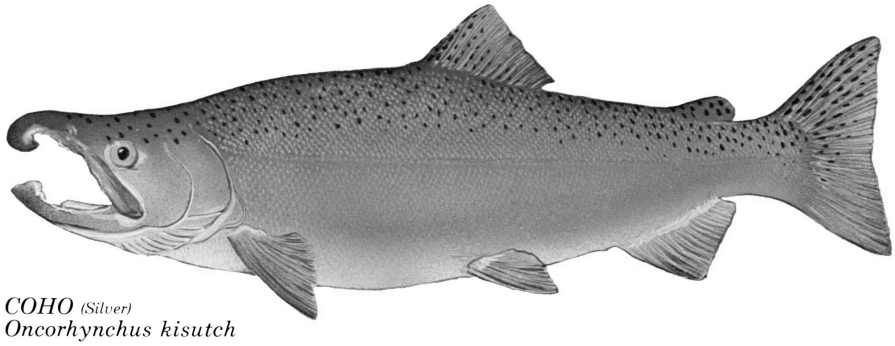
RECOVERY STRATEGY FOR CALIFORNIA COHO SALMON (*ONCORHYNCHUS KISUTCH*)

Report to the California Fish and Game Commission

August 2003



California Department of Fish and Game
The Resources Agency
State of California

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RECOVERY STRATEGY FOR CALIFORNIA COHO SALMON

Report to the California Fish and Game Commission

Prepared by
The California Department of Fish and Game

Species Recovery Plan Report 2003-1

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Executive Summary

On August 30, 2002, the California Fish and Game Commission (Commission) found that coho salmon (*Oncorhynchus kisutch*) warranted listing as an endangered species under the California Endangered Species Act (CESA) from San Francisco north to Punta Gorda and as a threatened species from Punta Gorda to the California-Oregon border. The division of coho salmon in California follows the federal designation of Evolutionary Significant Units (ESU); the California Central Coast (CCC) Coho ESU and the Southern Oregon-Northern Coastal California (SONCC) Coho ESU. Rather than proceeding immediately with regulatory action, the Commission, pursuant to Fish and Game Code (FGC) section 2114, directed the Department of Fish and Game (Department) to prepare a recovery strategy for coho salmon within 12 months (pursuant to FGC §2105 et seq.)

The Department issued a report to the Commission describing the status of coho salmon north of San Francisco Bay. Available information indicates that coho salmon from San Francisco Bay to the Oregon border have experienced a significant decline in the past 40 to 50 years. Coho salmon abundance, including hatchery stocks, is currently 6 to 15% 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 indicate an overall declining trend throughout California.

In accordance with the Comimission's direction, the Department established a 21-member California Statewide Coho Salmon Recovery Team (CRT) and a 12-member local coho salmon recovery team (SSRT) focusing on agricultural water and land uses in the Shasta and Scott river valleys. Both teams brought together people with various concerns and perspectives. The two teams aided the Department in development of a single strategy to recover coho salmon throughout its range in California.

The fundamental and statutorily required goal of this recovery strategy is to return coho salmon to level of sustained viability while protecting the genetic integrity of both ESUs, such that regulations or other protections under the California Endangered Species Act (FGC §2050 et seq.) are not necessary. The Department defines sustained viability as a future condition when naturally producing coho salmon are sufficient in abundance and in sufficient range and distribution to ensure

against extinction due to environmental fluctuation, stochastic events, and human land use impacts while allowing for incidental mortality of coho salmon and coho salmon by-catch associated with well-regulated ocean and recreation fisheries for other species of anadromous salmonids.

The recovery strategy has an additional goal to achieve harvestable populations of coho for tribal, recreational, and commercial fisheries.

GEOGRAPHIC SETTING

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 watersheds, south to the streams of northern Monterey Bay, including small tributaries to San Francisco Bay.

Two coho salmon ESUs occur partially or entirely within California. The California portion of the SONCC ESU occurs in twelve California watersheds from Punta Gorda north to the Oregon border. The CCC ESU occurs entirely in six watersheds from Santa Cruz north to Punta Gorda.

RECOVERY GOALS

To achieve the fundamental and statutorily required goal of the recovery strategy, coho salmon must first reach the point where the regulations or other protections for coho salmon listed under CESA are not necessary, and the species may be delisted. The CRT requested, and the Department agreed, to an additional goal of restoring tribal, recreational, and commercial coho salmon fisheries in California (restoring fisheries). Improving coho salmon populations and habitat is the means to achieve these two objectives.

Five criteria have been identified to achieve delisting:

I. Maintain and protect the number and size of key populations of coho salmon.

II. Maintain and increase the number of spawning adults and maximize freshwater and estuary survival of juveniles in basins to a level that reduces the probability of extinction to an insignificant level.

III. Maintain and increase the range and distribution of coho salmon to a level that reduces the probability of extinction of an ESU to an insignificant level.

IV. Maintain and protect habitat essential for coho salmon.

V. Maintain, improve, and restore coho salmon habitat to a level that reduces the probability of extinction to an insignificant level.

An additional criterion has been identified for the second objective:

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

RECOVERY IMPLEMENTATION

The causes for the decline of coho salmon are many and complex. On the whole, the strategy for recovery of coho salmon involves:

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 watersheds.

With the aid of the CRT, the Department developed a recovery strategy that will be implemented at two geographic levels. The first level is a larger, range-wide resolution. The recovery strategy identifies recommendations for range-wide issues. The second level is within each watershed. The recovery strategy identifies recommendations that apply to specific watersheds. These two levels allow for acting on recommendations that are more universal in their application and for taking specific actions intended for issues specific to a watershed. In line with this second course, the Department established the Shasta-Scott Pilot Program (SSP), a unique endeavor within the Shasta and Scott watersheds were coho salmon occur. The SSP contains a detailed analysis of agricultural water and land use issues in the Shasta and Scott valleys and a detailed set of recommendations in reference to such uses for recovery. Non-agricultural water and land use issues are addressed in the statewide recommendations and/or watershed-specific recommendations for the Shasta and Scott watersheds.

Several central elements underlie all levels of implementation. Those elements include: 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; and improved land management.

Table of Contents

1 Introduction 1-1

1.1 STATE OF CALIFORNIA COHO SALMON LISTING ACTIONS 1-1
1.2 FEDERAL COHO SALMON LISTING ACTIONS 1-2
1.3 STRATEGIC PLANNING FOR RECOVERY 1-3
1.3.1 FISH AND GAME COMMISSION ACTION 1-3
1.3.2 CALIFORNIA STATEWIDE RECOVERY TEAM 1-3
1.3.3 SHASTA-SCOTT RIVER RECOVERY TEAM 1-4
1.3.4 FEDERAL TECHNICAL REVIEW TEAMS 1-4
1.4 RECOVERY STRATEGY FOR COHO SALMON IN CALIFORNIA 1-5
1.4.1 GENERAL GOALS 1-5
1.4.2 ELEMENTS NECESSARY TO ACHIEVE RECOVERY GOALS 1-6
1.4.3 IMPLEMENTATION 1-7
1.4.3.1 Immediate Actions 1-7
1.4.3.2 Longer Term Actions 1-7
1.4.4 ADAPTIVE MANAGEMENT 1-7

2 Biology 2-1

2.1 RANGE 2-1
2.2 EVOLUTIONARILY SIGNIFICANT UNITS 2-2
2.2.1 SOUTHERN OREGON/NORTHERN CALIFORNIA COAST COHO ESU 2-5
2.2.2 CENTRAL CALIFORNIA COAST COHO ESU 2-5
2.3 LIFE HISTORY 2-6
2.4 POPULATION STRUCTURE AND VIABILITY 2-8
2.4.1 POPULATION STRUCTURE 2-9
2.4.2 POPULATION VIABILITY 2-10
2.5 GENETICS 2-11
2.6 HABITAT REQUIREMENTS 2-17
2.6.1 HABITAT REQUIREMENTS FOR ADULTS 2-17
2.6.1.1 Migration 2-17
2.6.1.2 Spawning 2-18
2.6.2 HABITAT REQUIREMENTS FOR JUVENILES 2-19
2.6.2.1 Eggs and Alevin Incubation 2-19
2.6.2.2 Fry Emergence 2-20
2.6.2.3 Juvenile Rearing 2-20
2.6.2.4 Emigration 2-21

2.6.3 ESSENTIAL ESTUARINE HABITAT 2-22
2.6.4 SUMMARY OF ESSENTIAL HABITAT 2-22
2.6.4.1 Stream Vegetation 2-23
2.6.4.2 Large Woody Debris 2-23
2.6.4.3 Sediment and Substrate 2-25
2.6.4.4 Hydrological Regime 2-25
2.6.4.5 Water Temperature 2-25
2.6.4.6 Dissolved Oxygen 2-26

3 Threats 3-1

3.1 CLIMATIC VARIATION 3-1
3.1.1 DROUGHT 3-1
3.1.2 FLOODING 3-2
3.1.3 OCEAN CONDITIONS 3-2
3.2 DISEASE 3-4
3.3 PREDATION 3-4
3.3.1 FRESHWATER PREDATION 3-4
3.3.2 MARINE PREDATION 3-5
3.4 HATCHERIES 3-6
3.5 GENETIC DIVERSITY 3-6
3.6 LAND USE 3-10
3.6.1 FORESTRY ACTIVITIES 3-10
3.6.2 WATER DIVERSIONS AND FISH SCREENS 3-11
3.6.3 INSTREAM FLOWS 3-13
3.6.4 ARTIFICIAL BARRIERS 3-14
3.6.5 GRAVEL EXTRACTION 3-16
3.6.6 SUCTION DREDGING 3-17
3.6.7 STREAMBED ALTERATION 3-17
3.6.8 WATER QUALITY 3-17
3.6.9 AGRICULTURAL IMPACTS 3-20
3.6.10 URBANIZATION 3-21
3.6.11 FISHING 3-21
3.6.12 ILLEGAL HARVEST 3-22

4 Recovery Goals and Delisting Criteria 4-1

4.1 FRAMEWORK FOR DELISTING CRITERIA 4-1
4.2 DELISTING REQUIREMENTS 4-3
4.2 FRAMEWORK FOR RESTORATION OF FISHERIES 4-8
4.2.1 RECREATIONAL FISHING 4-9
4.2.2 COMMERCIAL FISHING 4-10

5 Elements Necessary for Recovery 5-1
5.1 ROLE OF PUBLIC LANDS 5-1
5.1.1 FEDERAL LANDS 5-1
5.1.1.1 U.S. Forest Service (USFS) 5-2
5.1.1.2 U.S. Bureau of Land Management (BLM) 5-2
5.1.1.3 U.S. National Park Service (NPS) 5-7
5.1.1.4 U.S. Department of Defense (DOD) 5-7
5.1.1.5 U.S. Fish & Wildlfie Service (USFWS) 5-7
5.1.1.6 U.S. Bureau of Reclamation (BOR) 5-8
5.1.2 STATE LANDS 5-8
5.1.2 STATE LANDS 5-8
5.1.2.1 California Department of Parks and Recreation (DPR) 5-8
5.1.2.2 California Department of Forestry and Fire Protection (CDF) 5-8
5.1.2.3 California State Lands Commission (SLC) 5-9
5.1.2.4 California Department of Fish and Game 5-9
5.1.3 COUNTY AND CITY LANDS 5-10
5.2 PRIVATE AND PUBLIC COOPERATION 5-10
5.2.1 EXISTING PROGRAMS 5-10
5.2.1.1 Fisheries Restoration Grants Program 5-10
5.2.1.2 Farm Bill Grants 5-12
5.2.1.3 Watershed and Nonpoint Source Pollution Control Programs 5-13
5.2.1.4 Other Programs 5-15
5.2.2 MINIMIZING SOCIAL AND ECONOMIC IMPACTS 5-15
5.2.3 VOLUNTARY INCENTIVES 5-15
5.3 OUTREACH AND EDUCATION 5-15
5.3.1 RECOVERY STRATEGY RECOMMENDATIONS 5-16
5.3.2 EDUCATION AND OUTREACH PLAN 5-16
5..3.2.1 School Curricula 5-16
5.3.2.2 Interpretive Media 5-17
5.4 ASSESSMENT, MONITORING, AND RESEARCH 5-18
5.4.1 PROGRAM FRAMEWORK 5-18
5.4.1.1 Scientific Planning and Prioritization 5-18
5.4.1.2 Evaluating Current Monitoring 5-19
5.4.1.3 Data Management 5-19
5.4.1.4 New Research 5-21
5.4.1.5 Program Reporting 5-21
5.4.2 ASSESSMENT 5-21
5.4.3 MONITORING 5-22
5.4.3.1 Three-tiered Monitoring Framework 5-22
5.4.3.2 Monitoring of the Coho Salmon Monitoring Program 5-24
5.4.4 NEW RESEARCH 5-25
5.4.5 COLLABORATION AND PROGRAM PERFORMANCE 5-26
5.4.6 ASSESSMENT, MONITORING, AND RESEARCH 5-26

6 Range-wide Recommendations 6-1
6.1 STREAM FLOW 6-1
6.2 WATER RIGHTS 6-2
6.3 FISH PASSAGE 6-3
6.4 POLLUTANTS 6-3
6.5 SEDIMENTS 6-4
6.6 WATER TEMPERATURE 6-4
6.7 RECRUITMENT OF LARGE WOODY DEBRIS 6-5
6.8 STREAM COMPLEXITY 6-5
6.9 ECOLOGICAL REFUGIA 6-5
6.10 HABITAT FRAGMENTATION 6-5
6.11 COMPETITION 6-5
6.12 GENETICS 6-6
6.13 RIPARIAN VEGETATION 6-6
6.14 LAND USE 6-6
6.15 PUBLIC OUTREACH 6-7
6.16 INTEGRATION WTIH OTHER PLANS AND PROGRAMS 6-7
6.17 PERMITTING 6-7
6.18 WATERSHED PLANNING 6-8
6.19 ENFORCEMENT OF EXISTING LAWS 6-8
6.20 IMPLEMENTATION 6-9
6.21 INSTEAM GRAVEL MINING 6-10

7 Watershed Recommendations 7-1
7.1 WATERSHED CLASSIFICATION 7-1
7.2 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS ESU 7-2
7.2.1 ROGUE RIVER AND WINCHUCK RIVER HYDROLOGIC UNITS 7-2
7.2.1.1 Illinois River HSA 7-9
7.2.1.2 Winchuck River Hydrologic Unit / Winchuck River HSA 7-9
7.2.2 SMITH RIVER HYDROLOGIC UNIT 7-10
7.2.2.1 Recommendations for the Smith River HU 7-10
7.2.2.2 Mill Creek HSA 7-11
7.2.2.3 Wilson Creek HSA 7-12
7.2.2.4 Smith River Plain HSA 7-12
7.2.2.5 HSAs with No Recommendations 7-13
7.2.3 KLAMATH RIVER HU 7-13
7.2.3.1 Recommendations for the Klamath River HU 7-14
7.2.3.2 Klamath Glen HSA 7-14
7.2.3.3 Orleans HSA 7-16
7.2.3.4 Ukonom HSA 7-17
7.2.3.5 Happy Camp HSA 7-18
7.2.3.6 Seiad Valley HSA 7-20

7.2.3.7 Beaver Creek HSA 7-21
7.2.3.8 HSAs with No Recommendations 7-22
7.2.4 SALMON RIVER HYDROLOGIC AREA 7-22
7.2.4.1 Recommendations for the Salmon River HA 7-25
7.2.4.2 HSAs with No Recommendations 7-26
7.2.5 SHASTA VALLEY AND SCOTT RIVER HYDROLOGIC AREAS 7-26
7.2.5.1 Shasta Valley HA/HSA 7-26
7.2.5.2 Scott River HA 7-29
7.2.5.3 Recommendations for the Scott and Shasta Rivers (Non-agricultural) 7-30
7.2.6 TRINITY RIVER HYDROLOGIC UNIT 7-34
7.2.6.1 Trinity River HU Recommenations 7-37
7.2.6.2 Douglas Creek HSA 7-37
7.2.6.3 Grouse Creek HSA 7-38
7.2.6.4 Hyapom HSA 7-38
7.2.6.5 Hayfork HSA 7-38
7.2.6.6 HSAs with No Recommendations 7-39
7.2.7 MAD RIVER HYDROLOGIC UNIT 7-40
7.2.7.1 Mad HU Recommenations 7-43
7.2.7.2 Blue Lake HSA and North Fork Mad HSA 7-44
7.2.7.3 HSAs with No Recommendations 7-44
7.2.8 REDWOOD CREEK HYDROLOGIC UNIT 7-44
7.2.8.1 Redwood Creek HU Recommenations 7-47
7.2.8.2 HSAs with No Recommendations 7-48
7.2.9 TRINIDAD PLAIN HYDROLOGIC UNIT 7-48
7.2.9.1 Trinidad Plain HU Recommenations 7-49
7.2.9.2 Big Lagoon HSA 7-49
7.2.9.3 Little River HSA 7-49
7.2.10 EUREKA PLAIN HYDROLOGIC UNIT 7-50
7.2.11 EEL RIVER HYDROLOGIC UNIT 7-53
7.2.11.1 Eel River HU Recommendations 7-54
7.2.11.2 Ferndale HSA 7-54
7.2.11.3 South Fork Eel River HSA 7-57
7.2.11.4 Weott HSA 7-57
7.2.11.5 Laytonville HSA 7-58
7.2.11.6 Outlet Creek HSA 7-58
7.2.11.7 HSAs with No Recommendations 7-59
7.2.12 CAPE MENDOCINO HYDROLOGIC UNIT 7-62
7.2.12.1 Recommmendation for the Cape Mendocino HU 7-65
7.2.12.2 Mattole River HSA 7-65
7.2.12.3 HSAs with No Recommendations 7-68
7.3 CENTRAL CALIFORNIA COAST ESU 7-68
7.3.1 MENDOCINO COAST HYDROLOGIC UNIT 7-68
7.3.1.1 Mendocino Coast HU Recommendations 7-73
7.3.1.2 Albion River HSA 7-75

7.3.1.3 Big River HSA 7-76
7.3.1.4 Garcia River HSA 7-76
7.3.1.5 Navarro River HSA 7-77
7.3.1.6 Noyo River HSA 7-77
7.3.1.7 Ten Mile River HSA 7-78
7.3.1.8 HSAs with No Recommendations 7-78
7.3.2 RUSSIAN RIVER HYDROLOGIC UNIT 7-79
7.3.2.1 Recommendations for the Russian River HU 7-80
7.3.2.2 Russian River Mainstem 7-84
7.3.2.3 Guerneville HSA 7-84
7.3.2.4 Austin Creek HSA 7-85
7.3.2.5 Warm Springs HSA 7-85
7.3.2.6 Mark West Creek HSA 7-86
7.3.2.7 Santa Rosa Creek HSA 7-87
7.3.2.8 Forsythe Creek HSA 7-88
7.3.2.9 Geyserville HSA 7-88
7.3.3 BODEGA AND MARIN COASTAL HYDROLOGIC UNITS 7-89
7.3.3.1 Bodega Marin Coastal HU Recommendations 7-90
7.3.3.2 Salmon Creek HSA 7-93
7.3.3.3 Walker Creek HSA 7-93
7.3.3.4 Lagunitas Creek HSA 7-94
7.3.3.5 Bolinas HSA 7-96
7.3.3.6 HSAs with No Recommendations 7-97
7.3.4 SAN FRANCISCO BAY HYDROLOGIC UNITS 7-97
7.3.4.1 Recommendations for San Francisco Bay HUs 7-98
7.3.4.2 San Rafael HSA 7-98
7.3.4.3 HSAs with No Recommendations 7-98
7.3.5 SAN MATEO COAST HYDROLOGIC UNIT 7-101
7.3.5.1 Recommendations for San Mateo Coastal HU 7-102
7.3.5.2 San Gregorio Creek HSA and Pescadero Creek HSA 7-105
7.3.5.3 Año Nuevo (Gazos Creek) HSA 7-106
7.3.6 BIG BASIN HYDROLOGIC UNIT 7-106
7.3.6.1 Recommendations for the Big Basin HU 7-110
7.3.6.2 Davenport HSA 7-110
7.3.6.3 San Lorenzo River HSA 7-111
7.3.6.4 Aptos-Soquel HSA 7-112

8 Shasta-Scott Pilot Program 8-1
8.1 FRAMEWORK FOR AGRICULTURAL ISSUES 8-1
8.2 SHASTA-SCOTT PILOT PROGRAM RECOMMENDATIONS 8-2
8.2.1 WATER MANAGEMENT RECOMMENDATIONS 8-2
8.2.1.1 Emergency Water Plan 8-3
8.2.1.2 Verification of Water Diversions with Water Rights 8-3
8.2.1.3 Ramped Flows for Diversions 8-4

8.2.1.4 Pulse Flows 8-5
8.2.1.5 Using Unused Water and Water Rights for Instream Fish Flows 8-5
8.2.1.6 Irrigation Rotation Program 8-6
8.2.1.7 Install Head Gates and Measuring Devices on Diversions 8-6
8.2.1.8 Water Availability Projections and Forecasts 8-7
8.2.1.9 Instream flow Studies and Recommendations 8-8
8.2.1.10 Groundwater Studies 8-8
8.2.1.11 Water Balance Study 8-9
8.2.2 WATER AUGMENTATION RECOMMENDATIONS 8-10
8.2.2.1 Water Trust 8-10
8.2.2.2 Study Additional Large Surface Water Storage 8-11
8.2.2.3 Small Storage Opportunities 8-11
8.2.2.4 Store Water with a Conjunctive Groundwater Use Program and Groundwater Recharge Ponds 8-12
8.2.2.5 Scott Valley Tailings Storage 8-12
8.2.2.6 Water Conveyance to Shasta Valey from Main Klamath 8-13
8.2.2.7 Acquiring Water Rghts 8-13
8.2.3 HABITAT MANAGEMENT RECOMMENDATIONS – SCOTT RIVER 8-14
8.2.3.1 Improvement of Summer and Winter Rearing Habitat – Lack of Habitat Complexity 8-14
8.2.3.2 Improvement of Summer and Winter Rearing Habitat – High Water Temperatures 8-16
8.2.3.3 Improve Valley and Low-gradient Tributary Channel Structure and Function ... 8-17
8.2.3.4 Barriers to Fish Passage 8-18
8.2.3.5 Improvement of Spawning Habitat 8-18
8.2.4 HABITAT MANAGEMENT RECOMMENDATIONS – SHASTA RIVER 8-19
8.2.4.1 Improvement of Rearing Habitat 8-19
8.2.4.2 Barriers to Fish Passage 8-20
8.2.4.3 Spawning Gravel Management 8-21
8.2.4.4 Riparian Vegetation Management 8-23
8.2.4.5 Water Temperature 8-24
8.2.5 WATER USE EFFICIENCY RECOMMENDATIONS 8-24
8.2.5.1 Stock Water Alternatives 8-25
8.2.5.2 Landowner Workshops 8-25
8.2.5.3 Ditch Lining and Piping 8-25
8.2.5.4 Ditch Repair and Cleaning 8-26
8.2.5.5 Irrigation System Efficiency 8-26
8.2.5.6 Cropping Changes 8-27
8.2.5.7 Tailwater Reclamation 8-28
8.2.5.8 Agricultural Water Conservation Best Management Practices 8-29
8.2.6 PROTECTION RECOMMENDATIONS 8-29

8.2.7 MONITORING AND ASSESSMENT RECOMMENDATIONS 8-32
8.2.7.1 Monitoring and Assessment: Habitat 8-32
8.2.7.2 Monitoring and Assessment: Coho Salmon Populations 8-34
8.2.7.3 Cooperative Efforts 8-35
8.2.7 EDUCATION AND OUTREACH RECOMMENDATIONS 8-36
8.3 ADMINISTRATION AND IMPLEMENTATION 8-40

9 Timeframe and Economics of Recovery 9-1

10 Implementation 10-1
10.1 PRIORITIZATION OF WATERSHEDS 10-1
10.1.1 GENERAL PRINCIPLES 10-2
10.1.2 PRIORITIZATION PROCESS 10-19
10.1.2.1 Identify Refugia Watersheds and Risk of Extinction 10-19
10.1.2.2 Identify Restoration Potential 10-19
10.1.2.3 Identify Disconnected Habitats 10-20
10.2 IMPLEMENTATION SCHEDULE AND COSTS 10-21
10.3 FEASIBILITY 10-21
10.4 AVAILABILITY OF FUNDS 10-21
10.5 RESPONSIBLE PARTIES 10-21

11 Process for Revising the Recovery Strategy 11-1
11.1 TIMETABLE FOR REPORTING AND REVISION 11-1
11.2 TIMETABLE CLARIFYING NON-SPECIFIC LONG-TERM GOALS 11-2
11.3 ADAPTIVE MANAGEMENT 11-3

12 References Cited 12-1

List of Tables

TABLE 2-1 2-12
California streams for which coho salmon genetic tissue samples have been collected, analyzed, and reported, 1982 to the present

TABLE 2-2 2-23
Freshwater habitats of the different life stages of coho salmon

TABLE 2-3 2-24
Fundamental habitat elements and suitable ranges for coho salmon life stages

TABLE 3-1 3-7
Identified concerns about maintenance of existing genetic diversity and possible causes of reduction of genetic diversity in California coho salmon

TABLE 3-2 3-9
Guidelines for number of breeders per generation and number of breeders per year needed to maintain genetic diversity in populations of California coho salmon

TABLE 3-3 3-12
Forestry activities and potential effects to stream environment, salmonid habitat, and salmonid biology

TABLE 3-4 3-15
Major dams within the California portion of the Southern Oregon/ Northern California Coast Coho ESU that block coho salmon from accessing historical spawning and rearing habitat

TABLE 3-5 3-16
Major dams within the Central California Coast Coho ESU that block coho salmon from accessing historical spawning and rearing habitat

TABLE 3- 6 3-18
Clean Water Act Section 303(d) impaired water bodies within the range of coho salmon in California

TABLE 5-1 5-21
Partial outline of potential ecological and land management variables for coho salmon recovery strategy assessment, monitoring, and research

TABLE 8-1 8-3
Watersheds in the SONCC and CCC ESUs

TABLE 10-1 10-20
Implementation Schedule (in preparation)

List of Figures

FIGURE 2-1 2-3
Coho Evolutionarily Significant Units in California

FIGURE 2-2 2-6
Calendar indicating the seasonal presence of coho salmon in California coastal watersheds

FIGURE 2-3 2-14
Dendrogram based on pairwise genetic distances (Cavalli-Sforza and Edwards 1967) between 26 samples of coho salmon from southern Oregon and California

FIGURE 2-4 2-15
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

FIGURE 2-5 2-16
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 3-5

FIGURE 3-1 3-3
Monthly values for the PDO index: Jan 1900—Apr 2003

FIGURE 5-1 5-3
Land ownership in the SONCC ESU

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

FIGURE 7-1 7-3
Hydrologic units in California within the SONCC and CCC ESUs

FIGURE 7-2 7-5
Rogue River and Klamath River Hydrologic Units

FIGURE 7-3 7-7
Winchuck River and Smith River Hydrologic Units

FIGURE 7-4 7-23
Salmon River Hydrologic ARea

FIGURE 7-5 7-27
Shasta Valley HYdrologic Area

FIGURE 7-6 7-31
Scott River HYdrologic Area

FIGURE 7-7 7-35
Trinity River Hydrologic Unit

FIGURE 7-8 7-41
Mad River Hydrologic Unit

FIGURE 7-9 7-45
Redwood Creek and Trinidad Plain Hydrologic UnitS

FIGURE 7-10 7-51
Eureka Plain Hydrologic Unit

FIGURE 7-11 7-55
Eel River Hydrologic Unit

FIGURE 7-12 7-63
Cape Mendocino Hydrologic Unit

FIGURE 7-13 7-71
Mendocino Coast Hydrologic Unit (North)

FIGURE 7-14 7-73
Mendocino Coast Hydrologic Unit (South)

FIGURE 7-15 7-81
Russian River Hydrologic Unit

FIGURE 7-16 7-91
Bodega and Marin Coastal Hydrologic Units

FIGURE 7-17 7-99
San Francisco Bay Hydrologic Units

FIGURE 7-17 7-103
San Mateo Coast Hydrologic Unit

FIGURE 7-18 7-109
Big Basin Hydrologic Unit

FIGURE 10-1 10-3
Consistent presence of Coho Salmon in the SONCC ESU

FIGURE 10-2 10-5
Consistent presence of Coho Salmon in the CCC ESU

FIGURE 10-3 10-7
Risk of extinction in watersheds of the SONCC ESU

FIGURE 10-4 10-9
Risk of extinction in watersheds of the CCC ESU

FIGURE 10-5 10-11
Restoration and management potential in the SONCC ESU

FIGURE 10-6 10-13
Restoration and management potential in the CCC ESU

FIGURE 10-7 10-15
Disconnected habitats in the SONCC ESU

FIGURE 10-8 10-17
Disconnected habitats in the CCC ESU

FIGURE 11-1 11-4
Adaptive management cycle

List of Appendices

APPENDIX A: ABBREVIATIONS AND ACRONYMS

APPENDIX B: GLOSSARY

APPENDIX C: OTHER SPECIES AT RISK

APPENDIX D: EXISTING WATERSHED PROGAMS, GROUPS, AND RESOURCES

APPENDIX E: CALWATER UNITS

APPENDIX F: WATERSHED PRIORITIZATION

1 Introduction

Coho salmon (*Onchorynchus 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 the California.

As a result, the Commission received a petition to list coho salmon north of San Francisco to the Oregon border as an endangered species under the California Endangered Species Act (CESA). The 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.

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 section 2074.6, the Department prepared a status review evaluating the status separately for the two coho salmon Evolutionary Significant Units (ESU) that occur in California. (See Section 1.2 below regarding ESUs.) The Department recommended that coho 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 is prepared, keeping in place regulations allowing for take of coho, which were adopted by the Commission pursuant to Fish and Game Code section 2084 in April 2001.

1.2 FEDERAL COHO SALMON LISTING ACTIONS

Coho salmon in California, Oregon, Washington, and Idaho were petitioned for listing under the Federal Endangered Species Act (ESA) by Oregon Trout, Pacific Rivers Council, and others in 1993. National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries, formerly National Marine Fisheries Service or NMFS [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 Coastal Califorinia (SONCC) Coho ESU. The CCC 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 NMFS Southwest Fisheries Science Center (NMFS 2001a). This status review update confirms previous conclusions of the NOAA Fisheries Biological Review

[1] National Marine Fisheries Service (NMFS) now goes by the acronym NOAA Fisheries. NMFS is used in direct quotations and for citations to documents that were published when NMFS was the name of the organization; otherwise, NOAA Fisheries is used in this document.

Team: the CCC ESU is presently in danger of extinction[2] and the condition of coho salmon is worse than indicated by previous reviews. 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 recovery is a complex process that involves both state and federal actions. 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 Fish and Game Code section 2114, directed the Department to prepare a recovery strategy for coho salmon within 12 months under Fish and Game Code section 2105 et seq. The Department immediately embarked on establishing two recovery teams: a California statewide coho recovery team and a local team for a special focus on agricultural water and land use in the Shasta and Scott River valleys. 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 aided the Department in the development of a single recovery strategy to recover coho salmon throughout its range in California.

1.3.2 CALIFORNIA STATEWIDE RECOVERY TEAM

The California Statewide Recovery Team (CRT) is made of 21 members from a wide range of interests, professions, and perspectives. The team represents county, state, and federal governments, Indian tribes, commercial and recreational fishing, forestry, agriculture, ranching, water management, and environmental interests. The CRT first

[2] Extinction can describe the loss of all living members of a species, or more localized losses of geographic units smaller than the entire species. Extinction is used in this document to describe losses at various sub specific levels such as local geographic groups, populations, watersheds, runs, ESUs (or portions of them), and/or across the species range in California. The Department has qualified the term extinction in the text in an effort to make clear which level is being discussed.

met and commenced its work in December 2002. It undertook many significant issues: degraded habitat and depleted population numbers; prioritizing recovery actions across the range of both ESUs; water quality, quantity and use; county and other agencies carrying on their necessary work; 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; 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 longer warrant listing.*

1.3.3 SHASTA-SCOTT RIVER RECOVERY TEAM

The Scott-Shasta River recovery team (SSRT) is made up of 13 members representing a variety of interests in the two 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 River valleys. The focal points for the SSRT were to restore coho salmon populations, maintain healthy agricultural industry, and address water management in each valley.

1.3.4 FEDERAL TECHNICAL REVIEW TEAMS

NOAA Fisheries is in the process of developing scientifically based criteria for delisting ESUs of anadromous salmonids, including the CCC and SONCC ESUs of coho salmon. Federal recovery efforts are focused on geographically defined Recovery Domains, of which there are four in California. There are two phases in the Federal recovery planning process for anadromous salmonids. Phase I is the development of Technical Recovery Goals. These goals will be developed by Technical Review Teams (TRT), 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, local experts on salmon biology, and academia, and are chaired by a NOAA scientist. Department biologists are part of both coho salmon TRTs.

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.

1.4.1 GENERAL GOALS

The primary and statutorily required goal of 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. The recovery strategy will incorporate an additional goal of restoring tribal, recreational, and commercial coho salmon fisheries in California.

The recovery strategy must meet specific conditions that are evaluated by the Commission (Fish and Game Code section 2111(a)-(d).)[3] These conditions are:

a. The strategy will conserve, protect, restore, and enhance coho salmon (as a species;

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

c. The strategy is supported by the best available scientific data; and

d. The strategy represents an equitable apportionment of both public and private and regulatory and nonregulatory obligations.

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. Achieving this will involve a combination of five delisting requirements that address coho salmon

[3] Meeting the additional goal of restoring tribal, commercial, and recreational fisheries is not a requirement of the recovery strategy under Fish and Game Code section 2105 *et seq*.

populations and habitat. These recovery criteria are presented in a delisting framework.

The five recovery criteria or delisting requirements for coho salmon recovery in California are:

I. Maintain and protect the number and size of key populations of coho salmon.

II. Maintain and increase the number of spawning adults and maximize freshwater and estuary survival of juveniles in basins to a level that reduces the probability of extinction to an insignificant level.

III. Maintain, and increase the range and distribution of coho salmon to a level that reduces the probability of extinction of an ESU to an insignificant level.

IV. Maintain and protect habitat essential for coho salmon.

V. Maintain, restore, and enhance coho salmon habitat to a level that reduces the probability of extinction to an insignificant level.

An additional goal of the recovery strategy is to restore coho salmon numbers to the point where tribal, recreational, and commercial fishing may occur. This goal is not statutorily required by CESA. However, it is the intention of the Department to collaborate with the CRT, including the appropriate tribal and federal governments, and stakeholders once delisting is achieved and regulations and other protections under CESA are not necessary, to determine how to continue implementation of appropriate elements of the recovery strategy to accomplish this goal, pursuant to and consistent with other applicable local, state, and federal law and voluntary measures.

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, maximizing 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 ESU being endangered and the SONCC ESU being threatened, the recovery strategy will have particular focused efforts in the CCC ESU. Additionally, as unique populations are identified within either ESU, specific directed actions may occur to promote the potential of recovery.

Geographic division, prioritization, and implementation of recovery actions are of paramount importance to the recovery strategy. This methodology maximizes: 1) efficiency of resources; 2) involvement and decision-making by local entities, watershed councils, and landowners; 3) effective identification and resolution of issues impacting coho salmon; and 4) information gathering and interpretation of population and habitat condition, effectiveness of recovery activities, and changes to coho salmon from land use and environmental fluctuation or processes. Entire watersheds and subunits of watersheds are the primary geographic divisions and are discussed watershed by watershed.

1.4.3 IMPLEMENTATION

The recovery strategy includes hundreds of potential actions to recovery coho salmon. The implementation of these actions will require long-term commitments and involvement of many parties and organizations, many years, and considerable financial support, and careful planning and management. The recovery strategy describes issues facing coho salmon and the many recommendations to address the issues. At the end of this document, the implementation schedule lists the prioritized action, the party or parties responsible or able to carry out the actions, the estimated commencement and duration, and the estimated cost.

1.4.3.1 Interim Actions

Some recommendations for recovery of coho salmon can be implemented immediately, both because there already is the economic and technical feasibility and because no regulatory or statutory change is required to start the recovery activity or decision. For the purposes of this recovery strategy, interim, or short-term, 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

There are other recommendations that require more time and planning before they can be implemented, a long duration to complete, additional funding, or which would require changes to law or regulation to be successful or even allowable. These recommendations are categorized as long-term.

1.4.4 ADAPTIVE MANAGEMENT

The Department believes adaptive management[4] 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

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

managers in an iterative process that allows for plan flexibility and responsiveness in revising the coho 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 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 recovery strategy's adaptive management process 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 of 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 and programs and assessment and monitoring information.

6. Adjust and incorporate the results of implemenation and monitoring into future decisions and revisions of the recovery strategy.

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. In contrast to other salmonids, coho salmon follow a three-year life cycle in California, dying soon after they spawn. The following is summarized from the Department's *Status Review of California Coho Salmon North of San Francisco* (CDFG 2002).

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).

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) notes 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 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, NMFS 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).

Two ESUs of coho salmon are found in California: the SONCC ESU (from Punta Gorda, California, north across the state border to Cape Blanco, Oregon) and the CCC ESU (from Punta Gorda, California, south to the San Lorenzo River) (Figure 2-1). 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 ESU. The relationship of the Iron Gate Hatchery stock with the rest of the SONCC Coho ESU was judged uncertain, and 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.

ESUs reflect the best and most current understanding of the likely boundaries of reproductively isolated salmon populations over a broad geographic area. 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.

FIGURE 2-1: Coho Evolutionarily Significant Units in California

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Coho salmon now occupy only about 61% of the SONCC Coho ESU streams that were previously identified as 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 may have lost one or more brood-year lineages.

Although streams supporting coho salmon in the California portion of the SONCC Coho ESU appear to be fewer now in comparison to the period 1985–1991, 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 (1986–1991 vs. 1995–2000) indicates that the decline is not statistically significant, whereas the NOAA Fisheries analysis of the ungrouped data (1989–2000) indicate that the decline in the northern ESU is significant.

2.2.1 SOUTHERN OREGON/NORTHERN CALIFORNIA COAST COHO ESU

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.

2.2.2 CENTRAL CALIFORNIA COAST COHO ESU

Coho 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 and near-extinctions have occurred, is a significant portion of the range of coho salmon in this ESU. Widespread extirpation or near-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.

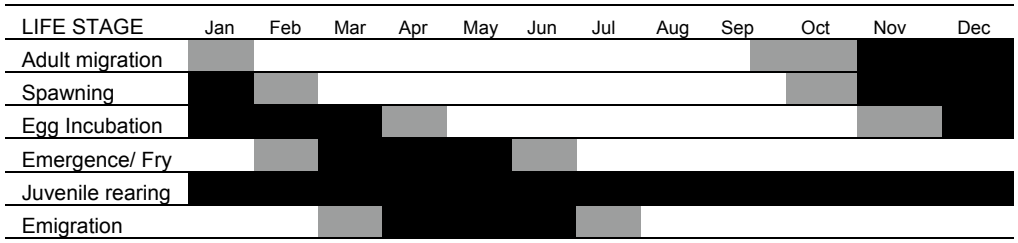
Small population size, along with large-scale fragmentation and collapse of range, indicate that metapopulation structure may be severely compromised and remaining populations may face greatly increased threats of extinction. For this reason, the

Department concluded that coho salmon in the CCC ESU are in serious danger of extinction throughout all or a significant portion of their range.

2.3 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. Coho salmon tend to move upstream during daylight hours and the diurnal timing varies by stream and/or flow (Neave 1943; Brett and MacKinnon 1954; Ellis 1962) (Figure 2-2).

FIGURE 2-2: 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.

Generally, coho salmon spawn in smaller streams than do Chinook salmon. In California, spawning mainly occurs 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 100 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 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 48 days at 48 ^{o}F, and 38 days at 51.3 ^{o}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; 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 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 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).

2.4 POPULATION STRUCTURE AND VIABILITY

McElhany et al. (2000) defines 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.

2.4.1 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) proposed 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) have stressed 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, NRC (1996) described 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) suggested 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.

2.4.2 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 100-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., 10

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 100 years is difficult to calculate (e.g., McElhaney et al. 2000; Morris et al. 1999; Dennis et al. 1991). Evaluation of viability is based on assessments of abundance, population growth rate, population structure, and diversity, reliable estimates of which are not available for California coho salmon. Therefore, it is not possible to determine viability targets, in terms of numbers of fish, for coho salmon at this time.

2.5 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 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 our understanding of coho population genetics in California. While the distribution of sampling within California (Table 2-1) is likely not sufficient to resolve coho population genetics at a scale useful to recovery planning 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 planning as they become available.

Waples et al. (2001), in a review of Pacific salmon diversity, reported 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 geographic component exists nevertheless. Although some earlier studies found low levels of diversity (Bartley et

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	Irongate Hatchery/Klamath River, Trinity River Hatchery, Mad River Hatchery	Transferrin locus Allozyme	Transferrin, PGI
Olin 1984[a]	Irongate 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.

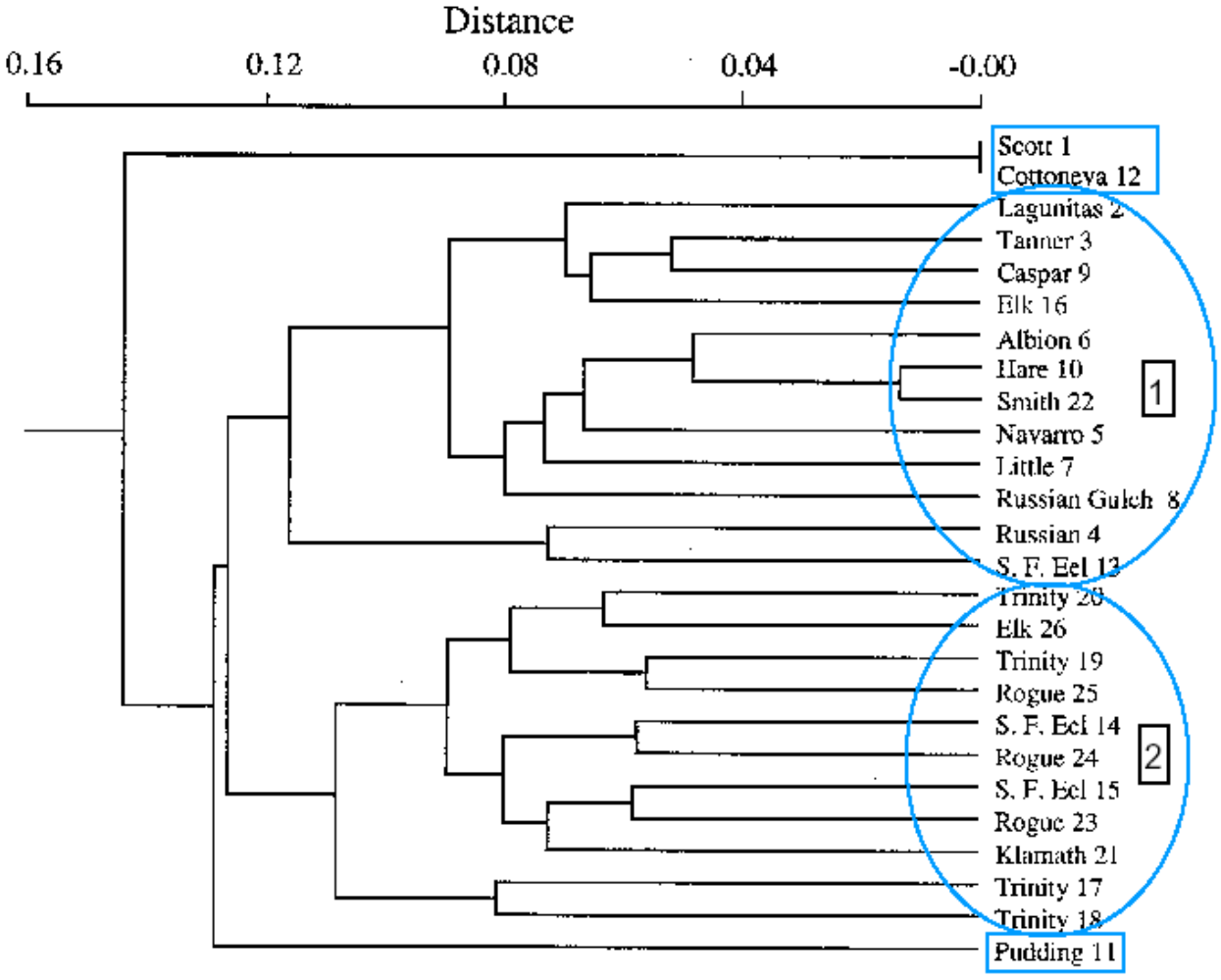
a. Reanalysis of these data appear in Sollazi 1986
b. Contains a reanalysis of 20 samples from Bartley et al. (1982) and the Iron Gate Hatchery sample from Olin (1984) along with four newly collected samples from Oregon and one from California.
c. Samples in this analysis overlap with those in Banks (1999) and Hedgecock et al. (2001).

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 2-1). 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 (SONCC coho ESU) and those south (CCC coho ESU) are likely to experience some level of gene-flow restriction that is greater than that experienced within each geographic region (see Section 2.1.1). Populations in the transition region around Punta Gorda are not easily placed in either of the two geographic regions (Figure 2-1). NOAA Fisheries identified four other more northerly coho salmon ESUs that extend from Oregon to Canada.

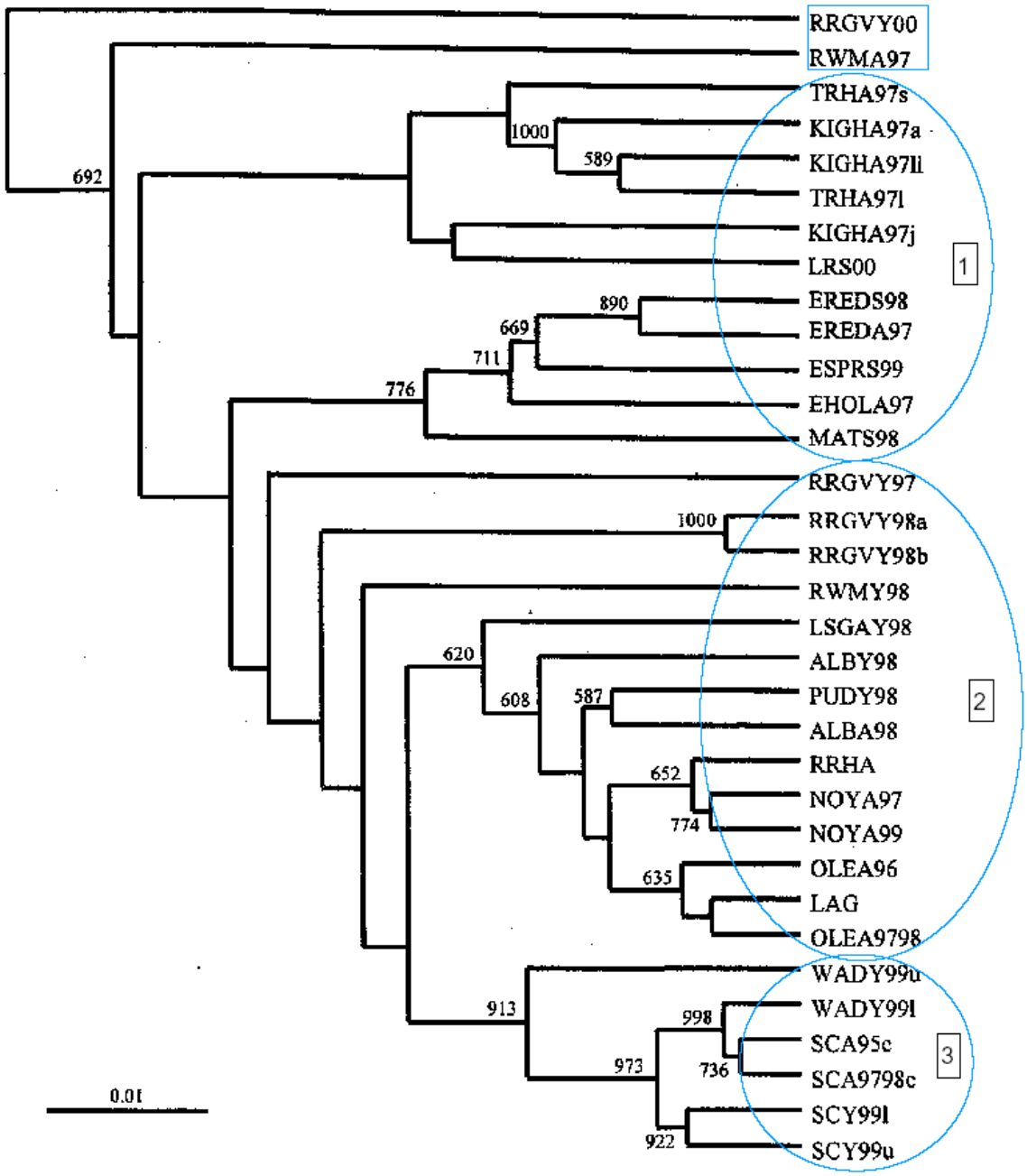
Identification of populations and determination of local population genetic structure are essential first steps in recovery planning. Figures 2-3, 2-4, and 2-5 show recently constructed genetic distance dendrograms using microsatellite DNA (Hedgecock et al. 2002) and allozyme (Weitkamp et al. 1995) data that depict the scale and relationships among the analyzed California coho salmon samples. 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.

FIGURE 2-3: Dendrogram based on pairwise genetic distances (Cavalli-Sforza and Edwards 1967) between 26 samples of coho salmon from southern Oregon and California



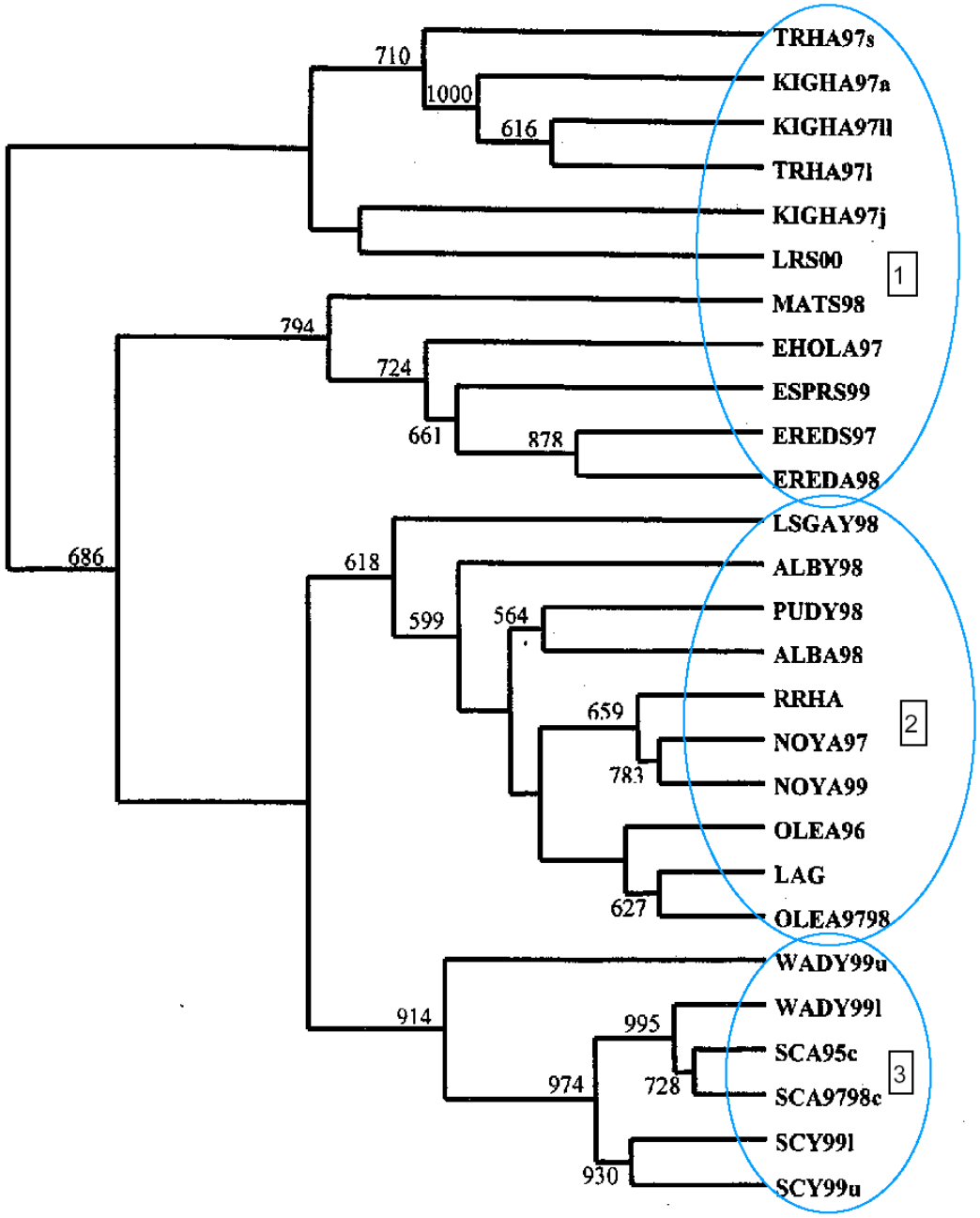
Notes:
Distances were calculated using data for 13 polymorphic allozyme loci from Bartley et al. (1982), Olin (1984), and new NOAA Fisheries samples. Ellipses encompass two major clusters: 1) mostly central California samples generally corresponding to the CCC coho ESU, and 2) samples corresponding to 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 2-4: 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*, Matole; 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. (2003).

FIGURE 2-5: 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 2-4.



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*, Matole; 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. (2003).

2.6 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.

2.6.1 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.

2.6.1.1 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 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 in (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 dissolved oxygen (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.

2.6.1.2 Spawning

Coho salmon typically spawn in small streams where the flow is 2.9 – 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 – 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 ft^2 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).

2.6.2 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.

2.6.2.1 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 reduce dissolved oxygen 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 dissolved oxygen 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 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 and sand (<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.

2.6.2.2 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).

2.6.2.3 Juvenile Rearing

The area of a particular steam 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 100 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 floodplains 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.

2.6.2.4 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.

2.6.3 ESSENTIAL ESTUARINE HABITAT

Estuaries are essential habitat of Pacific salmon, including coho salmon (Sedell et al. 1991). Both adult and juvenile coho salmon use estuaries throughout their range in California. 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.

2.6.4 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 discussed by life stage and shows the range, for each element, 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

2.6.4.1 Stream Vegetation

Vegetation in the riparian corridor provides many benefits to stream conditions and habitat. It serves as a buffer from sediment and pollution, influences the geomorphology and stream flow, and provides streambank stability. Vegetation adjacent to the water stabilizes the stream bank. The riparian buffer is vital to moderating water temperatures that influence spawning and rearing in two ways: the canopy protects the water from direct insulation and the buffer 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.

2.6.4.2 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.

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

ELEMENT	LIFE STAGE	SUITABLE RANGE	REFERENCE OR CITATION
Large woody debris	rearing juvenile	>400 ft^3/100 ft reach[a]	Murphy 1995
Riparian cover	rearing juvenile	>80%	Flosi et al. 1998
Sediment and substrate	spawning adult	20% fine sediment; .51-4.02 inches (size)[b]	Reiser and Bjornn 1979; Bjornn and Reiser 1991
	egg and fry	depth: 7.01-15.41 in; ~9.85; diameter: 1.54-5.40, ~3.70; <20% fine; <12% fine, <5% fine (optimum)	Briggs 1953; Cederholm and Reid 1987; PFMC 1999
Stream flow (peak flow, freshets, minimum summer flow)	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; .001-1.0 fish per 3.281 [.5-1 year old]	Reiser and Bjornn 1979; Bjornn and Reiser 1991
Turbidity (NTU c)	migrating adult	<30 ounces/gal a	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[d]	9.46-48.07	Bjornn and Reiser 1991
Dissolved oxygen (ounces/gallon)	migrating adult	≥80% saturation and >.037	Bjornn and Reiser 1991
	rearing juvenile	100% saturation (preferred); .037-.044 stressed, > .059 (optimum)	Reiser and Bjornn 1979; Bjornn and Reiser 1991, PFMC 1999
	egg and fry	near saturation (preferred); > .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); 62.1 (MWAT) and 64.4 (MWMT)	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	.98-2.46; 1.02; 1.9, .98-2.99	Briggs 1953; Reiser and Bjornn 1979; Bjornn and Reiser 1991
	rearing juvenile	.30-.98 (preferred for age 0), 1.02-1.51 (riffle), .30-.79 (pool); .16-1.283; .16-.98	Reiser and Bjornn 1979; Bjornn and Reiser 1991; PFMC 1999
	egg and fry	.82-2.95	PFMC 1999

Notes:
a. Coho salmon research conducted in southeast Alaska.
b. Estimated from other species or general for anadromous salmonids.
c. Nephelometric Turbidity Units
d. Various sizes and ages. Fish either aged (0 and 1) or measured 15.8-24.4cm).

2.6.4.3 Sediment and Substrate

The channel substrate type and size, and the quantity and distribution of sediment have important 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 dissolved oxygen, 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.

2.6.4.4 Hydrological Regime

The characteristics of the water and the geomorphology of the stream channel are fundamental to all coho salmon life stages that inhabit coastal watersheds. Important characteristics 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).

2.6.4.5 Water Temperature

Water temperature affects: 1) the rate and success of egg development; 2) fry maturation; 3) juvenile growth, distribution, and survival; 4) smoltification; 5) initiation of adult migration; and 6) 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.

2.6.4.6 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 the dissolved oxygen levels, impacting eggs and fry.

Threats 3

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. Timber harvest activities, especially past and present road construction, have had deleterious effects on coho salmon habitat. 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 substantially, as evidenced by the number of north- and central-coast streams that have been placed on the list of impaired water bodies, pursuant to section 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 due to sandbar formation at their mouths, created through coastal wave action and low summer flows. 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 floodplain, 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: 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

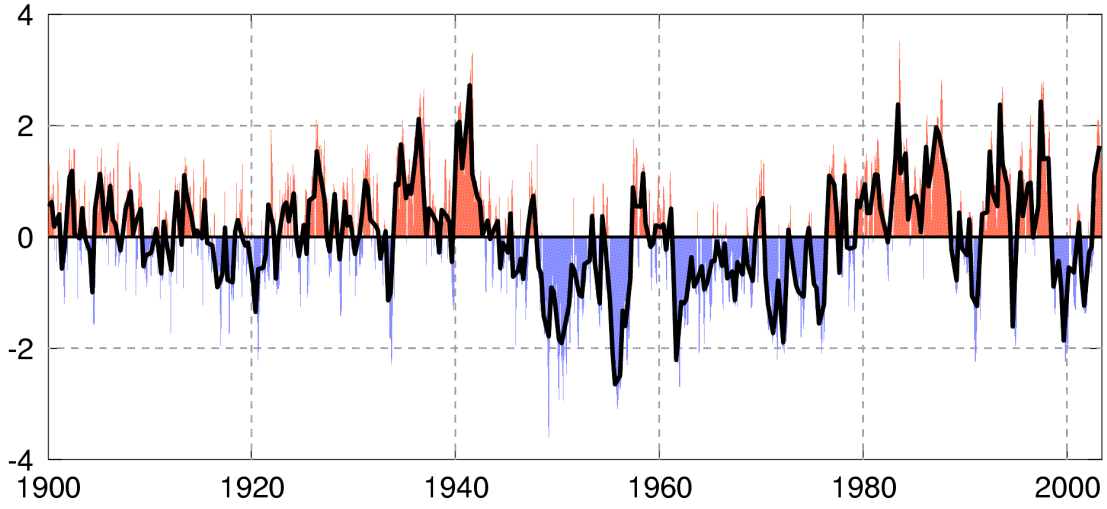
Changing ocean conditions, extreme climatic conditions, and natural variation in ocean conditions can strongly impact Pacific salmon populations. However, salmon populations have not, until the past century, experienced these conditions in conjunction with the widespread degradation of their spawning, 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 (Inter) Decadal Oscillation (PDO), and depending on phase, are associated with both 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 PDO index: Jan 1900—Apr 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 a 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/Aeromonas, infection and ichthyopthirius or "ich" (*Ichthyophthirius multifiliis*) (William Cox pers. comm.). The diseases that are known to cause significant losses in juvenile salmonids are furunculosis, columnaris, coldwater disease (*Flexibacter psychrophilis*), pseudomonas and aeromonas, ichthyopthirius, nanophyetes, and ceratamyxosis (*Ceratamyxa 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*), 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, there is no indication that they have had a significant impact on con salmon. Avian predators of juvenile salmonids include dipper (*Cinclus mexicanis*), gulls (*Larus spp.*), belted kingfisher (*Megaceryle alcyon*), herons (*Ardea spp*.), common merganser *(Mergus merganser*), and osprey (*Pandion haliaetus*) (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 acanthia*s). 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 2001a). 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 2.5 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:

- Have a potential for greater overall abundance because different populations can exploit different habitats and resources,
- 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
- 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 200; 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 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 1991.

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 adaptative 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 of all kinds on recovering stocks, even as we consider the valid use of hatcheries to affect recovery.

Many of the causes of genetic diversity loss are related to decreases in population size and associated decreases in effective population size (Ne) and number of breeders (Nb). Because per generation loss of genetic diversity is related to the effective population size of the spawner population, several authors have proposed Ne 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 italics were identified in CDFG (2002) as precautionary targets for maintenance of genetic variation in coho salmon populations.

3.6 LAND USE

A variety of actions 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 problems.

3.6.1 FORESTRY ACTIVITIES

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 dissolved oxygen (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). 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 effects to coho salmon and their habitat.

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 approximately 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. Where historical harvest and milling were close to waterways, modern trucks and tractors have enabled 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 that affect coho salmon habitat include: construction and maintenance of roads and stream crossings; tree felling; moving felled trees to log landings; removal of streamside vegetation; site preparation; and post-harvest broadcast burning in harvest units near watercourses. Table 3-3 describes forestry practices, changes to the landscape, and the potential effects on salmonid habitat conditions. As described in the discussion of legacy effects, there are on-going impacts to coho salmon habitat from historic timber operations.

The Department's conclusion is that historical forestry practices impacted watersheds inhabited by northern California coho salmon, and that current activities (e.g., road construction, use, and maintenance; activity near streams and on unstable slopes; removal of sources of future LWD) still affect important habitat elements essential to every life-stage of coho salmon that inhabit coastal streams and rivers.

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. The nature of diversions varies enormously, 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 through the appropriative water rights process, and by the Department of Fish and Game 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 water rights have been allocated though a court adjudication. These adjudications usually have not considered 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

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

	POTENTIAL EFFECTS TO		
FOREST PRACTICE	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

and growing issue in some parts of the coho salmon range. Extraction of flow from such wells often directly affects the adjacent stream, but is often not subject to same level of regulatory control as diversion of surface flow.

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

Depletion and storage of natural flows can drastically alter natural hydrological cycles and create significant impacts to downstream reaches by reducing the amount of flow needed to support 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 (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; FEMAT 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 (IFIM) 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 of Fish and Game 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 2002), but 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 diversion 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. NMFS (1995) identified a 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 ESU (Table 3-4) and four major dams within the CCC ESU (Table 3-5) 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 500 licensed or permitted dams on its tributaries (SEC 1996).

TABLE 3-4: Major dams within the California portion of the Southern Oregon/ Northern California Coast Coho ESU that block coho salmon from accessing historical spawning and rearing habitat

NAME OF DAM	LOCATION	UPSTREAM HABITAT BLOCKED	PERCENT OF 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
Dwinnel 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 3-5: Major dams within the Central California Coast Coho ESU that block coho salmon from accessing historical spawning and rearing habitat

NAME OF DAM	LOCATION	UPSTREAM HABITAT BLOCKED	PERCENT OF 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%

3.6.5 GRAVEL EXTRACTION

Instream mining (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 instream mining 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.

While instream gravel extraction has had direct, indirect, and cumulative impacts on salmonids in the recent past, no direct impacts to coho salmon have been documented under the current (post-1995) mining monitoring and reporting standards developed by the Department and the mining industry which were incorporated into: County Conditional Use Permits; State Mining and Reclamation Act (SMARA) required Reclamation Plans; and U.S. Army Corps of Engineer (USACE) Letters of Permission. Many rivers continue to suffer the effects of years of channel degradation from the millions of tons of aggregate removed from the systems over time (Collins and Dune 1990).

3.6.6 SUCTION DREDGING

Suction-dredge placer miners extract gold from the river gravels by sucking the gold-
Suction-dredge placer miners extract gold from the river gravels by sucking the gold-
bearing gravels through a nozzle (typically 6- to 8-in 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 (under Title 14 CCR, section 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 petitioned area. 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 3-6, and includes 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, mineral mining wastes, municipal wastewater discharge, road surface discharge, a urban stormwater discharge.

TABLE 3-6: Clean Water Act Section 303(d) impaired water bodies within the range of coho salmon in California

WATER BODIES AND AREA AFFECTED	STRESSOR	SOURCE OF POLLUTION [J]
SAN FRANCISCO BAY		
Carquinez Strait, 6560 acres; Richardson Bay, 2560 acres	Chlordane; copper; DDT; PCBs; PCBs (dioxin-like); Diazinon; Dieldrin; dioxin compounds; exotic species; mercury; Furan compounds; nickel; selenium; high coliform count	1, 5, 6, 7, 20, 26, 27, 28, 34, 38, 45
San Francisco Bay, 172,100 acres	Chlordane; copper; DDT; Diazinon; Dieldrin; dioxin compounds; exotic species; Furan compounds; mercury; nickel; PCBs; PCBs (dioxin-like); selenium; high coliform count	1, 5, 6, 7, 20, 26, 27, 28, 34, 36, 38, 47
San Pablo Bay, 71,300 acres; Suisun Bay, 25,000 acres; Suisun Marsh Wetlands, 57,000 acres; Suisun Slough, 10 miles	Chlordane; copper; DDT; Diazinon; Dieldrin; dioxin compounds; exotic species; Furan compounds; mercury; nickel; PCBs; PCBs (dioxin-like); selenium; high coliform count; metals	1, 5, 6, 7, 15, 20, 26, 27, 28, 34, 36, 38, 45
Tomales Bay; Calero Res.; Guadalupe Res.; Lake Herman; Merritt Lake; Alameda Cr.; Alamitos Cr.; Arroyo Corte Madera Delpresidio; Arroyo De La Laguna; Arroyo Del Valle; Arroyo Hondo; Butano Cr.; Calabazas Cr.; Corte Madera Cr.; Coyote Cr. (Marin and Santa Clara Cos); Gallinas Cr.; Guadalupe Cr.; Lagunitas Cr.; Laurel Cr.; Ledgewood Cr.; Los Gatos Cr.; Matadero Cr.; Miller Cr.; Mt. Diablo Cr.; Napa R.; Novato Cr.; Permanente Cr.; Pescadero Cr.; Petaluma R.; Pine Cr.; Pinole Cr.; Rodeo Cr.; San Antonio Cr.; San Felipe Cr.; San Francisquito Cr.; San Gregorio Cr.; San Leandro Cr.; San Lorenzo Cr.; San Mateo Cr.; San Pablo Cr.; San Rafael Cr.; Saratoga Cr.; Sonoma Cr.; Stevens Cr.; Walker Cr.; Walnut Cr.; Wildcat Cr. (Total: 8520 acres and 759 miles)	Metals; nutrients; pathogens; sedimentation/ siltation; mercury, floating material; organic enrichment/ low DO; Diazinon; salinity	1, 4b, 10, 15, 25, 28, 38, 42, 44, 45

Continued

TABLE 3-6: Clean Water Act Section 303(d) impaired water bodies within the range of coho salmon in California (continued)

WATER BODIES AND AREA AFFECTED	STRESSOR	SOURCE OF POLLUTION [J]
NORTH COAST		
Albion River, 14 miles	Sediment	28, 39
Eel River Delta, 6350 acres	Sediment; temperature	28, 31, 39
Elk River, 88 miles	Sediment	39
Freshwater Creek, 73 miles	Sediment	13, 16, 23, 28, 33, 34, 39
Garcia River, 39 miles	Sediment; temperature	13, 16, 23, 28, 32, 33, 34, 35, 39, 41
Gualala River, 35 Miles	Sediment	13, 16, 22, 23, 28, 33, 34, 39, 20
Klamath River, 190 Miles	Nutrients, organic enrichment/low DO; temperature	3, 11, 15, 17, 21, 26, 28
Mad River, 90 miles	Sediment	28, 36, 39
Mattole River, 56 miles	Sediment; temperature	13, 17, 28, 31, 32, 35, 39, 40

Under Section 303(d) of the 1972 Clean Water Act (CWA), 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. The law requires that these jurisdictions establish priority rankings for water 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 section 303(d) list of impaired water bodies (Table 3-6).

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 USEPA typically contain the total load and load allocations required by Section 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 USEPA and during that process, it has often been necessary for the RWQCBs to reevaluate, and sometimes change, the USEPA requirements.

3.6.9 AGRICULTURAL IMPACTS

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. 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 2001c). In February 2000, Sonoma County adopted a vineyard ordinance to control sedimentation caused by vineyard erosion (Merenlender et al. 2000). The ordinance identified three levels of vineyards and seven types of highly erosive soils, imposing corresponding requirements (CDFG 2001c).

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). 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.

3.6.10 URBANIZATION

Humans have traditionally settled near sources of water such as streams, lakes, and bays. Though the effects of timber, livestock, and agriculture can be destructive, there is usually a chance for recovery of the landscape. In urban areas, recovery is unlikely, because once the natural vegetation is gone and the stream and riparian habitats are modified, the changes are usually permanent (Booth 1991; Spence et al. 1996). Booth (1991) indicates that urbanized watersheds may increase peak flows associated with storm and flood events by as much as five times. Areas within the range of coho salmon where large-scale urban development has taken place include Arcata-Eureka, Fortuna, Willits, Ukiah, Santa Rosa, and the San Francisco Bay Area.

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 fisheries directed toward other salmon species. When regulations prohibit the retention of coho salmon, the majority of released fish survive. However, if large enough numbers are hooked, substantial mortality can be incurred.

The Klamath basin's Native American tribes (Yurok, Hoopa, 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 (Dave 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 (Tom Belt pers. comm.).

4 Recovery Goals and Delisting Criteria

The primary and statutorily required goal of 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 (FGC §2105). The recovery strategy incorporates an additional goal of restoring tribal, recreational, and commercial coho salmon fisheries in California (see Section VI below). The processes to achieve this additional goal are under the authority of the Commission and the Pacific Fisheries Management Council (PFMC), an organization comprised of the Pacific coastal states, including California, the federal government, affected Indian tribal governments, the ocean sport and commercial fishing industries, and ocean conservation organizations.

The frameworks for: a) recovery required by CESA, i.e., delisting; and b) restoring coho salmon fisheries are briefly discussed and outlined below. Research, monitoring, and adaptive management will be used to both improve the framework and measure achievement of these goals.

4.1 FRAMEWORK FOR DELISTING CRITERIA

The recovery strategy must meet specific conditions that are evaluated by the Commission (§2111(a)-(d).). These conditions are:

a. The strategy will conserve, protect, restore, and enhance coho salmon (as a species);

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

c. The strategy is supported by the best available scientific data; and

d. The strategy represents an equitable apportionment of both public and private and regulatory and nonregulatory obligations.

The approach to achieving the primary goal is to improve coho salmon populations and habitat so the species is neither threatened nor endangered with extinction throughout all, or in a significant portion of, its range. Hence, the regulations or other protections for coho listed under CESA would no longer be necessary. Achieving this will take a combination of five principle delisting requirements, addressing coho

salmon populations and habitat. These requirements, and criteria for each, are outlined below in a delisting framework.

Each criterion, and the processes for evaluating the status of the criterion, are listed below. The criteria are both scientifically objective and measurable. For many of these criteria, the timeline for development quantitative aspect is the same as that of the NOAA Fisheries' two TRTs work on the two coho salmon ESUs in California. The Department is participating in both TRTs, and when they release their public documents, the Department will add the quantitative elements to an update of its recovery strategy and will allow the framework to be adopted as formal delisting criteria. 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 generations.

The five delisting requirements are linked together by the overall ecological goals they attain through their integration. Those goals are to maximize genetic diversity and persistence through environmental variation and random events and across the range of coho salmon in California. The delisting requirements apply to natural stocks of coho salmon and coho salmon produced from conservation and mitigation hatcheries; their fulfillment at the ESU or range-wide level will signal the ability to downlist or delist coho salmon under CESA.

The scientific terminology included in the delisting requirements come from the fields of ecology and conservation biology and are defined in Appendix B: Glossary.

Downlisting/ delisting will occur when all requirements are fulfilled. Each requirement is fulfilled when all of its recovery criteria are met. Criteria are evaluated by the processes outlined under each criterion. Delisting will occur when incidental take from recreational fishing and by-catch from commercial fishing can be sustained without causing a high probability of extinction.

Important points to remember:

a. Because the CCC ESU will be listed as endangered, it will have two sets of criteria. The first set will be developed to determine when the CCC ESU can be down-listed from endangered to threatened. The second set will be for delisting.[1]

[1] The Southern Oregon~Northern California Coastal ESU will be listed as threatened so will have one set of criteria for delisting.

b. The Department, in conjunction with NOAA Fisheries, currently is in the process of evaluating specific, quantitative elements regarding recovery criteria. The Department intends to quantify coho salmon population and habitat metrics when the initial TRT processes are complete

c. Information the Department is gathering through presence~absence coho salmon surveys, initiated in 2000 and continuing, will be used to establish both the index sampling sites and the pool of random sampling sites referenced in several criteria.

d. A method to determine the risk of extinction of coho salmon populations will be developed in cooperation with the TRTs.

4.2 DELISTING REQUIREMENTS

I. Maintain and protect the number and size of key populations of coho salmon.

Criterion 1 *Key populations are maintained at levels that reduce the risk of their extinction to insignificant levels.*

Process:

1. Identify key populations within each ESU.
2. Determine population levels that reduce the risk of local extinction to insignificant levels.
3. Develop and implement population monitoring, both inland and ocean.
4. Identify and apply appropriate protection mechanisms for key populations.

II. Maintain and increase the number of spawning adults and maximize freshwater and estuary survival of juveniles in basins to a level that reduces the probability of extinction to an insignificant level.

Criterion 1 *Maintain current level of spawning and outmigration.*

Process:

a. Identify and apply actions and mechanisms for maintaining spawning and emigrating coho salmon.

b. Conduct inland spawning surveys.

c. Conduct ocean and nearshore surveys.[2]

c. Conduct juvenile emigration surveys.

[2] Being discussed as an alternate or complement for inland surveys for adult coho salmon.

Criterion 2 *Attain a sustained, increased (specified) level in number of adults returning to spawn at documented, recent spawning sites within basins.*

Process:

a. Determine what constitutes 'sustained' and the specific increases required.

b. Identify and apply actions and mechanisms for attaining increased sustained levels of spawning and emigrating coho salmon.

c. Conduct inland spawning surveys.

d. Conduct ocean and nearshore surveys.

e. Conduct juvenile emigration surveys.

Criterion 3 *Attain a sustained, increased (specified) level in new spawning sites within basins.*

Process:

a. Determine what constitutes 'sustained' and the specific increases required.

b. Identify and apply actions and mechanisms for attaining sustained new spawning sites.

c. Conduct inland spawning surveys.

Criterion 4 *Attain a sustained, increased (specified) level of juvenile survival within basins and estuaries.*[3]

Process:

a. Determine what constitutes 'sustained' and the specific increases required.

b. Identify and apply actions and mechanisms for attaining sustained survival of juvenile coho salmon.

c. Conduct juvenile emigration surveys.

d. Conduct juvenile estuarine surveys.

III. Maintain and increase the range and distribution[4] *of coho salmon to a level that reduces the probability of extinction of an ESU to an insignificant level.*

Range: The Department is investigating the likely potential to increase the range of the SONCC ESU in the upper Eel River basin, below Scott Dam/Lake Pillsbury, and

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[3] Survival, and not merely production, of young fish is the issue of importance.

[4] Range is primarily a geographic consideration; distribution is primarily an issue of ecology. Currently, both factors are issues for both ESUs.

in the watersheds that flow directly into San Francisco Bay in the CCC ESU. These criteria assume that the areas mentioned are realistic for re-expansion of current range of coho salmon.

Criterion 1 *Maintain the current range and distribution of coho salmon.*

Process:

a. Identify and apply actions and mechanisms to maintain current range and distribution.

b. Conduct population monitoring (presence/not present, adult, juvenile emigration).

Criterion 2 *Increase the range of coho salmon to represent the full range (north, south, inland) once occupied.*

To make the decision on what is realistic, three parameters will be evaluated:

- What we know about the present range in each ESU;
- What we know about the historic range in each ESU; and
- What current conditions exist that might limit or prevent range expansion.

Process:

a. Determine what is realistic for range expansion for each ESU.

b. Implement actions to expand coho salmon where identified as being feasible.

c. Conduct annual presence-absence surveys.

Criterion 3 *Coho salmon are consistently present in across the CCC from Santa Cruz County to Punta Gorda in Mendocino County to restore coastal connectivity.*

Process:

a. Identify and apply actions and mechanisms for expanding range of CCC Coho ESU.

b. Conduct annual presence-absence surveys.

Distribution: Increasing the distribution focuses on the condition of coho salmon streams.

Criterion 1 *Attain a sustained (specified) percent increase of suitable streams within basins where there is presence of coho salmon.*[5]

Process:

a. Determine what constitutes "sustained" and the target percent increases.

b. Identify and apply actions and mechanisms for attaining sustained increase.

c. Conduct annual presence~absence surveys.

Criterion 2 *Attain a sustained (specified) percent increase in the number of suitable streams within watershed basins where there is a presence of improved brood-year representation, from one year out of three present to two out of three present.*[6]

Process:

a. Determine what constitutes "sustained" and the target percent increase.

b. Identify and apply actions and mechanisms for attaining sustained increase.

c. Conduct brood year analysis.

Criterion 3 *Attain a sustained (specified) percent increase in the number of suitable streams within basins where there is a presence of the full brood-year compliment.*

Process:

a. Determine what constitutes 'sustained' and the target percent increase.

b. Identify and apply actions and mechanisms for attaining sustained increase.

c. Conduct brood year analysis.

IV. Maintain and protect habitat essential for coho salmon.

Criterion 1 *Essential habitat, including biological refugia, for coho salmon, is identified, mapped, and protected in each basin.*

Process:

a. Analyze existing watershed assessments and plans.

b. Gather necessary field data.

c. Conduct necessary mapping.

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[5] Both permanent index sites and rotating random sites will be utilized in the field sample methodology.

[6] There likely will also be a 0 of 3 to 1 of 3 metric for the CCC ESU.

d. Develop and apply a habitat quality index (HQI) based on a standard suite of measurable habitat quality parameters.

e. Identify and apply actions and mechanisms for protecting essential habitat.

Criterion 2 *Appropriate mechanisms to protect essential habitat are applied in each basin.*

Process:

a. Identify and apply appropriate protection mechanisms for essential coho habitat. These mechanisms are being identified as statewide and watershed-specific regarding their scope and interim and long-term regarding their initiation and duration.

V. Maintain, improve, and restore coho salmon habitat to a level that reduces the probability of extinction to an insignificant level.

Criterion 1 *Maintain areas where coho salmon habitat have already been restored or enhanced.*

Process:

a. Identify and apply appropriate maintenance procedures for restored or enhanced coho salmon habitat.

b. Develop and apply a HQI based on a standard suite of measurable habitat quality parameters.

c. Monitor coho salmon use of restored and enhanced habitat and effectiveness of restoration activities.

Criterion 2 *Restore, enhance, and maintain habitat already identified for restoration to benefit coho salmon.*

Process:

a. Analyze existing watershed assessments and plans.

b. Identify and apply actions and mechanisms to restore and enhance habitat.

c. Use Department Salmonid Restoration Grants Program.

d. Use other restoration programs that will benefit coho salmon.

e. Develop and apply a HQI based on a standard suite of measurable habitat quality parameters.

f. Monitor coho salmon use of restored and enhanced habitat and effectiveness of restoration activities.

Criterion 3 *A (specified) amount of coho habitat is restored, enhanced, and maintained in a (specified) condition within basins*[7].

Process:

a. Evaluate and prioritize non-assessed coho salmon habitat, including biological refugia, for restoration and enhancement potential.

b. Identify and apply actions and mechanisms to restore, enhance, and maintain habitat.

c. Use Department Salmonid Restoration Grants Program.

d. Use other restoration programs that will benefit coho salmon.

e. Use watershed councils and organizations with a component focusing on coho salmon restoration and recovery.

f. Determine amount, quality, and distribution of habitat necessary to reduce the probability of extinction for coho salmon to a level to be considered insignificant.

g. Develop and apply a HQI based on a standard suite of measurable habitat quality parameters.

h. Conduct watershed assessment, monitoring, and analysis of coho salmon use of habitat and effectiveness of coho salmon recovery actions.

4.3 FRAMEWORK FOR RESTORATION OF FISHERIES

An additional goal of the recovery strategy is to restore coho salmon numbers to the point where tribal, recreational, and commercial fishing may occur. It is the intent of the Department to collaborate with the appropriate tribes, the federal government, and stakeholders, once delisting is achieved and regulations or other protections under CESA are not necessary, to determine how to accomplish this goal. (See section below.)

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

Coho salmon population levels allowing for fishing will be at a level that exceeds the numbers necessary for recovery. Hence, restoration of the fisheries would occur some time after delisting is realized. Restoration of the fisheries would be implemented and monitored through fishing regulations governed by the Commission and the Pacific Fisheries Management Council and not by the Department through CESA. After delisting is achieved, the Department and the CRT, including appropriate tribes, the federal government, and stakeholders, would determine how to continue

[7] Permanent protection is not yet addressed and is an important element to be developed.

implementation of appropriate elements of the recovery strategy pursuant to and consistent with other applicable local, state, and federal law and voluntary measures.

4.3.1 RECREATIONAL FISHING

Criterion 1 *Commence selected recreational fishing for (specified) years once adult populations have been sustained at or exceeded (specified) level, as described in Delisting Requirements I and II.*[8]

Selected recreational fishing would be allowed at sites selected based on the relative health of coho salmon runs and the presence of recreational fishing opportunities and interest.

Process:

a. Select areas, timing, and duration of coho salmon recreational fisheries.
b. Open selected coho salmon recreational fishery.
c. Conduct coho salmon population monitoring.
d. Conduct inland spawning surveys.
e. Conduct creel surveys.[9] This would include a summary evaluation of what is known about incidental take of coho salmon from other recreational fishing.

Criterion 2 *Expand recreational fishery to the fullest extent feasible for (specified) years once it is shown that preliminary recreational fisheries have not reduced sustained levels of coho salmon in each ESU over initial (specified) years of fishing*[10].

Process:

a. Identify feasible and appropriate areas for extension of fishery.
b. Expand coho salmon recreational fishery.
c. Conduct coho salmon population monitoring.
d. Conduct inland spawning surveys.
e. Conduct creel surveys.

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8 Should be set in a 3-year increment and have an emergency trigger to close recreational fisheries based on events that could threaten coho salmon in a given year.

9 There is the potential to allow for an experimental fishery, which would not penalize those who caught coho salmon, prior to commencing a longer preliminary fishery. A creel survey strategy would be used to monitor what would occur.

10 Some areas, likely in the CCC ESU, may require decades, if ever, to allow for any recreational fishing.

Criterion 3 *Resume permanent, recreational fisheries once expanded recreational fisheries have not reduced sustained levels of coho salmon in each ESU over the initial (specified) years of fishing*[11].

Process:

a. Resume permanent coho salmon fishery.
b. Conduct coho salmon population monitoring.
c. Conduct inland spawning surveys.
d. Conduct creel surveys.

4.3.2 COMMERCIAL FISHING

There are two essential issues for the commercial fishing industry. The primary need is to have coho salmon recovery so that by-catch of coho salmon, when fishing for Chinook or other more abundant salmon species, is no longer a threat to coho salmon. A secondary objective of re-establishing a coho salmon commercial fishery is acknowledged and is not being dismissed at this time.

Criterion 1 *Establish experimental ocean harvesting of other anadromous salmonids for (specified) years once the numbers of ocean coho salmon are sufficient to allow for removal of by-catch restrictions.*[12]

Process:

a. Evaluate area, timing, duration, and degree of experimental commercial salmon fishery.
b. Open experimental commercial salmon fishery.
c. Conduct coho salmon population monitoring.
d. Conduct inland spawning surveys.
e. Conduct creel surveys.
f. Conduct commercial vessel catch monitoring.
g. Conduct commercial landing monitoring.

Criterion 2 *Commence experimental, limited commercial coho salmon fishery for (specified) years once it has been determined elimination of by-catch restriction for commercial harvest has not reduced sustained levels of coho salmon in each ESU over initial (specified) years of fishing.*

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[11] Extent of permanently established, recreational fishery will need to be based on any differential, regional effects to coho salmon by recreational catch.

[12] PFMC regulates ocean fishing. Part of that annual evaluation is by-catch restrictions on various fisheries due to the status of coho salmon. Once this restriction is deemed unnecessary by PFMC, commercial recovery criteria would be triggered.

Process:

a. Evaluate area, timing, duration, and degree of experimental coho salmon commercial fishery.

b. Open experimental commercial coho salmon fishery.

c. Conduct coho salmon population monitoring.

d. Conduct inland spawning surveys.

e. Conduct creel surveys.

f. Conduct commercial vessel catch monitoring.

g. Conduct commercial landing monitoring.

h. Conduct focused, financed, experimental commercial fishing.[13]

Criterion 3 *Establish a limited commercial coho salmon fishery for (specified) years after it has been determined that the experimental commercial fishery has not reduced sustained levels of coho salmon in each ESU over the initial (specified) years.*

Process:

a. Evaluate feasible expansion of coho salmon commercial fishery.

b. Expand coho salmon commercial fishery.

c. Conduct coho salmon population monitoring.

d. Conduct inland spawning surveys.

e. Conduct creel surveys.

f. Conduct commercial vessel catch monitoring.

g. Conduct commercial landing monitoring.

[13] Finance a limited number of commercial vessels to specifically investigate the ability to and impact of commercial fishing for coho salmon.

5 Elements Necessary for Recovery

The Fish and Game Code identifies three elements necessary to achieve the statutorily required 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; and c) procedures and programs for notice, education, research, monitoring, and strategy modification. With the exception of strategy modification, these essential elements are discussed in the following sections. Strategy modification is discussed in Chapter 11.

5.1 ROLE OF PUBLIC LANDS

The range of coho salmon in California is predominantly under private ownership (64%). Public lands encompass the remaining 36% of the species range, or approximately 5.4 million acres. Approximately 2.8 million acres 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 therefore 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. Following 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, National Park Service, Bureau of Land Management, Department of Defense, U. S. Fish and Wildlife Service, Department of Energy, and Bureau of Reclamation. 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)

USFS lands encompass approximately 4.2 million acres and include the Klamath, Mendocino, Shasta-Trinity, and Six Rivers National Forests. These lands represent 90% of the public lands in the SONCC 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 governments. 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 Bureau of Land Management 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)

BLM lands encompass approximately 330,263 acres 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 it 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

FIGURE 5-1: Land ownership in the SONCC ESU

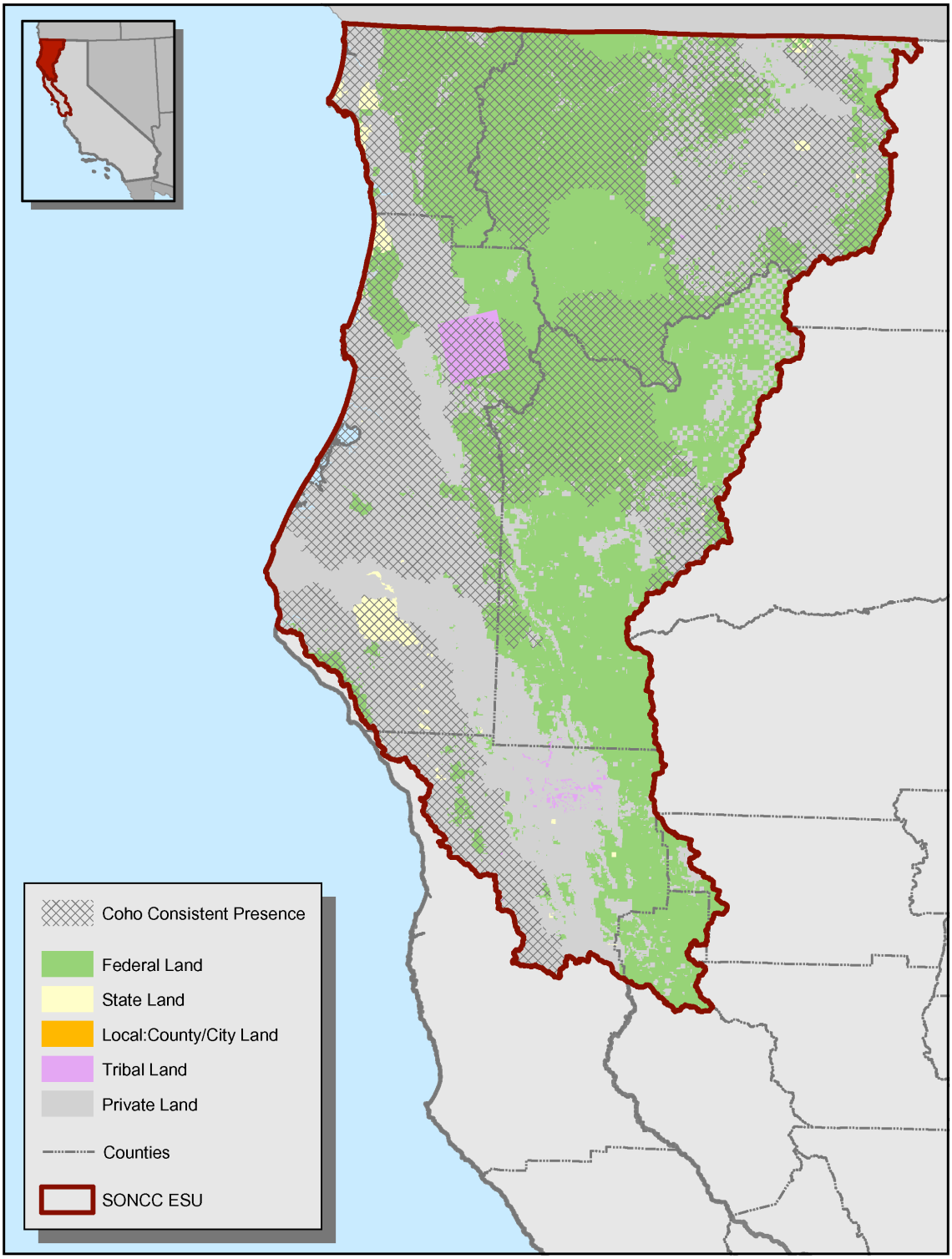

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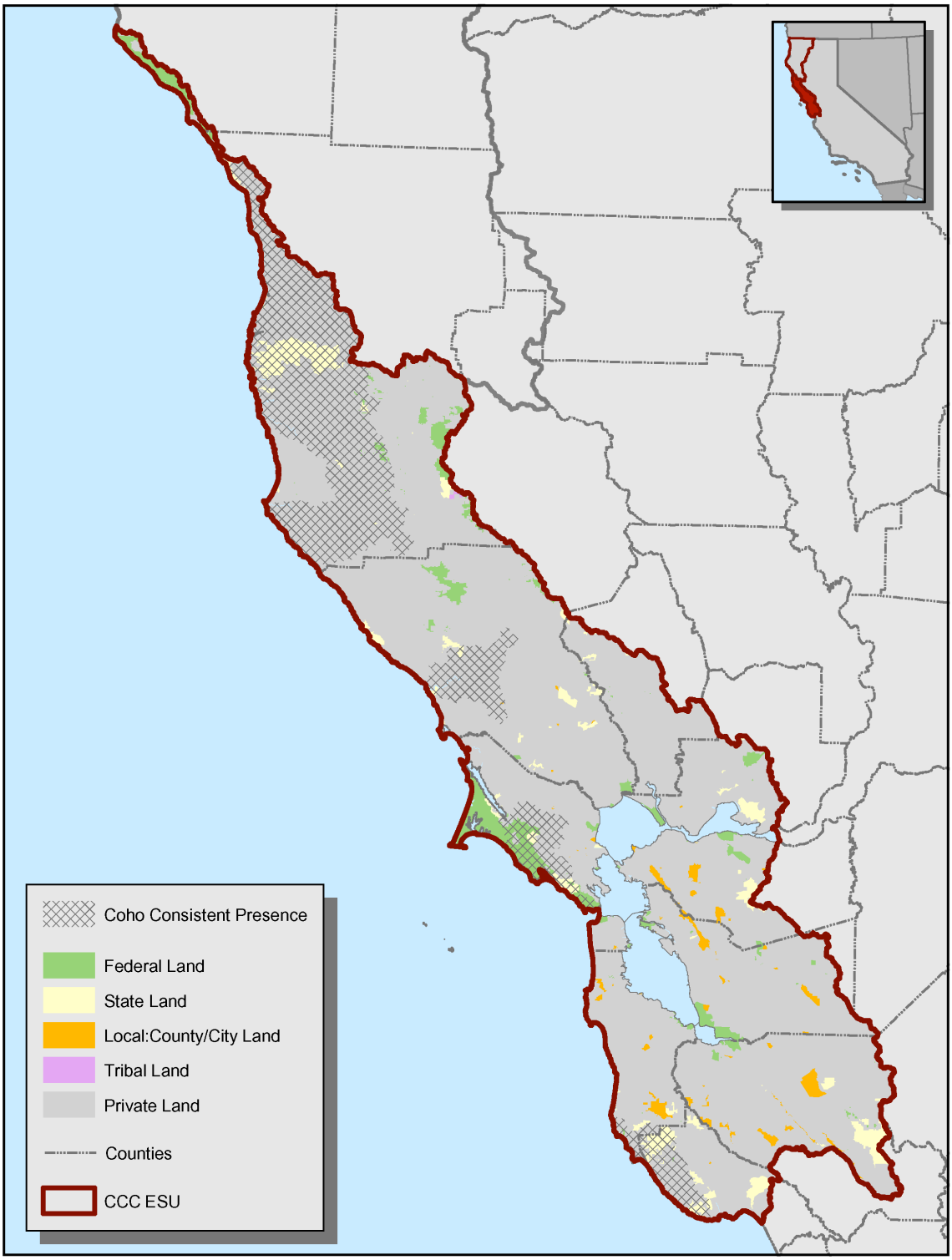
FIGURE 5-2: Land ownership in the CCC ESU



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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)

NPS lands encompass approximately 159,300 acres and include Redwood National Park, Point Reyes National Seashore, and Muir Woods National Monument.

The purpose of the NPS is "...to conserve the scenery and the natural and historic objects and the wildlife wherein 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)

DOD lands encompass approximately 55,524 acres 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 (INRMPs) in cooperation with the U.S. Fish and Wildlife Service and the appropriate state wildlife agency.

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, 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 & Wildlife Service (USFWS)

USFWS lands encompass 20,591 acres 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 (BOR)

BOR lands encompass approximately 285 acres in Siskiyou County and include the Klamath and Trinity River Projects in the range of the SONCC ESU. The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Reclamation's facilities are managed to fulfill water user contracts and protect and/or enhance conditions for fish, wildlife, land, and cultural resources.

5.1.2 STATE LANDS

The State of California administers 346,486 acres of public lands within the range of coho salmon, including lands managed by the Department of Parks and Recreation, Department of Forestry and Fire Protection, State Lands Commission, and the Department.

5.1.2.1 California Department of Parks and Recreation (DPR)

DPR lands encompass 263,261 acres 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)

CDF lands encompass 50,925 acres 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 California's forest practice rules which regulate timber harvesting on private lands.

The Demonstration State Forests are managed 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)

SLC lands encompass approximately 27,261 acres located in approximately 54 areas, ranging in size from 6 to 1559 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. 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 approximately 5,039 acres 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 70,351 acres within the range of coho salmon. Local governments set forth the obligations of local projects, both public and private.

5.2 PRIVATE AND PUBLIC COOPERATION

Voluntary cooperation between private and public sectors is a critical aspect of coho salmon recovery because coho salmon occur without regard to political boundaries and property lines. Private lands comprise approximately 64% 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 (Appendix D).

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 is the Department's primary tool for funding fishery improvement projects, education, organizational support and planning in salmon and steelhead watersheds and streams. Public agencies, non-profit

organizations, Indian tribes and private entities living and working in coastal watersheds from the Oregon border to the Mexican border are receiving grants to restore salmon and steelhead populations.

Funds for the Fishery Restoration Grants Program 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 Governor Davis and the governors of the states of Washington, Oregon, 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 Fisheries Restoration Grants Program 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 Department's Fisheries Restoration Grants Program 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 relative 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 Department has a staff of seven basin planners who assist the public in planning and developing worthwhile proposals. More information about the Department's Fisheries Restoration Grants Program can be found on the Department website at: http://www.dfg.ca.gov/nafwb/fishgrant.html.

5.2.1.2 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.

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 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.

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.

Wildlife Habitat Incentives Program: WHIP encourages the voluntary establishment of high quality wildlife habitat on private lands. While some NRCS programs are specifically designed for agricultural lands, WHIP 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: FFP 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: RC&D assist 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: EWP 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: CTA provides technical assistance to voluntary participants interested in planning and carrying out conservation activities to address local natural resource issues. NRCS staff work with land-users and communities to provide resource solutions throughout the watershed. CTA provides the science-based technical assistance needed to create long-term resource solutions at the local level.

5.2.1.3 Watershed and Nonpoint Source Pollution Control Programs

Watershed/Nonpoint Source grants are offered through the State Water Resources Control Board's (State Board) Division of Financial Assistance, in partnership with: the California Bay/Delta Authority (CALFED), the USEPA, the California Coastal Commission, and the Resources Agency. These grants are made available through funding from: Proposition 13, the Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000; the federal Clean Water Act section 319; and Proposition 50, Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002. 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 26, 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 26, Chapter 7, Article 5) (Proposition 13): The program provides grants to municipalities, local public agencies, nonprofit 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.

Nonpoint Source Implementation Program (Federal Clean Water Act Section 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 will be favored in the selection process. Grants are available to municipalities, local public agencies, educational institutions, nonprofit organizations or Indian tribes. Funds cannot be used for activities undertaken pursuant to a NPDES permit (including stormwater).

CALFED Drinking Water Quality Program (DWQP) (Proposition 13)
CALFED Drinking Water Quality Program (DWQP) (Proposition 50): 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 DWQP. The DWQP is focused on improving the quality of Central Valley and Delta water sources used for drinking water. Thus, projects eligible for DWQP funding will generally be located in the watersheds of the Central Valley Regional Board (Region 5).

Watershed Protection Program (Water Code, Division 26, Chapter 6, 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 (Proposition 13)
CALFED Watershed Program (Proposition 50): 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. The Watershed Program will support activities that provide benefits to the areas within the CALFED Solution Area.

5.2.1.4 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 locally driven. A guiding principle must be cooperation and coordination to promote partnership development. 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. Ideally, solutions will be ecosystem-based and will provide equitable problem-solving at the watershed scale in a comprehensive manner.

5.2.3 VOLUNTARY INCENTIVES

Population growth in California will continue to place further pressures on coho salmon habitat. An incentives-based approach will be critical to the success of a timely and effective coho salmon recovery strategy. 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 6, 7, and 8 contain the 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, and stakeholders 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 statewide and regional coho salmon recovery recommendations with educational components, including recommendations that focus on water flow, 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 grade-specific 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 (e.g., federal and state websites such as USFWS and the Department, local libraries, brochures, local watershed groups).

5.3.2.2 Interpretive Media

Internet Website. Pertinent and updated information on the recovery strategy and California coho salmon recovery efforts will be available at the Department's coho recovery website (http://cohorecovery.org).

Brochures. 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.

Video. 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 statewide coho salmon public relations campaign and in association with local outreach efforts.

Exhibits. Department grant funds may 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.

An "Anadromous Fish Exhibit" is under construction by the Department (Fishing-in-the-City, Interpretive Services) for display at Marine World in Vallejo. The exhibit consists of informative panels depicting a generalized salmonid life cycle, threats to salmonid existence in California habitats, and human efforts to protect and restore

salmonids and their habitat. When completed (summer, 2003), the exhibit will also include a circular tank exhibit with 50-100 steelhead trout. The exhibit could potentially be expanded to include live coho salmon (from hatchery) and an informative panel showing coho salmon recovery efforts. The exhibit has high exposure potential (500,000+ viewers per season).

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:[1]

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. The Department will establish an independent science panel to aid in establishing a robust, scientific foundation to the monitoring program and in setting and revising priorities.

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

1. Selection of appropriate metrics;
2. Determination of minimum datasets required to describe baseline conditions;
3. Selection of regional areas and independent populations for monitoring;
4. Development of sampling frameworks and sampling design;

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

5. Independent scientific review;
6. Standardized monitoring protocols;
7. Preparation and distribution of written protocols; and
8. Training and quality control for monitoring protocols.

There are many variables in need of assessment, monitoring, and research (Table 5-1). These variables 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 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: a) the scope and focus of ongoing efforts; b) the gaps in coverage and data; and c) 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.

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 its 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 set forth in Fish and Game Code section 857 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 and/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 ESU and 86% of the land in the CCC ESU 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

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

1. Hydrodynamics and sediment transport
2. System productivity
    a. Primary productivity
    b. Invertebrate
    c. Fish
    d. Nutrient cycling
3. Fluvial geomorphology
    a. Sediment [embeddedness, suspended]
    b. Turbidity
    c. Substrate particle size
    d. Large woody debris cycling
    e. Land sliding and debris flow
4. Hydrology
    a. Flow (rate, timing, quantity
    b. Temperature
    c. Other water quality (i.e., DO)
5. Ecological communities
    a. Riparian community
        1. Vegetation composition
        2. Invertebrate composition
        3. Vegetation condition
        4. Large woody debris recruitment
    b. Nearshore ocean condition
    c. Estuarine
        1. Condition
        2. Fish use
6. Water use
    a. Efficiency
    b. Transfer
    c. Storage
7. Land use
    a. Effects on habitat
    b. Effects on fish
    c. Land use change trajectories
    d. Economic considerations
        1. Land use and owners
        2. Communities (i.e., counties)
8. Fishing
9. Barriers to migration
10. Fish population
    a. Range
    b. Distribution
    c. Cohort replacement
    d. Abundance
    e. Fish health
11. Recovery efforts
    a. Implementation
    b. Effectiveness
    c. Validity (fish response)
12. Coho salmon ecology
    a. Disease
    b. Competition
    c. Genetics
13. Pollutants (type and source)

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 on-going 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 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 monitoring program's reporting component will be readily accessible and available to all organizations and parties involved in coho salmon recovery. The 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. Through the Department and the science panel, scientific review of the results and progress of the monitoring program will occur.

5.4.2 ASSESSMENT

In several watersheds, different types and levels of monitoring have been done or are on-going. In many other areas within the range of coho salmon, monitoring 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. The science panel will assist in reviewing existing information, developing a prioritization, and advising the Department in the means of filling information gaps.

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 be 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. Each has a role in the monitoring of coho salmon recovery. The types of monitoring include:

- *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 Department's coho salmon 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 (e.g., Jacobs et al. 2001). The Oregon Plan for Salmon and Watersheds (Oregon Plan) 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. A preliminary list of data to be collected is:
  - *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, N/P, solids, metals/toxins, temperature, channel form, valley form, valley width, geomorphic channel, channel substrate, canopy cover, LWD, riparian vegetation., LULC, 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 the Coho Salmon Monitoring Program

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: a) be coordinated with local monitoring efforts and integrated with each other, and b) 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 will be necessary. From this, ongoing monitoring of coho salmon populations will occur. This monitoring information will be directly tied to the Department's ability to recommend down-, up-, 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 Department's Fisheries Restoration Grants Program (Grants Program), efforts began to develop the Coastal Salmonid Restoration Monitoring and Evaluation Program (CSRMEP). CSRMEP is developing implementation and effective monitoring protocols to evaluate restoration efforts with the goal of improving and conserving coastal anadromous salmonid habitat. Several components of this effort currently underway:

a. Complete monitoring protocol development.
b. Field-test all protocols.
c. Complete a data management support system.
d. Provide training in protocol usage.
e. Begin testing the implementation of a comprehensive restoration effectiveness monitoring program.

Validation Monitoring: Validation monitoring evaluates whether and to what degree a specific action or 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 Grants Program 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

Establishing and maintaining partnerships for coho salmon recovery will be essential in developing an effective monitoring program. The Department will collaborate with other agencies, tribes, academic institutions, local watershed groups, and land owners. Collaborative monitoring efforts should be built around strong, core programs which operate under the review and guidance of a science panel appointed by the Director of the Department. These core monitoring programs should, in turn, be organized under the program performance monitoring and tiered monitoring framework presented above. Monitoring efforts may be local, regional, or span the range of coho salmon, and the Department will be responsible for integrating the information to understand the condition of coho salmon habitat and populations at the watershed, ESU, and statewide level.

Some monitoring is already taking place. In the future, these and other monitoring efforts would be consistent with validation, status, and trend monitoring protocols being developed by or in conjunction with the Department.

The performance of recovery efforts at a programmatic level will be tracked though an annual reporting of performance measures developed for the Pacific Coastal Salmon Recovery Fund (PCSRF) and reported annually to the Commission. The PCSRF Performance Measures consists of an annual project level reporting framework to track performance of the recovery and restoration of Pacific salmon, including monitoring.

5.4.5 COLLABORATION AND PROGRAM PERFORMANCE

Establishing and maintaining partnerships for coho salmon recovery will be essential in developing an effective monitoring program. The Department will collaborate with other agencies, tribes, academic institutions, local watershed groups, and land owners.

Collaborative monitoring efforts should be built around strong, core programs which operate under the review and guidance of a science panel appointed by the Director of the Department. These core monitoring programs should, in turn, be organized under the program performance monitoring and tiered monitoring framework presented above. Monitoring efforts may be local, regional, or span the range of coho salmon, and the Department will be responsible for integrating the information to understand the condition of coho salmon habitat and populations at the watershed, ESU, and statewide level.

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5.4.6 ASSESSMENT, MONITORING, AND RESEARCH

Assessment, monitoring, and research are important to coho salmon recovery. Recommendations for statewide monitoring, research and assessment that will contribute to recovery of coho salmon are set forth in Chapter 6.

6 Range-wide Recommendations

Many of the potential recovery actions to address the threats and issues discussed in Chapter 3 (Threats) 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 Department, in conjunction with the CRT, has developed the following recommendations with broad applicability. Parties responsible for implementing these recommendations are identified in Section 10.5 (in preparation).

The following recommendations do not constitute a complete list. Only recommendations on topics addressed by the CRT to date are presented here. Recommendation numbers presented below are derived from an interim numbering system used during the ongoing discussions with the CRT and are not sequential. They are presented here only as unique identifiers forreference to individual recommendations.

6.1 STREAM FLOW

SW I-B-1	Encourage the use of passive diversion devices designed to allow diversion of water only when minimum flow requirements are exceeded. Identify and develop adequate passive diversion structure designs.
SW I-C-1	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.
SW I-D-1	Encourage elimination of unnecessary and wasteful use of water from coho salmon streams, through education components of this strategy. Encourage water conservation for existing uses.
SW I-D-4	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.

SW I-D-5 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.

SW I-D-6 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.

SW I-D-7 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 lows; Support multiple uses of water storage systems ; and

b. Cost-share funding where low-flow, trickle recharge water storage is used to avoid adversely affecting stream flow or coho salmon habitat.

SW I-D-8 Support a comprehensive streamflow evaluation program to determine instream flow needs for coho salmon in priority watersheds.

6.2 WATER RIGHTS

SW II-A-1 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.

SW II-A-2 Identify unauthorized diversions.

SW II-A-4 Where flows are a limiting factor in priority coho salmon habitat, petitionthe SWRCB to add streams to the Declaration of Fully Appropriated Streams.

SW II-A-5 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 stream flow 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.

SW II-B-1 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 in-stream flows for the protection of coho salmon (Water Code section 1707).

SW II-B-2 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 from, which may include but not necessarily be limited to requirementsthat would not allow riparian water rights for the new parcels at the time subdivision approvals are made.

SW II-B-3	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. Responsible parties must obtain incidental take authorizations for operation of the screens. Those 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.

6.3 FISH PASSAGE

SW III-A-1	Continue and complete assessments and prioritizations for correction of fish passage barriers.
SW III-A-2	Develop and maintain a database of barriers to fish passage.
SW III-C-1	Encourage funding authorities to 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).
SW III-C-2	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.
SW III-C-3	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.
SW III-C-4	Encourage FEMA to fund upgrades to flood-damaged facilities to meet the requirements of the Endangered Species Act.
SW III-C-5	Evaluate the desirability and feasibility of relocating juvenile coho salmon from streams with a very high density of fish to nearby under-utilized high quality habitat. Develop a policy addressing this issue, and implement recommendations arising from the evaluation.
SW III-C-6	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.

6.4 POLLUTANTS

SW V-B-1	Improve water quality by reducing or minimizing point and non-point domestic and municipal sources of nutrient input (i.e. sewage treatment plant discharge, septic system discharge, and storm drain runoff). Support efforts by cities and rural communities to complete system upgrades to achieve Clean Water Act compliance.
SW V-E-1	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 Cal Tip program.
SW V-E-3	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.

6.5 SEDIMENTS

SW VI-A-2 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.

SW VI-B-1 Encourages 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.

SW VI-B-2 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.

SW VI-C-1 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 coho salmon streams.

SW VI-D-1 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 fish passage projects.

6.6 WATER TEMPERATURE

SW X-B-1 Identify and implement actions to maintain and restore water temperatures to meet habitat requirements for coho salmon in specific streams.

SW X-B-2 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.

6.7 RECRUITMENT OF LARGE WOODY DEBRIS

SW XIII-B-1a	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.
SW XIII-B-1b	Prioritize riparian vegetation communities for the purposes of restoring conifer LWD recruitment.
SW XII-B-2	Funding authorities should provide funding and technical support for riparian restoration.

6.8 STREAM COMPLEXITY

SW XIII-C-1	Modify maintenance manuals for consistency with habitat requirements and protection for coho salmon.
SW XIII-C-2	Where appropriate and feasible, work with all parties, including landowners, to reconfigure levees and channelized streams to benefit coho salmon.

6.9 ECOLOGICAL REFUGIA

SW XV-A-1	Identify key coho salmon refugia and inform land managers and other agencies of their locations anc characteristics.
SW XV-B-1	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.

6.10 HABITAT FRAGMENTATION

SW XVI-B-1	Restore habitat connectivity between coho salmon populations in coastal and low-gradient inland streams to promote the long-term viability of coho salmon.
SW XVI-B-2	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.

6.11 COMPETITION

SW XVIII-A-1	Develop a rapid-response eradication plan that can be implemented when invasive non-native species that negatively affect coho salmon are newly detected.
SW XVIII-A-2	Develop management guidelines to mitigate the impacts of non-native fish species on coho salmon.
SW XVIII-A-3	Encourage removal of non-native fish species from stock ponds where these fish pose a threat to coho salmon.

6.12 GENETICS

SW XX-B-1	Promote recovery actions that maintain the local genetic diversity of coho salmon populations to maximize fitness and long-term viability of coho salmon populations.

6.13 RIPARIAN VEGETATION

SW XXII-A-2	Where necessary, provide riparian protection from livestock while providing off-stream watering.
SW XXII-A-4	Encourage restoration of LWD and shade by improvement of existing riparian zones through planting, release of conifers, and control of alders, blackberries, and other competitors. The Department and others should provide incentives to landowners, such as technical support.
SW XXII-A-5	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.
SW XXII-A-6	Develop and implement initiatives, including funding where appropriate, to improve stream buffers that have been determined to be inadequate.

6.14 LAND USE

SW XXV-A-1	Continue providing subvention funds to counties for Williamson Act contracts to help preserve a rural landscape for more effective recovery of coho salmon.
SW XXV-B-3	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.
SW XXV-B-4	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.
SW XXV-B-5	Within the CCC ESU, 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.
SW XXV-B-6	Develop and implement initiatives to expand inadequate streamside protections for coho salmon. Include setbacks for development, restrictions on grading activities, and setbacks for septic system development. Enforce policies with ordinances.
SW XXV-C-1	Acquire conservation easements or land in fee title from willing landowners to protect coho salmon habitat.

6.15 PUBLIC OUTREACH

SW XXVIII-B-1 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.

6.16 INTEGRATION WITH OTHER PLANS AND PROGRAMS

SW XXX-B-1 As feasible, prepare and implement TMDL plans on a schedule that gives priority to key coho salmon watersheds.

SW XXX-B-3 Develop and implement sediment reduction and water quality improvement plans and meet and expedite the Clean Water Act TMDL requirements through technical assistance and incentives to landowners, making watersheds with coho salmon the highest priority for assistance.

SW XXX-B-5 Ensure that TMDL standards provide protection for coho salmon.

SW XXX-B-6 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.

SW XXX-D-1 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.

SW XXX-E-1 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.

SW XXX-E-2 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.

SW XXX-J-1 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.

6.17 PERMITTING

SW XXXI-A-1 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.

6.18 WATERSHED PLANNING

SW XXXII-B-2 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 stream flow, 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.

6.19 ENFORCEMENT OF EXISTING LAWS

SW XXXIII-A-01 Support full enforcement of existing laws, codes, regulations, and ordinances that address the protection of coho salmon and their habitat. These include, but are not limited to: Fish and Game Code Sections 1600, 5650, 5900 through 6100 (with an emphasis on 5901, 5937, and 6100), Public Resources Code Sections 10000-10005, the California Endangered Species Act, and the Federal Endangered Species Act. 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.

SW XXXIII-A-02 Provide adequate budgetary funding and positions for agencies with enforcement authority to enforce laws and codes relevant to coho salmon protection.

SW 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.

SW 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.

SW 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.

SW 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.

SW 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.

SW 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.

SW 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.).

SW XXXIII-A-11 Discourage illegal dumping, poaching, and other illegal activities by promoting "neighborhood watch" programs for streams and/or watersheds.

SW XXXIII-A-27 Establish environmental task forces made up of state, local, and federal enforcement agencies that operate in the range of coho salmon.

SW XXXIII-A-28 Increase funding for the Department's CALTIP program.

SW XXXIII-A-29 Seek programmatic incidental take authority with respect to screen design and installation that conforms to Department/NOAA Fisheries screening criteria.

6.20 IMPLEMENTATION

SW XXXIV-A-1 Provide funding and incentives for any 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.

SW XXXIV-A-2 Support continued and increased funding for the California Conservation Corps to implement coho salmon restoration projects.

6.21 INSTREAM GRAVEL MINING

SW XXXV-A-1 Within known or historic coho salmon habitat, permits for instream gravel mining 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).

[1] This recommendation is a modification of one developed by DFG staff and has not been specifically reviewed by the CRT.

7 Watershed Recommendations

Range-wide recommendations for recovering coho salmon in California are presented in Chapter 6. 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 watershed. Accordingly, the coho salmon recovery strategy emphasizes recovery recommendations and activities at various hydrologic levels within each ESU.

7.1 WATERSHED CLASSIFICATION

To provide consistency with existing resource databases, these recovery recommendations were compiled according to the geographic divisions of the CALWATER 2.2a system; the standard watershed mapping system used by the State of California (Appendix E). The CALWATER classification system includes (from largest to smallest) hydrologic regions, hydrologic units, hydrologic areas, hydrologic sub-areas, and planning watersheds. For purposes of this plan, issues and recommendations are primarily organized by two geographic levels, the *hydrologic unit (HU)*, which generally corresponds to major watersheds or sub-regions within the range of coho salmon, and within each HU by *hydrologic subarea (HSA)*, which generally corresponds to major tributary watersheds. In a few cases recommendations are presented for the *hydrologic area* (HA), a unit intermeidate 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 HU and Marin Coastal HU, multiple HUs tributary to San Francisco Bay).

The SONCC ESU has been divided into twelve watersheds (i.e., Hydrologic Units) and the CCC ESU into six (Table 7-1). HU boundaries within the range of coho salmon are illustrated in Figure 7-1. Each ESU and corresponding watersheds are discussed briefly below. The priority[1] for each HSA is provided as part of that discussion. Each watershed description is followed by several recommendations. These recommendations are at the most specific hydrologic delineation possible that could be supported by existing information.

[1] Prioritization is described in Section 10.1.

TABLE 7-1: Watersheds in the SONCC and CCC ESUs

SONCC	CCC
Rogue River HU and Winchuck River HU	Mendocino Coast HU
Smith River HU	Russian River HU
Klamath River HU	Bodega and Marin Coastal HUs
Salmon River HA	San Francisco Bay HUs
Shasta Valley HA and Scott River HA	San Mateo Coastal HU
Trinity River HU	Big Basin HU
Mad River HU	
Redwood Creek HU	
Trinidad Plain HU	
Eureka Plain HU	
Eel River HU	
Cape Mendocino HU	

7.2 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS ESU

The Department's status review (CDFG 2002) concluded that state Threatened listing of the California portion of the SONCC coho salmon ESU was warranted. Recent survey data show a substantial reduction in the number of streams occupied by coho salmon compared to their historical distribution, although the decline in coho salmon distribution in this ESU appears to have stabilized since the mid 1980's. However, because of the decline in distribution prior to the 1980s, the possibility of a severe reduction in distribution as indicated by field surveys and the downward trend of most abundance indicators, the Department concluded that coho salmon populations in California portion of this ESU will likely become endangered in the foreseeable future in the absence of the protection and management required by CESA. The Department, in consultation with CRT and SSRT, has identified the following protection and management actions to reverse the decline of coho salmon.

7.2.1 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 7-2), and the Winchuck River (Figure 7-3) are located in California.

FIGURE 7-1: Hydrologic units in California within the SONCC and CCC ESUs

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FIGURE 7-2: Rogue River and Klamath River Hydrologic Units

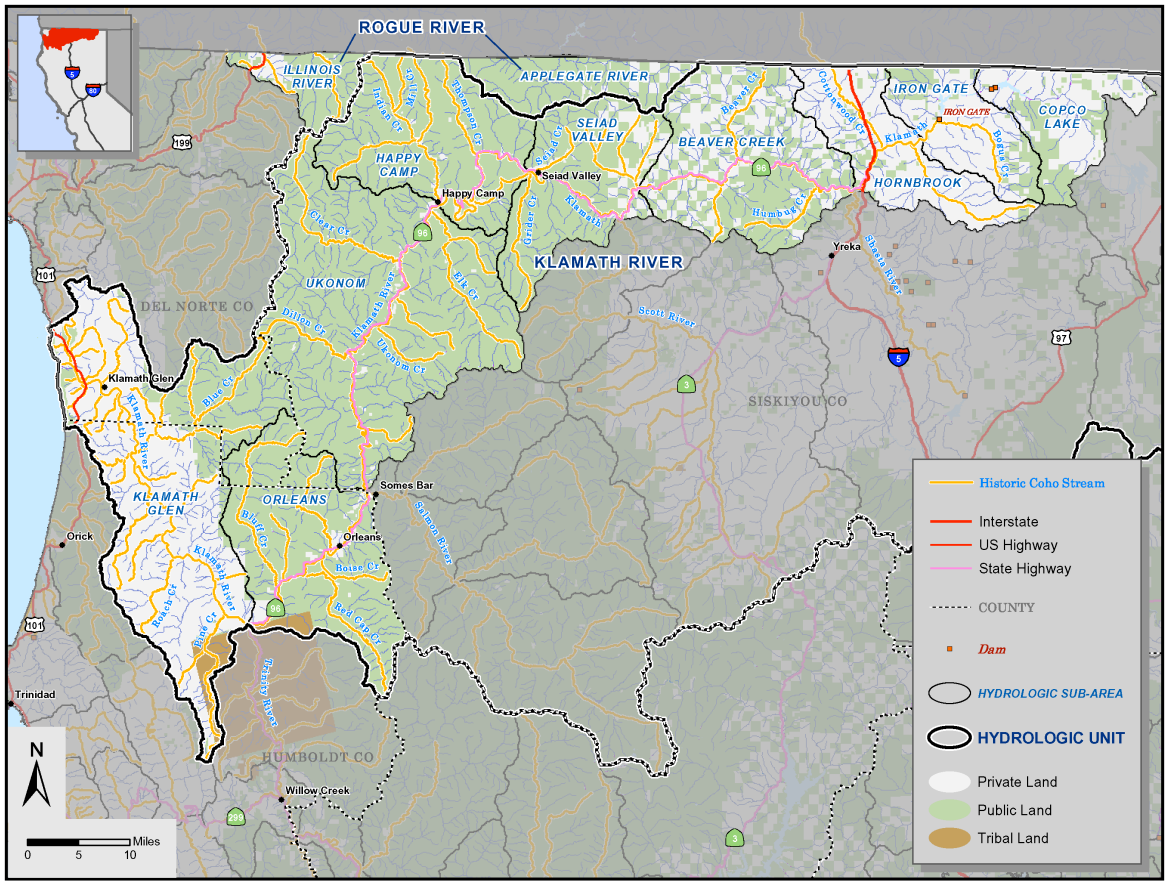

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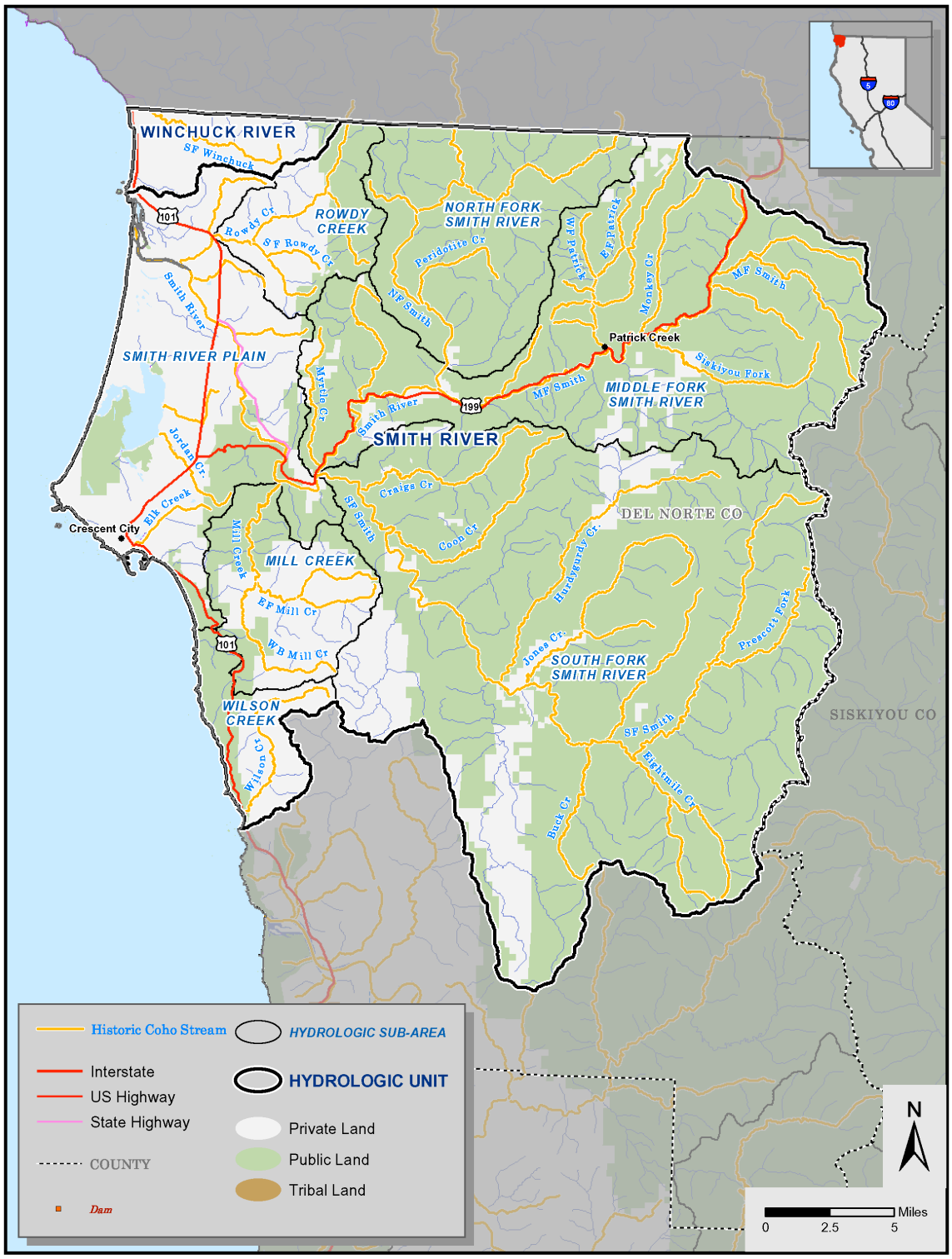
FIGURE 7-3: Winchuck River and Smith River Hydrologic Units



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7.2.1.1 Illinois River HSA (Priority Map Values: 5-3-4-5)

A very small portion of the Illinois River HSA is located in eastern Del Norte County, California. 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 among the main land use activities. 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.

Recommendations for the Illinois River HSA are:

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.

RO-IR-04 Develop a cooperative management strategy with Oregon Dept. Fish and Wildlife to improve downstream habitat conditions.

7.2.1.2 Winchuck River Hydrologic Unit / Winchuck River HSA (Priority Map Values: 5-5-5-5)

The South Fork Winchuck River is the only portion of the Winchuck River HSA located in California. The primary land use in the South Fork drainage is industrial timber production. Coho salmon have been found in the South Fork in recent Department surveys. 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.

Recommendations for the South Fork Winchuck River are:

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.

7.2.2 SMITH RIVER HYDROLOGIC UNIT

The Smith River (Figure 7-3) is California's fourth largest coastal river, with a watershed of approximately 390,400 acres (610 mi^2) in California, and 73,600 acres (115 mi^2) 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, most often planted after harvest, 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.

The main industries in the basin today are timber production, agriculture, sport fishing, gravel extraction, tourism, and other recreational activities. Agricultural industries within the basin include lily and flower production, beef and dairy ranching and some hay production. The majority of agricultural activities in the Smith River basin occur on the Smith River Plain along the lower seven miles of the river. Aggregate extraction in the Smith River basin occurs near the mouth of Sultan Creek downriver to the Reservation Ranch Bar.

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 1890's 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. Preliminary Smith River results from the 2002 Department presence/absence surveys of streams historically inhabited by coho salmon (Brown and Moyle 1991) shows a percentage increase in coho salmon presence over the previous year's data (79%-82%).

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.

7.2.2.1 Recommendations for the Smith River HU

SM-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.

SM-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 Clarks, Morrison, Peacock, Sultan and Little Mill creeks.

SM-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.

SM-HU-04 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, reestablish scour pools, recruit woody debris from banks, and ultimately restore fluvial processes that maintain coho salmon habitat.

SM-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.

SM-HU-06 Assess the impacts of steelhead outplanting at the Rowdy Creek Hatchery.

SM-HU-07 Adequately treat legacy sources of sediment and provide for minimization of new sediment input.

SM-HU-08 Support the use of the existing watershed coordinator to aid in implementing recommendations.

7.2.2.2 Mill Creek HSA (Priority Map Values: 5-4-4-5)

Mill Creek enters the Smith River approximately 15 river miles from the mouth. 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 22,400-acre (35 mi^2) basin is privately owned (timber production) with approximately 6,400 acres (10 mi^2) managed by Redwood National and State Parks.

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, fish passage, degraded riparian vegetation, and sediment input from the road network on public lands acquired from Stimpson Lumber.

Recommendations for the Mill Creek HSA are:

SM-MC-01 Assess, prioritize, and treat sediment sources (mostly legacy roads).

SM-MC-02 Develop and implement a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.

SM-MC-03 Develop and implement a plan for riparian planting.

7.2.2.3 Wilson Creek HSA (Priority Map Values: 5-4-5-5)

Wilson Creek is a tributary to the Pacific Ocean located approximately 4 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.

Although adult coho salmon have not been observed during spawning surveys, juveniles/smolts are found frequently in juvenile dive counts and electrofishing within Wilson Creek. Their numbers, however, are very low, which may factor into low observed adult escapement numbers (SRCo 2002).

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

Recommendations for the Wilson Creek HSA are:

SM-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

SM -WC-02 Develop a plan to increase connectivity of riparian habitat through fencing and planting.

SM-WC-03 Support the assessment, prioritization, and treatment of sources of sediment.

7.2.2.4 Smith River Plain HSA (Priority Map Values: 4-5-4-5)

SM-PL-01 Support the assessment, prioritization, and treatment of barriers to passage.

SM-PL-03 Support an assessment of the entire watershed.

SM-PL-04 Support prioritization and implementation of recommendations of the watershed assessment.

7.2.2.5 HSAs with No Recommendations

Hydrologic Subarea	Priority Map Values
Rowdy Creek HSA	5-4-4-5
South Fork Smith River HSA	4-3-4-5
Middle Fork Smith River HSA	4-4-4-5
North Fork Smith River HSA	4-3-4-5

7.2.3 KLAMATH RIVER HYDROLOGIC UNIT [2]

The origin of the Klamath River is at the outflow of Upper Klamath Lake, north of Klamath Falls, Oregon (Figure 7-2). The Upper Klamath River Basin has been highly modified over the past ninety-years, with 80-90% of historic wetlands having been reclaimed for agricultural, urban, and other development. On average, approximately 500,000 acre feet of water are diverted near the outlet of Upper Klamath Lake to provide irrigation deliveries to 200,000 acres of farmland within the U.S. Bureau of Reclamation's Klamath Project. Some of this water, in a warmed and more nutrified state, reenters the Klamath River at Keno, 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 979,816 acres (1,531 mi^2). The Klamath River HU has 1,832 miles of waterways, of which 1,780 miles (97%) are naturally occurring and 1,535 miles (84%) are perennial in nature. 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

[2] The discussion of the Klamath River HU does not include the Salmon River HA, Shasta Valley HA, Scott River HA, or the Trinity River HU, all of which are discussed below.

(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 mining, and agricultural conversion.

7.2.3.1 Recommendations for the Klamath River HU

KR-HU-02 Facilitate development of an adaptive management plan in preparation for low-flow emergencies in cooperation with the Bureau of Reclamation, NOAA Fisheries, USFWS, DOI, tribes, 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 fish passage.

KR-HU-06 Recommend that the Bureau of Reclamation implement the Trinity River TMDL instream flushing flows without affecting ROD allocations.

KR-HU-07 Analyze the feasibility and appropriateness of site-specific 2084 permits for sport fishing for hatchery 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 water quality coming into the Klamath River mainstem from the Upper Klamath Basin.

KR-HU-15 Address water quality and quantity problems in Klamath tributaries that exacerbate mainstem water quality problems.

KR-HU-17 Continue disease monitoring of juvenile salmon emigration in the Klamath River mainstem so that major disease outbreaks can be identified and their causes evaluated.

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 Project, or gravel introduction such as is done below other major dams (e.g., Trinity Dam).

KR-HU-21 Step up roads and fuels management, especially in tributaries with potential to contribute catastrophic loads of sediment to the mainstem Klamath.

7.2.3.2 Klamath Glen HSA (Priority Map Values: 5-5-5-5)

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 a population of 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, reduced quantity and habitat complexity. Many deep areas of the estuary have been filled in by excessive sedimentation, which may affect the mixing zone and be impacting food availability for juvenile salmonids. Rearing duration may be shorter now due to loss of habitat in the estuary.

Recommendations for the Klamath Glen HSA are:

KGHSA-01 Support the continuation of long-term estuary investigations to better understand the estuary's role in the survival of Klamath Basin coho salmon.

KGHSA-02 Develop a plan to restore off-channel estuarine, wetland, and slough habitat in lower Hunter and Salt creeks:

a. Investigate the purchase of key properties, conservation easements, or development rights from willing sellers; and

b. Encouraging the installation of livestock exclusion fencing to protect restored areas.

KGHSA-04 Plan for the protection and restoration of Klamath 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. Actions should:

a. Protect and/or restore riparian habitat,

b. Stabilize upslope areas to prevent sedimentation and aggradation of tributaries at their mouths, and

c. Improve federal land management to reduce impacts to riparian corridors and sediment loads.

KGHSA-05 Support actions to reduce sediment input from upslope sources, such as to:

a. Decommission roads and skidtrails.

b. Upgrade roads and maintenance practices,

c. Ensure adequate fish 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 hillslope drainage patterns.

KGHSA-07 Support treating sediment sources and improving riparian and instream habitat conditions to provide adequate and stable spawning and rearing areas for coho salmon.

KGHSA-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 streambanks 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.

KGHSA-12 Express appreciation for the outstanding cooperation between Tribes and Simpson Timber Company.

KGHSA-13 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.

7.2.3.3 Orleans HSA (Priority Map Values: 2-2-3-5)

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 harvesting, water diversions, gravel extraction, stream channelization and excessive sediment input, elevated summer water temperatures, and connectivity to tributaries.

Recommendations for the Orleans HSA are:

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 water quality and which provide thermal refugia for fish, 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.

KR-OR-02 Support activities to maintain connectivity (flow) between mainstem habitat and tributary habitat in Slate and Red Cap 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. Key watersheds serve as refugia for maintaining and recovering habitat for stocks of anadromous fish at risk, such as coho salmon.

KR-OR-07 Support actions to reduce sediment input from upslope sources, including measures to:

a. Decommission roads and skidtrails,

b. Upgrade roads and maintenance practices,

c. Ensure adequate fish 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 hillslope drainage patterns.

7.2.3.4 Ukonom HSA (Priority Map Values: 5-3-3-4)

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 were not 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 acid discharge, heavy metals and cyanide discharge from the Siskon Mine in the Dillon Creek watershed.

Recommendations for the Ukonom HSA are:

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 water quality, and provide thermal refugia for fish, 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.

KR-UK-02 Support actions to reduce sediment input from upslope sources, including measures to:

a. Decommission roads and skidtrails,

b. Upgrade roads and maintenance practices,

c. Ensure adequate fish 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 hillslope drainage patterns.

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 of riparian revegetation and streambank 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 floodplain areas using native species.

KR-UK-05 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.

KR-UK-09 Increase efficiency of water diversions and delivery systems.

KR-UK-10 Continue restoration and monitoring of Siskon Mine to prevent further degradation of the riparian resource.

7.2.3.5 Happy Camp HSA (Priority Map Values: 4-3-4-5)

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

Problems facing anadromous salmonids include, reduction in water quality (increased turbidity); acid mine drainage 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, large woody debris, sediment) and fish due to culverts and road crossings in the Thompson Creek Watershed.

Recommendations for the Happy Camp HSA are:

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 quality, and provide thermal refugia for fish, 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.

KR-HC-02 Support actions to reduce sediment input from upslope sources, including measures to:

a. Decommission roads and skidtrails,

b. Upgrade roads and maintenance practices,

c. Ensure adequate fish 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 hillslope drainage patterns.

KR-HC-05 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.

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 efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet this goal.

KR-HC-10 Encourage the North Coast RWQCB to continue monitoring Grey Eagle Mine and tailings as a follow-up to remediation that has already been done. Urge EPA Region 9 to consider coho salmon when dealing with both emergency and remedial actions.

7.2.3.6 Seiad Valley HSA (Priority Map Values: 4-4-4-4)

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

Problems facing anadromous salmonids include reduction in water quality (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, large woody debris, sediment) and fish passage due to road culverts and crossings in Seiad and Grider Creek Watersheds

Recommendations for the Seiad Valley HSA are:

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 water quality, and provide thermal refugia for fish, 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.

KR-SV-02 Support actions to reduce sediment input from upslope sources:

a. Decommission roads and skidtrails,

b. Upgrade roads and maintenance practices,

c. Ensure adequate fish 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 hillslope drainage patterns.

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 streambank 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 floodplain areas using native species.

KR-SV-05 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.

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.

7.2.3.7 Beaver Creek HSA (Priority Map Values: 4-4-4-4)

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 large woody debris needed for habitat complexity in Beaver Creek, and degraded riparian vegetation.

Recommendations for the Beaver Creek HSA are:

KR-BC-02 Encourage landowners to manage fuels to prevent catastrophic 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-05 Support actions to reduce sediment from upslope sources such as:

a. Decommission roads and skidtrails,

b. Upgrade roads and maintenance practices,

c. Ensure adequate fish 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, wet-seepy areas).

7.2.3.8 HSAs with No Recommendations

Hornbrook HSA (Priority Map Values: 2-2-3-4): The Hornbrook HSA is located between the confluence of the Shasta River and the Confluence of Little Bogus Creek. Problems facing coho salmon in the Hornbrook HSA include a major impoundment on Cottonwood Creek and irrigation diversions that cause the stream to go dry on some reaches during the summer. In addition, spawning gravels in Cottonwood Creek were depleted during the Construction of Interstate 5.

Iron Gate HSA (Priority Map Values: 4-4-3-1): 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 in the Iron Gate HSA include water diversions, fish passage, and sedimentation on Bogus Creek.

Copco Lake HSA (Priority Map Values: 0-1-2-1): The Copco Lake HSA is located upstream of Copco Lake and completely out of anadromous waters. Therefore the problems facing coho salmon in the Copco Lake HSA are the inability of migrating salmon to pass Iron Gate Dam

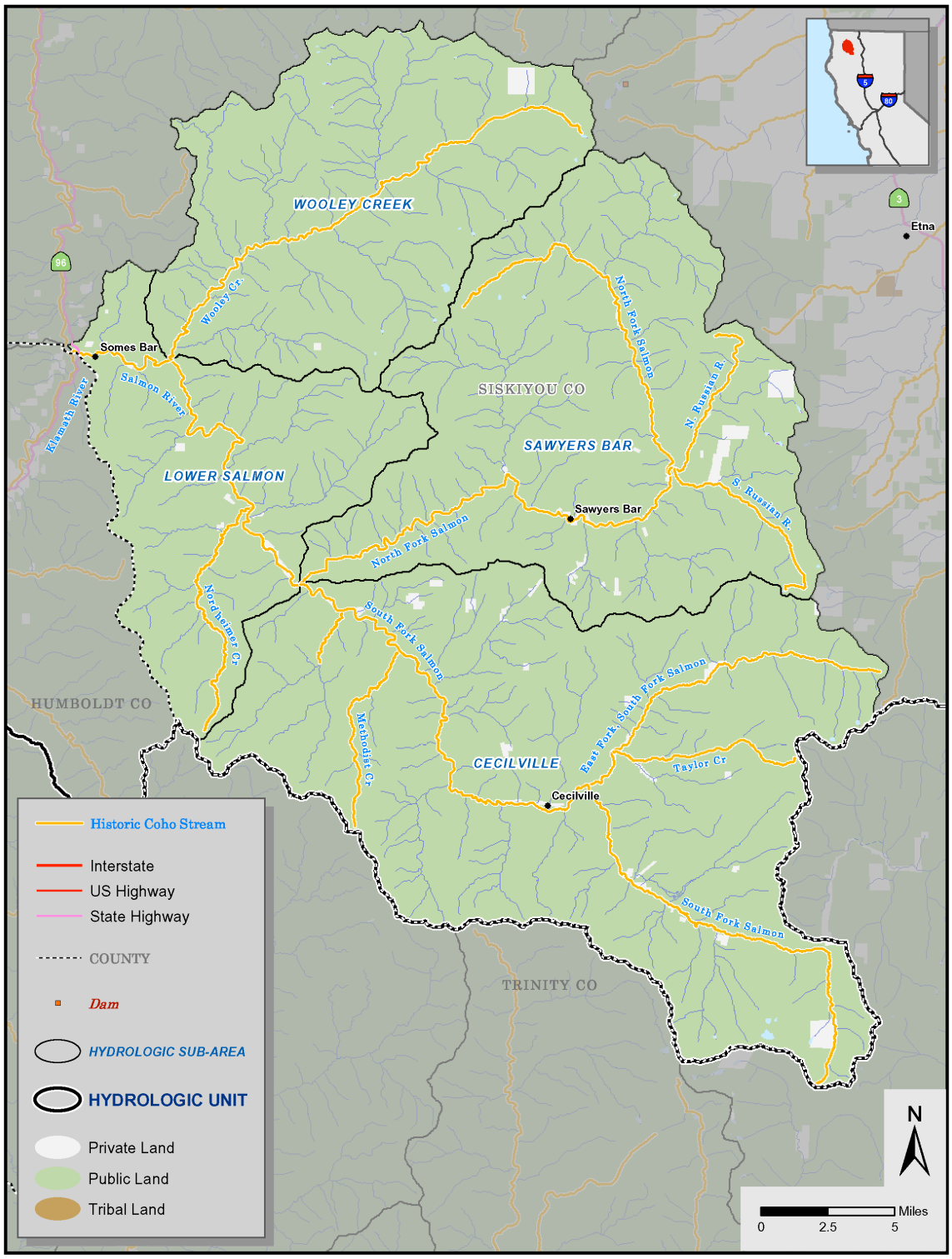
7.2.4 SALMON RIVER HYDROLOGIC AREA

The Salmon River is located in remote northwestern California in the Klamath Mountains (Figure 7-4). It is a major tributary to the Klamath River. The Salmon River drains an area of 480,626 acres (751 mi^2). 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 Forest Service. 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). California

FIGURE 7-4: Salmon River Hydrologic Area



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Department of Water Resources 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 1960's 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 exotics, barriers to fish passage, depleted LWD, high sediment loads from the extensive road system and past large wildfires, limited riparian function due to tailing piles from hydraulic mining, unscreened water diversions, and unstable spawning gravels.

7.2.4.1 Recommendations for the Salmon River HA

SA-HA-01 With the goal of reducing sediment and providing fish passage at all life history stages where roads affect streams inhabitated by coho salmon:

a. Request that USFS implement recommendations for roads already assessed and accelerate the Northwest Forest Plan road assessment schedule,

b. Encourage Siskiyou County to complete road sediment inventory assessment and implement treatment of County roads, and

c. Encourage Siskiyou County to implement recommendations of the completed assessment of barriers.

SA-HA-02 Establish a multi-agency task force to assume implementation of barrier removal. This task force would include at a minimum, representatives from Salmon River Restoration Council, USFS, NOAA Fisheries, USFWS, and the Department.

SA-HA-04 Support the on-going efforts of Salmon River Restoration Council to deal with invasive exotics using Integrated Past Management.

SA-HA-05 Reduce the risk of catastrophic fires through fuels management 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.

SA-HA-6 Investigate how USFS is dealing with riparian and aquatic conservation in Northwest Forest Plan regarding fire suppression and fuels management and encourage the USFS to consider coho salmon in their overall fuel management plan.

SA-HA-07 Recognize the Salmon River Restoration Council's value for cost-effective education and restoration.

SA-HA-08 Encourage USFS to continue to work closely with the Salmon River Restoration Council.

SA-HA-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;

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 remediate mine tailings.

7.2.4.2 HSAs with No Recommendations

Lower Salmon HSA (Priority Map Values: 2-1-3-5): 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 resulting from past forest fires.

Wooley Creek HSA (Priority Map Values: 1-1-2-5): Wooley Creek is a designated wilderness and provides habitat conditions largely unaffected by human influence.

Sawyers Bar HSA (Priority Map Values: 2-2-3-5): Problems facing coho salmon in the Sawyers Bar HSA include sediment input sediment input from roads, marginal summer water temperature conditions resulting from the broad, unvegetated floodplain and riparian areas and waste discharge from mine tailings.

Cecilville HSA (Priority Map Values: 4-4-4-5): Problems facing coho salmon in the Cecilville HSA include lack of deep pools for holding adults and juvenile rearing, summer water temperature conditions resulting from broad, unvegetated floodplain, impacts from past hydraulic mining and lack of potential winter rearing habitat, particularly cover in slow velocity areas.

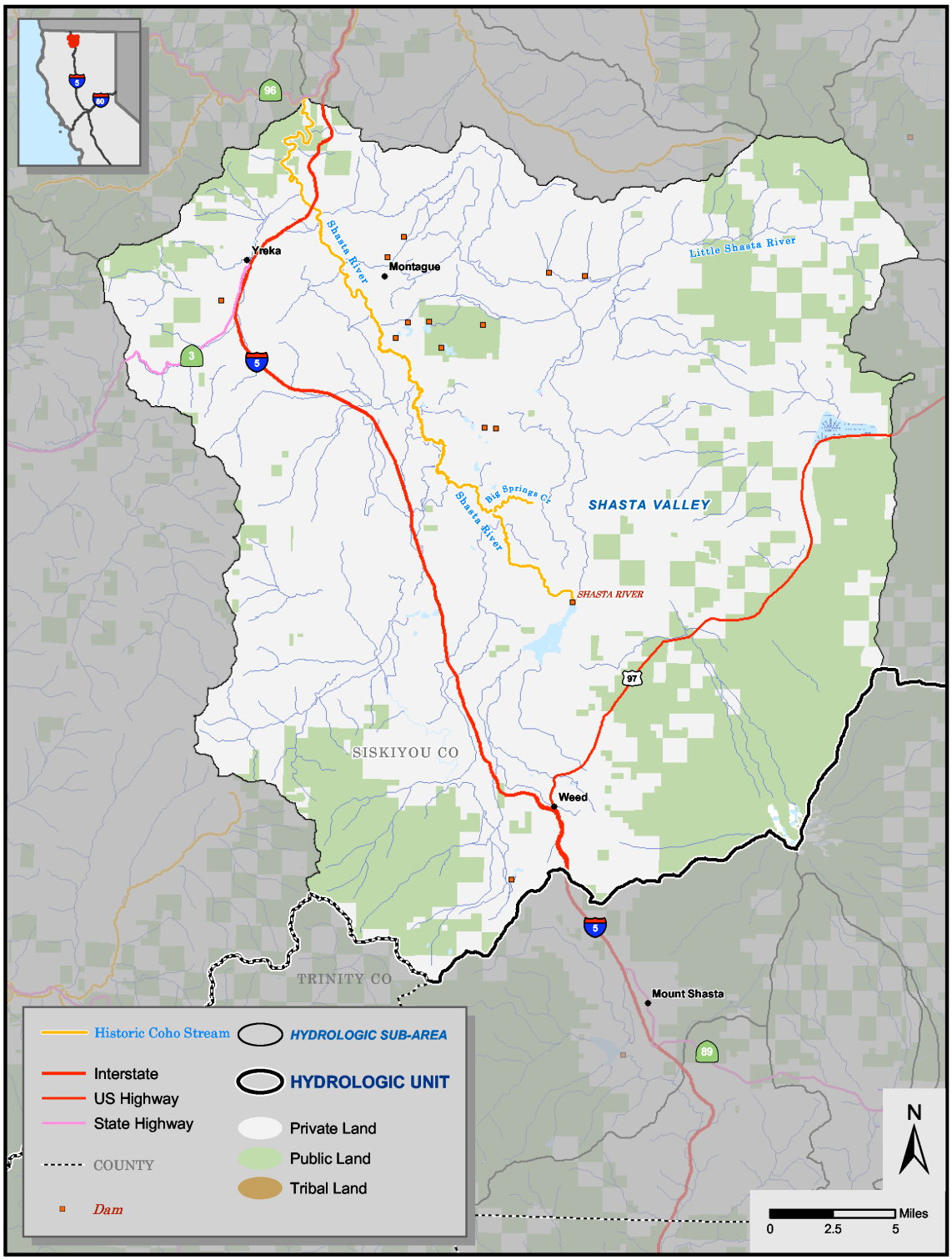
7.2.5 SHASTA VALLEY AND SCOTT RIVER HYDROLOGIC AREAS

This section includes the recommendations for the Shasta Valley HA and the Scott River HA that that do not relate to agricultural water and land use. The recommendations developed by SSRT for the Shasta-Scott Pilot Program to deal with agricultural water and land use issues are presented in Chapter 8.

7.2.5.1 Shasta Valley HA/HSA (Priority Map Values: 5-4-4-3)

The Shasta Valley HA is part of the Klamath River HU and consists of one HSA, the Shasta Valley HSA (Figure 7-5). The Shasta Valley HSA covers the Shasta River watershed, approximately 508,700 acres (793 mi^2). The Shasta River originates

FIGURE 7-5: Shasta Valley Hydrologic Area/Hydrologic Sub-Area



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within the higher elevations of the Eddy Mountains lying southwest of the town of Weed in Siskiyou County, California. It flows for 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 a distance of 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. The Shasta River Watershed is situated almost entirely within Siskiyou County. Numerous springs and a number of small tributary streams enter the Shasta River as it passes through the Shasta Valley. Glacial melting from Mt. Shasta and mountain 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 Shasta Watershed is Mt. Shasta at just over 14,000 feet high. Where the Shasta River enters the Klamath River, the elevation is just over 2,500 feet .

Seventy-two percent of the Shasta Watershed and Shasta River 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 a few landowners provide access. That portion of the Shasta River passing through BLM lands in the Shasta Canyon (approximately 3 river miles) 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 probably averaged a little more than 1,000 fish annually in the late 1950's(CDFG 1959). In the early 1960's, the runs were estimated to average 600 fish (CDFG 1979). Current counts are low in comparison to 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 dissolved oxygen, 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.

7.2.5.2 Scott River HA (Scott Valley HSA - Priority Map Values: 5-5-4-4) (Scott Bar HSA - Priority Map Values: 4-4-4-5)

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

climate. The watershed drains approximately 520,617 acres (812.2 mi^2). 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 the eastern mountains are covered by extensive areas of brush, oak, western juniper, and annual grass. The Scott River is part of the Klamath Mountain Province, which encompasses land in both Southern Oregon and Northern California.

The mainstem through Scott Valley is predominantly surrounded by irrigated farmland (32,000 acres; 50 mi^2) and rangeland comprising 16% of the watershed acreage. Remaining areas are upland areas of the watershed and are predominantly private owned and federally managed timberlands. The Klamath National Forest manages approximately 35% of the total Scott watershed acreage. The remaining (65%) acreage is under other public management or private ownership.

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

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

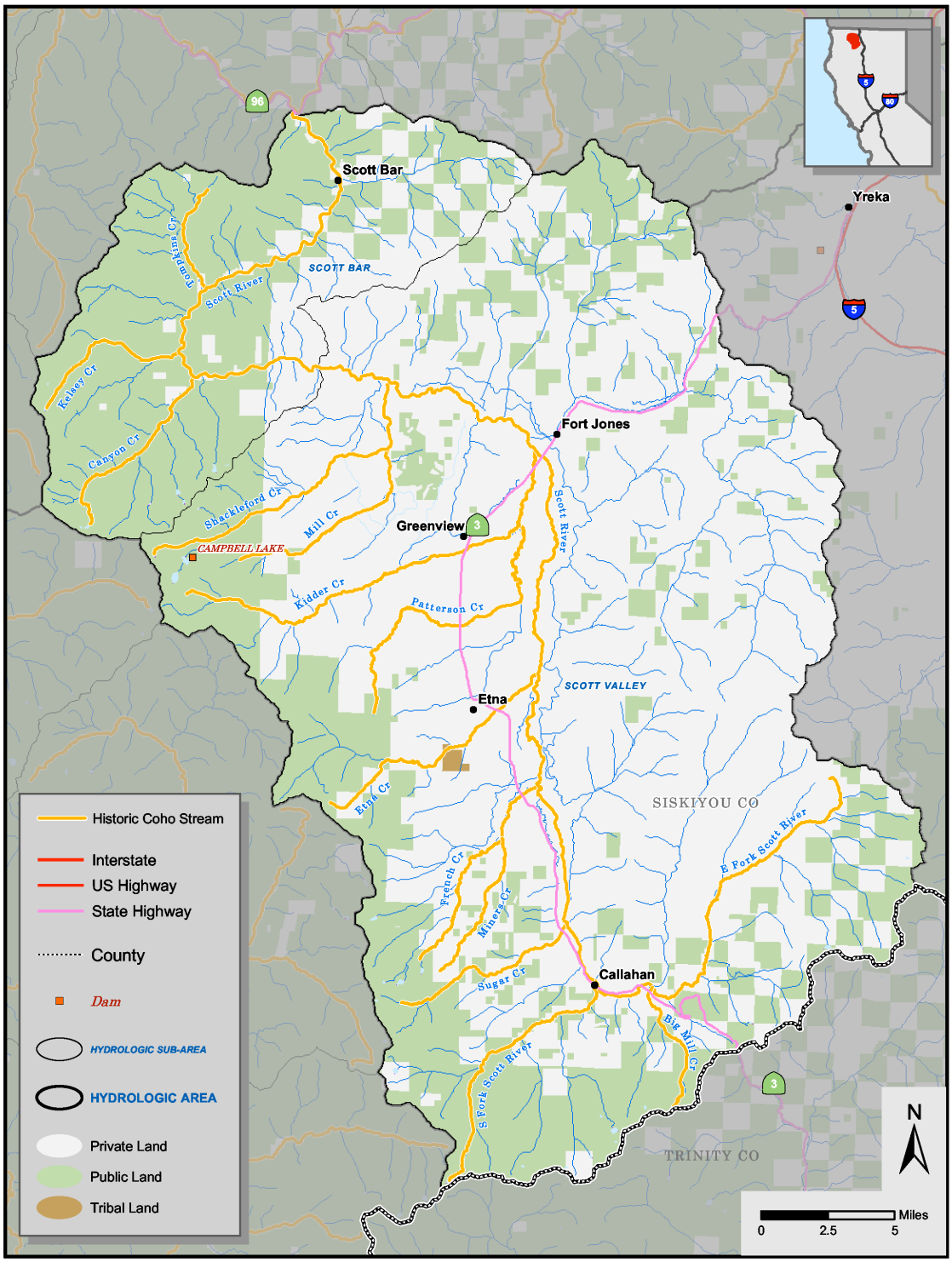
7.2.5.3 Recommendations for the Scott and Shasta Rivers (Non-agricultural)

SS-HA-01 Reduce the risk of catastrophic 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 anthropogenic-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 fish 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

FIGURE 7-6: Scott River Hydrologic Area



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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 fish passage projects.

SS-HA-04 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).

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 Clean Water Act compliance.

SS-HA-08 Minimize impacts of cattle grazing on watercourses 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 exercising the U.S. Forest Service right to stream flow in the Scott River for fish and wildlife within the Klamath National Forest under the Scott River Decree. This should be dealt with during the verification described in SSRT water management recommendations.

SS-HA-11 Request the Bureau of Reclamation 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.

7.2.6 TRINITY RIVER HYDROLOGIC UNIT

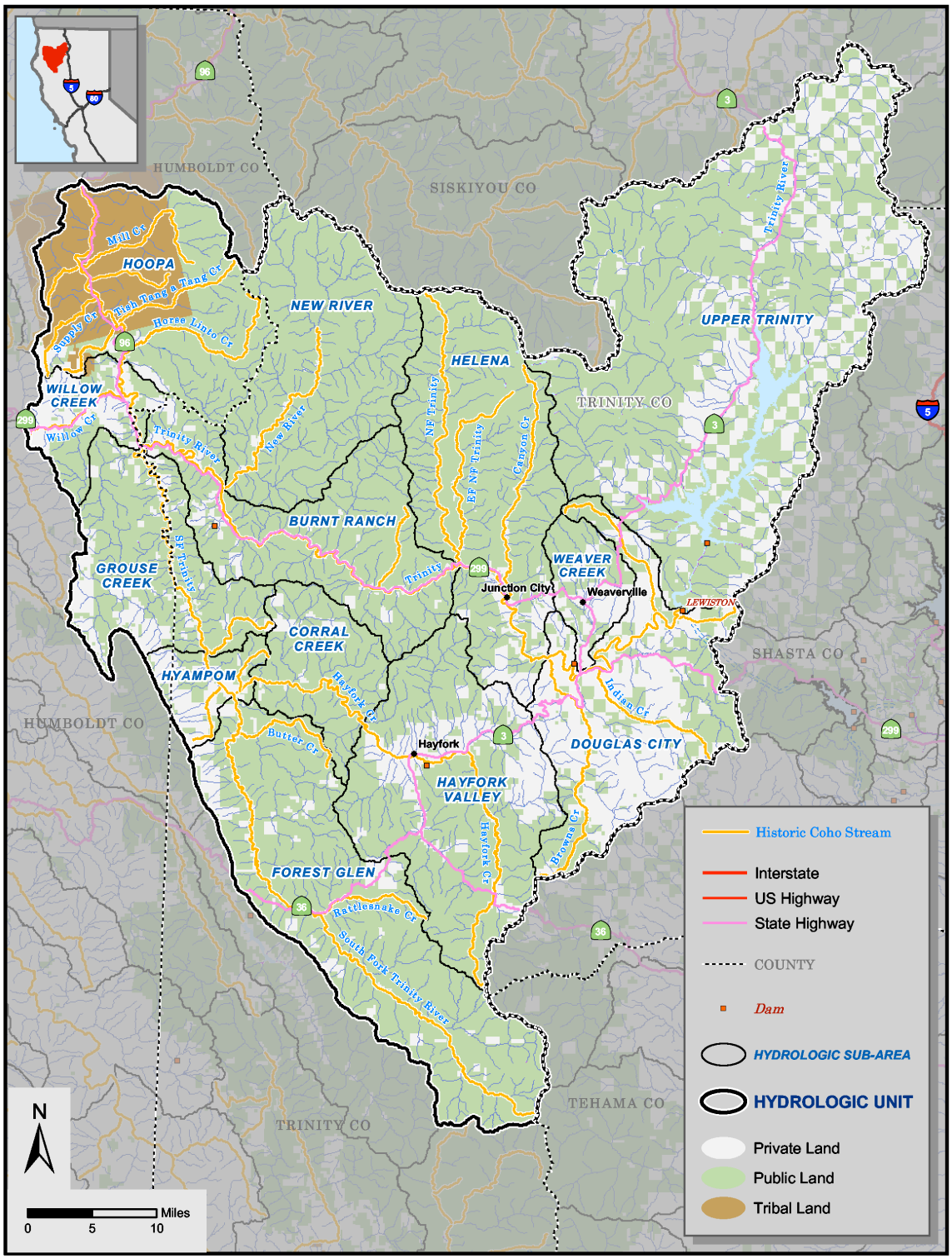
The Trinity River is the largest tributary to the Klamath River, draining approximately 1,304,179 acres (2,037.8 mi^2) in Humboldt and Trinity counties (Figure 7-7). The headwater streams originate in the pristine wilderness areas of the Trinity Alps and Trinity Mountains located in eastern Trinity County. 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 Indian reservations until it joins the Klamath River at Weitchpec, about 40 river miles (RM) from the Pacific Ocean. Anadromous fish passage is blocked by Lewiston Dam approximately 112 RM upstream from the mouth of the Trinity River.

Most of the Trinity River Watershed is in public ownership (69% of land is managed as public multiple use lands, 7% as protected lands). Only 24% of the watershed is in private ownership. Two Indian tribes, the Hoopa and Yurok, have reservations located all or in part within the Trinity Basin. Both of theses tribes have subsisted on anadromous fish runs historically and continue to do so. Much of their culture and tradition is derived from resources found within the basin. Historically, gold mining was an important economic activity in the region, and today the watershed supports limited suction dredging activity. 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. Many of 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 since 1977 in the Trinity River Watershed. 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 is 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 stream 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.

FIGURE 7-7: Trinity River Hydrologic Unit



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7.2.6.1 Trinity River HU Recommendations

TR-HU-03 Determine genetic make-up of current hatchery and natural stock and develop. Implement a hatchery genetic management plan (HGMP) for coho salmon to utilize the most fit and appropriate stock for use in the Trinity River.

TR-HU-04 Add a conservation element to the hatchery goals.

TR-HU-08 Support development of a County grading ordinance based on exemption, certification, and permitting criteria.

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 Urge 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 Urge Trinity County to establish riparian setbacks for grading activities on private lands, based on Fish and Game 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-15 Analyze the feasibility and appropriateness of site-specific 2084 permits for sport fishing for hatchery coho salmon.

7.2.6.2 Douglas City HSA (Priority Map Values: 5-5-5-4)

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, fish passage, reduce riparian function due to agricultural and grazing impacts, sedimentation from near-stream roads.

Recommendations for the Douglas City HSA are:

TR-DC-01 Investigate all water diversions on Reading Creek and Browns Creek. Restore fish passage and encourage instillation of screens to Department and NOAA Fisheries standards. Provide incentives to landowners when necessary to reach this goal.

TR-DC-02 Increase riparian function in lower Reading Creek and Browns Creek 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.

7.2.6.3 Grouse Creek HSA (Priority Map Values: 5-3-3-3)

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 problems associated with a large network of forest roads.

Recommendation for the Grouse Creek HSA is:

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.

7.2.6.4 Hyapom HSA (Priority Map Values: 1-1-2-3)

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 as 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.

Recommendations for the Hyapom Creek HSA are:

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 catastrophic 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.

7.2.6.5 Hayfork HSA (Priority Map Values: 0-1-2-2)

The Hayfork Valley HSA includes Hayfork Creek Watershed upstream of Little Creek. Coho salmon inhabited the watershed in the past but are now thought to be extirpated.

Problems facing coho salmon 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.

Recommendations for the Hayfork HSA are:

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.

7.2.6.6 HSAs with No Recommendations

Hoopa HSA (Priority Map Values: 4-2-3-2): The Hoopa HSA includes the mainstem of the Trinity River and its tributaries from the confluence with Klamath River up stream to Willow Creek.

Willow Creek HSA (Priority Map Values: 5-3-4-4): The Willow Creek HSA includes the Willow Creek watershed. Coho salmon inhabit Horse Linto Creek and first two miles of Willow Creek. Problems facing coho salmon in the Willow Creek HSA include removal of nearly all mature conifers from tributary riparian areas.

Burnt Ranch HSA (Priority Map Values: 4-4-3-3): The Burnt Ranch HSA includes the mainstem of the Trinity River and its tributaries from the South Fork confluence to the North Fork confluence.

New River HSA (Priority Map Values: 4-3-3-4): The New River HSA includes the New River watershed. Problems facing coho salmon in the New River HSA include steep terrain, mass wasting, degradation of spawning areas, erosion caused by road building and past mining practices and erosion and sediment accumulation caused by large fires.

Helena HSA (Priority Map Values: 4-5-4-4): The Helena HSA includes the mainstem of the Trinity River and its tributaries from the North Fork to Browns Creek. Problems facing coho salmon in the Helena HSA include reduced production of bottom-dwelling insects because of sediment accumulation.

Forest Glen HSA (Priority Map Values: 2-2-3-3): The Forest Glen HSA includes the South Fork Trinity River and its tributaries from Hayfork Creek up stream to the headwater of the South Fork. Problems facing coho salmon in the Forest Glen HSA

include impacts from historic mining activities, sedimentation, and low recruitment of spawning gravels.

Corral Creek HSA (Priority Map Values: 0-1-2-4): The Corral Creek HSA includes the Corral Creek watershed.

Weaver Creek HSA (Priority Map Values: 5-5-5-4): The Weaver Creek HSA includes the Weaver Creek watershed.

Upper Trinity River HSA (Priority Map Values: 0-1-2-1): The Upper Trinity HSA includes the mainstem of the Trinity River from Lewiston Dam up stream to the headwaters. Lewiston Dam is a total barrier to up and down stream migration of coho salmon.

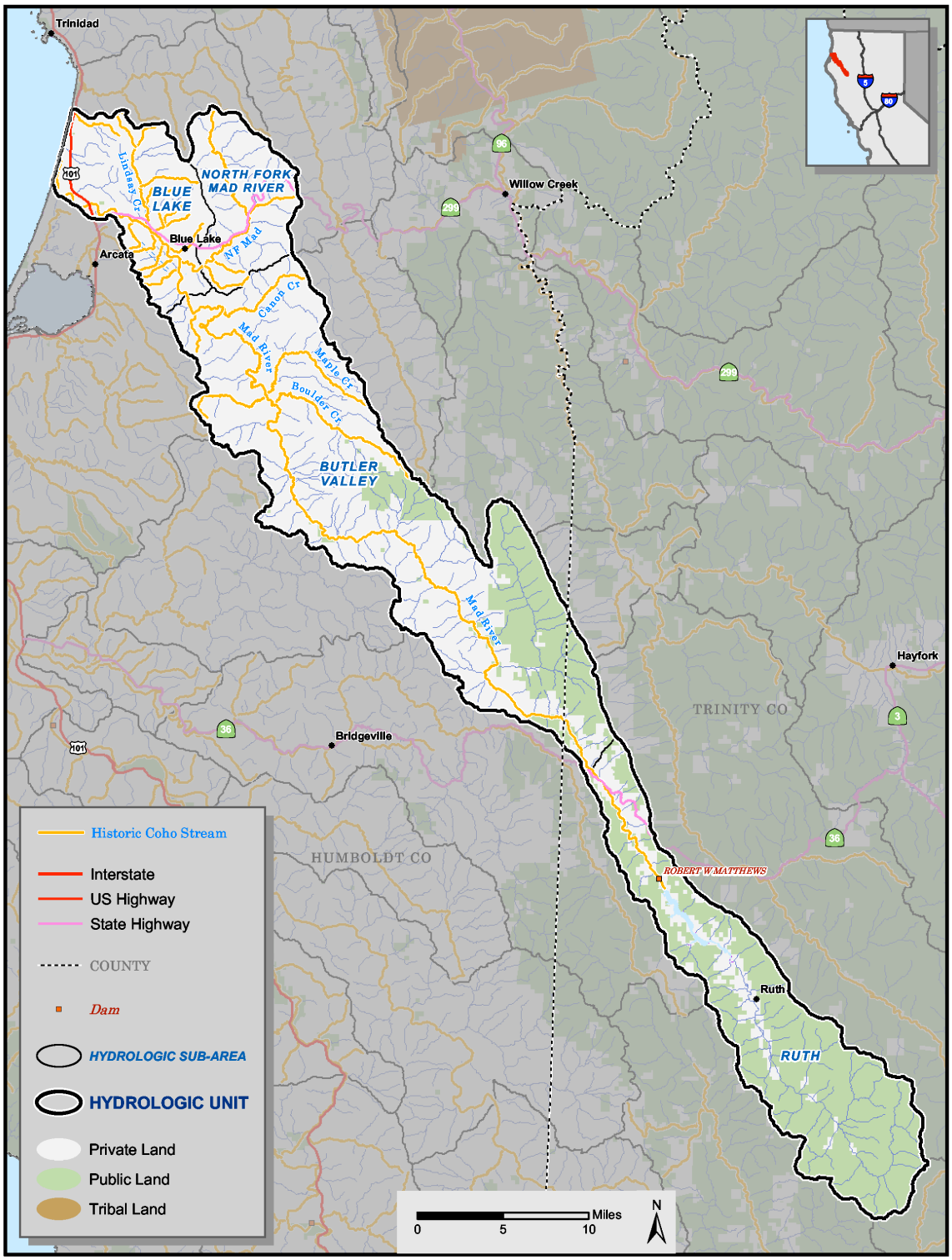
7.2.7 MAD RIVER HYDROLOGIC UNIT

The Mad River HU drains an area of approximately 318,000 acres (497 mi^2) (Figure 7-8). 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. Bureau of Land Management and the U.S. Forest Service manage 39% of the watershed. The remaining 61% of the land 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, as it approaches 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 declining trend in this river 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 Clean Water Act Section 303(d) as impaired for sediment, turbidity, and temperature. Potential 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.

FIGURE 7-8: Mad River Hydrologic Unit



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7.2.7.1 Mad River HU Recommendations

MR-HU-01 Work with landowners and other entities to reduce coho salmon tributary stream temperature through the development of mature coniferous streamside 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, and

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 Require the implementation of 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-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 fish 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 for a pilot project 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.

7.2.7.2 Blue Lake HSA (Priority Map Values: 5-5-4-3) and North Fork Mad HSA (Priority Map Values: 4-3-3-2)

Recommendations for the Blue Lake HSA and North Fork Mad HSA are:

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.

7.2.7.3 HSAs with No Recommendations

Two HSAs within the Mad River HU have no specific recommendations at this time.

Hydrologic Subarea	Priority Map Values
Butler Valley HSA	5-5-5-5
Ruth Lake HSA	0-1-2-0

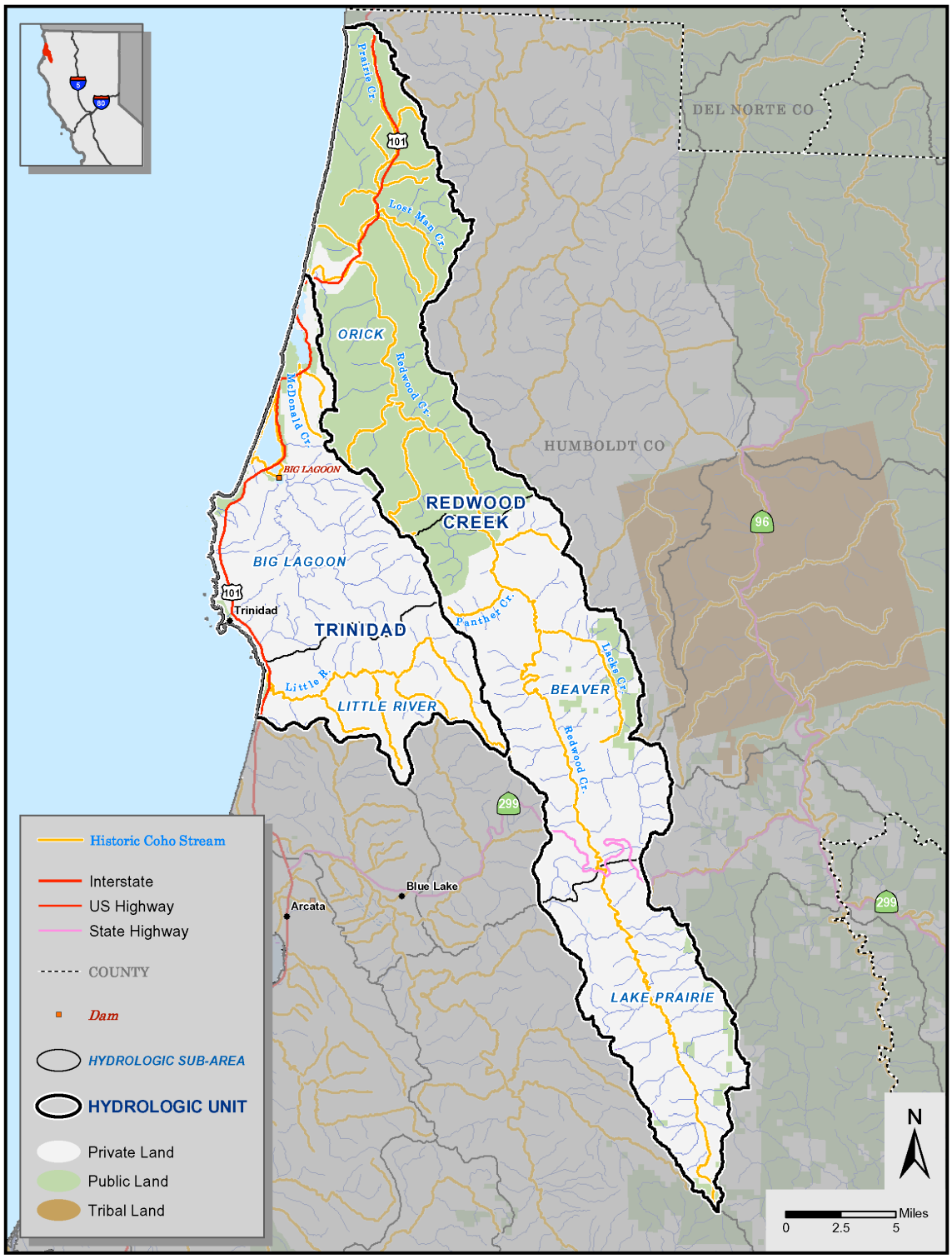
7.2.8 REDWOOD CREEK HYDROLOGIC UNIT

The Redwood Creek HU (Figure 7-9) covers an area of approximately 282 square miles. The HU is divided into three hydrologic sub-areas (HSAs): Orick HSA, containing the estuary and lower Redwood Creek; Beaver HSA, covering middle Redwood Creek from above Devil's Creek to Lupton Creek; and Lake Prairie HSA, covering upper Redwood Creek. A basin-wide assessment has been completed for Redwood Creek by the North Coast Watershed Assessment Program (Henly et al. 2002). The information from this assessment is the main source for this brief summary and for some of the recommendations.

The primary private land use activity in the Redwood Creek HU is timber production, especially in the middle and upper subbasins. 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. In addition to Prairie Creek, four other tributaries with coho salmon present in the Orick HSA include Elam, Tom McDonald, Bridge, and MacArthur Creeks, all within Redwood National and State Park (RNSP) boundaries. The historic coho salmon range includes Coyote, Panther, Lacks, Minor, Karen, Strawberry, and Pilchuck

FIGURE 7-9: Redwood Creek and Trinidad Plain Hydrologic Units



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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).

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 the Clean Water Act Section 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, and high fine sediment loading, and high turbidity levels (in part from high road concentration in watershed).

7.2.8.1 Redwood Creek HU Recommendations

RC-HU-01 Work with Redwood National and State Parks, private landowners, and interested parties to improve fish 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.

RC-HU-04 Encourage completion of assessments of sediment sources and upgrade deficient assessments; then urge 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 nearstream land use planning (especially on slopes greater than 35 per cent).

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-6 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.

7.2.8.2 HSAs with No Recommendations

Three HSAs in the Redwood Creek HU have no specific recommendations at this time.

Hydrologic Subarea	Priority Map Values
Orick HSA	5-5-5-2
Beaver HSA	1-1-3-3
Lake Prairie HSA	0-1-2-N/A

7.2.9 TRINIDAD PLAIN HYDROLOGIC UNIT

The Trinidad HU (Figure 7-9) includes the Coastal Lagoons (Freshwater, Big, Dry, and Stone) and their tributaries, the Little River drainage, and coastal streams from Strawberry Creek north to Freshwater Lagoon. These drainages extend 10 miles inland and crest at 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 activity 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 so 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.

7.2.9.1 Trinidad Plain HU Recommendations

TP-HU-01 Support the assessment, prioritization, and treatment of sediment sources, particularly roads, that 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.

7.2.9.2 Big Lagoon HSA (Priority Map Values: 4-4-4-1)

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 when returning coho salmon are in the area. 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.

Recommendation for the Big Lagoon HSA is:

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.

7.2.9.3 Little River HSA (Priority Map Values: 5-4-5-5)

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 (estuary) is confined between low levees and simplified to accommodate agricultural activities in the surrounding lands. The canopy, where present in this lower riparian zone, consists of a narrow strip of willows and some alders.

Recommendations for the Little River HSA are:

TP-LR-01 Develop a plan to improve the functioning of the lower river estuary. Reestablish conifers and a functional flood plain and riparian zone on the lower river channel. Reestablish more complex instream habitat.

TP-LR-02 Urge landowners to minimize the impacts of agricultural activities on the estuary.

TP-LR-03 Appropriate agencies should enforce any violation of law that occurred from construction of cranberry bogs in the Little River.

TP-LR-04 Work with Humboldt County and landowners to maintain current flood plain capacity and prevent future encroachment on the flood plain.

7.2.10 EUREKA PLAIN HU, HA, HSA (PRIORITY MAP VALUES: 5-5-5-5)

The Eureka Plain watershed (Figure 7-10), located on the northern coast of California 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 142,720 acres (223 mi^2) 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), stream water temperatures that are too high to support salmon 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 tributaries 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.

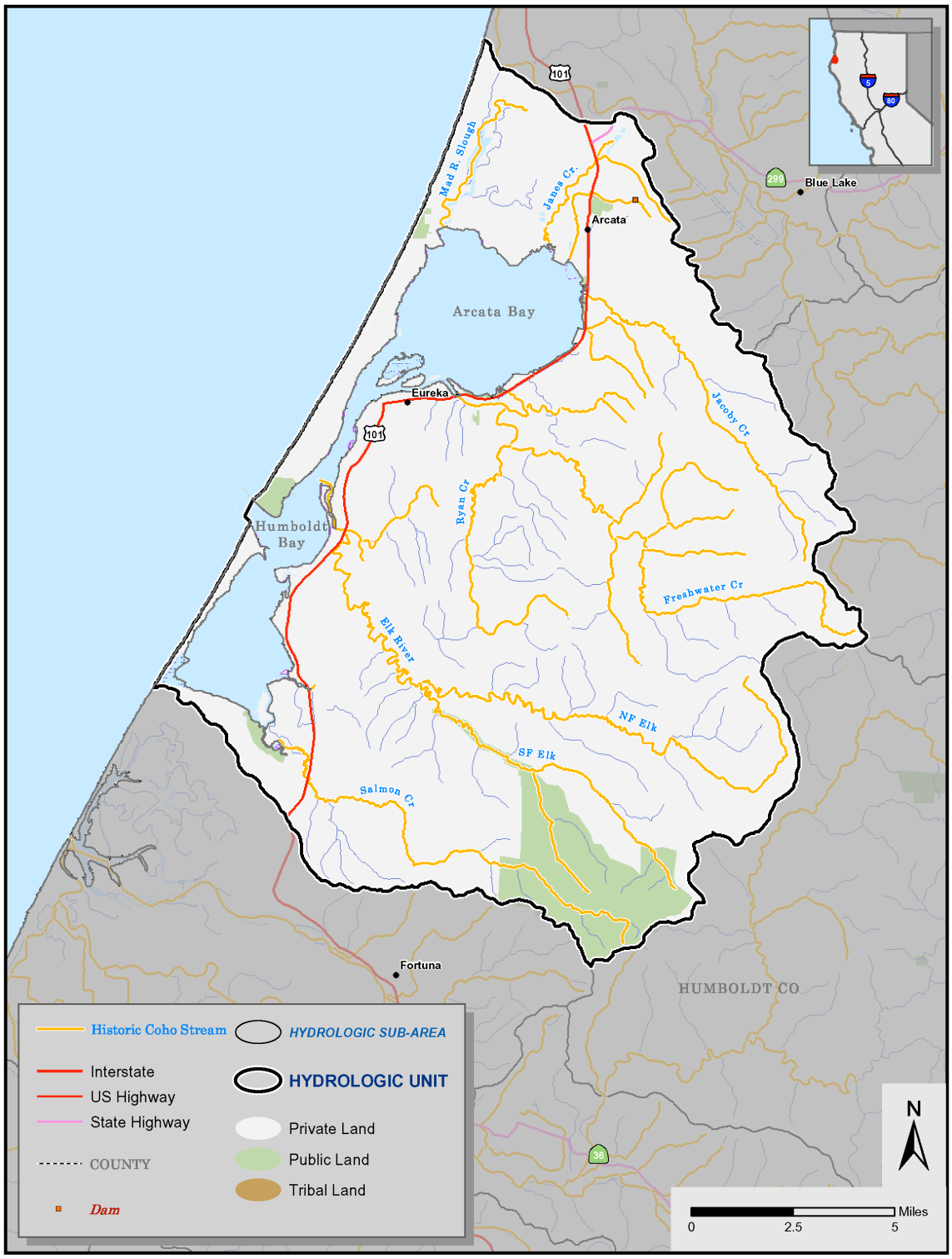
Recommendations for the Eureka Plain HU are:

EP-HU-03 In cooperation with agencies and landowners, plan to reestablish estuarine function.

EP-HU-04 Acknowledge the Arcata City Sewage Treatment Project and encourage implementation of similar projects elsewhere.

EP-HU-5 Assess sources of sediment input, prioritize and implement remediation projects.

FIGURE 7-10: Eureka Plain Hydrologic Unit



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7.2.11 EEL RIVER HYDROLOGIC UNIT

The Eel River is the third largest river system in California, encompassing approximately 2,357,760 acres (3,684 mi^2) within Humboldt, Mendocino, Trinity and Lake counties, and small portions of Colusa and Glenn counties (Figure 7-11). 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 945,280 acres (1,477 mi^2), North Fork 181,120 acres (283 mi^2), Middle Fork 481,920 acres (753 mi^2), South Fork 441,600 acres (690 mi^2), Van Duzen 273,920 acres (428 mi^2), and the estuary and delta 32,000 acres (50 mi^2). Other major tributaries include Kekawaka Creek, Outlet Creek, Tomki Creek, Dobbyns Creek, and Larabee Creek.

The principal features of the Eel River watershed are the rugged northwest-southeast trending ridges and canyons. The highest 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. Presently, the most significant land uses in the watershed are timber harvest, grazing, agriculture, in-channel gravel mining, recreation, and most recently, subdivision and residential development. The Eel is part of the state's Wild and Scenic Rivers system. 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 and its tributaries Rattlesnake, Mill, Grist, and Rock creeks (CDFG 1994). Coho salmon in the North Fork and Middle Fork Eel are now believed to be 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 older surveys conducted on 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 in the watershed. 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 is twelve miles below Scott Dam. As a result of these two dams, and a 9,258-foot-long tunnel just above Cape Horn Dam, an average of 160,000 acre-feet annually has been historically 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 large woody debris recruitment. Predation by non-native fish such as the Sacramento pikeminnow may have a major impact on salmonids. The pikeminnow have displaced salmonids in summer rearing streams.

7.2.11.1 Eel River HU Recommendations

ER-HU-01 Support the existing watershed cooperative working groups and the formation of new groups where necessary.

ER-HU-03 Continue on-going 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;

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.

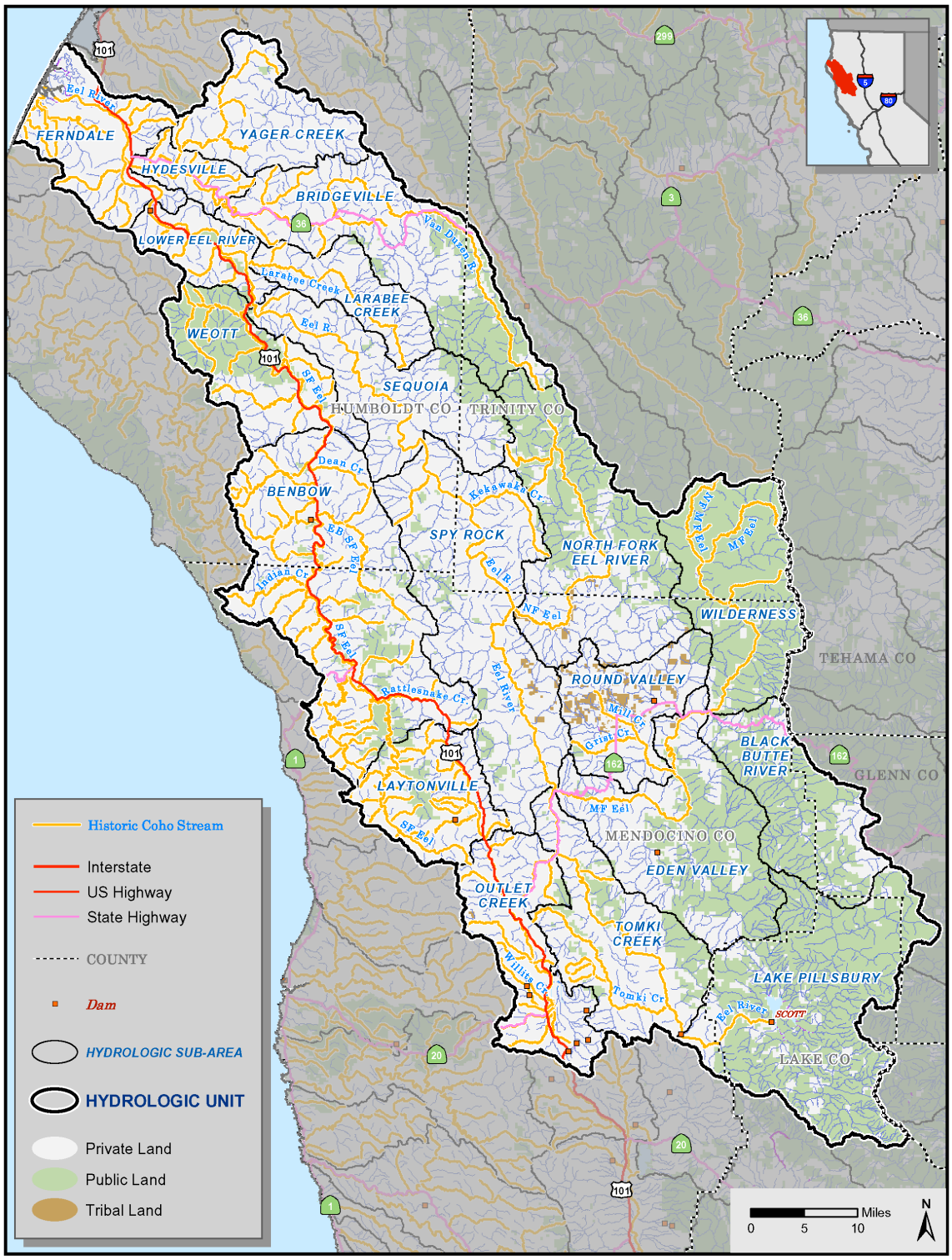
ER-HU-04 Support the assessment, prioritization, and treatment of sediment sources.

ER-HU-08 Develop a plan to restore an adequate migration corridor in the mainstem Eel River.

7.2.11.2 Ferndale HSA (Priority Map Values: 4-4-3-3)

The Ferndale HSA begins at the river mouth and extends upstream about 20 miles to the town of Rio Dell. 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

FIGURE 7-11: Eel River Hydrologic Unit



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private ownership with numerous family owned and operated ranches. The Ferdale HSA includes the mainstem of the Eel River from the mouth up stream to Scotia.

Problems facing coho salmon in the Ferndale HSA include sedimentation in the estuary, an increase in the average water temperature, decreased dissolved oxygen 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 dissolved oxygen levels in the estuary.

Recommendations for the Ferndale HSA are:

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.

7.2.11.3 South Fork Eel River HA

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

Recommendation for the entire South Fork Eel River HA is:

ER-SF-01 Explore opportunities to acquire conservation easements with conditions that provide for benefits to fisheries resources.

7.2.11.4 Weott HSA (Priority Map Values: 5-5-5-4)

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, pools below target values in quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values, spawning gravel deficient in quality and/or quantity, large debris accumulations are retaining large amounts of gravel and could need modification, grazing in riparian areas and barriers to fish migration.

Recommendations for the Weott HSA are:

ER-WE-01 Support the Department of Parks and Recreation's efforts to complete the storm proofing of Bull Creek watershed.

ER-WE-02 Support the Department of Parks and Recreation and private property owners planting of trees and implement other habitat enhancement as necessary in the Bull Creek 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.

7.2.11.5 Laytonville HSA (Priority Map Values: 4-5-5-5)

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 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, pools below target values in quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values, spawning gravel deficient in quality and/or quantity, large debris accumulations are retaining large amounts of gravel and could need modification, grazing in riparian areas and barriers to fish migration.

Recommendations for the Laytonville HSA are:

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-04 Support efforts by the 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).

7.2.11.6 Outlet Creek HSA (Priority Map Values: 5-5-5-4)

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, Baechtol, 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, pools below target values in water quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values, spawning gravel deficient in quality and/or quantity, grazing in riparian areas, and barriers to fish migration.

Recommendations for the Outlet Creek HSA are:

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.

7.2.11.7 HSAs with No Recommendations

Scotia HSA (Priority Map Values: 2-2-3-4): 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, with residents from several small towns including Pepperwood, Holmes, Shively and Redcrest. Small farming operations exist in the Eel River floodplain 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, pools below target values in quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values, spawning gravel deficient in quality and/or quantity, large debris accumulations are retaining large amounts of gravel and could need modification, grazing in riparian areas and barriers to fish migration.

Benbow HSA (Priority Map Values: 5-5-5-5): 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, pools below target values in quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values,

spawning gravel deficient in quality and/or quantity, large debris accumulations are retaining large amounts of gravel and could need modification, grazing in riparian areas and barriers to fish migration.

Larabee Creek HSA (Priority Map Values: 1-1-2-1): The Larabee Creek HSA includes the Larabee Creek watershed, a tributary to the lower mainstem of the Eel River. The Larabee Creek watershed is owned by the Pacific Lumber Company and numerous private ranches that manage their land for timber production and livestock grazing under a Habitat Conservation Plan.

Hydesville HSA (Priority Map Values: 4-4-4-3): The Hydesville HSA consists of the lower mainstem Van Duzen River and its lower tributaries. Much of this area is in private ownership and managed for beef or dairy cattle production, residential use, gravel mining and timber production in the upland areas. The tributaries in the Hydesville HSA have good potential for supporting coho salmon. However, no coho salmon have been found in recent surveys.

Problems facing coho salmon in the Hydesville HSA include above optimum summer water temperatures, pools below target values in quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values, spawning gravel deficient in quality and/or quantity, large debris accumulations are retaining large amounts of gravel and could need modification, and grazing in riparian areas.

Bridgeville HSA (Priority Map Values: 4-5-4-1): The Bridgeville HSA includes the Upper Van Duzen River and its tributaries. This lower reach of the Van Duzen mainstem and associated tributaries support steelhead and Chinook salmon, but no coho salmon have been observed in recent surveys.

Problems facing coho salmon in the Bridgeville HSA include above optimum summer water temperatures, pools below target values in water quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values, spawning gravel deficient in quality and/or quantity, large debris accumulations are retaining large amounts of gravel and could need modification, grazing in riparian areas, and barriers to fish migration.

Yager Creek HSA (Priority Map Values: 4-3-3-3): The Yager Creek HSA includes the middle and upper Yager Creek watersheds. Yager Creek is a tributary to the Van Duzen River. The lower portion of Yager Creek is owned by the Pacific Lumber Company and managed for timber production under a Habitat Conservation Plan.

The upper portion of Yager Creek is in private ownership and managed for timber and livestock production.

Most of Yager Creek is characterized by high water temperatures and little canopy, making it unsuitable as coho salmon habitat. In this HSA most of the potential coho salmon habitat is in tributaries to Yager Creek, including Cooper Mill Creek, Blanton Creek, Lawrence Creek, and its tributary Shaw Creek.

Problems facing coho salmon in the Yager Creek HSA include above optimum summer water temperatures, pools below target values in water quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values, spawning gravel deficient in quality and/or quantity, large debris accumulations that retain large amounts of gravel and could need modification, and barriers to fish migration.

Sequoia HSA (Priority Map Values: 1-1-2-1): The Sequoia HSA includes the mainstem of the Eel River from the confluence of the South Fork up stream to the Spy Rock HSA. The Sequoia Creek HSA supports steelhead and Chinook salmon but no coho salmon have been observed in recent surveys.

Spy Rock HSA (Priority Map Values: 1-1-2-1): The Spy Rock HSA includes the mainstem of the Eel River from the Sequoia HSA up stream to the confluence of the Middle Fork. The Spy Rock HSA supports steelhead and Chinook salmon but no coho salmon have been identified in recent surveys.

North Fork Eel River HSA (Priority Map Values: 1-1-1-N/A): North Fork of the Eel River HSA includes the entire North Fork Eel River watershed. Coho salmon are thought to be extirpated from the North Fork HSA.

Tomki Creek HSA (Priority Map Values: 1-1-2-1): The Tomki Creek HSA includes the upper mainstem of the Eel River from the confluence of the Middle fork up to the Lake Pillsbury HSA and includes the Tomki Creek watershed. No coho salmon have been observed in Tomki Creek or any of its tributaries in recent surveys

Lake Pillsbury HSA (Priority Map Values: 0-1-1-1): The Lake Pillsbury HSA includes the upper mainstem Eel River watershed.

Eden Valley HSA (Priority Map Values: 1-1-2-1): The Eden Valley HSA includes the lower mainstem of the Middle Fork Eel River. Coho salmon in the Eden Valley HSA are believed to be extirpated.

Round Valley HSA (Priority Map Values: 0-1-2-1): The Round Valley HSA includes the Mill Creek watershed, a tributary to the Middle Fork of the Eel River. Coho salmon in the Round Valley HSA are believed to be extirpated. Problems facing coho salmon in the Round Valley HSA include above optimum summer water temperatures, pools below target values in quantity or quality, escape covers below target values, streambanks failing and yielding fine sediment into the stream, fine sediment entering the stream from the road system, shade canopy below target values, spawning gravel deficient in quality and/or quantity, large debris accumulations are retaining large amounts of gravel and could need modification, and grazing in riparian areas.

Black Butte River HSA (Priority Map Values: 0-1-1-1): The Black Butte River HSA includes the Black Butte River watershed, a headwater tributary to the Middle Fork Eel River. Coho salmon in the Black Butte River HSA are believed to be extirpated.

Wilderness HSA (Priority Map Values: 0-1-1-1): The Wilderness HSA includes the headwaters of the Middle Fork Eel River up stream from the confluence of the Black Butte River. Coho salmon in the Wilderness HSA are believed to be extirpated.

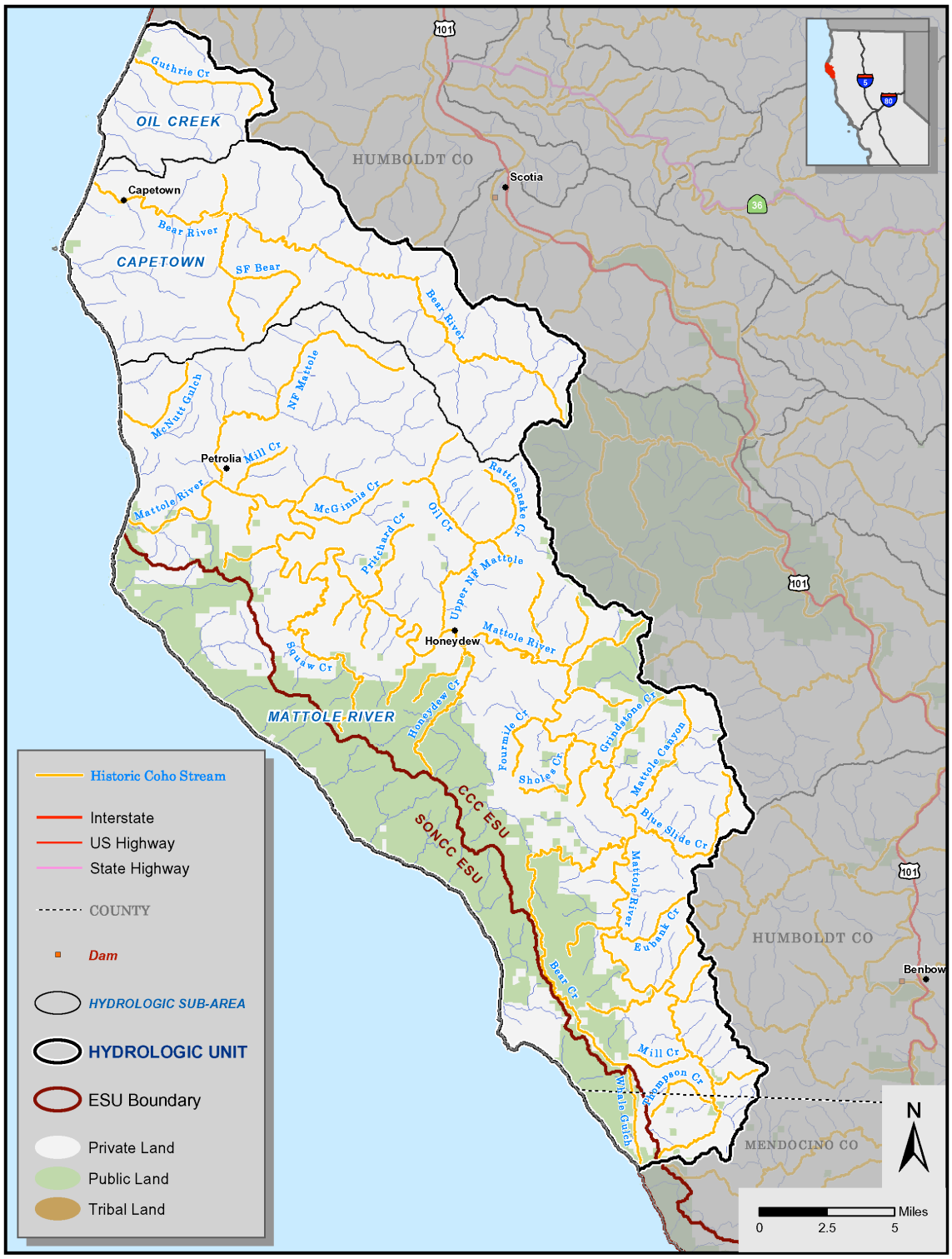
7.2.12 CAPE MENDOCINO HYDROLOGIC UNIT

The Cape Mendocino HU (Figure 7-12) encompasses approximately 247,680 acres (387 mi^2) 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 7.2.12.1 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 presence of steelhead and Chinook salmon in the Bear River watershed has been documented by the Department 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, personal communication), but the drainage has not been subject to regular surveys.

Problems for coho salmon recovery in the Cape Mendocino HU as a whole 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.

FIGURE 7-12: Cape Mendocino Hydrologic Unit



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7.2.12.1 Recommendation for the Cape Mendocino HU

CM-HU-01 Encourage the placement of LWD in stream channels to improve channel structure and function.

7.2.12.2 Mattole River HSA (Priority Map Values for SONCC portion: 4-5-5-5; Priority Map Values for CCC portion: 1-2-3-5)

A small portion of the Mattole River's southern-most headwaters originate 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.

A basin-wide assessment has been completed for the Mattole River by the North Coast Watershed Assessment Program (Downie et al. 2002). The Mattole River watershed was divided into 5 subbasins (Northern, Eastern, Southern, Western and the Estuary) in the watershed assessment and this recovery strategy uses the same organization. The Estuary 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 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.

Land use activities 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 large, 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.

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.

Southern Subbasin of the Mattole River: The Southern Subbasin of the Mattole River is located south of Bridge Creek (River Mile 52.1) and McKee Creek (River Mile 52.8), near Thorn Junction, and continues upstream to the Mattole headwaters near

Four Corners (River Mile 61.5), a distance along the mainstem Mattole of about 9.4 river miles. The subbasin is largely managed for timber production and cattle ranching. 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 subbasins.

Recommendations for the Southern Subbasin are:

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. Include in outreach and education sections of recovery plan.

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-06 Follow the NCRWQCB suggested Best Management Practices (BMPs) to protect water quality from the ground application of pesticides.

CM-MS-09 Request that Mendocino County investigate promoting cluster development away from streams to protect coho salmon.

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-15 Encourage the planting of trees in riparian areas where conditions are suitable.

Western Subbasin of the Mattole River: The Western Subbasin of the Mattole is located between the Little Bear Creek in the estuary (River Mile 0.3) and the headwaters of the South Fork of Bear Creek (River Mile 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.

Recommendations for the Western Subbasin are:

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-06 Encourage the assessment, prioritization, reclamation and enhancement of riparian habitat.

CM-MW-07 Recognize and support on-going efforts of landowners, BLM, and others to improve habitat conditions for coho salmon.

CM-MW-09 Conduct 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-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.

Northern Subbasin of the Mattole: The Northern Subbasin of the Mattole is located between the Estuary and Honeydew Creek (River Mile 26.5) along the northeastern side of the Mattole mainstem. Eighteen perennial streams drain a watershed area of 62,720 acres (98 mi^2). 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 naturally occurring geological processes and land use activities. 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.

Recommendations for the Northern Subbasin:

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 Creek, Conklin Creek, Oil Creek, 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.

Eastern Subbasin of the Mattole: The Eastern Subbasin of the Mattole is located between Honeydew Creek (River Mile 26.5) and Bridge Creek (River Mile 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 biological stream surveys indicate the presence of coho salmon in a few tributaries and steelhead throughout the Eastern Subbasin.

Recommendations for Eastern Subbasin:

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.

7.2.12.3 HSAs With No Recommendations

Hydrologic Subarea	Priority Map Values
Capetown HSA	1-1-2-5
Oil Creek HSA	0-1-2-5

7.3 CENTRAL CALIFORNIA COAST ESU

The Department's (CDFG 2002) status review concluded that state *Endangered* listing of the CCC coho ESU was warranted. Recent survey data indicate that widespread extirpation has already occurred within some of the 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). Coho salmon populations at the northern end 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 and near extinctions have occurred, is a major and significant portion of the range of coho salmon in this ESU. Small population size, along with large-scale fragmentation and collapse of range in this area indicate that CCC coho salmon are in serious danger of extinction throughout all or a significant portion of their range. The Department, in consultation with the CRT, has identified the following protection and management actions intended to reverse the decline of coho salmon.

7.3.1 MENDOCINO COAST HYDROLOGIC UNIT

The Mendocino Coast HU (Figures 7-13 and 7-14) is comprised of the coastal watersheds in Mendocino and Sonoma counties that are west and south of the Eel and Mattole basins, and west and north of the Russian River basin. The larger river basins in the HU include Ten Mile River, Noyo River, Big River, Albion River, Navarro

FIGURE 7-13: Mendocino Coast Hydrologic Unit (North)

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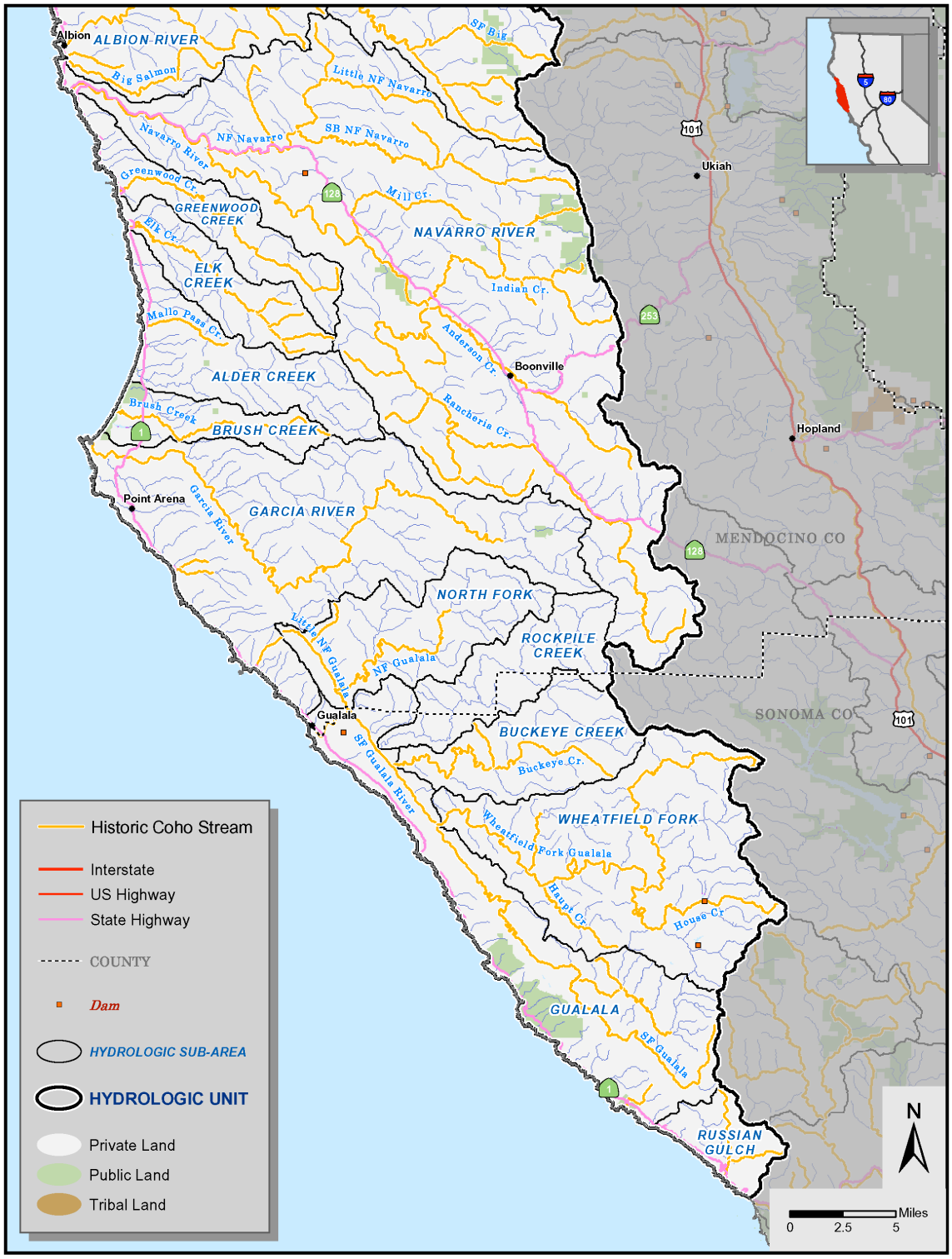
FIGURE 7-14: Mendocino Coast Hydrologic Unit (South)



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River, Garcia River, and Gualala River. Also included are numerous smaller streams draining directly to the Pacific Ocean. Total area of the HU is about 1.02 million acres, or 1,600 square miles. On the coast, air temperatures generally range from the high 30's to high 50's (ºF) in winter, and from the low 50's to high 60's (ºF) in summer. Average annual precipitation is about 40 inches on the coast and can be significantly higher on inland hill slopes. The HU lies totally within the federally designated Central California Coast Evolutionarily Significant Unit (CCC-ESU) for coho salmon. 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.

Historically, 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, have been 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.

The most common land use in this HU is timber production, although grazing (cattle and sheep), irrigated agriculture (orchards, vineyards), parks (mainly California state parks), rural subdivisions, and urban areas also occupy smaller portions of the area.

Though water quality characteristics in the HU are generally adequate for salmonids there remain several problems facing salmonid survival. Several major stream systems in the Mendocino Coast region are presently on the Regional Water Quality Board 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 large woody debris) as well as water diversions and illegal harvest may also limit production of coho salmon within the Unit.

7.3.1.1 Mendocino Coast HU Recommendations

MC-HU-04 Encourage Mendocino and Sonoma counties to adopt county grading ordinances.

MC-HU-07 Support the assessment, prioritization, and treatment of sediment sources at an HSA level.

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-11 Improve pool frequency and depth by actions to:

a. Increase scale and efficiency of LWD improvement efforts;

b. Continue to treat existing upslope sediment sources;

c. Avoid creating new sources (e.g., road crossings); and

d. 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-14 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;

d. Incentives to landowners, such as technical support.

MC-HU-16 The Department, SWRCB, RWQCB, 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-18 Coordinate with the North Coast Regional Water Quality Control Board (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-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.

7.3.1.2 Albion River HSA (Priority Map Values: 5-5-5-4)

The Albion River HSA consists of the Albion River, all its tributary streams and several adjacent streams draining directly to the Pacific Ocean. Watershed area is 43,791 acres, or 68 square miles. 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 – 2002), coho salmon have been found consistently in the Albion River and many of its tributaries, as well as the Little River, Little Salmon Creek and Big Salmon Creek.

Recommendations for the Albion River HSA are:

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 Clean Water Act TMDL. Make watersheds with an implementation schedule the highest priority.

MC-AR-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.

MC-AR-06 After genetic analysis, consider Albion River coho salmon for use as broodstock for reestablishing coho salmon populations in other Mendocino coastal streams.

MC-AR-12 Conduct comprehensive sub basin erosion control “storm proofing” combined with installation of LWD into streams.

MC-AR-13 Modify stream barriers to allow fish passage while maintaining LWD.

7.3.1.3 Big River HSA (Priority Map Values: 5-4-4-4)

The Big River HSA consists of Big River, all its tributary streams, and several adjacent streams draining directly to the Pacific Ocean. Watershed area is 128,423 acres, or 201 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 – 2002), coho salmon have shown consistent presence in Caspar Creek and have been found less consistently in Doyle Creek, Russian Gluch, and the Big River and its tributaries.

Recommendations for the Big River HSA are:

MC-BR-01 To minimize and reduce the effects of water diversions, take actions to improve State Water Resources Control Board (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, including funding of assessment and GIS mapping of water diversions and determination and monitoring of Fish and Game Code Section 1600 Program compliance related to water diversions.

MC-BR-02 Target Big River for enhancement of instream habitat by installation of LWD.

7.3.1.4 Garcia River HSA (Priority Map Values: 4-4-4-5)

The Garcia River HSA consists of the Garcia River, all its tributary streams, and also several smaller streams west of the Garcia basin that drain directly to the Pacific Ocean. Watershed area is 93,725 acres, or 146 square miles. The main Garcia River tributaries include Hathaway Creek, North Fork Garcia River, South Fork Garcia, Signal Creek, and Inman Creek. Streams draining directly to the Pacific Ocean include Schooner Gulch and Fish Rock Gulch. During recent surveys (2000 – 2002), coho salmon have been found only in 2002 in the North Fork Garcia River as well as the South Fork Garcia River and its tributary, Fleming Creek.

Recommendations for the Garcia River HSA are:

MC-GA-01 Acknowledge that a comprehensive approach to watershed planning is best.

MC-GA-02 Reestablish connectivity of North Fork Garcia 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 Clean Water Act 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.

7.3.1.5 Navarro River HSA (Priority Map Values: 5-5-4-3)

The Navarro River HSA consists of the Navarro River and all its tributary streams. Watershed area is 202,100 acres, or 316 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. During recent surveys (2000 – 2002), coho salmon have been found in 2002 and 2003 in the Navarro River and in all three years in some of its tributaries, including Marsh Gulch, Myrray Gulch, Flume Gulch, Flynn Creek, and North Branch North Fork Navarro River.

Recommendations for the Navarro River HSA are:

MC-NA-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.

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 Clean Water Act TMDL.

7.3.1.6 Noyo River HSA (Priority Map Values: 5-4-4-4)

The Noyo River HSA consists of the Noyo River, all its tributary streams, and several adjacent smaller streams draining directly to the Pacific Ocean. Watershed area is 106,260 acres, or 166 square miles. The main Noyo River tributaries include South Fork Noyo and North Fork Noyo. The more important adjacent streams include Pudding Creek and Hare Creek. During recent surveys (2000 – 2002), the Noyo River and many of its tributaries, as well as Pudding Creek and Hare Creek have shown consistent presence of coho salmon.

The recommendation for the Noyo River HSA is:

MC-NO-04 Request that Mendocino County implement a sediment reduction plan related to water quality.

7.3.1.7 Ten Mile River HSA (Priority Map Values: 4-4-4-4)

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. Watershed area is 82,543 acres, or 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. Its main tributaries are the North and South Forks. It enters the ocean about nine miles north of Fort Bragg. The Ten Mile River flows mainly through coastal forests and grasslands. During recent surveys (2000 – 2002), coho salmon have been found only in 2001 and 2002 in the Ten Mile River and most of its tributaries, although some of the tributaries such as Little North Fork Ten Mile River and Bear Haven Creek have had coho salmon present in all three years.

The recommendation for the Ten Mile River HSA is:

MC-TM-5 Provide technical assistance and incentives to Ten Mile River landowners for developing and implementing sediment reduction plans to meet the requirements of the Clean Water Act TMDL.

7.3.1.8 HSAs with No Recommendations

Gualala River HSA (Priority Map Values: 1-3-2-5): This HSA consist of the Gualala River and all its tributary streams. Watershed area is 222,399 acres, or 347 square miles. The main Gualala River tributaries include North Fork Gualala, Little North Fork Gualala, Rockpile Creek, South Fork Gualala, Buckeye Creek, Wheatfield Fork Gualala River, and Sproule Creek. The Gualala River begins on the western slope of the coastal ranges of Mendocino and Sonoma counties, the lower 3.5 miles (5.6 km) of the mainstem forming 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 (40 km).

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

Hydrologic Subareas	Priority Map Values
Usal HSA	4-4-4-4
Wages HSA	4-5-4-5

Greenwood HSA	1-2-2-5
Elk HSA	2-4-4-5
Alder HSA	0-1-2-5
Brush HSA	1-2-2-5
North Fork HSA	4-4-4-5
Rockpile HSA	0-1-2-4
Buckeye HSA	1-2-2-4
Wheatfield Fork HSA	1-2-2-4
Russian Gulch HSA	1-2-2-4

7.3.2 RUSSIAN RIVER HYDROLOGIC UNIT

The Russian River HU (Figure 7-15) covers an area of approximately 1,485 square miles and includes about 240 named and numerous un-named tributaries. Coho salmon have historically occurred in six of the 11 Russian River HSAs (Guerneville, Austin Creek, Geyserville, Mark West, Warm Springs, and Santa Rosa Creek HSAs).

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 of about 1,600,000 acre-feet occur 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 23 ºC in some sections of the river, causing stress to salmonids and promoting proliferation and persistence of predatory warmwater fish species. Fish migration is adversely affected by natural and man-made physical barriers such as bedrock constrictions and falls, debris jams, dams, road crossings, and culverts.

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 the recent trend being conversion of historic crop lands, livestock, dairy lands, and forest lands to vineyards.

Of the four salmonid species that historically occurred in the watershed (Chinook salmon, pink salmon, coho salmon, and steelhead trout), pink salmon have been virtually 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. A captive coho salmon broodstock program was initiated by the Department, NOAA Fisheries, and USACE at WSH in 2001. Using conservation hatchery principles, its 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 Clean Water Act.

7.3.2.1 Recommendations for the Russian River HU

RR-HU-04 Assess, prioritize, and develop plans to treat barriers to passage.

RR-HU-06 Assess riparian canopy and impacts of exotic vegetation (especially *Arundo donax*), prioritize, and plan riparian habitat reclamation and enhancement programs.

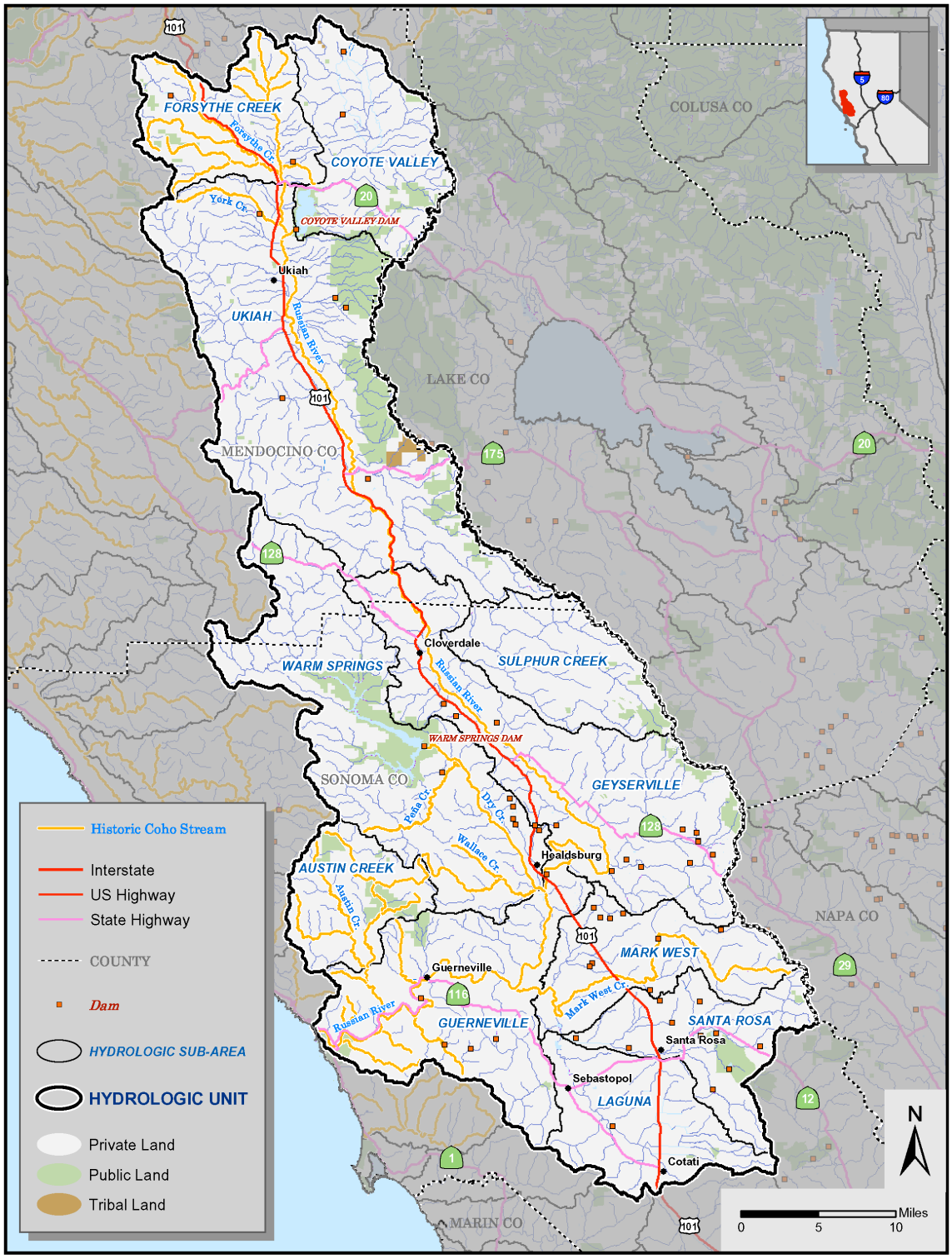
RR-HU-07 Implement the Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties.

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 (BML) 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;

FIGURE 7-15: Russian River Hydrologic Unit



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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 HGMP;

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 8 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-11 Sonoma County and Mendocino County should develop grading and erosion control standards supported by a grading ordinance, to minimize sediment impacts to coho salmon habitat.

RR-HU-12 Restore fish 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 fish passage inventories as needed to use a comprehensive watershed approach to fish passage. Integrate fish passage projects at county facilities with fish passage improvements involving other landowners, throughout targeted coho salmon watersheds.

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 programs to protect and increase instream flows for anadromous fish. 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.

7.3.2.2 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 posed by permanent and seasonal dams, stream crossings and culverts, inadequate gravel quantity, insufficient riparian stability, and inadequate water quality and quantity.

RR-MS-01 Manage summer flows in the mainstem of the Russian River to the benefit of rearing salmonids 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 salmonid rearing, and appropriate timing of opening to benefit salmonid migration/emigration.

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.

7.3.2.3 Guerneville HSA (Priority Map Values: 3-5-5-4)

The Guerneville HSA occupies the southwest end of the Russian River basin in Sonoma County and has an area of 102,301 acres (approximately 160 mi^2). 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 Creek, Fife Creek, Hulbert Creek, Dutchbill Creek, and Willow Creek.

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 805 acres in the Fife Creek watershed and 365 acres 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 – 2002), coho salmon were found only in three Russian River tributaries: Green Valley Creek, Dutchbill Creek, and Mark West Creek. Coho salmon have been 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.

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-07 Assess, prioritize, and develop plans to treat barriers to migration and improve fish passage.

7.3.2.4 Austin Creek HSA (Priority Map Values: 1-2-3-5)

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 39,867 acres (62 mi^2). 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 California State Park system 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 5,683 acres. During recent surveys (2000 – 2002), coho salmon have not been found in Austin Creek or any of its tributaries.

RR-AU-02 Assess, prioritize, and treat sources of excess sediment.

RR-AU-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.

RR-AU-05 Assess, prioritize, and develop plans to treat barriers to migration and improve fish passage.

7.3.2.5 Warm Springs HSA (Priority Map Values: 1-3-3-3)

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 139,537 acres (218 mi^2). 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 Creek and Mill Creek, 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 in 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 floodplain 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, converting the uplands to agricultural use. During recent surveys (2000 – 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.

Recommendations for the Warm Springs HSA are:

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-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-05 Assess, prioritize, and develop plans to treat barriers to migration and improve fish passage.

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 large woody debris or large boulder structures).

7.3.2.6 Mark West Creek HSA (Priority Map Values: 2-4-4-4)

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 55,247 acres (86 mi^2), and includes the major tributary watersheds of Windsor Creek, Humbug Creek, and Porter Creek. Mark West Creek and its tributaries drain a basin of approximately 40 square miles.

Most of the stream in the middle section is bordered by cultivated fields and housing developments. Where the Mark West subbasin meets the Russian River, vegetation is dominated by typical redwood forest. Oaks, bays, redwoods, Douglas fir, maples, madrone, and manzanita characterize the vegetation near the headwaters. Riparian vegetation is composed of willow, oak, bay, alder, maples, blackberry, and a few redwoods. During recent surveys (2000 – 2002), coho salmon were found in Mark West Creek only in 2001, although they were detected in 1993 and 1994.

Recommendations for the Mark West Creek HSA are:

RR-MW-01 Reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements.

RR-MW-02 Develop plans to improve instream habitat conditions.

RR-MW-03 Assess, prioritize, and develop plans to treat barriers to migration and improve fish passage.

RR-MW-04 Assess, prioritize, and develop plans to treat sources of excess sediment.

7.3.2.7 Santa Rosa Creek HSA (Priority Map Values: 1-3-3-3)

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 49,511 acres (77 mi^2). 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 graduating to oak woodland. The creek is channelized for about seven miles from the Santa Rosa City Hall downstream to Laguna de Santa Rosa. Santa Rosa, located at the intersection of Highway 101 and Highway 12, and is the most urbanized and densely populated city within the Russian River basin. The area has seen a long history of agricultural and urban development. 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 Creek watershed is primarily in private landownership, although some portions are owned by the City of Santa Rosa and the Sonoma County Regional Parks Department. 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 primary land use today is urban development, although livestock grazing and vineyard development also exist. The upper basin, incorporated into Hood Mountain Regional Park and the McCormick Sanctuary, is now protected from further development. During recent surveys (2000 – 2002), coho salmon have not been found in Santa Rosa Creek, although they have been detected in 1993 and 1994.

Recommendations for the Santa Rosa Creek HSA are:

RR-SR-03 Assess, prioritize, and develop plans to treat sources of excess sediment.

RR-SR-04 Assess, prioritize, and develop plans to treat barriers to passage.

7.3.2.8 Forsythe Creek[3] HSA (Priority Map Values: 1-3-2-3)

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 53,966 acres (84 square miles). The Forsythe Creek watershed and its tributaries drain a basin of approximately 47.7 mi^2. Major tributaries within Forsythe watershed are Mill, Jack Smith, and Eldridge creeks. Many man-made and several natural lakes occur throughout the basin. The West Fork has its headwaters in a mountain forest but predominantly flows through hills of range and pasture land 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 – 2002), coho salmon have not been found in any of the creeks or their tributaries in this HSA.

Recommendations for the Forsythe Creek HSA are:

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.

RR-FO-03 Assess, prioritize, and develop plans to treat barriers to migration and improve fish passage.

7.3.2.9 Geyserville HSA (Priority Map Values: 1-3-3-5)

The Geyserville HSA drains 133,006 acres (208 mi^2), 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, with the exception of the headwaters, where vegetation consists mostly of gray pine and oaks. Riparian vegetation is generally abundant with 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 an area of approximately 12.3 square miles. The mixed hardwood forests here are in excellent condition in this pristine sub-watershed. Much

[3] This HSA was not discussed by the CRT.

of the upper Maacama watershed remains in large parcels and is now under protection from further development under Sonoma County Open Space easements. During recent surveys (2000 – 2002), coho salmon have not been found in Maacama and Redwood creeks, although they have been detected in both streams in 1993 and 1994.

Recommendations for the Geyserville HSA are:

RR-GE-02 Assess, prioritize, and develop plans to treat barriers to migration and improve fish passage.

RR-GE-03 Assess, prioritize, and develop plans to treat sources of excess sediment.

7.3.3 BODEGA AND MARIN COASTAL HYDROLOGIC UNITS

The Bodega/Marin Coastal HUs (Figure 7-16) consist of nine HSAs, four of which have documented coho salmon presence – Salmon Creek, Walker Creek, Lagunitas Creek, and Bolinas. Together, they drain an area of about 265 mi^2. 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, 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 around Nicasio Reservoir.

Watersheds within the HUs have a variety of water quality impairments, including excess sediment, high temperature, low dissolved oxygen, and excessive nutrients. Chronic erosion and sediment sourcing into streams is the primary water quality challenge throughout the HU. Tomales Bay is listed on the Clean Water Act 303(d) list as an impaired water body for high concentrations of bacteria, nutrients, pathogens, metals (mercury) and sediment, and 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 on road crossings, high fine sediment loads, low summer stream flow, high summer water temperature, a shortage of cover in the form of large woody debris, 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.

7.3.3.1 Bodega Marin Coastal HU Recommendations

BM-HU-01 Implement BMPs for road projects. Support Sonoma and Marin County Department 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-02a 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 State Water Resources Control Board (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-06 On private and public lands, address issues of low flow by increasing riparian protection and restoration, increasing 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-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-12 Implement fish passage improvements as identified in inventories conducted by SPAWN, Taylor and Assoc., Trout Unlimited and the National Park Service. Expand inventories as needed for a comprehensive watershed approach for fish 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:

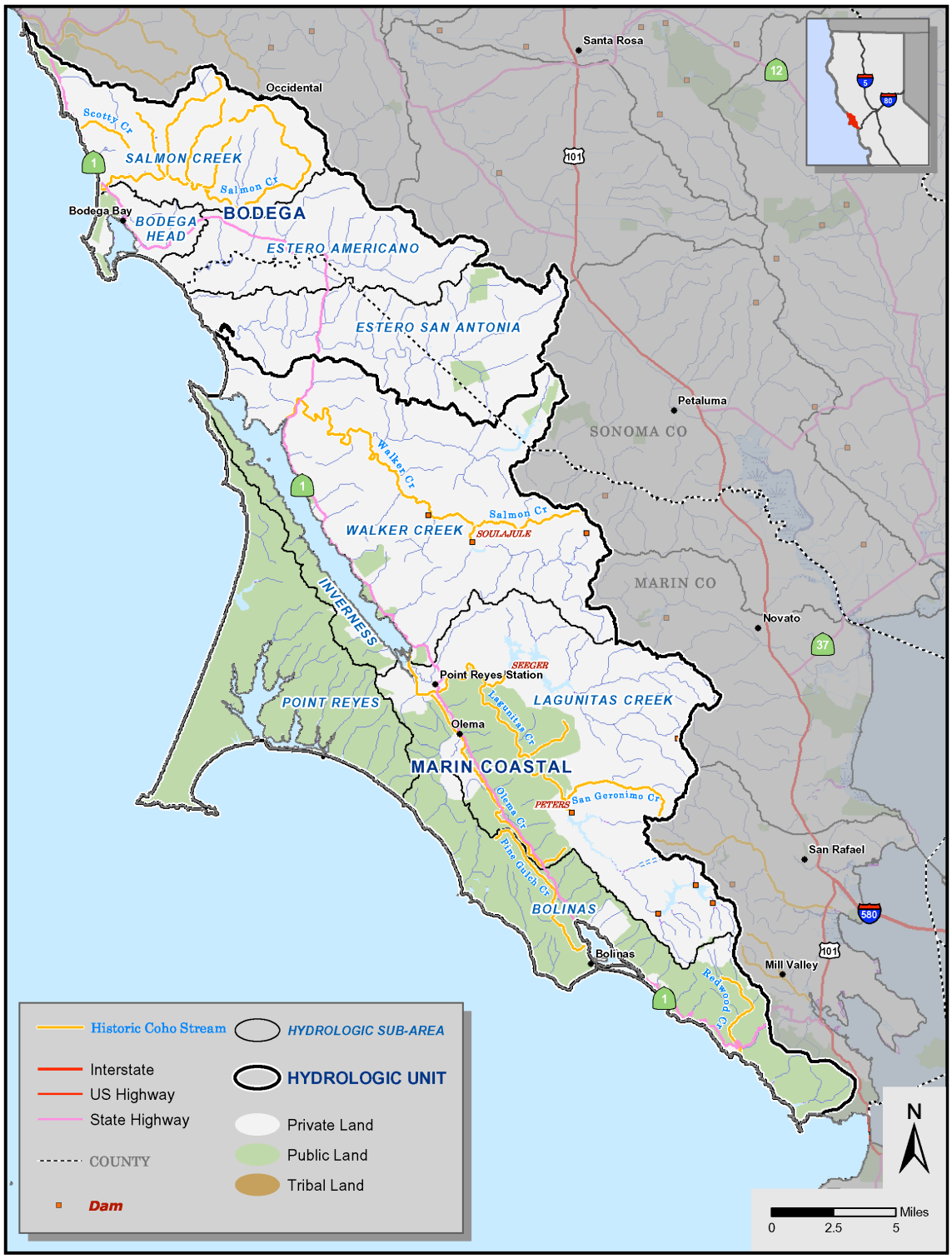
a. Enact and enforce Marin County Streamside Conservation Area Ordinance,

b. Adopt and implement FishNet 4C Road Maintenance Manual: Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Operations and Maintenance,

c. Systematically work to restore fish passage at county facilities, and

d. Address issues of sediment from roads through restoration and education.

FIGURE 7-16: Bodega and Marin Coastal Hydrologic Units



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7.3.3.2 Salmon Creek HSA (Priority Map Values: 1-3-3-5)

The Salmon Creek HSA is located in Sonoma County and consists of two watersheds, Salmon Creek and Scotty Creek. Salmon Creek drains 34.5 mi^2 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 which 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 – 2002), no coho salmon were found in any of the creeks of this HSA.

Recommendations for the Salmon Creek HSA are:

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-04 Implement recommendations of watershed plans consistent with the coho calmon 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.

7.3.3.3 Walker Creek HSA (Priority Map Values: 1-3-2-5)

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. Together with Lagunitas Creek, it provides 75% of the freshwater into Tomales Bay. Since 1985, 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 1900's, Walker Creek was a perennial stream (Haible 1976). The four main

tributaries to Walker Creek are Keys, Chileno, Salmon and Arroyo Sausal creeks. Soulajule Reservoir, which sits high in the watershed on Arroyo Sausal Creek that flows directly into Walker Creek, was constructed in 1968 and is currently managed by Marin Municipal Water District. 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 Clean Water Act 303(d) List by the San Francisco Regional Water Quality Control Board. During recent surveys (2000 – 2002), no coho salmon were found in Walker Creek or any of its tributaries.

Recommendations for the Walker Creek HSA are:

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-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-07 Encourage Marin Municipal Water District to continue to assess the release of water from Soulejule 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.

7.3.3.4 Lagunitas Creek HSA (Priority Map Values: 4-5-5-5)

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 the 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 (2000 – 2002), coho salmon were found consistently in Lagunitas Creek, as well as in Devil's Gulch and San Geronimo Creek, but only in one or two years in Olema Creek and two other smaller tributaries to Lagunitas Creek.

Recommendations for the Lagunitas Creek HSA are:

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 fish 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-05 Encourage MMWD to commit ongoing resources and support of stewardship in the basin beyond the 10-year mitigation order that expires in 2007 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, 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-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-11 Throughout the Lagunitas drainage, work with private landowners to encourage biotechnical bank stabilization, riparian protections, woody debris retention, and timing of water withdrawals to help protect fisheries.

BM-LA-14 In the San Geronimo 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 National Park Service 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 Marin Municipal Water District and the County of Marin to continue to implement and coordinate their Watershed Protection Agreement Program for additional water hook-ups in Nicasio and San Geronimo 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.

7.3.3.5 Bolinas HSA (Priority Map Values: 4-5-5-5)

The three watersheds in the Bolinas HSA where coho salmon have been identified are Redwood Creek, Pine Gulch Creek and Easkoot Creek.

Redwood Creek basin 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 park lands. Major watersheds include Fern, Bootjack, Rattlesnake, Spike Buck, Kent Canyon, and Green Gulch creeks.

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.

Easkoot Creek is a small perennial tributary with a 1.7 square mile watershed area, flowing 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 – 2002), coho salmon have been found consistently in Redwood Creek, but only in 2002 in Pine Gulch Creek and Easkoot Creek.

Recommendations for the Bolinas HSA are:

BM-BO-01 Implement recommendations of completed sediment source surveys. Supplement surveys as necessary.

BM-BO -02 Continue to support restoration efforts on Bolinas Lagoon and Big Lagoon to benefit coho salmon during all life phases and seasons.

BM-BO-04 Look for opportunities to increase woody debris 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 National Park Service to provide additional space for Stinson Beach Water District for off-stream storage to protect coho salmon in Easkoot Creek.

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.

7.3.3.6 HSAs with No Recommendations

Hydrologic Subarea	Priority Map Values
Bodega Head HSA	0-2-2-0
Bodega Bay HSA	0-1-1-0
Estero Americano HSA	0-1-2-5
Estero San Antonio HSA	0-2-2-5
Tomales Bay HSA	0-1-1-0
Inverness HSA	0-2-2-5
Point Reyes HSA	0-1-2-3
Drakes Estero HSA	0-1-1-0

7.3.4 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 7-17). 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 (Fig. 2.9, 2084 Order). 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 section 303(d) of the Clean Water Act. 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 Creek, San Pablo Creek, Walnut Creek, San Anselmo Creek, Corte Madera Creek, and Mill Valley (Arroyo Corte Madera Del Presidio) Creek (Leidy, 1984). No coho salmon have been observed in any waters of the San Francisco Bay Area in the past 21 years.

7.3.4.1 Recommendations for the San Francisco Bay HUs

SF-HU-01 Habitat suitability evaluations in the San Francisco Bay Area should include coho salmon.

SF-HU-02 Where appropriate, apply statewide recommendations to suitable streams in the San Francisco Bay.

7.3.4.2 San Rafael HSA (Priority Map Values: 0-3-2-3)

Historically, coho salmon occurred 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.

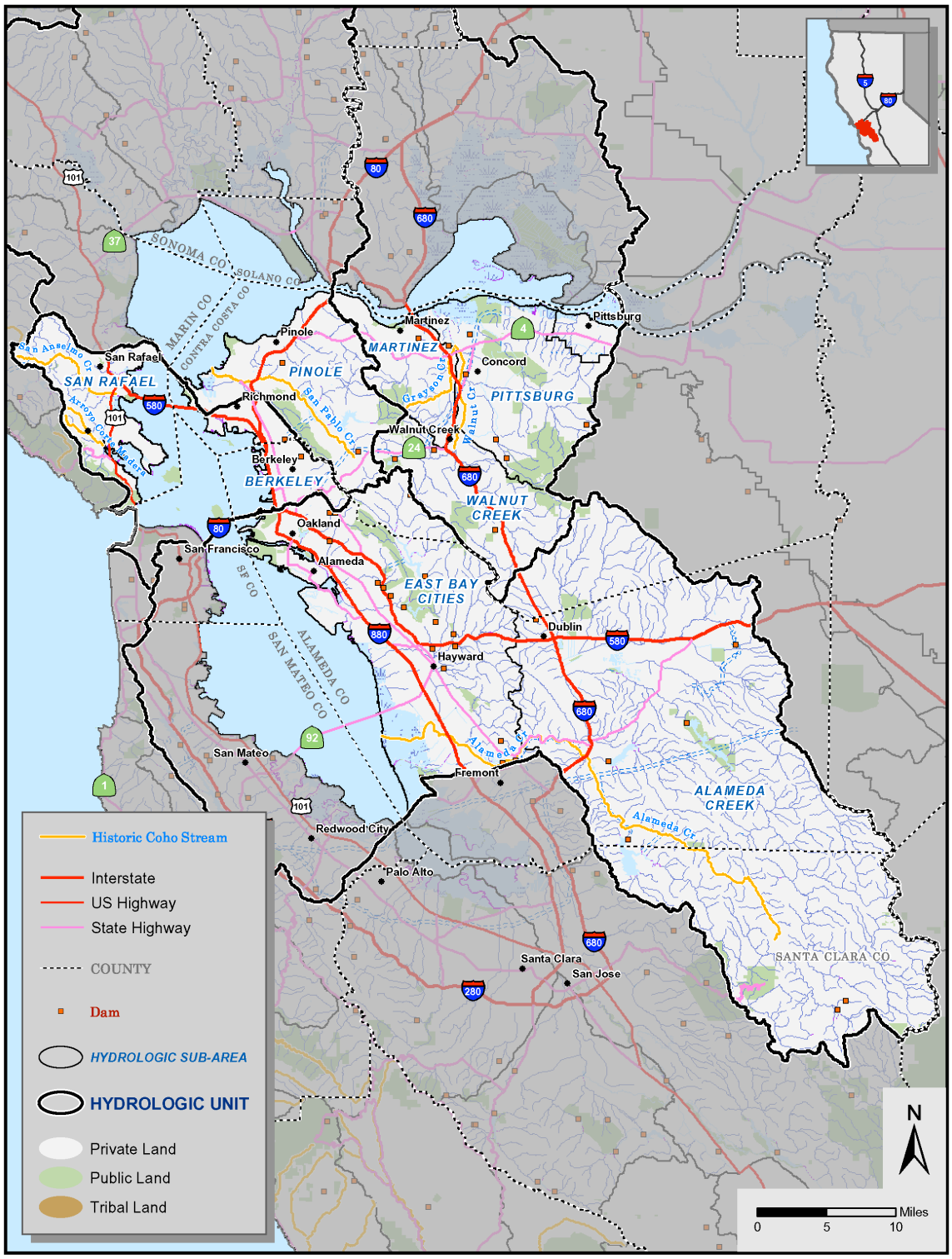
The recommendation for the San Rafael HSA is:

SF-SR-01 Work to restore coho salmon habitat, especially in Arroyo Corte Madera del Presidio and Corte Madera Creek.

7.3.4.3 HSAs with No Recommendations

Hydrologic Subarea	Priority Map Values
Berkeley	0-3-1-1
San Francisco Bayside	0-3-1-N/A
Bay	0-1-1-0
East Bay Cities	0-3-1-1
Alameda	0-3-2-1
San Mateo Bayside	0-3-2-1
Dumbarton	0-1-1-0
Fremont Bayside	0-2-1-1
Coyote Creek	0-3-2-1
Guadalupe River	0-3-2-1
Palo Alto	0-3-2-1
San Pablo Bay	0-1-1-0

FIGURE 7-17: San Francisco Bay Hydrologic Subareas Historically Occupied by Coho Salmon



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Hydrologic Subarea	Priority Map Values
Novato	0-2-2-5
Petaluma	0-3-2-5
Sonoma	0-3-2-4
Napa River	0-3-2-3
Pinole	0-2-2-1
Suisun Bay	0-1-1-0
Benicia	0-2-1-N/A
Suisun Creek	0-2-1-N/A
Suisun Slough	0-3-1-N/A
Grizzly Island	0-1-1-N/A
Grizzly Island - in Delta	0-1-1-N/A
Suisun Slough - in Delta	0-1-1-N/A
Pittsburg	0-3-1-1
Walnut Creek	0-2-1-1
Martinez	0-3-1-1
Pittsburg - in Delta	0-3-1-N/A

7.3.5 SAN MATEO COASTAL HYDROLOGIC UNIT

The San Mateo Coastal HU (Figure 7-18) 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 Ano 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 mi^2 . 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 mi^2) while the Gazos Creek watershed is approximately 20 mi^2.

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 Ano 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 large woody debris 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.

7.3.5.1 Recommendations for the San Mateo Coastal HU

SM-HU-01 Continue to operate MBSTP Kingfisher Flat Hatchery under the guidance of NOAA Fisheries and the Department as a conservation hatchery to reintroduce missing or supplement very weak brood years.

SM-HU-02 To minimize and reduce the effects of water diversions, take actions to improve State Water Resources Control Board (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, including funding of assessment and GIS mapping of water diversions and determination and monitoring of Fish and Game Code Section 1600 Program compliance related to water diversions.

SM-HU-04 Implement FishNet 4C priority actions that protect coho salmon.

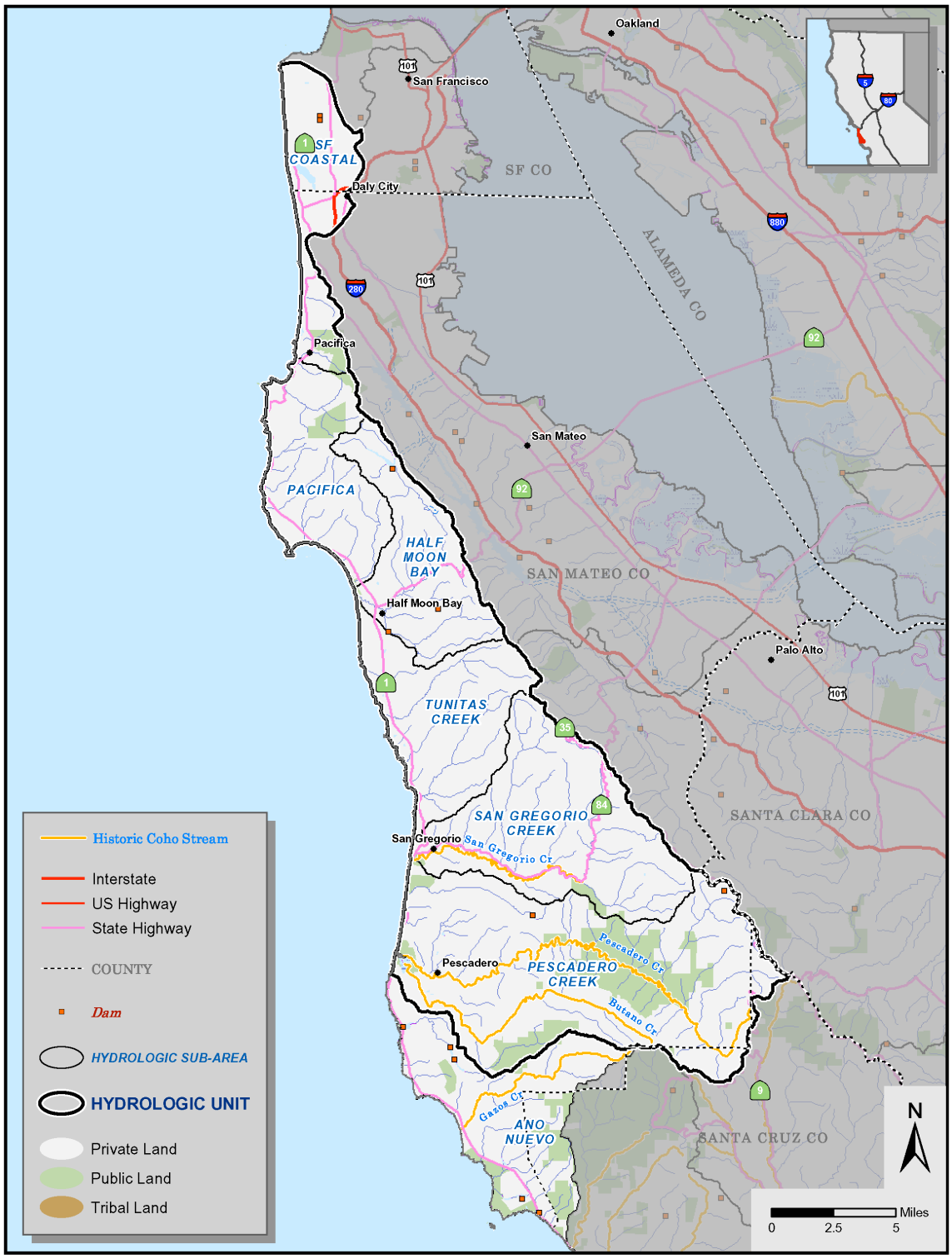
a. Continue to protect riparian zones on streams inhabited by coho salmon within the Coastal Zone according to Local Coastal Plan and Timber Harvest Plan prescriptions. Evaluate the need to apply coastal zone protections to streams inhabited by coho salmon that are not in the coastal zone;

b. Develop, adopt and implement written standards for routine operations and maintenance. Train staff in best management practices;

c. Conduct fish passage assessments and restore fish passage to coho salmon streams;

d. Conduct road assessments and address issues of sedimentation from county public works and parks roads and trails;

FIGURE 7-18: San Mateo Coastal Hydrologic Unit



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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.

7.3.5.2 San Gregorio Creek HSA (Priority Map Values: 0-3-4-5) and Pescadero Creek HSA (Priority Map Values 2-4-4-5)

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 (42 km) 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 (residential, commercial, road infrastructure) and recreation.

Recommendations for the San Gregorio Creek and Pescadero Creek HSAs are:

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 that addresses impacts to coho salmon.

SM-SG-04 Implement BMPs designed to reduce erosion of soil and consequential sedimentation of instream habitat attributable to roads (for example, 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 floodplain, and active revegetation.

SM-SG-07 Request that the State Water Resources Control Board (SWRCB) declare critical tributaries to San Gregorio and Pescadero creeks fully appropriated during summer and fall months.

7.3.5.3 Año Nuevo (Gazos Creek) HSA (Priority Map Values: 4-5-5-5)

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 un-named headwater tributaries.

Approximately 6 miles of Gazos Creek and 0.5 miles 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 – 2002), coho salmon were found inconsistently in Gazos Creeks. Gazos Creek had inconsistent presence of coho salmon during the 1990s.

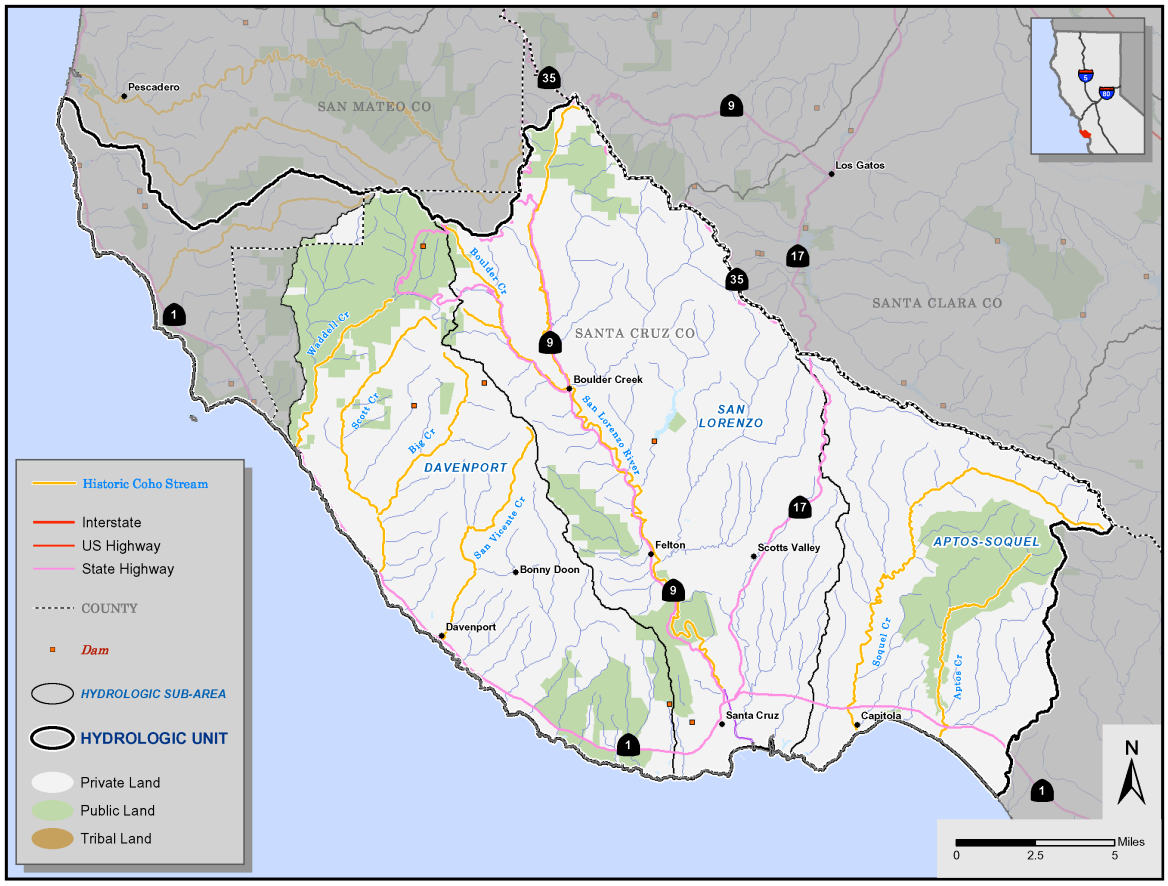
The recommendation for the Año Nuevo HSA is:

SM-AN-01 Implement the projects recommended as high priority for coho salmon in the Gazos Creek watershed restoration plan.

7.3.6 BIG BASIN HYDROLOGIC UNIT

The Big Basin Hydrologic HU (Figure 7-19) 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

FIGURE 7-19: Big Basin Hydrologic Unit



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been historically present: Waddell Creek (20 square miles; 51.8 km^2), Scott Creek (27 mi^2), San Vicente Creek (11 mi^2), San Lorenzo River (138 mi^2), Soquel Creek (23 mi^2), and Aptos Creek (25 mi^2). 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 (ºF); however, some streams or stream sections are too warm for coho salmon rearing.

Because rain and run-off is extremely rare in this HU during summer and fall months, and watershed areas are relatively small, stream flows during summer and fall are usually 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 interactions (e.g., cumulative effects) between many structures. 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 Kingfisher Flat Fish Hatchery, located on Big Creek (tributary to Scott Creek), is operated by the Monterey Bay Salmon and Trout Project (MBSTP), a cooperative salmonid rearing project under permit from the Department. 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 large woody debris.

7.3.6.1 Recommendations for the Big Basin HU

BB-HU-01 Continue to operate MBSTP Kingfisher Flat Hatchery under the guidance of NOAA Fisheries and the Department as a conservation hatchery to reintroduce missing, or supplement very weak, brood years. Support the funding to develop and implement a management plan. Operate the facility to accommodate recovery.

BB-HU-02 Provide education and training on coho salmon-friendly water diversion practices to facilitate compliance with pertinent regulation (e.g., Fish and Game Code 1600 et. seq., CFPR 916.9, California Water Code, the Department – NOAA Fisheries guidelines).

BB-HU-04 Develop, facilitate, and support by-pass stream-flow requirements on all streams inhabitated 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 on-going 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.

7.3.6.2 Davenport HSA (Priority Map Values: 4-5-5-5)

This HSA is comprised of the watersheds of Waddell, Scott, and San Vicente creeks. Together, they cover an area of about 150 mi^2 (. Waddell and Scott creeks are located a few miles north of the town of Davenport in the northern part of Santa Cruz County and San Vicente Creek flows through Davenport. The mainstem of Waddell Creek is approximately 4.8 miles in length and has an several perennial tributaries, the most significant of which are East and West Branches of Waddell Creek and Henry Creek. All 4.8 miles of the mainstem and 6 miles of the tributaries are potentially usable rearing habitat. Approximately 90% of the watershed is owned by DPR (Big Basin Redwoods State Park) with the remainder is 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 8 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 Creek and Mill Creek, 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 (4 km) of the mainstem and less than 0.25 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, which prevents anadromous salmonids from ascending into 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. Most estimates of historical abundance are educated guesses by fishery biologists and managers based on limited sampling, surveys, and personal observations. 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 – 2002), coho salmon were found consistently in Scott Creek and some of its tributaries, but less consistently in Waddell Creek.

Recommendations for the Davenport HSA are:

BB-DA-01 Work with the SWRCB to develop and enforce stream flow bypass requirements for diversions from the alluvial reaches ofWaddell Creek, mainstem Scott Creek, Big Creek, Mill Creek, and San Vicente Creek.

BB-DA-02 Petition the SWRCB to declare Scott Creek and San Vicente Creek fully appropriated during summer and fall months.

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 State Parks to develop a logjam management plan for Waddell Creek. Log jams should be closely examined for fish passage and conservatively modified if absolutely necessary for coho salmon passage.

7.3.6.3 San Lorenzo River HSA (Priority Map Values: 1-3-3-3)

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 6 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, cattle grazing, recreation, equestrian facilities, and quarry operations. The San Lorenzo River watershed provides water to residents of San Lorenzo Valley and Santa Cruz, thus stream flows are a critical issue in this watershed. During recent surveys (2000 – 2002), no coho salmon were found in the San Lorenzo River or any of its tributaries.

Recommendations for the San Lorenzo River HSA are:

BB-SL-01 Reduce erosion of soil and resulting sedimentation of in-stream habitat 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 Creek, Fall Creek, Bear Creek, Boulder Creek, and Branciforte Creek.

BB-SL-03 Evaluate the Felton Diversion Dam for impacts to coho salmon.

BB-SL-04 Improve adult fish 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 the recommendations of the CRT and the coho salmon recovery strategy.

7.3.6.4 Aptos-Soquel HSA (Priority Map Values: 1-3-3-3)

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 9 miles of mainstem and tributary are considered potentially usable coho salmon rearing habitat.

The Soquel Demonstration State Forest is approximately 2,681 acres, 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, 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 an additional 8 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 (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 – 2002), no coho salmon were found in Aptos or Soquel creeks.

Recommendations for the Aptos-Soquel HSA are:

BB-AP-01 Implement elements of the Soquel Creek Watershed Restoration 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 floodplains, improvements to fish 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, and self-monitoring of diversions.

8 Shasta-Scott Pilot Program

In accordance with the direction of the Commission, the Department established a Pilot Program to address coho salmon recovery issues associated with agriculture and agricultural water use in the Shasta Valley HA (Figure 7-5) and the Scott River HA (Figure 7-6), and established the Shasta-Scott Coho Recovery Team (SSRT) to advise the Department on these issues. All other issues within these two watersheds were addressed by the CRT. Both the SSRT and CRT aided the Department in the development of the Pilot Program (see Section 7.2.5).

8.1 FRAMEWORK FOR AGRICULTURAL ISSUES

The SSRT has reached preliminary agreement on the recommendations included in the Pilot Program. The SSRT intends to consider the recommendations in another round of review and to establish the framework for an implementation and permitting strategy (including Streambed Alteration Agreements and Incidental Take Permits) before finalizing the recommendations.

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 8.3; they will be more fully developed later. Recommendations for the following seven categories are presented in Section 8.2:

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, Best Management Practices, and implementing the CIMIS program (California Irrigation Management Information System) 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.

8.2 SHASTA-SCOTT PILOT PROGRAM RECOMMENDATIONS

The recommendations developed by the SSRT[1] to deal with agricultural water and land use issues are presented in eight solution categories: water management, water augmentation, habitat management, water use efficiency, protection, assessment and monitoring, education and outreach, and administration and implementation. Short issue and solution statements that provide context are provided within the list of recommendations.

8.2.1 WATER MANAGEMENT RECOMMENDATIONS

Low instream flows are the major issue discussed here in eleven sub-categories.

[1] The SSRT has reached preliminary agreement (termed “preliminary favorable regard”) on the recommendations within the first seven action areas. This is a status short of “final approval.” The team needs additional time to consider how the Pilot Program will be implemented before it can give its final approval. If an extension of the plan development period is granted by the Commission, the SSRT intends to pursue the establishment of an implementation and permitting framework necessary to allow their final approval of the recommendations.

8.2.1.1 Dry Year Water Plan

Issues: Low instream flows, especially in drought and dry years, limit habitat for coho salmon and other salmonids. Currently, 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.

WM-1a	Ask Scott River Watershed Council (SRWC) to develop an emergency 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."
WM-1b	Ask the Shasta 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."

8.2.1.2 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 other 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.

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: On-going

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.

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.

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: The following steps will be taken to ensure verification.

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. (15% of the diverters within the decree can request State Watermaster Service.)
3. If DWR is unable to verify compliance with the decreed water rights by 1/1/05, seek State Water Resources Control Board oversight and verification.
4. Develop a standard format for collection and reporting of diversion data.
5. Seek and obtain funding for the first three years.

Long-term: Seek state funding for general-fund portion of long-term Watermaster Service and implementation. Include water users in a DWR request for an incidental take permit for Watermaster Service.

8.2.1.3 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.

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.

WM-3b On the Scott River, investigate if ramping would be beneficial or necessary.
Short-term: Survey water users, the Department, 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.

8.2.1.4 Pulse Flows

Issues: Juvenile emigrants or other life stages may have difficulty migrating during some periods.

Solutions: Produce a pulse of flow, which will aid in migration.

WM-4a On the Shasta, the Shasta CRMP and the Department, 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, 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.

WM-4b On the Scott, the Department should research with the SRWC and RCD to determine if some streams could benefit with a pulse flow
Short-term: Implement research recommendations.

8.2.1.5 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.

WM-5a DWR and SWRCB should outline the procedure for developing instream flow dedications. Develop incentives for acquiring instream flow.
Short-term: Watermasters will:

1. Continue and expand opportunities to help manage flows on some streams;
2. Develop an informational report to describe the process and incentives; identify potential for future measures;

3. Develop guidelines to protect water users, inform funders, and ensure that water is used for instream flows.

WM-5b On the Scott, 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.

WM-5c On the Shasta, 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.

8.2.1.6 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.

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: The Department 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 would improve conditions.

WM-6b On non-watermastered reaches of the Scott River HA, develop a test 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.

8.2.1.7 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.

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.
WM-7b	Seek additional funds to provide structures for willing irrigators in non-water-mastered areas; the Department, 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.
WM-7c	On Shasta River, riparian users should participate. **Short-term:** Provide devices to riparian users. Continue to require riparian and pre-1914 water users to file annual statements of diversion and use.

8.2.1.8 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.

WM-8a	On the Scott, 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:** On-going.
WM-8b	On the Shasta, DWR, USFS, Shasta 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/team. Implement. Seek additional funding to initiate and implement a predictive program. **Long-term:** On-going

8.2.1.9 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.

WM-9 The Department and USFWS in cooperation with the community should seek funding to conduct instream flow studies on the Scott and Shasta to determine flow-habitat relationships. 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 Dry Year 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 using agreed-upon scientists identified by the Shasta CRMP and the Technical Committee of the SRWC. 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 application of a Conservation Implementation Program.
Long-term: Integrate findings into watershed planning processes.

8.2.1.10 Groundwater Studies

Issues: Low instream flows limit habitat for coho salmon and other salmonids and inhibit movement of coho 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.

WM-10a DWR, the Shasta 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, and 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.

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.

WM-10c Prior to groundwater study completion, recommend that County establish a 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. Beginning in 2006, review and analyze study results and determine thresholds and actions to protect resource for all users.
Long-term: Implement plan.

8.2.1.11 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.

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.

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.

8.2.2 WATER AUGMENTATION RECOMMENDATIONS

Water augmentation recommendations are presented in seven sub-categories.

8.2.2.1 Water Trust (water leasing)

Issues: Low instream flows limit 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.

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 a Department 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.

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.

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 application of a Conservation Implementation Program.

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.

8.2.2.2. 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.

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.
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. **Long-term:** 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. Seek funding for and implement feasible projects.

8.2.2.3. 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.

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.

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.

8.2.2.4 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).

WA-4a Along with general groundwater investigation on the Shasta (see WM-11a), include coordinating groundwater storage with operation of Lake Shastina.
Short-term: Conduct Shasta Groundwater Study to obtain basic data. Evaluate potential application of a Conservation Implementation Program.
Long-term: Look at options for conjunctive use in specific study.

WA-4b On the Scott, as part of both the general groundwater investigation and the surface reservoir investigation (see WM-11b), include conjunctive groundwater operation.
Short-term: Find funding and implement reconnaissance level study. Evaluate potential application of a Conservation Implementation Program.
Long-term: Pursue feasibility study and implement if warranted.

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 includes legal aspects. Evaluate potential application of a Project Conservation Implementation Program.
Long-term: Pursue feasibility study and implement if warranted.

8.2.2.5 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.

WA-5	Initiate reconnaissance-level study of 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.

8.2.2.6 Water Conveyance to Shasta Valley from Main Klamath

Issues: 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 groundwater pumping for agricultural purposes. The majority of the low temperature, high quality water from the Shasta River would then be left in the stream to the benefit of spawning and rearing coho salmon.

WA-6a	Study the legality of a water conveyance to Shasta Valley from the mainstem Klamath River. **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.
WA-6b	Conduct feasibility study of water conveyance to Shasta Valley from the mainstem Klamath River. **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.

8.2.2.7 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.

WA-7a	Conduct reconnaissance-level investigations of acquiring water rights. **Short-term:** Conduct cost-benefit analysis that includes socio-economic effects to community and legal considerations; Present options and survey public support. Proceed as warranted.
WA-7b	Depending upon results of study of acquiring water rights, engage and support projects. **Short-term:** Solicit interest from willing participants. Evaluate potential

	application of a Conservation Implementation Program. **Long-term:** Continue short-term actions.
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.

8.2.3 HABITAT MANAGEMENT RECOMMENDATIONS – SCOTT RIVER

These recommendations cover improving rearing habitat, temperature, habitat structure, passage, and spawning habitat.

8.2.3.1 Improvement of Summer and Winter Rearing Habitat – Lack of Habitat Complexity

Issue: 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.

Solution: 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.

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.

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 (i.e., channel meander, riparian vegetation recruitment, reduced sedimentations, etc.) are improved.

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 on-going riparian restoration efforts and continue to seek funding and carry out projects with an emphasis on the tributaries, especially those identified as potentially major streams inhabited by coho salmon. 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 coho salmon refugia.

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.

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 re-introduction fails or is found to be inappropriate, consider analogous habitat attribute efforts.

8.2.3.2 High Water Temperatures

Issue: 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.

Solution: 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.

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.
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.
Scott HM-1-2c	Install systems that treat warm water or percolate it through the ground to cool it. **Short-term:** Seek funding and carry out projects where appropriate.
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.

8.2.3.3 Improve Valley and Low-gradient Tributary Channel Structure and Function

Issue: 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 floodplain. 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) during higher flows resulting in increased streambank erosion and the need for rip rap. 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.

Solution: Restore valley river structure to an appropriate meander pattern, decreased channel slope, decreased width-to-depth ratios, proper connections with the floodplain and side channels, where feasible.

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. **Short-term:** 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. Acquire expert input to 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.
Scott HM-2b	Identify locations where the main channel can be reconnected to its floodplain 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.

Scott HM-2c Restore the Scott River floodplain 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.

8.2.3.4 Barriers to Fish Passage

Issue: 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. Some barriers are the result of human activity and have the potential of being remedied.

Coho spawners 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.

Solution: Continue to investigate and implement fish passage improvement projects and promote the surface connectivity of streams that provide coho salmon habitat.

Scott HM-3a Identify location, timing, duration and frequency of low flows that prevent juvenile access to rearing habitats.
Short-term: Compile information and incorporate into a GIS.
Long-term: Implement actions to remediate barriers.

Scott HM-3b Identify, prioritize, and treat barriers on private roads, consistent with the Five Counties process for road assessments. 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.

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.

8.2.3.5 Improvement of Spawning Habitat

Issue: 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.

Solution: Identify and conserve existing spawning habitat. Restore lost spawning habitat where possible. In locations where there are problems, increase habitat complexity and gravel quality.

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.
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.
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.

8.2.4 HABITAT MANAGEMENT RECOMMENDATIONS – SHASTA RIVER

These recommendations cover improving rearing habitat, fish passage, spawning gravel management, riparian vegetation management, and temperature.

8.2.4.1 Improvement of Rearing Habitat

Issues: Inaccessibility to tributaries, high stream temperatures, 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.

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.

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 or potentially accessible to coho salmon (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 HM-1c Implement habitat protection and improvement projects that enhance rearing habitat in high priority areas.
Short-term: Focus on areas currently accessible or potentially accessible to coho salmon (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-1b). Possible projects livestock control or exclusion fencing, tree and emergent planting, bioengineered bank stabilization, irrigation tailwater reduction.
Long-term: Continue projects. Monitor for effectiveness over the long term, using adaptive management to fine-tune projects for best benefit to coho salmon.

8.2.4.2 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. Some barriers are the result of human activity and have the potential of being remedied.

Solutions: Continue to investigate and implement fish passage improvement projects and promote the surface connectivity of streams that provide coho salmon habitat.

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.
Shasta HM-2b	Same as Shasta HM-2a **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.
Shasta HM-2c	Same as Shasta HM-2a **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.
Shasta HM-2d	Same as Shasta HM-2a **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.
Shasta HM-2e	Same as Shasta HM-2a **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.
Shasta HM-2f.	Same as Shasta HM-2a **Short-term:** Studies/repairs underway. Continue to completion. **Short-term:** Monitor for management, maintenance and effectiveness.
Shasta HM-2g	Same as Shasta HM-2a. 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.
Shasta HM-2h	Same as Shasta HM-2a. **Short-term:** Develop a plan for the second and seek funding. **Long-term:** Implement barrier modification on second barrier.
Shasta HM-2i	Same as Shasta HM-2a. **Short-term:** Implement results of on-going study of road barriers on Parks Creek.

8.2.4.3 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 mainstem, 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.

ShastaHM-3a	Continue to submit funding request for a Shasta river watesehd gravel budget 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 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 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 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.

8.2.4.4 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 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.

Solution: Increase riparian vegetation.

ShastaHM-4a Encourage riparian restoration projects using locally native vegetation, including both woody and herbaceous stocks. Project implementation should consider if:

a. The site previously supported riparian vegetation and still has the soil and hydrologic characteristics to support it;

b. Native plants selected are likely to flourish;

c. The width of the planted riparian zone is appropriate for the hydrologic regime at the site; and

d. 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, the 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 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.

Shasta HM-4c Educate the public and landowners on the importance of not removing riparian vegetation. See also EO-9.
Short-term: Prepare presentation materials with photos, illustrating desired future condition. Create awards and recognition. Because 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.

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.
Long-term: Create opportunity, 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.

8.2.4.5 Water Temperature

Issues: Water temperatures are influenced by the amount of river flow, 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.

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.

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.

8.2.5 WATER USE EFFICIENCY RECOMMENDATIONS

The overall goals for the water use efficiency recommendations are to:

- 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.

8.2.5.1 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.

WUE-1a	Develop the cost and potential stream-flow enhancement if all relevant diversions participated. **Short-term:** Coordinate with implementation of WUE-1b.
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.
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. **Short-term:** Provide education about management changes under ESA.

8.2.5.2 Landowner 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.

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.

8.2.5.3 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.

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.

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.

8.2.5.4 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 on-going ditch maintenance. Research funding opportunities and incentives for ditch repair and cleaning.

WUE-4 Promote routine and on-going ditch maintenance for ditches in active use. 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.

8.2.5.5. 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.

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.

WUE-5b Promote maintenance of existing sprinkler systems, such as: replacing gaskets and drains; replacing nozzles and/or heads with crop-specific equipment. Implement education program through UC Extension.

WUE-5c Develop/disseminate Best management Practices (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.

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.

WUE-5e Support DWR in implementing the California Irrigation Management Information System (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.

8.2.5.6 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.

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; establish guidelines verification and marketing processes. If mechanical barriers are identified to otherwise promising potential changes, develop plan 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.

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.

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.

8.2.5.7 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.

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

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.

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 statewide evaluation process to achieve positive cost/benefit ratio with adequate understanding of effects on instream flows before funds are allocated. Same for federally funded projects. Implement.
Long-term: Refine and adaptively manage.

8.2.5.8 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.

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.

8.2.6 PROTECTION RECOMMENDATIONS

This section contains recommendations that deal with barriers to passage and habitat Degradation.

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, protection of riparian vegetation, land use planning and enforcement of existing regulations.

P-1 Screen all diversions in the known and potential range of coho salmon.
Short-term: Identify funding and complete on-going screening program within known and potential range of coho. Assess habitat that will be made accessible to coho 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. 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

P-2 Promote and encourage protection of riparian zones that are important for coho through fencing or other measures.

Short-term: All riparian areas within range of coho will be identified and protected within 5 years:

a. 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.

b. Limit funding to planting of trees from local native stock only.

c. Provide funding for greatly expanded tree re-planting program. Provide protection from beavers for remaining large trees along the Shasta River.

d. Provide public with visual aids and recognition of achievement of desired future condition.

e. Fund studies to solve regeneration problems, such as those found in the Shasta Valley that are caused by the altered hydrological cycle and those in the Scott Valley that are caused by the drop in groundwater level.

Long-term:

a. Develop long-range riparian protection goals statement and recommendations based on stream meander width (e.g., Rosgen et al.).

b. Continue to emphasize need to establish/protect/maintain desired conditions.

c. If the consequences of altered hydrograph in Shasta cannot be overcome with native trees, investigate and develop biologically appropriate recommendations.

P-3 Expand routine/ daily fish screen maintenance program (volunteer and paid) whether installed with grant funds or by the Department.
Short-term: Local groups to work with the Department and NOAA Fisheries to develop comprehensive maintenance program by 2005.

a. Work with screen users to develop inspection verification procedure for use after transition period.

b. Use time afforded by grant funds to transition away from non-owner screen maintenance and, where appropriate, transfer screen maintenance to the diverter.

c. 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 the Department to stock and sell.

d. 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.

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: The Department to develop 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 eliminate need for fish rescue.
Long-term: Work to solve problems responsible for rescue needs.

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:

a. 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.

b. In Shasta, proceed to implementation phase, complete assessments. Eliminate passage problems wherever possible, install or replace ladders where necessary as short term fix.

c. Provide qualified Department engineer for design assistance in retrofitting barriers with ladders or correcting problems with locally produced and installed ladders as short term, temporary fix..

d. Develop BMPs for removal/ replacement/ operation, include these in 1603 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.

P-6 Recommend that the County 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.

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.

8.2.7 MONITORING AND ASSESSMENT RECOMMENDATIONS

These recommendations are divided into two categories, 1) habitat monitoring and assessment, which includes effectiveness monitoring for restoration actions, and the monitoring and assessment of coho salmon populations.

8.2.7.1 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 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.

MA-1	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. **Supports recommendations:** Habitat Management (HM-1b, HM-2e).
MA-2	Identify and assess riparian vegetation coverage and condition and monitor changes through time. **Supports recommendations:** HM-1-1c, HM-3b, HM-3d.
MA-3	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 statewide or regional monitoring programs **Long-term:** Continue implementation **Supports recommendations:** HM-1-1e, HM-2-1a, HM-2-1b, HM-4a, HM-4b, HM-2b, HM-2e, HM-3b, P-6, EO-8.
MA-4	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 statewide or regional

monitoring programs.
Long-term: Continue implementation.
Supports recommendations: WM-3a, WM-3b, WM-4a, WM-4b, WM-5b, WM-5c, WUE-5a, WUE-7a, HM-1-3b, HM-1-3d, HM-XXX (flow, HM-1b, HM-2e, HM-3b, HM-4a, P-6.

MA-5 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.
Supports recommendations: HM-4a, P-1, P-5.

MA-6 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 ACOE and NRCS records of activity for both HAs. Determine effects of levee system.
Long-term: Determine feasibility; and develop and implement remediations based on results of assessments.

MA-7 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.
Supports recommendations: WA-1a, WM-1a, WM-1b, HM-4-XXX (flow), WM-2c, WM-2e, WUE-5a, WM-3a, WM-3b, WM-5b, WM-5c.

MA-8 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 statewide 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.
Supports recommendations: HM-1-1b, HM-1-1c, HM-2e.

MA-9 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.
Supports recommendations: HM-2e, HM-4a.

MA-10 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.
Supports recommendations: WM-3a, WM-3b, WM-5b, WM-5c, WUE-5a, HM-4b, HM-1c.

MA-11 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: Provide information to groundwater committee referred to in WM-10c. Continue long-term monitoring.
Supports recommendations: WM-10a, WM-10b.

8.2.7.2 Monitoring and Assessment: Coho Salmon Populations

Issues: Baseline information is needed on the distribution and abundance of coho salmon within both watersheds. Monitoring coho populations over time is necessary to determine long-term trends in abundance, evaluate the effectiveness of coho 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 the Department and other fisheries experts to develop and implement a program to monitor coho abundance and distribution within the Shasta Valley and Scott River HSAs. Integrate this program with existing regional and statewide monitoring efforts.

MA-12 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.
Long-term: Develop management plans for remediation of limiting factors. Monitor effects to coho populations and habitat.

MA-13 Continue to identify the historic and current distributions of coho salmon adults and juveniles within the Scott River and Shasta Valley HSAs.
Short-term: Identify, evaluate, and map coho 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.
Supports recommendations: WM-3a, WM-3b, WM-4a, WM-4b, WM-5b, WM-5c, WUE-5a, HM-1-1a, HM-4a, HM-4b, HM-1a, HM-1b, HM-1c, P-1, P-5, P-6.

MA-14 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 Scott.
Long-term: Continue and improve abundance surveys. Use data to develop annual adult and emigrant abundance estimates for both valleys.
Supports recommendations: WM-3a, WM-3b, WM-5b, WM-5c, WUE-5a, HM-4b, HM-1c.

MA-15 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.
Supports recommendations: WM-3a, WM-3b, WM-5b, WM-5c, WUE-5a, HM-1c.

MA-16 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.

MA-17 Identify adult and juvenile diversity (genotypic/phenotypic) variations within the Scott and Shasta rivers for comparisons with other populations within the Southern Oregon-Northern California ESU.
Short-trem: Coordinate with state and federal agencies in collection of tissues.
Long-term: Make both phenotypic and genotypic data available to appropriate agencies and public.

MA-18 Food availability: conduct macro-invertebrate assessments and monitor changes through time.
Short-term: Expand studies and analyze results.
Long-term: Apply results as appropriate.

MA-19 Assess effectiveness of fish rescue program through monitoring survival of rescued fish
Short-term: Support the Department's effort to monitor and assess the survival of the rescued fish.
Long-term:. Provide assistance in monitoring fish survival.
Supports recommendation: P-4.

8.2.7.3 Cooperative Efforts

During implementation, groups active in the effort should coordinate with other assessment and monitoring programs, such as:

Department of Fish and Game/NOAA Fisheries:

Restoration Effectiveness Monitoring and Protocol Development Project
Restoration Validation Monitoring and Protocol Development Project
California Coastal Salmonid Monitoring Plan
Steelhead Research and Monitoring Program (SRAMP)
State (CESA)/Federal (ESA) Recovery Planning

Other State Agencies:

Department of Water Resources (DWR)
North Coast Regional Water Quality Control Board (NCRWQCB)
—TMDL (sediment, temperature, nutrients)

Other Federal Agencies:

Aquatic Resource and Ecological Monitoring Program (AREMP)
Natural Resources Conservation Service (NRCS)
Environmental Protection Agency (EPA)

Local/Regional Entities:

Resource Conservation Districts
Five Counties Salmonid Conservation and Road Program

Academic Institutions:

University of California Cooperative Extension
Humboldt State University
UC Berkeley/Davis
Institute for Forest and Watershed Management (IFWM)

8.2.8 EDUCATION AND OUTREACH RECOMMENDATIONS

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 national levels, to inform them about local efforts and successes in the Shasta and Scott Valleys. Participation of lead organization(s) may be contingent upon obtaining necessary funding.

Solutions: Use events, workshops, and various forms of media to encourage changes in attitudes and behavior that enhance coho salmon recovery. Seek and procure sources of funding where needed.

EO-1	Use existing extension services to inform landowners of funding programs for water conservation, fish habitat restoration, and BMPs. **Short-term:** Advertise available funding sources, assist landowners in identifying projects for support (based on SWRT recommendations), 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.
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.
EO-3	Fund demonstration projects on land with public access, showing fish-friendly BMPs (e.g., fish-safe use of pesticides / herbicides) 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.

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.

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 on-going programs and revise as necessary. Create new watershed and fisheries education programs.

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.

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.

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.

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 large woody debris 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.

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.

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.

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/responsibilities associated with them. The brochure should emphasize that access to ditches with easements must be granted to allow for ditch maintenance and repair.
Short-term: Develop this brochure and print 200 copies.
Long-term: None

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.

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.
Long-term: N/A

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.

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.

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.

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 an salmon festival.
Long-term: Continue to organize annual salmon festivals.

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.
Long-term: Update CIMIS informational materials every two years and re-circulate.

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 quarterly Shasta and Scott Watershed meetings.
Long-term: Continue to organize quarterly meetings.

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.

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.

8.3 ADMINISTRATION AND IMPLEMENTATION

Acceptance of the Shasta-Scott Pilot Program 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. Implementation costs for some recommendations proposed by the SSRT have been categorized as high, moderate or modest. For many other SSRT recommendations, no attempt was made to estimate costs due to lack of information or uncertainties regarding project scope or timing. It is therefore not possible to make even a crude estimate of overall restoration costs at this time.

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 Shasta-Scott Pilot Program 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.

9 Timeframe and Economics of Recovery

IN PREPARATION

9.1 INTERIM GOALS AND OBJECTIVES

9.2 LONG-TERM GOALS AND OBJECTIVES

10 Implementation

Several hundred statewide and watershed-specific recommendations for recovering coho salmon in California are listed in Chapter 6 (Range-wide Recommendations), Chapter 7 (Watershed Recommendations), and Chapter 8 (Shasta-Scott Pilot Program). To successfully implement these recommendations, watersheds within the coho salmon range should be prioritized. In addition, several elements must be identified for each task: a) level of priority; b) responsible party(ies) or organization(s); c) estimated initiation and duration of implementation; and d) estimated cost. These topics are covered in this chapter, to the extent that the information is available.

As described in Chapter 7, this recovery strategy mainly uses two watershed designations from the CALWATER 2.2a system (Appendix E), the *hydrologic unit* (HU), which generally corresponds to major watersheds or sub-regions, and within each HU by *hydrologic subarea* (HSA), which generally corresponds to major tributary watersheds. In a few cases, the *hydrologic area* (HA), a unit intermdiate in scale between the HU and the HAS, is used. For purposes of implementation priorities, rankings were only developed at the HSA level.

10.1 PRIORITIZATION OF WATERSHEDS

The recovery strategy incorporates a three-tiered process to prioritize watersheds for coho salmon recovery. This approach: 1) identifies for maintenance and recovery those watersheds supporting the best coho salmon populations in California and identifies those coho salmon populations that are currently at risk of extinction; 2) provides a ranking system for guiding recovery planning actions among watersheds; and 3) identifies those watersheds having 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 discussions with the CRT. The maps below are intended to guide recovery-planning actions. Appendix F describes how the 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]

10.1.1 GENERAL PRINCIPLES

In HSAs considered refugia for coho salmon, the recovery strategy will include actions that preserve, protect, and enhance these best remaining populations and their habitats. These HSAs, identified on Figure 10-1 (Consistent presence of coho salmon in the SONCC ESU) and Figure 10-2 (Consistent presence of coho salmon in the CCC ESU), 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 risk of extinction, identified in Figure 10-3 (SONCC ESU) and Figure 10-4 (CCC ESU), 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 salmon within these HSAs. HSAs scoring higher in this ranking should be given priority in the expenditure resources or resources available for restoration, other considerations being equal. HSA rankings for maintenance and recovery actions are presented for the SONCC ESU (Figure 10-5) and the CCC ESU (10-6).

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 Figure 10-7 (Disconnected habitats in the SONCC ESU) and Figure10-8 (Disconnected habitats in the CCC ESU). These HSAs 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 3- to 5-year intervals. This would allow review and modification, if warranted, of the HSA rankings.

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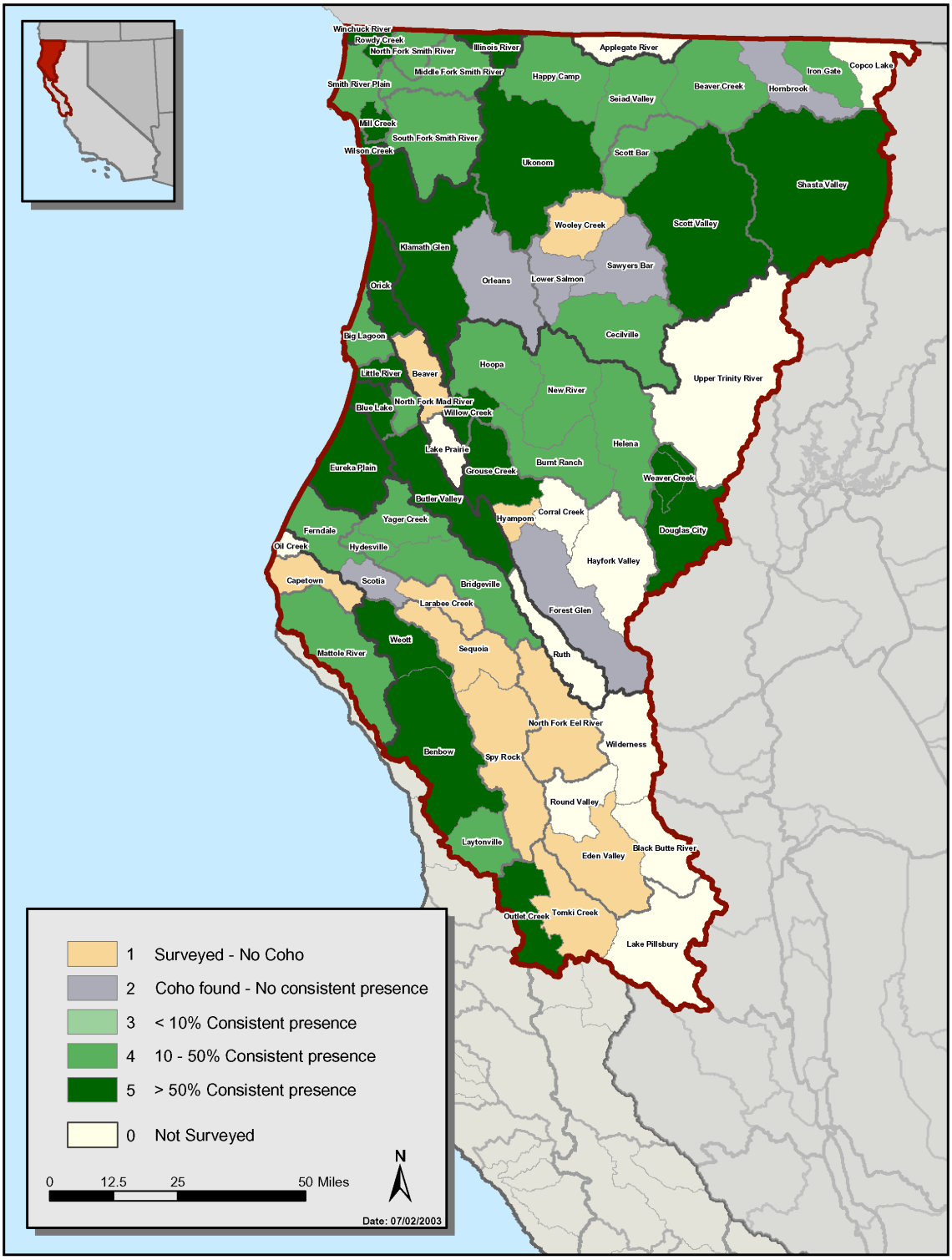
[1] Some situations may over-ride or alter recommended priorities. Examples include, but are not limited to, willing landowners, high cost-shares, unique funding opportunities or partnerships, multi-species projects, etc. Cost effectiveness must be considered regardless of priorities.

FIGURE 10-1: Consistent presence of coho salmon in the SONCC ESU



Note: Refugia watersheds have consistent presence >50%.

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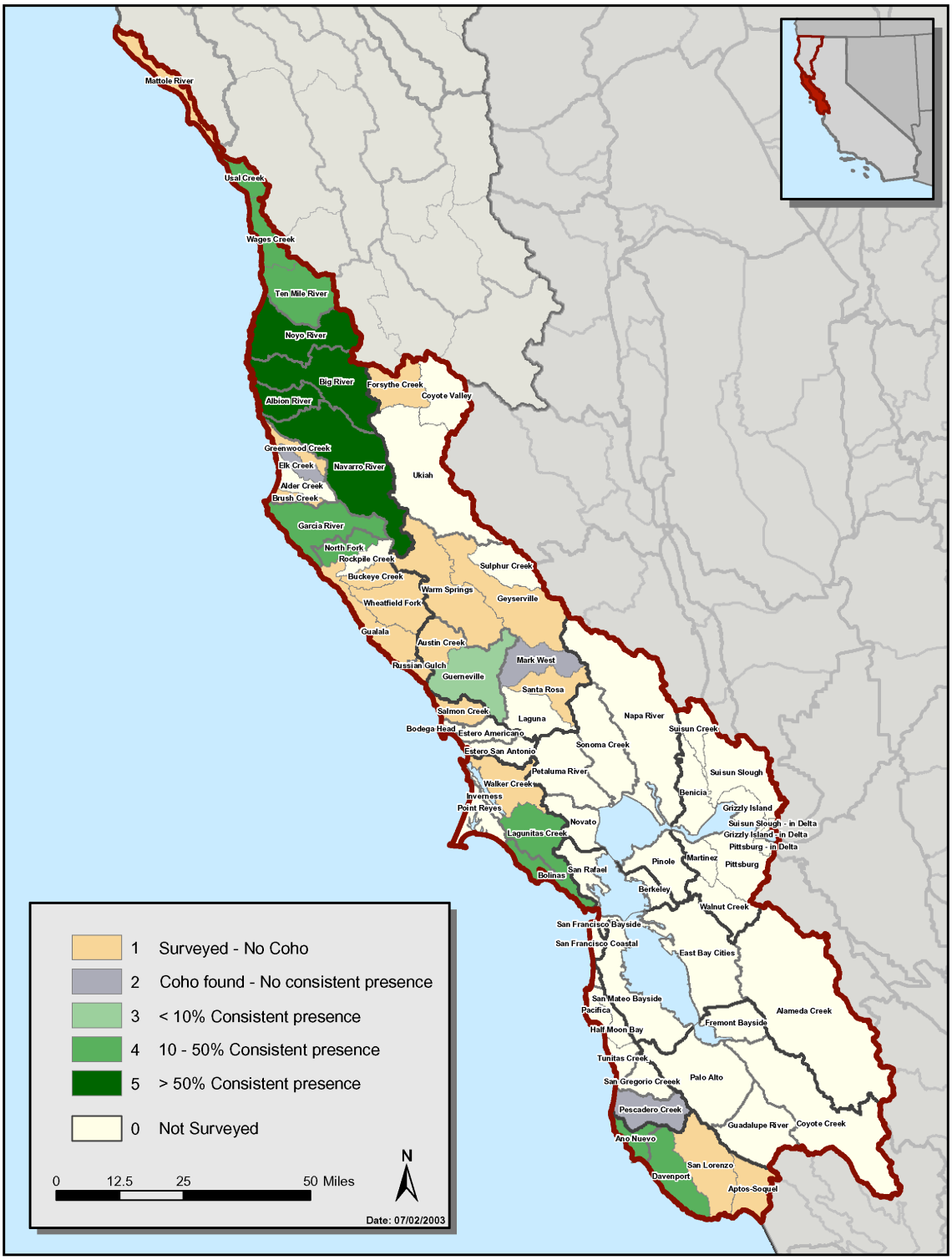
FIGURE 10-2: Consistent presence of coho salmon in the CCC ESU



Note: Refugia watersheds have consistent presence >10%.

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FIGURE 10-3: Risk of extinction in watersheds of the SONCC ESU

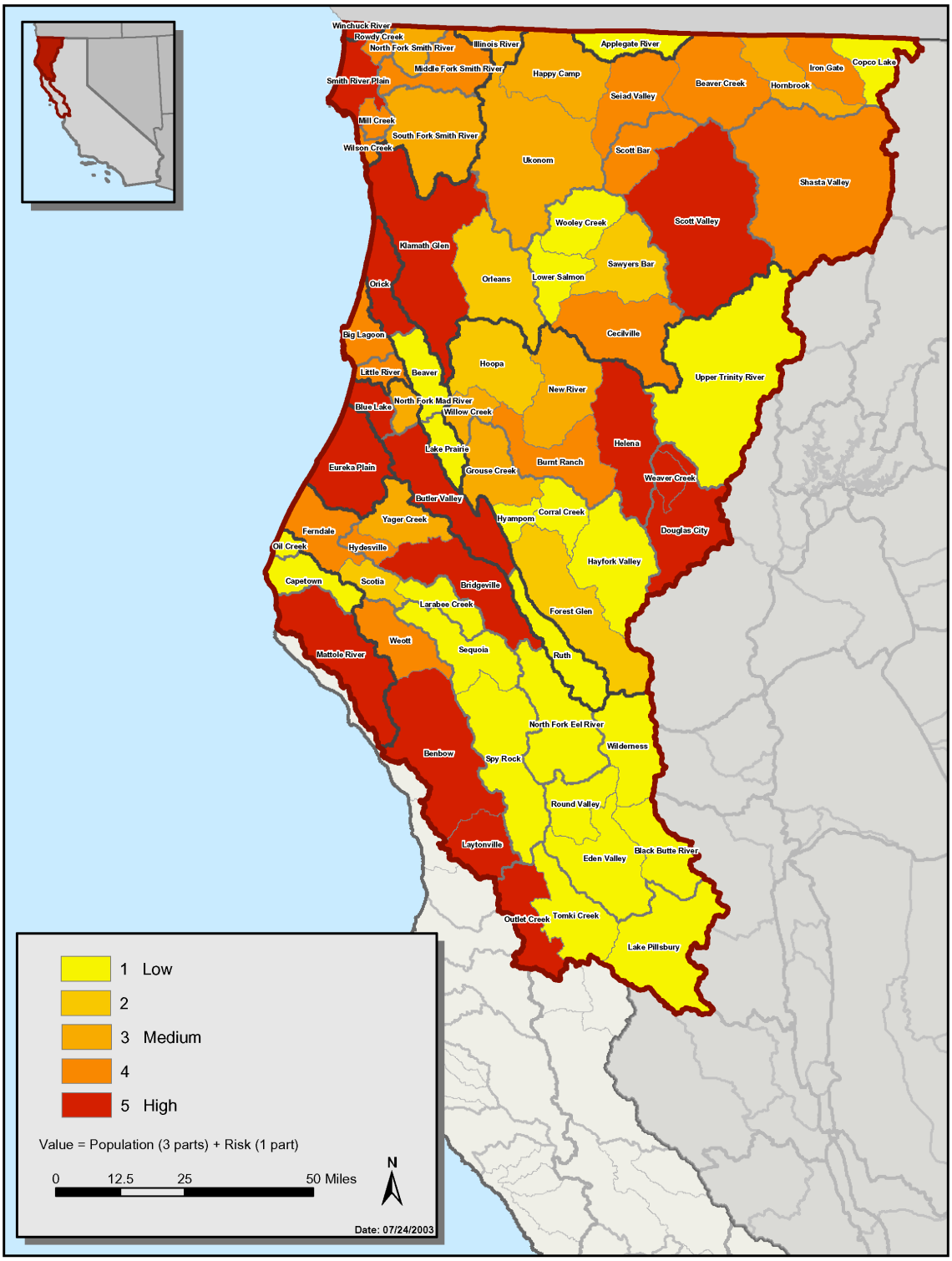

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FIGURE 10-4: Risk of extinction in watersheds of the CCC ESU

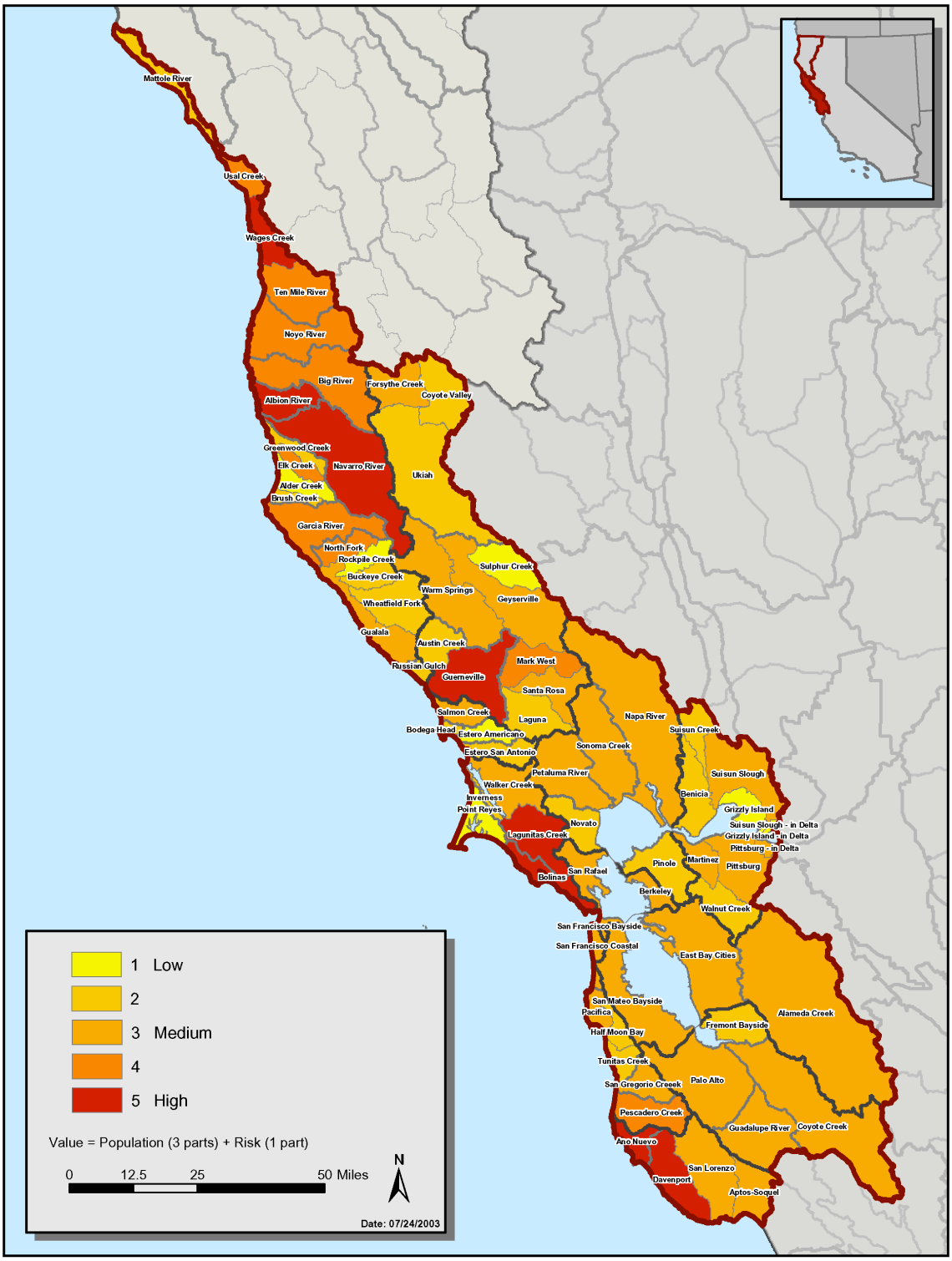

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FIGURE 10-5: Restoration and management potential in the SONCC ESU

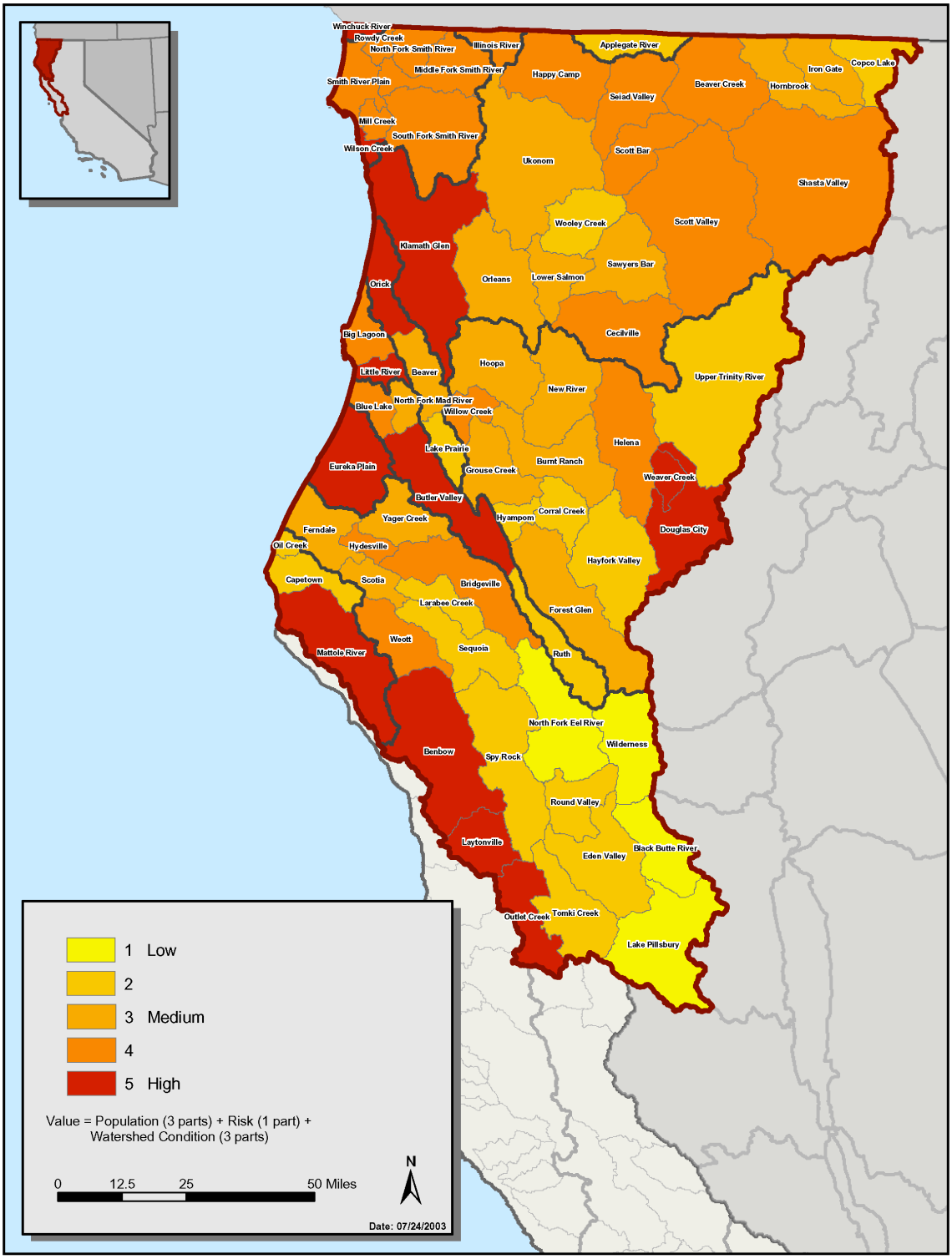

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FIGURE 10-6: Restoration and management potential in the CCC ESU

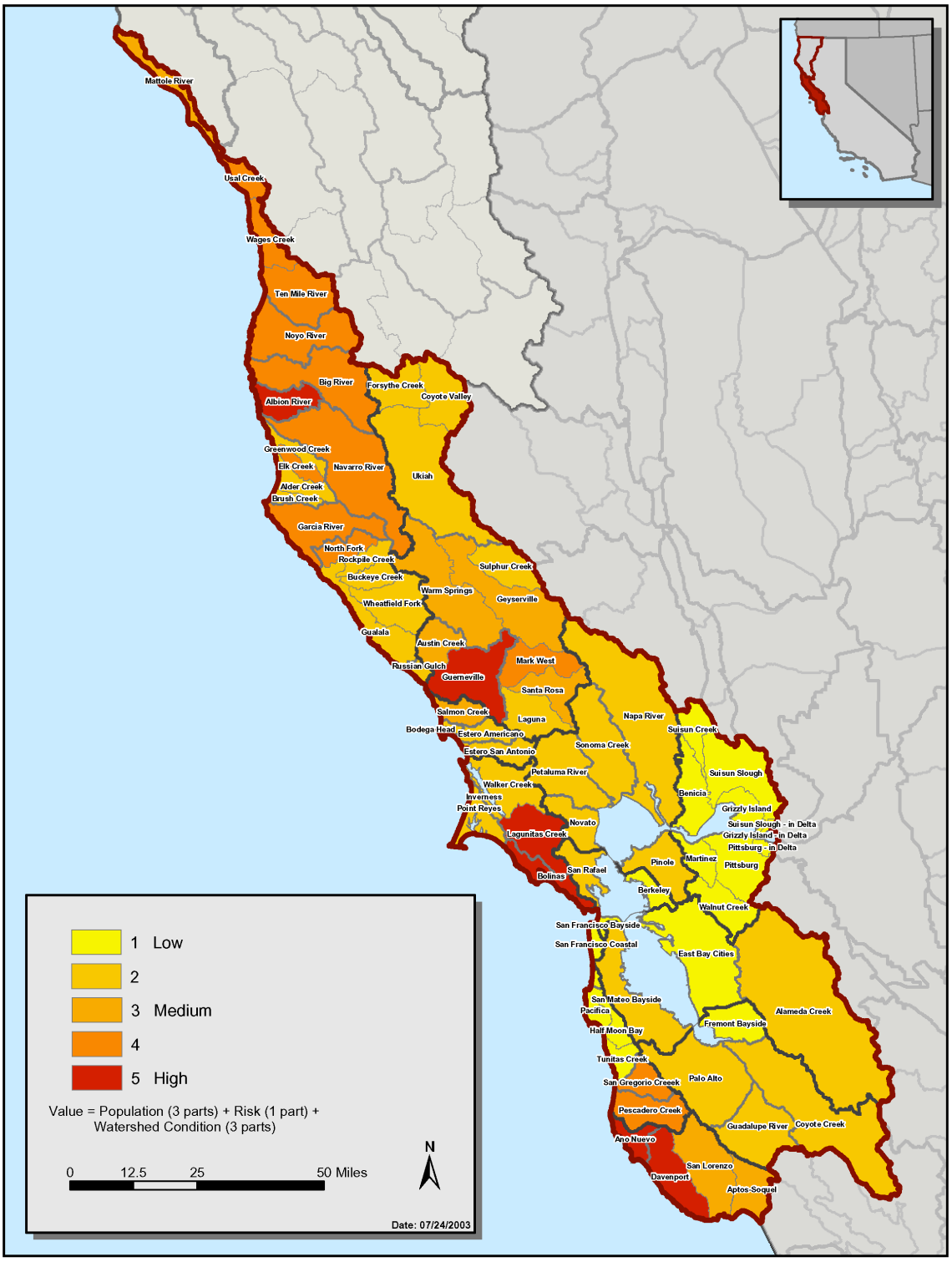

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FIGURE 10-7: Disconnected habitat in the SONCC ESU

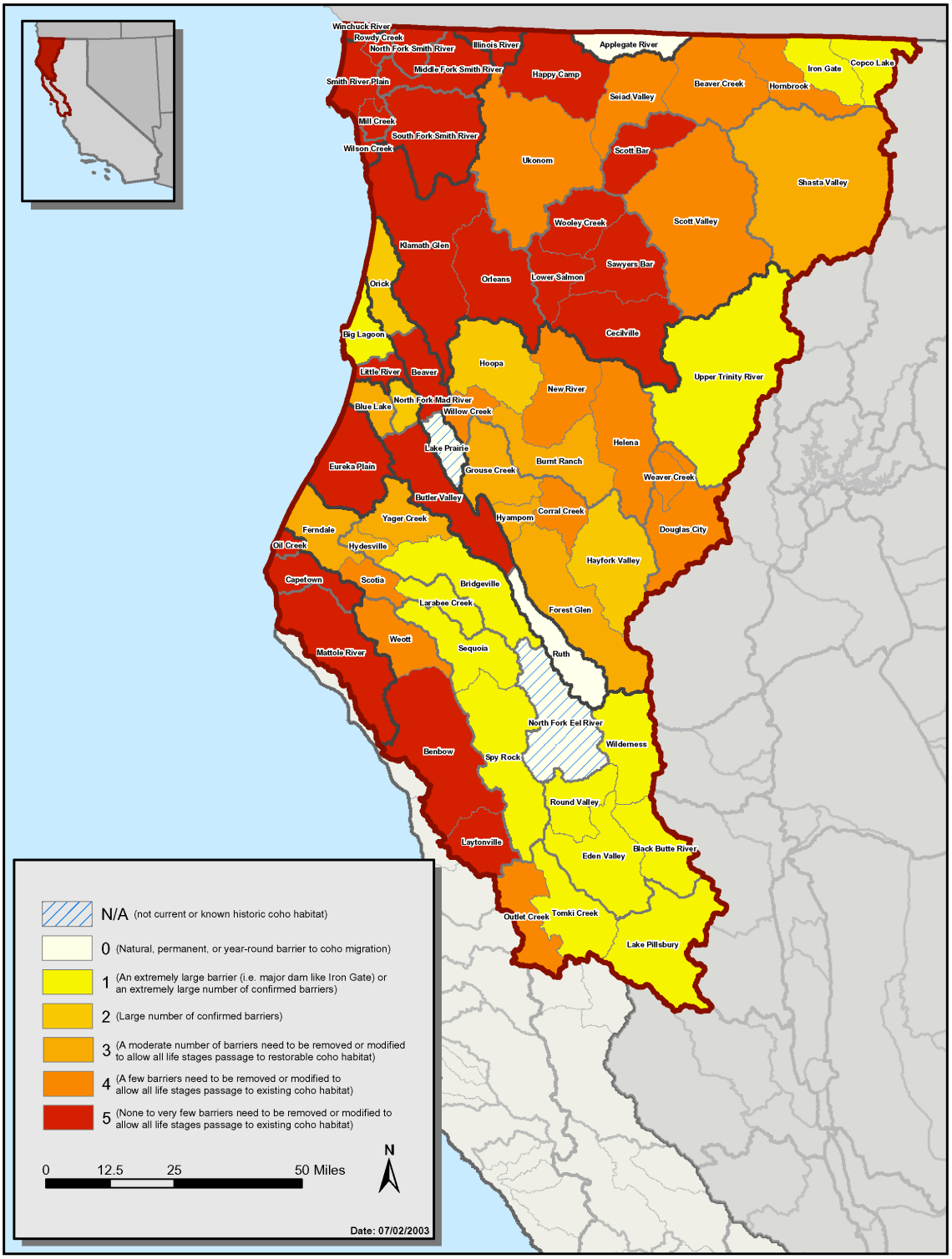

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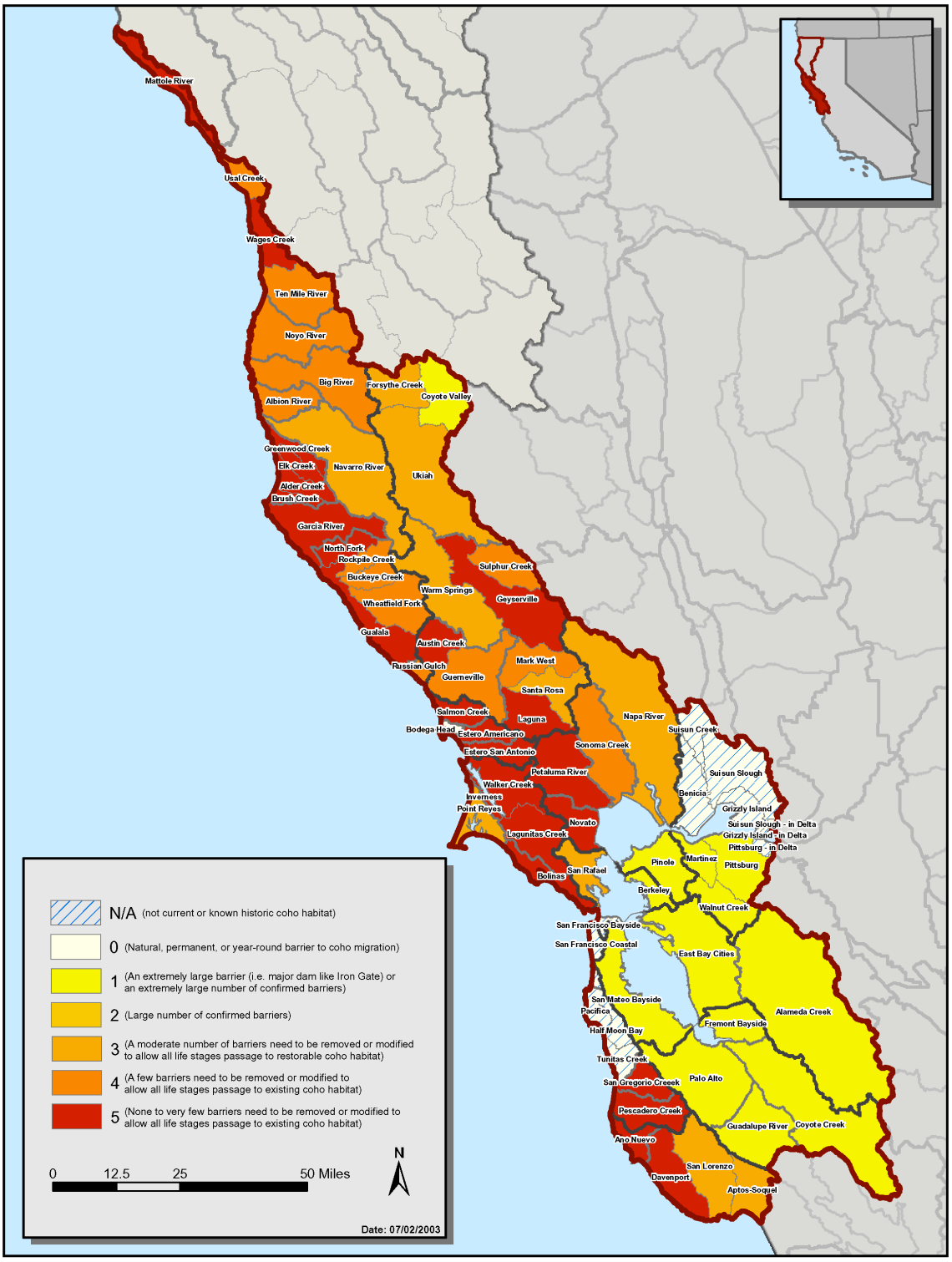
FIGURE 10-8: Disconnected habitat in the CCC ESU



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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.

10.1.2 PRIORITIZATION PROCESS

The three steps followed to prioritize the watersheds are described in this section.

10.1.2.1 Identify Refugia Watersheds (Figures 10-1 and 10-2) and Risk of Extinction (Figures 10-3 and 10-4)

Rationale: Those HSAs in the SONC ESU with consistent presence of > 50% should be considered refugia watersheds. HSAs in the Central California Coast ESU having consistent presence of > 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 population parameters, since coho salmon population abundance and genetic data are not available statewide. 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:

i. On public lands, consider full maintenance and recovery of instream and riparian areas.

ii. On private lands, provide incentives for riparian maintenance and recovery strategy activities that maintain and enhance coho salmon habitat.

iii. Identify any problems within these watersheds and recommend actions (for example; restoring estuarine habitats in Eureka Plain, Redwood Creek and Smith River).

iv. Prioritize biological refugia watersheds in the application of California coho statewide recommendations.

10.1.2.2 Identify Restoration Potential (Figures 10-5 and 10-6)

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 Action:

i. Determine if near-term (< 9 years) actions are adequate to maintain these populations at their current level.

ii. Determine if near-term and long-term actions will allow for expansion of these populations in all brood-years.

iii. If identified recovery strategy actions satisfy categories (b,i) and (b,ii) above, use the prioritize scheme to guide watershed restoration and other identified recovery strategy actions. If identified recovery strategy actions do not satisfy categories (b,i) and (b,ii) above, then recommendations *must* be upgraded.

iv. Develop recommendations specific enough to direct restoration actions.

v. Work with existing watershed groups in priority HSAs and landowners who are willing to work on watershed assessments to develop specific actions to restore coho habitat.

10.1.2.3 Identify Disconnected Habitats (Figures 10-7 and 10-8)

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:

i. 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 sites-specific evaluation = 1).

ii. Where appropriate, implement existing recommendations that are specific enough to direct barrier elimination.

iii. Develop additional, needed recommendations for barrier elimination.

10.2 IMPLEMENTATION SCHEDULE AND COSTS

The timing and duration required for recovery was given in Chapter 9 (Timeframe and Economics of Recovery). This chapter identifies estimated time for each recovery recommendation. Some recovery actions are already occurring (*ongoing*). But most actions are 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*).

TABLE 10-1: Implementation Schedule

PRIORITY	TASK #	TASK DESCRIPTION	RESPONSIBLE PARTY	ESTIMATED TIME	ESTIMATED COST

10.3 FEASIBILITY

The recovery strategy and implementation schedule must be capable of being carried out in a scientifically, technolocially, and economically reasonable and legal manner. Therefore, all of the processes and activities within this strategy are subject to these considerations.

10.4 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 responsible parties and participants to support and implement recovery strategy actions.

10.5 RESPONSIBLE PARTIES

Many parties and organizations are either responsible for recovery actions or will be instrumental in recovery of coho salmon in California. These include, but are not limited to:

Federal agencies:
- National Marine Fisheries Service (NOAA Fisheries)
- United States Forest Service (USFS)
- National Park Service (NPS)
- Bureau of Reclamation (BOR)
- United States Fish and Wildlife Service (USFWS)

State agencies:
- California Department of Fish and Game (DFG)
- California Departmentof Forestry and Fire Protection (CDF)
- California Department of Parks and Recreation (DPR)
- State Water Quality Control Board (SWQCB)
- California Department of Transportation (CalTrans)
- Board of Forestry and Fire Protection (BOF)

County governments

City governments

Tribal governments

Private industry (including forestry, agriculture, livestock, mining)

Private landowners

Conservation organization

Watershed councils and groups

Academic institutions

11 Process for Revising the Recovery Strategy

An essential component to any species recovery strategy is the provision of periodic review and, if necessary, revision of specific strategy elements. Given the long term nature of the strategy, flexibility and responsiveness are necessary. The strategy is based on the 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 the Department learns more about these topics, the strategy and coho salmon will benefit accordingly.

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 and the experience of stakeholders and managers in an iterative process involving:

- Implementing the recommended strategy;
- Monitoring the species, habitat, and social/political response;
- Review of monitoring information; and
- Determining what, if any, changes are necessary to progress on a trajectory toward achieving the plan goals and objectives.

11.1 TIMETABLE AND PROCESS FOR REPORTING AND REVISION

Pursuant to Fish and Game Code section 2113, the Department will convene recovery teams, both the CRT and the SSRT, on an annual basis to discuss "the status and progress of implementation of the recovery strategy." Information from these meetings would then be reported to the Commission. The Department, with the input of the recovery teams, will 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 utilizing information from monitoring and research and feedback from participants indicating a change is necessary to remain on track toward meeting the goals and objectives of the recovery strategy. The Department will report annually to the

Commission regarding the status and progress of implementation of the recovery strategy, including any recommendations for modification of the strategy.

The initial years of implementation will involve securing funds and working with local, state, and federal entities to initiate high priority programs or projects called for in the range-wide and watershed recommendations 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 be used by the Department's review of the coho salmon status review pursuant to Fish and Game Code section 2077, which requires the Department to review listed speciies 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. The Department's reports to the Commission will 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 may include in five year coho 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.

11.2 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: 1) new information on changed environmental conditions (e.g., significant floods or wildfires, fluctuation in ocean condition), 2) better knowledge on effects of human activities on coho

salmon populations and habitat, 3) better understanding of the biology of coho salmon, and/or 4) progress or increased effectiveness in recovery actions.

11.3 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: 1) application of recovery actions regarding the various issues and scales, both identified and future, 2) coordination and cooperation with other agencies, landowners, private industry, fishing organizations, and environmental organizations, 3) testing alternative recovery and conservation~land use practices, 4) ecosystem-based management for whole watersheds or portions of a watershed, 5) evaluation of coho salmon population health and habitat condition, and 6) 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.

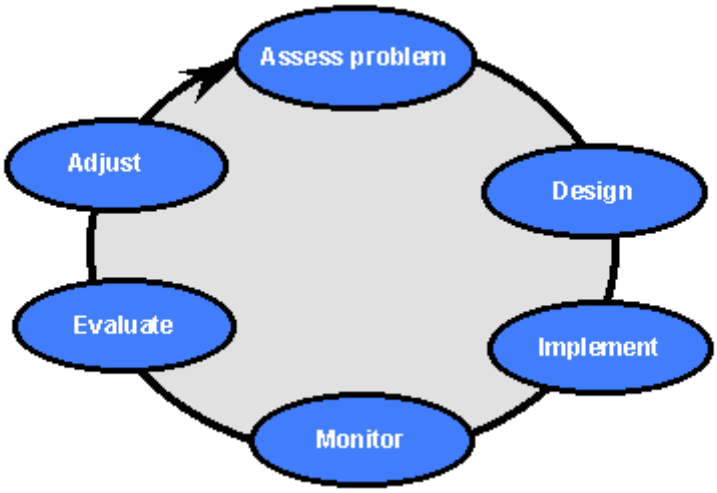
The recovery strategy's adaptive management process is a six-step cycle (Figure 11-1), the success of which depends on the completion of all six steps:

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. 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,

[1] Adapted from Taylor et al. 1997.

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 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 the implemenation and monitoring into future decisions and revisions of the recovery strategy.

FIGURE 11-1: Adaptive management cycle



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Appendices

APPENDIX A: ABBREVIATIONS AND ACRONYMS

APPENDIX B: GLOSSARY

APPENDIX C: OTHER SPECIES AT RISK

APPENDIX D: EXISTING WATERSHED PROGAMS, GROUPS, AND RESOURCES

APPENDIX E: CALWATER UNITS

APPENDIX F: WATERSHED PRIORITIZATION

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
CCC Coho ESU	Central California Coast Coho Evolutionarily Significant Unit
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
CGS	California Geological Survey (formerly Division of Mines and Geology)
Commission	California Fish and Game Commission
CRMP	Coordinated Resources Management Planning
CRT	California Statewide Recovery Team
CWA	Clean Water Act
Department	California Department of Fish and Game
DIRT	Direct Inventory of Roads and their Treatment
DO	Dissolved Oxygen
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
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FGC	California Fish and Game Code
FPA	Forest Practice Act
FPR	Forest Practice Rules
FRGP	Fisheries Restoration Grant Program
FWS	United States Fish and Wildlife Service
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
NCWAP	North Coast Watershed Assessment Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Adminstration
NTP	Non-industrial Timber Plan
NTU	Nephelometric Turbidity Unit
PALCO	Pacific Lumber Company
PCSRF	Pacific Coastal Salmon Recovery Fund
PDO	Pacific (inter)Decadal 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
SMARA	Surface Mine and Reclamation Act
SONCC Coho ESU	Southern Oregon/Northern California Coasts Evolutionarily Significant Unit
SPAWN	Salmon Protection and Watershed Network
SRAC	Smith River Advisory Council
SRWC	Scott River Watershed Council
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
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service

Glossary B

Adaptive management: A systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form, 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.

Adverse effects of water diversions: Removal of water from a system that reduces flows to the point where coho salmon summer rearing habitat is reduced or eliminated; groundwater is reduced so that riparian vegetation is significantly reduced; natural function of the stream and its structural complexity are reduced; or where other negative impacts on coho salmon significantly reduce their productivity.

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.

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.

Barriers to passage: Any physical, chemical, or biological factor that interferes with the natural passage of salmon through their freshwater habitat, including dams, inappropriate water flow or temperature, pollution, and predators.

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: (Synonym: 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." Because virtually all female 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 consistent 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.

By-catch restrictions: Legal or regulatory provisions that limit the type and amount of by-catch permitted in a fishery.

Captive broodstock program: A form of artificial propagation involving the collection of individuals from a natural population and using them in captivity to produce subsequent generations.

Carrying capacity: The maximum equilibrium number of fish (or other organisms) of a particular species that can be supported indefinitely in a given environment. Abbr.: K.

Ceremonial fishery: The harvest of fish or other aquatic resource in observance of native American traditions.

Cohort: (Synonym: Brood-year). 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."

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.

Consistent presence: Mapping convention based on existing coho salmon presence-absence surveys used to develop priotization maps for this recovery strategy. See discussion in Appendix F.

Conspecific: Belonging to the same species.

Critical flows for coho salmon: The minimum amount of water in a stream necessary to provide adequate juvenile rearing habitat, spawning habitat, and flows needed for migration. These flows vary by season and by stream.

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 statisitical analysis for grouping individuals or units based on quantifiable similarities). Dedrograms are often used to show the genetic relationships among populations or higher taxa.

Department: The State of California Resources Agency, Department of Fish and Game.

Desiccation: Drying

Domestication selection: Selection operating on a population during artificial propagation that produces adaptation to the hatchery environment. Domestication selection results in elimination of individuals, some of which may be well adapted to the natural environment.

Economically sustainable management of forest and agricultural lands: Forestry and farming practices that are profitable and don't adversely affect the environment.

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.: N_e.

El Niño / 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 6-18 months. See also 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'.

Environmentally sound growth and water supply development: Land use and infrastructure development for urban, rural residential, commercial, and agriculutral purposes that is planned and carried out so that it does not adversely affect coho salmon habitat. Specific issues with potentially adverse effects on coho salmon habitat include removal of riparian vegetation, reduction of stream flows, increases in water temperature, introduction of barriers to passage, excessive sediment supply, depletion of spawning gravels, increases in pollutants, or harm to the geomorphologic charatersitics of coho streams.

Epibenthic: Belonging or pertaining to the top surface of the bottom sediment zone of a body of water.

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.

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. The number of individuals that would ensure population viability with a negligible probability of extinction over 100 years is difficult to calculate. Concurrent with the federal coho recovery process, population viability analysis will be used to determine the coho salmon population sizes required to reduce the risk of extinction to a negligble (insignificant) level.

Fecundity: In salmon, the number of eggs produced by a female.

Fishery: A resource exploitation system that includes a specific aquatic resource such as fish, a fishing community, and all biological, economic, and social factors affecting it.

FishNet 4C Program: The FishNet 4C program is a county-based salmonid protection and restoration program that brings together the six Central California Coastal counties of Mendocino, Sonoma, Marin, San Mateo, Santa Cruz, and Monterey to address county land management regulations and practices that may affect salmonid populations.

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.

Five Counties Salmonid Conservation Program: The Five Counties Salmonid Conservation Program is a county-based salmonid protection and habitat restoration program which includes Del Norte, Humboldt, Mendocino, Siskiyou and Trinity Counties.

Flood plain: Terrace of relatively smooth land adjacent to a river channel, constructed by the present river in its existing regime and covered with water when the river overflows its banks. A river has one flood plain and may have one or more terraces representing abandoned flood plains.

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.

Fresh water: Water containing only small quantities of dissolved salts and minerals.

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 (N_e) decreases.

Habitat essential (for coho salmon): Coho salmon habitat needed to recover coho salmon populations to a high enough level to reduce the risk of extinction to a neglible level. Essential habitat will be determined as part of the process outlined in Section 4.2 IV.

Hatchery-origin fish: Also called "hatchery fish". Fish that have spent some portion of their lives, usually their early lives, in a hatchery. (See natural-origin fish.)

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.

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.

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 Section 4.2.1, Recreational Fishing, this refers to coho salmon who die after being caught and released by anglers fishing for other species.

Incidental take: Unintended killing or harming of individuals of a threatened or endangered species associated with an otherwise lawful activity.

Interim actions: Actions contributing to recovery that will be immediate in their implementation. These actions may be of temporary duration to meet an urgent need or they may lay the groundwork for more longterm 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 evolve and spreading invasively with significant negative effects on native animal or plant species.

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.

Legacy effects: Unnatural landscape or ecosystem perturbations resulting from environmentally unsustainable historic human resource use.

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.

Metapopulation: A set of variously 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.

Milt: Sperm.

Monitoring: Scientific inquiry focused on evaluation of a program in relation to its goals (see Research).

Morphology: The physical shape of an organism and its parts.

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.)

Negligible probability of extinction: See 'Extinction risk'.

Non-native fish species: Fish species inhabiting an ecosystem where it did not naturally evolve.

Off-stream storage: Storage of ground or suface water in ponds, tanks or other surface or underground impoundments that are not directly connected to active stream channels.

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 6-18 months, PDO events origniate 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: (Synonym: Stock). A group of randomly interbreeding 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. A salmon population may consist of a single isolated run or more than one run with some degree of gene flow. Synonymous with “stock” in this document.

Population assessment: Determination of the presence, size, and distribution of populations of a species, including historic and current presence and abundance.

Population risk: Defined here as risks to coho salmon from human activities (state-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 size: (Synonym: Abundance). In this document, the number of fish (usually adult) in the population. Also called census size of the population.

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."

Professional fisheries scientist: A fisheries biologist who is certified by the American Fisheries Society or who has equivalent qualifications.

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.

Rearing habitat: Habitat supporting coho salmon during their first year of life in fresh water, before downstream migration.

Recovery: The re-establishment or rehabilitation of a threatened or endangered species to a self-sustaining level in its natural ecosystem at which its risk of extinction becomes negligible. The point defined by attainment of established recovery goals.

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.

Redd: Nest of a salmon, usually a depression within the gravel substrate of a stream, into which the female deposits her eggs.

Refugia: An area that consistently supports a coho salmon population (including both continued presence and adequate abundance) that can serve as a source to repopulate nearby streams. At the present time, primarily only presence/absence data are available to identify refugia.

Refugia watersheds: Defined here using presence of coho salmon, since abundance or population information is not available for all watersheds in the state. In the SONCC ESU, those watersheds having consistent presence of coho salmon greater than 50% are considered refugia. In the CCC ESU, those watersheds having consistent presence of coho salmon greater than 10% are considered refugia.

Registered geologist: Geologist holding a valid registration in California which means having a minimum of a bachelor's degree in geology and five years' experience at a professional level as well as passing the exam of the state licensing Board for Geologists and Geophysicists.

Reproductive isolation: Absence of gene flow between a population and other populations of the same species.

Research: Scientific inquiry focused on answering original questions. May consist of experiments or original descriptions of structures, relationships, and processes. (See Monitoring).

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 stream or river.

Riparian restoration: The re-establishment of a naturally functioning riparian zone, using techniques such as bank stabilization to reduce erosion, elimination of invasive non-native plant species, and planting of native plant species as necessary.

Riparian vegetation communities: The various plant species that are found growing in mixed patterns in the riparian zone.

Road assessment: The inspection of stream crossings (including culverts and bridges), road sufaces, associated cut and fill slopes, and drainage structures (cross drains and ditches) to determine existing or potential sources of sediment delivery due to improper design, structural failure, or lack of maintenance. Any barriers to fish passage caused by stream crossing structures is also determined. The assessment includes recommended measures for correcting any problems and may also include a

prioritization of work points or road stretches based on estimated volume of sediment delivery, proximity to fish-bearing streams, and potential for failure.

Run: The spawning adults of a given species that return to a stream during a given season.

Salmonid: Any fish species belonging to the Family Salmonidae, including salmon and trout.

Self-sustaining population: A population that perpetuates itself in the absence of human intervention, without chronic decline, and in its natural ecosystem, at levels sufficient to make listing under CESA unwarranted.

Short-term actions: Actions contributing to recovery that can commence immediately or in the near future (i.e., within 5 years).

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.

Slackwater: Any stretch of water having little or no current, such as on the inside of a river bend or a backwater or side channel with slow-moving flow.

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.

Spawn: The process of depositing eggs by a female fish and fertilization by a male.

Spawner: Male or female fish ready for or engaged in spawning.

Stock: See population.

Stock transfer: Human transfer of fish from one location to another, often between separate basins or ESUs.

S**tream buffer zone:** Riparian zone of specified width that is given some measure of protection from developmental activities such as logging or road construction.

Subsistence fishery: A fishery that serves only as a food source or as the basis for small-scale trading commerce for its fishing community.

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 .

Sustained increase: Consistent presence of positive change.

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.

Take: Under CESA **(**§ 86 of the Fish and Game Code), "take" is defined as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." The federal ESA defines “take”more broadly as “harrass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such activity.”

TMDL (Total Maximum Daily Load) process: The TMDL process was established by the Clean Water Act, Section 303(d) to guide application of state standards to protect the designated "beneficial uses" (e.g. fishing, swimming, drinking, fish habitat, agriculture, aesthetic, etc.) of individual water bodies/watersheds. In California, the development of TMDLs for a water body determined to be impaired

for given pollutants is accompanied by the development of a water quality attainment strategy that describes how water quality standards will be attained.

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.

Unnecessary and wasteful use of water: Article X §2 of the California Constitution requires "...that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare." What is considered wasteful or unreasonable is usually determined on a case-by-case basis by the SWRCB or the courts.

Watershed: The topographic region drained by or contributing water to a stream, river system, or lake.

Wetland habitat: Structural and chemical elements within wet areas that make them suitable for habitation by plants and animal species. The EPA and the U.S. Army Corps of Engineers define a wetland as made of "areas saturated by surface or ground water so that they support vegetation adapted for life in saturated soil conditions".

Yolk sac: An external pouch containing nutrients for the growing alevin. When the yolk sac is used up, the alevin is said to be "buttoned- up" and enters the fry stage.

C Other Species at Risk

CONSTRAINTS ON RECOVERY ACTIONS 1
OTHER AT-RISK SPECIES IN THE RANGE OF COHO SALMON 2
Trinity Bristle Snail (*Monadenia setosa*) 2
California Freshwater Shrimp *(Syncaris pacifica)* 2
Lost River Sucker (*Delistes luxatus*) 3
Shortnose Sucker (*Chasmistes breviorostris*) 3
Tidewater Goby (*Eucyclogobius newberryi*) 3
Green Sturgeon (*Acipenser medirostris*) 4
Steelhead *(Oncorhynchus mykiss)* 4
Chinook Salmon (*O. tshatwytscha*) - California Coastal ESU 4
Siskiyou Mountains Salamander (*Plethodon stormi*) 5
California Tiger Salamander (*Ambystoma californiense*) 5
California Red-legged Frog (*Rana aurora draytonii*) 5
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) 5
Greater Sandhill Crane (*Grus Canadensis tabida*) 6
California Brown Pelican (*Pelecanus occidentalis californicus*) 6
Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) 7
Willow Flycatcher (*Empidonax traillii*) 7
Northern Spotted Owl (*Strix occidentalis caurina*) 7
Marbeled Murrelet (*Brachyramphus marmoratus marmoratus)* 7
Western Snowy Plover (*Charadrius alexandrinus nivosus*) 8
Bank Swallow (*Riparia riparia*) 8
Bald Eagle (*Haliaeetus leucocephalus*) 8
California Clapper Rail (*Rallus longirostris obsoletus*) 9
California Black Rail (*Laterallus jamaicensis coturniculus*) 9
Point Arena Mountain Beaver (*Aplodontia rufa nigra*) 9
Salt-marsh Harvest Mouse (*Reithrodontomys raviventris*) 9

Recovery actions and activities for coho salmon have the potential to affect other species listed under the Federal Endangered Species Act of 1973, as amended (ESA)[16 USC §§1531 *et seq*.] and under the California Endangered Species Act (CESA)[Fish and Game Code §§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 recovery actions that can be used at a site. For example, vortex rock weirs are commonly used to improve pool development for juvenile coho (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 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 increases 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 consulation 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 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, 71Cal.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 Fish and Game Code sections 5515, 5050, 3511 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 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 ususally associated with pools 1-3 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. It is found in the Lost River system and the Upper Klamath River watershed. Undetermined populations are present in Copco and Iron Gate reservoirs; these populations are thought to maintained by fish entrained by the Klamath hydropower project

Maintaining lake levels to benefit suckers may, under certain conditions, impact the flows needed for coho salmon downstream. Screening water diversions to avoid entrainment of downstream migrant juvenile coho salmon would also avoid sucker entrainment.

Shortnose Sucker (*Chasmistes breviorostris*)

The shortnose sucker is listed as endangered under both ESA and CESA and it is a state fully protected species. Shortnose suckers are known to occur in the Upper Klamath River watershed with undetermined populations in Copco and Iron Gate reservoirs and most abundant populations in the Lost River system.

Maintaining lake levels to benefit suckers may, under certain conditions, impact the flows needed for coho salmon downstream. Screening water diversions to avoid entrainment of downstream migrant juvenile coho salmon would also avoid sucker entrainment.

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, personal communication 1/23/03).

In general, actions to restore coho salmon are not likely to impact tidewater goby, although efforts to protect and restore coho nursery habitat in estuaries is likely to have a positive influence on the preservation of goby habitat; this includes such actions as reestablishment 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 if 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 are presumed extant in the mainstem Klamath and Trinity river watersheds and possibly in the Eel River watershed.

Development of cold-water flows would decrease the incidence of disease outbreak and would benefit sturgeon in these systems. Implementing the Hardy Phase II flow regime in the Klamath River would give these fish greater access to the upper portion of the watershed for spawning. Control of upslope sedimentation through increased buffer areas and the reduction of human caused disturbances in unstable soil types. Also decreasing sediment input from existing roads by using the most recent sediment control solutions, by the decommissioning of unused roads targeting those within the riparian first, and when new roads are required building them near or on the ridge line to decrease sediment input into streams.

Steelhead *(Oncorhynchus mykiss)*

Northern California and Central California Coastal ESUs steelhead 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 their life stages would benefit both of these species.

Chinook Salmon (*O. tshatwytscha*) - 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 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. Within the range of the coho salmon, this listing does not include Humboldt, Trinity, and Mendocino counties, Sonoma County north of the Sonoma Creek and Petaluma River drainages, and Marin County north of the Walker Creek drainage. California red-legged frogs are associated with dense riparian vegetation closely associated with deep (>2 feet) still or slow moving water, and may estivate within 300 feet of a riparian area. The California red-legged frog is now found primarily in the wetlands and streams in the coastal drainages of central California and has a significant likelihood of co-occurring with coho salmon in the southern part of their range.

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 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. Presently, the range of the SFGS extends into northern Santa Cruz County, however known populations are relatively 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 habitat have the potential to take SFGS. For example, grading of hillslopes to reduce stream sedimentation attributable to gullying is an important activity for coho recovery in coastal San Mateo County but can crush SFGS estivating in rodent burrows.

Because of the potential for take of SFGS, planning for coho 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 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 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. 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 (below 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*)

Within the range of the coho, the willow flycatcher is listed as endangered under CESA. Protection and improvement of riparian habitat associated with coho 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 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.

Marbeled Murrelet (*Brachyramphus marmoratus marmoratus)*

The marbeled murrelet is listed as endangered under CESA and threatened under ESA. Activities to protect and restore coho 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 marbeled 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 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-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 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 nursery habitat in estuaries is likely to have a positive influence on the preservation of marsh habitat for this speices.

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 habitat (such 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 – April 15) or juvenile dispersal season (December 15 – 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 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 nursery habitat in estuaries may have a positive influence on the preservation of marsh habitat.

D Existing Watershed Programs, Groups, and Resources

Group	Name	Region Covered	Description
Agriculture Conservation Committee Plan	California Association of Resource Conservation Districts	Statewide	To provide information review programs and provide input which affect farmland loss. Strengthen assistance to farmers and ranchers to address invasive and endangered species regulations. Educate RCD directors, partners, and legislature on animal and land management.
AmeriCorps Watershed Stewards Project (WSP)	none listed	none listed	The AmeriCorps Watershed Stewards Project (WSP) has formed a collaborative with timber companies. Commercial and sport fishing industry representatives, teachers, community members, non-profit organizations, and public agencies to conserve, restore, and sustain natural anadromous habitats for future generations.
Bureau of Land Management-Arcata Field Office	Lynda Roush	Pacific Southwest Region	It is the mission of the Bureau of Land Management to sustain the health, diversity and productivity of the public lands for the use and enjoyment of present and future generations.
California Cattlemen's Association	Ben Higgins	none listed	CCA has sponsored workshops with the assistance of U. C. Cooperative Extension and Natural Resources Conservation Service on water quality since 1996. The recently developed Watershed Resource Guide encourages and assists the formation of watershed groups.
California Dairy Quality Assurance Program	Deanne Meyer	Statewide	Voluntary, industry driven, offers continuing education and farm certification in: Food Safety/Emergency Preparedness; Environmental Stewardship; Animal Welfare 3 Components of Certification; Producer education (ESSC I), Producer develops an Environmental Stewardship Farm Management Plan, Third party diary evaluation.

Group	Name	Region Covered	Description
California Watershed Assessment Manual	Fraser Shilling	North Coast, Central Coast, Central Valley, including the west-side Sierra Nevada. Other areas will be addressed in the next phase.	To assist watershed groups, local agencies, private landowners, and watershed specialists in assessing watershed condition. The manual will be a toolbox of approaches and protocols appropriate for analyzing a variety natural resource issues in creek and river basins throughout the state.
Central Coast Vineyard Team	Membership	Central Coast	The Central Coast Vineyard Team will identify and promote the most environmentally safe, viticulturally and economically sustainable farming methods, while maintaining or improving quality and flavor of wine grapes. The team will b ea model for wine grape growers and will promote the public trust of stewardship for natural resources.
Digger Creek Restoration	Mendocino Coast Botanical Gardens	Mendocino County	They have replaced a poorly functioning culvert with a bridge and plan to do additional work with a culvert replacement under Ocean Drive on the same stream.

Group	Name	Region Covered	Description
Eel River Action Plan (River Basin & Watershed Plans)	Yager/Van Duzen Environmental Stewards (YES) Five Counties Salmonid Conservation Program The Eel River Watershed Improvement Group (ERWIG) The Mainstream Eel River Group (MERG) CA Conservation Corp (CCC) The Americorp Watershed Stewards Project (WSP) The Round Valley Indian Tribe Six Rivers National Forest Land & Resources Management Plan, 1995 Humboldt Redwoods State Park General Plan, 2001 Bureau of Land Management	Eel River/Van Duzen Rivers	There are several examples of watershed groups on the Eel River. Landowners have come together to develop watershed plans in cooperation with local, state and federal agencies. The Humboldt and Mendocino Resource Conservation Districts are instrumental to the recovery of coho salmon. The Humboldt County RCD through the "Lower Eel Basin Watershed Organizational Support Project" directs assistance to landowners and landowner based watershed groups leading to resource conservation and fish habitat improvements. This has been a very successful program that matches 319(h) funds from the California Water Quality Control Board and other implementation funds to implement watershed improvement projects.
Eel River Watershed Improvement Group (ERWIG)	none listed	North Coast	The Eel River Watershed Improvement Group (ERWIG) was formed in 1997 to develop cooperative relationships and implement fishery improvement projects with landowners in the Eel River system. It is focused on the lower Eel, Van Duzen River, South Fork Eel and associated tributaries.
Fish Friendly Farming Program	Sotoyome Resource Conservation District	Southern Sonoma County	The program is a voluntary certification program for grape growers who implement land management practices that restore and sustain fish habitat on their property. There are 4 workshops that assist farmers in completing a farm conservation plan using the programs Beneficial Management Practices for soil conservation, slopes, chemical use, water conservation, roads, erosion repairs, and an assessment and restoration of creek & river riparian corridors.

Group	Name	Region Covered	Description
Five Counties Salmonid Conservation Program	none listed	Del Norte, Humboldt, Mendocino, Siskiyou and Trinity Counties	The program is the first multiple country, watershed based conservation strategy formed in California to address the biological, watershed, political, social and economic effects of declining salmonid populations.
Gold Ridge RCD	Joe Pozzi	Western Sonoma County	The mission of the Gold Ridge RCD is to assist landowners in addressing their environmental concerns by maintaining a presence in natural resources conservation work in all watersheds within the District, to help involve landowners in Natural Resource Conservation Service projects and to provide a conduit for landowners through which state and federal monies can be obtained to support and implement restorative programs and practices.
Handbood for Prioritizing Watershed Protection and Restoration to Aid Recovery of Native Salmon (1995)	Dr. Willa Nehlsen	Pacific Northwest	Protecting and restoring watersheds is a key component to recovering salmon and other native fishes. With that goal in mind, in May 1994 Oregon State Senate President Bill Bradbury asked the Pacific Rivers Council for help in assembly a group to create a process for effective and scientifically-sound watershed protection and restoration.
Humboldt Bay Watershed Advisory Committee	none listed	Humboldt County	HBWAC has worked since 1997 to plan and guide cooperative salmon conservation efforts between local stakeholders while also considering regional ecological and socio-economic needs. They have recently prepared a conservation plan for salmon and steelhead trout.
Humboldt Bay Watershed Enhancement Program	none listed	Pacific Southwest Region	The Humboldt Bay Watershed Enhancement Program is a cooperative effort coordinated by the Natural Resources Services Division of Redwood Community Action Agency that involves timber companies, watershed restoration groups, contractors, a land trust, educators, volunteer monitors, private landowners, and government agencies. This program focuses on improving water quality and anadromous fisheries habitat within the Humboldt Bay watershed. The program is funded by the Environmental Protection agency grant program through the Calif. State Water Resources Control Board.

Group	Name	Region Covered	Description
Humboldt Resource Conservation District	none listed	none listed	The Humboldt Resource Conservation District directs assistance to landowners and landowner based watershed groups leading to resource conservation and fish habitat improvements. Projects include the Lower Eel Basin Watershed Organizational Support Project to provide direct assistance to landowner based groups in the Middle and Lower mainstem Eel River and delta of the Van Duzen River, and South Fork Eel River Watersheds. Projects implemented include management of dairy wasted, stream bank erosion and riparian restoration,
Large Woody Debris in N. Coast Streams Conference	Gary Nakamura	North Coast Streams	A conference on measurement, monitoring & management of large woody debris in N. Coast Streams and to improve understanding of the complexities involved in large woody debris (LWD) management that will assist in better restoration with the right approaches in the right places.
Lindsay Creek Working Group	none listed	Mad River HU	Works to protect and restore watershed processes in this sub watershed.
Management Practices to Protect Water Quality	Central Coast Vineyard Team	Central Coast	View CCVT's demonstration sites and see how they held up through the first year of the project. Discuss seed selection, planting methods, and costs for establishing cover and preventing erosion in order to comply with Clean Water Act regulations.
Mattole Restoration Council	none listed	Cape Mendocino	The Mattole Restoration Council has performed habitat assessment from 1988 through 1994 and published "Good Roads, Clear Creeks."
Mattole Salmon Group	Mattole Salmon Group	Cape Mendocino	This citizen-run group was formed in 1980, has conducted spawning surveys since that time and has documented down-migration through migrant trapping. They raised coho salmon via hatch boxes and placed in streams. This group is part of the DFG Cooperative Trapping and Rearing Program. Produced with DFG a five-year plan that provides guidance to the cooperative rearing and rescue projects.
Mendocino County Gualala River Voluntary Watershed Group	none listed	North Coast, Mendocino County	Gualala River-Landowners from Mendocino and Sonoma Counties are members of the Gualala Council, which is supported by the Sonoma Sotoyome RCD Staff.

Group	Name	Region Covered	Description
Mendocino County Garcia River Voluntary Watershed Group	Larry Mailliard	North Coast, Mendocino County	Garcia River-no staff, landowners group acting on their own, participated with UCCE to do research project on in-stream temperature monitoring with partial funding from CFBF, study to be released after per review.
Mendocino County Lower Albion Voluntary Watershed Group	Mike Jani	North Coast, Mendocino County	Lower Albion - no description of project
Mendocino County Navarro River Voluntary Watershed Group	Peter Bradford	North Coast, Mendocino County	Navarro River-landowners group - no staff
Mendocino County RCD Watershed Information Sharing Project	none listed	North Coast, Mendocino County	The RDC continues to develop working landowner watershed groups to increase resource conservation activities and education. The mission of MCRCD is to provide local leadership in the conservation of soil, water, and related natural resources through programs and partnerships with individuals, businesses, organizations and government.
Mendocino County Resource Conservation Restoration Projects	Janet Olave	SEE BELOW	The Mendocino County RCD has been in existence since 1945 and through the years has worked diligently to develop trusting relationships and strong partnerships with landowners, watershed groups, organizations, and government to accomplish conservation goals
Mendocino County Resource Conservation Restoration Projects	Janet Olave	Garcia Basin	Bluewaterhole Creek road related sediment delivery reduction project and implement water quality monitoring activities in five other tributaries over two year.

Group	Name	Region Covered	Description
Mendocino County Resource Conservation Restoration Projects	Janet Olave	Navarro Basin	Complete the initial Navarro Implementation Plan and begin the second phase, initiate the Robinson Creek Restoration project and Lower Indian Creek Restoration projects, implement the Arundo Eradication project, complete sediment reduction projects on Holmes Ranch Road, Hungry Hollow, and Bates Road, implement the Mendocino Natives Nursery to establish a self-sustaining local business that provides native plants for riparian improvement, complete the Mill Creek Monitoring project, and complete and promote the Streamlined Permitting project.
Mendocino County Resource Conservation Restoration Projects	Janet Olave	Coastal Rivers Basin	Continue to explore conservation activities and support the work of the Noyo Watershed Alliance as requested.
Mendocino County Resource Conservation Restoration Projects	Janet Olave	Eel River Basin	Cooperate with Humboldt County RCD to continue to assist local South Fork Eel landowners develop restoration plans. Promote project effectiveness study conducted in String Creek and Streeter Creek.
Mendocino County Resource Conservation Restoration Projects	Janet Olave	Russian River Basin	Complete Feliz Creek Riparian Restoration and Fish Habitat Improvement project, complete NcNab Ranch Road Assessment and secure funding for implementation, initiate Forsyth Creek Assessment project and seek implementation funding sources, continue the sponsorship of the Watershed Coordinator and participate in the Russian River Watershed Council. Work with Soyotome RCD continuing to promote Fish Friendly Farming Techniques. Continue to work with landowners and watershed groups to identify other projects in the watershed.
Mendocino County Upper Albion Voluntary Watershed Group	George Hollister	North Coast, Mendocino County	Upper Albion-landowners group-no staff-no description of project

Group	Name	Region Covered	Description
Mendocino County Voluntary Watershed Groups	Margaret Perry	Mendocino County	Ten Mile River Forest Landowners Association-The purpose of the association is, through cooperative self-help, to maintain, coordinate and facilitate the efforts of individual non-industrial landowners with Non-industrial Timber Management Plans who are interested in protecting, managing and improving their land, resources and the associated environment for the control of potential sources of nonpoint pollution, protection of surface and groundwater quality, and enhancement of aquatic habitat for native aquatic species.
Mendocino County Willits Voluntary Watershed Groups	Erlyne Schmidbauer	North Coast, Humboldt County	Willits-landowners group-Fish & Game funds for Davis Creek assessment through ERWIG out of Humboldt County-very large area with sub groups-drainage to the Eel River.
Rangeland Water Quality Shortcourse	Dr. Mel George, UCCE Range Specialist	Statewide	Statewide Survey to Evaluate: >Management practice implementation. >Reasons for implementation-document behavioral changes made after attending course. > Financial contributions to water quality management. >Impacts beyond 1.2 million acres. >753 surveys mailed 9/02-10/02 >35% return rate >Results: Ranch plan completed = 57% Practices implemented: 70% >Ranch Plan not completed= 43% Practices implemented: 40%
Rangeland Water Quality Shortcourse		Statewide	See above
Rangeland Water Quality Shortcourse		Statewide	See above
Rangeland Water Quality Shortcourse		Statewide	See above
Redwood Creek Landowners Association	none listed	Redwood Creek HU	Inventoried their properties with follow up upgrading and decommissioning of roads throughout the watershed to reduce future sediment impacts.

Group	Name	Region Covered	Description
Removing Barriers to Restoration	Report of the Task Force to the Secretary for Resources	Statewide	Private landowners, watershed groups and other local stakeholders have a critical role to play in achieving California's conservation goals. To that end, the Task Force to Remove Barriers to Restoration was convened to provide guidance to the Resources Agency and other state agencies to work more effectively with California's landowners to restore our natural resources. In order to generate creative solutions to these concerns, representatives from landowner groups, State agencies and the professional restoration community met four times to examine barriers to restoration, identify options for fixing them, and recommended specific actions to move the best ideas forward.
San Luis Obispo County Farm Bureau Agricultural Watershed Program and Watershed Working Groups	San Luis Obispo County Farm Bureau	San Luis Obispo County	The County Committee is responsible for helping individual watershed working groups (the landowners on the individual streams and watersheds) organize, develop their plans, find financial assistance, and correlate the date. The County Committee is the liaison to the regulatory agencies.
Sotoyome Resource Conservation District Watershed Information Sharing Project		Sonoma County	The purpose of the District is to focus on soil, water, and related natural resource problems within the District; to develop programs to help solve those problems; and to enlist coordinate assistance from private and public agencies that can contribute to accomplishing sound land use. Voluntary activity is a key component to the workings of an RCD. Being non-regulatory, RCD's are the only grassroots conservation delivery system that works cooperatively with multiple agencies and interest groups to identify problems and guide voluntary solutions to these problems.
Southern Sonoma County RCD	Paul Sheffer	Southern Sonoma County	The SSCRCD, in cooperation with local landowners, created and published the Petaluma Watershed Enhancement Plan. This plan created the formation of the Petaluma Watershed Council dedicated to addressing the problems and questions facing the Petaluma Watershed.
Southern Sonoma County RCD	Allison Herman	Southern Sonoma County	In 1997, the SSCRCD prepared and distributed the Sonoma Creek Watershed Enhancement Plan. Since then the District has been busy implementing the plans goals and objectives as funding has allowed. Projects included Sonoma Creek Habitat Inventory, streambank stabilization and riparian corridor enhancement projects along Carriger and Nathanson creeks, and installation and maintenance of wood duck nesting boxes as well as other successful projects.

Group	Name	Region Covered	Description
Southern Sonoma County RCD	Chris Delaney	Southern Sonoma County	The Stemple Creek Watershed Enhancement Plan was completed in 1994. Beginning in 1996 and continuing into 1997, the RCD completed a number of fencing projects for riparian habitat enhancement and erosion control for property owners along Stemple Creek. Project partners included Partners for Wildlife, the Sonoma County Fish & Wildlife Advisory Board and the Coastal Conservancy. In 1996, the RCD developed a model Dairy Construction Plan with landowners McClelland and Moretti. Another RCD partner, STRAW, created the "shrimp club" to assist local efforts i restoring habitat to enhance viability of the CA freshwater shrimp. In total, six miles of Stemple Creek has been restored collectively by all these partners.
Stream Steward Restoration Guide A Small Woodland Owners Guide to Stream Habitat Restoration	American Tree Farm System		The Stream Steward Restoration Guide provides Tree Farmers with a "crash course" in the basics of stream restoration. Since 1997 The American Tree Farm System and Trout Unlimited have worked together on Shared Streams projects that bring together tree farmers and fisheries and forestry experts to help restore and protect targeted watershed and their wildlife populations.
Sustainable Viticulture Program	California Association of Winegrape Growers	Central Coast, Sierra foothills, Central Valley	Sustainable agriculture integrates three main goals—environmental health, economic profitability, and social and economic equity. Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. Key themes in sustainable agriculture include:· economic profitability (marketing and business planning, pricing structures, ag policy) · stewardship of both natural resources (soil, air and water resources, ecosystem health)· human health and well-being (working and living conditions for laborers, the needs of rural communities, and consumer health and safety)· systems perspective (allows a larger and more thorough view of the consequences of farming practices on both human communities and the environment, and provides tools to explore the interconnections between individual farms, the local ecosystem, and larger communities and ecosystems)· interdisciplinary efforts in research and education (input and cooperation among researchers and educators from various disciplines, farmers, farmworkers, consumers, policymakers and others)

Group	Name	Region Covered	Description
Ten Mile River Forest Landowners Association	Nan Deniston		The purpose of the association is, through cooperative self-help, to maintain, coordinate, and facilitate the efforts of individual non-industrial landowners with Non-Industrial Timber Management Plans who are interested in protecting, managing and improving their land, resources and the associated environment for the control of potential sources of nonpoint pollution, protection of surface and groundwater quality, and enhancement of aquatic habitat for native aquatic species.
The California Freshwater Shrimp Project Publication	Laurette Rogers	Marin, Sonoma, Napa Counties	In 1993 a group of 4th grade students initiated "The California Freshwater Shrimp Project." To help preserve this endangered species they worked with ranchers to restore a creek habitat, presented to over 1,500 teachers and businesspeople, launched a media campaign, obtained over $100,000 in grants and awards, and applied academic skills to "real world" situations. The principles of project-based learning is discussed so that it can be applied to a variety of other situations.
The Fortuna Project	none listed	Humboldt County	The Fortuna Creeks project is a comprehensive watershed monitoring and restoration project for high school students, who conduct water quality testing, aquatic macroinvertebrate sampling and habitat typing for the lower Eel and Van Duzen Rivers. They also do bi-yearly creek clean-ups, increase public awareness about creek care and plant trees to bring back natural creek habitat and participate in spawner surveys to help monitor the local salmon population.
The Klamath Resource Information System The Ultimate Watershed Information Tool	Kier Associates	Klamath Basin	KRIS was developed by the fisheries and watershed professionals at Keir Associates, consultants in watershed and fish habitat assessment, restoration planning and implementation. This team is eager to bring KRIS' extraordinary date management power to the support of agency, landowner, and community watershed and fisheries protection and restoration programs.
The Mainstream Eel River Group (MERG)	none listed	North Coast	The Mainstream Eel River Group (MERG) works to educate and assist community members on salmonid restoration issues through the development and implementation of restoration projects. MERG works on the central mainstem from Dobbyns to Kekawakee.

Group	Name	Region Covered	Description
The STRAW Project (Students and Teachers Restoring a Watershed)	Laurette Rogers	Marin, Sonoma, Napa Counties	The STRAW Project evolved out of the student-initiated Shrimp Project, which connected students and teachers with ranchers in order to restore creek habitat. More than half of all STRAW restorations occur on ranchland with the ranchers serving as teachers, leaders and partners. Since 1993, classes of students have worked with teachers, ranchers biologists and community members to help save endangered species in the North Bay through watershed restoration.
Tomales Bay Watershed Council	none listed	Tomales Bay	Tomales Bay Watershed Council has prepared the Preliminary Tomales Bay Watershed Stewardship Plan.
Water Quality and You: A special educational series	Western Shasta Resource Conservation District	Shasta County	Special Educational Series on Water Quality & You, created for the Cow Creek Watershed residents, landowners, and stakeholders funded by the David and Lucille Packard Foundation for the Western Shasta Resource Conservation District.
Water Resource Committee	California Association of Resource Conservation Districts	Statewide	Provide information & review current programs to provide for holistic water management. Strengthen and educate local leadership of Resource Conservation Districts to address water issues. Provide information and assessments which are available at the local level.
Watershed Alliance Council	Steven Day	North Coast	Biodiversity conservation planning and monitoring with citizen participation and access to Geographic Information System (GIS) in the California North Coastal Basin.
Watershed Alliance Council	Tim McKay	North Coast	Regional environmental education and activism. Work to educate, agitate and where necessary litigate to achieve protection and improvement for water quality and endangered salmonids. Publish "Econews" and produce "Econews Report."
Watershed Alliance Council	Kim Rodriquez	Northern Klamath area	none given
Watershed Alliance Council	Tom Weseloh	none listed	none listed
Watershed Alliance Council	Mark Bergstrom	none listed	none listed

Group	Name	Region Covered	Description
Watershed Alliance Council	Danielle Gainok	North Coast	The Humboldt Fish Action Council is a 501 (c)(3) non-profit organization concerned with the survival of Northern CA's salmon populations. We are currently funded through the CA Salmon Stamp program to artificially propagate chinook salmon on Freshwater Creek, tributary to Humboldt Bay. We are also involved in monitoring local salmon and steelhead populations, making available life stage specific data for management and conservation of salmonids in Freshwater Creek.
Watershed Alliance Council	Ellen Fred	North Coast	Residents, property owners, concerned citizens protecting local watersheds.
Watershed Alliance Council	Larry Margler	North Coast	none listed
Watershed Improvement Network (WIN)	Save Our South Bay Wetlands	Pacific Southwest Regiion	Of San Francisco Bay's 200,000 acres of original wetlands, only 37,000 acres remain. Besides wildlife, these remaining wetlands and marshes are essential for pollution control, flood control, ground water rechard and saltwater intrusion control. Many of these remaining wetland parcels are proposed for development. SOS Bay Wetlands is acting to protect these wetlands and the quality of life they represent before they disappear.
Watershed Improvement Network (WIN)	Karen Solari	Pacific Southwest Regiion	The Six Rivers National Forest is one of 18 national forests in the Pacific Southwest Region of the US Department of Agriculture-Forest Service. The eighteen national forests in California cover only 20% of the land in the State but produce almost half the States runoff water. Because so much of California's water comes from the national forests, the health of our forest ecosystems and watersheds is critical. Many of California's national forests were created specifically to safeguard and preserve water supplies.
Watershed Management-education program through UC Davis	University of California Cooperative Extension	Statewide	The Watershed Advisor collaborates with landowners, watershed-planning groups & resource agencies to develop and implement scientifically sound watershed management plans & policies.

GROUP	NAME	REGION COVERED	DESCRIPTION
Watershed Processes and Erosion Control: A Workbook and Compendium *A Report of the FFFC Technical Committee*	The Fish, Farm and Forest Communities Forum (FFFC)	Statewide	The FFFC has three primary goals: 1) to facilitate the recovery of salmon and steelhead stocks in California, 2) to implement recovery measures voluntarily and proactively in cooperation with state and federal agencies based on the best available scientific evidence, and 3) to work towards those recovery programs which are the most cost effective and promote ecological, and social stability.
Wild on Watersheds	California Association of Resource Conservation Districts	Statewide	The program is a voluntary educational program to encourage a hands-on participation in watershed management.
Wolverton Gulch/Cummings Creek	none listed	none listed	Landowners on Wolverton Gulch and Cummings Creek have participated in restoration projects on their properties.
Yager/Van Duzen Environmental Stewards (YES)	none listed	none listed	YES is a group of landowners and resource managers working in Yager Creek, North Fork Yager Creek, Middle Fork Yager Creek, South Fork Yager Creek and the middle section of the Van Duzen River and associated tributaries. An inventory of 420 miles of roads will be completed in the spring of 2003 on YES member lands. All members must have a Water Quality Management Plan that has Best Management Practices designed to protect water quality.
Yurok Tribal Fisheries Program	none listed	Klamath Basin	They have developed a comprehensive watershed restoration plant for the lower Klamath River.
The Watershed Improvement Network	Ruth Blyther	Humboldt County	The Watershed Improvement Network is a collaborative alliance of watershed restorationists, planners, and managers throughout Humboldt County. Participants include citizens groups, private landowners, government agencies, private industry, native American tribes, educators, and small business owners. The long-term goal of the WIN project is to improve the health and productivity of Humboldt County's natural resources and economy.

E CALWATER Units

The CALWATER 2.2a system is the standard watershed mapping system used by the State of California. The CALWATER classification system includes (from largest to smallest) hydrologic regions, hydrologic units, hydrologic areas, hydrologic sub-areas, and planning watersheds. The following list includes the CALWATER units in the SONCC and CCC coho ESUs.

Hydrologic Unit (HU)	Hydrologic Area (HA)	Hydrologic Sub Area (HSA)	ESU
Winchuck River	Winchuck River	Winchuck River	SONCC
Rogue River	Illinois River	Illinois River	SONCC
	Applegate River	Applegate River	SONCC
Smith River	Lower Smith River	Smith River Plain	SONCC
		Rowdy Creek	SONCC
		Mill Creek	SONCC
	South Fork Smith River	South Fork Smith River	SONCC
	Middle Fork Smith River	Middle Fork Smith River	SONCC
	North Fork Smith River	North Fork Smith River	SONCC
	Wilson Creek	Wilson Creek	SONCC
Klamath River	Lower Klamath River	Klamath Glen	SONCC
		Orleans	SONCC
	Salmon River	Lower Salmon	SONCC
		Wooley Creek	SONCC
		Sawyers Bar	SONCC
		Cecilville	SONCC
	Middle Klamath River	Ukonom	SONCC
		Happy Camp	SONCC
		Seiad Valley	SONCC
		Beaver Creek	SONCC
		Hornbrook	SONCC
		Iron Gate	SONCC
		Copco Lake	SONCC
	Scott River	Scott Bar	SONCC
		Scott Valley	SONCC
	Shasta Valley	Shasta Valley	SONCC

Hydrologic Unit (HU)	Hydrologic Area (HA)	Hydrologic Sub Area (HSA)	ESU
Trinity River	Lower Trinity River	Hoopa	SONCC
		Willow Creek	SONCC
		Burnt Ranch	SONCC
		New River	SONCC
		Helena	SONCC
	South Fork Trinity River	Grouse Creek	SONCC
		Hyapom	SONCC
		Forest Glen	SONCC
		Corral Creek	SONCC
		Hayfork Valley	SONCC
	Middle Trinity River	Douglas City	SONCC
		Weaver Creek	SONCC
	Upper Trinity River	Upper Trinity River	SONCC
Redwood Creek	Orick	Orick	SONCC
	Beaver	Beaver	SONCC
	Lake Prairie	Lake Prairie	SONCC
Trinidad	Big Lagoon	Big Lagoon	SONCC
	Little River	Little River	SONCC
Mad River	Blue Lake	Blue Lake	SONCC
	North Fork Mad River	North Fork Mad River	SONCC
	Butler Valley	Butler Valley	SONCC
	Ruth	Ruth	SONCC
Eureka Plain	Eureka Plain	Eureka Plain	SONCC
Eel River	Lower Eel River	Ferndale	SONCC
		Scotia	SONCC
		Larabee Creek	SONCC
	Van Duzen River	Hydesville	SONCC
		Bridgeville	SONCC
		Yager Creek	SONCC
	South Fork Eel River	Weott	SONCC
		Benbow	SONCC
		Laytonville	SONCC
	Middle Main Eel River	Sequoia	SONCC
		Spy Rock	SONCC
	North Fork Eel River	North Fork Eel River	SONCC
	Upper Main Eel River	Outlet Creek	SONCC
		Tomki Creek	SONCC
		Lake Pillsbury	SONCC
	Middle Fork Eel River	Eden Valley	SONCC
		Round Valley	SONCC
		Black Butte River	SONCC
		Wilderness	SONCC

Hydrologic Unit (HU)	Hydrologic Area (HA)	Hydrologic Sub Area (HSA)	ESU
Cape Mendocino	Oil Creek	Oil Creek	SONCC
	Capetown	Capetown	SONCC
	Mattole River	Mattole River	SONCC
Mendocino Coast	Rockport	Usal Creek	CCC
		Wages Creek	CCC
		Ten Mile River	CCC
	Noyo River	Noyo River	CCC
	Big River	Big River	CCC
	Albion River	Albion River	CCC
	Navarro River	Navarro River	CCC
		Greenwood Creek	CCC
		Elk Creek	CCC
		Alder Creek	CCC
	Point Arena	Brush Creek	CCC
	Garcia River	Garcia River	CCC
	Gualala River	North Fork	CCC
		Rockpile Creek	CCC
		Buckeye Creek	CCC
		Wheatfield Fork	CCC
		Gualala	CCC
	Russian Gulch	Russian Gulch	CCC
Russian River	Lower Russian River	Guerneville	CCC
		Austin Creek	CCC
	Middle Russian River	Laguna	CCC
		Santa Rosa	CCC
		Mark West	CCC
		Warm Springs	CCC
		Geyserville	CCC
		Sulphur Creek	CCC
	Upper Russian River	Ukiah	CCC
		Coyote Valley	CCC
		Forsythe Creek	CCC
Bodega	Salmon Creek	Salmon Creek	CCC
	Estero Americano	Estero Americano	CCC
	Estero San Antonio	Estero San Antonio	CCC
	Bodega Harbor	Bodega Bay	CCC
Marin Coastal	Tomales Bay	Walker Creek	CCC
		Lagunitas Creek	CCC
		Inverness	CCC
	Point Reyes	Drakes Estero	CCC
	Bolinas	Bolinas	CCC

Hydrologic Unit (HU)	Hydrologic Area (HA)	Hydrologic Sub Area (HSA)	ESU
San Mateo	San Francisco Coastal	San Francisco Coastal	CCC
	San Mateo Coastal	Pacifica	CCC
		Half Moon Bay	CCC
		Tunitas Creek	CCC
	San Gregorio Creek	San Gregorio Creek	CCC
	Pescadero Creek	Pescadero Creek	CCC
	Año Nuevo	Año Nuevo	CCC
Bay Bridges	San Rafael	San Rafael	CCC
	Berkeley	Berkeley	CCC
	San Francisco Bayside	San Francisco Bayside	CCC
South Bay	East Bay Cities	East Bay Cities	CCC
	Alameda Creek	Alameda Creek	CCC
	San Mateo Bayside	San Mateo Bayside	CCC
Santa Clara	Fremont Bayside	Fremont Bayside	CCC
	Coyote Creek	Coyote Creek	CCC
	Guadalupe River	Guadalupe River	CCC
	Palo Alto	Palo Alto	CCC
San Pablo	Novato	Novato	CCC
	Petaluma River	Petaluma River	CCC
	Sonoma Creek	Sonoma Creek	CCC
	Napa River	Napa River	CCC
	Pinole	Pinole	CCC
Suisun	Fairfield	Benicia	CCC
		Suisun Creek	CCC
		Suisun Slough	CCC
		Grizzly Island	CCC
		Grizzly Island - in Delta	CCC
		Suisun Slough - in Delta	CCC
	Concord	Pittsburg	CCC
		Walnut Creek	CCC
		Martinez	CCC
		Pittsburg - in Delta	CCC
Big Basin	Santa Cruz	Davenport	CCC
		San Lorenzo	CCC
		Aptos-Soquel	CCC

F Watershed Prioritization

This document describes the data, processes, and methods used in getting to the Watershed Prioritization used by the CRT. It also discusses the limitations of the data and methods, and thus, the limitations of the results.

DATA USED IN THE ANALYSIS

Four maps were generated to implement the prioritizatin. This section describes each of these maps.

MAP 1: CONSISTENT PRESENCE

What: Shows the percentage of streams surveyed, in each HSA (Hydrologic Sub-Area), that have consistent presence of coho salmon over 2 or 3 years.

Data: Coho Presence/Absence (P/A) tables found in the Coho Recovery Team Watershed Summaries (provided by the regions)

Analysis: Since many of the watersheds had only 2 years of P/A data (2001 and 2002), the analysis was based on only the 2 years that were found consistently across all CALWATER hydrologic sub-area (HSA) watersheds. A handful of watersheds had additional years, and in those cases 2000 data was included.

Consistent Presence was defined as "surveyed and found in more than one of the 2 or 3 years of survey results, or surveyed and found in the only year surveyed." Then, by counting the number of streams surveyed per watershed (HSA), a percentage of consistent presence (Consistent Presence in 2 of 8 streams surveyed in that watershed = 25% Consistent Presence) was calculated.

Results were grouped into 6 rankings:

0 = No surveys in this watershed
1 = Streams surveyed, but no coho found
2 = Coho 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 2 YEARS' OF SURVEY RESULTS

CONSISTENT PRESENCE?	YEAR	YEAR
N	-	-
N	A	-
N	A	A
N, but coho found	P	A
Y	P	-
Y	P	P

FOR STREAMS WITH 3 YEARS' OF SURVEY RESULTS

CONSISTENT PRESENCE	YEAR	YEAR	YEAR
N	-	-	-
N	A	(A)	(A)
N, but coho found	P	A	-
N, but coho found	P	A	A
Y	P	P	A
Y	P	-	-
Y	P	P	-
Y	P	P	P

Limitations: This map was produced using presence/absence data, not abundance data. So it doesn't represent the total numbers of fish in any given HSA, just that they were there. Also, since a consistent field data capture technique was used only in recent years, there is only 2-3 years of data to look at, which limits the scope of the results. Finally, this map only shows where streams have been surveyed and whether coho 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 1 or 2 streams surveyed and could receive a 50% or 100% Consistent Presence with only 1 or 2 streams having coho presence, while other HSAs had 20+ streams surveyed and could have many more streams with coho 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 were most likely to be found, and it was assumed that there are very few additional streams that could have been surveyed where coho would have been found.

MAP 2: COHO POPULATION AND RISK

What: Shows the combination of Coho Population factors and Risk factors by HSA.

Data: This map represents the compilation of several data sources. See below for details on the 6 combined analyses used.

Analysis: The rankings for the 3 coho population factors were first added together, and then the 3 risk factor rankings were added together and divided by 3. 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 6 separate analysis (3 for coho population factors, and 3 for risk factors). See below for specific limitations on each of these.

Compiled Analysis: The following 6 items represent individual analyses that all went into the Coho Population and Risk Map. All of these analyses involved assigning a score to each HSA and then grouping the scores into ranks (usually 1-5). Since there are many factors that differ between the 2 ESUs (ecologically significant unit), these range breaks were often created separately for each ESU (3, 4, and 6).

1. **Consistent Presence** – see previous map

2. **Isolation Index**

Data: CALWATER 2.2 watersheds and 'Consistent Presence' data created from Presence/Absence data from Coho Recovery Team Watershed Summaries.

Analysis: This analysis assessed the geographic isolation of every watershed (HSA) that had any level of 'consistent presence' (codes 3, 4, or 5). To accomplish this, the following was done for each watershed that fell into this category:

1. Selected all watersheds within the same Hydrologic Unit (HU) that were at least partially within a 5 mile radius of the boundary of the selected watershed.

2. Summed the area of all of the selected border watersheds.

3. Summed the area of all of the selected border watersheds 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' watersheds, 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 HSA watersheds to other HSA watersheds within the larger HU watershed unit. It does not look at direct hydrologic connectivity, but at clusters of HSA that eventually drain to the same point.

3. Run Length

Data: 100K DFG Streams layer from Eric Haney (Region 1)

Analysis: For this analysis we first took the downstream stream length from the output point of each watershed (HSA) to the mouth (ocean or SF Bay). We then added a 'pseudo radius' value was calculated for each watershed based on its area. This addition created a run length that pushed partially into the watershed, and it also gave us run lengths for coastal watersheds that otherwise would have received a zero value. We then grouped the results into rankings based on 5 categories (different ranges for the 2 ESUs).

High rankings were given to both very short and very long runs, with the assumption that these represented potential unique populations of coho.

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 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) was calculated.

4. Census Population Density

Data: Year 2000 Census Data from DFG library (by Census Tract)

Analysis: For this analysis the existing Density Class field (1-10) was used in the data, 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 5 rankings for each ESU.

Limitations: A risk to the coho population is inferred based on the density of people. While the Census data are fairly accurate, the relationship of human density to coho 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, 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 almost all water diversions from streams. However, what they doesn't 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 DFG library (USGS DLG data by county)

Analysis: Miles of roads per watershed (HSA) were counted and then divided by total square miles per watershed to get a miles/sq mile figure. The results were then grouped into 5 rankings for each ESU.

Limitations: The 100K Roads data used for this analysis are the best available for the whole coho 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.

MAP 3: PRIORITIZED WATERSHEDS FOR MANAGEMENT ACTIONS

What: Shows the combination of Coho 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 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 3 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 3 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 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 Population and Risk. In addition, the 3 ranks collected from Department field staff are subjective.

MAP 4: DISCONNECTED HABITAT

What: Shows the amount and type of stream barriers to coho migration.

Data: These data are based on the professional opinion of DFG 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 habitat

0 = natural, permanent, or year-round barrier to coho migration

1 = an extremely large barrier (i.e. 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 habitat

4 = a few barriers need to be removed or modified to allow all life stages passage to existing coho habitat

5 = none to very few barriers need to be removed or modified to allow all life stages passage to existing coho habitat

Limitations: The data for this map are based on professional opinions from Department field staff and are subjective.