES:	Current farm operations may not employ agricultural BMPs.					
SOLUTIONS:	Develop Agricultural Water Conservation BMPs that meet the needs of local landowners, particular with respect to regulatory issues.					
4	D	WUE-8	Develop Agricultural Water Conservation BMPs. **Short-term:** Revive Resource Management Advisory Committee (RMAC)-type planning approach. Get stakeholder agencies (State and Federal) to work with agriculture to develop a BMP/Safe Harbor program.	UC Davis Cooperative Extension, NRCS, DWR, NCRWQCB	Interim	See WUE-7a.

[5] Tailwater capture and reuse projects should only be done after reasonable measures have been taken to minimize its creation in the first place, information has been gathered to quantify magnitude of problem to be solved to assure cost effectiveness of individual project, and adequate assurances are in place to prevent further dewatering of the system as a whole. There is an inherent risk of trading improvements in water quality for losses in water quantity if new land is irrigated with the tailwater, or existing irrigated ground is irrigated more than it previously had been.
Establish prioritization process and guidelines to direct future funding from all agency sources toward those projects that accomplish water quality improvements only where protection is included to assure that it will not be done by sacrificing instream flows, thereby jeopardizing other users and fish.
Reductions in tailwater may contribute to dewatering of system if new land is irrigated.
Efficiency measures may not yield benefits in terms of water quantity if losses are currently either returning to the system, or are used by others who would shift to other surface sources if tailwater were eliminated.
Efficiency measures may not improve quality if tailwater does not reach the stream.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
PROTECTION — SHASTA VALLEY HSA, SCOTT BAR HSA, AND SCOTT VALLEY HSA						
PROTECTION						
ISSUES: Adult coho salmon migrate upstream and spawn during the winter months, juveniles remain (rear) in the mainstem and tributary streams for one full year before they migrate downstream and out of the watersheds. Throughout the course of that year, there are many activities that take place that could minimize the production of coho salmon.						
SOLUTIONS: Promote coho salmon recovery by minimizing the potential for entrainment in diversions, protecting riparian vegetation, encouraging effective land-use planning and enforcing of existing regulations.						
4	E	P-1	Screen all diversions in the known and potential range of coho salmon. **Short-term:** Identify funding and complete ongoing screening program within known and potential range of coho salmon. Assess habitat that will be made accessible to coho salmon after completion of scheduled projects. Coordinate between involved Federal and State Agencies, local and private entities to develop a prioritized list of any remaining unscreened diversions and action plans including designs. **Long-term:** Deal with screen maintenance problems. Identify funding and complete ongoing screening program within the known and potential range of coho salmon. Develop protocols for coho salmon trapping and relocation. Establish verification procedures to assure that screens are properly installed and maintained by person(s) benefiting from use of the screened diversion. Support evaluation of, and transition to, less labor intensive designs to minimize future maintenance.	CDFG, SRWC, CRMP, RCDs, Landowners	Interim	Little or no incremental cost.
4	D	P-2	Promote and encourage protection of riparian zones that are important for coho salmon through fencing or other measures. Use grazing management, where appropriate, in association with vegetation utilization monitoring and stream-bank protection. **Short-term:** Identify and continue to develop incentive based programs (e.g., NRCS's CRP) for riparian protection zones. Develop GIS layer for accomplished and needed protection areas. Limit funding to planting of trees from local native stock only. Provide funding for greatly expanded tree re-planting program. Provide protection for remaining large trees along Shasta from beavers. Provide public with visual aids and recognition of achievement of desired future condition. Fund studies to solve regeneration problems as found in Shasta due to altered hydrological cycle and Scott due to drop in groundwater level. All riparian areas within range of coho salmon will be identified and protected within 5 years. **Long-term:** Develop long range riparian protection goals statement and recommendations based on stream meander width (e.g., Rosgen et al.). Continue to emphasize need to establish/protect/maintain desired conditions. If consequences of altered hydrograph in Shasta cannot be overcome with native trees, investigate and develop biologically appropriate recommendations.	Siskiyou County, NRCS, SRWC, NCRWQCB, CRMP, RCDs, Landowners, UC Cooperative Extension	Interim	Little or no incremental cost.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION Short-term Action (if stated), Long-term Action (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
PROTECTION (continued)						
4	E	P-3	Expand routine/ daily fish screen maintenance program (volunteer and paid) whether installed with grant funds or by the CDFG. **Short-term:** Local groups to work with CDFG and NOAA to develop comprehensive maintenance program by 2005. Work with screen users to develop inspection verification procedure for use after transition period. Use time afforded by grant funds to transition away from non-owner screen maintenance and, where appropriate, transfer screen maintenance to the diverter. Prepare maintenance manual, provide part names, numbers and sources, encourage local hardware or farm supply store to stock parts subject to wear, or make arrangements for CDFG to stock and sell. Use existing grant-funded personnel to assess existing screens (public and private) to identify all normally replaceable parts used, to modify screens where possible to standardize all parts possible, and prepare hardware lists of replacement parts and number of screens needing each. **Long-term:** Long-term procedure should implement inspection/verification, integrated with verification of water use described in WM-2. Provide periodic on-site training on proper screen maintenance and repair.	CDFG, SRWC, CRMP, RCDs, Landowners	Interim	$60,000/yr for outreach. Other costs covered by WM-2.
4	E	P-4	Evaluate fish rescue and relocation program. Make improvements if program is viable, and develop steps to minimize the need for rescue and relocation within 5 years. **Short-term:** CDFG develops a fish rescue plan, which will include identification of areas of suitable habitat for all coho salmon life stages, trapping sites, release sites, responsible parties and effectiveness monitoring. Schedule any additional necessary field surveys, create GIS map of problem areas, assess causes of each, then develop list of actions needed to minimize need for fish rescue. **Long-term:** Work to address problems responsible for bulk of rescue needs.	CDFG	Ongoing	Little or no incremental cost.
4	E	P-5	Develop construction and removal procedures or alternate means of diverting water for irrigation dams (gravel or flashboard) that minimize impacts to coho salmon. **Short-term:** Identify locations of existing structures, assess impacts to coho salmon, and recommend improvements to procedures and individual structure design. Work with diverters to implement these improvements. Determine timing of coho salmon emergence. In Shasta, proceed to implementation phase, complete assessments. Eliminate passage problems wherever possible, install or replace ladders where necessary as short term fix. Provide qualified CDFG engineer for design assistance in retrofitting barriers with ladders or correcting problems with locally produced and installed ladders as short term, temporary fix. Develop BMPs for removal/ replacement/ operation, and include these in 1600 process and monitor for effectiveness for both agriculture and fish. **Long-term:** Work with other agencies to assure that additional barriers are not created in future. Eliminate or reduce passage problems where ladders were used as short-term solutions or mitigation. Fund experimental designs to test approaches under local field conditions.	CDFG, SRWC, CRMP, RCDs, DWR	Interim	Incremental cost is development of BMPs. Approximate cost is $200,000.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
PROTECTION (continued)						
4	C	P-6	Recommend to County to develop agricultural land use policies addressing coho salmon recovery actions, ideas and protections. **Short-term:** Develop agricultural land use policies as appropriate to address coho salmon recovery actions, ideas and protections. **Long-term:** Implement County agricultural land use policies as appropriate.	Siskiyou County	Long-term	See qualitative discussion of land use.
4	E	P-7	Recommend enforcement of existing laws, codes, regulations and existing court decrees that are relevant to coho salmon recovery. **Short-term:** Support adequate funding of agencies with enforcement authority. Develop outreach, information and education program specific to existing laws, codes, regulations and existing court decrees. Recommend to local Fish and Game Commission that fines go to recovery restoration efforts **Long-term:** Continue enforcement.	CDFG	Interim	See qualitative discussion of enforcement.
MONITORING AND ASSESSMENT — SHASTA VALLEY HSA, SCOTT BAR HSA, AND SCOTT VALLEY HSA						
MONITORING AND ASSESSMENT: HABITAT						
ISSUES:	Monitoring and assessment actions are needed in both watersheds to identify and evaluate limiting factors for coho salmon, assist in the prioritization of management alternatives, and evaluate the implementation and effectiveness of individual restoration actions.					
SOLUTIONS:	The SSRT should seek to provide for physical access following acceptable protocols and agreements for community based organizations (SRWC, Shasta River CRMP, SOSS) and public agencies (State, federal, local) to conduct monitoring and assessment activities. To maximize the cost effectiveness of monitoring and assessment work, activities in both HSAs should be closely coordinated with ongoing local and regional monitoring programs. Information collected should be grouped and aggregated for public release so that privacy is not violated and made available through web-based linkages and databases. To evaluate the effectiveness of individual restoration actions, funds should be provided to monitor changes in both habitat parameters and potential response by coho salmon following implementation.					
4	D	MA-1a	Where agricultural roads have a potential effect on coho salmon, conduct roads inventory and assessments including the location of fish barriers and sediment delivery potential. Monitor physical changes to aquatic resources through time. **Short-term:** Identify and prioritize sediment sources and passage problems for correction. **Long-term:** Implement remediation actions and monitor effectiveness over time.	CDFG, SRWC, NCRWQCB, CRMP, RCDs	Interim	
4	D	MA-1b	Identify and assess riparian vegetation coverage and condition and monitor changes through time. **Short-term:** Design and implement assessment and monitoring. **Long-term:** Continue implementation.	CDFG, SRWC, NCRWQCB, CRMP, RCDs	Ongoing	
4	E	MA-1c	Assess baseline physical habitat conditions including but not limited to channel structure, side channel (including beaver ponds), spawning gravel, riparian vegetation, habitat complexity/connectivity, large woody debris recruitment, and monitor changes in habitat quality and quantity including those associated with restoration activities. **Short-term:** Design and implement comprehensive assessment and monitoring incorporating protocols developed in range-wide or regional monitoring programs. **Long-term:** Continue implementation.	CDFG, SRWC, CRMP, RCDs	Ongoing	

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
MONITORING AND ASSESSMENT: HABITAT (continued)						
4	E	MA-1d	Assess water quality/quantity parameters including but not limited to dissolved oxygen, pH, suspended sediment, temperature, turbidity, flow, hyporheic flow, nutrients/pollutants (agricultural return flows, pesticides, herbicides, wastewater) and monitor changes through time. Identify and assess point and non-point pollution sources (e.g., irrigation returns, sediment). Coordinate with the TMDL process. **Short-term:** Design and implement comprehensive assessment and monitoring incorporating protocols developed in range-wide or regional monitoring programs. **Long-term:** Continue implementation.	NCRWQCB, SRWC, CRMP, RCDs	Interim	
4	E	MA-1e	Complete inventory and mapping of surface water diversions within the Scott and Shasta Valleys. **Short-term:** Complete study including QA/QC. **Long-term:** Incorporate into planning process.	CDFG, DWR	Long-term	
4	C	MA-1f	Identify and assess effects of flood control levees on over wintering and other habitat conditions for coho salmon and monitor habitat changes through time. **Short-term:** Find USACE and NRCS records of activity for both HAs. Determine effects of levee system. **Long-term:** Determine feasibility. Develop and implement remediations based on results of assessments.	SRWC, CRMP, RCDs	Ongoing	$200,000.
4	D	MA-1g	Inventory, assess, and monitor effectiveness of water use efficiency/water conservation, water augmentation and water management projects expected to contribute to instream flow. **Short-term:** Design and implement comprehensive monitoring program. Work with DWR to predict effectiveness of the various water use efficiency and conservation practices in both valleys. **Long-term:** Compile results and incorporate into planning.	SRWC, CRMP, RCDs, NRCS	Long-term	
4	D	MA-1h	Inventory, assess, and evaluate instream habitat and riparian restoration project activities and BMPs and monitor effectiveness in improving habitat for coho salmon. **Short-term:** Design and implement comprehensive assessment and monitoring incorporating protocols developed in range-wide or regional monitoring programs. Make sure effectiveness monitoring is a component of future habitat improvement projects. **Long-term:** Continue implementation and incorporate into future management plans or actions.	CDFG, SRWC, CRMP, RCDs	Interim	
4	C	MA-1i	Inventory, evaluate, and monitor changes in land use practices over time including conversion from agriculture to other uses for impacts on coho salmon and their habitat. **Short-term:** Collect baseline data. **Long-term:** Evaluate and incorporate information into the County land use policy.	SRWC, CRMP, RCDs, Siskiyou County, DWR	Interim	
4	D	MA-1j	Conduct adult and juvenile current and potential carrying capacity estimates and monitor changes over time. **Short-term:** Assess and estimate current and potential carrying capacity. Evaluate potential method for predicting carrying capacity. **Long-term:** Apply abundance data to determine realization of carrying capacity.	CDFG, NOAA Fisheries	Interim/ Continual	

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated)**, Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
MONITORING AND ASSESSMENT: HABITAT (continued)						
4	E	MA-1k	Conduct groundwater monitoring in support of the studies referred to in WM-10a and WM-10b. **Short-term:** Support and expand coverage and frequency of current DWR and local group long-term monitoring. If ground water is used to supplement surface water for instream flows, monitor the effects on stream flows and well levels. Collect and distribute monitoring data from additional wells to establish groundwater contours. **Long-term:** Information to be provided to groundwater committee referred to in WM-10c. Continue long-term monitoring.	DWR	Interim/ Ongoing	
MONITORING AND ASSESSMENT: COHO SALMON POPULATIONS						
ISSUES:	Baseline information is needed on the distribution and abundance of coho salmon within both watersheds. Monitoring coho salmon populations over time is necessary to determine long-term trends in abundance, evaluate the effectiveness of coho salmon recovery actions and progress toward meeting recovery goals, and provide data to guide changes in management actions. Availability of baseline information is affected by the difficulty, due to high winter flows, of counting adult salmon.					
SOLUTIONS:	Work with CDFG and other fisheries experts to develop and implement a program to monitor coho salmon abundance and distribution within the Shasta Valley and Scott River HSAs. Integrate this program with existing regional and range-wide monitoring efforts.					
4	E	MA-2a	Conduct limiting factors analysis and monitor changes through time by life stage for coho salmon. **Short-term:** Identify additional data needs to complete both efforts. Assess disease as a limiting factor. **Long-term:** Develop management plans for remediation of limiting factors. Monitor effects to coho salmon populations and habitat.	CDFG, NOAA Fisheries, SRWC, CRMP	Interim/ Ongoing	$176,000.
4	E	MA-2b	Continue to identify the historic and current distributions of coho salmon adults and juveniles within the Scott Bar, Scott Valley, and Shasta Valley HSAs. **Short-term:** Identify, evaluate, and map coho salmon spawning and rearing habitat utilization areas and monitor changes through time. **Long-term:** Monitor and analyze spatial structure and changes in distribution through time. Continue to implement and use results to modify monitoring protocols, and modify restoration techniques.	CDFG, SRWC, CRMP, RCDs, NOAA Fisheries	Interim/ Ongoing	
4	E	MA-2c	Conduct adult and juvenile abundance estimates and monitor changes over time. **Short-term:** Begin abundance surveys. Develop and implement statistical methodology for adult and juvenile salmon. Improve methods for counting adult salmon in the Scott. **Long-term:** Continue and improve abundance surveys. Use data to develop annual adult and out-migrant abundance estimates for both valleys.	CDFG, NOAA Fisheries	Interim/ Continual	
4	D	MA-2d	Conduct analysis of juvenile growth rates and production estimates and monitor changes through time. **Short-term:** Develop and implement a comprehensive study plan with appropriate agencies **Long-term:** Continue studies and apply results as appropriate.	CDFG, NOAA Fisheries	Interim/ Continual	

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated)**, Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
MONITORING AND ASSESSMENT: COHO SALMON POPULATIONS (continued)						
4	C	MA-2e	Conduct standard measurements of trapped spawners and carcasses **Short-term:** Develop egg production estimates and spawner age distribution **Long-term:** Apply data via appropriate agencies.	CDFG, SRWC, CRMP, RCDs	Interim/ Ongoing	$176,000.
4	C	MA-2f	Identify adult and juvenile diversity (genotypic/phenotypic) variations within the Scott and Shasta rivers for comparisons with other populations within the SONCC Coho ESU. **Short-term:** Coordinate with State and Federal agencies in collection of tissues. **Long-term:** Make both phenotypic and genotypic data available to appropriate agencies and public.	CDFG, NOAA Fisheries	Long-term	$176,000.
4	C	MA-2g	To evaluate food availability, conduct macroinvertebrate assessments and monitor changes through time. **Short-term:** Expand studies and analyze results. **Long-term:** Apply results as appropriate.	CDFG, SRWC, CRMP, RCDs, DWR	Long-term	$176,000.
4	E	MA-2h	Assess effectiveness of fish rescue program through monitoring survival of rescued fish. **Short-term:** Support CDFG effort to monitor and assess the survival of the rescued fish. **Long-term:** Provide assistance in monitoring fish survival.	CDFG	Interim/ Ongoing	
EDUCATION AND OUTREACH — SHASTA VALLEY HSA, SCOTT BAR HSA, AND SCOTT VALLEY HSA						
EDUCATION AND OUTREACH						
ISSUES:	1) Coho salmon recovery cannot succeed without buy-in from local people. Education and outreach can help landowners and members of the public understand why restoring coho salmon and their habitat is worthwhile, and how they can help. 2) To improve funding opportunities for restoration, education must also be targeted towards agency and elected officials at the State and Federal levels, to inform them about local efforts and successes in the Shasta and Scott valleys.					
SOLUTIONS:	Use events, workshops, and various forms of media to encourage changes in attitudes and behavior that enhance coho salmon recovery.					
4	D	EO-1	Use existing extension services to inform landowners of funding programs for water conservation, fish habitat restoration, and Best Management Practices (BMPs). **Short-term:** Advertise available funding sources, assist landowners in identifying projects for support (based on CRT recommendations), and provide grant writing resources/ training. Monitor extension effectiveness (# projects funded, # projects implemented) on a routine basis. **Long-term:** Expand extension efforts to include all interested landowners. Insure that all priority projects are funded. Continue to monitor extension effectiveness.	NRCS, UC Davis Cooperative Extension, USFWS, CDFG	Interim/ Continual	**Short-term:** $20,000/year. **Long-term:** $20,000/yr.
4	D	EO-2	Sponsor land stewardship training courses (e.g., ranch planning, road maintenance, alternative stock watering system development and maintenance, irrigation ditch maintenance, and water use efficiency, prioritizing activities that tangibly increase instream flows and improve water quality). **Short-term:** Implement local-adapted land stewardship courses. **Long-term:** Expand locally adapted land stewardship courses and monitor their effectiveness.	SRWC, NCRWQCB, CRMP, RCDs, UC Davis Cooperative Extension, NRCS	Interim/ Continual	**Short-term:** $50,000/yr. **Long-term:** $50,000/yr.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated)**, Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
EDUCATION AND OUTREACH (continued)						
4	C	EO-3	Fund demonstration projects on land with public access, showing fish-friendly BMPs and associated agricultural innovations. **Short-term:** Identify locations for demonstration projects. Undertake integrated restoration efforts at these sites. Organize tours to visit these demonstration projects. Organize tours of successful demonstration projects in other watersheds, to gain inspiration. **Long-term:** Continue to improve demonstration projects, while developing an active research program to assess demonstration project effectiveness.	SRWC, CRMP, RCDs, UC Davis Cooperative Extension, NRCS, USFWS	Interim/ Continual	**Short-term:** $75,000/yr. **Long-term:** $75,000/yr.
4	D	EO-4	Use available outreach resources to inform landowners about existing riparian easement or lease programs and how to participate in them. **Short-term:** Contact landowners and help them identify how riparian easements can assist them in achieving land management objectives. Identify funding sources to help compensate landowners for establishing and maintaining riparian easements. **Long-term:** Expand outreach efforts throughout the Shasta and Scott valleys.	SRWC, CRMP, RCDs,	Interim/ Continual	**Short-term:** $3,000/yr. **Long-term:** $3,000/yr.
4	C	EO-5	Enhance funding for school systems to continue and expand watershed and fisheries education (examples of activities already done in Siskiyou County: aquarium incubators in classrooms; a riparian plant nursery; student participation in spawning survey data gathering). **Short-term:** Increase participation in current programs, and expand them to other agencies and communities. Evaluate program effectiveness and revise as necessary. **Long-term:** Review overall effectiveness of ongoing programs and revise as necessary. Create new watershed and fisheries education programs.	Schools, Tribes, CDFG, SRWC, CRMP, RCDs	Interim/ Continual	**Short-term:** $75,000/yr. **Long-term:** $75,000/yr.
4	C	EO-6	Develop and distribute widely an informational brochure explaining coho salmon life history, habitat requirements, and both its historic and recent distribution. **Short-term:** Develop this brochure and print 10,000 copies. **Long-term:** Revise and reprint the brochure as needed.	CDFG, Private Graphics Consultant	Interim	**Short-term:** $10,000/yr. **Long-term:** $10,000/yr.
4	C	EO-7	Develop and distribute widely a newsletter describing current fisheries restoration efforts, as well as how the public can become involved. **Short-term:** Publish a newsletter (15,000 copies) that is inserted into local newspapers once every six months, beginning in late summer/fall 2003. **Long-term:** Continue to publish a newsletter at least once a year.	SRWC, Siskiyou RCD, CRMP, RCDs, Siskiyou County, CDFG, USFWS, NOAA Fisheries	Interim/ Continual	**Short-term:** $20,000/yr. **Long-term:** $15,000/yr.
4	C	EO-8	Develop and distribute an informational brochure describing plant species recommended for riparian restoration, emphasizing the use of native plant species and matching species to specific stream-bank conditions. Causes of past riparian planting failures and remedies to these will be discussed. **Short-term:** Consult past and continuing local riparian restoration programs to gather information about riparian species nursery management, restoration site selection, outplanting, and plant protection. Use this information to develop the brochure. **Long-term:** Monitor riparian restoration project effectiveness (e.g., plant survival, increased cover, lowered water temperatures, improved bank stabilization, and then revise and reprint the brochure as needed.	Siskiyou County, SRWC, CRMP, RCDs, CDFG	Interim	**Short-term:** $3,500/yr. **Long-term:** $3,500/yr.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
EDUCATION AND OUTREACH (continued)						
4	C	EO-9	Develop and distribute a publication targeting non-agricultural landowners that highlights the importance of not removing riparian vegetation, and the beneficial role of LWD in properly functioning streams. **Short-term:** Publish an annual newsletter (1,000 copies) and distribute via local, State and Federal agencies. Offer incentives to participate in riparian protection/enhancement programs (free workshops on riparian restoration, free riparian species seedlings, etc.). Provide recognition and awards to exemplary non-agricultural land-owners, highlighting their riparian protection/restoration efforts. Coordinate with the Yreka Creek Committee in designing complementary riparian protection programs. **Long-term:** Continue to publish a newsletter at least once a year. Expand initiatives that enhance protection and recovery of riparian areas, especially where beneficial to coho salmon.	SRWC, Siskiyou RCD, CRMP, RCDs, Siskiyou County	Interim/ Continual	**Short-term:** $2,500/yr. **Long-term:** $5,000/yr.
4	C	EO-10	Based on a literature review of beaver-salmon interactions, publish a brochure to educate the public about the impacts of beavers and their dams on coho salmon and coho salmon recovery. **Short-term:** Review beaver-salmon interaction literature to provide a basis for brochure content. **Long-term:** Revise and republish brochure as necessary.	CDFG	Long-term	**Short-term:** $1,000/yr. **Long-term:** $1,000/yr.
4	C	EO-11	Produce a locally oriented fish-friendly road and stream care handbook for free distribution. **Short-term:** Develop this handbook and print 1,000. **Long-term:** Update every two years, or as needed.	SRWC, CRMP, RCDs, CDFG, Tribes, Siskiyou County	Interim	**Short-term:** $25,000. **Long-term:** $7,500 every two yrs.
4	D	EO-12	Produce a brochure targeted at prospective landowners, real estate agents, and title companies that describes adjudicated water rights, irrigation ditch easements, and the requirements and responsibilities associated with them. The brochure should emphasize that access to ditches with easements must be granted to allow for ditch maintenance and repair.	DWR, Siskiyou County	Interim	$500.
4	C	EO-13	Recruit local media and media personalities to inform the public about restoration efforts. Develop and submit Opinion-Editorial pieces related to local coho salmon restoration efforts/issues. **Short-term:** Interview local people spearheading fish restoration efforts for radio, newspapers, and cable TV. Do this quarterly. **Long-term:** Continue to produce interviews and reports for local radio, newspapers, and cable TV every three months.	SRWC, CRMP, RCDs, Schools, Siskiyou County, Tribes, CDFG	Interim/ Continual	**Short-term:** $5,000/yr. **Long-term:** $5,000/yr.
4	C	EO-14	Use media professionals to create informational videos that are local in context, to be shown to schools, service clubs, county fair-goers, etc. **Short-term:** Shoot informational video during 2003-2004 (during all four seasons). Edit video during latter portion of 2004. Begin using video in early 2005.	SRWC, CRMP, RCDs, Tribes, USFWS, CDFG	Interim	**Short-term:** $25,000.
4	C	EO-15	Establish a web site with coho salmon biology information, up-to-date restoration grant funding, and examples of projects. Ask local websites to provide a link to this coho salmon site. **Short-term:** Create website and make operational by the end of 2003. Provide for monthly website maintenance and updates. **Long-term:** Continue to maintain and update website monthly.	CDFG	Interim/ Continual	**Short-term:** $5,000. **Long-term:** $1,000/yr.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
EDUCATION AND OUTREACH (continued)						
4	C	EO-16	Develop an informational PowerPoint presentation on coho salmon recovery and provide this to local groups (service organizations, county fair, local extension offices, etc.). **Short-term:** Develop PowerPoint presentation, send to other agencies/groups for review, then revise and distribute. **Long-term:** Update every two years, or as needed.	CDFG, SRWC, CRMP, RCDs, and other agencies to provide review.	Interim	**Short-term:** $1,000. **Long-term:** $1,000 every two yrs.
4	D	EO-17	Establish contacts and organize events that bring resource-dependent people from throughout the Klamath Basin together, and that foster communication, friendship, and cooperation. **Short-term:** Organize an event/gathering that people throughout the Klamath Basin might want to attend (SSRT brainstorming needed). **Long-term:** Continue to organize basin wide gatherings regularly, and publicize these gatherings widely.	CDFG, USFWS, NOAA Fisheries, Tribes, and the public.	Interim/ Continual	**Short-term:** $10,000/yr. **Long-term:** $7,500/yr.
4	C	EO-18	Organize an annual (coho) salmon festival, inviting the general public. Put on a mini version of this festival at the county fair, to help advertise the event. **Short-term:** Select an optimal season (fall?) and date, and organize a salmon festival at this time every year. **Long-term:** Continue to organize annual salmon festivals.	SRWC, CRMP, RCDs, Siskiyou County, Tribes, and all agencies.	Interim/ Continual	**Short-term:** $5,000/yr. **Long-term:** $5,000/yr.
4	C	EO-19	Provide the public with information about the California Irrigation Management Information System (CIMIS) **Short-term:** Produce CIMIS informational materials for circulation through a variety of media. Update CIMIS informational materials every two years and re-circulate.	DWR	Interim/ Continual	**Short-term:** $1,000/year **Long-term:** $1,000 every two yrs.
4	D	EO-20	For each of the Shasta and Scott watersheds, organize a quarterly forum for exchange of information between parties collecting data, conducting research, and implementing restoration projects on the ground. These meetings will be open to the public. **Short-term:** Organize meetings in the Shasta and Scott watersheds quarterly. **Long-term:** Continue to organize quarterly meetings.	SRWC, CRMP, RCDs	Interim/ Continual	**Short-term:** $800/yr. **Long-term:** $800/yr.
4	D	EO-21	Produce quarterly Congressional Briefings (State and Federal). **Short-term:** Each briefing should summarize recent fish run trends, projects funded/ completed, projects recently applied for, upcoming project applications, and pressing issues. **Long-term:** Continue to submit quarterly Congressional Briefings.	SRWC, CRMP, RCDs, Siskiyou County, USFWS, NOAA Fisheries, CDFG	Interim/ Continual	**Short-term:** $1,000/yr. **Long-term:** $1,000/yr.
4	D	EO-22	Conduct tours for media, legislators (State and Federal), schools, public, and others to show coho salmon and habitat recovery efforts. **Short-term:** Organize tours during summer, late fall (during coho salmon run), and spring. **Long-term:** Continue to organize tours, as necessary.	SRWC, CRMP, RCDs, CDFG, Tribes, Siskiyou County	Interim	**Short-term:** $1,000/yr. **Long-term:** $1,000/yr.

11 Economics of Recovery

An estimate of the cost of implementing the Recovery Strategy is required by California statute. In cooperation with the CRT and the SSRT, quantitative estimates were developed for both the fiscal cost of implementing the Recovery Strategy, and the socioeconomic impacts of implementing the Recovery Strategy. Summary information is provided below. For a more in-depth discussion, refer to the complete economic report in Appendix I.

The assumption in the economic analysis is that Governments will bear the cost of "positive" incentives needed to acquire water, conservation easements and other assets, and will also bear the cost of public works projects, dam removal, and timber management Alternative C, which was selected for inclusion by the Commission. Private landowners will bear the cost of coming into compliance with existing laws and the cost of additional regulations that pertain to listing of the species.

11.1 ECONOMIC BENEFITS

Coho salmon recovery will have significant costs, but will also provide economic benefits. Benefits associated with Yurok and Hoopa Valley tribes' Federally reserved fishing rights, increased commercial land and water use activities, multiple species benefits, and improved water quality, and watershed health will be realized, but they are not quantified. Coho salmon recovery will also result in benefits to recreational and commercial fishing and related industries, which are also not quantified in this document.

Benefits associated with non-use values include intrinsic, or existence, values which are derived from the knowledge that coho salmon populations exist, and bequest values which confer value to the resource for the benefit of future generations. Based on studies that examined streams in Colorado and salmon restoration in the Columbia River Basin, the San Joaquin River, and the Elwha River, the extrapolated value of California coho salmon recovery could be significantly larger than the fiscal or socioeconomic costs of recovery.

11.2 FISCAL COSTS AND SOCIOECONOMIC IMPACTS

The economics analysis (Appendix I) considers the costs of a variety of recovery recommendations implemented in diverse regions of California. The fiscal or budgetary cost of a recovery recommendation is the expenditure needed to physically perform the action. The socioeconomic impact of a recovery recommendation includes: 1) income foregone because the recovery recommendation is undertaken, and 2) transfers to the local region (in this case, the HSA) from outside the region because the recovery recommendation is undertaken.

Fiscal cost impacts of the various recovery recommendations are presented in the simplest possible terms: the current dollar cost of completing the project now. Absent information about the specific sequencing of recovery recommendations over the coming decades, and lacking information on how State obligations would be financed, it is impossible to calculate financing costs, or convert actions over some period of time into current dollar equivalents. Instead, the costs were simply calculated as if all recovery recommendations would be completed immediately.

In order to develop these cost and impact assessments, the primary unit of analysis is the HSA. There are three classes of recovery costs at the HSA level. The first class of costs is the cost of commonly recommended recovery recommendations that are proposed for many HSAs. The second category is those costs unique to the specific circumstances of an HSA or HU. The third category is costs that have been identified but which cannot be quantified at this time. Each of these classes of costs has associated socioeconomic impacts.

The total fiscal cost of the Recovery Strategy is about $4.5 billion. This cost estimate may understate the full cost of Recovery Strategy implementation, because some costs cannot be quantified at this time. There is limited information available about the quantity of each recovery action that will be undertaken and these cost estimates can be revised as additional information becomes available. On the other hand, this cost estimate may overestimate the cost of Recovery Strategy implementation because some costs may be incurred even if the Recovery Strategy were not implemented. In addition, some costs may be incurred as a result of actions taken to avoid take of coho salmon or to fully mitigate impacts of authorized take once the species is listed. The following cost estimates must be viewed with these considerations in mind.

Using the current level of information on the recommendations contained in this strategy, about $466 million, or 9% of the total, will be incurred to implement the SSPP. However, it should be noted that the actual fraction of costs incurred in Shasta Valley and Scott River HAs will be less than this because the cost of water acquisition has been included for the SSPP, but has not been measured for the rest of the coho salmon range. The SSPP recommendations also are intended to be more focused than those in other watersheds. Nonetheless, a notably large portion of costs will be incurred in these HAs. If water acquisition costs in other areas of the SONCC Coho ESU and in the CCC Coho ESU are proportional to those in the SSPP (where water acquisition accounts for about 20% of the total) it is likely that the costs of recovery under the strategy will approach $5 billion.

Restoration costs are higher in the SONCC Coho ESU than the CCC Coho ESU, likely because coho salmon are more widely distributed within the SONCC Coho ESU. Costs are especially high in the Klamath River HU, where Iron Gate Dam is located. High costs were also noted in the Mendocino Coast and Trinity River HUs. These three HUs, combined, account for over 85% of measured restoration costs.

Monitoring, evaluation, planning, and education and outreach costs are about $90 million dollars; about 2% of total estimate fiscal costs. There are no significant socioeconomic impacts associated with these recommendations.

Restoration activities will generate positive socioeconomic impacts. Socioeconomic impacts generated from restoration equal about one-half of the fiscal costs of restoration or $2.1 billion. The socioeconomic impacts of water acquisition in the SONCC range will be negative (for the SSPP these negative impacts equal about $6 million), as will the socioeconomic impacts of timber management changes. Negative socioeconomic impacts of the timber management changes are not expected to be significant. Implementing the timber management recommendations will result in few incremental costs.

11.2.1 UNIT COSTS

In the first step of measuring the economic cost and impact of implementing the Recovery Strategy, recovery recommendations common to many HSAs are identified. Unit costs for these activities were estimated, and ways in which costs vary systematically across HSAs were identified. Unit cost estimates were developed for the following commonly recommended recovery recommendations:

a. Removing or alleviating barriers to fish passage;
b. Implementing riparian revegetation and other stream-bank improvements;
c. Improving in-stream complexity, including the placement of LWD;
d. Road treatment and/or decommissioning;
e. Restoring wetlands and off-channel areas;
f. Water acquisitions;
g. Undertaking biological studies to understand and monitor coho salmon behavior;
h. Watershed planning and other non-biological studies;
i. Education and outreach efforts (including improvements in coordination among participants); and
j. Timber management.

Aggregate cost estimates for these common recovery recommendations were developed with a series of restoration cost models. These models are designed to combine unit cost estimates with information on the potential scale at which recommended activities could be undertaken and information about the ways that unit costs are likely to vary across HU/HSAs.[1] At this time, limited information is available about the quantity of each recovery recommendation that will be undertaken. Maximum flexibility was built into these spreadsheet models so that, as additional information about the scale at which recovery recommendations will be undertaken becomes available, more accurate estimates of the aggregate cost of recovery can be made easily and quickly.

In some cases the recommendations in the Recovery Strategy do not provide guidance on the scale at which recommended activities should be undertaken. For example, at the HU- and HSA-level the recommendations do not specify the amount of water acquisition that may be required to meet recovery goals. This omission precludes the comprehensive measurement of the cost of coho salmon recovery. Nonetheless, cost and socioeconomic impact estimates for many recovery recommendations can be developed, and unit costs can be characterized in even more cases.

11.2.1.1 Fish Passage

The cost of treating barriers to fish passage includes a discussion of the unit cost of dam removal, installing fish ladders, treating non-structural sites, replacing culverts, and screening water diversions. To estimate the fiscal cost of treating barriers to fish passage, surveys of the cost of fish passage improvement in general and indicative project costs in California and to a lesser extent Oregon and Washington, were used. The review of historical barrier treatment projects allows an estimate of the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact was calculated in the form of regional transfers that will occur as a result of barrier treatment to be total fiscal costs less that fraction.

[1] A major source of variation is likely to come from regional differences in wage rates since labor costs form a large part of the total unit cost of most recovery recommendations. Data on average wages paid to constructions workers in California counties were used to identify how recovery costs are likely to vary across HSAs as a result of labor costs. For HSAs that fall in more than one county, wages are assumed to be a simple average of the wages in all counties covered

11.2.1.2 Riparian Restoration

The fiscal costs of riparian revegetation or planting and other stream-bank improvement activities, including fencing, depend on the complexity of the project to be undertaken (e.g., the materials to be used), the remoteness of the parcel of land to be treated, and the degree of site preparation that is needed. While the quantity of stream bank that may need treatment and/or riparian planting was estimated, no information is currently available about the nature of sites that will be treated. The unit costs of stream-side activities were estimated using average construction cost estimates developed by the United States Department of Agriculture (USDA) and surveys of historical project costs. The assumption was used that at any stream mile that needs riparian revegetation, the width of the buffer created will be 50 feet. A review of historical projects allows one to estimate the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact was calculated in the form of regional transfers that will occur as a result of riparian revegetation and stream-bank restoration to be total fiscal costs less that fraction. There will be other welfare costs associated with removing land from its highest and best private use and dedicating this land to habitat for salmon. These costs cannot be quantified at this time.

11.2.1.3 In-channel Restoration

The costs of in-channel restoration work, including the placement of LWD, depend on the remoteness of the site to be treated and the width of the waterway to be treated. No information was available about these parameters for the in-stream sites that will be treated as a result of the Recovery Strategy. Illustrative unit costs for these activities were developed by surveying historical project costs and previous literature on this topic. The review of historical projects allows one to estimate the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact was calculated in the form of regional transfers that will occur as a result of in-stream restoration to be total fiscal costs less that fraction.

11.2.1.4 Road Treatment and Decommissioning

The Recovery Strategy contains several broad categories of recommendations dealing with roads, which differ in their unit cost, socioeconomic impacts and, likely, in their cost-effectiveness. The broad categories of recommendations are:

a. Road decommissioning;

b. Road upgrading;

c. Relocation of roads in riparian areas;

d. Implementation of best-management practices (BMPs) in road construction; and

e. Limiting use of roads (e.g., in winter or if road is legally closed).

The average unit cost and socioeconomic impact of road decommissioning and upgrading was estimated based on surveys of historical project costs. However, no information is available about which roads will actually be treated, relocated, or have access limited. This precludes a full accounting of impacts of this class of recovery recommendation.

11.2.1.5 Wetlands Restoration

In a limited number of HUs/HSAs wetlands restoration is mentioned as a recovery recommendation. Many of the activities that fall under the category of wetlands restoration, as defined by the USDA, are also common to the other categories of restoration activities considered. For example, the USDA considers culvert replacement, fencing, and critical area planting to be activities that may be undertaken as part of wetlands restoration. Since the quantities of these activities that will be undertaken in any given HSA are not known, the aggregate cost of wetlands restoration is not calculated distinct from other, related, recovery recommendations. The socioeconomic impacts of wetland restoration will depend on the alternative use of the land devoted to coho salmon as a result of the restoration effort but these costs cannot be quantified at this time.

11.2.1.6 Water Acquisition

The aggregate fiscal cost of water acquisition and/or agricultural land acquisition within the range of coho salmon will depend on the quantity of water and/or land to be acquired and whether water rights will be permanently transferred or purchased for single periods. Because potential sellers of water rights may decide to forgo the agricultural profits they would have gained from irrigating (instead of making alternative arrangements for other sources of water), we can predict that in those circumstances the annual cost of an acre-foot of water in a particular HSA is predicted to be equal to the net agricultural returns (gross returns less operating costs) that water would have created. The unit cost of water acquisition increases sharply when acquisition of irrigation water for pasture is complete and water that is used to irrigate increasingly high value cropland (e.g., wine grapes, broccoli) is acquired.

Taking agricultural land out of production so that more water is available for coho salmon recovery has a socioeconomic cost because land that once provided private income no longer does so. Conceptually, when agricultural land is left fallow because irrigation water has been transferred to serving the needs of coho salmon, the farmer that sold the water right has neither lost nor gained income. However, the laborers that worked this land and the firms that sold the farmer inputs for this land have not been made whole. Their lost income, equal to the farmer's operating costs in the event that the parcel of land had been planted and harvested, is the socioeconomic cost of this recovery recommendation.

Aggregate water acquisition costs are estimated only for the SSPP. The SSPP contains several recovery recommendations intended to increased instream flows for coho salmon. These include, but are not limited to, verifying compliance with adjudicated water rights, donation of unused water rights, providing alternative stock water systems, substitution of groundwater for surface water for irrigation, and water acquisition. It cannot be known with certainty how much water will be produced for coho salmon through each of these strategies. To obtain an estimate of the full costs of securing instream flows for coho salmon, this analysis assumes that additional instream flows will be generated solely through the acquisition of water rights from willing sellers. This assumption is made only for the purposes of an illustrative calculation of the cost of recovery and should not be taken as an endorsement of this approach to increasing instream flows in the SSPP area or elsewhere.

11.2.1.7 Monitoring and Research

Technical studies that the Recovery Strategy recommends range from monitoring efforts to genetic analyses. A review of the Department's inventory of previously funded restoration activities allows us to estimate the cost of recovery recommendations that are technical monitoring or biological research activities when project-specific cost estimates are not readily available. A similar approach is used to estimate the cost of non-biological studies or planning exercises and education and outreach efforts. The assumption is that these costs do not vary systematically by HSA. The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

11.2.2 COST ESTIMATES

The aggregate cost estimates presented in Appendix I include not only the cost of performing recommendations that are common to many HU/HSAs, but also the cost of specific tasks that respond to the unique circumstances of each HU/HSA. Some of these items are a significant portion of the costs estimated here. For example, restoring coarse sediment transport near Iron Gate Dam may cost as much as $500 million. Implementing the Trinity Record of Decision is estimated to cost about $12 million per year.

Separate cost and socioeconomic impact estimates have been developed for the Shasta Valley and Scott River HSAs. The methodology used to estimate the cost of implementing the SSPP is similar to the methodology used to estimate the cost of the general Recovery Strategy. For habitat restoration in particular, the methodology described above is directly applied. However, by working closely with the SSRT cost estimates are provided for nearly every suggested recovery recommendation.[2] These cost estimates are included in Appendix I. This approach reflects the fact that the SSPP contains many recovery recommendations related to water management and acquisition that are not found in the larger Recovery Strategy.

Three alternative sets of recommendations were developed regarding timber management in areas with coho salmon. Alternative C (and elements of Alternative B that have few costs associated with them) were adopted by the Commission. There are few incremental costs and socioeconomic impacts associated with Alternative C and elements 19 and 20 of Alternative B.

The adopted timber management recommendations do not imply significant incremental costs above those estimated in other sections of the economic report. The recommendations call for implementation of road management plans, which may imply that costs will be incurred to decommission or treat roads, treatment of watercourse crossings, riparian revegetation, watershed planning, education, and monitoring of recovery measures. The costs of these actions have been estimated in other sections of the economic report.

To illustrate which costs previously estimated are also associated with the adopted timber management recommendations, the following were identified: 1) HSAs with at least 75 percent of land cover in forest; 2) HUs containing these HSAs; and 3) costs of road treatment, road decommissioning, riparian revegetation, and treatment of stream crossings in those HUs. These estimated costs are summarized in Table 11-1. The total amount of costs associated with timber management recommendations, excluding planning, education, and monitoring, is about $1.7 billion.

Some items included in the estimate of the aggregate cost of the Recovery Strategy are costs that may be incurred even if this Recovery Strategy were not implemented. For example, the cost of implementing the Trinity River Record of Decision is included as a cost associated with coho salmon recovery. To the extent that these costs would be incurred in the absence of this Recovery Strategy, the cost estimates presented here overstate the cost of implementation. In addition, some of these costs may be incurred not as a result of implementing the Recovery Strategy, but as a result of listing to the extent that costs are incurred as a result of actions taken to avoid take or to fully mitigate impacts of the authorized take of coho salmon. On the other hand, costs that would be incurred as a result of the Clean Water Act or other related statutes and regulations were excluded. While TMDL regulations, for example, are quite relevant to coho salmon recovery, costs attributable to this process are not counted as a cost of coho salmon recovery as the regulations would have been enacted anyway. However, many recommendations that target a reduction in sedimentation, which are included in Recovery Strategy costs, will also aid compliance with established TMDLs.

[2] No cost estimates have been developed for P-6, P-7, WUE-6a, WUE-6b, and WUE-6c. At this time, these recommendations are too general to cost.

Tables 11-1 through 11-3 summarize the measured fiscal cost of the Recovery Strategy. Habitat restoration costs are presented by HU; other costs are presented on a range-wide basis. Tables 11-4 and 11-5 summarize the measured socioeconomic impacts of the Recovery Strategy. Habitat restoration impacts are presented by HU, while other costs are presented on a range-wide basis. These estimates include the cost of implementing the SSPP, which is shown separately.

Some identified costs are not calculated at this stage. For example, the aggregate cost estimates in Tables 11-1 through 11-5 do not include specific line items for the range-wide recommendations because the majority of these recommendations cannot be assigned an estimated cost at this time. In addition, the cost of many of the range-wide recommendations will be captured by estimating the cost of the HU/HSA-specific recommendations. Given the magnitude of the measured recovery costs, failure to measure the costs of the range-wide recommendations explicitly does not qualitatively impact the recovery cost calculations. Another important unmeasured cost is the cost of water acquisition outside of the Shasta Valley and Scott River HSAs. These costs are likely to be significant, as are the associated socioeconomic impacts.

Another important unresolved issue with the cost of coho salmon recovery under the strategy is the role of increased enforcement of permits and take restrictions. There is some amount of unpermitted water diversion from streams containing coho salmon, for example, and some diverters take more than their allowable quantity. With regard to other issues like fencing, ESA and CESA take prohibitions may require that ranchers construct fencing and stock watering facilities more than is currently the case. This analysis has not attempted to parse out the total quantity of actions for recovery as opposed to actions required by the listing of the coho salmon. The costs of recovery were calculated based on the increment of various actions relative to the status quo.

The cost of achieving interim recovery goals is likely to include the cost of most of the biological and non-biological studies and watershed plan preparation called for in the Recovery Strategy. These costs will likely be incurred before many restoration costs. Other interim costs will include the cost of implementing restoration recommendations in the highest priority watersheds.

TABLE 11-1: Recovery strategy costs by Hydrologic Unit

HYDROLOGIC UNIT	COST ($)
Big Basin	253,907,283
Bodega	17,574,450
Cape Mendocino	146,915,528
Eel River	612,526,817
Eureka Plain	22,403,308
Klamath River	849,118,462
Mad River	26,176,223
Marin Coastal	57,802,142
Mendocino Coast	780,043,197
Redwood Creek	23,866,194
Rogue River	7,034,832
Russian River	265,193,565
San Francisco Bay	130,564,775
San Mateo	63,270,569
Smith River	21,864,544
Trinidad	21,864,544
Trinity River	564,392,468
Winchuck River	2,827,116
Total SONCC (w/o SSPP)	1,680,502,407
Total CCC	1,465,138,565
Total SONCC/CCC Restoration Costs	3,954,194,850
Total SSPP Restoration	371,583,569
Total Restoration Incl. SSPP	4,325,778,420

SOURCE: Authors' calculation. Habitat restoration includes removal of barriers to fish passage, riparian revegetation and stream-bank improvements, placement of LWD and improvements in instream complexity, and road treatment and decommissioning. SSPP is the Shasta-Scott Pilot Program.

TABLE 11-2: Range-wide costs

COST CATEGORY	COST ($)
MONITORING, EVALUATION AND PLANNING	
Total excl. SSPP	44,000,000
Total SSPP	10,604,000
Total incl. SSPP	54,604,000
EDUCATION AND OUTREACH	
Total excl. SSPP	31,000,000
Total SSPP	8,832,520
Total incl. SSPP	39,832,520
WATER MANAGEMENT	
Total excl. SSPP	--
Total SSPP	10,334,024
WATER USE EFFICIENCY	
Total excl. SSPP	--
Total SSPP	3,200,000
WATER ACQUISITION	
Total excl. SSPP	UNKNOWN
Total SSPP	60,217,676
PROTECTION	
Total excl. SSPP	0
Total SSPP	1,244,789
TIMBER MANAGEMENT	
Alternative C and elements 19 and 20 of Alternative B	FEW INCREMENTAL COSTS

SOURCE: Authors' calculation. SSPP is the Shasta-Scott Pilot Program. No cost estimates are available for water acquisition in the CCC or SONCC excluding the SSPP.

TABLE 11-3: Total estimated costs of coho salmon recovery

Total SONCC/CCC costs excluding water ($)	4,492,194,850
Total SSPP costs ($)	466,016,578

SOURCE: Authors' calculation. SSPP is the Shasta-Scott Pilot Program. No cost estimates are available for water acquisition in the CCC or SONCC excluding the SSPP. Excludes costs identified but not quantified.

TABLE 11-4: Socioeconomic impacts of restoration

HYDROLOGIC UNIT	IMPACTS ($)
Big Basin	157,582,359
Bodega	6,867,489
Cape Mendocino	87,121,241
Eel River	346,282,468
Eureka Plain	5,404,169
Klamath River	219,664,691
Mad River	15,304,285
Marin Coastal	36,888,250
Mendocino Coast	465,155,708
Redwood Creek	12,975,736
Rogue River	4,980,192
Russian River	169,652,499
San Francisco Bay HUs	82,073,590
San Mateo	42,081,530
Smith River	68,695,861
Trinidad	15,330,384
Trinity River	247,326,119
Winchuck River	1,917,551
Total SONCC (w/o SSPP)	1,082,338,237
Total CCC	902,965,885
TOTAL SONCC/CCC RESTORATION COSTS	1,985,304,122
TOTAL SSPP RESTORATION	159,296,346
TOTAL RESTORATION INCLUDING SSPP	2,144,600,468

SOURCE: Authors' calculation. Habitat restoration includes removal of barriers to fish passage, riparian revegetation and stream-bank improvements, placement of LWD and improvements in instream complexity, and road treatment and decommissioning. SSPP is the Shasta-Scott Pilot Program.

TABLE 11-5: Range-wide measured socioeconomic impacts

COST CATEGORY	**IMPACT ($)**
MONITORING, EVALUATION AND PLANNING	
Total excl. SSPP	0
Total SSPP	0
Total incl. SSPP	0
EDUCATION AND OUTREACH	
Total excl. SSPP	0
Total SSPP	0
Total incl. SSPP	0
WATER MANAGEMENT	
Total excl. SSPP	--
Total SSPP	0
WATER USE EFFICIENCY	
Total excl. SSPP	--
Total SSPP	2,020,000
WATER ACQUISITION	
Total excl. SSPP	UNKNOWN
Total SSPP	(6,143,359)
PROTECTION	
Total excl. SSPP	0
Total SSPP	0
TIMBER MANAGEMENT	
Alternative C and elements 19 and 20 of Alternative B	FEW INCREMENTAL IMPACTS

SOURCE: Authors' calculation. SSPP is the Shasta-Scott Pilot Program. No socioeconomic estimates are available for water acquisition in the CCC or SONCC excluding the SSPP.

12 Process for Managing and Revising the Recovery Strategy

Any recovery strategy includes provisions for management and coordination of implementation, periodic review, and revision of specific strategy elements. Given the extensive range of coho salmon, the number and complexity of the recovery tasks, and the comprehensive nature of this Recovery Strategy, communication and coordination among participating groups, private entities, landowners, and agencies, is a basic requirement for success.

The recovery of coho salmon is long-term in nature, and as such, the Recovery Strategy must be flexible and responsive to changing conditions and new information. The Recovery Strategy is based on the best available, current information. However, comprehensive and predictive information is currently not available regarding many ecological processes, cumulative effects of human activities, effects of stochastic natural events, the most effective conservation management practices for several land-use activities, and the most effective and appropriate means of addressing stakeholder issues or conflicts. As the Department receives more information regarding these and other topics, the strategy will be improved, and consequently, coho salmon will benefit.

The Department has established an adaptive management approach (*sensu* Blann 2000) as part of this Recovery Strategy. The purpose of the adaptive management approach is to combine the scientific method, the best available science, and the experience of stakeholders and land managers in an iterative process involving:

a. Implementing the recommended recovery tasks;

b. Monitoring coho salmon and its habitat, and the social, economic, and political consequences;

c. Reviewing monitoring and research information; and

d. Determining what, if any, changes are necessary to achieve the Recovery Strategy goals and criteria.

Further information on the adaptive management process is provided in Section 12.4, below.

12.1 MANAGEMENT AND COORDINATION OF IMPLEMENTATION

It is readily apparent that the two-tiered approach (i.e., landscape-level and watershed-specific) to recovery of coho salmon populations across their range in California is complex. Successful implementation of even the highest priority tasks will require individuals, organizations, and agencies to work in concert and with a clear understanding of what must be done to complete the recommended tasks, and the time frame under which the tasks should be completed.

To establish and maintain the coordination necessary for coho salmon recovery, the Department will designate a range-wide coordinator and at least one regional coordinator for each of the Department's two northern coastal regions. The coordinators will work with the appropriate Department personnel, representatives from other agencies, watershed groups, landowners, and private and non-profit entities to:

a. Support regional efforts to implement the strategy by providing a clear interpretation of the tasks, including a detailed schedule of required actions, who must complete the actions, when the actions need to be accomplished, and potential sources for funding;

b. Work with data groups, such as the Department's Wildlife and Habitat Data Analysis Branch (WHDAB), to set up an accessible database of information and a planning and progress tracking system;

c. Represent the Department in meetings with city, county, other State, and Federal agencies to coordinate activities recommended for coho salmon recovery;

d. Ensure interaction between the Department and local watershed groups so that information generated by these groups may be used to update the Recovery Strategy;

e. Assist in the establishment or broadening the scope of watershed planning groups in high priority watersheds that have been identified through the gap analysis (Appendix E) as areas where more information and project planning is needed;

f. Work with the California Watershed Council (partnership between California Environmental Protection Agency and The Resources Agency) to ensure that the coho salmon recovery strategy is duly applied through the programs and priorities set by this council;

g. Organize annual meetings of recovery teams and entities participating in recovery actions with updates on progress and consideration of new information;

h. Conduct an annual review and update, if necessary, of the prioritization of recommended tasks; and

i. Assemble annual progress reports.

In conjunction with developing a schedule of actions, the coho salmon recovery implementation coordinators will develop milestones for the strategy for the first five years, based on the interim priorities. As progress is made and new information analyzed, milestones will be developed for further five-year increments until coho recovery is achieved. Example milestones include:

a. Work with NOAA Fisheries to re-evaluate and potentially revise recovery criteria and recovery units (Year 1);

b. Coordinate with the Department's Fisheries Restoration Grant Program (FRGP) to integrate the strategy into the solicitation for 2004/05 grant cycle (Feb 2004 - Year 1);

c. Convene an annual meeting of coastal funding entities (e.g., Coastal Conservancy, Regional Water Quality Control Boards, etc.) that fund recovery and restoration efforts to promote understanding of funding programs and priorities, identify funding gaps, discuss projects, and evaluate progress;

d. Consider creation of regional watershed coordinators in order to better coordinate local and regional efforts in developing local watershed plans and priority actions, and coordinate the implementation of these plans by working closely with regional entities involved in recovery and restoration efforts;

e. Work with the Department's Conservation Education Branch to develop a public outreach program for priority watersheds and essential recommendations, and for recommendations identified for enforcement (Year 1);

f. Work with the Department's wardens to monitor and develop enforcement strategies in watersheds that support key coho salmon populations (Year 1-5);

g. Work with the Department's basin planners or other designees to build planning/implementation capacity with watershed groups in high priority watersheds (Year 1);

h. Meet with other agencies to coordinate implementation of recommended tasks under their authority and/or responsibility (Years 1-2);

i. Meet with the SWRCB and the NCRWQCB to develop an MOA/MOU for coordination of tasks addressing water rights, flows, and quality;

j. Coordinate with data management groups to update coho salmon monitoring and population data, and locations for collection of such data (Years 1 through 5);

k. Determine which highest priority (Task Level "E" in implementation table) recommended tasks can be addressed with the funding available (all years);

l. Determine which barrier removal projects in medium to high priority watersheds (ranks 3-5) that will re-establish access to formerly occupied habitat can be achieved with existing funding (Years 1-5); and

m. Make significant progress toward achieving highest priority recommended tasks for which funding is available in priority watersheds (Years 1- 5).

12.2 TIMETABLE AND PROCESS FOR REPORTING AND REVISION

Pursuant to FGC §2113, the Department will convene the CRT and the SSRT and report to the Commission on an annual basis regarding the status and progress of implementation of the Recovery Strategy. The Department, with the input of the recovery teams, will review and update prioritization of recommended tasks, and address any new information or changed conditions by developing recommendations to the Commission for modification of the strategy. Recommendations for recovery plan element modification would be formulated using information from monitoring/research and feedback from participants indicating a change is necessary to remain on track toward meeting the goals and criteria of the Recovery Strategy. In reporting annually to the Commission regarding the status and progress of implementation of the Recovery Strategy, the Department will include recommendations for modification of the strategy. Annual coho salmon recovery reports that are sent to the Commission will be posted on the Department's web site.

The initial years of implementation will involve securing funds and working with local, State, and Federal entities to initiate high priority programs and tasks called for in the range-wide and watershed implementation schedules of the Recovery Strategy. The assessment and monitoring elements will also be in their formative state. Annual meetings will be important during these early years to assess progress on strategy elements and decide on any necessary adjustments to the strategy for purposes of clarity and aiding implementation.

Over time, trends should be visible in habitat monitoring and project-level effectiveness monitoring. Information on coho salmon distribution and abundance may also give indications of response to management decisions based on the Recovery Strategy. Larger adjustments to the strategy for the purpose of improving efficacy or making progress toward goals and objectives may be warranted at this time.

Information from these annual progress reports will become part of the Department's coho salmon status review pursuant to FGC §2077, which requires the Department to review listed species every five years to determine if conditions that led to the original listing are still present. Information regarding the population trend, range, distribution, abundance, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, and the impact of existing management efforts will be reviewed.

Department reports to the Commission may include a review of the identification of the habitat that may be essential to the continued existence of the species and the department's recommendations for management activities and other recommendations for recovery of the species. If CESA recovery goals and delisting criteria are considered to have been met, the Department coho salmon status review report may contain a recommendation to remove the species from the list of endangered species or the list of threatened species for the Commission's consideration.

12.3 TIMETABLE CLARIFYING NON-SPECIFIC LONG-TERM GOALS

As information regarding the time and cost for successful implementation of recovery goals and objectives becomes available, the Department will be able to provide more details on specific, long-term recovery goals. These long-term goals will be re-visited during the annual reviews. Long-term goals may be refined with new information on changed environmental conditions (e.g., significant floods or wildfires, fluctuation in ocean condition), better knowledge of effects of human activities on coho salmon populations and habitat, better understanding of the biology of coho salmon, progress or increased effectiveness in recovery actions, and/or other information.

12.4 ADAPTIVE MANAGEMENT[1]

The Department believes adaptive management is essential for successful planning and implementation of coho salmon recovery.

> *Adaptive management is a systematic process for continually improving Department management policies and practices concerning coho salmon recovery by learning from the outcomes of recovery strategy programs and activities.*

This management approach will allow for application of recovery actions regarding the various issues and scales, both identified and future; coordination and cooperation with other agencies, landowners, private industry, fishing organizations, and environmental organizations; testing alternative recovery and conservation land-use practices; ecosystem-based management for whole watersheds or portions of a watershed; evaluation of coho salmon population health and habitat condition; and incorporation of new information and better decision making based on research and monitoring of coho salmon recovery.

Essential to the progress of adaptive management will be input from local resource managers in government and industry, communities, and landowners who make decisions about land use and management, protecting and managing natural resources, and who will be responsible for implementing the majority of the recovery actions for coho salmon.

The Recovery Strategy adaptive management process is a six-step cycle (Figure 12-1), the success of which depends on the completion of all six steps:

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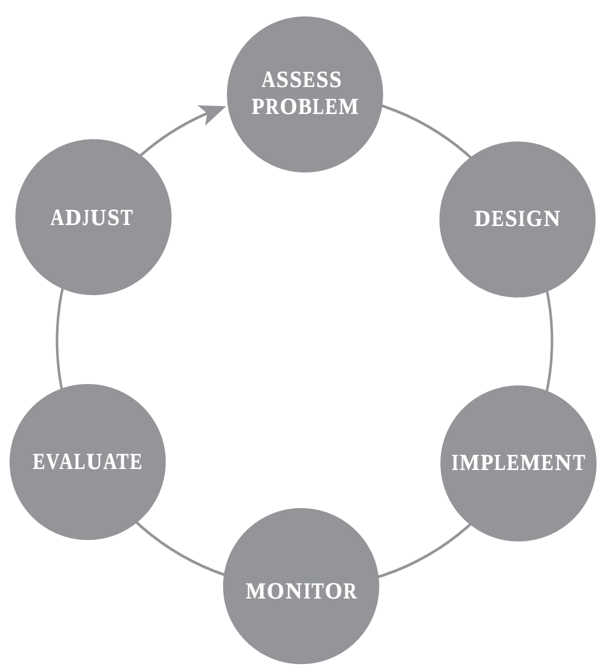
1 Adapted from Taylor et al. 1997.

1. *Assess Problem*. There are several processes to this step:
   a. Identify the problems and issues facing coho salmon and habitat and evaluate the scientific, management, and economic options and feasibility of potential solutions;
   b. Acknowledge where there are uncertainties in policy or practice and that what is "best" for a particular management issue may vary by region and over time; and
   c. Assess the current condition of factors affecting coho salmon recovery and where assessment is still necessary.
2. *Design*. Thoughtful selection of the policies, programs, and activities to be applied to recovery and additional assessment.
3. *Implement*. Implementation of identified programs and activities for recovery of coho salmon and continuing assessment designed to reveal the critical knowledge that is currently lacking,
4. *Monitor*. Examination of the key response indicators that inform the Department on the progress and effectiveness of recovery programs and activities and status and trend of coho salmon and habitat.
5. *Evaluate*. Analysis of the outcomes of recovery activities and programs and assessment and monitoring information during evaluation of the progress of coho salmon recovery, reassessment of the original objectives, and consideration of revising the Recovery Strategy.
6. *Adjust*. Incorporation of the results of implementation and monitoring into future decisions and revisions of the Recovery Strategy.

FIGURE 12-1: Adaptive management cycle



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Appendix A
Abbreviations and Acronyms

ABAG	Association of Bay Area Governments
BLM	Bureau of Land Management
BMPs	Best Management Practices
BOF	California Board of Forestry and Fire Protection
CALFED	CALFED Bay-Delta Program
Caltrans	California Department of Transportation
CCC	Central California Coast
CCR	California Code of Regulations
CDF	California Department of Forestry and Fire Protection
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFIP	California Forest Improvement Program
cfs	cubic feet per second
CGS	California Geological Survey
CHERT	County of Humboldt Extraction Review Team
CIMIS	California Irrigation Management Information System
Commission	California Fish and Game Commission
CRMP	coordinated resources management planning
CRP	Conservation Reserve Program
CRT	California Range-wide Coho Salmon Recovery Team
CWA	Clean Water Act
Department	California Department of Fish and Game
DIRT	direct inventory of roads and their treatment
DLRP	Division of Land Resource Protection
DNA	deoxyribonucleic acid
DO	dissolved oxygen

DOC	Department of Conservation
DOD	Department of Defense
DOI	Department of the Interior
DPR	California Department of Parks and Recreation
DWR	California Department of Water Resources
ENSO	El Niño/Southern Oscillation
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
FEMAT	Forest Ecosystem Management Assessment
FERC	Federal Energy Regulatory Commission
FGC	California Fish and Game Code
FLPMA	Federal Land Policy and Management Act
FPA	Forest Practice Act
FPR	Forest Practice Rules
FRGP	Fisheries Restoration Grant Program
FY	fiscal year
GIS	geographic information system
HA	hydrologic area
HCP	habitat conservation plan
HGMP	hatchery genetic management plan
HQI	habitat quality index
HSA	hydrologic subarea
HU	hydrologic unit
LWD	large woody debris
MMWD	Marin Municipal Water District
MOA	memorandum of agreement
MWAT	maximum weekly average temperature
MWMT	maximum weekly maximum temperature
NCRWQCB	North Coast Regional Water Quality Control Board

NCWAP	North Coast Watershed Assessment Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NTP	Non-industrial Timber Plan
NTU	Nephelometric Turbidity Unit
NRC	National Research Council
NRCS	Natural Resources Conservation Service
PAH	polycyclic aromatic hydrocarbon
PALCO	Pacific Lumber Company
PCB	polychlorinated biphenyl
PCSRF	Pacific Coastal Salmon Recovery Fund
PDO	Pacific interdecadal oscillation
PFMC	Pacific Fishery Management Council
PIT	passive integrated transponder
RCD	Resource Conservation District
RM	river mile
ROD	record of decision
RPF	registered professional foresters
RWQCB	California Regional Water Quality Control Board
SLC	State Lands Commission
SMARA	Surface Mine and Reclamation Act
SONCC	Southern Oregon/Northern California Coasts
SPAWN	Salmon Protection and Watershed Network
SRAC	Smith River Advisory Council
SRWC	Scott River Watershed Council
SSPP	Shasta-Scott Pilot Program
SSRT	Shasta-Scott Recovery Team
SWRCB	State Water Resources Control Board
SYP	sustained yield plans
T & I	threatened and impaired water body
THP	timber harvest plan

TMDL total maximum daily load

TRT Technical Review Team

UPGMA unweighted pair group method with arithmetic averages

USACE United States Army Corps of Engineers

USBR United States Bureau of Reclamation

USDA United States Department of Agriculture

USFS United States Forest Service

USFWS United States Fish and Wildlife Service

WRP Wetlands Reserve Program

WSH Warm Springs Hatchery

Appendix B Glossary

Adaptive management: A systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Active adaptive management employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed.

Adjudication: A process whereby the quantity and priority date of all water rights in a given area are determined either by civil action in a court of law, or by statutory adjudication before the State Water Resources Control Board.

Aggradation: In reference to streams, the raising of stream beds or flood plains by deposition of sediment eroded and transported from upstream.

Aggregate extraction: The mining of sand, gravel, and (sometimes) bedrock from a river or stream.

Alevin: Stage in the life cycle of salmon following emergence from the egg stage, characterized by the presence of a yolk sac attached to the body.

Allele: Any of the different forms of a gene.

Allele frequency: The proportion of a particular allele in a population.

Allozyme: Variant form of an enzyme encoded by a particular allele at a given locus. Allozymes can often be distinguished by protein electrophoresis.

Alluvial: Composed of material deposited by running water.

Anadromous: Pertaining to fish that spend part of their life cycle in the ocean and return to freshwater streams to spawn, for example salmon, trout, and shad.

Appropriated water: A quantity of water authorized for a specific use.

Appropriative water rights: Right to use a given quantity of water for reasonable and beneficial use in a prescribed place in order of priority based on the time water is first put to use. Since December 19, 1914, the exclusive method for establishing an appropriative water right is through the permit system administered by the State Water Resources Control Board. Percolating groundwater is governed by a separate body of law not addressed here.

Artificial propagation: Human assistance in the reproduction of an organism. In Pacific salmon, artificial propagation may include spawning and rearing in hatcheries, stock transfers, creation of spawning habitat, egg bank programs, captive broodstock programs, and cryopreservation of gametes.

Benthic: Belonging or pertaining to the bottom sediment zone of a body of water.

Biological refugia: For Pacific salmon, parts of the freshwater habitat unperturbed by human activities or other factors that would diminish the natural production of a population.

Brood year: Population of coho salmon that perpetuates itself by spawning in three-year intervals. Due to the rigid three-year life cycle of coho salmon, any given stream may provide habitat for three temporally separated populations, or brood years, that are largely reproductively independent from each other (with the exception of precocious males and females, called jacks and jills, respectively, that engage in spawning after two years and thus provide gene flow between brood years). When the spawning season spans portions of more than one year, as it does for coho salmon, the brood year is identified by the year in which spawning began. For example, offspring of coho salmon that spawned in 1996-1997 are identified as "brood year 1996." Because most coho salmon of a brood year return to spawn after one summer of freshwater life and two summers of ocean life, a brood year tends to form a distinct genetic lineage.

By-catch: Non-target fish or other organisms caught in a particular fishery. Among Pacific salmon, coho salmon may constitute part of the by-catch of the commercial Chinook salmon fishery.

Carrying capacity: The maximum equilibrium number of individuals of a particular species that can be supported indefinitely in a given environment. *Abbr.: K.*

Cohort: A group of fish that hatched during a given spawning season. When the spawning season spans portions of more than one year, as it does for coho salmon, the brood year is identified by the year in which spawning began. For example, offspring of coho salmon that spawned in 1996-1997 are identified as "brood year 1996." (Synonym: brood year).

Cohort failure: Extinction of a cohort (year-class) of fish due to either a lack of spawning in that year or the failure of any offspring of a spawning event to survive. Also called brood-year extinction.

Conservation hatchery: Fish hatchery that follows practices designed to stabilize and increase the size of a natural population while maintaining its phenotypic characteristics and genotypic integrity.

Conspecific: Belonging to the same species.

Cryopreservation: Preservation of living gametes at very low temperature; typically, freezing and storage of sperm in liquid nitrogen for later use in spawning.

Dendrogram: A branching diagram showing hierarchical structure in a data set resulting from cluster analysis (a type of statistical analysis for grouping individuals or units based on quantifiable similarities). Dendrograms are often used to show the genetic relationships among populations or higher taxa.

Distribution: The number of, and geographic relationship among streams inhabited by coho salmon within the ESU and species (see range).

Domestication selection: Used in management of genetic resources to express information about expected rates of random genetic change due to inbreeding and/or genetic drift. The size of a hypothetical ideal population with the same amount of random genetic change as the actual population experiences. Typically the effective population size is lower than the census population size. *Abbr.: NE.*

Downlisting: The moving of a species from the "Endangered" list to the "Threatened" list under CESA as a result of recovery of population sizes to the point where danger of extinction is less extreme than before, although continued protection is still warranted.

Effective population size: The effective number of breeding individuals in a population. The size of a hypothetical idealized population that would exhibit the same amount of genetic drift and loss of genetic variation as the actual population. Typically the effective population size is lower than the actual or census population size. *Abbr.: Ne.*

El Ni o/Southern Oscillation (ENSO): A term describing fluctuations of the ocean-atmosphere system in the tropical Pacific that can have secondary effects in the north Pacific range of coho salmon. During El Niño conditions the normal westerly trade winds across the tropical Pacific relax, creating (among many other effects) a rise in sea-surface temperatures in the eastern Pacific along South America. During strong El Niño events, sea surface temperatures along California may also increase and can contribute to poor ocean survival of coho salmon. The reversal of this condition (the Southern Oscillation or La Niña) produces a decrease in sea surface temperatures and is often associated with good ocean survival of coho salmon. Typical ENSO events are of relatively short duration, lasting between 6 to 18 months (see Pacific (Inter)Decadal Oscillation).

Embeddedness: The degree to which rocks and gravel are surrounded or covered by fine sediment on a stream or lake bottom.

Emigration: Seaward migration of salmon from their natal streams to the ocean. Also called "outmigration."

Entrainment: The incidental trapping of fish and other organisms in the water diverted from a stream or other source for purposes of agricultural irrigation, cooling of power plants, or other industrial activity.

Epibenthic: Belonging or pertaining to the top surface of the bottom sediment zone of a body of water.

Escapement: In reference to Pacific salmon, the number of fish of a population that return to a stream to spawn (spawning escapement).

Estuary: The seaward end or the widened tidal mouth of a river where fresh water comes into contact with seawater and where tidal effects are evident.

Evolutionarily Significant Unit (ESU): A population or group of populations that is considered distinct, and hence a species, for purposes of the Endangered Species Act. An ESU must be reproductively isolated from other populations of the same species and must represent an important component in the evolutionary legacy of the species.

Eutrophic: Pertaining to a lake or other body of water characterized by high concentrations of nutrients such as nitrogen and phosphorus resulting in high productivity. Eutrophic waters are often shallow and sometimes experience algal blooms and periods of low oxygen concentrations.

Exotic: An organism that is not native to the area where it is found. A non-native or non-indigenous species, often introduced as a result of human activities.

Extinction: In evolutionary biology, the failure of a group of organisms of variable size and inclusiveness (e.g., ranging from local geographic or temporally defined groups to species) to have surviving descendents.

Extinction risk: In this document, the probability that a given population will become extinct within 100 years. Low probability of extinction is arbitrarily defined for this purpose as 5% over 100 years.

Fecundity: In salmon, the number of eggs produced by a female.

Fish screen: A porous barrier placed across the inlet or outlet of a lake or stream or across the opening of a water diversion structure in a stream to prevent the passage of fish.

Fitness: The probability of an organism to reach reproductive age and produce viable offspring. For a population, fitness is the frequency distribution of reproductive success of sexually mature adults.

Fragmentation: In reference to salmon, the loss of connection of freshwater habitat due to migration barriers such as impassable dams or inadequate water quantity or quality, resulting in the inability of the fish to reach and fully utilize the habitat necessary to complete their life cycle and maintain natural levels of productivity.

Freshet (or Storm Flow): Rapid temporary rise in stream discharge caused by heavy rain or rapid melting of snow or ice.

Fry: Stage in the life cycle of salmon following the "alevin" stage, characterized by the loss of the yolk sac and beginning of feeding on external prey.

Gene flow: The introduction of genes into the gene pool of a population due to migration of individuals between populations.

Genetic drift: Random changes in allele frequencies due to the sampling error associated with a moderate to small number of matings. Genetic drift typically results in the loss of genetic variation (e.g., loss of rare alleles or decrease of heterozygosity) and increases as the effective population size (Ne) decreases.

Head Gate: The gate that controls water flow into irrigation canals and ditches; the controls or gate at the entrance to a canal or conduit system. Also, the diversion structure that controls the flow rate from a conveyance system (canals and laterals) into the farm conveyance system.

Heterozygosity: The fraction of individuals in a population that are heterozygous (having two different alleles) at a particular locus. Also, the fraction of heterozygous loci in the genome of an individual.

Hydrograph: A graphic representation or plot of changes in the flow of water or in the elevation of water level plotted against time. A hydrograph may contain information on stage, flow, velocity, and other hydraulic properties of water.

Hydrologic connectivity: A direct connection between run-off to a stream and development sites, typically roads, that contributes sediment or other pollutants to the stream.

Hyporheic: Pertaining to the zone of substrate in a stream bottom that extends 1 to 2 meters (approx. 3 to 6 ft.) below the surface of the stream bed.

Immigration: Migration of salmon from the ocean to their freshwater spawning grounds.

Incidental mortality: The unintentional death of an organism caused during the course of an otherwise lawful activity. In the context of recreational fishing, this refers to coho salmon that die after being caught and released by anglers fishing for other species.

Incidental take: Under CESA, it is the taking of a State-listed or candidate species where the taking is incidental to and not the purpose of carrying out otherwise lawful activities.

Interim actions: Actions contributing to recovery that will be: 1) immediate in their implementation, i.e., within the first five years of implementation of the Recovery Strategy; and 2) do not require legal or regulatory changes. These actions may be of temporary duration to meet an urgent need or they may lay the groundwork for more long-term actions.

Interstices: The physical spaces between gravel or other substrate particles.

Intragravel: Within the gravel substrate of a stream.

Invasive non-native species: Animal or plant species present in an ecosystem where it did not naturally occur and is increasing in number and range with significant negative effects on native animal or plant species.

Key populations: Populations of coho salmon that qualify as likely refugia, source populations, or metapopulations. Generally, key populations are those populations that occur in coho salmon habitat of relatively high quality, with a full complement of year-classes, or with abundances that are high relative to other populations within the same recovery unit, or place them at an insignificant risk of extinction.

Lagoon: Within the range of coho salmon, a lagoon is an estuary that is separated from tidal action during the summer by the formation of a sand bar at its mouth. This is the case in many California coastal streams and rivers.

Large woody debris (LWD): Large, relatively stable woody material usually having a diameter greater than 30 cm (12 inches) and a length greater than 2 m (6 feet) that intrudes into the stream channel.

Locus (Pl.: Loci): The physical location of a gene or other DNA sequence on a chromosome.

Macroinvertebrates: Aquatic invertebrates that conventionally are at least 0.5 mm in length and live primarily on the bottom substrate of streams and rivers. They feed on plant matter, detritus, or smaller animals and, in turn, provide food for larger consumers such as fish.

Maintain: To prevent further decline in the number and size of populations and the amount and quality of their habitat.

Mass wasting: The down-slope movement of rock and soil near the Earth's surface mainly due to the force of gravity. Mass-wasting is an important part of the erosion process, occurring continuously on all slopes. Some mass-wasting processes act very slowly, others occur very suddenly, often with disastrous results. The eroded materials often end up in rivers or streams where they may be transported further downstream.

Metapopulation: A set of largely isolated subpopulations connected by some degree of migration among them.

Microsatellite DNA: DNA sequences consisting of tandem repeats of short oligonucleotide sequences, such as poly-(AT) or poly-(TAGC). The repeats are usually two to five nucleotides long and are inherited in a Mendelian fashion. Analysis of microsatellite inheritance can be used to gain information about microevolutionary processes such as migration and gene flow.

Mine tailings: Mine waste and mine tailings are often used interchangeably to describe the waste material remaining after a mineral commodity is extracted from the host rock(s). Mine tailings more specifically refers to the waste material that results from processing the mineral commodity. True mine tailings usually are high in metals, low in pH, and composed of materials the size of sand to silt. Dredger tailings such as those associated with gold separation activities are usually comprised of unsorted cobbles, gravel, and fine sediments.

Mitigation hatcheries: Fish hatcheries, usually built below flood control or power-generating dams, that are intended to compensate for the loss of upstream spawning habitat and natural fish production resulting from dam construction.

Natural-origin fish: Also called "natural fish." Fish that are offspring of parents that spawned in the wild. Natural-origin fish spend their entire lives in the natural environment. (See "Hatchery-origin fish").

Nutrification: An increase in the concentrations of nutrients such as nitrogen and phosphorus in a body of water.

Pacific (Inter)Decadal Oscillation (PDO): The "Pacific Decadal Oscillation" (PDO) describes a long-lived pattern of Pacific climate variability that can affect ocean survival of coho salmon. Unlike El Niño/Southern Oscillation events, which originate in the tropics and last from 6 to 18 months, PDO events originate in the northeastern Pacific and cycle over periods of about 50 years. Within a PDO cycle there may be short lived reversals of conditions. "Warm" or "positive" PDO phases are associated with enhanced ocean productivity in Alaska and inhibited productivity off the west coast of the contiguous United States. "Cold" or "negative" PDO eras have the opposite pattern, and are generally favorable for ocean survival of coho salmon from California. Causes for the PDO are not currently known.

Parr: Stage in the life cycle of salmon following the "fry" stage, characterized by the presence of dark vertical bands on the side of its body.

Population: A group of individuals of the same species that live in the same place at the same time and exhibit some level of reproductive isolation from other such groups. In some contexts, a randomly mating group of individuals that is reproductively isolated from other groups. A population may consist of a single isolated run or more than one connected run. Synonymous with "stock" in this document.

Population risk: Defined here as risks to coho salmon from human activities (range-wide coho salmon population abundance and genetic data are not available). It combines anthropogenic risk factors (e.g., human population density, water diversions, road density) and population parameters (e.g., consistent presence of coho salmon, isolation index for coho salmon populations, and run length of coho salmon populations).

Population viability analysis: Analysis of a species and its population genetic structure to determine the level of independence of the populations. A viable salmonid population has been defined by NOAA Fisheries as "an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year time frame."

Probability of extinction: See Extinction Risk.

Properly Functioning Condition (PFC): With regard to conifer LWD recruitment. A concept used by NOAA Fisheries to describe the sustained presence of natural processes leading to habitat conditions that are necessary for the long-term survival and recovery of a fish species through the full range of environmental variation. In terms of conifer LWD recruitment, PFC refers to achieving a natural rate of large conifers falling directly in or sliding downslope to become active in channel processes such as pool formation, sediment retention, or otherwise providing the habitat complexity sufficient to ensure long-term survival of salmonid populations. This rate of LWD recruitment is to be determined by the best available science. (NMFS 1999).

Protect: To ensure the status and integrity of coho salmon populations, habitat, and essential ecological processes.

Pulse flows: Temporarily increased water flow in a river or stream at specific opportune times intended to increase habitat for migrating fish .

Ramped flows: The sequential and gradual, rather than simultaneous, initiation and completion of water diversions from a river or stream to buffer significant changes in water levels and instream flows.

Range: The geographic area and extent within California that is defined by the watersheds where coho salmon were historically (including currently) present.

Recovery: The re-establishment or rehabilitation of a threatened or endangered species to a self-sustaining level in its natural ecosystem.

Recovery supplementation: Short-term artificial propagation designed to reduce the risk of extinction of a small or chaotically fluctuating recovering population in its natural habitat by temporarily increasing population size using conservation hatchery fish, while maintaining genetic diversity and minimizing genetic change in the natural and hatchery populations.

Recovery unit: A geographic and hydrologically distinct area within each ESU that includes a number of related coho salmon populations and which will be the scale at which successful achievement of delisting goals and criteria will be measured and evaluated.

Recruitment: The natural process of replenishing a resource, such as gravel recruitment or recruitment of large woody debris in a stream. With reference to fish and fisheries, recruitment refers to the development and growth of the fish to a point where they enter the fishable stock.

Redd: Nest of a salmon, usually a depression within the gravel substrate of a stream, into which the female deposits her eggs.

Reproductive isolation: Absence of gene flow between a population and other populations of the same species.

Restore: In the context of coho salmon recovery, to return coho salmon to self-sustaining levels within their natural habitat throughout their historic range, or to return habitat attributes (e.g., flow, sediment characteristics, water temperature, water quality and habitat complexity) to a condition that will support the recovery of coho salmon to self-sustaining levels.

Riffle: A shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation. Substrate is usually composed of gravel, pebble, and cobble-sized particles.

Riparian zone: The terrestrial zone adjacent to a water course.

Riprap: A man-made facing layer (protective cover) of stones, rocks, or other hard, durable material for stream-bank protection and stabilization and to reduce erosion.

Run: The spawning adults of a given species that return to a stream during a given season.

Short-term actions: See Interim Actions.

Siltation: The deposition and build-up of silt (detrital rock particle having a diameter in the range of 1/256 to 1/16 mm) that is suspended in a body of water. The term is often used to include larger and smaller sedimentary particles ranging in size from clay to sand.

Sink population or subpopulation: Populations that, within a given metapopulation structure of a species, are characterized by vastly lower productivities than other (source) populations and consistently receive individuals from the source populations through one-way movement of migrants.

Smolt: Stage in the life cycle of salmon following the "parr" stage, characterized by hormonal and other physiological changes that prepare the fish for its seaward migration and life in salt water, the loss of parr marks, and appearance of a silvery color.

Smoltification: Hormonal and other physiological changes associated with the seaward migration of salmon and adaptation to a saltwater environment.

Source population or subpopulation: Populations that, within a given metapopulation structure of a species, are characterized by vastly higher productivities than other (sink) populations and consistently contribute individuals to the sink populations through one-way movement of migrants.

Source-sink relationship: Metapopulation structure in which subpopulations in the source areas have vastly higher productivities than those in the sink areas, and characterized by one-way movement of migrants from the source area to the sink area.

Stock: See Population.

Stock transfer: Human transfer of fish from one location to another, often between separate basins or ESUs.

Stream buffer zone: Riparian zone of specified width that is given some measure of protection from developmental activities such as logging or road construction.

Stream order: Designation of stream segments within a drainage basin; a system of numbering streams according to sequence of tributary size. The smallest perennial tributary is designated as order 1, the junction of two first-order streams produces a stream segment of order 2, etc. The main stream is always of the highest order.

Substrate: Particulate material comprising the bottom of a body of water, such as mud, silt, gravel, or rock.

Suspended sediment: Material (usually clay, silt, and sand) carried for a considerable period of time in suspension without deposition on the bed of the body of water .

Supersaturation: Presence of a solute (e.g., salt or oxygen) in a solvent at levels that exceed saturation for a given set of conditions, especially temperature and pressure.

Tailwater reclamation: The process of collecting irrigation water runoff for reuse in the system. Also called "tailwater recovery."

Take: "Take" under California law is defined by FGC §86 as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill."

Transferrin: A protein synthesized in the liver that transports iron in the blood to the erythrocytes for use in heme synthesis. Transferrin has been used in the past in immunological procedures such as microcomplement fixation assays to examine the genetic relationship between populations and other related taxa.

Turbidity: Reduced clarity of a liquid due to the presence of suspended matter.

Watershed: The topographic region drained by or contributing water to a stream, river system, or lake.

Watershed recovery unit: See Recovery Unit.

Appendix C
Other Species at Risk

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Recovery actions for coho salmon have the potential to affect other species listed under the Federal Endangered Species Act of 1973, as amended (ESA) [16 USC section 1 *et seq.*] and under the California Endangered Species Act (CESA) [FGC §2050 *et seq.*]. Potential effects could range from beneficial to detrimental to the conservation of these species.

CONSTRAINTS ON RECOVERY ACTIONS

The presence of listed species may limit coho salmon recovery actions at a site. For example, vortex rock weirs are commonly used to improve pool development for juvenile coho salmon (Flosi et al. 1998), but these structures are not permitted in streams where California freshwater shrimp are present. The presence of other listed species may also increase the time and/or cost required to implement a coho salmon recovery action. For example, to avoid noise disturbance to nesting marbled murrelets, heavy equipment work is typically prohibited within known murrelet habitat until after September 15. This restricts the work window to conduct some projects requiring heavy equipment, and can cause significant delays. In turn, delays can increase costs such as equipment mobilization and may create problems for projects involving public funds, which are typically allocated for a set time period.

Coho salmon recovery actions are not expected to have long-term adverse impacts on other listed species. However, recovery actions may require consultation with appropriate agencies, and/or the issuance of incidental take authorizations and/or other permits.

The presence of listed species (including coho salmon) could also increase the time and cost of California Environmental Quality Act (CEQA) review required for State or local permits associated with coho salmon recovery. The CEQA mandatory findings of significance (CEQA Guidelines section 15065(a)) require an Environmental Impact Report (EIR) if an action has the potential to "...reduce the number or restrict the range of a rare or endangered plant or animal..." Under existing case law, the threshold for triggering this mandatory finding of significance is very low (San Bernardino Audubon Society v. Metropolitan Water District, 1999, 7 1Cal.App.4th 382). The additional time required for an EIR (as compared to a Negative Declaration (or a CEQA exemption) could significantly add to the time and cost required to implement a recovery action having the potential for take. The Department and other implementing public agencies undertaking recovery actions will have to assess on a case-by-case basis the potential of the proposed action to meaningfully reduce the number or restrict the range of other listed species when approving recovery projects.

Another potential complication could occur if State-designated "fully protected" species are present, as the Department is prohibited from authorizing any take of fully protected species, (See FGC §55 15, 5050, 35 1 1 and 4700). The Commission can, however, authorize take of fully protected species for necessary scientific research and many recovery projects may be susceptible to design so as to avoid the take of fully protected species.

OTHER AT-RISK SPECIES IN THE RANGE OF COHO SALMON

Below are brief descriptions of other at-risk species that should be considered when implementing the coho salmon Recovery Strategy. Individual listed plant species are not discussed in this Recovery Strategy, although they also must be considered when implementing coho salmon recovery actions. It has been the Department's practice for salmonid restoration grant projects to require rare plant surveys prior to implementing ground-disturbing actions and, if necessary, to modify projects to avoid any disturbance of rare plant colonies; in practice, conflicts between rare plants and salmonid habitat restoration actions have been infrequent and avoidance of such conflicts is relatively simple.

Trinity Bristle Snail *(Monadenia setosa)*

The Trinity bristle snail is listed as threatened under CESA and only occurs in the Trinity River HU This species typically occupies conifer and mixed conifer/hardwood stands with tree diameter greater than 11 inches at breast height and canopy cover greater than 60%. The snail prefers moist microhabitats where large woody debris is greater than 10 inches and is moderately decayed. Lichens and mosses on rocks and logs are typically present on occupied sites. Maple and alder tree species are often present, indicating a reliable moisture content on which the snails depend.

Increased large woody debris recruitment in riparian zones would benefit Trinity bristle snails. Areas of potential habitat within the range of the Trinity bristle snail should be surveyed according to published protocol prior to commencement of any coho salmon recovery activities. Occupied habitat will need to be identified and avoided. If a project would result in incidental take of Trinity bristle snail, the project would require incidental take authorization from the Department.

California Freshwater Shrimp *(Syncaris pacifica)*

The California freshwater shrimp is listed as endangered under both ESA and CESA. It is endemic to Marin, Sonoma, and Napa counties, where it occurs in low-gradient streams (< 1%) with moderate to heavy riparian vegetation. Freshwater shrimp are usually associated with pools 1 to 3 feet deep, especially those with stable undercut banks with exposed root systems and the top of the undercut below the water surface.

Protection and improvement of riparian habitat would increase vegetative cover required for protection from predators. Sediment control and placement of large woody debris would improve habitat quality for shrimp by increasing pool development and structural cover. Replacement of culverts with bridges or arch culverts would promote connectivity of shrimp habitat. Fish habitat structures that completely span a stream (including vortex rock weirs) must be avoided in shrimp habitat to avoid creating barriers to instream movement of shrimp. Any planning for in-water work in shrimp habitat should include surveys to determine if they are present. If they are present, the project will require take authorization from U.S. Fish and Wildlife Service (FWS) and the Department.

Lost River Sucker *(Delistes luxatus)*

The Lost River sucker is listed as endangered under both ESA and CESA, and is fully protected. Lost River suckers are found in the Lost River system and the Upper Klamath River watershed with a few uncertain sized populations in Copco and Iron Gate reservoirs. These populations are thought to be maintained by entrained fish in the Klamath hydropower project. The reduction of pesticides, fertilizers and other pollutants from entering the lake would increase viable habitat by decreasing the contaminants that start and/or cause the process of excessive eutrophication and anoxic water conditions. The improvement of water quality conditions would benefit both Lost River suckers and coho salmon. Maintaining lake levels to benefit suckers may impact the flows needed for coho salmon downstream.

Shortnose Sucker *(Chasmistes brevirostris)*

The shortnose sucker is listed as endangered under both ESA and CESA and it is a State fully protected species. Shortnose suckers are know to occur in the Upper Klamath River watershed with undetermined populations in Copco and Iron Gate reservoirs and the most abundant populations in the Lost River system. The reduction of pesticides, fertilizers and other pollutants from entering Upper Klamath Lake would increase viable habitat by decreasing the contaminants that start or cause the process of excessive eutrophication and anoxic water conditions. The improvement of water quality conditions would benefit both shortnose suckers and coho salmon. Maintaining lake levels to benefit suckers may impact the flows needed for coho salmon downstream.

Tidewater Goby *(Eucyclogobius newberryi)*

The tidewater goby is listed as endangered under ESA. The tidewater goby's habitat consists of brackish shallow lagoons and lower freshwater stream reaches where the water is fairly still but not stagnant. They tend to be associated with muddy substrates (Jim Watkins pers. comm. 1/23/03).

In general, actions to restore coho salmon are not likely to impact tidewater goby, although efforts to protect and restore coho salmon nursery habitat in estuaries is likely to have a positive influence on the preservation of goby habitat; this includes such actions as re-establishment of functional estuaries and lagoons by the removal, or setback, of levees that confine the water course, and allowing for the reconnection of wetlands, sloughs, and the tidal influenced areas. Any planning for in-water work in goby habitat (such as placing LWD in estuaries) should include surveys to determine goby presence. If gobies are present, the project will require take authorization from FWS.

Green Sturgeon *(Acipenser medirostris)*

In January 2003, NOAA Fisheries determined that listing green sturgeon under the ESA was not warranted. However, because of uncertain population structure and status of the species, NOAA Fisheries is adding two distinct populations segments of green sturgeon (one north of the Eel River, the other south of the Eel River) to the agency's list of candidate species. Green sturgeon is presumed extant in the mainstem Klamath and Trinity rivers and possibly in the Eel River.

Development of cold-water flows would decrease the incidence of disease outbreak benefiting sturgeon and coho salmon in the Klamath, Trinity, and Eel River systems. Implementing a Hardy Phase II like flow regime in the Klamath River would give these fish greater access to the upper portion of the watershed for spawning. Other benefits include the control of upslope sedimentation through increased buffer areas and the reduction of human caused disturbances in unstable soil types, and decreased sediment input from existing roads through sediment control measures.

Steelhead *(Oncorhynchus mykiss)*

Steelhead in both Northern California and Central California Coastal ESUs often share the same habitat or reaches of streams with coho salmon, therefore both species would likely benefit from habitat improvements projects for either species. Projects that decrease the sediment input into the stream, provide cooler (more optimal) water temperatures, and sufficient flows for all life stages would benefit both of these species.

Chinook Salmon *(O. tshawytscha)* – California Coastal ESU

Chinook salmon generally spawn in larger streams than coho salmon. Many of these streams are either migration corridors or are in themselves used by coho salmon for spawning. Projects that decrease sediment input into streams, provide cooler (more optimal) water temperatures, and sufficient flows for all life stages would benefit both of these species.

Siskiyou Mountains Salamander *(Plethodon stormi)*

The Siskiyou Mountains salamander is a lungless, completely terrestrial salamander listed as threatened under CESA. This species occurs in the Applegate HU and Seiad Valley HSA, in Siskiyou County. Suitable habitat includes rock outcrops, talus (rock on rock substrates), and forested rocky soils. Areas of potential habitat within the range of the Siskiyou Mountains salamander should be surveyed according to published protocol prior to commencement of any coho salmon recovery activities. Occupied habitat will need to be identified and avoided. If the project would result in incidental take of Siskiyou Mountain salamander, the project would require incidental take authorization from the Department.

California Tiger Salamander *(Ambystoma californiense)*

Recommendations and actions associated with recovery of coho salmon in California are not expected to have adverse effects on California tiger salamander populations, because potential actions are not expected to overlap with their habitat.

California Red-legged Frog *(Rana aurora draytonii)*

The California red-legged frog is listed as threatened under ESA. California red-legged frogs occur, within the range of the coho salmon, from Point Reyes south and inland to the Sacramento Valley. They are found primarily in the wetlands and streams in the coastal drainages of central California and there is a significant likelihood of co-occurring with coho salmon in the southern part of their range. The frogs are associated with dense riparian vegetation closely associated with deep (>2 feet) still or slow moving water, and may aestivate within 300 feet of a riparian area.

Although protection and improvement of habitat for coho salmon will sometimes improve habitat for California red-legged frogs, some activities to protect and restore coho salmon habitat (for example projects requiring heavy equipment) have the potential to take frogs. Any planning for restoration actions in California red-legged frog habitat should include surveys for the species. If the project would result in take of California red-legged frogs, the project would require incidental take authorization from FWS.

San Francisco Garter Snake *(Thamnophis sirtalis tetrataenia)*

The San Francisco garter snake (SFGS) is listed as endangered under both ESA and CESA, and has State fully protected status. SFGS presently range from San Mateo County to northern Santa Cruz County, however known populations are limited in extent. SFGS may co-occur with coho salmon in San Gregorio and La Honda creeks, Pescadero Marsh and Creek, Butano, Gazos, Old Woman, Whitehouse, and Waddell creeks.

Although protection and improvement of habitat for coho salmon will sometimes improve habitat for SFGS and their preferred prey (California red-legged frogs), some activities to protect and restore coho salmon habitat have the potential to take SFGS. For example, grading of hill slopes to reduce stream sedimentation attributable to gullying is an important activity for coho salmon recovery in coastal San Mateo County but can crush SFGS aestivating in rodent burrows.

Because of the potential for take of SFGS, planning for coho salmon habitat restoration activities within suitable habitat for the snake in San Mateo and Santa Cruz counties should include surveys for SFGS by a permitted biologist. If SFGS are identified at a project site, measures to avoid impacts would include (at least) that an experienced biologist, approved by the Department and named on a valid 10(a)(1)(A) Federal Scientific Collection Permit issued by USFWS for handling SFGS, be present during all project activities within areas of SFGS habitat. If necessary, habitat work could be scheduled to occur in September and October to avoid impacts to hibernating snakes and snakes concentrated along stream corridors feeding and giving birth to live young. Planning for coho salmon recovery actions within the range of the SFGS will need to consider the time and budget required for permitting and coordination. Federal permitting for coho salmon recovery actions in SFGS habitat could be facilitated by development of a programmatic FWS Section 7 consultation.

Greater Sandhill Crane *(Grus canadensis tabida)*

The greater sandhill crane is listed as threatened under CESA and has State fully protected status. This species breeds in northeastern California, the western most extent being Scott Valley (Siskiyou County). This species relies on permanently flooded wetlands for nesting with nearby flood irrigated pasture to provide food for newly hatched colts. Impacts to nesting or brooding birds from project activities such as building riparian fencing adjacent to crane breeding habitat would have to be evaluated on a case-by-case basis. However, impacts can usually be mitigated and take avoided by avoiding disturbance during the critical nesting period (March 1 to August 1) or maintaining a distance of 0.5 mile from the potential breeding habitat. The Department is developing a recovery plan for this species.

California Brown Pelican *(Pelecanus occidentalis californicus)*

The California brown pelican is listed as endangered under both ESA and CESA and has State fully protected status. In Northern California, the Brown Pelican inhabits the coastline and estuaries mainly in the late summer and fall (June to November) and is considered uncommon to rare from December to May. Actions to restore coho salmon are not likely to impact this species, although efforts to protect and restore estuarine habitat may have a positive influence on this species. Most breeding occurs in Southern California (Channel Islands), outside of the range of coho salmon.

Western Yellow-billed Cuckoo *(Coccyzus americanus occidentalis)*

The western yellow-billed cuckoo is listed as endangered under CESA. The most recent information indicates nesting pairs have been found on the lower Eel River (near Fortuna). Historically, there are scattered records around Humboldt Bay and south along the coast, but breeding status was undetermined. Cuckoo breeding habitat consists of riparian areas with a cottonwood and/or willow component. Alders have been found to be component of the habitat utilized by the birds found on the Eel River. They breed later than most migrant species, beginning in June and continuing through September. Projects that would increase both the quantity and quality of riparian vegetation would benefit this species. Projects that would take place during the critical breeding period (June through September) would require surveys to determine presence. If the project would result in take of western yellow-billed cuckoo, incidental take authorization from the Department would be required.

Willow Flycatcher *(Empidonax traillii)*

The willow flycatcher is listed as endangered under CESA and is found within the range of coho salmon. Protection and improvement of riparian habitat associated with coho salmon recovery actions will promote potential willow flycatcher habitat. However, care must be taken to avoid disturbing breeding sites of the flycatcher. Impacts to breeding sites can be mitigated by avoiding heavy equipment work and harvest of willow branches for riparian revegetation within 0.25 miles of any site with known or potential habitat for willow flycatcher during the breeding season. By limiting the harvest of willow for revegetation to no more than one-third of any willow plant annually and taking care not trample or over harvest the willow sources, the long-term integrity of willow flycatcher habitat can be protected. If the project would result in take of willow flycatchers, incidental take authorization from the Department would be required.

Northern Spotted Owl *(Strix occidentalis caurina)*

The northern spotted owl is listed as threatened under ESA. Activities to protect and restore coho salmon habitat should not alter habitat for the owls, however the potential exists for project-related noise (e.g., heavy equipment required for projects such as culvert removal or placement of large woody debris) to disturb nesting birds. Adverse impacts can be avoided by limiting heavy equipment work within 0.25 miles of spotted owl habitat to the period of August 1 to October 31. If the project would result in take of northern spotted owls, incidental take authorization from FWS and would be required.

Marbled Murrelet *(Brachyramphus marmoratus marmoratus)*

The marbled murrelet is listed as endangered under CESA and threatened under ESA. Activities to protect and restore coho salmon habitat should not alter habitat for marbled murrelets, however the potential exists for project-related noise (e.g., heavy equipment required for projects such as culvert removal or placement of large woody debris) to disturb nesting birds. Adverse impacts can be avoided by limiting heavy equipment work within 0.25 miles of marbled murrelet habitat to the period of September 15 to October 31. If the project would result in take of marbled murrelets, incidental take authorization from FWS and the Department would be required.

Western Snowy Plover *(Charadrius alexandrinus nivosus)*

The western snowy plover is listed as threatened under ESA. Snowy plovers have mainly been described as nesting adjacent to tidal waters, however some individuals may breed on gravel bars in coastal rivers; in particular, nesting snowy plovers have been identified in the Eel River watershed up to 50 miles inland. Activities to protect and restore coho salmon habitat should not alter habitat for snowy plover, however heavy equipment work in areas with extensive gravel bars relatively near the coast has the potential to disturb or injure nesting snowy plovers. Adverse impacts can be avoided by limiting heavy equipment work within 0.25 miles of snowy plover nesting habitat to the period October 1 to October 31. If the project would result in take of snowy plovers, incidental take authorization from FWS would be required.

Bank Swallow *(Riparia riparia)*

The bank swallow is listed as threatened under CESA. Presently the only known breeding population of bank swallows in the coho salmon range is along the Scott River. To avoid adverse impacts to bank swallows, any potential breeding habitat should be surveyed during the breeding season (March 1 to July 31) to determine swallow presence. Any modification of bank swallow nesting habitat should be avoided. If the project would result in take of bank swallows, incidental take authorization from the Department would be required.

Bald Eagle *(Haliaeetus leucocephalus)*

The bald eagle is listed as endangered under CESA and threatened under ESA. The bald eagle is also protected under Fish and Game Code section 3503.5, which prohibits take. Recovery of coho salmon will increase winter foraging opportunities for bald eagles. However, the potential exists for the noise from heavy equipment required for projects such as culvert removal or placement of large woody debris to disturb nesting birds. Such impacts can be avoided by limiting heavy equipment work within 0.25 miles of any bald eagle nests to the period of September 1 to October 31. To prevent possible impacts of turbidity on bald eagle foraging, necessary precautions must be used to avoid significant increases in turbidity during any construction, and erosion control measures must be in place before the first significant fall rains.

California Clapper Rail *(Rallus longirostris obsoletus)*

The California clapper rail is listed as endangered under ESA and CESA, and has State fully protected status. California clapper rails are found in tidal marshes around San Francisco Bay. In general, actions to restore coho salmon are not likely to impact this species, although efforts to protect and restore coho salmon nursery habitat in estuaries may have a positive influence on the preservation of marsh habitat for this species.

California Black Rail *(Laterallus jamaicensis coturniculus)*

The California black rail is listed as threatened under CESA and has State fully protected status. The California black rail is more widely distributed than the California clapper rail, from San Francisco Bay south and in both brackish and freshwater marsh habitat. In general, actions to restore coho salmon are not likely to impact this species, although efforts to protect and restore coho salmon nursery habitat in estuaries is likely to have a positive influence on the preservation of marsh habitat for this species.

Point Arena Mountain Beaver *(Aplodontia rufa nigra)*

The Point Arena mountain beaver is listed as endangered under ESA. Point Arena mountain beavers have been identified in the Alder Creek, Brush Creek, and Garcia River HSAs, in an area extending roughly five miles south and eight miles north of Point Arena, and up to approximately five miles inland from the coast.

Aspects of mountain beaver habitat are consistent with coho salmon habitat (such as cool climate, lush vegetation, stable stream banks), however some common habitat restoration methods (such as tree planting) may not be compatible with the herbaceous and small woody vegetation associated with mountain beaver habitat. In addition, special care is needed when working (or walking) in mountain beaver habitat to avoid collapsing burrows. Disturbance during the breeding season (December 15 to April 15) or juvenile dispersal season (December 15 to June 15) should be avoided in the course of adhering to criteria for protection of salmonids (i.e., no instream work until after July 1). Because of the potential for impacts to Point Arena mountain beaver, planning for coho salmon habitat restoration activities within the riparian zone in the Alder Creek, Brush Creek, and Garcia River HSAs should include mountain beaver surveys. If Point Arena mountain beaver are present the project will require take authorization from FWS.

Salt-marsh Harvest Mouse *(Reithrodontomys raviventris)*

The salt marsh harvest mouse is listed as endangered under ESA and CESA, and has State fully protected status; they are found in tidal marshes around San Francisco Bay. In general, actions to restore coho salmon are not likely to impact this species, although efforts to protect and restore coho salmon nursery habitat in estuaries may have a positive influence on the preservation of marsh habitat.

Appendix D
Key Streams and Rivers

This appendix lists streams and rivers preliminarily identified, based on current information, by the Department for the recovery goal of maintaining or improving key populations or establishing additional populations of coho salmon. Watercourse names in parentheses are commonly used synonyms.

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Rogue/Winchuck rivers	South Fork Winchuck River	
	Broken Kettle Creek	
	South Fork Broken Kettle Creek	
	East Fork Illinois River	
	Elk Creek	
	Brushy Creek	
	Dunn Creek	
	North Fork Dunn Creek	
Smith River	Dominie Creek	Yonkers Creek
	Rowdy Creek	Jordan Creek
	South Fork Rowdy Creek	Buck Creek
	Savoy Creek	North Fork Smith River
	Copper Creek	Still Creek
	Morrison Creek	Diamond Creek
	Jaqua Creek (Little Mill Creek)	Shelly Creek
	Sultan Creek (Sutton Creek)	Monkey Creek
	Peacock Creek	Siskiyou Fork
	Clarks Creek	
	Mill Creek	
	East Fork Mill Creek	
	Bummer Lake Creek	
	West Branch Mill Creek	
	Elk Creek	
	South Fork Smith River	
	Craigs Creek	
	Hurdy Gurdy Creek	
	Jones Creek	
	Quartz Creek	
	Eightmile Creek	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Smith River (continued)	Middle Fork Smith River	
	Myrtle Creek	
	Patrick Creek	
	Griffin Creek	
	Knopti Creek	
	Wilson Creek	
Shasta Valley	Shasta River	Little Shasta River
	Big Springs Creek	Willow Creek
	Parks Creek	
	Yreka Creek	
Scott River	Mill Creek (near Scott Bar)	Tompkins Creek
	Wooliver Creek	Kidder Creek
	Kelsey Creek	Boulder Creek
	Canyon Creek	
	Shackleford Creek	
	Mill Creek	
	Patterson Creek	
	Etna Creek	
	French Creek	
	Miners Creek	
	Sugar Creek	
	South Fork Scott River	
	East Fork Scott River	
	Big Mill Creek	
Salmon River	Nordheimer Creek	Wooley Creek
	North Fork Salmon River	East Fork Knownothing Creek
	South Fork Salmon River (to Big Flat)	Negro Creek
	Knownothing Creek	East Fork-South Fork Salmon River
	Methodist Creek	
Middle Klamath River	Bluff Creek	Aikens Creek
	Slate Creek	Cougar Creek
	Red Cap Creek	Little Grider Creek
	Boise Creek	Doolittle Creek
	Camp Creek	Horse Creek *(Happy Camp HSA)*
	Irving Creek	China Creek
	Stanshaw Creek	West Fork Beaver Creek
	Sandy Bar Creek	Cow Creek
	Dillon Creek	Empire Creek
	Swillup Creek	Little Humbug Creek
	King Creek	Williams Creek

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Middle Klamath River (continued)	Independence Creek	Cottonwood Creek
	Titus Creek	
	Clear Creek	
	South Fork Clear Creek	
	Elk Creek	
	East Fork Elk Creek	
	Indian Creek	
	South Fork Indian Creek	
	East Fork Indian Creek	
	Mill Creek	
	Thompson Creek	
	Fort Goff Creek	
	Portuguese Creek	
	Seiad Creek	
	East Fork Seiad Creek	
	Grider Creek	
	Walker Creek	
	Horse Creek *(Seiad Valley HSA)*	
	Buckhorn Creek	
	Salt Gulch	
	Middle Creek	
	Beaver Creek	
	Humbug Creek	
	Little Bogus Creek	
	Dry Creek	
	Bogus Creek	
Lower Klamath River	Salt Creek	
	Hunter Creek (East Fork Hunter Creek)	
	Mynot Creek	
	High Prairie Creek	
	Richardson Creek	
	Hoppaw Creek	
	Saugep Creek	
	Waukell Creek	
	Turwar Creek	
	McGarvey Creek	
	Tarup Creek	
	Omagaar Creek	
	Blue Creek	
	Pularvasar Creek	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Lower Klamath River (continued)	West Fork Blue Creek	
	Crescent City Fork Blue Creek	
	Ah Pah Creek	
	North Fork Ah Pah Creek	
	South Fork Ah Pah Creek	
	Bear Creek	
	Surpur Creek	
	Tectah Creek	
	Johnson Creek	
	Pecwan Creek	
	East Fork Pecwan Creek	
	Mettah Creek	
	Roach Creek	
	Tully Creek	
	Pine Creek	
	Cow Creek	
Trinity River	Soctish Creek	East Fork New River
	Mill Creek	Big French Creek
	Hostler Creek	Price Creek
	Supply Creek	Reading Creek
	Campbell Creek	
	Tish Tang Creek	
	Horse Linto Creek	
	Cedar Creek	
	Willow Creek	
	Sharber Creek	
	New River	
	Madden Creek (Old Campbell Creek)	
	Manzanita Creek	
	North Fork Trinity River	
	East Fork North Fork Trinity River	
	Canyon Creek	
	Dutch Creek	
	Little Browns Creek	
	Weaver Creek	
	East Weaver Creek	
	Five Cent Gulch	
	West Weaver Creek	
	Sidney Gulch	
	Browns Creek	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Trinity River (continued)	Indian Creek	
	Grass Valley Creek	
	Rush Creek	
	Deadwood Creek	
South Fork Trinity River	Eltapom Creek	Pelletreau Creek
	Hayfork Creek	
	Olsen Creek	
	Butter Creek	
Mad River	Warren Creek	Strawberry Creek
	Lindsay Creek	Mill Creek
	Grassy Creek	Kelly Creek
	Squaw Creek	Palmer Creek
	Mather Creek	Powers Creek (Dave Powers Creek)
	Hall Creek	Quarry Creek
	Noisy Creek	Black Creek
	Leggit Creek	
	Hatchery Creek (Camp Bauer Creek)	
	North Fork Mad River	
	Sullivan Gulch	
	Dry Creek	
	Canon Creek	
	Maple Creek	
	Boulder Creek	
Redwood Creek	Skunk Cabbage Creek	McArthur Creek
	Prairie Creek	Coyote Creek
	Little Lost Man Creek	Panther Creek
	Lost Man Creek	Lacks Creek
	Streelow Creek (Wolf Creek)	Minor Creek
	May Creek	Emerald Creek (Harry Weir Creek)
	Godwood Creek	
	Boyes Creek	
	Brown Creek	
	Elam Creek	
	Tom McDonald Creek	
	Bridge Creek	
Trinidad Plain	Maple Creek	
	Pitcher Creek	
	North Fork Maple Creek	
	Little River	
	South Fork Little River (Carson Creek)	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Trinidad Plain (continued)	Railroad Creek	
	Lower South Fork Little River	
	Upper South Fork Little River	
Eureka Plain	Jacoby Creek	Janes Creek
	Cochran Creek	Jolly Giant Creek
	Freshwater Creek	Washington Gulch
	Ryan Creek	Rocky Gulch
	McCready Gulch	
	Little Freshwater Creek	
	Cloney Gulch	
	Falls Gulch	
	Graham Gulch	
	South Fork Freshwater Creek	
	Elk River	
	Martin Slough	
	North Fork Elk River	
	Browns Gulch	
	Lake Creek	
	Bridge Creek	
	McWhinney Creek	
	South Branch North Fork Elk River	
	North Branch North Fork Elk River	
	Doe Creek	
	South Fork Elk River	
	Tom Gulch	
	Little South Fork Elk River	
	Salmon Creek	
Lower Eel-Van Duzen rivers	Howe Creek	Salt River
	Atwell Creek	Strongs Creek
	Larabee Creek	Price Creek
	Carson Creek	Oil Creek
	Jordan Creek	Monument Creek
	Shively Creek	Dinner Creek
	Bear Creek	Wolverton Gulch
	Chadd Creek	Wilson Creek
	Yager Creek	Cuddeback Creek
	Cooper Mill Creek	Fiedler Creek
	Lawrence Creek	Cummings Creek
	Shaw Creek	Root Creek
	Hely Creek	Stevens Creek
	Grizzly Creek	Newman Creek

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
South Fork Eel River	South Fork Eel River	Mill Creek (*Weott HSA;* tributary to Bull Creek)
	Bull Creek	Fish Creek *(Weott HSA)*
	Squaw Creek *(Weott HSA)*	Dean Creek
	Decker Creek	Bear Canyon Creek
	Canoe Creek	Warden Creek
	Elk Creek	Cox Creek
	Salmon Creek	East Branch South Fork Eel River
	Mill Creek *(Weott HSA; tributary to Salmon Creek)*	Squaw Creek *(Benbow HSA)*
	Butte Creek	Fish Creek *(Benbow HSA)*
	Leggett Creek	Connick Creek
	Redwood Creek (Pollock Creek; *Benbow*	*HSA)* Bridges Creek
	Seely Creek	Mill Creek *(Benbow HSA)*
	Miller Creek	Bear Creek*(Benbow HSA)*
	China Creek	Little Low Gap Creek
	Dinner Creek	Rattlesnake Creek
	Sproul Creek (Sprowl Creek)	Foster Creek
	Little Sproul Creek	Cummings Creek
	West Fork Sproul Creek	Streeter Creek
	Durphy Creek	Mill Creek *(Laytonville HSA)*
	Milk Ranch Creek	Barnwell Creek
	Indian Creek	Deer Creek
	Jones Creek	Mud Creek
	Moody Creek	
	Sebbas Creek	
	Coulborn Creek	
	Anderson Creek	
	Piercy Creek	
	Standley Creek	
	McCoy Creek	
	Bear Pen Creek	
	Red Mountain Creek	
	Wildcat Creek	
	Hollow Tree Creek	
	Walters Creek	
	Redwood Creek *(Benbow HSA)*	
	South Fork Redwood Creek	
	Bond Creek	
	Michaels Creek	
	Doctors Creek	
	Waldron Creek	
	Huckleberry Creek	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
South Fork Eel River (continued)	Bear Wallow Creek	
	Little Bear Wallow Creek	
	Butler Creek	
	Mule Creek	
	Cedar Creek	
	Low Gap Creek	
	Ten Mile Creek	
	Grub Creek	
	Big Rock Creek	
	Mud Springs Creek	
	Cahto Creek	
	Elder Creek	
	Jack of Hearts Creek	
	Dark Canyon Creek	
	Little Charlie Creek	
	Dutch Charlie Creek	
	Redwood Creek *(Laytonville HSA)*	
	Rock Creek	
	Kenny creek	
	Haun Creek	
	Taylor Creek	
	Bear Creek *(Laytonville HSA)*	
Middle/Upper and North Fork Eel River	Outlet Creek	Long Valley Creek
(Tributaries to the mainstem Eel River)	Bloody Run Creek	Reeves Canyon Creek
	Ryan Creek	Haehl Creek
	Mill Creek	
	Willits Creek	
	Broaddus Creek	
	Baechtel Creek	
Cape Mendocino	Squaw Creek	Mill Creek (Lighthouse Road)
(Tributaries to the Mattole River)	Woods Creek	North Fork Mattole River
	Honeydew Creek	Mill Creek (Petrolia)
	Four Mile Creek	Clear Creek
	Sholes Creek	Indian Creek
	Grindstone Creek	Upper North Fork Mattole River
	Blue Slide Creek	Oil Creek
	Bear Creek	Devils Creek
	South Fork Bear Creek	Bear Trap Creek
	Eubank Creek	Middle Creek
	Bridge Creek	Westlund Creek
	Mckee Creek	Gilham Creek

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Cape Mendocino (continued)	Van Auken Creek (Van Arken Creek)	Harrow Creek
	Anderson Creek	Mattole Canyon
	Mill Creek (headwaters)	Big Finley
	Baker Creek	Stanley Creek
	Thompson Creek	
CCC COHO ESU		
Mendocino Coast	Cottaneva Creek	To be determined
	Pudding Creek	
	Caspar Creek	
	North Fork Big Creek	
	Albion River	
	North Fork Navarro River	
	Elk Creek (Elk HSA)	
	South Fork Garcia River	
	North Fork Gualala River	
Russian River	Green Valley Creek	To be determined
Bodega-Marin Coastal	Lagunitas Creek	To be determined
	Redwood Creek	
San Francisco Bay	none	To be determined
San Mateo	none	To be determined
Big Basin	Scott Creek	To be determined

Appendix E
Watershed Groups and Gap Analysis

Watershed programs and groups are recognized as valuable assets and partners in the recovery of coho salmon. The Department has identified watershed programs, groups, and other resources currently involved in making watershed improvements that may benefit salmonids. The purpose of this analysis was to determine whether or not medium to high priority watersheds (priority ranking 3 to 5) had affiliated watershed groups. In watersheds, or hydrologic subareas (HSAs), where groups were not identified (Table E-1), the Department will endeavor to work with landowners, the local people, agencies and associations to help develop a working group for that HSA. In those HSAs with an existing watershed program or group (Table E-2), the Department will collaborate with them to ensure that actions needed to benefit coho salmon are mutually acceptable.

TABLE E-1: High priority watersheds that do not have identified watershed groups

HYDROLOGIC UNIT	HYDROLOGIC SUBAREA
Trinidad	Big Lagoon
	Little River
Mendocino Coast	Wages Creek
	Ten Mile River
	Elk Creek
	North Fork Garcia
Marin Coastal	Bolinas

TABLE E-2: Existing Watershed programs and groups

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
WINCHUCK RIVER	Winchuck River	South Coast Watershed Council	Harry Hoogesteger	
ROGUE RIVER	Illinois River	Illinois Valley Watershed Council	Coordinator	jvswcdwc@cavenet.com
		Illinois Valley Soil and Watershed Conservation District	District Manager	jvswcdwc@cavenet.com
	Applegate River	Applegate River Watershed Council	Daniel Newberry	
SMITH RIVER	Smith River Plain	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	Rowdy Creek	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	Mill Creek	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	South Fork Smith River	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	Middle Fork Smith River	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	North Fork Smith River	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	Wilson Creek	Rural Human Services	Dan Burgess	
KLAMATH RIVER	Klamath Glen	Yurok Tribal Fisheries Program	Dale Gale	dgale@northcoast.com
		Klamath Resource Information System	Bill Kier Associates	
	Orleans	Karuk Tribal Fisheries		
		Klamath Resource Information System	Bill Kier Associates	
		Hoopa Tribal Fisheries	George Kautsky	
	Lower Salmon	Salmon River Restoration Council	Jim Villetonteaux	info@srrc.org
		Klamath Resource Information System	Bill Kier Associates	
	Wooley Creek	Salmon River Restoration Council	Jim Villetonteaux	info@srrc.org
	Sawyers Bar	Salmon River Restoration Council	Jim Villetonteaux	info@srrc.org
		Klamath Resource Information System	Bill Kier Associates	
	Cecilville	Salmon River Restoration Council	Jim Villetonteaux	info@srrc.org
		Klamath Resource Information System	Bill Kier Associates	
	Ukonom	Klamath Resource Information System	Bill Kier Associates	
	Happy Camp	Klamath Resource Information System	Bill Kier Associates	
	Seiad Valley	Klamath Resource Information System	Bill Kier Associates	

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
KLAMATH RIVER (continued)	Beaver Creek	Klamath Resource Information System	Bill Kier Associates	
	Hornbrook	Klamath Resource Information System	Bill Kier Associates	
	Iron Gate	Klamath Resource Information System	Bill Kier Associates	
	Copco Lake	Klamath Resource Information System	Bill Kier Associates	
	Scott Bar	Klamath Resource Information System	Bill Kier Associates	
		Scott River Watershed Council	Rhonda Muse	rmuse@sisqtel.net
	Scott Valley	Scott River Watershed Council	Rhonda Muse	rmuse@sisqtel.net
		Siskiyou Resource Conservation District		sisqrcd@sisqtel.net
		French Creek Watershed Advisory Group	Jay Powers	
		Klamath Resource Information System	Bill Kier Associates	
	Shasta Valley	Shasta River CRMP		
		Shasta Valley Resource Conservation District	Richard Christie	richard-christie@ca.nacdnet.org
		Klamath Resource Information System	Bill Kier Associates	
TRINITY RIVER	Hoopa	Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
		Hoopa Tribal Fisheries	George Kautsky	
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
	Willow Creek	Hoopa Tribal Fisheries	George Kautsky	
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
	Burnt Ranch	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	New River	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.go
	Helena	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
TRINITY RIVER (continued)	Helena (continued)	Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Grouse Creek	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Hyampom	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Forest Glen	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Corral Creek	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Hayfork Valley	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Douglas City	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Weaver Creek	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
TRINITY RIVER (continued)	Weaver Creek (continued)	Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Upper Trinity River	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
REDWOOD CREEK	Orick	Redwood Creek Landowners Association	Bernie Bush – Simpson Timber	
	Beaver	Redwood Creek Landowners Association	Bernie Bush – Simpson Timber	
	Lake Prairie	Redwood Creek Landowners Association	Bernie Bush – Simpson Timber	
TRINIDAD	Big Lagoon			
	Little River			
MAD RIVER	Blue Lake	Mad River Watershed Group	Dave Spheril	
	North Fork Mad River	Mad River Watershed Group	Dave Spheril	
	Butler Valley	Mad River Watershed Group	Dave Spheril	
	Ruth			
EUREKA PLAIN	Eureka Plain	Humboldt Bay Watershed Advisory Committee	Ruth Blyther	
		Harbor District	Dave Hull	
EEL RIVER	Ferndale	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Scotia	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Larabee Creek	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Hydesville	Friends of the Eel River		foer@eelriver.org
		Friends of the Van Duzen		
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Bridgeville	Friends of the Eel River		foer@eelriver.org
		Friends of the Van Duzen		
		Eel River Watershed Improvement Group	Ruth Goodfield	

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
EEL RIVER (continued)	Yager Creek	Cummings Ck Watershed Advisory Council	Bill Matson	bmatson@saber.net
		Yager Environmental Stewards	Dina Moore	lonestar@humboldt1.com
		Friends of the Van Duzen		
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Weott	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Benbow	China Creek Restoration Group	Jerry Sevier	
		Eel River Restoration Project	Harry Vaughn	hvaughn@northcoast.com
		Seely Creek Watershed Assoc.	Mike Vollmer	mike@isf-sw.org
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Laytonville	Woodman Creek Road Assoc.	Kent Westwood	
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Sequoia	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Spy Rock	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Mainstem Eel Restoration Group	Ann Forest	merg1997@yahoo.com
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	North Fork Eel River	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Outlet Creek	Willits Landowner Group	Erlyne Schmidbauer	schmidtba@pacific.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Tomki Creek	Willits Landowner Group	Erlyne Schmidbauer	schmidtba@pacific.net

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
EEL RIVER (continued)	Tomiki Creek (continued)	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Lake Pillsbury	Upper Eel Landowners Association	Stuart Smith	
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Eden Valley	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Round Valley	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Round Valley Indian Tribes	Warren Mitchell	rvinatres@saber.net
		Round Valley Resource Center	Brian Dick	rvcenter@pacific.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Black Butte River	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Wilderness	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
CAPE MENDOCINO	Oil Creek			
	Capetown	Bear River Regional Resource Conservancy		
	Mattole River	Mattole Restoration Council	Chris Larson	mrc@inreach.com
		Mattole Salmon Group	Gary Peterson	msg@mattolesalmon.org

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
MENDOCINO COAST	Usal Creek	InterTribal Sinkyone Wilderness Council	Hawk Rosales	
	Wages Creek			
	Ten Mile River			
	Noyo River	Noyo Watershed Alliance	Michelle White	wildlifeworkshop@hotmail.com
	Big River			
	Albion River	Albion River Watershed Protection Association	Linda Perkins	
	Navarro River	Navarro River Watershed Working Group		
		Friends of the Navarro River	Diane Paget	
	Greenwood Creek			
	Elk Creek			
	Alder Creek			
	Brush Creek			
	Garcia River	Friends of the Garcia River		pdobbins@mcn.org
		Friends of Schooner Gulch	Peter Ryemiller	
	North Fork			
	Rockpile Creek			
	Buckeye Creek			
	Wheatfield Fork			
	Gualala	Friends of the Gualala River		
		Gualala River Watershed Council	Kathleen Morgan	kmorgan@mcn.org
	Russian Gulch			
RUSSIAN RIVER	Guerneville	West County Watershed Network		wcwnetwork@yahoogroups.com
		Stewards of Slavianka	Michele Luna	sos@mcn.org
		Dutch Bill Creek Watershed Group	Broc Dolman	broc@oaec.org
		Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Austin Creek	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
RUSSIAN RIVER (continued)	Austin Creek (continued)	For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Laguna	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
		Blucher Creek Watershed Council	Diane Niessen	diane.nissen@sonoma.edu
		West County Watershed Network		wcwnetwork@yahoogroups.com
	Santa Rosa	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Mark West	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Warm Springs	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Geyserville	Fish Net 4C	Kallie Kull	Kallie@igc.org
		Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Russian River Unlimited	Rebecca Kress	russianriverunlimited@hotmail.com
	Sulphur Creek	Fish Net 4C	Kallie Kull	Kallie@igc.org
		Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
	Ukiah	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
		Russian River Unlimited	Rebecca Kress	russianriverunlimited@hotmail.com
		Robinson Creek Watershed Group	Sheryl Greene	sgreen@pacific.net

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
RUSSIAN RIVER (continued)	Ukiah Creek (continued)	For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
	Coyote Valley	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Forsythe Creek	Forsythe Watershed Advisory Group	Mendocino County RCD	
		Friends of Forsythe Creek		
		Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		Russian River Unlimited	Rebecca Kress	russianriverunlimited@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
BODEGA	Salmon Creek	Salmon Creek Watershed Council	Kathleen Kraft	KKKraft@yahoo.com
	Bodega Head			
	Bodega Bay	West County Watershed Group	Brock Dolman	
	Estero Americano	West County Watershed Group	Brock Dolman	
	Estero San Antonio			
MARIN COASTAL	Tomales Bay	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
	Walker Creek	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
	Lagunitas Creek	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
		MMWD Lagunitas TAC	Greg Andrew	gandrew@marinwater.org
		SPAWN	Reuven Walder	reuven@spawnusa.org
		Trout Unlimited	Stan Griffen	
	Inverness	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
	Point Reyes	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
		Pt. Reyes NS Salmon Program	Brannon Ketcham	Brannon_ketcham@nps.gov
	Drakes Estero			
	Bolinas	Pt. Reyes NS Salmon Program	Brannon Ketcham	Brannon_ketcham@nps.gov
SAN MATEO	San Francisco Coastal	N/A	N/A	N/A
	Pacifica	San Pedro Creek Watershed Coalition	Christine Chan	sgerc@attbi.com

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
SAN MATEO (continued)	Half Moon Bay	Pilarcitos Creek Advisory Committee	Tim Frahm	Timfrahm@hotmail.com
	Tunitas Creek	N/A	N/A	N/A
	San Gregorio Creeek	San Gregorio Environmental Resource Center	Catherine Swatland	sgerc@attbi.co
	Año Nuevo	Coastal Watershed Council	Tamara Dolan	cwc_office@yahoo.com
	Pescadero Creek	Pescadero Conservation Alliance	John Wade	jwsavsland@aol.com
BAY BRIDGES	Bay Waters			
	San Rafael	Friends of Corte Madera Creek Watershed	Carole d'Alessio	dalessio@microweb.com
		Mill Valley Streamkeepers	Betsy Bikle	betsybikle@wellesley.alum.edu
	Berkeley			
	San Francisco Bayside			
SOUTH BAY	Bay Channel			
	East Bay Cities			
	Alameda Creek			
	San Mateo Bayside			
SANTA CLARA	Dumbarton South			
	Fremont Bayside			
	Coyote Creek			
	Guadalupe River			
	Palo Alto			
SAN PABLO	San Pablo Bay			
	Novato	Friends of Novato Creek	Sue Lattanzio	suelattanzio@earthlink.net
	Petaluma River	Petaluma River Foundation	Andy Rodgers	arodgers@econ-inc.net
	Sonoma Creek	Sonoma Ecology Center	Will Pier	sec-pier@vom.com
	Napa River	Various (see below)		
		Carneros Stewardship Group	Leigh Sharpe	Leigh@naparcd.org
		Dry Creek Watershed Group	Leigh Sharpe	Leigh@naparcd.org
		Sulphur Creek Watershed Group	Leigh Sharpe	Leigh@naparcd.org
		Friends of Napa River	Bernhard Krevet	krevet@attglobal.net

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
SAN PABLO (continued)	Napa River (continued)	Rutherford Dust Society	Davie Pina	davie@pinavineyards.com
	Pinole			
SUISUN	Suisun Bay			
	Benicia			
	Suisun Creek	Suisun Creek Restoration Team	Laurel Marcus	laurelm@ix.netcom.com
	Suisun Slough			
	Grizzly Island			
	Grizzly Island – in Delta			
	Suisun Slough – in Delta			
	Pittsburg			
	Walnut Creek			
	Martinez			
	Pittsburg – in Delta			
	Suisun Bay – in Delta			
BIG BASIN	Davenport	San Andreas Land Conservancy	David Kossack	dkossack@igc.org
	San Lorenzo	San Lorenzo Watershed Caretakers	Karen Christensen	sccrcd@cruzio.com
	Aptos-Soquel	Friends of Soquel Creek	Kay Spencer	oya@friendsofsoquelcreek.org
	Año Nuevo	Scotts Creek Watershed Council	Mathers Rowley	ScottsCreekCRMP@aol.com

Appendix F
Watershed Prioritization

This document describes the data, processes, and methods used by the CRT in developing the Watershed Prioritization (Section 6.3). It also discusses the limitations of the data and methods, and thus, the limitations of the results.

Watershed delineations are based on the CALWATER Hydrologic Subareas (HSAs), as described in Chapter 6 (Recovery Units and Watersheds). Four maps were generated to implement the prioritization. This section describes each of these maps and the data used in their development.

MAP 1: CONSISTENT PRESENCE

What: Shows the percentage of streams surveyed, in each HSA, that have Consistent Presence of coho salmon over two or three years.

Data: Coho salmon presence/absence tables found in the watershed summaries provided to the CRT by the Department regions.

Analysis: Since presence/absence data for only two years (2001 and 2002) were available for many of the watersheds, the analysis was based on the two years that were found consistently across HSAs. A handful of HSAs were surveyed in 2000 and those survey results were included.

Consistent Presence was defined as outlined below. Then, by counting the number of streams surveyed per HSA, a percentage of consistent presence (Consistent Presence in two of eight streams surveyed in that watershed = 25% Consistent Presence) was calculated.

Results were grouped into six rankings:

0 = No surveys in this watershed
1 = Streams surveyed, but no coho salmon found
2 = Coho salmon found, but no Consistent Presence
3 = 0-9% Consistent Presence
4 = 10-49% Consistent Presence
5 = 50-100% Consistent Presence

Shown below are the criteria used to determine if a stream had Consistent Presence:

FOR STREAMS WITH TWO YEARS OF SURVEY RESULTS

CONSISTENT PRESENCE	YEAR	YEAR
N	no data	no data
N	A	no data
N	A	A
N, but coho salmon found	P	A
Y	P	no data
Y	P	P

FOR STREAMS WITH THREE YEARS OF SURVEY RESULTS

CONSISTENT PRESENCE	YEAR	YEAR	YEAR
N	no data	no data	no data
N	A	(A)	(A)
N, but coho salmon found	P	A	no data
N, but coho salmon found	P	A	A
Y	P	P	A
Y	P	no data	no data
Y	P	P	no data
Y	P	P	P

Limitations: This map was produced using presence/absence data, not abundance data. Therefore, it doesn't represent the total numbers of fish in any given HSA, only that they were there. Also, since a consistent field data capture technique was used only in recent years, there are only two or three years of data to evaluate, which limits the scope of the results. Finally, this map only shows where streams have been surveyed and whether coho salmon were found. Many streams were not surveyed. This creates a bias based on how many streams were surveyed in a given HSA. Some HSAs had only one or two streams surveyed and could receive a 50% or 100% Consistent Presence with only one or two streams having coho salmon presence, while other HSAs had 20+ streams surveyed and could have many more streams with coho salmon presence and still not reach the 50% Consistent Presence mark. The streams that were surveyed, however, were based on historic data that showed where the coho salmon were most likely to be found, and it was assumed that there are very few additional streams that could have been surveyed where coho salmon would have been found.

Consistent Presence for the SONCC Coho ESU is shown on Figure 6-23 and for the CCC Coho ESU, on Figure 6-24.

MAP 2: COHO SALMON POPULATION AND RISK

What: Shows the combination of coho salmon population factors and risk factors by HSA.

Data: This map represents the compilation of several data sources. See below for details on the six combined analyses used.

Analysis: The rankings for the three coho salmon population factors were first added together, and then the three risk factor rankings were added together and divided by three. This added the risk factors in as equivalent to each individual population factor. Finally, both totals were added and then grouped into quintiles separately for each ESU.

Limitations: This map was produced by combining the rankings of six separate analyses (three for coho salmon population factors, and three for risk factors). See below for specific limitations on each of these.

Compiled Analysis: The following six items represent individual analyses that all were considered in the coho salmon population and risk map. All of these analyses involved assigning a score to each HSA and then grouping the scores into ranks (usually 1 to 5). Since there are many factors that differ between the two ESUs, these range breaks were often created separately for each ESU (3, 4, and 5).

1. CONSISTENT PRESENCE – SEE PREVIOUS MAP

2. ISOLATION INDEX

Data: CALWATER 2.2 HSAs and consistent presence data created from presence/absence data from watershed summaries.

Analysis: This analysis assessed the geographic isolation of every HSA that had any level of Consistent Presence (ranks 3, 4, and 5). To accomplish this, the following was done for each HSA that fell into this category:

1. Selected all HSAs within the same HU that were at least partially within a 5-mile radius of the boundary of the selected HSA.
2. Summed the area of all of the selected border HSAs.
3. Summed the area of all of the selected border HSAs that also had some level of Consistent Presence.
4. Calculated the percentage of Consistent Presence area out of the total area. The lower the percentage of nearby Consistent Presence HSAs, the more isolated the ranking.

The rankings were as follows:

1 = 100-70% (not very isolated)
3 = 70-45% (somewhat isolated)
5 = 45-0% (very isolated)

Limitations: This analysis is based on the proximity of HSAs to other HSAs within the larger HU. It does not look at direct hydrologic connectivity, but at clusters of HSAs that eventually drain to the same point.

3. RUN LENGTH

Data: 100K Department streams layer from Eric Haney (Region 1)

Analysis: For this analysis the downstream stream length from the output point of each HSA to the mouth (ocean or SF Bay) was used. Then a 'pseudo radius' value for each HSA based on its area was added. This addition created a run length that pushed partially into the HSA and it also provided run lengths for coastal HSAs that otherwise would have received a zero value. The results were then grouped into rankings based on five categories (different ranges for the two ESUs).

High rankings were given to both very short and very long runs, with the assumption that these represented potential unique populations of coho salmon.

RANKING	SONCC	CCC
5	0-13 miles	0-4 miles
3	14-40	5-6
1	41-82	7-8
3	83-126	9-11
5	127-200	12-31

Limitations: Because good point location data for the coho salmon are not available, exact run-lengths to spawning areas could not be calculated; instead, an average value (that goes mid-way into the HSA where there are coho salmon) was calculated.

4. CENSUS POPULATION DENSITY

Data: Year 2000 census data from Department library (by Census Tract)

Analysis: For this analysis the existing Density Class field (1-10) was used and aggregated up from Census Tract to HSA. For each Census Tract (or part of a Census Tract as clipped by the HSA boundary), the Density Class was multiplied by the percentage area of the Tract to the HSA, and then all the pieces were added. The results were then grouped into five rankings for each ESU.

Limitations: A risk to the coho salmon population is inferred based on the density of people. While the census data are fairly accurate, the relationship of human density to coho salmon risk is not necessarily a direct linear one.

5. POINTS OF WATER DIVERSION

Data: State Water Resources Control Board's Water Rights Information System (data from 12/2002).

Analysis: Within the historical range of coho salmon, the points of diversion were summarized by HSA. The totals were then grouped into ranks based on percentiles:

PERCENTILE	RANGE	RANK
50%	0-19	1
60%	20-41	2
70%	42-64	3
80%	65-186	4
95%	187-1045	5

Limitations: The data used for this analysis were the best available and capture most of the legal water diversions from streams. However, what they do not capture (at this time) is the amount of water pulled out at each diversion. Some diversions may be for a single residence, while another may be for a very large water district transfer or large irrigation project. Ideally, the amount of water diverted rather than the number of diversions would be used.

6. ROAD DENSITY

Data: 100K roads data from the Department library (USGS DLG data by county)

Analysis: Miles of roads per HSA were counted and then divided by total square miles per HSA to get a miles/sq mile figure. The results were then grouped into five rankings for each ESU.

Limitations: The 100K roads data used for this analysis are the best available for the whole coho salmon range at this time. However, at the 100K-scale of data capture, large numbers of smaller rural roads are left out, thus somewhat diminishing the road density in the rural areas. Ideally, 24K roads data would be used.

Risk of extinction for the SONCC Coho ESU is shown on Figure 6-25 and for the CCC Coho ESU on Figure 6-26.

MAP 3: PRIORITIZED WATERSHEDS FOR MANAGEMENT ACTIONS

What: Shows the combination of coho salmon population factors, risk factors and watershed status by HSA.

Data: This map represents the compilation of several data sources. It starts with Map 2: Coho salmon population and risk (see above) and adds a combined watershed status analysis that was compiled based on the professional opinion of Department field staff on three categories for each HSA: potential habitat, disconnected habitat, and watershed condition.

Analysis: Department field staff were asked to rank each HSA (1-5) in their region based on the following three categories: 1) potential habitat, stream gradient and pools; 2) disconnected habitat, barriers; and 3) watershed condition, overall condition, impairments, disturbances. These ranks were then added together and added to the totals from Map 2: Coho salmon population and risk. The totals were then grouped into ranks (1-5) separately for each ESU.

Limitations: The limitations for this map include the limitations from Map 2: Coho salmon population and risk. In addition, the three ranks collected from Department field staff are subjective.

MAP 4: DISCONNECTED HABITAT

What: Shows the amount and type of stream barriers to coho salmon migration.

Data: These data are based on the professional opinion of Department field staff.

Analysis: Department field staff were asked to rank each HSA (1-5) in their region based on disconnected habitat. The possible categories are as follows:

N/A = not current or known historic coho salmon habitat

0 = natural, permanent, or year-round barrier to coho salmon migration

1 = an extremely large barrier (e.g., major dam like Iron Gate) or an extremely large number of confirmed barriers

2 = large numbers of confirmed barriers

3 = a moderate number of barriers need to be removed or modified to allow all life stages passage to restorable coho salmon habitat

4 = a few barriers need to be removed or modified to allow all life stages passage to existing coho salmon habitat

5 = none to very few barriers need to be removed or modified to allow all life stages passage to existing coho salmon habitat

Limitations: The data for this map are based on professional opinions from Department field staff and are subjective.

Restoration and management potential for the SONCC Coho ESU is shown on Figure 6-27 and for the CCC Coho ESU on Figure 6-28. Disconnected habitat for the SONCC Coho ESU is shown on Figure 6-29 and for the CCC Coho ESU on Figure 6-30.

Appendix G
Role of Existing Hatcheries

Table of Contents

List of Tables

This appendix describes how existing hatcheries may play a role in the recovery of California's coho salmon. Appendix H provides guidelines for the operation of hatcheries.

BACKGROUND

The Hatchery Working Group of the CRT met on June 12, 2003, to discuss the role of existing coho salmon artificial production facilities in coho salmon recovery. The following report contains elements agreed upon at that meeting and subsequent additions by Working Group members. Not all Working Group members supported the addition of the following subsections entitled "Principles of hatchery operation in support of coho salmon recovery," "Monitoring and Evaluation Recommendations," and "Specific Recommendations" in this section of the Recovery Strategy. However, these subsections are included in this draft to reflect the contributions of all Working Group members and decisions made at the meeting.

Table G-1 lists the coho salmon artificial production facilities that are currently active in California.

TABLE G-1: Recent coho salmon production facilities in California

FACILITY NAME	OPERATOR	TYPE OF FACILITY	STREAM	LOCATION (COUNTY)	ESU[1]	OPS. BEGAN
Big Creek Hatchery	Private/NOAA Fisheries	Cooperative Enhancement Recovery	Big Creek (Tributary to Scott Creek)	Santa Cruz	CCC	1986
Don Clausen/Warm Springs Hatchery	CDFG	Mitigation/Enhancement/Recovery	Dry Creek (Tributary to Russian River)	Sonoma	CCC	1980
Noyo Egg Taking Station	CDFG	Enhancement	South Fork Noyo River	Mendocino	CCC	1962
Mad River Hatchery	CDFG	Enhancement	Mad River	Humboldt	SONCC	1970
Trinity River Hatchery	CDFG	Mitigation	Trinity River	Trinity	SONCC	1958
Iron Gate Hatchery	CDFG	Mitigation	Klamath River	Siskiyou	SONCC	1965
Rowdy Creek Hatchery	Private	Cooperative Enhancement	Rowdy Creek (Tributary to Smith River)	Del Norte	SONCC	1972

NOTES:

1. ESU abbreviations are CCC: Central California Coast Coho ESU, SONCC: Southern Oregon/Northern California Coasts Coho ESU.

SOURCE: CDFG 2002 with modification

NOAA FISHERIES PRELIMINARY EVALUATION OF THE POTENTIAL ROLE OF COHO SALMON HATCHERIES IN COHO SALMON RECOVERY

NOAA Fisheries (2003) assigned each current California coho salmon hatchery program to a category from 1 to 4, based on variation in 1) the degree of genetic divergence between the hatchery stock and the natural populations that occupy the watershed into which the hatchery stock is released, 2) the origin of the hatchery stock, and 3) the status of the natural populations in the watershed. This categorization is intended to provide useful information for determining the ESU status of individual hatchery stocks, and may also be useful as a rough guide for determining the potential usefulness of a stock for conservation purposes. However, the decision to use or avoid using a particular stock for purposes of conservation requires a detailed evaluation of each particular case, including evaluation on the relative benefits and risks of artificial propagation and other conservation strategies (NOAA Fisheries 2003).

This information emphasizes a conservative approach towards the use of hatcheries in the role of recovery, and takes into consideration the fact that it is not known if or how current hatchery programs will fit into the coho salmon recovery process. NOAA Fisheries is currently undergoing review of its hatchery policy based on the most accurate scientific information pertinent to the consideration of artificial propagation in ESA listing decisions. The new Federal hatchery listing policy is intended to more clearly articulate how NOAA Fisheries will consider hatchery salmonids in evaluating the risk of extinction for Pacific salmon and steelhead Evolutionarily Significant Units (ESUs), and in making subsequent listing determinations under the ESA. Completion of this process and finalization of the NOAA Fisheries Hatchery Policy is not expected before the end of 2003. Concurrently, NOAA Fisheries initiated status reviews of 25 West Coast salmonid ESUs. Updated ESA listing determinations will be proposed after preliminary analysis and review of the best available scientific information, and after consideration of protective measures being carried out to protect the species. Finalization of updated Federal ESU listing determinations is expected in 2004.

In consideration of possible dichotomies between the final NOAA Fisheries policies and those of the CRT, the Department, in consultation with NOAA Fisheries, will evaluate how to incorporate these documents into the Coho Salmon Recovery Strategy when they become available.

The following is excerpted from NOAA Fisheries (2003). Hatchery categories are highlighted in bold and italics in the text. The profile of the each coho salmon hatchery in the following accounts is meant to provide background that led to its subsequent category rating. All citations and personal communications in this section are as cited in NOAA Fisheries (2003); the original citations were not necessarily reviewed by members of the Working Group. *Blank spaces in the following excerpt from NOAA Fisheries (2003) were left blank as in the original draft document.*

The categories in each account are defined as follows:

- Category 1 stocks are characterized by no more than minimal divergence between the hatchery stock and the local natural populations and regular, substantial incorporation of natural origin fish into the hatchery broodstock. Within category 1, category 1a stocks are characterized by the existence of a native natural population of the same species in the watershed, while category 1b stocks are characterized by the lack of such a population (e.g., the local naturally spawning population was introduced from elsewhere). Note that a category 1a designation can describe a range of biological scenarios, and does not necessarily imply that the hatchery stock and the associated natural population are close to a 'pristine' state.

- Category 2 stocks are no more than moderately diverged from the local, natural population(s) in the watershed. Category 2a stocks were founded from a local, native population in the watershed in which they are released. Category 2b stocks were founded non-locally but from within the ESU, and are released in a watershed that does not contain a native natural population. Category 2c stocks were founded non-locally but from within the ESU, and are released in a watershed that contains a native natural population.
- Category 3 stocks are substantially diverged from the natural populations in the watershed in which they are released. The >a=, >b=, and >c= designations are the same as described for category 2.
- Category 4 stocks are characterized either by being founded predominantly from sources that are not considered part of the ESU in question, or by extreme divergence from the natural populations in the watershed in which they are released, regardless of founding source.

1. STOCK NAME: IRON GATE HATCHERY COHO SALMON (KLAMATH COHO SALMON [CDFG])

Hatchery/Collection Site: Iron Gate Hatchery is on the Klamath River 306 km upriver near Hornbrook (CDFG/NMFS 2001). This hatchery was built by Pacific Power and Light Company to mitigate the Iron Gate Project and is operated by the Department. Fish are collected at an auxiliary ladder at the hatchery outlet and at the main ladder at the base of Iron Gate Dam.

Broodstock Origin and History

Year Founded: The hatchery was founded in 1965, with the first releases occurring in 1966.

Source: The Iron Gate Hatchery coho salmon stock was founded with Trinity River fish released in 1966 and Cascade (Columbia River) fish released in 1966, 1968, 1969, and 1970. Other stocks released from Iron Gate include Trinity (1969 and 1977) and unknown (1970). Only Klamath stocks have been released at the hatchery since 1977. The Klamath Basin has also been planted with other hatchery stocks including Darrah Springs and Mad River hatcheries (NMFS 1997).

Broodstock Size/Natural Population Size: An average of 1,120 adult coho salmon were trapped and 161 females were spawned during the brood years 1991 to 2000 (Hiser 1993-95, Rushton 1996-2002a). Coho salmon runs in the Klamath River Basin have been greatly diminished and are now largely composed of hatchery fish (CDFG 1994).

Subsequent Events

Recent Events: All coho salmon have been marked with a left maxillary clip since 1995. Hatchery and naturally spawned fish are used in the broodstock in proportion to that which return to the hatchery (CDFG/NMFS 2001).

Relationship to Current Natural Population: Data not available.

Current Program Goals: The hatchery coho salmon production goals are 75,000 yearlings raised to 1020/lb and released from March 15 to May 1 (CDFG/NMFS 2001).

Population Genetics: Allozyme data indicate that there is little genetic structure in California and Oregon coho salmon, but a Northern and a Southern group are apparent (Weitkamp et al. 1995). Iron Gate Hatchery samples fall within the Northern group, but are not uniquely grouped. New microsatellite DNA data for California coho salmon show Iron Gate and Trinity hatcheries grouped closely together as the only Northern samples and distant from other more Southern coho salmon samples (D. Hedgecock pers. comm.).

Morphology/Behavior/Fitness: No data available.

Previous Determination: NMFS (1997) was uncertain about the Iron Gate stock ESU status.

Category and Rationale: Category 2c. Since the late 1970s, the entire broodstock has originated from the Klamath River Basin, and has included some natural origin fish. The current relationship between the hatchery and natural populations in the basin is uncertain, however. The hatchery population may be somewhat diverged from the local natural populations. The pre-1977 introductions of non-local stocks may have also influenced the hatchery stock.

2. STOCK NAME: TRINITY RIVER HATCHERY COHO SALMON (TRINITY RIVER COHO SALMON [CDFG]).

Hatchery/Collection Site: Trinity River Hatchery is located below Lewiston Dam 248 km upriver (CDFG/NMFS 2001). The trap is located at the hatchery.

Broodstock Origin and History

Year Founded: The hatchery was completed in 1963 and the first release of coho salmon was in 1966. Trapping began in 1958.

Source: The Trinity River Hatchery coho salmon broodstock was started using progeny of fish collected at the weir, but Eel River (1965), Cascade (1966-1967, 1969), Alsea (1970), and Noyo (1970) stocks were released as well. Trinity River fish were also released in those years. Only Trinity River stocks have been released from the hatchery since 1970. Trinity River coho salmon has been a very productive program and is often used as a source of coho salmon in other hatcheries throughout California. The same non-local stocks used at the hatchery were also released elsewhere in the Trinity Basin.

Broodstock Size/Natural Population Size: About 3,814 adult coho salmon were trapped during 1991 to 2001, and about 562 females were spawned during brood years 1991 to 2001 (Ramsden 1993-2002). It is commonly assumed that there is little to no natural coho salmon production in the Trinity Basin except for Trinity River Hatchery strays (CDFG/NMFS 2001).

Subsequent Events

Recent Events: All coho salmon are marked starting with the 1995 brood year with a right maxillary clip. Hatchery and naturally spawned fish are used in the broodstock in proportion to that which return to the hatchery (CDFG/NMFS 2001).

Relationship to Current Natural Population: It is commonly assumed that there is little to no natural coho salmon production in the Trinity Basin except for Trinity River Hatchery strays (CDFG/NMFS 2001).[1]

Current Program Goals: The hatchery coho salmon production goals are 500,000 yearlings raised to 10-20/lb and released from March 15 to May 1 (CDFG/NMFS 2001).

Population Genetics: Allozyme data, as mentioned above, indicate little genetic structure for coho salmon in California (Weitkamp et al. 1995). All the Trinity samples are in the Northern group with the two Trinity River Hatchery samples grouped together within the Northern

[1] The hatchery category for this hatchery was influenced by the assumption that there is no natural production in the Trinity River. However, more recent information suggests that perhaps about 10% of the total production in the Trinity River is natural production (S. Witalis pers. comm.; W. Sinnen pers. comm. as cited in CDFG 2002). Reevaluation in light of this new information might result in modification of the NOAA Fisheries hatchery category for Trinity River Hatchery.

group. However, Trinity samples are separate from Deadwood Creek, Trinity River, and Iron Gate Hatchery. The microsatellite data show Iron Gate and Trinity Hatcheries grouped closely together and away from more Southern coho salmon (D. Hedgecock pers. comm.).

Morphology/Behavior/Fitness: No data available.

Previous Determination: NMFS (1997) determined that the Trinity River Hatchery stock was in the ESU, but not essential for recovery. However, it was determined that this hatchery may play an important role in recovery efforts because there appears to be no natural production in the basin.

Category and Rationale: Category 2b. Although this stock has had introductions from non-local sources, since 1970, all of the broodstock has come from the hatchery weir. Genetic evidence does not group Trinity fish with the recorded source populations, suggesting that these introductions may have had little influence on the current stock. The relationship between the hatchery stock and any remaining natural populations in the basin is uncertain, but because of extensive hatchery straying, there is little reason to believe that there is substantial divergence between the natural and hatchery populations.

3. STOCK NAME: MAD RIVER HATCHERY COHO SALMON (MAD RIVER COHO SALMON [CDFG]).

Hatchery/Collection Site: Mad River Hatchery is located 20 km upriver near the town of Blue Lake, California (CDFG/NMFS 2001). The trap is located at the hatchery. Since 1995, the trap has been inoperable and all fish entering the hatchery through the ladder have been volunteers.

Broodstock Origin and History

Year Founded: The hatchery opened in 1970 and the first coho salmon were released in 1971.

Source: Mad River Hatchery has used the greatest number of coho salmon broodstocks, both out-of-basin and out-of-ESU, of any Department hatchery. The stock was begun with Noyo broodstock, released in 1970. Fish from the Noyo stock were released from the hatchery for an additional 11 years (1971, 1972, 1975, 1976, 1981, 1985, 1988, 1991, 1993-1994, and 1996). Other stocks released from the hatchery include Alsea (1973), Klamath (1981, 1983, 1986-1989), Klaskanine (1973), Prairie Creek (1988, 1990), Sandy (1980), Green River (1979), Trask (1972), Trinity (1971), and unknown (1977). Darrah Springs used exotic stocks to also release numerous coho salmon into the Mad River during 1960s and 1970s (NMFS 1997).

Broodstock Size/Natural Population Size: About 38 adult coho salmon were trapped from 1991 to 2000, with 16 females spawned during the brood years 1991 to 1999 (Gallagher 1994 a, b, c, 1995; Cartwright 1996-2001).

Subsequent Events

Recent Events: Since the 1998 brood year, trapping operations have averaged 23 fish. The program is undergoing re-evaluation. The 1999 coho salmon brood year was the last raised and was released in March of 2001.

Relationship to Current Natural Population: There are no coho salmon abundance estimates for the Mad River, but juveniles are widely distributed throughout the basin (NMFS 2001).

Current Program Goals: The hatchery is California's only supplementation hatchery. Its coho salmon production goal before ending the program was 250,000 yearlings raised to 8-10/lb and released from March to May (CDFG/NMFS 2001).

Population Genetics: Hjort and Schreck (1982) evaluated a number of coho salmon hatchery stocks based on one locus. The Mad River Hatchery clusters separately from Iron Gate and Trinity hatcheries.

Morphology/Behavior/Fitness: No data available.

Previous Determination: NMFS (1997) determined that the Mad River Hatchery stock was not in the ESU.

Category and Rationale: Category 4. The program has a large, and recent, use of out-of-basin and out-of-ESU broodstock. The program has been ended and this decision only considers coho salmon that returned during 2002.

4. STOCK NAME: NOYO RIVER FISH STATION COHO SALMON (NOYO COHO SALMON [CDFG])

Hatchery/Collection Site: The Noyo River Egg Station is located on the South Fork Noyo River within the Jackson State Demonstration Forest 17 km inland of Fort Bragg (Jones 2001). Fish are spawned at the station, but incubated and raised at a number of Department facilities, most commonly Mad River Hatchery, Don Clausen Fish Hatchery, and Silverado Fish Transfer Station. Coho salmon are imprinted at the Noyo Station for a minimum of two weeks before release.

Broodstock Origin and History

Year Founded: The site was originally constructed as a research facility in 1961, but egg-taking activities were initiated immediately.

Source: There are no records of broodstock from other locations being used at Noyo. The Noyo program has been very successful. Introductions into other watersheds using Noyo fish have been extensive. Marking has been sporadic, but when available, hatchery fish are excluded from the broodstock. Out-of-ESU coho salmon have been planted in the Noyo River, including Alsea (Oregon Coast ESU) and Klaskanine (Lower Columbia River ESU) fish.

Broodstock Size/Natural Population Size: There was an average of 524 fish trapped from 1991 to 2001 and 100 females spawned in brood years 1991 to 2001 (Grass 1992-2002). However, in 1998 and 1999, only 16 and 85 fish were trapped. There are no coho salmon abundance estimates for the Noyo River, but juveniles are widely distributed and abundant throughout the basin (NMFS 2001).

Subsequent Events

Recent Events:

Relationship to Current Natural Population:

Current Program Goals: The program's goal is to develop a minimum sustained escapement to the South Fork Noyo River of 1,500 adult coho salmon annually. To reach this goal, the program target is 75,000 smolts released from March to April each year (Hunter 1987).

Population Genetics: Microsatellite data show Noyo samples clustering tightly with other coho salmon stocks south of the Eel River (D. Hedgecock pers. comm.).

Morphology/Behavior/Fitness:

Previous Determination: NMFS (1997) determined that the Noyo River Hatchery stock was in the ESU, but a final decision was deferred.

Category and Rationale: Category 2a. The stock founded several decades ago from local collections, and there have been no out-of-basin stocks introduced into the broodstock over its history. An unknown but probably no more than moderate proportion of naturally spawned fish have been included into broodstock ever year.

5. STOCK NAME: DON CLAUSEN HATCHERY COHO SALMON (WARM SPRINGS COHO SALMON [CDFG]).

Hatchery/Collection Site: The Don Clausen Fish Hatchery is located on Dry Creek at the base of Warm Springs Dam, 71 km upstream from the mouth of the Russian River. The trap is at the hatchery.

Broodstock Origin and History

Year Founded: The hatchery went into service in 1980. The first releases were in 1981.

Source: Noyo River coho salmon were heavily planted into the Russian River. The program was considered unsuccessful and ended in 1996. Starting in 2001, a captive broodstock program was initiated. Fish for the captive broodstock program are obtained by electrofishing 300 to 600 juveniles from the Green Valley and Mark West Springs Creeks (Russian River Basin), or the Olema and Redwood Creeks (Marin County) if necessary (NMFS 2002a).

Broodstock Size/Natural Population Size: From 300 to 600 juveniles will be taken from the Russian River, or failing that, the Lagunitas-Olema system. No population estimates are available for the Russian River Basin, but fish are rare and only occur consistently in Green Valley Creek (NMFS 2002a).

Subsequent Events

Recent events: In 2001, 337 juvenile coho salmon were taken from Green Valley and Mark West Springs Creeks (Russian River Basin), and Olema Creek to initiate the captive broodstock program (NMFS 2002a).

Relationship to Current Natural Population:

Current Program Goals: The captive broodstock program proposes to release 50,000 fingerlings and 50,000 yearlings into five Russian River streams.

Population Genetics: Allozyme data show Willow Creek, Russian River, grouping with the Southern cluster, closest to the South Fork of the Eel River (Weitkamp *et al.* 1995). Newer microsatellite data show the previous hatchery closely related to the Noyo River and Lagunitas Creek samples (D. Hedgecock pers. comm.)

Morphology/Behavior/Fitness.

Previous Determination: There has been no previous NMFS consideration of the new Don Clausen captive broodstock hatchery program.

Category and Rationale: Category 1a. This stock is recently founded from a native natural population.

6. STOCK NAME: KINGFISHER FLAT (BIG CREEK) HATCHERY COHO SALMON (SCOTT CREEK COHO SALMON [MBSTP]).

Hatchery/Collection Site: Kingfisher Flat Hatchery is located on Big Creek, a tributary of Scott Creek, 6 RM from the mouth. This hatchery takes on increased importance because it is the

Southern extent of coho salmon's range. Broodstock are taken by divers netting adults usually in Big Creek below the hatchery. However, this can also occur throughout the Scott Creek system (NMFS, draft biological opinion).

Broodstock Origin and History

Year Founded: The Monterey Bay Salmon & Trout Program (MBSTP) started the Kingfisher Flat hatchery in 1975, but it was not in operation until 1982. California State hatchery activity near this site has a long history back to 1904 (Strieg 1991). Due to flood damage, the State hatchery program ended in 1942. There was also a nearby ocean-ranching operation, SilverKing Oceanic Farms, at Waddell Creek and the San Lorenzo River from the 1960s until the early 1980s.

Source: Since 1976, when the MBSTP took over operations, there have been no out-of-basin fish introduced into Scott Creek. Since then, broodstock have been taken by nets in Scott Creek. All coho salmon are marked. No hatchery fish are used in spawning unless minimum goals are not met. Mating occurs in a factorial protocol. Prior to 1942, when there was a State hatchery, there were widespread introductions of broodstock from within California, including Mt. Shasta (1913, 1915, 1917, 1928, and 1937), Ft. Seward (1930, and 1932), and Prairie Creek (1933, 1934, 1936, 1938, and 1941) hatcheries. This stock was considered an extremely healthy one and was widely planted throughout the State's coastal streams. During the Silver-King operation, broodstock was obtained from Oregon, Washington, British Columbia, and Alaska.

Broodstock Size/Natural Population Size: Up to 30 females and 45 males can be taken with the restriction that the first 10 spawning pairs to be observed must be undisturbed. Then, only one out of four females may be taken to insure natural spawning. However, in recent years, few to no fish have been taken for spawning due to low abundance. However, in 2001, 123 coho salmon were observed and 26 wild females were taken for spawning. Of the remaining 97 coho salmon, 43 were marked. There are no abundance surveys, but coho salmon are well distributed within the Scott Creek basin (NMFS, Draft BO).

Subsequent Events

Recent Events: Starting in 2002, a captive broodstock program for Scott Creek was initiated at the NMFS Santa Cruz Laboratory. The 2001 returning coho salmon numbers to Scott Creek were estimated to be well over 300. The hatchery staff handled 109 females (26 wild) and 123 males (36 wild).

Relationship to Current Natural Population:

Current Program Goals: The goal is to spawn 30 unmarked females and 45 unmarked males to obtain approximately 60,000 eggs (NMFS 2002b).

Population Genetics: Microsatellite data show Scott Creek samples, including Big Creek Hatchery samples, clustering tightly together as a branch of the Central California group (D. Hedgecock pers. comm.).

Morphology/Behavior/Fitness:

Previous Determination: NMFS (1996) determined that the Kingfisher Flat Hatchery stock was in the ESU, but a final decision was deferred.

Category and Rationale: Category 1a. There have been no introductions into the watershed in the last 30 years and, in most years, the broodstock has consisted substantially or entirely of wild fish.

PRINCIPLES OF HATCHERY OPERATION IN SUPPORT OF COHO SALMON RECOVERY

To minimize the loss of both overall and adaptive genetic diversity in existing coho salmon populations with hatchery influence, incorporation of conservation strategies in hatchery operations should include comprehensive genetic analyses to detect inbreeding, outbreeding, and domestication selection, and rearing and release techniques that maximize fitness and reduce straying. All aspects of hatchery operations that affect the health and survival of both hatchery and natural fish should be rigorously monitored and evaluated to maximize the probability of long-term success.

Coho salmon production facilities should operate according to the following principles in support of recovery of coho salmon:

1. Justification for coho salmon hatchery production should be based on the best scientific information and be consistent with recovery goals.
2. Hatcheries should not impede recovery of coho salmon.
3. Hatcheries should:
    a. conserve the full range of existing genetic diversity of the run;
    b. not affect morphological, physiological, ecological, reproductive, or behavioral features of coho salmon that reduce fitness; and
    c. not negatively affect any endemic natural populations in the streams where hatchery fish are released.
4. Hatchery operations and monitoring should be managed in support of recovery using the best scientific information.
5. Hatcheries should as much as possible be managed to meet mitigation requirements, while avoiding further degradation of natural coho salmon production and impediments to recovery.
6. Department and Commission policies should focus on natural stocks as the basis of California's salmon production.
7. All artificially produced coho salmon should continue to receive an external mark along with any other marks or tags deemed necessary to effectively monitor and evaluate the effect of the hatchery program on recovery. Marking facilitates broodstock management and identification of all hatchery-origin coho salmon for monitoring.
8. Hatchery monitoring and evaluation plans should be designed to measure the effect of hatchery production on coho salmon recovery.
9. Hatchery management and operations should address Tribal Trust, Department/NOAA Fisheries Hatchery Recommendations, and Hatchery and Genetic Management Plans while maximizing attainment of recovery goals for coho salmon.
10. Coho salmon hatcheries should be managed to maintain Tribal fisheries to the maximum extent possible, while still attaining recovery goals.
11. Prior to the establishment of conservation programs, all hatcheries will be required to develop Hatchery and Genetic Management Plans.
12. Research is an appropriate secondary objective for a coho salmon hatchery, especially for research that addresses coho salmon recovery relative to hatchery operations.

13. Coho salmon hatcheries should operate in a way that maximizes the effective population size of the hatchery and hatchery + natural populations while at the same time preserving existing adaptive variation, within-population diversity, and between-population diversity.
14. Small rearing programs have traditionally produced coho salmon throughout their range in California. These programs should be consistent with the recovery guidelines presented here.

MONITORING AND EVALUATION RECOMMENDATIONS

Concurrent hatchery and recovery programs can only be successful with appropriate monitoring to estimate the contribution of artificially propagated fish to the natural population during the supplementation process, and to monitor genetic characteristics of the natural and hatchery populations. At the same time, habitat assessments and baseline monitoring and evaluation of the physical and biological components of the ecosystem are necessary to monitor quality and quantity in the receiving environment. These important tools provide a means to evaluate ways of improving hatchery activities and increase the chances of successful recovery efforts.

In order to effectively monitor the effects of current and future coho salmon artificial propagation on recovery of coho salmon, the Hatchery Working Group recommends that the Department work toward establishing or maintaining the following management, monitoring, and evaluation elements:

1. Obtain accurate adult censuses of natural- and hatchery-origin coho salmon whenever possible, including hatchery contribution to natural spawning, elucidate interactions among hatchery- and natural-origin fish, estimate natural- and hatchery-origin stray rates.
2. Continue and expand efforts to gather up-to-date baseline population genetics data on all natural- and hatchery-origin coho salmon stocks, especially those that have the potential to be affected (positively or negatively) by hatchery production.
3. Use historic and contemporary outmigrant and hatchery marking data to analyze production and outmigration timing of hatchery- and natural-origin stocks. Expand or modify monitoring as necessary to ensure that monitoring meets data needs for effective evaluation of hatchery/natural fish interactions.
4. Develop an overarching plan within the Department, NOAA Fisheries, and Tribal governments for achieving and modifying hatchery goals in the context of recovery of natural coho salmon runs while maintaining Tribal trust obligations to mitigate for lost habitat.
5. Develop a mechanism for proposing modifications to hatchery operations to aid recovery of coho salmon that is inclusive of all affected groups, that recognizes:
   a. the unique responsibilities of the Department's hatchery and biology staff and managers to manage these facilities according to the Department and FGC policies in the public trust;
   b. Federal Tribal trust obligations;
   c. NOAA Fisheries responsibilities under the ESA;
   d. existing agreements, regulations, mitigation obligations, and planning processes; and
   e. CESA requirements and other requirements under law.

6. Modify hatchery operations to actively aid recovery whenever possible and to, at minimum, avoid impeding coho salmon recovery.
7. Actively pursue opportunities to collect data on morphology, physiology, behavior, and ecology of hatchery- and natural-origin coho salmon with the goal of identifying and minimizing any negative fish culture or fish release effects on native, naturally occurring populations of CESA- and ESA-listed salmonids, and their habitat.
8. Continue evaluations of Department hatchery management with the goal of managing hatcheries to maximize natural production and minimize negative effects.
9. Increase broodstock monitoring and management intensity (e.g., genetic management of broodstock, broodstock collection and spawning strategies, rearing and release strategies, evaluation of effective population size) as necessary to a level commensurate with protection of listed stocks.
10. Avoid ecological/behavioral impacts of coho salmon hatchery releases on other endemic species (e.g., Chinook salmon and steelhead).
11. Avoid ecological/behavioral impacts of Chinook salmon and steelhead hatchery releases on coho salmon.
12. Initiate assessment and monitoring of stream and ocean carrying capacity and the relation of hatchery production to density dependent effects, especially density dependent mortality.

SPECIFIC RECOMMENDATIONS

The following specific recommendations were forwarded from the Hatchery Working Group and rely heavily on the Department/NOAA National Marine Fisheries Service Southwest Region Joint Hatchery Review Committee Final Report on Anadromous Salmonid Hatcheries in California (CDFG/NMFS 2001).

Since the hatchery review (CDFG/NMFS 2001) was prepared, more genetic information has become available with which to evaluate natural and hatchery coho salmon stocks in both the CCC Coho ESU and the SONCC Coho ESU (Hedgecock et al. 2003; J.C. Garza pers. comm.). This information and any new information on population genetics will be incorporated into recovery planning as it becomes available.

1. Evaluate the potential of the Noyo Fish Taking Station to develop a role as a research facility due to the putative purity of the stock there and the presence of a barrier at which to collect data and control entry to and exit from the system.
2. Incorporation of recovery strategies for coho salmon in hatchery operations should be consistent with other ongoing planning processes including NOAA Fisheries' ESA recovery planning process, annual reviews of Trinity River Hatchery operations in the context of the Federal Tribal Trust obligation of Trinity River Hatchery, and the re-licensing of the Klamath River Project, including the Iron Gate Dam and Hatchery.
3. The Department, Tribes and NOAA Fisheries should follow through with HGMP plans to consider how or whether the coho salmon program at Trinity River Hatchery should be utilized in the recovery of Trinity Basin coho salmon (CDFG/NMFS 2001). These plans should be based on the most recent popula-

tion genetics and demographic information on the composition of the existing coho salmon run to the basin and the influence of the abundant hatchery stock on the remnant natural stock.

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Appendix H
Recommended Guidelines for Recovery Hatcheries

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INTRODUCTION

Many coho salmon runs in California have experienced local extinction, fragmentation, and brood-year extinction, or are at such low apparent abundance that they are judged at high risk of extinction (Bryant 1994, Weitkamp et al. 1996, CDFG 2002, NOAA Fisheries 2003). Ideally, natural recolonization or supplementation by similar nearby stocks is preferable to using hatchery stocks to recover these runs (Reisenbichler et al. 2003). However, extremely depleted stocks and ESA and CESA listings of many California salmon populations have made it necessary for the Department to evaluate the use of specialized anadromous fish hatchery programs along with extensive monitoring to help meet certain recovery goals. In some of these extreme cases the risks posed by releasing relatively small numbers of hatchery fish from well defined programs focused on recovery are acceptable. Still, the Department considers captive broodstock and recovery supplementation projects to be unproven last-chance efforts to protect and recover severely reduced and imperiled populations. The small number of projects that exist have not shown conclusively that they are able to rehabilitate depleted runs or establish recolonized runs. The evidence of whether hatchery fish can reliably establish natural runs is mixed and the results of hatchery introductions are unpredictable (see review in CDFG 2002). Therefore, it is prudent that recovery hatcheries only be employed when all other means of coho salmon recovery have been exhausted or when extirpation is imminent. The Department does not consider recovery hatchery programs a substitute for habitat improvement and improvement of natural salmon production.

The following definitions of hatcheries are used in this section (also see Attachment 1: Glossary). These are the same definitions used in the status review of coho salmon North of San Francisco in CDFG (2002). There may be some confusion over what is intended by some terms; for example, the term “supplementation” for some people may equate to what we call “enhancement” in this section. This section deals only with recovery hatcheries (translocation of adults to spawn in another place, or of naturally produced juveniles, while they may be considered at some time, are not considered in this document[1]). Modification of existing hatcheries to include a conservation ethic will be discussed in a separate section. Note that success criteria for each of the following are different.

- *Supplementation hatcheries* are intended to contribute to the natural spawning population (primary success criterion is recruitment to spawner population).
- *Mitigation hatcheries* are intended to make up for reductions in natural spawning due to human-caused habitat loss (e.g. dam construction; primary success criterion is replacement of lost production).
- *Enhancement hatcheries* are intended to improve a fishery by increasing the number of catchable fish in the ocean or stream (primary success criterion is recruitment to a fishery).

[1] Natural colonization/supplementation, when feasible, should have priority over hatchery intervention. Recovery hatcheries should only be employed in extreme cases. Translocation of young-of-the-year coho salmon to a watershed where coho salmon have experienced extinction should be explored prior to establishment of a recovery hatchery.

- *Recovery hatcheries* are experimental programs intended to supplement depressed natural populations or provide fish for artificial recolonization of streams that have experienced local or brood-year extinctions, to maintain genetic diversity within and among stocks, and to conserve valuable or rare genes and genotypes. They may, or may not, rely on captive broodstock to accomplish these goals. Recovery hatcheries attempt to minimize or eliminate negative effects common to fish culture, resulting in as close to wild fish as possible (primary success criteria are increased abundance of spawners and/or outmigrants, lowered risk of extinction, recolonization of a self-sustaining population, and/or brood-year reconstruction, while avoiding negative hatchery impacts as much as possible).

California has only five current coho salmon artificial propagation programs (Table H-1). Two of these, Big Creek Hatchery and Don Clausen/Warm Springs Hatchery are currently operated as recovery hatchery programs for coho salmon. Only two other anadromous salmon recovery hatchery programs exist in California; both produce winter-run Chinook salmon. The USFWS operates a recovery supplementation program and, in cooperation with U.C. Davis' Bodega Marine Laboratory,[2] a captive broodstock program for winter-run Chinook salmon at Livingston Stone National Fish Hatchery located at the base of Shasta Dam on the Sacramento River. Trinity River and Iron Gate Hatcheries are mitigation facilities. Noyo Egg Taking Facility and, to a much lesser extent Big Creek Hatchery, are intended to provide fishery enhancement.

RECOMMENDATIONS FOR DEPARTMENT POLICY ON RECOVERY HATCHERIES FOR COHO SALMON

The Hatchery Working Group of the CRT and reviewers in the Department (Attachment 2) developed the following recommendations for policies that concern the establishment, operation, and closure of recovery hatcheries for coho salmon. The recommendations were developed using the best available scientific information, and are consistent with the Fish and Game Code sections relevant to hatcheries for anadromous salmonids (Attachment 3), the California Endangered Species Act (CESA), and Fish and Game Commission (Commission) and Department anadromous fish policies (Attachment 4). Although these policy recommendations are specific to coho salmon recovery, they apply equally well to any recovery hatchery for recovery of anadromous salmonids, and we recommend that they be used as guidance for any recovery hatchery.

The following policies should be applied to all coho salmon recovery hatcheries.

1. The purpose of a recovery hatchery as defined in this section is to aid and/or accelerate recovery of coho salmon by reducing risk of extinction due to one or more of a number of factors that result from low abundance, cohort failure, and/or drastic population fluctuation. The focus of a recovery hatchery is to reduce extinction risk and improve natural production in accordance with Department, Commission, and Federal Endangered Species Act (ESA) policies.
2. The Department considers recovery hatchery programs for the purpose of restoring natural runs of salmon to be unproven. The number of facilities

[2] Originally this project was done in cooperation with both U.C. Davis' Bodega Marine Laboratory in Bodega Bay, and Steinhart Aquarium in San Francisco. However, cooperative elements at Steinhart Aquarium have recently been phased out of the program.

should be limited to that which is necessary to meet identified coho salmon recovery needs. The number of facilities should be sufficient to meet recovery needs, but small enough to ensure that agencies can effectively coordinate recovery at the ESU and range-wide level, maintain connectivity and communication among programs, resource agencies, and the public, promote efficient use of resources, and avoid overproduction of hatchery-origin coho salmon. The number of facilities should be scaled to avoid redundancy and to ensure that recovery is not disproportionately reliant on hatchery-origin coho salmon.

3. In accordance with items 1 and 2 above, recovery hatchery operations will avoid excess hatchery production above that which is deemed necessary by the Department and NOAA Fisheries to meet recovery goals. The number of fish produced should be sufficient to significantly reduce the probability of extinction, accurately represent the genetic variation in the natural population, minimize random or directional genetic change in captivity, and to re-establish a self-sustaining natural run.
4. In all cases, recovery hatchery operations should be subsequent to or concomitant with active and focused habitat improvements designed to increase natural production with the ultimate objective of reaching recovery goals.
5. All recovery hatchery programs must be part of and integral to the overall plan for recovery of coho salmon at the ESU and range-wide levels.
6. All recovery hatchery programs must be consistent with CESA and ESA.
7. Recovery hatchery programs should have a planned, finite, and short-term lifespan. Ideally the life of a recovery hatchery program would be only 1-3 generations. However, the Department recognizes that unique elements of coho salmon life-history may necessitate longer-term projects on the order of 3-4 generations to accomplish difficult tasks like rebuilding missing year classes or repopulating locally extinct runs. In such cases, the life-span of the recovery hatchery should be the minimum amount of time consistent with reaching specific project goals.
8. All operations should be continually assessed and modified to avoid establishment of a hatchery-dependent run in which the hatchery persistently acts as the source in a source-sink relationship with the natural run; A comprehensive risk/benefit analysis will be prepared prior to the establishment of any new recovery hatchery operation.
9. Recovery hatcheries must be operated in a way that protects naturally recovering coho salmon populations from the possible adverse biological and monitoring effects of inadvertent hatchery influence, especially those populations specifically targeted for natural recovery and nearby populations that are not targets of hatchery-based recovery efforts.
10. Recovery hatchery operations should be done in a way that protects all existing populations of native salmonids and other native fish already living in the receiving ecosystem. An assessment (e.g., identification of species composition, size, and density measurement) should be done to determine if there will be impacts (e.g., competition, predation, niche partitioning) to fish already present.
11. Hatchery releases should be based on the receiving ecosystem's carrying capacity. Conservation/recovery hatchery programs should only be approved in

places where guideline conditions are met and habitat is not a limiting factor for the existing natural stock, where unused habitat is demonstrably available, and where competition and other negative ecological interactions between natural- and proposed hatchery-origin stock can be avoided or are minimal. Habitat availability includes demonstrably consistent connectivity of spawning habitat, rearing habitat, and corridors for migration under current conditions. In special cases, exceptions may be made for places where necessary habitat improvements are obvious, relatively easy to do in a short time, and have a high probability of substantially improving a stream's ability to support coho salmon. In these cases, recovery hatchery construction may be conditionally approved with the condition that substantial progress is made toward habitat improvement prior to releasing fish. Requiring suitable habitat increases the probability of success of supplementing natural runs and will avoid creating unwanted hatchery-dependent runs.

12. Recovery hatchery programs should be located to maximize recolonization potential of nearby depleted streams through natural metapopulation processes, while attempting to avoid circumventing natural patterns of reproductive isolation among populations.

13. Existing facilities should be used for recovery actions before constructing new ones for efficiency and to concentrate scarce resources. However, the Department recognizes that in many cases existing production facilities that were designed for a very different purpose will require substantial modification to meet recovery hatchery needs.

14. When considering the establishment of new facilities, coordinated efforts that are consistent with, and integral to, the overall recovery plan and involving active participation of State, Federal, and Tribal resource agencies, watershed groups, or stakeholder groups, will be preferred to isolated projects. Interagency and intergroup coordination is a necessary feature for establishing and operating a recovery hatchery and recovery hatchery program. Development of MOAs among participants for recovery hatchery programs should be required.

15. Guidelines presented in this section will be used by the Department along with any other appropriate information and decision-making processes to determine whether a recovery hatchery program is needed, what general kind of operation it should be, and how to operate, monitor, report, and decommission the facility. Guideline criteria should be evaluated at the population level, not on a stream or watershed basis, to ensure that hatchery operations are consistent with population viability and Federal/State recovery goals.

16. Recovery hatchery programs should have detailed operating plans, including emergency and decommission plans prior to the beginning of operations. Plans should carefully define the intended geographic scope of the project (e.g., run, watershed, region, ESU). These plans should include provisions for adaptive management.

17. Steering committees or technical advisory groups consisting of teams of technical experts and management staff should be be established to advise and assist in the operation of each facility. These committees must include at a minimum representatives of the appropriate Federal, State, and Tribal resource

agencies (including, but not limited to, NOAA Fisheries, CDFG, and, in some cases, USFWS and/or Tribal Fisheries Agencies), permitting agencies, and the permittee. Inclusion of other technical and management personnel to meet specific advisory needs should be included as necessary and appropriate. An independent committee of conservation professionals in specific areas of expertise (e.g., genetics, population viability, ecology) should be established for consultation on highly technical issues. Final decisions concerning hatchery operations are the responsibility of the Federal and State permit holder operating the facility, and will be done in accordance with permit conditions while striving to meet coordinated recovery goals.

18. Research on topics that aid or accelerate recovery is an appropriate secondary use for recovery hatchery programs and their products.
19. The Department will coordinate with NOAA Fisheries on the establishment and operation of recovery hatchery programs.
20. Appropriate Federal and State permitting is required prior to the operation of any recovery hatchery or recovery hatchery program.

GUIDELINES FOR ESTABLISHMENT AND OPERATION OF RECOVERY HATCHERY PROGRAMS

The Working Group developed guidelines for the use of captive broodstock and/or recovery supplementation as an integrated tool for coho salmon recovery. The following research and guidance documents were influential in the development of the guidelines: Hard et al. 1992, CDFG undated, Weitkamp et al. 1996, Busby et al. 1996, Myers et al. 1998, Waples 1994, NMFS 1999, Flagg and Nash 1999, CDFG/NMFS 2001, NMFS 2003, and Reisenbichler et al. 2003. For example, see Attachment 5 for relevant information from Reisenbichler et al. (2003).

Table H-1 contains guidelines for conditions under which some type of recovery hatchery program for coho salmon may be appropriate. The guidelines describe conditions regarding abundance, brood-year cycle, uniqueness relative to other populations, carrying capacity and productivity, potential for natural recolonization, and value. Meeting any of these criteria is suggestive that a recovery hatchery program may be appropriate as a component of a recovery strategy. Using these guidelines along with the policies identified in this section, the Department can decide on which programs will best address coordinated recovery needs.

Figure H-1, which also cites Table H-2, shows a simplified flow chart that can be used in the initial phases of determining whether a recovery hatchery should be contemplated as a recovery tool.

Identification of reproductively isolated populations is essential to maintaining existing patterns of diversity in coho salmon. The Department should use any and all information on patterns of reproductive isolation to identify populations including results arrived at through NOAA Fisheries Recovery planning process, population genetics data currently in development, geographic data, ocean distribution data, mark data, phenotypic data (e.g., run timing, age structure, outmigration timing, size and growth), and any other data deemed appropriate.

Establishment of a recovery hatchery should require that a coho salmon population be a component of an ESU listed as endangered, or that it meet the strict guidelines presented in this section. Recovery hatcheries should be minimally employed, if at all, in the SONCC Coho ESU, but may be more appropriate for use in the CCC Coho ESU.

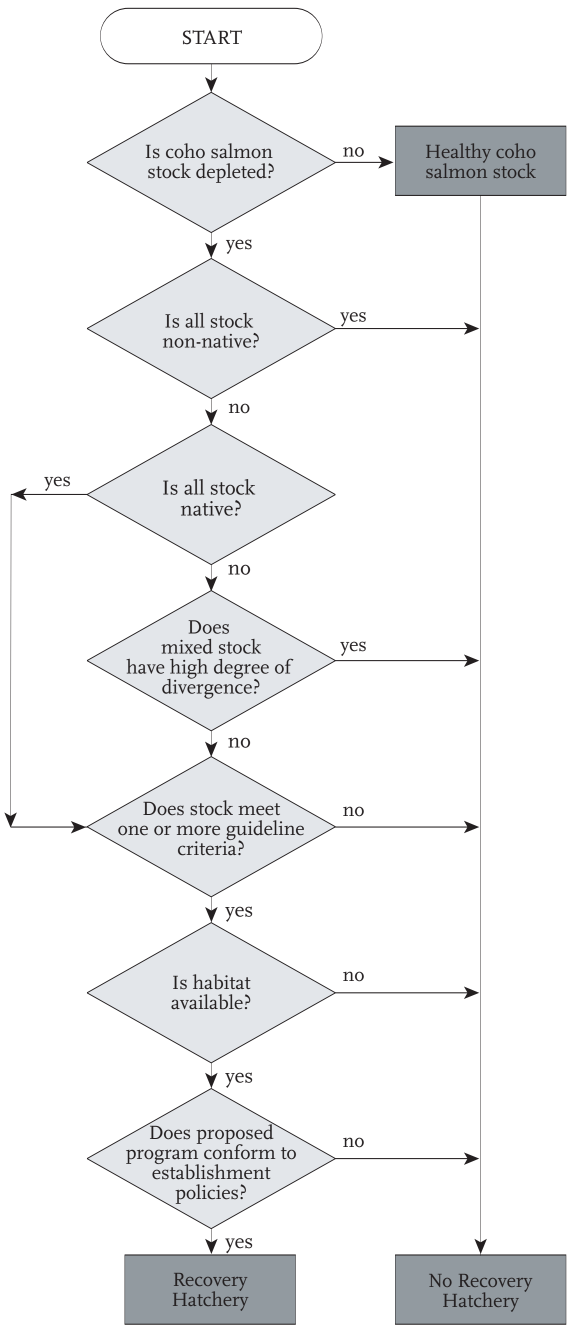
TABLE H-1: Decision guidelines for establishing a recovery hatchery program (after NMFS 1999 with modification)[1]

CATEGORY	GUIDELINES	TYPE OF PROGRAM INDICATED
Abundance [2]	Very low abundance OR Low abundance and declining OR Moderate abundance and precipitous decline OR Low to moderate average abundance and high amplitude of population fluctuation that frequently includes zero OR Little or no natural production over at least one generation (3 years)	CB, RS, G
	Low abundance relative to available habitat and production capacity	CB, RS
Brood-year cycle	Two of three brood years are consistently missing or extremely weak	CB, G
Uniqueness relative to other populations	Evidence of unique genetic qualities and meets one or more or the abundance or brood-year cycle criteria	CB, RS, G
	Unique adaptations to specific local conditions and meets one or more or the abundance or brood-year cycle criteria	CB, RS, G
Carrying capacity and productivity	Population has unrealized potential for high productivity in the currently available habitat in comparison to other populations in the ESU due to consistently lower than supportable population size or chaotic population size fluctuation	RS
Potential for natural recolonization	Historically present but currently extinct, good measured habitat is available AND Potential for natural recolonization is low	CB, G
Value	Unique social, economic, or cultural value, including unique importance to Tribal society, economy, or culture AND meets one or more of the abundance or brood-year cycle criteria	CB, RS, G

NOTES:

1. Meeting any of these criteria indicates that a captive broodstock program (CB), a recovery supplementation project (RS), a cryopreservation project (G), or some combination, as integrated elements of the recovery plan might aid or accelerate recovery. The population must have been judged to be at high risk of extinction in the immediate future as a prerequisite to establishing a captive broodstock program. Application of these guidelines assumes that there is good evidence that habitat is currently available, including viable connections between spawning areas, rearing areas, and the ocean.
2. Based on population size which may include more than one stream or watershed.

FIGURE H-1: Flow chart depicting simplified decision rules for exploring whether a coho salmon recovery hatchery may be an appropriate recovery tool



Refer to Table H-2 for specific guidelines, and to the text for specific establishment policies. (After Flagg and Nash 1999 with modifications.)

TABLE H-2: General guidelines for operation of a recovery hatchery program. Individualized operations plans for each project should be designed in consultation with resource agencies and steering committees and in accordance with permit conditions.

ISSUE	GUIDELINES
Source populations for broodstock	Best guidance is to rely on results of recent population genetic analyses and life history data to find the most similar stock (i.e., a stock with the same ancestral lineage) to the target stock. Nearby stocks are the most likely candidates for reintroductions, but genetic analyses should be used to verify their suitability. Donor stocks should be from streams that are ecologically similar to the receiving system to increase the likelihood that they are well adapted to it. Donor stocks should have similar pattern of within-population genetic diversity to extant populations to ensure a basis for adaptive response to environmental change.
	If target population is very small, consider taking all available representatives of the population into the hatchery. But, only if the risk to the population by bringing it into the hatchery is less than that in the stream with habitat restoration.
	If a portion of the adult run is collected as broodstock, collect them throughout the spawning season in proportion to the natural run.
	If a portion of the juvenile population is collected as broodstock, design the collection protocol to avoid collecting large numbers of closely related individuals, e.g., collect from several locations at several times during the natural outmigration period. Also avoid mixed collections consisting of juveniles from more than one population.
	Limit the proportion of hatchery fish contribution to broodstock to ≤10% of total OR Avoid hatchery fish contribution to broodstock.
Spawning	Spawn captive broodstock only during the natural spawning season.
	Spawn as many adults as possible using single pair matings or from 2-4 males per female.
	Attempt to equalize family size to maximize effective population size (may be best accomplished during rearing).
	Use cryopreserved sperm as appropriate to create desired effects, but take care to balance with reduced viability especially with small numbers of available eggs.
	Consider induced spawning or photoperiod manipulation to maximize the number of captive broodstock spawners available during the natural spawning season.
	If juveniles are used as a broodstock source, determine relatedness among individuals using genetic analysis prior to spawning and use this information to avoid inbreeding.
	Use genetics data as much as possible to avoid inadvertent hybridization in the hatchery.
	Monitor readiness to spawn using best available technologies (e.g., ultrasound).
	PIT tag broodstock to individually identify them.
Fish rearing	Avoid direct human contact with fish that are to be released to the wild whenever possible, e.g., use automatic feeders instead of feeding by hand.
	Consider multiple rearing locations to spread risk in case of catastrophe.
	Control or eliminate disease outbreaks before they occur, manage if they do. Consider whether inoculations are appropriate standard operating procedure.
	Separate family groups as much as possible during rearing and carefully record the composition of groupings.
	Develop redundant systems to avoid loss of broodstock or their progeny.
	Attempt to mimic natural conditions as much as possible, especially for fish that will be released.
	Water supplies should be free of pathogens and predators.
	Determine whether and how both fresh and salt water should be used in the program, and carefully manage and document transitions of fish from one to the other.
	Attempt to equalize parental contribution to maximize effective population size.

(continued)

TABLE H-2: General guidelines for operation of a recovery hatchery program (continued)

ISSUE	GUIDELINES
Release protocols	Release juvenile fish as early as possible to attempt to avoid domestication. However, this issue may not be easy to resolve because other options may be more attractive for a given program. Considerations should be given to the tradeoffs between return rate, release size, and fitness (see Reisenbichler et al. 2003, Table 4, in Attachment 2 for a review). A combination of life-stage release strategies is also worth considering, although combinations may significantly complicate monitoring.
	Attempt to release juveniles at the same size as the natural fish to improve the chances that the hatchery and natural fish will have similar life histories related to size at outmigration. Hatchery capacity and cost may be a factor in life stage at release (i.e., releasing smolts may cost more and use up more space for a longer time than releasing fry).
	Release into stream at the place you want them to return, possibly after an imprinting period if the release location is not in the same place as the rearing location Release number should be scaled with carrying capacity to avoid possible increases in density dependent mortality of both natural and hatchery fish when carrying capacity is approached.
	Releasing juveniles in one location may be preferable to scattered releases to exploit the functional response of predators and to assure adequate returns to at least one location. However, scattered releases may be better for stocks that tend to hold in place for a while or residualize.
	Minimize stress associated with handling and transportation.
	Screen all fish for disease before release.
	Transport fish for release in more than one truck, or transport in more than one trip, to spread the risk in case of accident.
	Release protocols should avoid or minimize negative ecological interactions with conspecific natural fish and with other species.
	Develop a monitoring system for hatchery produced juvenile holding, rearing, and outmigration.

The hatchery working group identified two types of recovery hatchery operations for purposes of this Recovery Strategy: recovery supplementation and captive broodstock. These are best thought of as hatchery program components that can be used together or separately depending on the situation and goals of the recovery project. Recovery supplementation would typically involve spawning returning adults and releasing the progeny to the stream in stages from egg to early-smolt. In most cases, fish would be held only for a short time as adults before spawning and then, possibly, for a short time as juveniles before release. Early release (egg, fry, or fingerling) is preferred because it increases opportunities for natural selection to occur in the stream and decreases the opportunity for domestication selection to occur in the hatchery. Smolt releases should only be employed if the benefit of improved survival (e.g., to offset winter mortality) outweighs the risk of extended hatchery rearing. Recovery supplementation programs would differ from other supplementation programs by the high level of genetic management and monitoring involved, and the goal of producing fish that are as genetically, morphologically, behaviorally, and ecologically similar to naturally produced fish as possible.

Captive broodstock programs would involve capturing fish at one of several points in the life cycle, raising them or their progeny to maturity as broodstock, and spawning them as they mature. Captive broodstock can be implemented purely as insurance against cohort failure or the loss of the entire run, in which fish would not be released unless special conditions were met. Alternatively, captive broodstock could be a component of a recovery supplementation program, in which fish would be regularly released. Cryopreservation of gametes (sperm) provides some needed spawning flexibility, and may allow rebuilding missing year classes. It should be a part of either type of program. Some programs may choose to use all three elements to meet their goals.

Guidelines for operation of a recovery hatchery are shown in Table H-2. The guidelines address four issues: source populations for broodstock, spawning, fish rearing and release protocols. These are general guidelines that can be developed in greater detail based on the specific needs of each project.

Population genetics data (e.g., amount of within-population diversity, patterns of between-population diversity, and relationships among ancestral lineages) and other information on life history are essential to determine which populations are most similar to one another for broodstock selection. If stock transfers have occurred or if hatchery influence is suspected, then these analyses are even more important. The short-term goals of recovery hatcheries are to stabilize or increase population size (hatchery-origin + natural origin) while at the same time preserving within-population genetic diversity, between-population diversity patterns, and adaptive variation, with the long-term goal of establishing self-sustaining viable populations. Knowledge of population genetic structure is critical to establishment of an effective program.

ESSENTIAL PROGRAM ELEMENTS AND OPPORTUNITIES FOR DEVELOPMENT OF A HATCHERY RESEARCH PROGRAM

Although each program will be somewhat different due to differing needs and means to achieve them, we identify a suite of essential program elements that every hatchery recovery program should contain. In this section we also explore the need for dissemination of research.

Every recovery hatchery program should have the following elements.

1. The program should have a written plan that identifies well-defined program goals and management actions to achieve them. The program should be justified by an evaluation of the relative benefits and risks of alternative hatchery practices, alternative non-hatchery means to achieving the program goals, and a no action alternative. This evaluation should be included in the plan. The plan should also include research goals, a monitoring and evaluation plan, contingency and emergency plans, and a decommission plan.
2. A steering committee should be in place even before the hatchery begins operation to advise and provide technical expertise (see Policies). The steering committee should meet quarterly to discuss adaptive management of the program.
3. Genetic monitoring and broodstock management are the cornerstones of a successful recovery hatchery and should be included in the operations plan.
4. Recovery hatchery programs should have appropriate levels of redundancy and safeguards to secure broodstock and production (e.g., redundant water supplies and electricity, secure areas away from the general public for holding fish).
5. Recovery hatchery programs are unproven for recovery purposes. Therefore, any information or experience gained is of tremendous value to adaptive management of them. Sharing information and regular reporting, both written reports and presentations, are critical to effective management of these programs, and will be required.
6. Thresholds should be identified as triggers for adaptive management.
7. Recovery hatchery programs should develop written plans that clearly document the program. This report should be annual while the program is in place, with a final report that evaluates the entire program when it is completed.
8. A monitoring component should be outlined that assesses the effectiveness of the recovery hatchery program and its ability to aid in the recovery of native, natural-spawning coho salmon.

9. Research components could be identified that address questions relevant to improving conservation/hatchery technology, hatchery-natural interactions, and use of hatchery fish in species recovery.
10. Provisions should be in place for troubleshooting and problem solving. This is an important part of the work of the steering committee. Adaptive management should be an integral part of the program.
11. Very early in the development of the project, each project should write an emergency interruption plan (if one does not already exist) in case of emergency disruption of the project (e.g., due to loss of water availability or quality, catastrophes and accidents, staff or budget cuts, disease outbreaks). The plan should detail what will happen to broodstock, production, staff, and how to maintain the project off site if necessary. All existing California hatcheries currently have such plans already.
12. Multiple facilities should be considered for housing broodstock and production to spread the risk of catastrophes. This is especially important for listed species but is important for any valuable broodstock.
13. Program monitoring and reporting is an essential feature of the program (see the following section).

PROGRAM MONITORING

Each program should have a schedule for interim evaluation of program success in relation to program goals and to document program activities. Because these programs rely on adaptive management and are relatively "new" and experimental, the timely documentation of results is crucial to program success. Written annual reports will be required that document both captive breeding statistics (e.g., number spawned, spawning matrix, percent eye-up, life-stage specific mortality, problems that arose and their solutions, number of fish released, size of release, growth rate, genetic analysis of broodstock and production), and field related statistics (e.g., number of returning adults, effect of releases on effective population size of the combined hatchery and natural population, carrying capacity and habitat availability as it relates to release size, ecological interactions among hatchery and natural fish, outmigration timing of hatchery and natural fish, contribution of hatchery stock to natural spawning, ocean impacts (e.g., effects of Pacific Decadal Oscillation, El Niño/La Niña events, changes in upwelling indexes), fishery impacts on hatchery stocks). A periodic reevaluation of risks should also be included in progress reports. The Department should develop a standard data reporting format that would simplify and streamline the reporting process for recovery hatcheries.

In order to effectively monitor the hatchery population, each fish released should receive a unique tag and an external mark. Typically this unique tag will be a coded wire tag, but other tagging methods (e.g., PIT tags) are possible depending on funding, hatchery logistics, new techniques, and need. Projects should plan on 100 percent tagging of releases and subsequent monitoring to determine their fate.

Each program should also make provisions for a comprehensive final report that documents the program's history and activities and interprets the results of the program over its life span. This report should include recommendations on ways to improve recovery hatchery programs in the future.

Programs should clearly delineate procedures for disseminating research results generated by the facility. Permits should contain language that connects resource agencies with regular reporting of research results pertaining to the project. Reporting must be regular, informative, and in a format usable by the resource agencies for adaptive management of the program.

PROGRAM DURATION, CLOSEOUT GUIDELINES, CONTINGENCY AND EMERGENCY CLOSEOUT PLANS, AND DISPOSITION OF UNUSED BROODSTOCK

Recovery hatchery programs are envisioned to be short term projects with lifespans on the order of 1-4 coho salmon generations (3-12 years). A closed recovery hatchery would represent a successful effort that was able to substantially contribute to recovery of the species. Because of this built in short lifespan, it is essential that each program develop early in its life a close-out plan. The close-out plan should at minimum contain the following.

1. The expected life of the program and conditions under which the facility should initiate close-out. These should be tied to reaching recovery goals specific to the program as well as overall recovery goals. Performance standards should be evaluated for years 1-3 and if met, 4-6, 7-9, etc. Failure to meet performance standards in two generations should, in most cases, trigger initiation of close-out procedures.
2. Provisions for closing the facility, including a possible end use.
3. Provisions for disposition of unused broodstock and any other fish on-site at the time of close-out.
4. Provisions for staff transition.
5. Production and dissemination of a final documentation report.

A second plan should be produced that describes how the facility will deal with an emergency close-out that might occur with little or no warning due to accident or catastrophe, or a funding shortfall. These plans should contain the provisions above, but should take into account that the implementation time may be very short.

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ATTACHMENT 1: GLOSSARY

Artificial propagation: Human assistance in the reproduction of an organism. In Pacific salmon, artificial propagation may include spawning and rearing in hatcheries, stock transfers, creation of spawning habitat, egg bank programs, captive broodstock programs, and cryopreservation of gametes.

Captive broodstock program: A form of artificial propagation involving the collection of individuals or gametes from a natural population and rearing of these individuals to maturity in captivity.

Carrying capacity: The maximum equilibrium number of individuals of a particular species that can be supported indefinitely in a given environment. *Abbr.: K.*

CESA: California Endangered Species Act.

Cohort failure: Extinction of a cohort (year-class) of fish due to either a lack of spawning in that year or to failure of any offspring of a spawning event to survive. Also called brood-year extinction.

Cryopreservation: Preservation of living gametes at very low temperature. Typically, freezing sperm in liquid nitrogen for later use in spawning.

Domestication selection: Natural selection operating on a population during artificial propagation that encourages adaptation to the hatchery environment at the expense of adaptation to the natural environment.

Effective population size: Used in management of genetic resources to express information about expected rates of random genetic change due to inbreeding and/or genetic drift. The size of a hypothetical ideal population with the same amount of random genetic change as the actual population experiences. Typically the effective population size is lower than the census population size. *Abbr.:* N_e.

ESA: Federal Endangered Species Act.

Evolutionarily Significant Unit (ESU): A population or group of populations that is considered distinct, and hence a species, for purposes of the Endangered Species Act. An ESU must be reproductively isolated from other populations of the same species and must represent an important component in the evolutionary legacy of the species.

Extinction: In evolutionary biology, the failure of groups of organisms of varying size and inclusiveness (e.g., local geographic or temporally-defined groups to species) to have surviving descendants.

Extinction risk: In this document, the probability that a given population will become extinct within 100 years. Low probability of extinction is arbitrarily defined for this purpose as 5% over 100 years.

Hatchery-origin fish: Also, "hatchery fish." Fish that have spent some portion of their lives, usually their early lives, in a hatchery. (See natural-origin fish.)

Metapopulation: A set of largely isolated subpopulations connected by some degree of migration among them.

Monitoring: Scientific inquiry focused on evaluation of a program in relation to its goals (see Research).

Natural-origin fish: Also, "natural fish." Fish that are offspring of parents that spawned in the wild.

Natural-origin fish spend their entire lives in the natural environment. (See hatchery-origin fish.)

Population: A group of individuals of the same species that live in the same place at the same time and exhibit some level of reproductive isolation from other such groups. In some contexts, a randomly mating group of individuals that is reproductively isolated from other groups. A population may consist of a single isolated run or more than one connected run. Synonymous with "stock" in this document.

Population size: In this document, the number of, usually adult, fish in the population. Also known as census size of the population. Abundance.

Recovery: The re-establishment or rehabilitation of a threatened or endangered species to a self-sustaining level in its natural ecosystem.

Recovery supplementation: Short-term artificial propagation designed to reduce the risk of extinction of a small or chaotically fluctuating recovering population in its natural habitat by temporarily increasing population size using recovery hatchery fish, while maintaining available genetic diversity and avoiding genetic change in the natural and hatchery populations.

Research: Scientific inquiry focused on answering original questions. May consist of experiments or original descriptions of structures, relationships, and processes (See Monitoring).

Run: The spawning adults of a given species that return to a stream during a given season.

Self-sustaining population: A population that perpetuates itself without human intervention, without chronic decline, and in its natural ecosystem, at sufficient levels that listing under CESA is not warranted.

Source-sink relationship: Metapopulation structure in which subpopulations in the source areas have vastly different productivities than those is the sink areas, and characterized by one-way movement of migrants from the source area to the sink area.

Stock: See "population."

Stock transfer: Human-caused transfer of fish from one location to another, typically in the context of out-of-basin or out-of-ESU transfers.

ATTACHMENT 2: PARTICIPANTS ON THE HATCHERY WORKING GROUP OF THE CALIFORNIA COHO SALMON RECOVERY TEAM AND DEPARTMENT REVIEWERS

HATCHERY WORKING GROUP:

Michael Lacy, DFG (Chair)
Jean Baldrige, Entrix
George Kautsky, Hoopa Tribal Fisheries
Greg Bryant, NOAA Fisheries
Daniel Logan, NOAA Fisheries
Shirley Witalis, NOAA Fisheries
Ruth Sundermeyer, Entrix
Paul Siri, Private Consultant to Sonoma County Water Agency

DFG REVIEWERS:

Chuck Knutsen
Royce Gunter
Brett Wilson
Bob Coey
Larry Preston
Gary Stacey
Bob McAllister
Kevan Urquhart
Jennifer Nelson
Gail Newton
Dennis McEwan

ATTACHMENT 3: SECTIONS OF THE 2003 FISH AND GAME CODE RELEVANT TO THE ESTABLISHMENT AND OPERATION OF RECOVERY HATCHERIES FOR ANADROMOUS SALMONIDS

FISH AND GAME CODE §§1120-1126

1120. The commission shall establish fish hatcheries for stocking the waters of this State with fish. The department shall maintain and operate such hatcheries.

1121. In any lease entered into whereby the State leases from any county, city, irrigation district, or other public agency in this State, real property for the purpose of establishing or maintaining a fish hatchery, the State may agree to indemnify and hold harmless the lessor by reason of the uses authorized by such lease. Insurance may be purchased by the Department of General Services to protect the State against loss or expense arising out of such an agreement.

1122. Any claim for damages arising against the State under Section 1121 shall be presented to the State Board of Control in accordance with Section 905.2 of the Government Code, and if not covered by insurance as herein provided shall be payable only out of funds appropriated by the Legislature for such purposes. If the State elects to insure its liability under Section 1121, the State Board of Control may automatically deny any such claim.

1123. The department may purchase and import spawn or ova of fish suitable for food, and stock with such spawn or ova the waters of this State.

1123.5. Notwithstanding Section 1120 or any other provision of law, all funds allocated for fish purchases for the department's urban fishing program shall be used to purchase all fish and aquatic organisms by contract, pursuant to the requirements of the Public Contract Code, from private registered aquaculture facilities within the State unless the department determines one of the following conditions exists:

(a) After reasonable notice, the private facilities are unable to provide the specified fish or aquatic organism.

(b) The fish or aquatic organism is infected or diseased.

1124. It is unlawful to take any fish in any pond or reservoir belonging to or controlled by the department and used for propagating, protecting, or conserving fish.

1125. The Secretary of the Interior of the United States and his duly authorized agents may conduct fish cultural operations and scientific investigations in the waters of this State in such a manner and at such times as may be jointly considered necessary and proper by the secretary and his agents, and the commission.

1126. Notwithstanding any other provision of law, department personnel may construct or repair bird exclosures at State owned or operated fish hatcheries. These activities shall not be subject to review by the Public Works Board. Nothing in this section exempts the department from complying with any provision of law governing services performed under contract by noncivil service employees.

FISH AND GAME CODE §1150

1150. The boards of supervisors of the several counties may establish and maintain fish hatcheries, and may purchase the spawn or ova of fish.

FISH AND GAME CODE §§1170-1175

1170. The commission may issue a permit, subject to such restrictions and regulations as the commission deems desirable, to a nonprofit organization to construct and operate an anadromous fish hatchery.

1171. The commission shall not issue a permit unless it determines the nonprofit organization has the financial capability to successfully construct and operate the hatchery and will diligently and properly conduct the operation authorized under the permit.

1172. No permit will be issued which may tend to deplete the natural runs of anadromous fish, result in waste or deterioration of fish, or when the proposed operation is located on a stream or river below a State or Federal fish hatchery or egg-taking station.

1173. All fish handled under authority of this article during the time they are in the hatchery or in the wild are the property of the State and when in the wild may be taken under the authority of a sport or commercial fishing license as otherwise authorized for wild fish.

1174. Any permit granted by the commission pursuant to this article shall contain all of the following conditions:

(a) If after a hearing the commission finds that the operation described in the permit and conducted pursuant to this article is not in the best public interest, the commission may alter the conditions of the permit to mitigate the adverse effects, or may cause an orderly termination of the operation under the permit. An orderly termination shall not exceed a three-year period and shall culminate in the revocation of the permit in its entirety.

(b) If the commission finds that the operation has caused deterioration of the natural run of anadromous fish in the waters covered by the permit, it may require the permittee to return the fishery to the same condition as was prior to issuance of the permit. If the permittee fails to take appropriate action, the commission may direct the department to take the action, and the permittee shall bear any cost incurred by the department.

(c) Prior to release into State waters and at any other time deemed necessary by the department, the fish may be examined by the department to determine that they are not diseased or infected with any disease which, in the opinion of the department, may be detrimental to the State fishery resources.

1175. The State shall assume no responsibility for the operation of a hatchery pursuant to this article and shall not be in any manner liable for its operation.

FISH AND GAME CODE §§1200-1206

1200. The department is authorized to enter into agreements with counties, nonprofit groups, private persons, individually or in combination, for the management and operation of rearing facilities for salmon and steelhead. All such agreements shall be in accordance with the policies of the commission and the criteria of the department which govern the operation under such agreements. The purpose for operating such facilities shall be to provide additional fishing resources and to augment natural runs.

1201. An applicant who wishes to enter into an agreement to operate a rearing facility shall demonstrate, to the satisfaction of the department prior to executing such agreement, such applicant's financial ability to properly operate the rearing facility. The department shall develop and specify the means for an applicant to make such a demonstration.

1202. All fish handled or released under authority of this article are the property of the State and may be taken only after their release into the wild and under the authority of a sport or commercial fishing license.

1203. The release of fish reared in facilities pursuant to this article shall be made in accordance with the policy of the commission.

1204. The department shall fund the agreements provided for in Section 1200 only on a matching basis with the persons or entities who enter into such agreements. Funds appropriated for the purposes of this article shall not be used to purchase equipment or for construction. The department shall be reimbursed from funds appropriated for the purposes of this article for administrative costs, legal costs, and supervisorial costs relating to the execution and supervision of such agreements by the department.

1205. The department shall, subject to the limitations of appropriate egg sources and funding, make available fish of appropriate size and species to persons or entities who enter into agreements pursuant to this article.

1206. Salmon and steelhead raised pursuant to this article shall be released in streams, rivers, or waters north of Point Conception and upon release shall have unimpeded access to the sea.

FISH AND GAME CODE §6100

6100. Notwithstanding any provision of Article 3 (commencing with Section 5980) and Article 4 (commencing with Section 6020), on or after the effective date of this article, any new diversion of water from any stream having populations of salmon and steelhead which is determined by the department to be deleterious to salmon and steelhead shall be screened by the owner. The construction, operation, or maintenance costs of any screen required pursuant to this article shall be borne by the owner of the diversion.

The department within 30 days of receipt of a notice of such diversion, or within the time determined by mutual written agreement, shall submit to the owner its proposals as to measures necessary to protect the salmon and steelhead. The department shall notify the owner that it shall make onsite investigation and shall make any other investigation before it shall propose any measure necessary to protect fishlife.

The department, or any agency of the State, shall provide the owner of the diversion any available information which is required by such owner in order to comply with the provisions of this article. The diversion shall not commence until the department has determined that measures necessary to protect fishlife have been incorporated into the plans and construction of such diversion.

FISH AND GAME CODE §§6900-6903.5

6900. This chapter shall be known and may be cited as the Salmon, Steelhead Trout, and Anadromous Fisheries Program Act.

6901. The Legislature, for purposes of this chapter, finds as follows:

(a) According to the department, the natural production of salmon and steelhead trout in California has declined to approximately 1,000,000 adult chinook or king salmon, 100,000 coho or silver salmon, and 150,000 steelhead trout.

(b) The naturally spawning salmon and steelhead trout resources of the State have declined dramatically within the past four decades, primarily as a result of lost stream habitat on many streams in the State.

(c) Much of the loss of salmon and steelhead trout and anadromous fish in the State has occurred in the central valley.

(d) Protection of, and an increase in, the naturally spawning salmon and steelhead trout resources of the State would provide a valuable public resource to the residents, a large statewide economic benefit, and would, in addition, provide employment opportunities not otherwise available to the citizens of this State, particularly in rural areas of present underemployment.

e) Proper salmon and steelhead trout resource management requires maintaining adequate levels of natural, as compared to hatchery, spawning and rearing.

(f) Reliance upon hatchery production of salmon and steelhead trout in California is at or near the maximum percentage that it should occupy in the mix of natural and artificial hatchery production in the State. Hatchery production may be an appropriate means of protecting and increasing salmon and steelhead in specific situations; however, when both are feasible alternatives, preference shall be given to natural production.

(g) The protection of, and increase in, the naturally spawning salmon and steelhead trout of the State must be accomplished primarily through the improvement of stream habitat.

(h) Funds provided by the Legislature since 1978 to further the protection and increase of the fisheries of the State have been administered by the Department of Fish and Game in a successful program of contracts with local government and nonprofit agencies and private groups in ways that have attracted substantial citizen effort.

(i) The department's contract program has demonstrated that California has a large and enthusiastic corps of citizens that are eager to further the restoration of the stream and fishery resources of this State and that are willing to provide significant amounts of time and labor to that purpose.

(j) There is need for a comprehensive salmon, steelhead trout, and anadromous fisheries plan, program, and State government organization to guide the State's efforts to protect and increase the naturally spawning salmon, steelhead trout, and anadromous fishery resources of the State.

6902. The Legislature, for purposes of this chapter, declares as follows:

(a) It is the policy of the State to significantly increase the natural production of salmon and steelhead trout by the end of this century. The department shall develop a plan and a program that strives to double the current natural production of salmon and steelhead trout resources.

(b) It is the policy of the State to recognize and encourage the participation of the public in privately and publicly funded mitigation, restoration, and enhancement programs in order to protect and increase naturally spawning salmon and steelhead trout resources.

(c) It is the policy of the State that existing natural salmon and steelhead trout habitat shall not be diminished further without offsetting the impacts of the lost habitat.

6903. It is the policy of the State and the department to encourage nonprofit salmon release and return operations subject to this code operated by, or on behalf of, licensed commercial salmon fishermen for the purpose of enhancing California's salmon populations and increasing the salmon harvest by commercial and recreational fishermen. The department shall, to the extent that funds and personnel are available, cooperate with fishing organizations in the siting and establishment of those operations to ensure the protection of natural spawning stocks of native salmon. The organizations conducting the operations may receive salmon eggs and juvenile salmon for the purposes of the operation, and, where appropriate, shall have priority to receive salmon eggs and juvenile salmon for those purposes after the needs of habitat mitigation efforts, and State hatcheries are met.

6903.5. The department shall encourage other nonprofit hatcheries and nonprofit artificial propagation operations, operated by, or on behalf of, licensed fishermen, for the purpose of rebuilding or enhancing marine fish populations, including, but not limited to, those for Dungeness crab, sea urchin, and California halibut, consistent with the protection of these species in the wild, in order to provide sustainable marine fish populations for harvest by commercial and recreational fishermen. The department shall, to the extent funds and personnel are available, cooperate with these nonprofit hatcheries and nonprofit artificial propagation operations in determining the feasibility, siting, and establishment of those activities and sharing technical information to ensure the protection of the marine environment.

FISH AND GAME CODE §§6920-6924

6920. (a) The department shall, with the advice of the Advisory Committee on Salmon and Steelhead Trout and the Commercial Salmon Trollers Advisory Committee, prepare and maintain a detailed and comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries.

(b) The department shall consult with every public agency whose policies or decisions may affect the goals of this program to determine if there are feasible means for those public agencies to help the department achieve the goals of this program.

6921. The program shall identify the measures the department will carry out to achieve the policies set forth in Section 6902.

6922. The program shall include, but is not limited to, all of the following elements:

(a) Identification of streams where the natural production of salmon and steelhead trout can be increased primarily through the improvement of stream and streambank conditions without effect on land ownership, land use practices, or changes in streamflow operations.

(b) Identification of streams where the natural production of salmon and steelhead trout can be increased only through the improvement of land use practices or changes in streamflow operations.

(c) Identification of streams where the protection of, and increase in, salmon and steelhead trout resources require, as a result of significant prior loss of stream habitat, the construction of artificial propagation facilities.

(d) A program element for evaluating the effectiveness of the program.

(e) Recommendations for an organizational structure, staffing, budgeting, long-term sources of funding, changes in State statutes and regulations and Federal and local government policy and such other administrative and legislative actions as the department finds to be necessary to accomplish the purposes of this chapter.

(f) Identification of measures to protect and increase the production of other anadromous fisheries consistent with policies set forth in Section 6902.

(g) Identification of alternatives to, or mitigation of, manmade factors which cause the loss of juvenile and adult fish in California's stream system.

6923. Measures which are the responsibility of other agencies or persons, such as the repair or replacement of dysfunctional fish screens, are not eligible for funding under the program.

6924. The department shall determine the initial elements of the program and transmit a report describing those elements to the Legislature and the Advisory Committee on Salmon and Steelhead Trout within six months of the effective date of this chapter.

ATTACHMENT 4: CALIFORNIA FISH AND GAME COMMISSION POLICIES RELEVANT TO THE ESTABLISHMENT AND OPERATION OF RECOVERY HATCHERIES

CALIFORNIA FISH AND GAME COMMISSION POLICY ON COOPERATIVELY OPERATED REARING PROGRAMS FOR SALMON AND STEELHEAD

It is the policy of the Fish and Game Commission that:

I. The State's salmon and steelhead resources may be used to support cooperative rearing programs. Rearing programs may be of two types: (1) those that grow fish for use in accelerating the restoration/rehabilitation of depleted wild populations in underseeded habitat and (2) those that are dedicated solely to growing fish for harvest. The following constraints apply to both types:

  A. Only those fish surplus to the needs of the Department's programs shall be utilized for such programs and allocation shall be based on past performance and the Department's evaluation of the potential of proposed new programs.

  B. The suitability and acceptance or rejection of proposed programs shall be determined by the Department, after reviewing a written proposal. A written project and management plan providing for evaluation and covering a period of five years must be evaluated and approved by the Department. Prior to reauthorization the Department must determine that the project is in compliance with the approved plan and continuance of the program is in the best interest of the State's fishery resources.

  C. Routine care and food costs shall be the financial responsibility of the sponsoring entity. The Department shall provide technical advice and special assistance as appropriate.

  D. Fish raised in these programs shall not be stocked in, or broodstock captured from, waters where the Department has determined that adverse effects to native fish populations or other aquatic species may result.

II. The bulk of the State's salmon and steelhead resources shall be produced naturally. The State's goals of maintaining and increasing natural production take precedence over the goals of cooperatively operated rearing programs.

(Amended 6/18/93)

CALIFORNIA FISH AND GAME COMMISSION POLICY ON SALMON

It is the policy of the Fish and Game Commission that:

I. Salmon shall be managed to protect, restore and maintain the populations and genetic integrity of all identifiable stocks. Naturally spawned salmon shall provide the foundation for the Department's management program.

II. Salmon streams shall be inventoried for quantity and quality of habitat, including instream flow requirements. Restoration plans shall identify habitats for restoration and acquisition and opportunities to protect or guarantee future instream flows. Commercial Salmon Trollers Stamp and other funding shall be directed to implement the plans.

III. Existing salmon habitat shall not be diminished further without offsetting the impacts of the lost habitat. All available steps shall be taken to prevent loss of habitat, and the Department shall oppose any development or project which will result in irreplaceable loss of fish. Artificial production shall not be considered as appropriate mitigation for loss of wild fish or their habitat.

IV. Salmon shall be rescued only when they will be returned to the stream system of origin. Rescue of juvenile salmon shall be limited to circumstances where fish can be held until habitat conditions improve, or where immediate release can be made in understocked areas of their natal stream system.

V. In coastal streams without Department hatcheries, artificial rearing shall be limited to areas where the Department determines it would be beneficial to supplement natural production to re-establish or enhance the depleted wild population. In the Sacramento, American, Feather, San Joaquin, Klamath, and Trinity river systems, hatchery production shall be used to meet established mitigation goals. At the discretion of the Department excess eggs and fish from State, Federal, or cooperative hatcheries may be used to provide additional fish for the commercial and sport fisheries.

VI. Resident fish will not be planted or resident fisheries developed in drainages of salmon waters, where, in the opinion of the Department, such planting or development will interfere with salmon populations. Exceptions to this policy may be authorized by the Commission (a) where the stream is no longer adaptable to anadromous runs, or (b) during the mid-summer period in those individual streams considered on a water-by-water basis where there is a high demand for angling recreation and such planting or development has been determined by the Department not to be detrimental to salmon.

(Amended 6/18/93)

CALIFORNIA FISH AND GAME COMMISSION POLICY ON STEELHEAD RAINBOW TROUT

It is the policy of the Fish and Game Commission that:

I. Steelhead rainbow trout shall be managed to protect and maintain the populations and genetic integrity of all identifiable stocks. Naturally spawned steelhead shall provide the foundation of the Department's management program.

II. Steelhead shall be rescued only when they will be returned to the stream system of origin. Rescue of juvenile steelhead shall be limited to circumstances where fish can be held until habitat conditions improve, or where immediate release can be made in understocked areas of their natal stream system.

III. Restoration and acquisition plans shall be developed and implemented to safeguard such critical habitats as estuaries, coastal lagoons, and spawning and rearing areas, and to protect or guarantee future instream flows. All steelhead streams shall be inventoried for quantity and quality of habitat, including stream flow conditions. Steelhead Restoration Card and other funding shall be directed to implement the plans.

IV. Existing steelhead trout habitat shall not be diminished further without offsetting mitigation of equal or greater long-term habitat benefits. All available steps shall be taken to prevent loss of habitat, and the Department shall oppose any development or project which will result in irreplaceable losses. Artificial production shall not be considered appropriate mitigation for loss of wild fish or their habitat.

V. Sport fishing for sea-run steelhead shall be encouraged where the Department has determined that harvest will not harm existing wild populations. Harvest of juveniles shall only be permitted where such harvest does not impair adequate returns of adults for sport fishing and spawning. Special restrictions on the harvest of wild juvenile steelhead may be necessary when a fishery includes both wild and hatchery stocks.

VI. Resident fish will not be planted or resident fisheries developed in drainages of steelhead waters, where, in the opinion of the Department, such planting or development will interfere with steelhead populations.

VII. Exceptions to this policy may be made by the Commission (a) where the stream is no longer adaptable to anadromous runs, or (b) during the midsummer period in those individual streams considered on a water-by-water basis where there is a high demand for angling recreation and such planting or development has been determined by the Department not to be detrimental to steelhead.

The following waters are excepted:

Nacimiento River San Luis Obispo County
North Fork Battle Creek Shasta County, (upstream from Manton)
Cow Creek Shasta County, (upstream from Fern Road and Ingot)
Antelope Creek Tehama County, (upstream from Ponderosa Way)
Deer Creek Tehama County, (upstream from upper Deer Creek Falls)
American River Sacramento County, (only in Arden Pond)

(Amended 6/18/93)

ATTACHMENT 5: TABLE 4 FROM REISENBICHLER ET AL. 2003

TABLE 4. Alternative developmental stages for fish used to initiate populations in restored streams.

Stage	Advantages	Disadvantages	Comments
Adult	Naturalization begins immediately and occurs over the first cohort's entire life. Low cost.	Spawning success may be low owing to egress or suboptimal spawning distribution (because spawners did not imprint within the "new" stream as juveniles) or stress from handling and transporting (Shreck et al. 2001), and – for hatchery adults – ineffective mating and spawning behavior (e.g., Leider et al. 1990; Fleming and Gross 1994).	Reproductive success and juvenile survival are likely to be greater with translocated adults from nearby, environmentally similar streams than with hatchery adults. In some situations low spawning success, in conjunction with subsequent low survival of progeny due to poor genetic adaptedness to the new stream, may result in few if any progeny surviving to reproduce, and low effective population size.
Embryo or fry (incubated in a hatchery, steam-side incubator or artificial redd)	Naturalization occurs in the first cohort over nearly the entire period of freshwater rearing. Avoids possible low spawning success from releases of (F_0) adults. Low cost.	Often requires manipulation of water temperatures at a hatchery to mimic those in various parts of the watershed so as to achieve appropriate timing of development.	The increased survival from conception or incubation in a hatchery should result in many more fish surviving to maturity than from natural spawning of translocated adults. Despite some failed fry releases, often due to inappropriate time or condition at release into streams already seeded with wild fish or into streams with poor habitat (e.g., McGie 1980; Lestelle et al. 1993), our experience and that of others (e.g., Close and Anderson 1992) suggest that fry releases can be very effective in establishing populations.
Juvenile, after a period of feeding in a hatchery	High survival while in the hatchery which presumably leads to increased production of (F_1) adults.	Early rearing in the hatchery (domestication) probably retards naturalization. Intermediate cost due to extended hatchery rearing and transport of large fish at outplanting. Once natural reproduction occurs, releases of "fed-fry" can result in severe competition and suppression of juveniles from natural spawning (Nickelson et al. 1986).	The net results of domestication (Reisenbichler and Rubin 1999; Waples 1999) during early freshwater rearing and then naturalization during subsequent freshwater rearing is unknown; however, the naturalization of such a cohort should be substantially less than that of a cohort released as fry. Fed fry must not be larger than F_1 or later juveniles from natural spawning; otherwise, naturalization will be delayed as the latter are displaced or suppressed by the former.
Smolt, reared in a hatchery	High survival to returning (F_1) adult.	Cohort experiences domestication; naturalization is delayed until the F_1 generation, which also suffers from poor reproductive success of returning F_0 fish as discussed above for adult releases. High cost due to "full-term" hatchery rearing and transport of large fish at outplanting.	Probably produces the greatest number of adults spawning in the F_1 generation, but delays naturalization and probably restoration because of genetic bottlenecks (when many matings of adult F_0 fish are unsuccessful) and domestication. Some stakeholders nevertheless favor this strategy because it is most consistent with conventional hatchery protocol, has been highly successful in augmenting harvest, and gives the illusion of rapid restoration when large numbers of (hatchery) adults spawn naturally.

Appendix I
Cost and Socioeconomic Impacts of Implementing the California Coho Salmon Recovery Strategy

January 2004

SUBMITTED TO

California Department of Fish and Game

PREPARED BY

David Sunding and Alix Peterson Zwane

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LIST OF ATTACHMENTS

I.1 INTRODUCTION

This report measures the cost of implementing the Coho Salmon Recovery Strategy (Recovery Strategy) for the Central California Coast (CCC) Coho Evolutionary Significant Unit (ESU) and the California portion of the Southern Oregon-Northern California Coasts (SONCC) Coho ESU. An estimate of the cost of implementing the strategy is required by California statute governing the Recovery Strategy Pilot Program (Fish and Game Code (FGC) §§2105-2116). To respond to this requirement, at the request of the Department of Fish and Game (Department) and in cooperation with the Range-wide Coho Salmon Recovery Team (CRT) and the Shasta-Scott Recovery Team (SSRT), economists developed quantitative estimates of both the fiscal cost and the socioeconomic impacts of implementing the Recovery Strategy. Implementing the Recovery Strategy will provide benefits for multiple species, watershed health, water quality, and the environment generally. It will also result in benefits to recreational and commercial fishing and related industries.

The report begins by describing the method used to develop aggregate costs and socioeconomic impacts of recommendations at the hydrologic unit (HU) level that are common to many HUs and hydrologic subareas (HSAs). The conceptual distinction between fiscal costs and socioeconomic impacts is then discussed and this methodology is then applied. Estimates of the aggregate cost of recovery by ESU are presented. These aggregate cost estimates do not reflect the full cost of Recovery Strategy implementation, because some costs cannot be quantified at this time. Detailed cost estimates at the HU level are provided in Attachments 1 to 5. At this time, there is limited information available about the quantity of each recovery action that will be undertaken and these cost estimates can be revised as additional information becomes available. However, these aggregate cost estimates may overestimate the cost of Recovery Strategy implementation because some of the costs may be incurred even if the Recovery Strategy were not implemented. In addition, these aggregate cost estimates include costs that may be incurred as a result of actions taken to avoid take of coho salmon or to fully mitigate impacts of authorized take of coho salmon once the species is listed.

The aggregate cost estimates presented here include not only the cost of implementing recommendations that are common to many HU/HSAs, but also the cost of specific recommendations that respond to the unique circumstances of a single HU or HSA. Cost estimates for these specific recommendations, are included in estimates of the aggregate cost of recovery. Some of these items are a significant portion of the costs estimated here. For example, restoring coarse sediment transport near Iron Gate Dam may cost as much as $500 million. Implementing the Trinity Record of Decision is estimated to cost about $12 million per year.

The aggregate cost estimates do not include specific line items for the range-wide recommendations because the majority of these recommendations cannot be assigned an estimated cost at this time. In addition, the cost of many of the range-wide recommendations is captured by estimating the cost of the HU/HSA-specific recommendations. The economists suspect that, given the magnitude of the measured recovery costs, failure to measure the costs of the range-wide recommendations explicitly does not impact qualitatively the recovery cost calculations.

The aggregate cost estimates also include the cost of implementing recommendations regarding timberland management. In accordance with a request by the Fish and Game Commission (Commission) for a range of alternatives regarding recommendations for timberland management, three alternative sets of recommendations were presented in the November 2003 Public Review Draft of the Recovery Strategy. Cost estimates were developed for these alternatives. They are presented in section I.13. When considering the cost of implementing recommendations regarding timberland management, one must consider the estimated costs presented in section I.13 in light of the recommendations that were finally approved for inclusion into the Recovery Strategy.

Some items included in the estimate of the aggregate cost of the Recovery Strategy are costs that may be incurred even if the Recovery Strategy were not implemented. For example, the cost of implementing the Trinity River Record of Decision (about $12 million per year) and the cost of the Fisheries Restoration Grant Program ($20-25 million per year) are included as costs associated with coho salmon recovery. The decision to include these costs was made in consultation with the Department. To the extent that these costs would be incurred in the absence of this plan, the cost estimates presented here overstate the cost of Recovery Strategy implementation. Costs that would be incurred as a result of the Clean Water Act or other related statutes and regulations were excluded. While TMDL regulations, for example, are quite relevant to coho salmon recovery, costs attributable to this process are not counted as a cost of coho salmon recovery; however, tasks enacted as part of this Recovery Strategy that address sediment may also help meet TMDL targets.

Separate cost and socioeconomic impact estimates have been developed for the Shasta Valley and Scott Valley HSAs. These cost estimates are described and presented in section I.14.

Section I.16 discusses impacts that have been identified but not quantified at this time. The magnitude of these costs will likely be an important determinant of the total cost and socioeconomic impact of the Recovery Strategy.

I.2 METHODOLOGY CONSIDERATIONS FOR DEVELOPMENT OF ECONOMIC IMPACTS OF COMMON RECOVERY RECOMMENDATIONS

This section of the report provides estimates of the unit cost of recommendations at the HU/HSA level that are common to many HU/HSAs and the aggregate cost of these recommendations. While coho salmon recovery in Central and Northern California will require many actions that are unique to particular watersheds, the recommendations in the Recovery Strategy include several actions that are common to many HSAs. This section includes discussions of (1) the fiscal or budgetary cost of implementing these common recommendations and (2) the socioeconomic impacts of implementing these recommendations. Specific recommendations cover:

1. Removing or reducing barriers to fish passage;
2. Implementing riparian revegetation and other stream-bank improvements;
3. Improving instream complexity, including the placement of large woody debris (LWD);
4. Road treatment and/or decommissioning;
5. Restoring wetlands and off-channel areas;
6. Water acquisitions;
7. Undertaking biological studies to understand and monitor salmon behavior;

8. Watershed planning and other non-biological studies;
9. Education and outreach efforts (including improvements in coordination); and
10. Changes in timberland management.

The primary focus is the unit cost of these activities. In some cases the recommendations in the Recovery Strategy do not provide guidance on the scale at which recommended activities should be undertaken because this kind of detailed information is not currently available. For example, at the HU- and HSA-level the recommendations do not specify the amount of water acquisition required to meet recovery goals. This precludes the comprehensive measurement of the cost of coho salmon recovery under the strategy. Nonetheless, it is possible to provide cost estimates for many recovery actions, and to characterize unit costs in even more cases.

I.2.1 DEVELOPMENT OF AGGREGATE COST ESTIMATES

Aggregate cost estimates were developed with a series of spreadsheet models that have been provided to the Department. These models are designed to combine unit cost estimates with information on the potential scale at which recommended activities could be undertaken. At this time, there is limited information available about the quantity of each recovery action that will be undertaken. As discussed later in the report, there is also limited information about the extent to which each class of recovery recommendation will be achieved through increased enforcement or voluntary actions (in which case the fiscal cost of the action is born by private actors), and the extent to which each class of recovery action will be achieved through payments to landowners and other resource managers (in which case the fiscal cost of the action is born by the public sector). Maximum flexibility has been built into these spreadsheet models so that, as additional information about the scale at which recovery recommendations will be undertaken becomes available, more accurate estimates of the aggregate cost of recovery can be made easily and quickly.

The calculation of aggregate costs from unit costs also requires identification of ways in which unit costs are likely to vary systematically across HU/HSAs. A major source of variation is likely to come from regional differences in wage rates since labor costs form a large part of the total unit cost of most recovery recommendations.[1] Data on average wages paid to construction workers in California counties were used to identify how recovery costs are likely to vary across HSAs as a result of labor costs. The economists mapped the county-level wage data to HSAs using GIS results provided by the Department.[2]

Table I-1 reports average construction wages, by county, in regions covered by the Recovery Strategy. These data show that wages vary by as much as 25 percent across counties, and thus across HSAs in which coho salmon recovery activities will take place. Wages are higher in more urbanized counties located near the Bay Area or the Central Coast than they are in more rural counties in Northern California.

To calculate the aggregate fiscal cost of each type of recovery action, by HU, ESU, and range-wide, the following steps were taken:

Step 1: Illustrative project costs for each class of recovery action were identified by examining unit costs of activities that must be undertaken as part of the recovery action and by surveying evidence on historical project costs;

1 The remoteness of the job site is another factor that influences the cost of a particular recovery project. In some cases, we are able to use cursory information about the distance of a project from a road to incorporate this factor into the analysis.

2 For HSAs that fall in more than one county, wages are assumed to be a simple average of the wages in all counties covered.

Step 2: As appropriate, ways in which recovery action costs are likely to vary systematically were identified (e.g., in-channel restoration is likely to be more costly at more remote streams);

Step 3: The extent to which differences in wage rates will affect recovery action costs in each HSA was identified using the wage information presented in Table I-1;

Step 4: Base-case assumptions about the quantity of each type of recovery action that will be required in each HSA (e.g., the fraction of stream miles needing riparian revegetation or LWD placement, or the fraction of roads needing decommissioning) were made drawing on information received from the Department, members of the recovery team, and previous literature as appropriate;

Step 5: Using the HSA-specific unit costs developed in steps 1-3, unit costs were multiplied by the HSA-specific recovery action quantities developed in step 4;

Step 6: Total costs for each recovery action by HSA were summed to develop aggregate cost estimates for each HU, ESU and the State as a whole.

TABLE I-1: Average 2002 construction industry wages by county

County	Average Construction wage ($/hour)	County wage as percentage of California average wage (%)
Alameda	23.72	120
Contra Costa	23.72	120
Del Norte	18.06	92
Glenn	18.06	92
Humboldt	18.06	92
Lake	18.06	92
Marin	24.80	126
Mendocino	19.03	97
Napa	22.89	116
San Francisco	24.80	126
San Mateo	24.80	126
Santa Clara	23.13	117
Santa Cruz	20.29	103
Siskiyou	18.06	92
Sonoma	20.53	104
Solano	22.89	116
Trinity	18.06	92
All CA counties	19.69	

Source: California Office of Employment Statistics, employment and wages by occupation. Available: http://www.calmis.ca.gov/file/occup$/oes$.htm

I.2.2 TIMING OF RECOVERY RECOMMENDATIONS

Fiscal cost impacts of the various recovery recommendations are presented in the simplest possible terms: the current dollar cost of completing the action now. Absent information about the specific sequencing of recovery recommendations over the coming decades, and lacking information on how State obligations would be financed, it is impossible to calculate financing costs, or to convert actions over some period of time into current dollar equivalents. Instead, costs were calculated as if all recovery recommendations would be completed immediately.

Stretching recovery recommendations over some time period would have at least three effects on current dollar costs of the Recovery Strategy. First, inflation would drive up the nominal costs of all actions. Second, discounting to present values would decrease the lump-sum amount of money needed to finance recovery over some period of time. Third, if recovery were financed by a bond issued up front, then the State would incur financing costs since bondholders would have to be paid yields in excess of the return on allowable investments.

The cost of achieving interim recovery goals is likely to include the cost of most of the biological and non-biological studies and watershed planning exercises called for in the Recovery Strategy. Other interim costs will include the cost of implementing restoration recommendations in the highest priority watersheds. While these watersheds have been identified, the most important recovery recommendations within these watersheds have not been identified at a sufficiently disaggregated level to separately identify these costs. Thus, further quantification of the cost of achieving interim recovery goals is not possible at this time.

I.2.3 FISCAL COSTS VS. SOCIOECONOMIC IMPACTS

For each of the classes of recovery recommendations considered in this section, the fiscal cost of the action and, separately, the socioeconomic impacts of the action are addressed. The fiscal or budgetary cost of a recovery action is the expenditure needed to physically perform the action. The socioeconomic impact of a recovery action includes income foregone because the recovery action is undertaken, and transfers to the local region (in this case, the HSA) from outside the region because the recovery action is undertaken.

Consider the example of riparian revegetation. The fiscal cost of this action is the expenditure required to purchase, plant, and maintain appropriate vegetation in streamside areas. Income may be foregone as a result of this action because land is now devoted to recovering salmon populations. If riparian areas that once provided income from timber harvesting are left to maintain riparian cover for coho salmon, the stream of foregone profits from timber harvesting is an element of the social cost of this recovery action. Tax revenue is also forgone because land is now devoted to maintaining salmon populations. The benefits to landowners of avoiding the loss of land to ongoing erosion is not accounted for.

The welfare costs of recovery recommendations are distinct from the regional transfers associated with recovery recommendations that complete the calculation of socioeconomic impacts. Regional transfers arise when employment or other economic activity occurs in a particular region as a result of a recovery action that otherwise would have taken place in another region. To continue with the example of riparian revegetation, undertaking this recovery action in a particular HSA generates jobs and other economic activity in that HSA, but this activity is not a net gain for the State of California; it is a transfer of economic activity from one region to another. Resources dedicated to riparian revegetation would have been put to another use if the Recovery Strategy were not implemented. Each class of recovery action has analogous socioeconomic impacts, though the magnitude of these transfers varies.

Socioeconomic impacts, in the form of employment effects and other changes in regional economic activity, can be positive or negative. An example of negative socioeconomic impacts arises in the case of water acquisitions. If water is purchased from willing sellers of water rights to increase instream flows for coho salmon, the seller of the water rights is at least no worse off than she would have been if her water rights had been used for production of irrigated agriculture. However, if, as a result of the sale of water rights, agricultural land is left fallow that otherwise would have been used in production, there is an associated decline in demand for agricultural inputs (e.g., fertilizer or pesticide) and a decline in demand for agricultural labor. This economic activity will not take place in the region as a result of the implementation of the Recovery Strategy.

If the State of California, or individual regions covered by the Recovery Strategy, were in a State of full employment, the generation of economic activity as a result of Recovery Strategy implementation could increase the demand for labor and increase equilibrium, or prevailing, wage rates. In general, the economists consider this to be unlikely in the case of the Recovery Strategy. The cost of the Recovery Strategy is small relative to total economic output in the State, and, more importantly, most of the regions in which the bulk of the recovery recommendations will take place face structural unemployment.

Table I-2 summarizes California unemployment rates in 2002 by county and also presents information on whether particular counties have been identified as labor surplus areas by the US Department of Labor. With the exception of urbanized counties in the Bay Area, the unemployment rates in counties containing coho salmon HSAs are above the State average. Almost one-half of these counties have been identified to be labor surplus areas by the US Department of Labor.

TABLE I-2: California unemployment rates by county

County	Unemployment rate (%)	Labor surplus area?
Alameda	6.8	
Contra Costa	5.2	San Pablo City only
Del Norte	9.2	YES
Glenn	10.2	YES
Humboldt	6.5	YES
Lake	8.4	YES
Marin	4.0	
Mendocino	7.2	YES
Napa	4.3	
San Francisco	7.3	
San Mateo	5.0	
Santa Clara	8.4	
Santa Cruz	8.0	Watsonville City only
Siskiyou	9.8	YES
Sonoma	4.5	
Solano	5.5	
Trinity	9.6	YES
All CA counties	6.7	

Source: California Office of Employment Statistics, monthly labor force for counties, 2002 benchmark. Available: www.calmis.ca.gov/file/lfhist/02aacou.txt. Labor surplus areas 2003 defined by US Dept. of Labor as areas with unemployment rates above 6 percent for Jan. 2000-Dec. 2001. Available: www.uses.doleta.gov/pdf/lsajurisdictions03.pdf.

Labor surplus areas are defined as areas with unemployment rates above six percent for two years. Thus, this designation is a good indicator of long-term unemployment. Increasing economic activity in a labor surplus area by transferring resources from outside the region to area will be unlikely to increase wages at the margin.[3] By the same logic, wages are also unlikely to be affected by transferring resources from the area (as in the water acquisition example above) to another region.

To calculate the aggregate socioeconomic impacts of commonly-recommended recovery recommendations, steps similar to those outlined for aggregate fiscal costs above were followed. This implies that limited information about the scale or quantity of each recovery action is an important constraint in making this calculation, just as it is in the case of the calculation of aggregate fiscal costs.

The following steps summarize the calculation of socioeconomic impacts in each HSA, HU and range-wide:

Step 1: The fraction of illustrative project costs (identified in the course of calculating the fiscal cost of recovery recommendations) attributable to permitting, planning, and mobilization were estimated. These expenditures do not generate appreciable economic activity or employment in local regions;

Step 2: Regional transfers were estimated as total fiscal costs for each recovery action by HSA less the fraction of these costs identified in Step 1;

Step 3: Welfare impacts associated with each class of recovery action were identified; where possible, these impacts were quantified by multiplying unit social costs (or benefits) by the amount of each recovery action that would be undertaken;

Step 4: Tax impacts associated with each class of recovery action were identified; where possible, these impacts were quantified by multiplying unit costs (or benefits) by the amount of each recovery action that would be undertaken; and

Step 5: Impacts calculated in Steps 2-4 were summed to develop aggregate socioeconomic impact estimates for each HU, ESU and the State as a whole.

I.3 BARRIERS TO FISH PASSAGE

In many HUs and HSAs, assessment, prioritization, and treatment of barriers to fish passage have been identified as recovery priorities. Assessing the cost of these activities requires information about (1) the inventory of barriers in each HSA, (2) the location of barriers in HSA, and (3) the size or complexity of all barriers. In this section the cost of projects to treat each of these types of barriers is discussed. To estimate the cost of treating barriers, the Department supplied an inventory of potential barriers by HSA. This inventory database includes a description of the barrier, information (if known) about whether the barrier constitutes a total, partial, or temporal (seasonal) barrier to fish passage, and information, developed using GIS, about whether the barrier is located in a forested, agricultural, suburban, or urban area. It is important to note that this database contains potential barriers and that not all of these potential barriers have been field verified. The Department has identified the following types of potential barriers:[4]

[3] Note that if volunteer labor is used for restoration activities this can reduce the fiscal costs of these activities. It does not change the way the socioeconomic impacts are calculated. These are still correctly calculated using market wage rates on the assumption that this wage is foregone when volunteers supply their labor for restoration, just as it is foregone when leisure is chosen over labor.

[4] Barriers information provided by the Department comes from the California Coastal Conservancy. 2003. Assessment of Potential Barriers to Fish in California Coastal Watersheds.

- Dams;
- Non-structural sites (e.g., log jams);
- Fish passage facilities;
- Stream crossings (e.g., culverts);
- Unknown/Other barriers; and
- Water diversions.

I.3.1 FISCAL COSTS

I.3.1.1 Dams

The Department has identified by HU dams that could act as potential barriers to fish passage in the coho salmon ESUs. There are at least two major actions that can be taken to improve fish passage at dams; the dam can be removed (more likely to be feasible in the case of small dams) or ladders, screens, and pumps can be installed to allow fish to pass over the dam.[5] The fiscal cost of either of these actions varies widely and depends on (1) the physical location of the barrier, (2) the height of the barrier, and (3) the width of the barrier. The barrier inventory supplied by the Department does not include information about these physical characteristics of dams; information on the height of about 250 of the dams was collected from the National Inventory of Dams[6] and matched with the Department's data using reported dam names.

To estimate the fiscal cost of dam treatment, surveys previously performed by other authors of the cost of fish passage improvement at dams were considered, and indicative project costs were based on similar project costs in California and, to a lesser extent, in Oregon and Washington.

The cost of removing dams varies fairly regularly with the height and width of the dam, but project-specific factors, such as structure type, sediments, water rights, easements, and the need for monitoring can greatly impact the total cost of treatment (Rhode Island Habitat Restoration Portal (2001).[7] Friends of the Earth et al. (1999)[8] performed case studies of more than 30 dam removal projects in the United States and found that some small dams can be removed for under $10,000. The removal of a larger dam (e.g., 15-20 feet in height) can cost as much as $1 million. In neither case do these cost estimates include the important considerations of the cost of permits, easements, design, or monitoring. The median cost of dam removal in this study was about $100,000. However, this finding cannot be interpreted to suggest that this will be true in California or elsewhere in the future. Previous dam removals were not the result of a random selection; it is likely that relatively inexpensive removal projects have been undertaken first and that average removal costs will rise over time.

As in the case of dam removal, the cost of constructing an artificial fishway is proportional to the height of the dam or other obstruction. Rhode Island Habitat Restoration Portal (2001) and Connecticut River Watershed Council, Inc. (2000)[9] show illustrative fishway construction

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5 New fish ladders may be installed or modified to replace poorly functioning ladders that cannot pass fish easily during certain flow conditions. Modified or new fish ladders may have wider flow ranges for passing fish. Locations for new fish ladders would be where construction, operation, and maintenance access are most efficient, usually at stream edges. Potential designs of fish ladders include pool and weir, vertical slot, and roughened channel types. Source: http://www.delta.dfg.ca.gov/afrp/documents/DeerPEA.pdf.

6 Available: http://crunch.tec.army.mil/nid/webpages/nid.cfm.

7 Rhode Island Habitat Restoration Portal. 2001. Restoring coastal habitats for Rhode Island's future: Costs of restoration. Available: http://www.edc.uri.edu/restoration/html/tech_sci/socio/costs.htm.

8 Friends of the Earth, American Rivers, Trout Unlimited. 1999. Dam Removal Success Stories: Restoring Rivers Through Selective Removal of Dams that Don't Make Sense. Available: http://www.americanrivers.org/damremovaltoolkit/ssoverview.htm.

9 Connecticut River Watershed Council, Inc. 2000. Providing fish passage around dams in the Northeast: a fishway for your stream. The Connecticut River Watershed Council, Inc., Easthampton, Massachusetts.

costs for two commonly used fishways, steeppass and denil. These findings show that installation of steeppass fishways, which can be used for dams up to 12 feet in height, costs about $10,000 for every vertical foot of dam height. When dam height exceeds eight or nine feet, a resting pool should be added, which costs another $5,000. A denil fishway, used for larger dams, costs about $20,000 for every vertical foot for dams up to six feet in height. For higher dams, denil fishways cost about $25,000 to $30,000 for every vertical foot. These costs also apply to projects to improve passage at the 37 fish passage facilities identified by the Department in its barrier inventory.

A survey of recent expenditures on projects to remove dams or improve fish passage at dams in California undertaken by the authors is broadly consistent with the findings of surveys in other parts of the United States. For example, removal of the four water diversion dams, varying in height from six to twelve feet, along Butte Creek cost about $9.18 million in 1998 (12 unscreened diversions were also treated). This suggests an average dam removal cost of about $2 million. Removal of the Lake Christopher dam (10 feet in height and 400 feet in length) cost about $100,000 in 1994. At the time, repair costs to improve fish passage were estimated at $160,000 to $180,000. Both of these projects are described in detail by American Rivers (1999).[10] The Fife Creek Check Dam Removal and Habitat Enhancement Project in Sonoma County, which was funded by the Department in 1999, cost about $54,000.[11] The economists reviewed the projects recently funded by the Department to improve fish passage at dams by installing ladders and pumps and they found that costs ranged from $150,000 to $1.6 million, with a mean cost of about $900,000.[12]

Based on this information about recent projects, the following assumptions were made in calculating the total expected cost of dam removal and treatment in the coho salmon ESUs:

1. Dams smaller than 15 feet in height will be removed if treated;
2. The average cost of removing a small dam (less than 15 feet) in this region is $500,000;
3. For dams of known height greater than 15 feet, treatment costs will be $15,000 per foot;
4. For dams of unknown height that have been identified as complete barriers to fish passage, the cost of treatment will be $900,000;
5. For dams of unknown height that have been identified as partial and/or temporal barriers to fish passage, or barriers of unknown magnitude, the cost of treatment will be $450,000.

The Bureau of Reclamation (BOR) assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002).[13] The assumption was made that this fraction of project costs will be spent on permitting and other indirect costs for all barriers projects except culvert treatment. This fraction of total unit costs is not expected to vary by HSA. Of the remaining costs, the assumption

10 American Rivers. 1999. Completed Dam Removals in California. Available: http://www.americanrivers.org/damremovaltoolkit/sscalifornia.htm.

11 State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. 2000. Summary of projects funded in 1999. Available: http://www.dfg.ca.gov/nafwb/1999grants.htm.

12 State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. Summary of projects funded in various years. Available: http://www.dfg.ca.gov/nafwb. See also California Department of Water Resources, Bulletin 250-2002, Fish passage improvement. Available: http://www.isi.water.ca.gov/fish/ChapterFront/Front%20Matter.pdf.

13 Hudson, R.D. 2002. Upgrading and installing fish screens: Developing cost estimates. In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

was made that 15 percent are attributable to labor, consistent with the other culvert replacement itemized budgets (see the discussion of stream crossings in section I.3.1.3). This fraction of costs (about nine percent of project costs) will vary by HSA according to local wage rates.

Based on advice received from the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are dams will require treating except in those HUs where the Department has more precise information about the number of dams that act as barriers. Attachment 1 summarizes the estimated aggregate cost of dam treatment by HU.

I.3.1.2 Non-structural Sites

Non-structural barriers such as log-jams, boulder jams, and other barriers of natural materials can impede fish passage in ways similar to dams. The Department has identified over 3,000 non-structural barriers and almost 100 other sites that are similar (e.g., trash or tires blocking streams). Unlike many dams, most non-structural sites can be removed or altered to allow fish passage. The cost of barrier removal can vary depending on the location of the barrier, permitting requirements, and sediment impacts of removal. Direct removal costs generally depend on the sheer size of the site to be altered reports. Table I-3 presents illustrative unit costs for activities to be undertaken when non-structural sites are treated. These costs reflect range-wide averages as calculated by the United States Department of Agriculture (USDA) in Oregon as part of its Environmental Quality Incentives Program (EQIP) program.[14]

TABLE I-3: Construction unit costs for treatment of non-structural sites in Oregon

Activity	Unit cost ($)	Unit
Rock excavation	7.5	CY
Wet excavation	1.75	CY
LWD removal	125	ton
Log removal	100	ton
Rock clearing	25	ton
Root wad removal	100	ton

Source: USDA EQIP Program (2002)
Units: LF: linear foot, CY: cubic yard, SF: square foot.

The Department's inventory of potential non-structural barriers to passage does not include information on the size of the barriers. Thus, to estimate the approximate size of the non-structural barriers to passage that will be removed, information about the cost of previous Department-funded non-structural barrier removal projects was reviewed and a range of relevant projects funded by the Department since 1999 was identified. These projects ranged in cost from $1,600 to $28,000. Based on this information, an average project cost was assumed to be $10,000 for purposes of calculating the total cost of non-structural barrier removal.

BOR calculates that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, 15 percent were assumed to be attributable to labor, consistent with some actual itemized budgets for culvert replacement (see the discussion of stream cross-

14 It appears that this class of recovery action has not been funded by EQIP in California yet. Project costs are likely to be similar.

ings in section I.3.1.3). This fraction of costs (about 9 percent of project costs) will vary by HSA according to local wage rates.

On the advice of the Department, impact calculations assumed that approximately 50 percent of the potential barriers to fish passage that are non-structural sites will require treating. Attachment 1 summarizes the estimated aggregate cost of non-structural site treatment by HU.

I.3.1.3 Stream Crossings

Many existing culverts, built at a time when concerns about fish passage were less prevalent than they are currently, are now recognized as potentially important targets of the Recovery Strategy because older culverts can block access to reaches of potential habitat. Replacing culverts involves removal of old-style culverts (often large pipes) at stream crossings and replacing them with structures that fish can pass through more easily, such as concrete arch or box culverts. The surrounding road segment must be rebuilt. Table I-4 presents information on the unit cost of construction elements of culvert treatment in California.

Culvert replacement can be a complex and costly activity. Non-construction activities, not included in Table I-4, can account for a significant fraction of the total costs. As an illustration of the non-construction costs that are important parts of culvert replacement activities, Table I-5 presents itemized budgets for several culvert replacement and repair projects in Washington State.[15] Notably, traffic control and pre-project mobilization, (which includes permitting) are major elements of total project costs. This is likely to be less important for forest roads, but at least 20 percent of the culverts potentially needing replacement in the coho salmon ESUs are not associated with forest roads, but other more heavily trafficked county and city roads. Costs are also likely to differ depending on whether private landowners or the public sector performs culvert replacement. Costs may be higher for the public sector.

TABLE I-4: Construction unit costs for treatment of stream crossing barriers to passage in California

Activity	Unit Cost ($)	Units
Arch culverts	32.8	LF-Diameter/LF
Non-structural non-reinforced concrete	150	CY
Non-structural reinforced concrete	250	CY
Earthwork excavation	1.5	CY
Geoweb/Geocell soil cellular confinement system	5	SF
Gravel, in place	18	CY
Rock, in place	100	CY
Constructing step-pool/ weir below culvert	2,000	LF

Source: USDA EQIP Program (2002) Available: http://waterhome.brc.tamus.edu/NRCSdata/Costs/, California Department of Transportation (Caltrans) pers. comm. (step-pool/ weir construction).
Units: LF: linear foot, CY: cubic yard, SF: square foot.

15 These cost estimates come from winning bidders responding to requests from the Department of Transportation. In Caltrans' experience, item-by-item cost data are skewed by the bidding process. Bidders have incentives to present estimated costs that differ from their actual costs as part of the effort to be the lowest bidder (pers. comm. Recovery Team). Thus, these figures must be interpreted with care.

TABLE I-5: Illustrative project costs for treatment of stream crossing barriers to passage in Washington State

Project:	Culvert replacement ($ '000)			Culvert repair ($ '000)
County: Activity	King (suburban)	Snohomish (rural)	Whatcom (rural)	Chelan (rural)
Mobilization	46	50	8	16
Structure/obstruction removal	7	8	1	1
Grading	8	23	3	
Culvert drainage	259	128	8	150
Surfacing	14	20	1	
Pavement	21	11	2	
Erosion control/ planting	38	16	24	1
Traffic control	236	250	15	40
Other miscellaneous	8	24	13	12
Total cost	637	530	75	220

Washington State Dept of Transportation Bid Check Reports, engineering estimates. http://www.wsdot.wa.gov/biz/contaa/BIDTAB/. Snohomish culvert replacement project included an additional pavement installation element costing about $228,000 not included here. Thus, traffic control costs associated with culvert replacement only are likely less than the costs reported here.

The total fiscal cost of culvert replacement activities depends on (1) the type of the road that crosses the stream, (2) the size of the waterway crossed, and (3) whether the land where the culvert is located is privately or publicly owned. Evergreen Funding Consultants (2003) surveyed culvert replacement projects and found that while culvert replacement on forest roads costs between $15,000-$40,000 on a small waterway less than ten feet wide, it can cost as much as $100,000 to replace a forest road culvert at a tributary between ten and 20 feet wide and $150,000 to replace a forest road culvert at a tributary over 20 feet wide. These project cost estimates include the cost of construction, permitting, and traffic control.[16] For non-forest roads, Table I-6 summarizes Evergreen Funding Consultants' findings.

Information provided by Caltrans to the CRT is consistent with the information provided in Table I-6. Caltrans reports that culvert replacement, with no change in flow capacity, can range in cost from $20,000 to over $1 million. Replacement with an upgrade in flow capacity and improvements in culvert slope ranges in cost from about $30,000 to $2 million. Caltrans projects an average cost of about $400,000 for replacement in the coho salmon range since most fish culverts are either box culverts or large circular culverts. For culvert rehabilitation,

TABLE I-6: Estimated cost of culvert treatment by road type ($000)

	Road Type		
Size of waterway	Two-lane road (minor)	Two-lane road (major)	Highway
Less than 10 feet	50-100	100-200	200-350
10-20 feet	140-240	200-350	300-450
20-30 feet	180-280	250-450	600-800

Source: Evergreen Funding Consultants (2003)

16 According to the Highway Construction Cost Comparison Survey performed by the Washington State DOT (2002), preliminary engineering costs are about 5 percent higher in California than they are in Washington. However, environmental mitigation costs are generally lower in California. In total, illustrative highway construction costs (for a Diamond interchange) are about 40 percent higher in California than they are in Washington. The survey does not identify the source of this variation.

Caltrans estimates that costs range from $15,000 to $500,000; with an average cost of about $100,000 if no added effort is made to improve fish passage. If rehabilitation addresses fish passage concerns only, project costs average about $80,000. Caltrans cost estimates are probably indicative of the costs that counties will face as well.

In the event that culverts are to be replaced with span bridges, project costs will likely be much higher (Caltrans pers. comm. Evergreen Funding Consultants 2003). This depends on the span of the waterway in question; for larger waterways, culverts may have to be cast in place; in that event the cost of bridges and culverts will be similar. If bridges are used in instances in which a pre-cast culvert might be available, the incremental cost associated with the choice of a bridge can be on the order of $300,000 (Caltrans pers. comm.).[17]

When estimating the cost of culvert treatment in practice, it will be important to consider local labor costs, since traffic control is a labor-intensive activity, as well as the location of culverts and waterway size. The itemized budgets for the culvert replacement projects in Washington State reviewed by the economists suggest that traffic control labor represents about 20 percent of total traffic control costs. Itemized budgets from Oregon suggest that construction labor costs are about 12 percent of total construction costs (Medford District Resource Advisory Committee Project number 118-409).

Based on estimates made by Evergreen Funding Consultants (2003) and review of culvert replacement and repair projects in California, Washington, and Oregon, the costs of culvert treatment are expected to vary according to the geographic location of culverts, the extent to which stream crossings constitute partial/temporal or total barriers, and waterway size as summarized in Table I-7. To estimate the cost of treating stream crossings in the coho salmon ESUs, it is necessary to contend with the fact that no data are available in the Department's inventory of potential barriers about the size of the culverts that have been identified as potential barriers to fish passage. The barrier inventory does identify whether the culvert occurs at a tributary (a relatively smaller waterway) or a stream (a relatively larger waterway). This information was used to predict how the cost of culvert treatment will vary among barriers. Data were provided by the Department about land use in the area in which culverts have been identified. As discussed above, it is likely that culverts in forest regions are smaller and less costly to treat than culverts in other regions. The traffic control costs in project budgets reviewed by the economists suggest that culverts in suburban and urban areas are likely to be more costly

TABLE I-7: Cost per project to provide fish passage/mitigate barrier

Stream Crossing	Land-use where stream crossing located			
	Forest	Agriculture	Suburban	Urban
Tributary:				
Total barrier	56	140	280	490
Partial/ temporal barrier	28	70	140	245
Stream:				
Total barrier	140	336	490	700
Partial/ temporal barrier	70	168	245	350

Source: See text. Some potential barriers are of unknown severity. The conservative assumption has been made that these constitute total barriers to passage.

17 Whether a culvert receives remediation treatment vs. a full replacement not only depends on type and timing of impediment, but most importantly on size and condition of original culvert and ease of full replacement. For example, a large box culvert on Sir Francis Drive Road in West Marin, with another 30 years of wear, and huge costs and inconveniences associated with traffic control, would more likely receive an interior structural fix (e.g. baffles and step pool construction), vs. a full replacement. Often, the Capital Improvements Projects schedule and budget of a government entity such as a county or city, highly influences the type of project (FishNet 4C Program public comment).

to treat than stream crossings in less-traveled rural or agricultural areas. No data are available about whether culverts that will be treated are on public or private roads. Thus, the explicit costs calculations cannot take potentially higher public sector costs into account. However, unit cost estimates are informed by surveys of both public and private costs.

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens. (Hudson 2002). It was assumed that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets that were reviewed. This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

Based on advice provided by the recovery team, a review of the Marin County Stream Crossing Inventory and Fish Passage Evaluation (Ross Taylor and Associates 2003) and a review of the Inventory of Select Migration Barriers in the San Geronimo sub-watershed,[18] this analysis assumes that approximately 50 percent of the potential barriers to fish passage that are stream crossings will require treatment for coho salmon recovery. For each HSA, the fraction of treatment that will be culvert rehabilitation, as opposed to replacement, depends on whether the barriers identified in the HSA are partial and/or temporal barriers as opposed to total or unknown barriers. With no basis to identify when span bridges may be appropriate, the assumption was made that culvert rehabilitation and treatment will be used. Attachment 1 summarizes the estimated aggregate cost of stream crossing treatment by HU.[19]

I.3.1.4 Fish Passage Facilities

The Department has identified 45 fish passage facilities in the coho salmon ESUs that may constitute barriers to passage, presumably because the pumps, fish ladders, and screens at these facilities require repair or upgrades.

To estimate the cost of improving fish passage at these facilities, the economists reviewed the cost of projects funded by the Department recently to repair and upgrade fish ladders and install pumps and screens. For these eight recent projects, costs for repairing and upgrading fish passage at facilities ranged from around $60,000 to over $1.6 million. On average, the cost of treatment for this type of barrier was $760,000.[20] The assumption was made that costs on larger waterways (streams) will be slightly greater than this ($900,000) and costs on smaller waterways (tributaries) will be lower ($500,000).

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets that have been reviewed. This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

On the advice of the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are fish passage facilities will require treatment for

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18 Prepared by the Salmon Protection and Watershed Network. 2002. Available: http://www.spawnusa.org/reports/Mig_Bar_Rpt_10-10-02.pdf.

19 For a limited number of culverts, precise treatment cost estimates have been provided by the Department. These culverts are in the Klamath River HU, Eel River HU and Scott River HA.

20 State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. Summary of projects funded in various years. Available: http://www.dfg.ca.gov/nafwb. See also California Department of Water Resources, Bulletin 250-2002, Fish passage improvement. Available: http://www.isi.water.ca.gov/fish/ChapterFront/Front%20Matter.pdf.

coho salmon recovery. Attachment 1 summarizes the estimated aggregate cost of stream crossing treatment by HU.

I.3.1.5 Water Diversions

The Department has identified approximately 1,100 locations where water is diverted from streams for agriculture, domestic, or industrial uses through unscreened intakes in the coho salmon ESUs. The majority of these diversions are for irrigation purposes. Fish screening devices can be placed at these diversions to prevent fish from entering the diversion and being lost. Water continues to pass as needed, but fish cannot leave the stream. USDA has estimated the average cost of fish screen installation in California as relatively modest. These cost estimates are summarized in Table I-8.

TABLE I-8: Construction unit costs for fish screen installation in California

Device	Units	Unit cost ($)
Fish Screen - Passive	Each	1,000
Fish Screen - Self Cleaning	Each	3,000
Fish Screen - Large	Each	40,000
Fish Screen - Small	Each	10,000

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/

Actual projects undertaken or proposed in Washington State report costs that are similar to these average cost estimates provided by USDA. For example, a proposal submitted to the Columbia Basin Fish and Wildlife Authority in 2001 proposed to install passive fish screens at all Walla Walla Basin irrigation diversions (197 diversions in total) at a total cost of about $1 million. The physical cost of the screens was estimated to be about $2,300 each, including a 15 percent cost share from land owners.[21] Field assessments were estimated to cost about $30,000 or about $150 per diversion. There are likely to be significant economies of scale associated with the assessment requirements of water diversions. That is, these associated costs are likely to be lower on a per unit basis when many diversions are to be screened.

To take another example, a project proposal for the fabrication and installation of two new fish screening facilities and the rehabilitation of one existing screening facility on irrigation diversions on the Wentachee River in 2003 estimated a construction cost of $45,000.[22] Screening costs are higher on larger bodies of water than small ones. Based on this review, when the aggregate costs of water diversion treatment is calculated, the assumption was made that barriers on relatively small tributaries can be treated at a cost of $10,000, and barriers on relatively larger stream can be treated at a cost of $40,000.

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets reviewed by the economists (see the discussion of stream crossings in section I.3.1.3). This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

21 CBFWA FY 2001 Project ID 23048. Available: http://www.cbfwf.org/2001/highpriority/projects/23048.htm.

22 CBFWA FY 2001 Project ID 29028. Available: http://www.cbfwf.org/files/province/cascade/projects/29028.htm.

On the advice of the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are diversions will require treating. Attachment 1 summarizes the estimated aggregate cost of diversion treatment by HU.

I.3.2 SOCIOECONOMIC IMPACTS

As discussed in section I.3.1, for each category of barriers, a review of historical barrier treatment projects provides the information necessary to estimate the fraction of project costs attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of barrier treatment was calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts as a result of these transfers are summarized in Attachment 1.

Other welfare impacts associated with barrier removal are more difficult to quantify because of the limited information available about which potential barriers will actually be treated as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

Dam removal may result in third-party impacts if dams currently serve a useful economic or recreational purpose. The benefits that these dams currently provide would be lost in the event that dams were removed to improve passage for coho salmon. Culvert replacement or treatment may increase or reduce flooding and associated costs. Screening water diversions and improving fish passage facilities should result in few substantive social costs, though maintenance requirements will result.

I.4 RIPARIAN REVEGETATION AND STREAM-BANK IMPROVEMENTS

One of the most common recommendations in the Recovery Strategy is riparian revegetation, accomplished by planting trees along stream and tributary banks to provide shade over the water that coho salmon use. These efforts are often part of larger projects to improve the condition of stream banks, including fencing and channel stabilization. This section considers the cost of riparian revegetation and more general stream-bank improvements.

The recommendations of the CRT with respect to riparian revegetation are fairly general in nature. Currently, information is not available as to the size of the buffer zones that the CRT believes are required at different types of streams. Similarly, information is not available to estimate the number of stream miles that require revegetation or other types of stream-bank improvements and the physical location of sites needing treatment. Given the general nature of the recommendations, the estimates of aggregate costs and socioeconomic impacts are necessarily sensitive to assumptions made about the values of these parameters.

I.4.1 FISCAL COSTS

I.4.1.1 Riparian Revegetation

The fiscal costs of riparian revegetation or planting depend on (1) the complexity of the project to be undertaken (e.g., the materials to be used), (2) the remoteness of the parcel of land to be treated, and (3) the degree of site preparation that is needed. Evergreen Funding Consultants (2003) suggest a budget of between $5,000 per acre and $135,000 per acre, with higher costs for projects that involve larger trees, more heavy machinery, and limited accessibility. These estimates include the cost of permitting and several years of maintenance. Notably, Federal government support for riparian revegetation projects in California under the EQIP program provides 50 percent cost-sharing assuming a cost of implementation of $2,000 per acre, significantly lower than the cost of typical programs in Washington State surveyed by Evergreen Funding Consultants.[23]

The complexity of riparian revegetation projects depends on whether planting is part of a larger set of stream-bank protection and improvement activities, which can vary widely in cost depending on site-specific goals and needs. The next subsection discusses the average unit cost of typical stream-bank improvement activities in California.

Site preparation costs depend significantly on the slope of the land being planted and the amount of clearing required. Evergreen Funding Consultants (2003) report that for medium-cost projects, as defined by materials used and site accessibility, revegetation on flat and fairly clear sites cost between $10,000 and $30,000 per acre. Projects on steep sites where significant clearing is required will cost around $100,000 per acre. Clearly, determining whether a riparian revegetation project will be cost-effective depends significantly on the site type. Determining the aggregate cost of riparian revegetation also depends on the site types in each HSA, but no information is available about this in the Recovery Strategy.

High-cost riparian revegetation projects, in terms of materials used and site accessibility, have certainly been undertaken in other regions with endangered salmonid populations. If regulators and/or landowners want to provide drastic and rapid improvements in shade at streams and creeks, one option is to transplant large trees. For example, at the Stables Creek reconstruction project in Snohomish County, Washington, 15-20 foot high trees were planted at the stream bank. Using volunteer labor and donated material is more likely to make this sort of project cost-effective from the perspective of public agencies.

Riparian revegetation projects also vary in cost according to site accessibility. The Department has provided information about the distance of streams in each HSA from roads. Riparian revegetation at sites further from roads is likely to be more costly than at sites near roads. Evergreen Funding Consultants (2003) estimate that projects on an average slope, and requiring average clearing and materials, vary in cost from about $20,000 to $80,000 per acre. For this analysis, the assumption was made that the average cost of riparian revegetation projects will vary as follows:

- Projects at stream area located less that 0.25 miles from a road cost $30,000 per acre;
- Projects at stream area located between 0.25 and 0.5 miles from a road cost $35,000 per acre;
- Projects at stream area located between 0.50 and 1 mile from a road cost $45,000 per acre;
- Projects at stream area located between 1 and 2 miles from a road cost $50,000 per acre;
- Projects at stream area located between 2 and 3 miles from a road cost $55,000 per acre; and
- Projects at stream area located more than 3 miles from a road cost $60,000 per acre.

The assumption was also made that at any stream mile that needs riparian revegetation, the width of the buffer created will be 50 feet. These assumptions result in fairly conservative cost estimates, but this is appropriate in the absence of additional information about the cost of materials required at sites. These parameters can easily be changed when the spreadsheet models provided to the Department are updated.

23 The cost estimates discussed in this section do not include the potential cost of conservation easements in riparian zones. See section I.4.2.1 for a discussion of the data required to estimate the cost of easements.

Riparian revegetation is a fairly labor intensive activity. As discussed in section I.2.1, labor costs largely determine how the cost of recovery actions will vary spatially, controlling for topographical differences among potential project sites. Thus, the labor requirements for projects will partially determine where riparian revegetation is relatively cost-effective. Typical restoration costs estimates reported by Bair (2002) suggest that about three percent of total project costs are due to labor. Because permitting and planning account for 53 percent of total costs, this is a fairly large fraction of total implementation costs. In calculations to estimate the aggregate cost of riparian revegetation, the assumption was made that three percent of unit costs will vary by HSA.

Attachment 2 summarizes the estimated aggregate cost of riparian revegetation by HU. These cost estimates are developed using estimates of the amount of riparian planting work that will be needed that were provided by the Department, and, in the case of the CCC Coho ESU, total cost estimates by HSA provided by the Department. Where the Department has provided this information at the HU level, the assumption was made that needs are divided among HSAs within an HU equally.[24]

I.4.1.2 Stream-bank Improvements

While riparian revegetation can be undertaken in isolation, these planting efforts may also be part of larger projects intended to stabilize and improve stream banks to reduce erosion. Table I-9 summarizes the average unit cost of various stream-bank improvement activities in California as reported by USDA.

TABLE I-9: Construction unit costs for stream-bank improvement activities in California

Stream bank improvement activities	Units	Unit cost ($)
Compacted Fill	CY	2.5
Cut and filling	CY	130
Geotextile Fabric	SF	1.25
Grading and Shaping	AC	200
Mobilization	Each	1250
Rock, In Place	CY	100
Rock/fill	CY	50
Seedbed preparation	AC	50
Stream tree revetment	Each	22
Wildlife Repellant (chemical)	AC	100
Stream bank protection, general	LF	125

Source: USDA EQIP Program (2002) Available: http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

USDA cost estimates report that stream-bank protection projects in general cost about $125 per square foot in California. However, these cost estimates do not include the cost of maintenance or permitting. Evergreen Funding Consultants (2003) provide project cost estimates that include the cost of permitting and short-run maintenance and range from $30 per

[24] In the SONCC Coho ESU, the Department provided estimates of the quantity of riparian revegetation and stream-bank improvements needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

foot to $1,000 per foot. More complex projects in more remote areas will be more costly. In addition, projects needing significant excavation and grading will be more costly, as will those located in areas where the width of the stream is greater.

Besides depending on project complexity, the cost of stream-bank improvement projects will also depend on the productivity of labor hired for the project and local wage rates. Table I-10 summarizes approximate labor requirements for typical stream-bank improvement activities. In general, the larger the vegetation products being planted, the more labor that will required for each stream mile treated. Seeding is much less costly than planting containerized plants or larger trees.

To calculate the aggregate cost of stream-bank improvements, the assumption was made that stream-bank improvement projects cost including permitting and maintenance are higher than the construction-only costs reported by USDA, and roughly in the middle of the cost estimates reported by Evergreen Funding Consultants (2003). As discussed in the previous subsection, it is difficult to determine, based on limited available information, how to vary stream-bank improvement costs within HSAs except on the basis of site remoteness.[25] The estimated cost of this class of recovery action is about $200 per lineal foot for stream-bank area that is less than 0.25 miles from a road. As the distance of the stream bank from a road increases, unit costs are assumed to increase in the following manner:

- Projects at stream area located between 0.25 and 0.5 miles from a road cost $250 per lineal foot;
- Projects at stream area located between 0.50 and 1 mile from a road cost $275 per lineal foot;
- Projects at stream area located between 1 and 2 miles from a road cost $300 per lineal foot;
- Projects at stream area located between 2 and 3 miles from a road cost $325 per lineal foot; and
- Projects at stream area located more than 3 miles from a road cost $350 per lineal foot.

TABLE I-10: Labor requirements for stream-bank improvements

Activity	Per person labor required
Brush layering	6-17 LF/hr
Brush mattress	0.2-1.2 SY/hr
Plant Roll	20 LF/hr
Fascine placement	5 LF/hr
Sprig planting	5-24 SY/hr
Seedling planting	30-120 plants/hr
Ball and Burlap shrubs	1-158 plants/hr
Containerized plants	20-100 plants/ hr
Seeding	0.05-0.5 AC/hr
Hydroseeding	0.12-0.37 AC/ hr

Source: Hoag (2000).
Units: LF: linear foot, SY: square yard, SF: square foot, AC: acre.

25 Lack of information about site characteristics across HSAs may explain why these cost estimates are significantly higher than those reported by Hampton (2002) from a survey of 12 erosion control projects in California. He reports average unit costs that are very low compared those that we use here, on the order of $8 per lineal foot.

Costs vary across HSAs according to wage rates. The assumption was made that planning and permitting costs account for 53 percent of total unit costs and do not vary by HSA, just as in the case of riparian revegetation. Ideally, costs would also vary by the size of the waterway and extent of excavation needed, but with no information on the number of stream miles where stream-bank improvements are needed, there is no basis on which to introduce variation in costs by project complexity. As in the case of riparian revegetation, the assumption was made that three percent of total costs are attributable to labor and that these costs vary across HSAs according to local wage rates.

Attachment 2 summarizes the estimated aggregate cost of stream-bank improvements by HU. These cost estimates are developed using estimates of the amount of stream-side restoration work that will be needed that were provided by the Department. Where the Department provided information only about riparian planting (about two-thirds of SONCC Coho ESU HUs), the assumption was made that about one-half the number of stream miles would need stream-bank improvement work as well.[26] In addition, where the Department has provided this information at the HU level, the assumption was made that needs are divided equally among HSAs within an HU.

I.4.1.3 Fencing

A common recovery recommendation that is suggested to limit the access of livestock to streams and creeks is fencing. Livestock use of natural water channels stresses stream banks and can cause erosion. Associated sediment can harm salmon. Fencing is often an element of larger riparian revegetation projects, but unit costs of this activity in isolation are also available.

The unit cost of fencing depends on the type of fencing used. More elaborate fencing, with many gates or posts is more expensive to install than simple barbed wire fences. Fencing on steep slopes where significant clearing is required will also be more expensive than projects implemented on flatter ground or with minimal pre-existing vegetation. Evergreen Funding Consultants (2003) suggest budgeting between $3 and $12 per lineal foot for fencing projects. Table I-11 summarizes the average unit cost of various elements of fencing installation projects as calculated by USDA.

To calculate the aggregate cost of fencing activities in the coho salmon ESUs, an average cost of $8 per lineal foot was assumed. Costs are also assumed to vary across HSAs according to the local average construction wages.[27]

Attachment 2 summarizes the estimated aggregate cost of fencing by HU. These cost estimates are developed using estimates of the amount of fencing that will be needed that were provided by the Department. Where the Department has provided this information at the HU level, the assumption was made that needs are divided among HSAs within an HU equally.[28]

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[26] The Department provided estimates of the quantity of riparian revegetation and stream-bank improvements needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

[27] Ideally, costs would also vary according to the sort of materials that would be used, with the simplest fencing projects costing about $3 per lineal foot and the most complex projects costing about $12 per lineal foot. However, at this time we have no basis on which to make inferences about the sort of material that would be used in different HSAs. In the spreadsheet model, this is an option for future analysis.

[28] The Department has provided specific fencing costs for the Davenport HSA in Big Basin, which are incorporated into the analysis.

TABLE I-11: Construction unit cost of fencing project elements in California

Element of fencing project	Units	Unit cost ($)
Fence - Gate - 12ft	Each	75
Fence - Gate - 14ft	Each	85
Fence - Gate - 16ft	Each	100
Fence "T" posts	Each	1.5
Fence Posts (metal)	Each	8
Fence Posts (wood)	Each	5
Fencing, Conventional	LF	3.5
Fencing, Suspension	LF	2
Fencing, Electrical	LF	1.5
Fencing (smooth) without power	LF	1.5
Fencing (woven) 4 inch squares	LF	3
Fencing (woven) 5 inch squares	LF	3.25
Cattle Guard (Large)	Each	4,000
Cattle Guard (Small)	Each	3,000
Concrete, In Place	CY	350

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

I.4.2 SOCIOECONOMIC IMPACTS

I.4.2.1 Riparian Revegetation and Stream-bank Improvements

As discussed in section I.4.1.1, information from historical riparian revegetation projects and stream-bank restoration projects provides a basis for estimating the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of riparian revegetation and stream-bank restoration is calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 2.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

The full social costs of riparian revegetation and stream-bank restoration depend on how the riparian land affected will be treated. If the Department or another entity purchases riparian land for salmon restoration, this land will no longer generate income for its previous owner. The land price that will be paid reflects this foregone income if land markets are competitive. Table I-12 shows illustrative unit values for forest land, which might be purchased for habitat conservation, particularly in riparian areas. These unit values suggest that the social cost of forest land acquisition may be lower in the SONCC Coho ESU than in the CCC Coho ESU, though costs range widely within all counties for which data are available.

If land is not purchased outright for salmon habitat conservation, the Department or other entities may elect to purchase conservation easements on riparian land. Conservation easements pay landowners to restrict development. The per-acre cost of easements is generally lower than the full market price of land; the easement price should reflect the difference between the amount of income that could be earned on a parcel without development restrictions, and the income that can be earned once the easement is in place. For narrow riparian buffers, little income may be available in light of the listing of coho salmon as a threatened or

TABLE I-12: Illustrative unit values of the social cost of forest land acquisition, selected California counties ($/acre)

	Unit prices of forest land		
County	Average ($/acre)	Minimum ($/acre)	Maximum ($/acre)
Sonoma	3,128	1,089	5,392
Santa Cruz	7,347	3,167	11,063
San Mateo	7,360	1,656	15,857
Mendocino	12,406	3,000	24,750
Humboldt	7,181	625	56,471
Del Norte	5,914	2,417	16,204

Source: Save the Redwoods League (pers. comm. 2003). Prices reflect current dollar actual payments made 1990-2002 for properties larger than ten acres.

endangered species, but for larger parcels this would not necessarily be the case. The unit price of easements for coho salmon depends on (1) the extent to which listing of coho salmon reduces development options in riparian areas, (2) the area where easements would be sought, and (3) which development rights would be sold.

The cost of conservation easements can vary widely across locations and depends heavily on the precise terms of the easement. Without further information on the terms at which easements would be sought, and where they would be desirable, the impacts of this class of potential recovery actions cannot be estimated at this time. Illustrative values for easement costs have been provided by California Cattleman's Association for the case of rangeland. Easement costs for rangeland in the North Coast can be expected to cost in the range of $400 to $600 per acre. Pacific Forest Trust has provided information about the cost of forest easements in the coho salmon range. They suggest a rule of thumb that easement costs should be about 40 percent of market value given development restrictions that would likely address coho salmon recovery needs. Lower values will be appropriate in more remote regions where development pressures are lower.

Currently, the Department has identified the cost of two recommendations that propose conservation easements (ER-FE-02 and ER-SF-02). The Department estimates that the cost of these recommendations will be $60 million over 10 years, or a present value cost of $51 million, assuming a discount rate of three percent. This amount is included in the estimate of total cost of Recovery Strategy implementation, though additional funds may be required for easements.

In the event that forest land is purchased outright in riparian areas for salmon restoration, or riparian conservation easements are purchased, there may be several associated tax implications. One of these is highlighted, the implications of the title transfer for the property tax paid to the State government on this land. Currently, for the purposes of taxation, timberland in the Redwood Region is assessed according to the schedule presented in Table I-13. According to the California State Board of Equalization, in the event that a timberland parcel is designated as inoperable, as it may well be if purchased for salmon habitat restoration or use is restricted as a result of an easement, it will be valued as if it is Site V (the lowest level of potential forestry productivity). If the parcel was previously assessed at a higher value, the property tax associated with the land may fall, with associated implications for public budgets.

I.4.2.2 Fencing

As discussed in section I.4.1.3, review of average fencing project costs provides a basis for estimating the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of

TABLE I-13: Timberland value assessment for tax purposes in California, 2002

Site class	Assessed value ($/acre)
Site I	279
Site II	227
Site III	198
Site IV	172
Site V	54

Source: State of California Board of Equalization, November 2002). Site class is classification of the potential productivity of forest land.

fencing is calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 2.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

If fencing projects deprive landowners of a place to water their animals, the cost of tanks and/or troughs may be included as an element of the full cost of fencing projects. Tanks for livestock watering cost about $2 per gallon, and troughs cost about $1 per gallon (USDA 2002). Labor will also be required to service these tanks that may be greater than the labor requirements associated with watering animals prior to the installation of the fence. Whether the cost of water to service these tanks is a social cost of these projects depends on pre-existing water rights allocations and landowners' obligations as a result of the listing of the coho salmon as endangered or threatened.

I.5 PLACEMENT OF LWD/INSTREAM COMPLEXITY

I.5.1 FISCAL COSTS

Riparian revegetation is intended to create a stock of biomass that will fall into streams and rivers over time, creating pools and other essential salmon habitat. Other projects can be undertaken to speed up the process of generating instream complexity. LWD can be placed in waterways, and other activities can be undertaken to improve in-channel habitat. Evergreen Funding Consultants (2003) estimate that LWD placement costs about $20,000 per stream mile; costs rise as the width of water bodies increase and as the size of the material to be placed in channels grows. Engineered log jams can cost as much as $80,000 per structure. Engineered log jams also require significant design and logistic preparation; for example, a series of engineered log jams created on the North Fork Stillagumish River in Washington cost $550,000 to implement and three years of preparation.

Other activities to improve in-channel habitat can be undertaken as part of LWD projects. The average unit cost of these activities in California, as estimated by USDA, is presented in Table I-14. Many of these activities are closely related to erosion control measures and fencing activities discussed previously.

Project costs for in-channel restoration have been developed by the Office of Spill Prevention and Response (OSPR) at the Department. Based on cost estimates reported by Bair (2000)[29] and

[29] Bair, B. 2000. Stream restoration cost estimates. In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

TABLE I-14: Construction unit cost of in-channel habitat improvement elements in California

Activity	Units	Unit cost ($)
Clearing and Snagging	LF	25
Compacted Fill	CY	2.5
Critical Area Planting	AC	1,000
Cut and filling	CY	130
Fence	LF	4
Geotextile Fabric	SF	1.25
Grading and Shaping	AC	200
Rock/fill	CY	50
Stream Tree Revetment	Each	22
Water Control Structure	Each	15,000

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

Hampton (2000)[30], OSPR allocates about $60,000 per stream mile for restoration in a small rocky stream and $140,000 per stream mile in a large rocky stream. These cost estimates each include five years of monitoring and maintenance and a ten percent administration fee.

To estimate the aggregate cost of LWD placement and in-channel restoration in the coho salmon ESUs, the estimates developed by Evergreen Funding Consultants (2003) for LWD placement and the estimates developed by OSPR for in-channel restoration were used. While no systematic information is available about the width of the streams included in the Department's stream inventory by HU or HSA, information is available about the distance of streams from roads. Evidence presented by Evergreen Funding Consultants suggests that project costs rise as the restoration site becomes more remote from roads. Consistent with this experience in Washington State, the assumption was made that project costs rise as the distance of streams from roads increases. The assumption was also made that costs will vary among HSAs on the basis of construction industry wages. Thus, projects in remote areas in high wage regions will be relatively more expensive per stream mile than identical projects, in terms of materials used, in low-wage areas at easily accessible sites.

For general in-channel restoration activities, following OSPR the assumption was made that permitting costs are about $15,000 per stream mile, regardless of project location. All other costs total $25,000 per stream mile for project sites within 0.25 miles from a road. OSPR reports that labor costs generally total about eight percent of non-permitting costs. This information was used to estimate how project costs vary among HSAs according to the relative costliness of labor. As in the case of LWD projects, the assumption was made that non-permitting costs rise as streams become more distant from roads. In particular:

- Sites between 0.25 and 0.5 miles from a road have non-permitting project costs of $26,000 per mile;
- Sites between 1 and 2 miles from a site have non-permitting project costs of $27,000 per mile;
- Sites that are between 2 and 3 miles from a road have non-permitting project costs of $28,000 per mile; and

30 Hampton, S. 2000. The costs of restoring anadromous fish habitat: Results of a survey from California. In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

- Sites further than 3 miles from a road have non-permitting project costs of $29,000 per mile.

For LWD placement alone, the assumption was made that for sites less than 0.25 miles from a road, project costs will be $20,000 per mile on average. The assumption was made that permitting costs account for about 38 percent of total costs and labor accounts for about eight percent of non-permitting costs, consistent with the assumptions made about instream complexity work. As sites increase in distance from roads, total unit costs rise in the following manner:

- Sites between 0.25 and 0.5 miles from a road have project costs of $21,000 per mile;
- Sites between 1 and 2 miles from a site have per mile project costs of $23,000;
- Sites that are between 2 and 3 miles from a road have per mile project costs of $25,000; and
- Sites further than 3 miles from a road have project unit costs of $30,000.

Attachment 3 summarizes the estimated aggregate cost of LWD placement and restoring in-channel complexity by HU. These cost estimates were developed using estimates, provided by the Department, of the amount of LWD placement and in-channel restoration work that will be needed, and, in the case of the CCC Coho ESU, total cost estimates by HSA. Where the Department provided information only about LWD needs (about two-thirds of HUs in the SONCC Coho ESU), the assumption was made that a similar number of stream miles would need in-channel restoration work as well.[31]

I.5.2 SOCIOECONOMIC IMPACTS

As discussed in section I.5.1, review of historical LWD placement projects and instream restoration projects provides a basis for estimating the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of LWD placement and instream restoration was calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 3.

I.6 ROAD TREATMENT AND DECOMMISSIONING

The Recovery Strategy contains several broad categories of recommendations dealing with roads, which differ in their unit cost, socioeconomic impacts and, likely, in their cost-effectiveness. The broad categories of recommendations are:

1. Road decommissioning;
2. Road upgrading;
3. Relocation of roads in riparian areas;
4. Implementation of best-management practices (BMPs) in road construction; and
5. Limiting use of roads (e.g., in winter or if road is legally closed).

31 The Department provided estimates of the quantity of in-stream restoration needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

Many road treatment actions are recommended in conjunction with culvert replacement (see the discussion of barriers to fish passage above). For most HSAs where roads are identified as a source of sediment that harm coho salmon, the CRT also urges road and sediment assessments.[32] To the economists' knowledge, little quantitative information about the number of road miles needing each of the recommended actions is available at this time, so it is impossible to calculate precisely the cost of this class of recovery recommendations.[33] This section includes a discussion of the unit cost of road decommissioning and road upgrades (many BMPs in road construction are also implemented in road treatment after initial construction). It also includes a discussion of the socioeconomic cost of limiting the use of certain roads to reduce erosion that is harmful to coho salmon.

I.6.1 FISCAL COST

I.6.1.1 Road Treatment

A variety of activities can be undertaken to reduce the sediment burden associated with previously constructed roads. Pacific Watershed Associates (2003) summarizes these as "stormproofing" activities, which remove unstable sidecast and fill materials from steep slopes and in other appropriate locations, and also apply surface drainage techniques.[34] Stormproofing can also include upgrading stream crossings.

Illustrative unit costs for typical road treatment activities in California as calculated by USDA are summarized in Table I-15. Along a given stretch of road, the number of rolling dips and water crossings that will be required to adequately treat sediment is project-specific. It depends on both the soil type and the grade of the road. Treating steeper roads with more erosive soils will require more rolling dips and waterbars per mile (Keller and Sherar 2003).[35]

The survey results reported by Weaver (2002) and the figures in Table I-16 are the basis for the unit cost estimates used to estimate the aggregate cost of road treatment in the coho salmon ESUs. The assumption was made that labor costs account for about 40 percent of total costs

TABLE I-15: Construction unit costs for road treatment activities in California

Activity	Units	Unit cost ($)
Compacted Fill	CY	2.5
Earthwork excavation	CY	1.5
Grading and Shaping	AC	200
Grading Shaping and Filling	AC	500
Road & Landing Removal	AC	2000
Rolling Dip	Each	350
Rock Ford or Crossing	Each	4,000
Waterbar	Each	150

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

32 There are other recommendations that are more general exhortations to control legacy sediment sources, or to avoid the creation of new sediment sources. We assume that these are related to either road upgrading or the adoption of BMP in road construction.

33 This is not surprising. Anywhere from 15 to 50 percent of roads on the landscape are not on maps maintained by large timber companies, counties and the State. Weaver, B. 2002. Road upgrading, decommissioning, and maintenance-estimating costs on small and large scales. In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

34 Pacific Watershed Associates. 2003. Watershed assessment and erosion prevention planning project for the Garrapata Creek Watershed, Monterey, CA. Prepared for Department of Fish and Game, March 2003.

35 Keller G. and J. Sherar. 2003. Low-volume roads engineering: Best management practices field guide. US Agency for International Development and USDA, Forest Service. Available: http://www.zietlow.com/manual/gk1/foreword.pdf.

and that the labor element of the unit cost of road treatment varies across HSAs according to local wage rates. Since San Mateo County is a relatively high-wage region, (construction wages in this county were 126 percent of the California average in 2002), the assumption was made that the range-wide average labor cost per mile is $5,900 (74 percent of $8,000 which is the per mile cost of labor in Table I-16). The assumption was made that the range-wide average cost of the non-labor component of road treatment is $10,000 per mile (the per mile non-labor treatment cost in Table I-16). This cost is assumed to be constant across HSAs. Planning, mobilization and permitting are estimated to be about 25 percent of total project costs per mile (as they are in the example presented above). The average total per-mile cost is $15,900.

The Department has provided information about the approximate number of road miles that will need treatment or decommissioning in the Cape Mendocino, Eel River, Eureka Plain, Klamath River, Mad River, Redwood Creek, Rogue River, Smith River, Trinidad, Trinity River, and Winchuck River HUs. The assumption was made that the distribution of these road miles among the HSAs in these HUs is approximately equal to the distribution of U.S. Geological Survey (USGS) Class 4 (unpaved or unimproved) roads in rural forest regions. The Department has provided information about the approximate number of road miles that will need treatment or decommissioning in each of the HSAs in the Mendocino Coast, Marin, San Mateo, Russian River, Bodega and Big Basin HUs.

The assumption was made that 85 percent of roads identified by the Department as needing treatment will require stormproofing. This is consistent with a survey of typical findings on a watershed-by-watershed basis reported by Pacific Watershed Associates (2003).[36] The estimated cost of road treatment by HU is summarized in Attachment 4.

TABLE I-16: Illustrative unit and project costs for road-related erosion control (San Mate County, CA)

Cost element		Unit cost ($/hr)	Time commitment (hours)			Total costs ($)
			Treatment	Logistics	Total	
Moving expenses	Excavator	110	3	0	3	330
	Dozer	85	3	0	3	255
Equipment for site treatment	Excavator	135	18	5	23	3,105
	Dozer	95	47	14	61	5,795
Equipment for drainage sites	Bobcat	95	124	37	161	15,295
	Dozer	95	3	1	4	380
	Bobcat	95	27	8	35	3,325
Laborers		35	1,142	343	1485	51,975
Foot bridges						6,000
Culvert materials						155
Rocks						1,320
Mulch etc.						275
Planning etc.						29,100
Total						117,310

Source: Pacific Watershed Associates (2003b).
Total project covers 6.5 miles of road; unit cost is $18,000 per mile.

36 In practice, the percentage of roads that will be treated will depend on the threshold level of sediment delivery that is used to define sites as treatment-worthy. This threshold can vary from 20 to 50 cubic yards (Weaver 2002). No guidance is given by the Recovery Strategy as to what the threshold will be for the purposes of coho salmon recovery.

The Recovery Strategy proposes the adoption of best management practices in new road construction. This may entail increased costs for both the public and private sectors. For example, this may require constructing more rolling dips when new roads are created than might otherwise have been the case. However, these increased up-front costs may be off-set to some degree be reduced ongoing maintenance costs. Because information is not currently available on the amount of roads that will be built over the next 25 years by HSA, the cost of these road-related recovery actions cannot be quantified at this time.

I.6.1.2 Road Decommissioning

Modern road decommissioning is a form of reverse road construction that is generally appropriate for only a portion of a road inventory slated for sediment reduction treatment. On average, about 10 to 20 percent of a problem road network will require decommissioning (Pacific Watershed Associates 2003).

Table I-17 summarizes estimates of the unit costs of typical road decommissioning activities gathered by the Environmental Protection Agency. Similar costs for ripping and decompaction are reported by Weaver (2002). While these numbers are instructive, a review of actual road decommissioning projects undertaken by Harr and Nichols (1993) suggests that decommissioning costs per mile depend crucially on whether waterbars must be constructed, and the extent of tree removal that must be undertaken prior to excavation. Harr and Nichols's widely cited findings are summarized in Table I-18. In current dollars, the results of their survey suggest that road decommissioning costs can vary from about $3,400 per mile to about $9,000 per mile. Labor requirements per mile also vary widely depending on the difficulty of the tree removal task.

Coffin (2000)-1[37] reviewed the cost of road decommissioning in the Gifford-Pinchot National Forest. He found that costs range from about $3,000 per mile to $23,000 per mile and average about $10,000 per mile. Mobilization costs, including permitting are more stable, about $4,000 per project regardless of project size. As Coffin emphasizes, since mobilization costs include permitting, these costs depend on who owns the land where the road to be decommissioned is found. Environmental permitting may be less expensive on non-Federal lands.

To calculate the cost of road decommissioning, the assumption was made that the per-mile cost will be consistent with the findings of both Harr and Nichols (1993) and Coffin (2000). The assumptions were made that the unit cost of road decommissioning is $9,000 per mile and that labor costs represent about 40 percent of total costs, just as they do in the road treatment aggre-

TABLE I-17: Illustrative unit costs for road decommissioning activities

Treatment method	Cost ($/mile)
Ripping/ scarification	
Ripping with D7 or D8 tractor	700
Scarification with D8-mounted brush blade	1,100
Scarification to 6-inch depth and installation of water bars with track hoe	2,100
Ripping and slash scattering with track hoe	600-800
Ripping, slash scattering, and water bar installation with track hoe	1,000
Ripping with track hoe	300-500

Source: EPA Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (available: www.p2pays.org/ref/04/03686/index-3.html). Cost estimates converted to 2000 dollars using price index developed by Summers and Heston (2003) and rounded to nearest 100 dollars.

37 Coffin, B. 2000. Estimating costs of road decommissions, In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

TABLE I-18: Illustrative project costs for road decommissioning

Project number	Description of road treatment required	Length of segment (mile)	Time required (hours)	Cost ($)	Cost ($/mile)
1	Minimal removal of small trees, pre-existing water-bars	7	232	23,700	3,400
2	Extensive clearing of large trees	1.6	135	14,000	8,800
3	Extensive clearing, pulling sidecase, constructing sidebars	0.8	77	7,300	9,200

Source: Harr and Nichols (1993). Authors' conversion to 2000 dollars using price index developed by Summers and Heston (2003) and rounded to nearest 100 dollars.
Decommissioning of 11 road segments in Canyon Creek, Washington in 1987-88.
Case (3) is an average of four different projects.

gate cost calculation. Mobilization/permitting costs total about $3,000 (slightly lower than the mobilization cost estimates provided by Coffin because most roads in the California range of coho salmon are on non-Federal land). Non-permitting costs are assumed to vary by HSA according to local construction wages. Mobilization/permitting costs are assumed to be constant across HSAs.

The Department has provided information about the approximate amount of road miles that will need treatment or decommissioning in the Cape Mendocino, Eel River, Eureka Plain, Klamath River, Mad River, Redwood Creek, Rogue River, Smith River, Trinidad, Trinity River, and Winchuck River HUs. In these HUs, the assumption was made that 15 percent of these road miles will ultimately require decommissioning. The assumption was made that the distribution of these road miles among the HSAs in these HUs is approximately equal to the distribution of USGS Class 4 (unpaved or unimproved) roads in rural forest regions. For other HUs, road miles requiring treatment were provided at the HSA level. The estimated cost of road treatment by HU is summarized in Attachment 4.

I.6.2 SOCIOECONOMIC IMPACTS

As discussed in section I.6.1, review of historical road treatment and decommissioning projects makes it possible to estimate the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of road treatment and decommissioning has been calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 4.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

Limiting the use of certain roads in the winter or relocating roads imposes economic costs and more time and fuel must be spent to reach desired destinations. Given the limited data available on roads in general, and the lack of identification of which roads would in practice have access limited, it is impossible to quantify the cost of this road-related recovery recommendation.

I.7 RESTORING WETLANDS AND OFF-CHANNEL AREAS

I.7.1 FISCAL COSTS

In a limited number of HUs/HSAs wetlands restoration is mentioned as a recommended recovery activity. The unit costs of common wetlands restoration activities, as calculated by USDA for California, are summarized in Table I-19. As this table suggests, many of the activities that fall under the category of wetlands restoration are also common to the other categories of restoration activities considered in this document. For example, USDA considers culvert replacement, fencing, and critical area planting to be activities that may be undertaken as part of wetlands restoration. Because the quantities of these activities that will be undertaken in any given HSA are not generally known, the aggregate cost of wetlands restoration has not been calculated as an activity that is distinct from other, related recovery recommendations.

I.7.2 SOCIOECONOMIC IMPACTS

The analysis of the socioeconomic impacts of wetlands restoration is similar to that for riparian revegetation and conservation easements.

I.8 WATER ACQUISITIONS

Water markets are an increasingly important means of allocating scarce water supplies in California. Additionally, they have become a prime tool used by government agencies to enhance instream flows. Hanak (2003) shows that environmental water purchases by the State and Federal governments now account for the largest and fastest-growing share of water transfers in California.

Environmental water transfers can take a variety of forms. The most common is an intrayear or "spot" transaction where the landowner sells all or a fraction of his entitlement to the agency. The transaction is for one year only and there is no change underlying water rights. Typically, farmers fallow their land under such an arrangement to reduce consumptive use, but other arrangements are possible (such as a shift to groundwater pumping) when environmental conditions allow. Other potential arrangements include long-term or permanent transfers involving a reduction in the agricultural base, and intermittent or "options" transfers where there is a long-term contract between the landowners and the agency but the water is transferred only under certain conditions.

TABLE I-19: Construction unit costs for wetlands restoration activities in California

Activity	Units	Unit cost ($)
Arch culverts	Diameter-LF/LF	32.8
Concrete, Non-Structural Non-Reinforced	CY	150
Concrete, Non-Structural Reinforced	CY	250
Critical Area Planting	AC	1000
Deleveling	AC	300
Earthwork excavation normal	CY	1.5
Fence	LF	4
Mobilization	Each	1250
Riparian Herbaceous Cover	AC	500

Source: USDA EQIP Program (2002) http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

The price at which water is sold on environmental water markets is determined by negotiations between landowners and the purchasing entity. Because the transfer is voluntary, the lowest price at which a farmer will sell is called the "reservation price" and is equal to the net operating income (or revenue minus variable costs) earned per unit sold. As a rough rule of thumb, the methods used by BOR and the California Department of Water Resources were followed and the assumption was made that the market price of water is 50 percent greater than the reservation price.

The Recovery Strategy includes the recommendation of land acquisition and/or water rights acquisition in several HSAs. In practice, water rights acquisition functions very similar to land acquisition. In agricultural areas where farmed land is irrigated, loss of water rights generally means in practice that land formerly irrigated with this water will be left fallow. The seller of water rights forgoes the agricultural profits that would have been gained in the event that the water had been used for irrigation. However, as previously noted, other arrangements are possible (such as a shift to groundwater pumping) when environmental conditions allow.

I.8.1 FISCAL COST

In circumstances where potential sellers of water rights do not shift to groundwater pumping or make other arrangements such that agricultural lands are not left fallow, potential sellers of water rights may forgo the agricultural profits they would have gained from irrigating. In these circumstances, the annual cost of an acre-foot of water in a particular HSA can be predicted to be equal to the net agricultural returns (gross returns less operating costs) that water would have created.

By combining data on acre-feet of irrigation water per acre used in a particular HSA with information about net agricultural returns per acre, the price of an acre-foot of water can be estimated. Agricultural census data on irrigated pasture and crop land by county and county-level data on irrigated water withdrawals for pasture and crops provided by USGS were used to calculate acre-feet of water per acre of pasture and crops planted by county. Farm operating costs and gross agricultural returns per acre for pasture and typical crops were provided by U.C. Extension's current cost and return studies. The calculation takes the form:

$$(G_{it} / acre_{it} - C_{it} / acre_{it})*acre_{it} / W_{it} = P_{it} / W_{it} \qquad (1)$$

where, for crop *i* (*i* = pasture, crops) in county *t*, *G* is gross agricultural returns, *C* is agricultural operating costs, *W* is acre-feet of water used, and *P* is the price of water, measured in dollars. The variable acre measures acres planted in crop i in county t. The equation is solved for P_{it} / W_{it}, which is the minimum payment that would be made for water acquisitions. The actual values of these parameters are presented in Attachment 5. As discussed above, the assumption was made that prices paid for water acquisitions in practice will be $1.5^* P_{it} / W_{it}$.

The aggregate fiscal cost of water acquisition and agricultural land acquisition will depend on the quantity of water and/or land to be acquired and whether water rights will be permanently transferred or purchased for single periods. The marginal cost of annual water rights acquisition is summarized in Figure I-1. The curve is non-linear because costs increase sharply when acquisition of irrigation water for pasture is complete and increasingly high value cropland (e.g., winegrapes, broccoli) is left fallow.

I.8.2 SOCIOECONOMIC IMPACTS

Taking agricultural land out of production so that more water is available for coho salmon recovery has a socioeconomic cost because land that once provided private income no longer does so. Conceptually, when agricultural land formerly harvested is left fallow because irrigation water

FIGURE I-1: Marginal cost of annual water rights acquisition

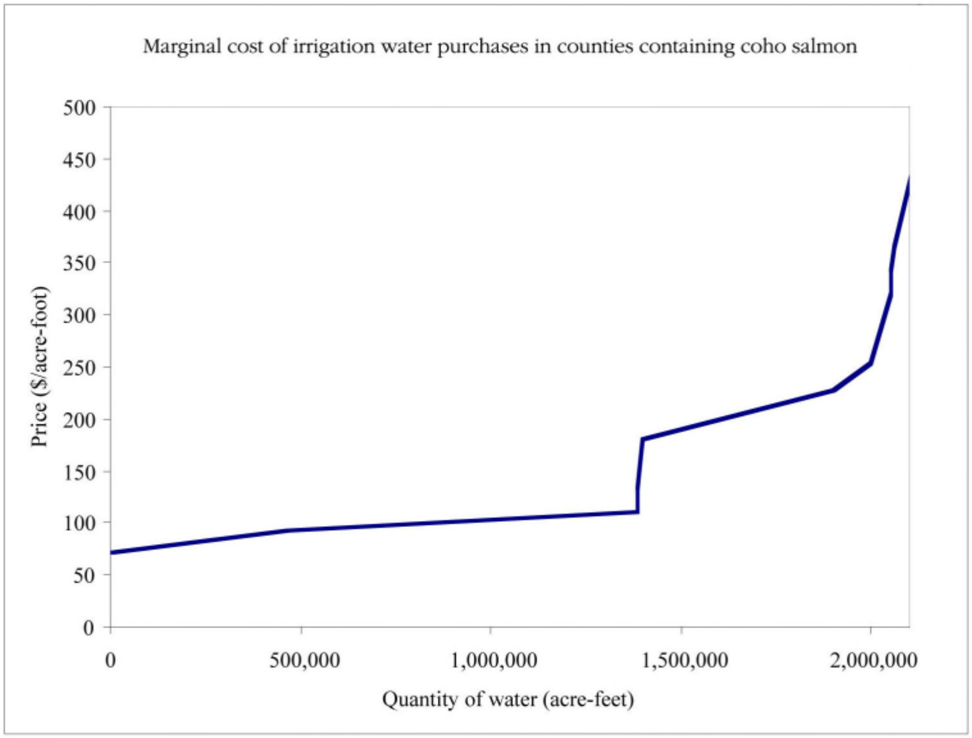
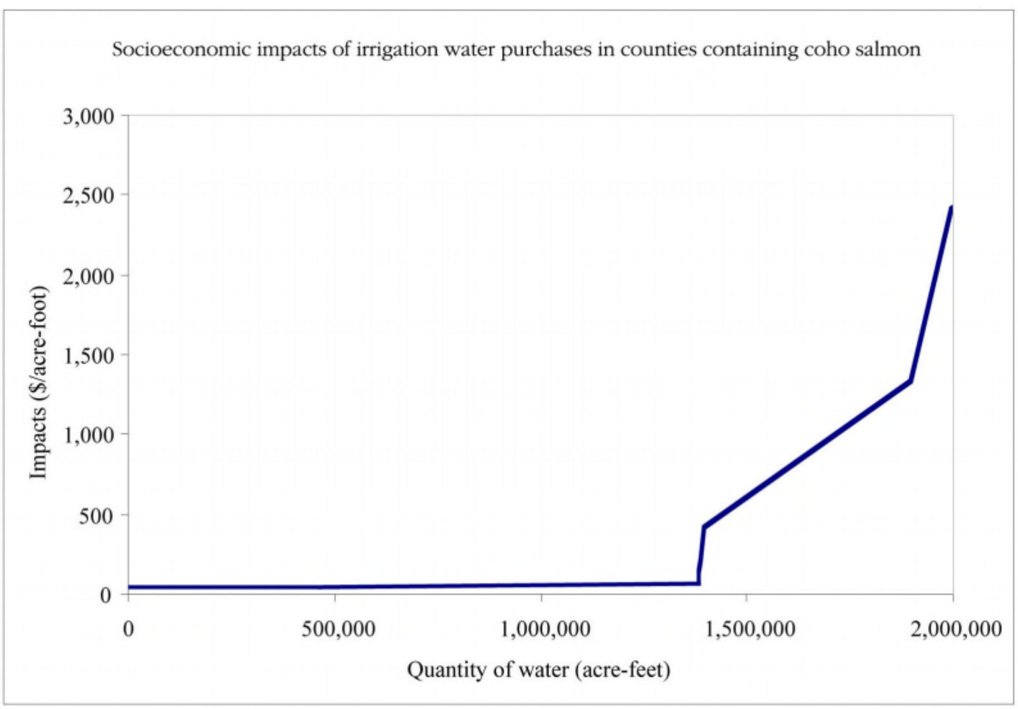


FIGURE I-2: Socioeconomic impacts of water rights acquisition



has been transferred to serving the needs of coho salmon, the farmer that sold the water right has neither lost nor gained income. She has received at least the same profit from the sale of water that she would have if the relevant parcel of land had been planted. However, the laborers that worked this land and the firms that sold the farmer inputs for this land have not been made whole. Their lost income, equal to the farmer's operating costs in the event that she had planted and harvested the parcel of land, are the socioeconomic cost of this recovery action.

Assuming that water is acquired at the lowest possible fiscal cost, it is possible to calculate and graph the socioeconomic cost of water rights acquisitions, per acre-foot of water purchased, that is implied by the price schedule shown in Figure I-1. The socioeconomic cost can be calculated with an equation similar to equation 1, which takes the form:

$$(C_{it} / acre_{it})*acre_{it} / W_{it} = SE_{it} / W_{it} \qquad (2)$$

All variables are defined as above, except the equation now calculates the socioeconomic cost, SE, of water rights acquisitions. This equation was solved for SE_{it} / W_{it}. The socioeconomic impacts of water purchases are shown in Figure I-2. Impacts are fairly low until quantity purchased exceeds 1.4 million acre feet.

I.9 BIOLOGICAL STUDIES

I.9.1 FISCAL COSTS

The Recovery Strategy recommends a range of technical studies from monitoring efforts to genetic analyses. A review of the Department's inventory of restoration activities suggests that individual monitoring projects can be expected to cost about $160,000 on average. Projects that include surveying and other research efforts that the Department has funded or partially funded have cost about $176,000 on average. These historical averages were used to estimate the cost of recovery recommendations that are technical monitoring or biological research activities.

There are about 30 recovery recommendations that recommend biological or technical scientific studies. The cost of recovery recommendations that are biological studies have been estimated to be about $7 million.[38] These costs are not discounted because this class of recovery action is generally assumed to be an interim action, occurring in the near future.

There are about 10 recovery recommendations that are clearly identifiable as monitoring efforts. The annual cost of the cost of the monitoring efforts is estimated to be about $1.4 million on the basis of the historical project costs described above. Assuming that the same amount will be spent each year on each monitoring effort, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $24 million.[39]

I.9.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

38 For five of these recommendations, the Department has identified more precise costs estimates. These are BM-WA-04, BM-WA-07 KR-HU-05, KR-SV-03, and BB-SL-03. These are estimated to cost $500,000, $500,000, $1.5 million, $600,000, and $200,000 respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

39 For three of these recommendations, the Department has identified more precise costs estimates. These are KR-KG-18, SR-HU-17, and KR-HU-18. These are estimated to cost $200,000 $30,000, and $30,000 per year respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

I.10 WATERSHED PLANNING AND OTHER NON-BIOLOGICAL STUDIES

I.10.1 FISCAL COSTS

As mentioned throughout this section, many recommendations for specific recovery recommendations are accompanied by a recommendation that planning and prioritization efforts precede implementation. Planning recommendations may call for broad watershed planning, or more targeted exercises such as barriers or road inventories.

The Department has supplied a database that summarizes all recovery efforts that it has currently or partially funded for anadromous salmonids in the recent past. This includes approximately 60 planning efforts, for a wide variety of purposes. The average cost of these planning exercises (excluding a major coast-wide effort led by the Department itself and two very small projects that appear to be either mis-characterized or anomalous) is about $186,000. Costs of planning efforts can vary widely; even excluding the outliers mentioned above, the Department's records include efforts that cost as little as $10,000 and those that cost over $1,000,000 in total. As an initial means of estimating the cost of planning activities, the conservative assumption that each planning recovery action will cost about $200,000 was made. There are about 63 recovery recommendations that are non-biological studies or planning exercises. This implies that the total cost of this class of recovery recommendations is estimated to be about $13 million.[40] These costs do not vary systematically across HSAs.

The assessment of barriers to passage as a cost associated with treating barriers was included in that category, and not a cost that is part of this class of recovery recommendations. Assessing barriers to passage is assumed to cost about $20,000 per HSA.

I.10.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

I.11 EDUCATION AND OUTREACH

I.11.1 FISCAL COSTS

In many different contexts and HSAs, the Recovery Strategy recommends performing education and outreach (including efforts to increase or improve inter-agency coordination) regarding salmon recovery and habitat restoration. While estimating the cost of any particular education effort would be difficult, it is possible to predict the average unit costs of education and outreach efforts.

The Department has supplied a database that summarizes all recovery efforts that it has currently or partially funded for anadromous salmonids in the recent past. This includes information about 200 education and outreach programs. The average cost of an education or outreach activity is about $67,000 according to this database. Costs are slightly lower, about $49,000 per program, when programs specifically concern coho salmon, as opposed to other anadromous salmonids.

On the basis of this survey, the economists assumed that the annual cost of education and outreach programs regarding coho salmon recovery and habitat restoration will be about

[40] For four of these recommendations, the Department has identified more precise costs estimates. These are BB-HU-06, BB-HU-03, ER-OC-01, and BB-AP-02. These are estimated to cost $400,000 $250,000, $250,000, and $300,000 respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

$60,000, and, as recommended by the Recovery Strategy, about 61 education programs (including technical assistance efforts) will be undertaken.[41]

Assuming that an equal amount will be spent each year on each education and outreach program, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $31 million.

I.11.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

I.12 HSA/HU SPECIFIC RECOMMENDATIONS

In the Recovery Strategy there are about 20 recommendations that address specific concerns in individual HSAs. In consultation with the Department, the economists have identified estimates of the cost of each of these activities.[42] These recommendations and cost estimates are summarized in Table I-20. Where possible, these cost estimates have been included in the estimates of aggregate costs.

TABLE I-20: HSA/HU-specific[1] recommendations for which costs are implemented individually

Number	Recommendation	Estimated cost ($)
KR-HU-19	Restore appropriate coarse sediment supply and transport near Iron Gate Dam. Means to achieve this could include full or partial removal of the Klamath River Project, or gravel introduction such as is done below other major dams (e.g., Trinity Dam).	500,000,000
KR-KG-22	Encourage cooperation between industrial timber land managers and tribes to restore coho salmon habitat. Use the successful Tribal/Simpson Resource Company program as an example.	none
KR-KG-26	Continue funding and technical support for the California Conservation Corps to continue their collaborative participation with the Yurok Tribe and Simpson Resource Company to implement watershed restoration throughout the lower Klamath subbasin.	1,100,000 per year
TR-HU-01	Implement the Trinity River Record of Decision (ROD). See Chapter 9 in the Recovery Strategy for the full text of the recommendation.	12,000,000 per year
EP-HU-03	Acknowledge the Arcata City Sewage Treatment Project and encourage implementation of similar projects elsewhere where possible.	none
EP-HU-11	Maintain and protect channel conditions important for all life stages of coho salmon.	14,180,000

(continued)

41 For a limited number of recommendations, the Department has supplied more precise cost estimates. These are recommendations BM-WA-02, BM-LA-11, BM-LA-12, BM-HU-02, and ER-HU-01 which are estimated to cost $50,000, $50,000, $50,000, $20,000 and $500,000 respectively. Aggregate cost estimates reflect these figures.

42 There were some recommendations for which costs cannot be assigned. These recommendations (e.g., beaver investigations; water drafting for fire suppression, expressions of encouragement) are too vague to assign costs to at this time.

TABLE I-20: HSA/HU-specific[1] recommendations for which costs are implemented individually (continued)

Number	Recommendation	Estimated cost ($)
EP-HU-12	Restore channel conditions important for all life stages of coho salmon.	Included in costs for EP-HU-11
MC-GA-06	Utilize as a model for erosion reduction and LWD placement the comprehensive approach practiced in the South Fork of the Garcia River.	none
MC-GA-08	Maintain Hathaway Creek, North Fork Garcia, Rolling Brook, Mill Creek (lower Garcia River), South Fork Garcia, Signal, Mill Creek (upper Garcia River) to continue to provide coldwater input to the mainstem Garcia.	none
MC-GA-12	Excavate a geomorphically designed channel in the lower North Fork Garcia to rectify subsurface flow during summer months and prevent coho salmon stranding.	25,000
RR-HU-09	Implement Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties.	60,000
RR-HU-11	Stock first priority barren streams, including Felta and Mill Creeks (tributary to Dry Creek west of Healdsburg); Freezeout, Willow and Sheephouse creeks (near Duncan Mills); and Ward Creek (tributary to Austin Creek). Identify additional streams that may be suitable for stocking as restoration occurs.	1,000,000
RR-HU-26	Review and, if appropriate, approve Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Operations and Maintenance (FishNet 4C 2004).	200,000 per year, per county
RR-GU-05	Stock Willow, Sheephouse, Freezeout, Dutchbill, and Green Valley creeks as part of the coho salmon broodstock program.	1,500,000
RR-AC-05	Stock high priority barren streams, including Ward Creek, with the coho salmon broodstock program.	1,500,000
RR-WS-07	Stock high priority barren streams, such as Mill and Felta creeks, as part of the coho salmon broodstock program.	1,500,000
BM-WA-04	Implement high priority coho salmon enhancement projects for the reduction of sediment delivery and the restoration of riparian corridors as listed in the Walker Creek Enhancement Plan (2001).	500,000
BM-BO-02	Continue restoration efforts on Bolinas and Big lagoons to benefit coho salmon during all life phases and seasons.	7,000,000
BB-HU-01	Continue to operate MBSTP Kingfisher Flat Hatchery as a conservation hatchery, following the guidelines of the Department and NOAA Fisheries.	40,000 per year
BB-HU-08	Develop a lagoon management plan that addresses the needs of coho salmon.	400,000 per county

Note:

1. The recommendations are listed in the order they appear in Chapter 9 of the Recovery Strategy.

Source: DFG.

I.13 TIMBERLAND MANAGEMENT

Three alternative sets of recommendations were developed for timberland management in areas with coho salmon. One alternative, Alternative A, was presented to the CRT by petitioner members of that team. The second and third alternatives, Alternative B and Alternative C, were developed by the Department, in part, from a recommendation that was presented to the CRT by forest landowner representatives of that team (specifically sections 1-10 of these alternatives).

This section measures the cost to forest landowners or companies from implementing these various alternatives. This is an implicit calculation of fiscal cost to companies of implementing these alternatives. Results are developed and expressed in a manner consistent with the rest of the document. First, each alternative was separated into its components with the most potential to change resource allocation. Next, for each recovery action the per-acre cost of effecting the change was calculated. Then, this per-acre cost was multiplied by the number of acres affected by the Recovery Strategy to obtain the total cost. At this stage, there are insufficient data to calculate socioeconomic costs of implementing these alternatives.

While there are at present three alternatives, we calculate costs for Alternatives A and B. There are few incremental costs associated with Alternative C. The total cost of implementation depends on what is included in the Recovery Strategy for timber management.

I.13.1 ALTERNATIVE RECOMMENDATIONS

Discussions of Alternatives A, B, and C are provided in this section.

I.13.1.1 Alternative A

Alternative A could be implemented in two different ways. The Commission could approve this alternative for inclusion in the strategy as: (1) guidelines (pursuant to FGC §2112) for issuance of Incidental Take Permits under FGC §2081(b) or consistency determinations under FGC §2080.1 where these recommended measures would fully mitigate take and at the same time contribute to the recovery of coho salmon. The effect of this would be to streamline the permitting process as an incentive for recovery. In accordance with FGC §2114, the guidelines would be part of the Commission's rulemaking for listing; or (2) a recommendation to the California Board of Forestry and Fire Protection (BOF) to implement it through a rulemaking proceeding to establish regulations that ensure that timber operations are consistent with the long-term survival of coho salmon.

The most expensive component of Alternative A is the restriction on timber companies to operate on unpaved roads in the wet season. In particular, "use of any unpaved road segments within or appurtenant to a timber harvest plan area shall cease when any of the following occur: (a) precipitation is sufficient to generate overland flow off the road surface; or (b) use of any portion of the road results in rutting of the road surface. Road use shall not resume until the road is dry. "Dry" is defined as a road surface that is well drained; and is not rutting, discharging fine sediments, or causing a visible turbidity increase in a ditch or on a road surface that drains into a Class I, II, or III watercourse. Access for road inspection and access to correct emergency situation shall be allowed at any time by a vehicles rated one ton or less." This restriction presents significant operational difficulties. Working with data from The Pacific Lumber Company (PALCO), it is estimated that the road restrictions alone could decrease the per-acre value of timberland by 5 to 10 percent.

Large per-acre impacts are also associated with the requirement in Alternative A that landowners retain the 10 largest trees along Class I watercourses. The requirement specifies that "recruitment of LWD to Class I watercourses shall be ensured by retaining the ten largest diameter confers (live or dead), on each side of the watercourse, per 330 feet of stream length, within 50 feet of the watercourse or lake transition line." This requirement will have minimal impact in some cases, but a major impact in others. PALCO data suggest that per-acre impacts range anywhere from 5 to 85 percent of value. Since Class I watercourses comprise only 3 percent of PALCO land, the diminished value across all ownership (a weighted value) is from 0.2 to 2.6 percent.

With regard to Class II watercourses, Alternative A provides that "at least 85 percent overstory canopy shall be retained within 50 feet of the watercourse or lake transition line. In an additional outer zone, overstory canopy closure shall be at least 65 percent. The overstory canopy in each zone shall be composed of at least 25 percent overstory conifer canopy post-harvest. The outer zone shall be 25 feet in width where side slope class is 30 to 50 percent. The outer zone shall be 75 feet in width where the slope class is greater than 50 percent. While attaining the canopy retention standards described in section 2.a.(5), recruitment of LWD to Class II watercourses shall be ensured by retain the five largest conifers (dead or alive) on each side of the watercourse per 330 feet of stream channel length, within 50 feet of the watercourse of lake transition line."

These requirements are estimated to reduce timber harvest in affected areas by 35 percent, resulting in a similar loss in per-acre value. In the case of PALCO, 4 percent of total ownership is of this type, implying a weighted loss in value of between 1.0 and 1.4 percent.

"Inner gorge" requirements on Class I and II watercourses are also relatively expensive. Alternative A envisions that "where an inner gorge extends beyond a Class II WLPZ and slopes are greater than 55 percent, a special management zone shall be established beyond the WLPZ where the use of even aged regeneration methods is prohibited. This zone shall extend upslope to the first major break in slope (i.e., where the slope is less than 55 percent for a distance of 100 feet or more) or 200 feet as measured from the watercourse of lake transition line, whichever is less. Within this zone, methods and retention standards shall be as described in 14 CCR §§913.2, 933.2, and 953.2."

The provision on even-age regeneration is forecasted to reduce harvest volumes by 50 percent in these areas, which account for 4 percent of PALCO lands. The implied diminution in value across all acres is between 1.6 and 2 percent.

Finally, Alternative A requires a 25-foot "protection zone" on each side of Class III watercourses for "slopes less than 30 percent and at least a 50-foot protection zone on each side of the watercourse for slopes greater than 30 percent. Retain all trees situated within the channel zone (i.e., bank-full channel) and trees that have boles that overlap the edge of the bank-full channel. Within the protection zones at least 50 percent of the understory vegetation shall be left post-harvest in an evenly distributed condition. All regeneration conifers, snags, LWD, and hardwoods shall be retained within the Class III protection zones except removal as necessary for yarding and crossings. Commercial timber operations will be allowed to "yard through" a Class III riparian management zone. Burning for purposes of site preparation shall not be initiated in the protection zones."

This provision is anticipated to have a relatively minor impact on timberland values. PALCO estimates a loss in value of between 0 and 5 percent per acre. Affected lands comprise roughly 18 percent of their total ownership, with the result that the diminished value across all lands is between 0.0 and 0.9 percent.

Taking these five main components of Alternative A together, it is estimated that the total percentage reduction in timberland value is between 7.8 and 16.9 percent.

I.13.1.2 Alternative B

There are two ways in which certain sections of Alternative B could be implemented. The Commission could approve Section 17 and 18 for inclusion in the strategy as a recommendation to the California Department of Forestry and Fire Protection (CDF) and the Department to improve within existing law and authorities the implementation and enforcement of the Forest Practices Rules to ensure that timber operations are consistent with recovery of coho salmon. If existing law and authorities are found to be inadequate to provide for such improvements, then the Commission could alternately recommend that the Department and/or CDF seek legislation to provide such authority. This means that CDF would support the Department in the Timber Harvest Plan (THP) review process if the Department determined that any of these measures, as determined on a site-specific basis should be applied to protect coho salmon. Alternatively, the Commission could approve Sections 16, 17, and 18 together as guidelines (pursuant to FGC §2112) for issuance of Incidental Take Permits under FGC §2081(b) or consistency determinations under FGC §2080.1 where these recommended measures would fully mitigate take and at the same time contribute to the recovery of coho salmon. The effect of this would be to streamline the permitting process as an incentive for recovery. In accordance with FGC §2114, the guidelines would be part of the Commission's rulemaking for listing.

The main cost difference between Alternatives B and A is that the cost of the road restrictions is much lower in the former. Alternative B requires only that "for construction, reconstruction, upgrades, maintenance, and operation of roads within and appurtenant to THPs detailed site specific recommendations will be developed consistent with the Handbook for Forest and Ranch Roads (prepared by Pacific Watershed Associates, 1994c, for the Mendocino County Resource Conservation District in cooperation with CDF and the U.S. Soil Conservation Service. Mendocino Resource Conservation District, Ukiah, California. 163 pages)." It is difficult to quantify the costs of this action item as it does not entail specific changes, and since many companies already follow these practices. Thus, while the road restrictions in Alternative B may well impose costs for some operations and at some locations, they are not quantified in this document.

Several aspects of Alternative B are identical to Alternative A. These include the requirement for Class I, II and III watercourses described above. One difference is for watercourses where an inner gorge is present. For Class II only, Alternative B requires that the landowner (1) provide 200' Watercourse and Lake Protection Zones (WLPZ); (2) require uneven-aged management; (3) prohibit tractor operations; and (4) require review of timber operations by a registered geologist. The cost of the "inner gorge" requirements is a loss in per-acre value of between 40 and 50 percent since even-age regeneration is still prohibited, but as opposed to Alternative A the loss applies only to Class II watercourses. The weighted average value of timberland is reduced between 1.2 and 1.5 percent.

One requirement that is contained in Alternative B and not Alternative A is that where a headwall swale is present, (1) utilize only single-tree selection prescriptions as per 14 CCR §913.2(a)(2)(A) that retain the diameter distribution present before timber operations or a "thinning from below" prescription as per 14 CCR §913.3(a) that retains dominant and codominant trees; and (2) require review of timber operations by a certified engineering geologist. This requirement will also prohibit even-age regeneration, resulting in a loss in land values of between 40 and 50 percent where it applies. PALCO estimates that 1 percent of its land would be affected by this provision, so that the weighted average loss in value from this provision is between 0.4 and 0.5 percent.

Taken together, Alternative B is estimated to reduce timberland values by 2.8 to 6.9 percent. The difference between the cost of this alternative and the cost of Alternative A is explained by the looser restrictions in road usage, construction and maintenance in the latter.

Using the calculated figures for percentage diminution in timberland value, it is possible to obtain a rough measure of the costs of the two alternatives. The percentage diminution in value should be applied to the value of timber harvesting rights per acre to obtain per-acre costs. Based on the advice of PALCO, we assume that the rights to harvest timber throughout the range of coho salmon habitat is valued at about $1,400 per acre on average. It follows that Alternative A amounts to a diminution in value of between $109 and $237 per acre. Alternative B will reduce values by between $39 and $97 per acre.

Since the publication of the November 2003 Public Review Draft of the Recovery Strategy new recommendations were added to Alternative B by the Department in response to public comments. Two of these recommendations require some discussion. The Department recommends in Section 19 that a "proof of concept" pilot program be developed and implemented to test a mathematical or scientific method of cumulative effects analysis as was suggested in the 2001 report, *A Scientific Basis for the Prediction of Cumulative Watershed Effects*, (otherwise known as the "Dunne Report"), by the U.C. Committee on Cumulative Watershed Effects. The pilot program would be developed and implemented by a panel of experts such as those at the University of California in cooperation with the Department, CDF, and the State Water Resources Control Board. The cost of this recommendation is approximately $900,000. In addition, the Department recommends in Section 17.b that "For Class I watercourses, within the watercourse and lake protection zone retain trees that provide direct shading to pools, consistent with the conifer retention standards in the Threatened and Impaired Watershed Rules." In discussions with PALCO and experts at the Department, it has been estimated that the impact of this additional recommendation will be negligible. In light of this minimal cost increase, the estimated total cost of implementing Alternative B has not been changed as a result of this additional recommendation. The limited impact of this additional recommendation is largely a result of the limited range of its impact; few THPs are impacted and when they are impacted the measure would affect the harvest of at most ten trees per THP. In addition, the measure generally will not result in a diminution of board feet harvested; landowners and/or companies would be allowed to substitute harvest elsewhere for the affected trees. This may increase the total costs of harvest, but not by a significant amount.

Data from CDF indicate that there are 3.84 million acres of privately owned timberland throughout the range of coho salmon habitat. Taking this acreage of Timberland Production Zones and multiplying by the weighted average per acre diminution in value, it follows that the cost of Alternative A is between $419 and $910 million. The cost of Alternative B is lower, and is estimated to fall between $151 and $373 million. These are present value calculations consistent with other fiscal cost estimates detailed in this report.

I.13.1.3 Alternative C

Alternative C does not involve incremental costs above those estimated in other sections of this report. This alternative calls for implementation of road management plans, which may imply that costs will be incurred for decommissioning or treatment of roads, treatment of watercourse crossings, riparian revegetation, watershed planning, education, and monitoring of recovery measures. We have estimated the costs of these actions in other sections of the economic report.

To illustrate which previously estimated costs include those associated with Alternative C, we took the following steps: First, HSAs with at least 75 percent of land cover in forest were identified. Second, HUs containing these HSAs were identified. Third, the estimated costs of road treatment, road decommissioning, riparian revegetation, and treatment of stream crossings in those HUs were identified. These estimated costs are summarized in Table I-21. Again, these are not new costs, but elements of previously estimated costs that include those associated with Alternative C. The total amount of these costs, excluding planning, education, and monitoring, is about $1.7 billion.

This report discusses previously that that total cost of watershed planning recommendations in the Recovery Strategy is estimated to be about $13 million.

TABLE I-21: Previously estimated costs of elements of recovery strategy which include those associated with Alternate C

HU	Road decommissioning ($)	Road treatment ($)	Riparian revegetation ($)	Stream crossings treatment ($)	Total cost of Alternative C by HU
EEL RIVER	126,822,230	190,777,692	29,858,170	11,293,206	358,751,299
KLAMATH RIVER	93,259,127	140,391,013	18,721,487	18,220,276	270,591,903
MAD RIVER	2,943,269	2,866,960	2,145,205	1,604,953	9,560,386
MENDOCINO COAST	13,291,428	133,158,247	743,507	284,571,592	431,764,775
REDWOOD CREEK	4,002,911	3,082,316	3,411,259	277,914	10,774,400
ROGUE RIVER	2,700,007	4,064,554	-	41,687	6,806,248
RUSSIAN RIVER	10,540,518	105,465,802	528,450	27,589,621	144,124,391
SAN MATEO	1,593,896	15,858,272	123,562	995,513	18,571,243
SMITH RIVER	31,529,016	47,463,350	2,468,586	3,831,737	85,292,690
TRINIDAD	8,089,361	12,177,614	103,304	548,880	20,919,159
TRINITY RIVER	124,142,457	186,882,354	3,241,052	13,791,476	328,057,338
WINCHUCK RIVER	935,637	1,408,495	35,989	138,957	2,519,078
Total cost	419,849,858	843,596,668	61,380,573	362,905,812	1,687,732,911

Assuming that an equal amount will be spent each year on education and outreach, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $31 million.

There are about 30 recovery recommendations concerning biological or technical scientific studies. We estimate that the cost of recovery recommendations that are biological studies will be about $7 million. These costs are not discounted because this class of recovery action is generally assumed to be an interim action, occurring in the near future.

There are about 10 recovery recommendations that are clearly identifiable as monitoring efforts. The annual cost of the monitoring efforts is estimated to be about $1.4 million on the basis of the historical project costs described above. Assuming that the same amount will be spent each year on each monitoring effort, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $24 million.

I.13.2 SOCIOECONOMIC IMPACTS

Socioeconomic impacts associated with this class of recovery recommendations can be partially quantified at this time on the following basis. First, lost profit to the landowner is a negative socioeconomic impact. Second, there will be lost jobs as a result of implementing either Alternative A or Alternative B. There are few incremental impacts associated with Alternative C. If either Alternative A or Alternative B is implemented as incidental take permitting guidelines then some or all of the socioeconomic impacts calculated here would be attributable to listing.

To estimate employment and payroll effects, we assume that there are 6.4 jobs in logging and sawmilling per million board feet of timber harvest and an annual payroll of $30,000 per employee. These figures are based on an economic analysis of the proposed watershed rules announced by BOF on July 23, 1999 performed by Professor William McKillop of U.C. Berkeley. These figures suggest that lost payroll per million board feet of timber lost is equal to $192,000 annually.

It is estimated that the total percentage reduction in timberland value is between 7.8 and 16.9 percent for Alternative A. Assuming that lost board feet of timber harvest is proportional to lost land value, annual payroll losses associated with this alternative range from $15 million to $32 million. Assuming recovery over 25 years and a discount rate of three percent the estimated total payroll impacts of this class of recovery action is about $261-$557 million. Total measured socioeconomic impacts equal these payroll impacts plus lost profits and so range from $680 million to $1.46 billion.

It is estimated that the total percentage reduction in timberland value is between 2.8 and 6.9 percent for Alternative B. Assuming that lost board feet of timber harvest is proportional to lost land value, annual payroll losses associated with this alternative range from $5 million to $13 million. Assuming recovery over 25 years and a discount rate of three percent the estimated total payroll impacts of this class of recovery action is about $94 million to $226 million. Total measured socioeconomic impacts equal these payroll impacts plus lost profits and so range from $244 million to $598 million.

I.14 SHASTA-SCOTT PILOT PROGRAM

The methodology used to estimate the cost of implementing the Shasta-Scott Pilot Program (SSPP) is similar to the methodology used to estimate the cost of the general Recovery Strategy. However, using detailed information from the SSRT, cost estimates were developed for nearly every recovery recommendation.[43] These cost estimates are included in the SSPP document. This approach reflects the fact that the SSPP contains many recovery recommendations related to water management and acquisition that are not found in recommendations that apply throughout the range of the coho salmon in California. Table I-22 lists the categories of recovery recommendations identified in the SSPP and their fiscal cost and socioeconomic impacts. This subsection includes a discussion about how these cost estimates were developed.

TABLE I-22: Economic cost and impact of implementation of Shasta-Scott Pilot Program

Recovery action	Fiscal costs ($)	Socioeconomic impacts ($)
1 Water management	10,334,024	
2 Water augmentation	60,217,676	(6,143,359)
3 Habitat management and restoration		
• Barriers to passage	7,059,636	4,211,782
• Instream restoration	3,797,400	2,453,750
• Streamside restoration	324,610,877	152,567,375
• Road treatment	84,764	63,439
• Other habitat restoration	36,030,892	
4 Protection	1,244,789	
5 Water use efficiency	3,200,000	2,020,000
6 Monitoring and assessment	10,604,000	
7 Education and outreach	8,832,520	
Total	**466,016,578**	**155,172,987**

Source: Authors' calculations.

43 No cost estimates have been developed for P-6, P-7, WUE-6a, WUE-6b, and WUE-6c. These recommendations are too speculative or vague at this time to cost.

I.14.1 WATER MANAGEMENT

In close consultation with the SSRT, the economists estimated the cost of each individual recovery action related to water management. The total cost of this class of recovery action in the SSPP is estimated to be about $10 million. There are no significant socioeconomic impacts associated with this class of recovery recommendations.

I.14.2 WATER AUGMENTATION

An important category of recovery recommendation in the SSPP is water augmentation. To estimate the cost of this class of recovery recommendations, it has been necessary to make strong assumptions about (1) the extent to which instream flows will need to be augmented in the SSPP region for coho salmon recovery, and (2) the means by which this goal will be accomplished.

The Department and the SSRT have stated that, at this time, it is not possible to determine with certainty the amount of water that will be left in streams in the SSPP region for coho salmon recovery purposes. An estimate of the amount that will be needed has been made for the purposes of calculating the cost of implementing the Recovery Strategy, but neither the SSRT nor the Department endorses this number as a basis for policy action. Solely for the purposes of this illustrative calculation, it was assumed that instream flows in the SSPP region will be increased by 8,400 acre-feet per year.

The SSPP contains several recovery recommendations intended to result in increased instream flows for coho salmon. They include, but are not limited to, verifying compliance by water rights users, donation of unused water rights, substitution of groundwater for surface water for irrigation, and water acquisition. It cannot be known ex ante how much water will be procured for coho salmon through each of these strategies. To estimate the cost of securing instream flows for coho salmon, the SSRT has suggested that it is appropriate to assume that increased instream flows will be generated solely through the acquisition of water rights from willing sellers. This assumption is made only for the purposes of an illustrative calculation of the cost of coho salmon recovery and should not be taken as an endorsement of this approach to increasing instream flows in the SSPP region.

Using the assumptions about the amount of water to be acquired and the methods by which these flows are to assured, the cost of instream flows augmentation in the SSPP region was estimated using the methodology described in section I.8.1. The assumption was made that the price of an acre-foot of water will be about $100 per year. Since the SSPP specifies that a trust will be created with an endowment to be used for securing water rights, it is possible to estimate that, in present value, the cost of water augmentation in the SSPP region will be on the order of $60 million (assuming a 25-year recovery period and a 3 percent discount rate). The socioeconomic impacts associated with this acquisition of water for fish, in the form of lost jobs and other economic activity will be about $6 million in present value.

I.14.3 HABITAT MANAGEMENT AND RESTORATION

The cost of habitat management and restoration in the SSPP region was estimated using the methodology described in section I.2.1. The SSRT provided estimates of the amount of each habitat restoration activity that would be undertaken in the region for the purposes of coho salmon recovery. For other habitat management and restoration activities that do not fall into the categories listed in section I.11.1 (e.g., Scott HM-1-2c, Scott HM-2c, Scott HM-3c) specific cost estimates were developed in consultation with the SSRT. Every attempt has been made to ensure that the cost of monitoring and assessment and education and outreach activities identified as costs associated with habitat management and restoration are not double-counted in this accounting exercise. These costs are included as part of the monitoring and assessment and education and outreach activities for the purpose of developing the cost and impact estimates summarized in Table I-21.

I.14.4 PROTECTION

This class of recovery recommendations includes the development of best management practices. The assumption was made that it will cost about $60,000 to develop and disseminate (see section I.11.1 for a discussion of the development of this figure) and several recommendations for which costs cannot be estimated at this time.

I.14.5 WATER USE EFFICIENCY

The most important water use efficiency recommendation that is not a study or education effort is the proposal that ditch-lining be implemented to reduce water loss. The SSRT has stated that approximately 20 miles of ditches could be eligible for lining. Based on a review of a similar project implemented in the Oroville Wyandotte Irrigation district in 2003 (and proposed in 2001), the economists estimated that this action should cost about $161,000 per mile of ditch, or around $3.2 million for all 20 miles of ditches. Associated positive socioeconomic impacts would be on the order of $2 million.

If the water savings estimates in the Oroville Wyandotte Irrigation district are indicative of the cost-effectiveness of ditch-lining in the SSPP region, then it is possible to estimate that this recovery action would cost about $600 per acre-foot of water. This is about six times the estimated cost of water acquisitions achieved through fallowing in this region.

I.14.6 MONITORING AND ASSESSMENT

The cost of monitoring and assessment actions identified in the SSPP were estimated by (1) relying on specific cost estimates provided by the SSRT where possible, and (2) by relying on historical average costs of monitoring and assessment activities where these estimates are not available. The estimated cost of this class of recovery action in the SSPP region is about $7 million, with no significant socioeconomic impacts.

I.14.7 EDUCATION AND OUTREACH

The cost of education and outreach actions identified in the SSPP were estimated by (1) relying on specific cost estimates provided by the SSRT where possible, and (2) by relying on historical average costs of education and outreach activities where these estimates are not available. The estimated cost of this class of recovery action in the SSPP region is about $9 million, with no significant socioeconomic impacts.

I.15 AGGREGATE COSTS AND ECONOMIC IMPACTS

Table I-23 summarizes estimates of the aggregate costs and socioeconomic impact of coho salmon recovery under the strategy. These estimates include the cost of implementing the SSPP (shown on a disaggregated basis) and the mid-point estimate of the cost of implementing the timber management alternatives, but exclude the cost of water acquisition in all regions outside of the SSPP area. These figures also exclude the costs and impacts of actions that cannot be quantified at this time. Thus, these costs and impacts may only partially reflect the cost of coho salmon recovery under the strategy. On the other hand, as stated before, these aggregate cost estimates may overestimate the cost of Recovery Strategy implementation because some of the costs may be incurred even if the Recovery Strategy were not implemented. In addition, these aggregate cost estimates

TABLE I-23: Summary of cost and impacts of coho salmon recovery

Class of recovery action	Fiscal Costs ($)	Socioecon. Impacts ($)
Habitat Restoration		
SONCC Coho ESU	1,680,502,407	1,082,338,237
CCC Coho ESU	1,465,138,565	902,965,885
Total excl. SSPP	3,145,640,972	1,985,304,122
Scott	117,826,696	56,002,243
Shasta	217,725,981	103,294,103
Other SSPP restoration	36,030,892	
Total SSPP	371,583,569	159,296,346
Total incl. SSPP	3,517,224,542	2,144,600,468
Monitoring, evaluation and planning		
Total excl. SSPP	44,000,000	0
Total SSPP	10,604,000	0
Total incl. SSPP	54,604,000	0
Education and outreach		
Total excl. SSPP	31,000,000	0
Total SSPP	8,832,520	0
Total incl. SSPP	39,832,520	0
Water management		
Total excl. SSPP		
Total SSPP	10,334,024	0
Water use efficiency		
Total excl. SSPP		
Total SSPP	3,200,000	2,020,000
Water acquisition		
Total excl. SSPP		UNKNOWN
Total SSPP	60,217,676	(6,143,359)
Other (includes SSPP Protection and easements)		
Total excl. SSPP	808,553,878	
Total SSPP	1,244,789	
Timberland management		
Alternative A	419,000,000-910,000,000	(1,460,000,000)-(680,000,000)
Alternative B	151,000,000-373,000,000	(598,000,000)-(224,000,000)
Alternative C	FEW INCREMENTAL COSTS	FEW INCREMENTAL COSTS

Source: Authors' calculation. Habitat restoration includes removal of barriers to fish passage, riparian revegetation and streambank improvements, placement of LWD and improvements in instream complexity, and road treatment and decommissioning. SSPP is the Shasta and Scott River Pilot Program No cost estimates are available for water acquisition in the CCC or SONCC excluding the SSPP. Excludes impacts identified but not quantified.

may overestimate the cost of Recovery Strategy implementation to the extent that some of the costs may be incurred as a result of actions taken to avoid take of coho salmon or to fully mitigate impacts of the authorized take of coho salmon once the species is listed.

The total measured fiscal costs of implementing the Recovery Strategy are about $5 billion dollars. Of these measured costs, about $466 million, or 9 percent of total measured costs, will be incurred in the SSPP region. The actual fraction of costs incurred in the SSPP region will be less than this because the cost of water acquisition has been explicitly measured for the SSPP, but has not been measured for the rest of the range. Nonetheless, a notably large portion of costs will be incurred in these HSAs.

Restoration costs are higher in the SONCC Coho ESU than the CCC Coho ESU, likely because coho salmon are more widely distributed within the SONCC Coho ESU. Costs are especially high in the Klamath River HU, where Iron Gate Dam is located. High costs were also noted in the Mendocino Coast and Trinity River HUs. These three HUs, combined, account for over 85 percent of measured restoration costs.

Monitoring, evaluation, planning, education, and outreach costs are about $90 million dollars. This is about 2 percent of total estimated fiscal costs. There are no significant socioeconomic impacts associated with these actions.

Implementing the recommendations for timberland management could result in costs ranging from $150 million to $910 million, depending on which alternative, or combination of elements from those alternatives, is adopted. If Alternative A were adopted, costs would be in the range of $419 million to $910 million. Costs would be lower if Alternative B were adopted, in the range of $151 million to $373 million. There are few incremental costs associated with Alternative C. This report presents a total cost estimate that includes the average of timberland management Alternatives A and B, which is $463 million.

Restoration activities will generate positive socioeconomic impacts. Socioeconomic impacts generated from restoration equal about one-half of the fiscal costs of restoration or $2.1 billion. The socioeconomic impacts of water acquisition in the SONCC Coho ESU will be negative (for the SSPP these negative impacts equal about $6 million), as will the socioeconomic impacts of timberland management changes. Negative socioeconomic impacts of the timberland management changes are estimate to range from about $225 million to about $1.46 billion.

I.16 IMPACTS IDENTIFIED BUT NOT QUANTIFIED: PERMITTING AND ENFORCEMENT

An important unresolved issue with the cost of coho salmon recovery under the strategy is the role of enforcement of permits and take restrictions. There is some amount of unpermitted water diversion from streams containing coho salmon, for example, and some diverters use more than their allowable quantity. With regard to other issues like fencing, existing take restrictions may require that ranchers be fencing and constructing troughs more than is currently the case. This analysis has not attempted to parse out the total quantity of actions required for recovery as opposed to actions required by the listing of the coho salmon. Instead the costs of recovery have been calculated based on the increment of various actions relative to the status quo.

While a full treatment of enforcement is beyond the scope of this study, from an economic point of view it should be mentioned that the fiscal costs of coho salmon recovery under the strategy can be reduced, dramatically in some cases, from enforcement of existing law.

A related question arises in the area of water quality concerns. Several recommendations were directed at reducing pollutant loads (including sedimentation) that may adversely affect coho salmon recovery. The regional water quality control boards in California are formulating and implementing plans to reduce pesticide runoff. This observation raises the question about whether the costs of water quality improvement actions identified by the CRT should be all or partially attributable to coho salmon recovery, and which would be incurred as a result of the Clean Water Act or other statutes and regulations. TMDL regulations, for example, are quite relevant to coho salmon recovery. Costs attributable to this process should not be counted as a cost of coho salmon recovery if the regulations would have been enacted anyway.

ATTACHMENT 1

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU	Barriers To Passage	Cost ($)
BAY BRIDGES	22	6,844,544
BIG BASIN	160	32,712,513
BODEGA	2	363,382
CAPE MENDOCINO	34	1,158,305
EEL RIVER	576	28,328,381
EUREKA PLAIN	42	3,652,731
KLAMATH RIVER (excl SSPP)	554	23,692,266
MAD RIVER	68	3,991,020
MARIN COASTAL	66	13,835,076
MENDOCINO COAST	1,980	292,909,680
REDWOOD CREEK	18	471,908
ROGUE RIVER	21	270,271
RUSSIAN RIVER	386	64,255,622
SAN MATEO	39	10,751,122
SAN PABLO	248	50,582,418
SANTA CLARA	62	23,873,536
SMITH RIVER	543	11,428,398
SOUTH BAY	88	34,545,539
SUISUN	241	21,563,281
TRINIDAD	11	742,725
TRINITY RIVER	282	26,168,024
WINCHUCK RIVER	4	173,845
Total SONCC	2,702	196,097,109
Total CCC	2,741	456,217,478
Total excl. SSPP	**5,443**	**652,314,587**
Scott	23	2,604,636
Shasta	8	4,455,000
Total SSPP	**31**	**7,059,636**
Total incl. SSPP	**5,474**	**659,374,223**

Barriers information provided by the Department comes from the State Coastal Conservancy (SCC) Report of Potential Barriers to Fish Passage (Bowen et al, Report to the Legislature, 2003).

See Section I.3.1 of this appendix for the underlying assumptions of the above calculations.

ATTACHMENT 1

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY BARRIER TYPE

Barrier type	Cost ($)
Dams	213,077,622
Non-structural sites	15,526,701
Fish passage facilities	12,702,929
Stream crossings	391,932,079
Unknown/Other barriers	1,144,792
Water diversions	21,910,100
Assessment and prioritization	3,080,000
Total	659,374,223

ATTACHMENT 1

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU	Barriers to Passage	Cost ($)
BAY BRIDGES	22	4,058,726
BIG BASIN	160	19,579,508
BODEGA	2	158,029
CAPE MENDOCINO	34	646,983
EEL RIVER	576	16,769,028
EUREKA PLAIN	42	2,179,639
KLAMATH RIVER (excl. SSPP)	554	14,047,359
MAD RIVER	68	2,346,612
MARIN COASTAL	66	8,217,045
MENDOCINO COAST	1,980	175,529,808
REDWOOD CREEK	18	247,145
ROGUE RIVER	21	138,163
RUSSIAN RIVER	386	38,421,373
SAN MATEO	39	6,378,673
SAN PABLO	248	30,277,451
SANTA CLARA	62	14,264,122
SMITH RIVER	543	6,773,039
SOUTH BAY	88	20,679,324
SUISUN	241	12,793,969
TRINIDAD	11	421,635
TRINITY RIVER	282	15,544,814
WINCHUCK RIVER	4	92,307
Total SONCC	2,702	116,542,265
Total CCC	2,741	273,022,487
Total excl. SSPP	**5,443**	**389,564,752**
Scott	23	1,550,782
Shasta	8	2,661,000
Total SSPP	**31**	**4,211,782**
Total incl. SSPP	**5,474**	**393,776,534**

Barriers information provided by the Department comes from the State Coastal Conservancy (SCC) Report of Potential Barriers to Fish Passage (Bowen et al, Report to the Legislature, 2003).

See Section I.3.2 of this appendix for the underlying assumptions of the above calculations.

ATTACHMENT 1

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY BARRIER TYPE

Barrier Type		Cost ($)
Dams		127,846,573
Non-structural sites		9,316,020
Fish passage facilities		7,621,758
Stream crossings		235,159,247
Unknown/Other barriers		686,875
Water diversions		13,146,060
Assessment and prioritization	-	
Total		393,776,534

ATTACHMENT 1

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
BAY BRIDGES	**43**	**22**	**6,844,544**	
Dams	17	9	5,543,167	652,137
Non-structural sites	2	1	10,234	10,234
Fish passage facilities	0	0	0	
Stream crossings	22	11	1,203,468	109,406
Unknown/Other barriers	2	1	7,675	7,675
Water diversions	0	0	0	
Assessment and prioritization			80,000	
BIG BASIN	**320**	**160**	**32,712,513**	
Dams	99	50	26,899,263	543,419
Non-structural sites	103	52	501,510	9,738
Fish passage facilities	6	3	1,708,862	569,621
Stream crossings	98	49	3,457,239	70,556
Unknown/Other barriers	10	5	45,333	9,067
Water diversions	4	2	20,307	10,153
Assessment and prioritization			80,000	
BODEGA	**3**	**2**	**363,382**	
Dams	1	1	230,255	460,511
Non-structural sites	1	1	5,019	10,038
Fish passage facilities	0	0	0	
Stream crossings	1	1	28,108	56,215
Unknown/Other barriers	0	0	0	
Water diversions	0	0	0	
Assessment and prioritization			100,000	
CAPE MENDOCINO	**67**	**34**	**1,158,305**	
Dams	0	0	0	
Non-structural sites	35	18	169,088	9,662
Fish passage facilities	0	0	0	
Stream crossings	27	14	884,347	65,507
Unknown/Other barriers	5	3	24,869	9,948
Water diversions	0	0	0	
Assessment and prioritization			80,000	

Continued…

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and barrier type	No. Potential barriers	No. Actual barriers	Cost ($)	Unit cost
EEL RIVER	**1,152**	**576**	**28,328,381**	
Dams	34	17	10,126,168	595,657
Non-structural sites	859	430	4,203,345	9,787
Fish passage facilities	6	3	2,092,113	697,371
Stream crossings	226	113	11,293,206	99,940
Unknown/Other barriers	24	12	173,951	123,844
Water diversions	3	2	59,597	39,732
Assessment and prioritization			380,000	
EUREKA PLAIN	**84**	**42**	**3,652,731**	
Dams	7	4	2,009,913	574,261
Non-structural sites	51	26	253,100	9,925
Fish passage facilities	0	0	0	
Stream crossings	24	12	1,354,830	112,903
Unknown/Other barriers	2	1	14,888	14,888
Water diversions	0	0	0	
Assessment and prioritization			20,000	
MAD RIVER	**141**	**68**	**3,991,020**	
Dams	7	1	450,000	450,000
Non-structural sites	93	47	459,054	9,872
Fish passage facilities	3	2	1,339,942	893,295
Stream crossings	33	17	1,604,953	97,270
Unknown/Other barriers	1	1	7,444	7,444
Water diversions	4	2	49,627	24,814
Assessment and prioritization			80,000	
MARIN COASTAL	**132**	**66**	**13,835,076**	
Dams	42	21	10,614,771	505,465
Non-structural sites	11	6	53,726	9,768
Fish passage facilities	0	0	0	
Stream crossings	75	38	3,008,670	80,231
Unknown/Other barriers	4	2	17,909	8,954
Water diversions	0	0	0	
Assessment and prioritization			360,000	

Continued…

TOTAL ESTIMATED COST OF

BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
MENDOCINO COAST	**3,960**	**1,980**	**292,909,680**	
Dams	29	15	6,965,753	480,397
Non-structural sites	94	47	444,054	9,448
Fish passage facilities	2	1	498,492	498,492
Stream crossings	3,827	1,914	284,571,592	148,718
Unknown/Other barriers	5	3	54,834	53,339
Water diversions	3	2	14,955	9,970
Assessment and prioritization			360,000	
REDWOOD CREEK	**40**	**18**	**471,908**	
Dams	4	0	0	
Non-structural sites	27	14	126,550	9,374
Fish passage facilities	0	0	0	
Stream crossings	8	4	277,914	69,478
Unknown/Other barriers	1	1	7,444	7,444
Water diversions	0	0	0	
Assessment and prioritization			60,000	
ROGUE RIVER	**41**	**21**	**270,271**	
Dams	0	0	0	
Non-structural sites	35	18	171,215	9,784
Fish passage facilities	0	0	0	
Stream crossings	3	2	41,687	27,791
Unknown/Other barriers	1	1	7,444	7,444
Water diversions	2	1	9,925	9,925
Assessment and prioritization			40,000	
RUSSIAN RIVER	**771**	**386**	**64,255,622**	
Dams	106	53	29,311,973	553,056
Non-structural sites	34	17	162,444	9,556
Fish passage facilities	9	5	3,046,063	676,903
Stream crossings	427	214	27,589,621	129,225
Unknown/Other barriers	6	3	155,167	151,832
Water diversions	189	95	3,770,354	39,898
Assessment and prioritization			220,000	

Continued...

TOTAL ESTIMATED COST OF

BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
SAN MATEO	**69**	**39**	**10,751,122**	
Dams	29	19	8,558,793	450,463
Non-structural sites	20	10	99,510	9,951
Fish passage facilities	3	2	972,189	648,126
Stream crossings	16	8	995,513	124,439
Unknown/Other barriers	1	1	5,117	10,234
Water diversions	0	0	0	
Assessment and prioritization			120,000	
SAN PABLO	**495**	**248**	**50,582,418**	
Dams	139	70	35,172,497	506,079
Non-structural sites	52	26	263,803	10,146
Fish passage facilities	3	2	1,166,821	777,880
Stream crossings	174	87	11,633,272	133,716
Unknown/Other barriers	32	16	299,098	275,218
Water diversions	95	48	1,926,928	40,567
Assessment and prioritization			120,000	
SANTA CLARA	**124**	**62**	**23,873,536**	
Dams	69	35	18,768,639	544,019
Non-structural sites	16	8	68,819	8,602
Fish passage facilities	4	2	1,630,310	815,155
Stream crossings	34	17	3,300,670	194,157
Unknown/Other barriers	1	1	5,098	10,195
Water diversions	0	0	0	
Assessment and prioritization			100,000	
SMITH RIVER	**124**	**543**	**11,428,398**	
Dams	14	3	1,350,000	450,000
Non-structural sites	888	444	4,354,811	9,808
Fish passage facilities	0	0	0	
Stream crossings	102	51	3,831,737	75,132
Unknown/Other barriers	1	1	163,771	163,771
Water diversions	89	45	1,588,079	35,687
Assessment and prioritization			140,000	

Continued…

TOTAL ESTIMATED COST OF

BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
SOUTH BAY	**175**	**88**	**34,545,539**	
Dams	114	57	30,842,411	541,095
Non-structural sites	17	9	66,191	7,787
Fish passage facilities	0	0	0	
Stream crossings	37	19	3,521,293	190,340
Unknown/Other barriers	7	4	35,645	10,184
Water diversions	0	0	0	
Assessment and prioritization			80,000	
SUISUN	**482**	**241**	**21,563,281**	
Dams	40	20	11,876,006	593,800
Non-structural sites	1	1	5,073	10,146
Fish passage facilities	0	0	0	
Stream crossings	7	4	634,370	181,249
Unknown/Other barriers	0	0	0	
Water diversions	434	217	8,807,832	40,589
Assessment and prioritization			240,000	
TRINIDAD	**22**	**11**	**742,725**	
Dams	1	1	119,106	238,212
Non-structural sites	7	4	34,739	9,925
Fish passage facilities	0	0	0	
Stream crossings	14	7	548,880	78,411
Unknown/Other barriers	0	0	0	
Water diversions	0	0	0	
Assessment and prioritization			40,000	
TRINITY RIVER	**564**	**282**	**26,168,024**	
Dams	14	7	7,101,692	1,014,527
Non-structural sites	89	45	434,240	9,758
Fish passage facilities	1	1	248,137	496,275
Stream crossings	237	119	13,791,476	116,384
Unknown/Other barriers	6	3	24,814	13,234
Water diversions	217	109	4,307,665	39,702
Assessment and prioritization			260,000	

Continued…

TOTAL ESTIMATED COST OF

BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
WINCHUCK RIVER	**9**	**4**	**173,845**	
Dams	2	0	0	
Non-structural sites	1	1	4,963	9,925
Fish passage facilities	0	0	0	
Stream crossings	4	2	138,957	69,478
Unknown/Other barriers	0	0	0	
Water diversions	2	1	9,925	9,925
Assessment and prioritization			20,000	
Water diversions	78	39	1,344,905	34,485
Assessment and prioritization			320,000	
KLAMATH RIVER	**1,169**	**585**	**30,751,902**	
Dams	31	16	7,137,216	460,466
Non-structural sites	752	376	3,635,213	9,668
Fish passage facilities	0	0	0	
Stream crossings	291	146	18,220,276	125,225
Unknown/Other barriers	17	9	94,292	37,367
Water diversions	78	39	1,344,905	34,485
Assessment and prioritization			320,000	
SCOTT RIVER	**59**	**23**	**2,604,636**	
Dams	4	2	446,647	223,324
Non-structural sites	7	0	0	
Fish passage facilities	0	0	0	
Stream crossings	42	21	2,137,989	101,809
Unknown/Other barriers	0	0	0	
Water diversions	6	0	0	
Assessment and prioritization			20,000	
SHASTA VALLEY	**30**	**8**	**4,455,000**	
Dams	19	8	4,435,000	554,375
Non-structural sites	2	0	0	
Fish passage facilities	0	0	0	
Stream crossings	7	0	0	
Unknown/Other barriers	0	0	0	
Water diversions	2	0	0	
Assessment and prioritization			20,000	

Continued…

TOTAL ESTIMATED COST OF

BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
KLAMATH RIVER (excl. SSPP)	**1,080**	**554**	**23,692,266**	
Dams	8	6	2,255,569	
Non-structural sites	743	376	3,635,213	
Fish passage facilities	0	0	0	
Stream crossings	242	125	16,082,287	
Unknown/Other barriers	17	9	94,292	
Water diversions	70	39	1,344,905	
Assessment and prioritization			280,000	

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
BAY BRIDGES	**43**	**22**	**4,058,726**	
Dams	17	9	3,325,900	391,282
Non-structural sites	2	1	6,140	6,140
Fish passage facilities	0	0	0	
Stream crossings	22	11	722,081	65,644
Unknown/Other barriers	2	1	4,605	4,605
Water diversions	0	0	0	
BIG BASIN	**320**	**160**	**19,579,508**	
Dams	99	50	16,139,558	326,052
Non-structural sites	103	52	300,906	5,843
Fish passage facilities	6	3	1,025,317	341,772
Stream crossings	98	49	2,074,343	42,334
Unknown/Other barriers	10	5	27,200	5,440
Water diversions	4	2	12,184	6,092
BODEGA	**3**	**2**	**158,029**	
Dams	1	1	138,153	276,306
Non-structural sites	1	1	3,012	6,023
Fish passage facilities	0	0	0	
Stream crossings	1	1	16,865	33,729
Unknown/Other barriers	0	0	0	
Water diversions	0	0	0	
CAPE MENDOCINO	**67**	**34**	**646,983**	
Dams	0	0	0	
Non-structural sites	35	18	101,453	5,797
Fish passage facilities	0	0	0	
Stream crossings	27	14	530,608	39,304
Unknown/Other barriers	5	3	14,921	5,969
Water diversions	0	0	0	

Continued…

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF
BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
EEL RIVER	**1,152**	**576**	**16,769,028**	
Dams	34	17	6,075,701	357,394
Non-structural sites	859	430	2,522,007	5,872
Fish passage facilities	6	3	1,255,268	418,423
Stream crossings	226	113	6,775,924	59,964
Unknown/Other barriers	24	12	104,371	74,306
Water diversions	3	2	35,758	23,839
EUREKA PLAIN	**84**	**42**	**2,179,639**	
Dams	7	4	1,205,948	344,556
Non-structural sites	51	26	151,860	5,955
Fish passage facilities	0	0	0	
Stream crossings	24	12	812,898	67,742
Unknown/Other barriers	2	1	8,933	8,933
Water diversions	0	0	0	
MAD RIVER	**141**	**68**	**2,346,612**	
Dams	7	1	270,000	270,000
Non-structural sites	93	47	275,432	5,923
Fish passage facilities	3	2	803,965	535,977
Stream crossings	33	17	962,972	58,362
Unknown/Other barriers	1	1	4,466	4,466
Water diversions	4	2	29,776	14,888
MARIN COASTAL	**132**	**66**	**8,217,045**	
Dams	42	21	6,368,863	303,279
Non-structural sites	11	6	32,236	5,861
Fish passage facilities	0	0	0	
Stream crossings	75	38	1,805,202	48,139
Unknown/Other barriers	4	2	10,745	5,373
Water diversions	0	0	0	

Continued…

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
MENDOCINO COAST	**3,960**	**1,980**	**175,529,808**	
Dams	29	15	4,179,452	288,238
Non-structural sites	94	47	266,432	5,669
Fish passage facilities	2	1	299,095	299,095
Stream crossings	3,827	1,914	170,742,955	89,231
Unknown/Other barriers	5	3	32,900	32,003
Water diversions	3	2	8,973	5,982
REDWOOD CREEK	**40**	**18**	**247,145**	
Dams	4	0	0	
Non-structural sites	27	14	75,930	5,624
Fish passage facilities	0	0	0	
Stream crossings	8	4	166,748	41,687
Unknown/Other barriers	1	1	4,466	4,466
Water diversions	0	0	0	
ROGUE RIVER	**41**	**21**	**138,163**	
Dams	0	0	0	
Non-structural sites	35	18	102,729	5,870
Fish passage facilities	0	0	0	
Stream crossings	3	2	25,012	16,675
Unknown/Other barriers	1	1	4,466	4,466
Water diversions	2	1	5,955	5,955
RUSSIAN RIVER	**771**	**386**	**38,421,373**	
Dams	106	53	17,587,184	331,834
Non-structural sites	34	17	97,466	5,733
Fish passage facilities	9	5	1,827,638	406,142
Stream crossings	427	214	16,553,773	77,535
Unknown/Other barriers	6	3	93,100	91,099
Water diversions	189	95	2,262,212	23,939

Continued…

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
SAN MATEO	**69**	**39**	**6,378,673**	
Dams	29	19	5,135,276	270,278
Non-structural sites	20	10	59,706	5,971
Fish passage facilities	3	2	583,314	388,876
Stream crossings	16	8	597,308	74,663
Unknown/Other barriers	1	1	3,070	6,140
Water diversions	0	0	0	
SAN PABLO	**495**	**248**	**30,277,451**	
Dams	139	70	21,103,498	303,647
Non-structural sites	52	26	158,282	6,088
Fish passage facilities	3	2	700,092	466,728
Stream crossings	174	87	6,979,963	80,229
Unknown/Other barriers	32	16	179,459	165,131
Water diversions	95	48	1,156,157	24,340
SANTA CLARA	**124**	**62**	**14,264,122**	
Dams	69	35	11,261,183	326,411
Non-structural sites	16	8	41,291	5,161
Fish passage facilities	4	2	978,186	489,093
Stream crossings	34	17	1,980,402	116,494
Unknown/Other barriers	1	1	3,059	6,117
Water diversions	0	0	0	
SMITH RIVER	**124**	**543**	**6,773,039**	
Dams	14	3	810,000	270,000
Non-structural sites	888	444	2,612,887	5,885
Fish passage facilities	0	0	0	
Stream crossings	102	51	2,299,042	45,079
Unknown/Other barriers	1	1	98,262	98,262
Water diversions	89	45	952,848	21,412

Continued…

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
SOUTH BAY	**175**	**88**	**20,679,324**	
Dams	114	57	18,505,447	324,657
Non-structural sites	17	9	39,714	4,672
Fish passage facilities	0	0	0	
Stream crossings	37	19	2,112,776	114,204
Unknown/Other barriers	7	4	21,387	6,111
Water diversions	0	0	0	
SUISUN	**482**	**241**	**12,793,969**	
Dams	40	20	7,125,603	356,280
Non-structural sites	1	1	3,044	6,088
Fish passage facilities	0	0	0	
Stream crossings	7	4	380,622	108,749
Unknown/Other barriers	0	0	0	
Water diversions	434	217	5,284,699	24,353
TRINIDAD	**22**	**11**	**421,635**	
Dams	1	1	71,464	142,927
Non-structural sites	7	4	20,844	5,955
Fish passage facilities	0	0	0	
Stream crossings	14	7	329,328	47,047
Unknown/Other barriers	0	0	0	
Water diversions	0	0	0	
TRINITY RIVER	**564**	**282**	**15,544,814**	
Dams	14	7	4,261,015	608,716
Non-structural sites	89	45	260,544	5,855
Fish passage facilities	1	1	148,882	297,765
Stream crossings	237	119	8,274,885	69,830
Unknown/Other barriers	6	3	14,888	7,940
Water diversions	217	109	2,584,599	23,821

Continued...

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF

BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
WINCHUCK RIVER	**9**	**4**	**92,307**	
Dams	2	0	0	
Non-structural sites	1	1	2,978	5,955
Fish passage facilities	0	0	0	
Stream crossings	4	2	83,374	41,687
Unknown/Other barriers	0	0	0	
Water diversions	2	1	5,955	5,955
KLAMATH RIVER	**1,169**	**585**	**18,259,141**	
Dams	31	16	4,282,330	276,279
Non-structural sites	752	376	2,181,128	5,801
Fish passage facilities	0	0	0	
Stream crossings	291	146	10,932,166	75,135
Unknown/Other barriers	17	9	56,575	22,420
Water diversions	78	39	806,943	20,691
SCOTT RIVER	**59**	**23**	**1,550,782**	
Dams	4	2	267,988	133,994
Non-structural sites	7	0	0	
Fish passage facilities	0	0	0	
Stream crossings	42	21	1,282,793	61,085
Unknown/Other barriers	0	0	0	
Water diversions	6	0	0	
SHASTA VALLEY	**30**	**8**	**2,661,000**	
Dams	19	8	2,661,000	332,625
Non-structural sites	2	0	0	
Fish passage facilities	0	0	0	
Stream crossings	7	0	0	
Unknown/Other barriers	0	0	0	
Water diversions	2	0	0	

Continued…

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
KLAMATH RIVER (excl. SSPP)	**1,080**	**554**	**14,047,359**	
Dams	8	6	1,353,341	
Non-structural sites	743	376	2,181,128	
Fish passage facilities	0	0	0	
Stream crossings	242	125	9,649,372	
Unknown/Other barriers	17	9	56,575	
Water diversions	70	39	806,943	

ATTACHMENT 2

TOTAL ESTIMATED COST OF RIPARIAN REVEGETATION BY HU

HU	Riparian Revegetation Cost ($)	Stream Miles Where Riparian Revegetation Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	90,640	N.a.	
BODEGA	85,647	N.a.	
CAPE MENDOCINO	15,433,726	85	181,133
EEL RIVER	29,858,170	165	181,122
EUREKA PLAIN	-	-	
KLAMATH RIVER	18,721,487	103	180,993
MAD RIVER	2,145,205	12	180,993
MARIN COASTAL	1,094,358	-	
MENDOCINO COAST	743,507	-	
REDWOOD CREEK	3,411,259	19	180,993
ROGUE RIVER	-	-	
RUSSIAN RIVER	528,450	-	
SAN MATEO	123,562	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	2,468,586	14	180,993
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	103,304	1	180,993
TRINITY RIVER	3,241,052	18	180,993
WINCHUCK RIVER	35,989	0	180,993
Total SONCC	75,418,779	417	
Total CCC	2,666,164		
Total	**78,084,943**	**417**	
Scott	47,782,069	264	180,993
Shasta	39,818,391	220	180,993
Total SSPP	**87,600,460**	**484**	
Total incl. SSPP	**165,685,403**	**901**	

Note: assumes buffer of 50 feet.

ATTACHMENT 2

TOTAL ESTIMATED COST OF STREAMBANK RESTORATION BY HU

HU	Riparian Revegetation Cost ($)	Stream Miles Where Riparian Revegetation Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	61,164,203	46	1,323,974
BODEGA	1,685,832	1	1,325,214
CAPE MENDOCINO	56,140,177	43	1,317,744
EEL RIVER	181,015,158	137	1,317,661
EUREKA PLAIN	-	-	
KLAMATH RIVER	25,893,312	20	1,316,722
MAD RIVER	7,803,184	6	1,316,722
MARIN COASTAL	8,139,193	8	1,072,867
MENDOCINO COAST	222,331,325	169	1,319,017
REDWOOD CREEK	12,408,455	9	1,316,722
ROGUE RIVER	-	-	
RUSSIAN RIVER	32,999,164	25	1,319,932
SAN MATEO	-	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	8,979,483	7	1,316,722
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	751,536	1	1,316,722
TRINITY RIVER	11,789,327	9	1,316,722
WINCHUCK RIVER	261,820	0.20	1,316,722
Total SONCC	305,042,453	400	
Total CCC	326,319,717	80	
Total	**631,362,170**	**480**	
Scott	65,836,089	50	1,316,722
Shasta	171,173,832	130	1,316,722
Total SSPP	**237,009,922**	**180**	
Total incl. SSPP	**868,372,091**	**660**	

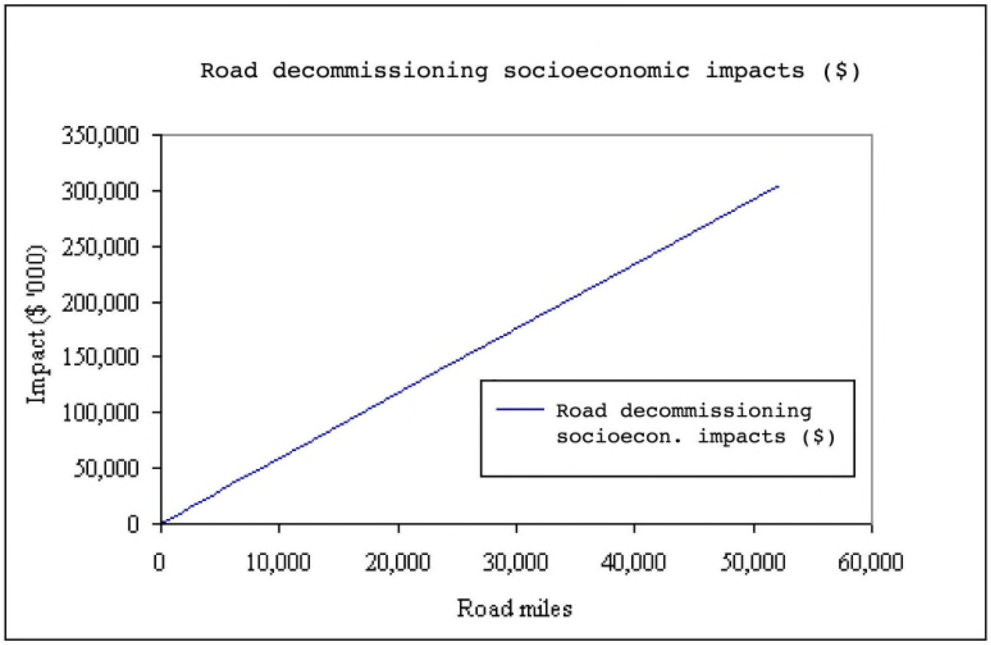
ATTACHMENT 2

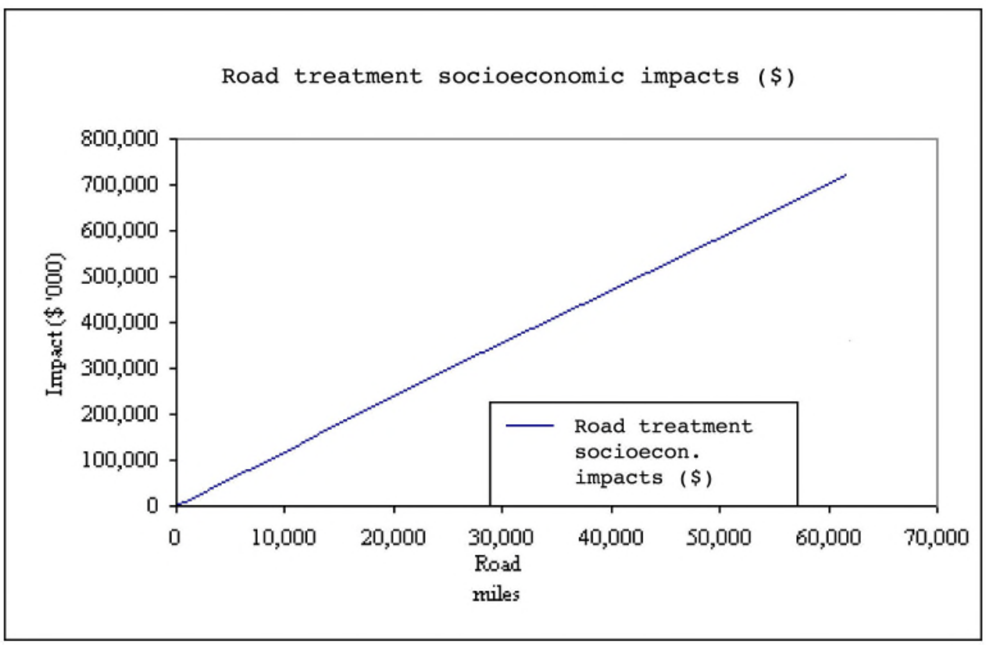
TOTAL ESTIMATED COST OF FENCING BY HU

HU	Fencing Cost ($)	Stream Miles Where Fencing Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	225,030	N.a.	N.a.
BODEGA	29	3	9
CAPE MENDOCINO	-	-	
EEL RIVER	421	56	8
EUREKA PLAIN	142	19	7
KLAMATH RIVER	12,830	1,748	7
MAD RIVER	-	-	
MARIN COASTAL	105	10	10
MENDOCINO COAST	1,805	231	8
REDWOOD CREEK	-	-	
ROGUE RIVER	-	-	
RUSSIAN RIVER	15	2	8
SAN MATEO	-	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	1	0	7
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	3	0	7
TRINITY RIVER	-	-	
WINCHUCK RIVER	-	-	
Total SONCC	13,397	2,071	
Total CCC	226,983		
Total	**240,380**	**2,071**	
Scott	138	50	3
Shasta	358	130	3
Total SSPP	**495**	**180**	
Total incl. SSPP	**240,875**	**2,251**	

Notes: Fencing miles needed not provided by DFG for Big Basin; total costs provided instead.

ATTACHMENT 2





I. COST AND SOCIOECONOMIC IMPACTS

ATTACHMENT 2

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF RIPARIAN REVEGETATION BY HU

HU	Riparian Revegetation Socioecon. Impact ($)	Stream Miles Where Riparian Revegetation Needed	Unit Impact ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	42,601	-	
BODEGA	40,254	-	
CAPE MENDOCINO	7,253,851	85	85,133
EEL RIVER	14,033,340	165	85,127
EUREKA PLAIN	-	-	
KLAMATH RIVER	8,799,099	103	85,067
MAD RIVER	1,008,246	12	85,067
MARIN COASTAL	514,348	-	
MENDOCINO COAST	349,448	-	
REDWOOD CREEK	1,603,292	19	85,067
ROGUE RIVER	-	-	
RUSSIAN RIVER	248,372	-	
SAN MATEO	58,074	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	1,160,236	14	85,067
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	48,553	1	85,067
TRINITY RIVER	1,523,295	18	85,067
WINCHUCK RIVER	16,915	0	85,067
Total SONCC	35,446,826	417	
Total CCC	1,253,097		
Total excl. SSPP	**36,699,923**	**417**	
Scott	22,457,572	264	85,067
Shasta	18,714,644	220	85,067
Total SSPP	**41,172,216**	**484**	
Total incl. SSPP	**77,872,139**	**901**	

Note: assumes buffer of 50 feet.

ATTACHMENT 2

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF STREAMBANK RESTORATION BY HU

HU	Restoring Streambank Socioecon. Impact ($)	Stream Miles Where Streambank Restoration Needed	Unit Impact ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	28,747,175	46	622,268
BODEGA	792,341	1	622,850
CAPE MENDOCINO	26,385,883	43	619,340
EEL RIVER	85,077,124	137	619,301
EUREKA PLAIN	-	-	
KLAMATH RIVER	12,169,857	20	618,859
MAD RIVER	3,667,496	6	618,859
MARIN COASTAL	3,825,421	8	504,247
MENDOCINO COAST	104,495,723	169	619,938
REDWOOD CREEK	5,831,974	9	618,859
ROGUE RIVER	-	-	
RUSSIAN RIVER	15,509,607	25	620,368
SAN MATEO	-	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	4,220,357	7	618,859
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	353,222	1	618,859
TRINITY RIVER	5,540,984	9	618,859
WINCHUCK RIVER	123,055	0	618,859
Total SONCC	143,369,953	400	
Total CCC	153,370,267	80	
Total excl. SSPP	**296,740,220**	**480**	
Scott	30,942,962	50	449,151
Shasta	80,451,701	130	143,959
Total SSPP	**111,394,663**	**180**	
Total incl. SSPP	**408,134,883**	**660**	

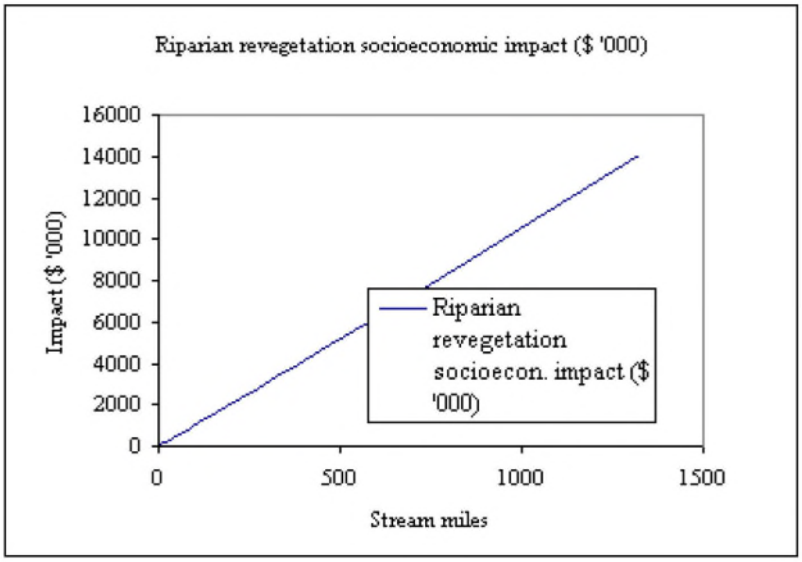
ATTACHMENT 2

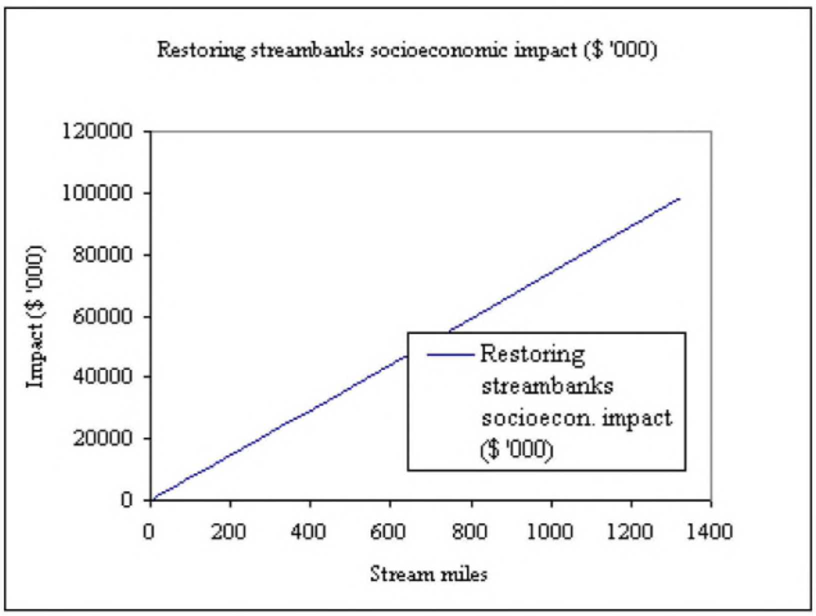
TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF FENCING BY HU

HU	Present Value Of Fencing Socioecon. Impact ($)	Stream Miles Where Fencing Needed	Unit Impact ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	225,030		N.a.
BODEGA	29	3	9
CAPE MENDOCINO	-	-	
EEL RIVER	421	56	8
EUREKA PLAIN	142	19	7
KLAMATH RIVER	12,830	1,748	7
MAD RIVER	-	-	
MARIN COASTAL	105	10	10
MENDOCINO COAST	1,805	231	8
REDWOOD CREEK	-	-	
ROGUE RIVER	-	-	
RUSSIAN RIVER	15	2	8
SAN MATEO	-	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	1	0	7
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	3	0	7
TRINITY RIVER	-	-	
WINCHUCK RIVER	-	-	
Total SONCC	13,397	2,071	
Total CCC	226,983		
Total excl. SSPP	**240,380**	**2,071**	
Scott	138	50	449,151
Shasta	358	130	143,959
Total SSPP	**495**	**180**	
Total incl. SSPP	**240,875**	**2,251**	

Notes: Fencing miles needed not provided by DFG for Big Basin; total costs provided instead.

ATTACHMENT 2





ATTACHMENT 3

TOTAL ESTIMATED COST OF LWD PLACEMENT BY HU

HU	LWD Placement Cost ($)	Stream Miles Where LWD Placement Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	38,994,078	N.a.	
BODEGA	1,539,521	N.a.	
CAPE MENDOCINO	665,474	33	19,941
EEL RIVER	-	-	
EUREKA PLAIN	-	-	
KLAMATH RIVER	8,924,026	448	19,914
MAD RIVER	2,141,958	108	19,914
MARIN COASTAL	6,699,179	N.a.	
MENDOCINO COAST	48,885,118	N.a.	-
REDWOOD CREEK	163,097	8	19,914
ROGUE RIVER	-	-	
RUSSIAN RIVER	20,501,402	N.a.	
SAN MATEO	13,438,759	N.a.	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	-	-	
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	-	-	
TRINITY RIVER	-	-	
WINCHUCK RIVER	3,776	0.19	19,914
Total SONCC	11,898,330	597	
Total CCC	130,058,058	N.a.	
Total excl. SSPP	**141,956,388**	**597**	
Scott	1,500,000	N.a.	
Shasta	758,400	40	18,960
Total SSPP	**2,258,400**		
Total incl. SSPP	**144,214,788**	**N.a.**	

ATTACHMENT 3

TOTAL ESTIMATED COST OF RESTORING IN-CHANNEL COMPLEXITY BY HU

HU	Restoring In-Channel Complexity Cost ($)	Stream Miles Where In-Channel Complexity Restoration Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	58,192,502	N.a.	
BODEGA	2,113,118	N.a.	
CAPE MENDOCINO	3,341,909	84	39,886
EEL RIVER	4,724,764	118	39,885
EUREKA PLAIN	715,873	18	39,834
KLAMATH RIVER	17,851,019	448	39,834
MAD RIVER	4,284,628	108	39,834
MARIN COASTAL	8,743,467	N.a.	
MENDOCINO COAST	68,435,890	N.a.	
REDWOOD CREEK	326,248	8	39,834
ROGUE RIVER	-	-	
RUSSIAN RIVER	24,902,591	N.a.	
SAN MATEO	21,504,958	N.a.	
SAN PABLO	-	-	
SANTA CLARA	1	-	
SMITH RIVER	-	-	
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	-	-	
TRINITY RIVER	3,211,482	81	39,834
WINCHUCK RIVER	7,554	0.19	39,834
Total SONCC	34,463,477	865	
Total CCC	183,892,527	N.a.	
Total excl. SSPP	**218,356,004**	**865**	
Scott	19,000	1	38,000
Shasta	1,520,000	40	38,000
Total SSPP	**1,539,000**	**41**	
Total incl. SSPP	**219,895,004**	**N.a.**	

ATTACHMENT 3

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF LWD PLACEMENT BY HU

HU	LWD Placement Impacts ($)	Stream Miles Where LWD Placement Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	25,346,151	N.a.	
BODEGA	1,000,689	N.a.	
CAPE MENDOCINO	431,866	33	12,941
EEL RIVER	-	-	
EUREKA PLAIN	-	-	
KLAMATH RIVER	5,787,113	448	12,914
MAD RIVER	1,389,031	108	12,914
MARIN COASTAL	4,354,467	N.a.	
MENDOCINO COAST	31,775,326	N.a.	
REDWOOD CREEK	105,766	8	12,914
ROGUE RIVER	-	-	
RUSSIAN RIVER	13,325,912	N.a.	
SAN MATEO	8,735,194	N.a.	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	-	-	
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	-	-	
TRINITY RIVER	-	-	
WINCHUCK RIVER	2,449	0.19	12,914
Total SONCC	7,716,225	597	
Total CCC	84,537,738	N.a.	
Total excl. SSPP	**92,253,963**	**597**	
Scott	975,000	-	
Shasta	478,400	40	18,960
Total SSPP	**1,453,400**	**40**	
Total incl. SSPP	**93,707,363**	**N.a.**	

ATTACHMENT 3

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF RESTORING IN-CHANNEL COMPLEXITY BY HU

HU	Restoring In-Channel Complexity Cost ($)	Stream Miles Where In-Channel Complexity Restoration Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	37,825,126	N.a.	
BODEGA	1,373,527	N.a.	
CAPE MENDOCINO	2,172,241	84	25,926
EEL RIVER	3,071,097	118	25,925
EUREKA PLAIN	465,317	18	25,892
KLAMATH RIVER	11,603,162	448	25,892
MAD RIVER	2,785,008	108	25,892
MARIN COASTAL	5,683,254	N.a.	
MENDOCINO COAST	44,483,329	N.a.	
REDWOOD CREEK	212,061	8	25,892
ROGUE RIVER	-	-	
RUSSIAN RIVER	16,186,684	N.a.	
SAN MATEO	13,978,223	N.a.	
SAN PABLO	-	-	
SANTA CLARA		-	
SMITH RIVER	-	-	
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	-	-	
TRINITY RIVER	2,087,463	81	25,892
WINCHUCK RIVER	4,910	0.19	25,892
Total SONCC	22,401,260	865	
Total CCC	119,530,142	N.a.	
Total excl. SSPP	**141,931,402**	**865**	
Scott	12,350	1	38,000
Shasta	988,000	40	38,000
Total SSPP	**1,000,350**	**41**	
Total incl. SSPP	**142,931,752**	**N.a.**	

ATTACHMENT 4

TOTAL ESTIMATED COST OF ROAD DECOMMISSIONING BY HU

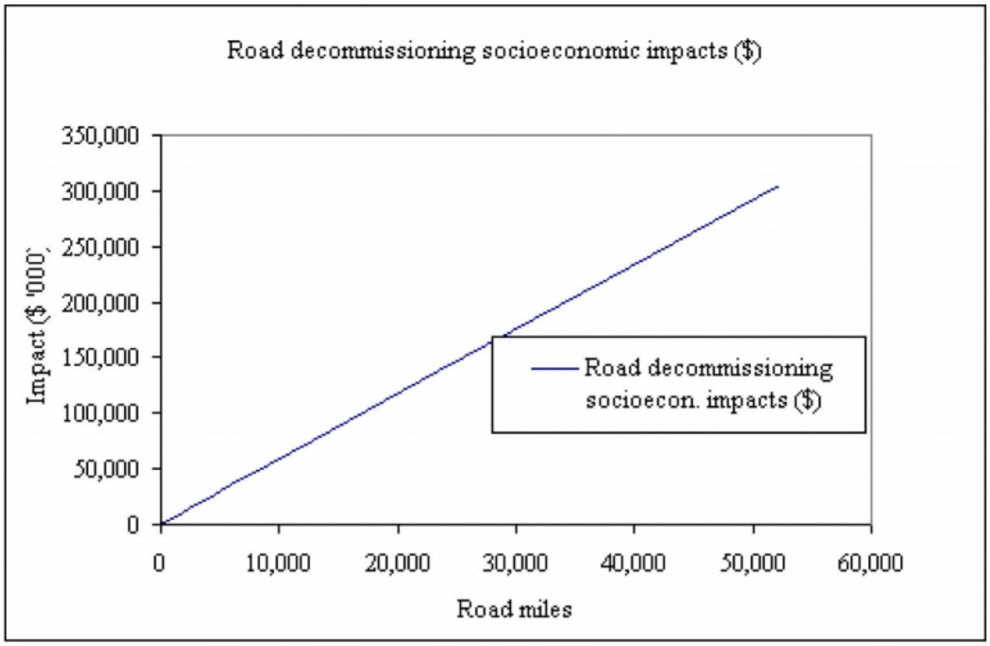
HU	Road Decommissioning Socioecon. Impacts ($)	Road Miles Where Decommissioning Needed	Unit Impacts ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	3,749,590	610	6,149
BODEGA	286,507	47	6,102
CAPE MENDOCINO	18,682,068	3,187	5,862
EEL RIVER	84,548,153	14,432	5,858
EUREKA PLAIN	1,025,673	177	5,801
KLAMATH RIVER	62,172,751	10,717	5,801
MAD RIVER	1,962,179	338	5,801
MARIN COASTAL	1,175,225	177	6,623
MENDOCINO COAST	8,860,952	1,492	5,941
REDWOOD CREEK	2,668,607	460	5,801
ROGUE RIVER	1,800,005	310	5,801
RUSSIAN RIVER	7,027,012	1,163	6,045
SAN MATEO	1,062,597	162	6,559
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	21,019,344	3,623	5,801
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	5,392,908	930	5,801
TRINITY RIVER	82,761,638	14,266	5,801
WINCHUCK RIVER	623,758	108	5,801
Total SONCC	282,657,085	52,198	
Total CCC	22,161,884		
Total excl. SSPP	**304,818,969**	**52,198**	
Scott	-	-	
Shasta	-	-	
Total SSPP	**-**	**-**	
Total incl. SSPP	**304,818,969**	**52,198**	

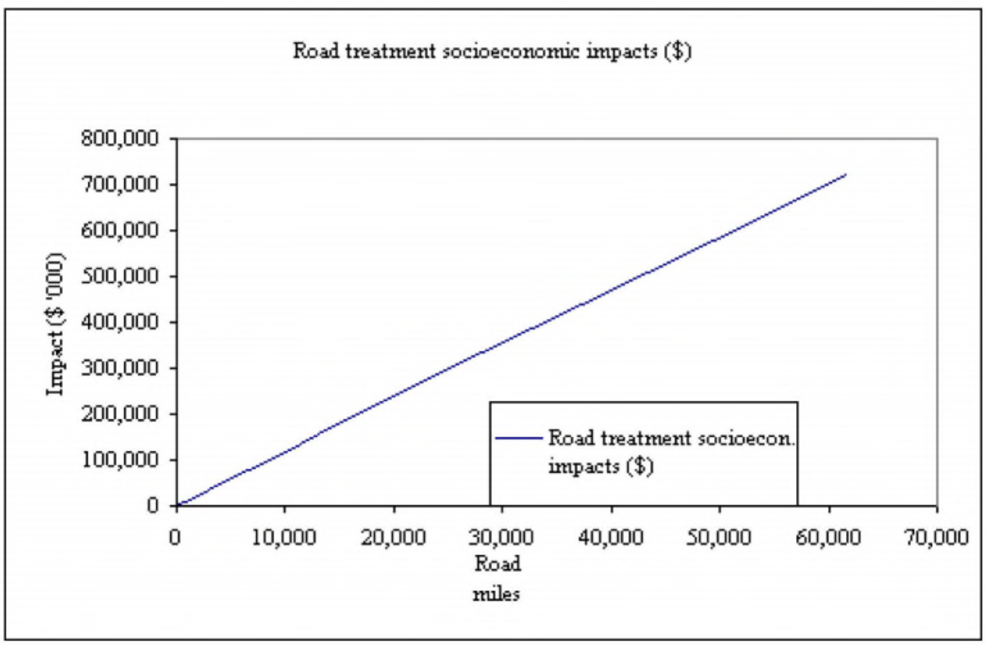
ATTACHMENT 4

TOTAL ESTIMATED COST OF ROAD TREATMENT BY HU

HU	Road Treatment Socioecon. Impacts ($)	Road Miles Where Treatment Needed	Unit Impact ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	42,067,177	3,455	12,175
BODEGA	3,216,114	266	12,088
CAPE MENDOCINO	31,548,349	2,709	11,647
EEL RIVER	142,783,304	12,267	11,639
EUREKA PLAIN	1,733,398	150	11,534
KLAMATH RIVER	105,072,519	9,109	11,534
MAD RIVER	2,145,712	186	11,534
MARIN COASTAL	13,118,385	1,006	13,046
MENDOCINO COAST	99,659,317	8,452	11,791
REDWOOD CREEK	2,306,891	200	11,534
ROGUE RIVER	3,042,024	264	11,534
RUSSIAN RIVER	78,933,524	6,588	11,982
SAN MATEO	11,868,770	918	12,929
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	35,522,884	3,080	11,534
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	9,114,063	790	11,534
TRINITY RIVER	139,867,925	12,126	11,534
WINCHUCK RIVER	1,054,157	91	11,534
Total SONCC	474,191,226	61,658	
Total CCC	248,863,288		
Total excl. SSPP	**723,054,513**	**61,658**	
Scott	63,439	6	11,534
Shasta	-	-	
Total SSPP	**63,439**	**6**	
Total incl. SSPP	**723,117,953**	**61,663**	

ATTACHMENT 4





ATTACHMENT 5

County	Pasture Operating Costs/Acre	Gross Pasture Returns/Acre	Agriculture Operating Costs/Acre	Gross Agriculture Returns/Acre	Region
Alameda	428	1,030	4,463	5,121	Central coast
Contra Costa	428	1,030	4,463	5,121	Central coast
San Mateo	428	1,030	4,463	5,121	Central coast
Santa Clara	428	1,030	4,463	5,121	Central coast
Santa Cruz	428	1,030	4,463	5,121	Central Coast
Solano	428	1,030	4,463	5,121	Central Coast
Glenn	245	254	221	550	Intermountain
Siskiyou	245	254	222	550	Intermountain
Trinity	245	254	223	550	Intermountain
Del Norte	266	405	1,938	6,300	North Coast
Humboldt	266	405	1,938	6,300	North Coast
Lake	266	405	1,938	6,300	North Coast
Marin	266	405	1,938	6,300	North Coast
Mendocino	266	405	1,938	6,300	North Coast
Napa	266	405	3,561	18,190	North Coast
San Francisco	266	405	3,561	18,190	North Coast
Sonoma	266	405	2,899	12,219	North Coast

Notes on sources:
Farm operating cost data and water use obtained from UC Extension current cost and return studies.
These can be found at http://coststudies.ucdavis.edu/county.htm
The following studies were used here:

1. Pasture in Mendocino county
2. Alfalfa in Siskiyou county
3. Wine grapes in Napa county
4. Wine grapes in Sonoma county
5. Wine grapes in Lake county
6. Broccoli & Cauliflower in Central coast
7. For pasture in the Central Coast used alfalfa data

Notes on sources of other data used to generate this analysis:
County census data for 1997 on irrigated pasture and crop land by county were obtained from http://govinfo.kerr.orst.edu/php/agri/index.php.
County data on irrigated water withdraw levels in 1995 for pasture and crops were obtained from http://water.usgs.gov/watuse/spread95.html.

ATTACHMENT 6

HABITAT RESTORATION FISCAL COSTS	Cost ($)	Quantity	HABITAT RESTORATION SOCIOECON. IMPACTS	Impacts ($)	Quantity
Riparian revegetation (miles)					
Total SONCC	75,418,779	417	Total SONCC	35,446,826	417
Total CCC	2,666,164		Total CCC	1,253,097	
Total	**78,084,943**	**417**	**Total excl. SSPP**	**36,699,923**	**417**
Scott	47,782,069	264	Scott	22,457,572	264
Shasta	39,818,391	220	Shasta	18,714,644	220
Total SSPP	**87,600,460**	**484**	**Total SSPP**	**41,172,216**	**484**
Total incl. SSPP	**165,685,403**	**901**	**Total incl. SSPP**	**77,872,139**	**901**
Streambank restoration (miles)					
Total SONCC	305,042,453	400	Total SONCC	143,369,953	400
Total CCC	326,319,717	80	Total CCC	153,370,267	80
Total	**631,362,170**	**480**	**Total excl. SSPP**	**296,740,220**	**480**
Scott	65,836,089	50	Scott	30,942,962	50
Shasta	171,173,832	130	Shasta	80,451,701	130
Total SSPP	**237,009,922**	**180**	**Total SSPP**	**111,394,663**	**180**
Total incl. SSPP	**868,372,091**	**660**	**Total incl. SSPP**	**408,134,883**	**660**
Fencing (miles)					
Total SONCC	13,397	2,071	Total SONCC	13,397	2,071
Total CCC	226,983		Total CCC	226,983	
Total	**240,380**	**2,071**	**Total excl. SSPP**	**240,380**	**2,071**
Scott	138	50	Scott	138	50
Shasta	358	130	Shasta	358	130
Total SSPP	**495**	**180**	**Total SSPP**	**495**	**180**
Total incl. SSPP	**240,875**	**2,251**	**Total incl. SSPP**	**240,875**	**2,251**
Barriers to passage (number)					
Total SONCC	196,097,109	2702	Total SONCC	116,542,265	2702
Total CCC	456,217,478	2741	Total CCC	273,022,487	2741
Total excl. SSPP	**652,314,587**	5443	**Total excl. SSPP**	**389,564,752**	5443
Scott	2,604,636	23	Scott	1,550,782	23
Shasta	4,455,000	8	Shasta	2,661,000	8
Total SSPP	**7,059,636**	31	**Total SSPP**	**4,211,782**	31
Total incl. SSPP	**659,374,223**	5474	**Total incl. SSPP**	**393,776,534**	5474

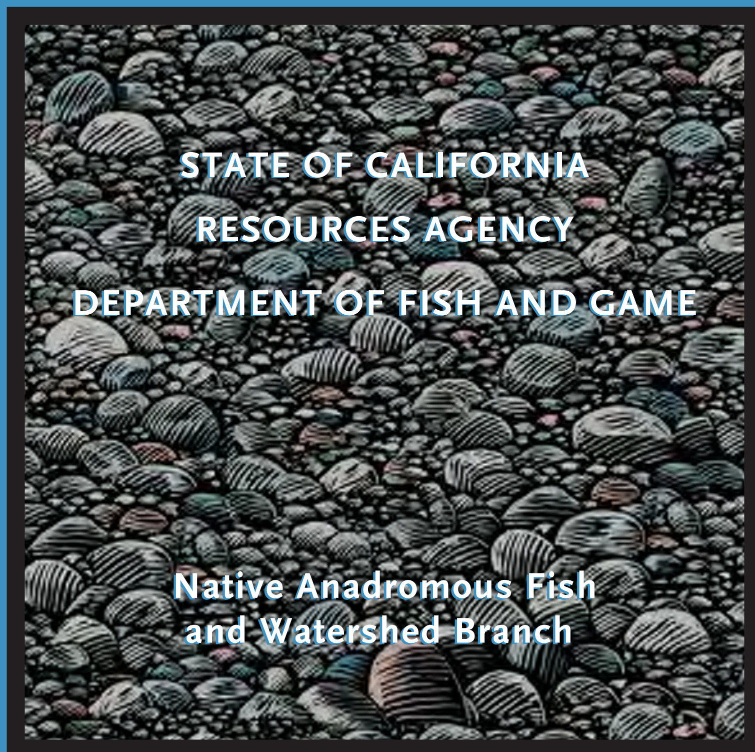
ATTACHMENT 6

Continued…

HABITAT RESTORATION FISCAL COSTS	Cost ($)	Quantity	HABITAT RESTORATION SOCIOECON. IMPACTS	Impacts ($)	Quantity
Road decommissioning (miles)					
Total SONCC	423,985,628	50,039	Total SONCC	282,657,085	52,198
Total CCC	33,242,825	2,159	Total CCC	22,161,884	
Total excl. SSPP	**457,228,453**	**52,198**	**Total excl. SSPP**	**304,818,969**	**52,198**
Scott	-	-	Scott	-	-
Shasta	-	-	Shasta	-	-
Total SSPP	**-**	**-**	**Total SSPP**	**-**	**-**
Total incl. SSPP	**457,228,453**	**52,198**	**Total incl. SSPP**	**304,818,969**	**52,198**
Road treatment (miles)					
Total SONCC	633,583,234	49,425	Total SONCC	474,191,226	61,658
Total CCC	332,514,813	12,232	Total CCC	248,863,288	
Total excl. SSPP	**966,098,047**	**61,658**	**Total excl. SSPP**	**723,054,513**	**61,658**
Scott	84,764	6	Scott	63,439	6
Shasta	-	-	Shasta	-	-
Total SSPP	**84,764**	**6**	**Total SSPP**	**63,439**	**6**
Total incl. SSPP	**966,182,811**	**61,663**	**Total incl. SSPP**	**723,117,953**	**61,663**
Total excl. SSPP	**141,956,388**	**597**			
LWD placement (miles)					
Total SONCC	11,898,330	597	Total SONCC	7,716,225	597
Total CCC	130,058,058	N.a.	Total CCC	84,537,738	N.a.
Total excl. SSPP	**141,956,388**	**597**	**Total excl. SSPP**	**92,253,963**	**597**
Scott	1,500,000	N.a.	Scott	975,000	-
Shasta	758,400	40	Shasta	478,400	40
Total SSPP	**2,258,400**		**Total SSPP**	**1,453,400**	**40**
Total incl. SSPP	**144,214,788**	**N.a.**	**Total incl. SSPP**	**93,707,363**	**N.a.**
In-stream complexity (miles)					
Total SONCC	34,463,477	865	Total SONCC	22,401,260	865
Total CCC	183,892,527	N.a.	Total CCC	119,530,142	N.a.
Total excl. SSPP	**218,356,004**	**865**	**Total excl. SSPP**	**141,931,402**	**865**
Scott	19,000	1	Scott	12,350	1
Shasta	1,520,000	40	Shasta	988,000	40
Total SSPP	**1,539,000**	**41**	**Total SSPP**	**1,000,350**	**41**
Total incl. SSPP	**219,895,004**	**N.a.**	**Total incl. SSPP**	**142,931,752**	**N.a.**

Continued…

HABITAT RESTORATION FISCAL COSTS			HABITAT RESTORATION SOCIOECON. IMPACTS		
	Cost ($)	Quantity		Impacts ($)	Quantity
Total SONCC	1,680,502,407		Total SONCC	1,082,338,237	
Total CCC	1,465,138,565		Total CCC	902,965,885	
Total excl. SSPP	**3,145,640,972**		**Total excl. SSPP**	**1,985,304,122**	
Scott	117,826,696		Scott	56,002,243	
Shasta	217,725,981		Shasta	103,294,103	
Total SSPP	**335,552,677**		**Total SSPP**	**159,296,346**	
Total incl. SSPP	**3,481,193,649**		**Total incl. SSPP**	**2,144,600,468**	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RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME
Native Anadromous Fish
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