

Redwood Creek
Integrated Watershed Strategy






June 22, 2006

Redwood Creek Watershed Group

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Abbreviations and Acronyms

AOI	Agreement of Intent
ASBS	Area of Special Biological Significance
BF	Benefit Factor
BLM	Bureau of Land Management
BMP	Best Management Practices
CALTRANS	California Department of Transportation
CCA	Critical Coast Area
CDBG	California Dept. of Housing and Community Development Block Grant Program
CEQA	California Environmental Quality Act
DCR	Disadvantaged Community Ratio
cfs	cubic foot per second
CDPR	California Department of Parks and Recreation
CDF	California Department of Forestry and Fire Protection
CDFG	California Department of Fish and Game
Corps	U.S. Army Corps of Engineers
DTB	Dyet T and Bhatia Urban and Regional Planners
DWR	Department of Water Resources
EIS/EIR	Environmental Impact Statement/Environmental Impact Report
IRWM	Integrated Regional Water Management
FEMAT	Forest Ecosystem Management Assessment Team
FMTF	California Flood Management Task Force
HC	Humboldt County
HSU	Humboldt State University
GMP/GP	General Management Plan/General Plan
IWS	Integrated Watershed Strategy
LWD	Large Woody Debris
MHI	Median Household Income
MWA	Mendocino Water Agency
NEPA	National Environmental Policy Act
NCRWQCB	North Coast Regional Water Quality Control Board
NCWAP	North Coast Watershed Assessment Program
NMFS	National Marine Fisheries Service; NOAA Fisheries
NOAA	National Oceanic and Atmospheric Administration; NOAA Fisheries
NPS	National Park Service
NRLT	North Coast Regional Land Trust
OCSD	Orick Community Services District
OLA	Oscar Larson and Associates
PCFWWRA	Pacific Coast Fish, Wildlife and Wetlands Restoration Association
POTW	Publicly-Owned Treatment Works
RCWG	Redwood Creek Watershed Group
RFMF	Reduced Funding Match Factor
RI	Recurrence Interval
RNP	Redwood National Park
RNSP	Redwood National and State Parks
RUS	Rural Utilities Division of USDA
SCC	California Coastal Commission
SHN	SHN Consulting Engineers & Geologists, Inc
SMZ	Stream Management Zone
SPARC	Scientific Planning and Review Committee
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	California State Water Resources Control Board
SWQPA	State Water Quality Protection Area
T&E	Threatened and Endangered
TCPD	Trinity County Planning Department
TMDL	Total Maximum Daily Load
USCB	U.S. Department of Commerce, Census Bureau
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WLPZ	Watercourse and Lake Protection Zone
WMA	Water Management Area
WMI	Watershed Management Initiative
5C	Five Counties Road Erosion Inventory

Redwood Creek Integrated Watershed Strategy

EXECUTIVE SUMMARY

The Redwood Creek Integrated Watershed Strategy was prepared by the Redwood Creek Watershed Group. The group is a collaborative watershed partnership whose purpose is to improve watershed conditions in Redwood Creek, preserve current land uses, and provide economic opportunity for the Orick community. Membership includes private landowners, and local and federal agencies that manage more than 90 percent of the Redwood Creek watershed. Membership also includes non-profit organizations, and agencies with regulatory or scientific interest in the watershed.

The goal of the Redwood Creek Integrated Watershed Strategy is to improve and protect water quality, water supply, and aquatic and riparian habitat throughout the Redwood Creek watershed, including the estuary and coastal areas. The strategy meets this goal by integrating natural resource needs with infrastructure needs at the watershed scale, and using state water priorities and management strategies to propose projects throughout the watershed. The strategy also expands partnerships that foster communication, coordination, planning, education, and public outreach regarding all aspects of water management in the watershed. Monitoring project effectiveness and long-term watershed trends is an important component of the strategy. Monitoring results will provide the basis for science-based adaptive management.

The Redwood Creek watershed contains significant natural and public trust resources. The watershed supports three federally listed as threatened salmonid species, including Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and steelhead trout (*O. mykiss*), as well as the non-listed coastal cutthroat trout (*O. clarki*) and resident fish species. The upper watershed contains a vast expanse of private land that is managed for timber production and ranching, and public land managed by the Bureau of Land Management and U.S. Forest Service.

In the lower watershed, Redwood National and State Parks contains superlative, world renowned groves of coastal redwood trees (*Sequoia sempervirons*). The Orick community is located in the picturesque valley that contains the coastal floodplain of Redwood Creek. At the mouth of Redwood Creek, the estuary is a unique and biologically important resource for aquatic species. The coastline surrounding the estuary is scenic and relatively undeveloped. North of Redwood Creek is 35 miles of magnificent coastline with state legislated protection for the significant estuarine, marine and terrestrial coastal resources. Designations include Critical Coastal Areas and a Water Quality Protection Area.

The Redwood Creek watershed has known water quality problems that limit salmonid populations in the watershed and economic opportunities in the Orick community. Redwood Creek is USEPA 303(d) listed for sediment and water temperature impairment caused by past timber harvest activities and erosion during large floods. Large woody debris which provides high flow shelter and channel complexity is limited in the mainstem channel. The shortage of mature conifers available for large woody debris recruitment and high summer water temperatures reflect poor riparian conditions. Excess sediment, high summer water tempera-

tures, the lack of in-channel large woody debris, and current riparian conditions are considered limiting factors to anadromous salmonid production in the watershed.

In the lower reach of Redwood Creek within the Orick valley, levees provide flood control for the Orick community, but also impact the biological and physical functions of the estuary. The current flood capacity of the levee system is greatly reduced from the original design because of channel aggradation, vegetation growth and levee subsidence resulting from insufficient levee maintenance. Levees constructed into the estuary disrupt natural water circulation patterns and sediment transport processes, eliminate deepwater pools, and significantly reduce the overall size of the tidal prism, estuary, and lagoon. The physical condition and water quality of the Redwood Creek estuary are considered limiting factors to anadromous salmonid production in the watershed.

Water quality issues from failing septic systems in the Orick community limit economic opportunities in the community. Orick qualifies as a disadvantaged community, and is transitioning from a resource-based to a service-based economy. The lack of a modern-day sewage treatment facility hinders this transition which relies on improved recreational opportunities, sustainable businesses, and planned community growth. Effluent contamination from failing septic systems likely contributes to reduced water quality in the estuary.

The Redwood Creek Integrated Watershed Strategy addresses these water quality issues by proposing projects related to flood control, sediment loads, summer water temperature, groundwater contamination, and aquatic and riparian habitat quality. The projects include:

- Short-Term Flood Control
- Long-Term Flood Control
- Restoration of the Redwood Creek Estuary
- Wastewater Treatment for the Orick Community
- Strawberry Creek Restoration
- Erosion Control and Prevention on Private and Public Lands
- Inner Gorge Protection and Restoration
- Restoration of Riparian Areas along Redwood Creek and its Major Tributaries

The Redwood Creek Integrated Watershed Strategy is consistent with local, state and federal water management initiatives, plans, priorities, strategies, and laws. The strategy is based on significant scientific information regarding water quality and watershed processes, and is considered a living document that will be updated as watershed conditions and implementation priorities change. Programmatic funding is needed to implement the Redwood Creek Integrated Watershed Strategy and realize the benefits from this cooperative and integrated effort.

Redwood Creek Integrated Watershed Strategy

1. OVERVIEW

Introduction

The goal of the Integrated Watershed Strategy (IWS) for Redwood Creek, Humboldt County, California is to improve and protect water quality, water supply, and aquatic and riparian habitat throughout the Redwood Creek watershed, including the estuary and coastal areas. The goal will be met by the implementation of projects that address issues related to sediment, summer water temperature, groundwater contamination, and aquatic and riparian habitat quality. Implementation of this strategy requires a collaborative and voluntary approach. The IWS builds and expands partnerships that foster communication, coordination, planning, and education and public outreach regarding all aspects of water management in the watershed.

Prepared by the Redwood Creek Watershed Group, the Redwood Creek IWS complements the North Coast Regional Water Management Group's effort and the North Coast Integrated Regional Water Management Plan (NCRP 2005). The IWS for Redwood Creek is consistent with Proposition 50 guidelines for Integrated Regional Water Management Plans (DWR-SWRCB 2004).

The Redwood Creek IWS is a living document and will be updated as watershed conditions and implementation priorities change. An important component of the IWS is monitoring project effectiveness and long-term watershed trends. Monitoring results will provide the basis for science-based adaptive management.

In Redwood Creek, private landowners, non-profit organizations and local, state and federal agencies are working together to improve watershed conditions in Redwood Creek and provide economic opportunity for the Orick community. Cooperation is well established between groups with seemingly conflicting interests. Watershed studies in Redwood Creek also began more than three decades ago. Thus, the Redwood Creek IWS is based on existing scientific information and is part of a cooperative effort to meet stated goals and objectives. The IWS assumes no further environmental regulations will be needed to implement the strategy.

Graphics courtesy of Redwood National and State Parks

Redwood Creek Watershed Group

The Redwood Creek Watershed Group (RCWG) is the watershed planning group who prepared the Redwood Creek IWS. Formed in 2004, the RCWG is organized by an Agreement of Intent (AOI, Appendix A). The group is a collaborative partnership that seeks to improve watershed conditions in Redwood Creek by implementing statewide water priorities and management strategies while meeting local needs.

The RCWG represents the dominant land use, ownership, and resource issues in the watershed. Membership includes private landowners, and local and federal agencies that manage most of the Redwood Creek watershed, non-profit organizations, and agencies with regulatory or scientific interest in the watershed (Table 1). Additional information on the relation of the RCWG and this document to local agency planning can be found in Appendix B.

Table 1. Redwood Creek Watershed Group - signatories to the Agreement of Intent.

Local Agencies and Community
- Humboldt County
- Orick Community Services District
- Orick Levee Committee

State and Federal Agencies
- Bureau of Land Management
- Redwood National and State Parks
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

Private Landowners
- Landowners adjacent to the Redwood Creek estuary
- Redwood Creek Landowners Association

Non-Profit Organizations
- Pacific Coast Fish, Wildlife and Wetlands Restoration Association
- Redwood Regional Watershed Center

Local agencies and community

- **Humboldt County** is the regional governing body whose jurisdiction covers the non-federal lands in the Redwood Creek watershed. It is responsible for land use planning and maintenance of the Redwood Creek Federal Flood Control Project.
- **The Orick Community Services District** (OCSD) is the local governing body of Orick that provides municipal services, including drinking water and fire protection. In 1974, the OCSD formally acquired, by voter approval, the powers to operate as a wastewater authority (SHN 2004).
- **The Orick Levee Committee** is a local citizens group concerned with the proper maintenance of the Redwood Creek Flood Control Project in Orick.

Private landowners

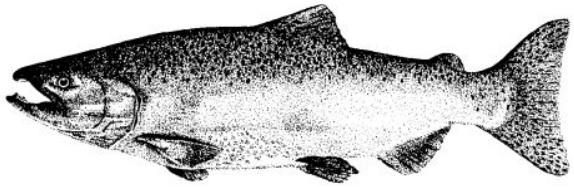
- **Estuary Landowners** own property adjacent to the Redwood Creek estuary.
- **Redwood Creek Landowners Association** (RCLA) is a group of landowners who manage 90 percent of the private land upstream of Redwood National and State Parks in the upper watershed.

State and federal agencies

- **Bureau of Land Management** (BLM) manages land in the upper watershed.
- **Redwood National and State Parks** (RNSP) is located in the lower watershed and manages about 40 percent of the watershed. RNSP is comprised of both National Park Service (91 percent) and California State Park (9 percent) lands which are managed cooperatively by an agreement between the two agencies.
- **U.S. Fish and Wildlife Service** (USFWS) has funded several projects in the watershed.
- **U.S. Geological Survey** (USGS) conducts research and monitoring in Redwood Creek.

Non-profit organizations

- **Pacific Coast Fish, Wildlife and Wetlands Restoration Association** (PCFWWRA) coordinates erosion control and prevention projects and restoration work in the watershed.
- **Redwood Regional Watershed Center** facilitates watershed-related education in the Redwood Creek watershed.



Other groups that are not signatories to the AOI also participated in the development of the IWS. California Trout, a recreational fishing and conservation organization, regularly attends RCWG meetings and has contributed significantly to the development of IWS objectives, strategies and projects. Humboldt State University's Water and Wastewater Treatment Engineering Design class developed an environmentally sustainable wastewater treatment alternative for Orick.

As the Redwood Creek IWS is implemented, the RCWG will continue to facilitate stakeholder involvement, communication, planning, and decision making during regularly scheduled meetings. The group is responsible for further development and implementation of the IWS as well as coordinating and sharing monitoring data and results. Project and watershed trend monitoring will enable the RCWG to reevaluate implementation priorities and provide recommendations for adaptive management of both individual projects and the IWS. The RCWG will perform education and public outreach, as needed, to share information with the Orick community, general public, researchers, and local, state, and federal agencies.

State and Federal Coordination

State and federal agencies have been directly involved with the development of strategies and implementation projects for the Redwood Creek IWS. The primary agencies include the California Department of Fish and Game, U.S. Army Corps of Engineers, NOAA Fisheries, U.S. Fish and Wildlife Service, and Redwood National and State Parks. Contributions from each group include:

- **California Department of Fish and Game** (CDFG) provided guidance during the early stages of forming the RCWG, and helped develop strategies and implementation projects.

- **U.S. Army Corps of Engineers** (Corps) met with the Orick Levee Committee, various agencies and community leaders to discuss Orick flood control and options that could improve the levees. The Corps also met with the RCWG to discuss implementation projects and the various stages of project development.

- **NOAA Fisheries** (NOAA) provided early guidance on IWS objectives and strategies.

- **U.S. Fish and Wildlife Service** (USFWS) actively participated in the development of the restoration strategy for Strawberry Creek watershed (RCWG 2006).

- **National Park Service** (NPS) provided background information from various watershed studies that helped formulate implementation projects, and helped coordinate the preparation of this document.

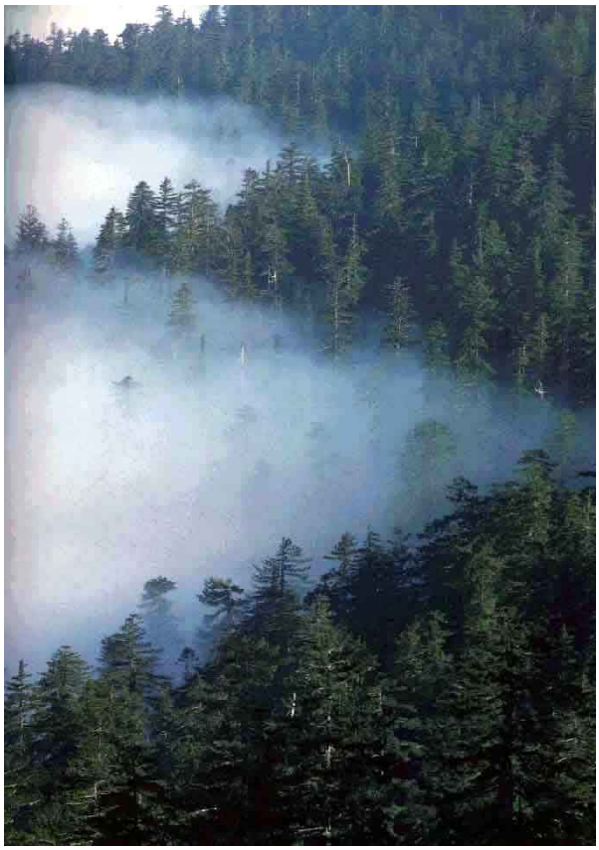


Photo courtesy of Redwood National and State Parks

Basis for the Redwood Creek IWS

The Redwood Creek IWS is based on statewide priorities and recommendations from assessment and planning efforts in Redwood Creek (Table 2), as well as, results from extensive monitoring and research completed in the watershed (Table 3). Statewide priorities consist of projects, policies and programs that, when implemented, improve and protect the beneficial uses of water. Redwood Creek has been identified by several state water quality and salmonid protection and recovery programs as a high priority. A detailed discussion of how state priorities apply to this strategy can be found in Appendix C.

Table 2. Supporting documents for the Redwood Creek IWS.

Statewide Priorities Documents
• Redwood Creek Sediment TMDL (USEPA 1998) • Recovery Strategy for California Coho Salmon (CDFG 2004) • North Coast Watershed Assessment Program (NCWAP 2002, Cannata et al. 2006) • California Salmonid Stream Habitat Restoration Manual (CDFG 2002) • Plan for California's Nonpoint Source Pollution Control Program (SWRCB 1999) and applicable management measures (USEPA 2001, USEPA 2002, USEPA 2003) • Areas of Special Biological Significance: California's Marine State Water Quality Protection Areas (SWRCB 2003) • California 2002 Critical Coastal Areas Draft Strategic Plan (SCC 2003) • Watershed Management Initiative (NCRWQCB 2005) • California Floodplain Management Report - Final Recommendations (FMTF 2002) • Surface Water Ambient Monitoring Program (NCRWQCB 2004, Puckett 2002) • Publicly Owned Treatment Works Program Priorities (NCRWQCB 2005a)
Redwood Creek Assessments and Planning Documents
• Reconnaissance Survey of Redwood National Park Area of Special Biological Significance (Boyd et al. 1981) • Management Alternatives for the Redwood Creek Estuary (Hofstra 1983) • Restoring the Redwood Creek Estuary (Hofstra and Sacklin 1987) • Redwood Creek Watershed Analysis (RNSP 1997) • Protecting Resources at Redwood National and State Parks Through Cooperation and Understanding (Hofstra et al. 1997) • Final General Management Plan/General Plan, Environmental Impact Statement/Environmental Impact Report, Volume 1 (NPS-CDPR 1999) • Onsite Wastewater System Pollution Study Final Report for Orick (OLA 1999) • A Proposal for a Redwood Creek Watershed Assessment (RNSP 2001) • Hydraulic Analysis of Alternative Levee Configurations for Lower Redwood Creek (Moffatt & Nichol Engineers 2003) • Feasibility Study for Orick Wastewater Collection, Treatment, and Disposal (SHN 2004) • Assessment of Coastal Water Resources and Watershed Conditions in Redwood National and State Parks (Humboldt State University 2004) • Upper Redwood Creek Watershed Road Assessment Summary Report (Bundros et al. 2003) • Upper Redwood Creek Watershed Road Assessment: Updated Summary Report (Bundros et al. 2004). • Strategies and Opportunities for the Restoration of Redwood Creek Estuary (RNSP progress)

Table 3. Long-term watershed studies in Redwood Creek.

Redwood Creek Watershed Studies
Fisheries • Downstream migrant trapping at two stations on Redwood Creek • Summer steelhead annual surveys in mainstem Redwood Creek (conducted since 1981 from Lacks Creek downstream to Hayes Creek) • Summer counts of cutthroat trout in mainstem Redwood Creek (conducted since 1988) • Opportunistic Redwood Creek mainstem spawning surveys • Fish distribution in tributaries and mainstem Redwood Creek mainstem • Fish barriers and passage assessment at culverts throughout watershed • Juvenile coho studies in Prairie Creek
Redwood Creek Estuary • Annual fish population and growth estimates (annually since 1980) • Summer water temperature monitoring • Estuary cross-section surveys to monitor habitat volume (periodically since 1982) • Surface water elevations to monitor opening and closing of the stream mouth • Qualitative surveys of birds and terrestrial species presence (conducted since 1990) • Salmonid life history from 25 years of juvenile and adult fish scales • Exotic species monitoring and management *
Water Quality and Channel Response • Summer stream temperature monitoring of the Redwood Creek and selected tributaries • Ground and surface water quality monitoring in the Orick valley * • Stream discharge, sediment and turbidity monitoring in Redwood Creek and selected tributaries • Channel cross-section surveys of the Redwood Creek main channel • Channel cross-section surveys of leveed reach through Orick to monitor flood capacity and channel response to gravel extraction • Longitudinal survey of the Redwood Creek main channel to monitor pools
Erosion Control and Prevention • Effectiveness monitoring of decommissioned and upgraded roads • Stream crossing adjustments and changes in turbidity (Lost Man Creek) • Changes in stream biota (insects, amphibians, fish and algae) 27 years after watershed restoration in RNSP Redwood Creek tributaries
* Proposed future studies

Results from research and monitoring studies have been fundamental to the development of the IWS for Redwood Creek. Decades of research and monitoring studies in the watershed have been conducted by the USGS, Humboldt State University (HSU), U.S. Forest Service (USFS) Redwood Sciences Lab, NPS, CDFG and others.

Summary of Objectives and Implementation Projects

The RCWG has met regularly to define objectives and develop implementation projects for the Redwood Creek IWS. The major watershed management objectives include:
1. Water quality improvement and protection, 2. Protection and restoration of salmonid species, 3. Flood control, 4. Economic opportunities – environmental justice, 5. Adaptive management, and 6. Partnerships.

Implementation projects identified by the RCWG for the Redwood Creek watershed are listed below. Monitoring, education, and public outreach are common to all implementation projects.

IWS Implementation Projects

- **Wastewater Treatment Facility** - provide appropriate wastewater treatment to protect groundwater and surface water, and drinking water supply in the Orick valley, and allow for planned community growth and economic development.
- **Short-term Flood Control** - perform maintenance of the Redwood Creek Flood Control Project to ensure flood protection until a long-term solution can be found.
- **Long-term Flood Control** - provide flood protection for the Orick community that reduces long-term levee maintenance and does not preclude estuary restoration.
- **Estuary Restoration** - restore biological and physical functions of the Redwood Creek estuary. Restoration of estuary tributaries (Dorrance and Sand Cache creeks) would also be considered.
- **Strawberry Creek Restoration** - restore channel morphology, salmonid habitat and riparian conditions for this estuary tributary, and perform erosion control and prevention in the Strawberry Creek watershed.
- **Erosion Control and Prevention** - implement erosion control and prevention on private and public land in the Redwood Creek watershed.
- **Inner Gorge Protection and Restoration** - protect and restore inner gorge areas in the Redwood Creek watershed.
- **Riparian Restoration** - restore riparian conditions along Redwood Creek and its major tributaries.

Summary of Statewide Water Management Strategies

California has several water management strategies intended to help local agencies and governments manage their water and related resources. The Redwood Creek IWS uses 11 statewide water management strategies to meet the stated IWS objectives (Table 4). Many of the strategies are related and complement each other. Appendix D describes the strategies and how they are used in the Redwood Creek IWS to improve and protect water quality and aquatic and riparian habitats in the Redwood Creek watershed.

Environmental Regulations and Compliance

Aside from the normal permits, additional state and federal regulatory actions should not be needed to implement the Redwood Creek IWS. Existing documents and plans provide a regulatory framework for water quality protection and improvement in Redwood Creek. Examples include the North Coast Basin Plan (NCRWQCB 2001) with waste discharge requirements for timber harvest operations (NCRWQCB 2004), and the sediment TMDL for Redwood Creek (USEPA 1998).

The objectives and other guidance presented in this document are consistent with all applicable federal, state, and local assessment, planning, and land use documents for the Redwood Creek watershed. These documents are listed in Tables 2 and 8. As a strategic document, the IWS is not subject to the requirements of the National Environmental Policy Act (NEPA) or California Environmental Quality Act (CEQA). However, Appendix E contains a general description of positive and negative impacts that could occur through implementation of IWS projects. A full environmental analysis will be completed prior to implementation of any project, as appropriate.

Table 4. Statewide water management strategies considered in the Redwood Creek IWS.

Statewide Water Management Strategy	Redwood Creek IWS	
	Used in IWS	Considered but not used
Ecosystem restoration*	●	
Environmental and habitat protection and improvement*	●	
Water supply reliability*	●	
Flood management*	●	
Groundwater management*		●
Recreation and public access*	●	
Storm water capture and management*		●
Water conservation*		●
Water quality protection and improvement*	●	
Water recycling*	●	
Wetlands enhancement and creation*	●	
Nonpoint source pollution control	●	
Watershed planning	●	
Wastewater treatment	●	

* Statewide water management strategies that must be considered to meet minimum IRWM Plan Standards.

2. OBJECTIVES

The overall goals of the IWS for Redwood Creek are to improve and protect water quality, water supply and aquatic habitat from the headwaters to the estuary. The objectives in the Redwood Creek IWS achieve these goals by using a collaborative and cooperative process that involves the major stakeholders in the watershed. The objectives were developed by the RCWG and are relevant at both the watershed and larger North Coast regional scales. Six objectives were identified for the Redwood Creek IWS and are listed below.

Redwood Creek IWS Objectives

1. Water quality improvement and protection
2. Protection and restoration of salmonid species
3. Flood control
4. Economic opportunities – environmental justice
5. Adaptive management
6. Partnerships

The following is a brief description of each objective and how the IWS objectives integrate with each other.

Objective 1: Water Quality Improvement and Protection

This objective addresses high summer water temperatures, high sediment loads, and groundwater contamination which are impacting beneficial uses. Water quality issues in Redwood Creek affect public health, salmonid populations, and economic opportunities for the Orick community. Contamination from failing septic systems in the Orick valley threatens groundwater used for community drinking water. Septic contamination combined with excessive sediment, high summer stream temperatures, and altered water circulation patterns likely contribute to degraded water quality conditions in the Redwood Creek estuary. Redwood Creek is currently listed under the Clean Water Act Section 303(d) for sediment and temperature impairment. This objective complements other IWS objectives that improve habitat for anadromous salmonid species.

Objective 2: Protection and Restoration of Salmonid Species

This objective addresses threats to salmonid habitat, improvement of habitat quality, and restoration of watershed processes. It considers issues related to management of inner gorge slopes, reestablishing large, mature conifers for recruitment of LWD, reducing stream temperatures, and restoring the biological and physical functions of the Redwood Creek estuary. This objective complements other IWS objectives that protect water quality, and provide flood control and economic opportunity to Orick. Combined benefits from this and other IWS objectives directly benefit the marine resources in the state Water Quality Protection Area around the mouth of Redwood Creek.

Objective 3: Flood Control

This objective directly addresses flood control for the Orick community and estuary restoration. It considers issues related to the Redwood Creek Federal Flood Control Project which provides flood control for the Orick community, but also impacts important biological and physical functions of the Redwood Creek estuary (NPS-CDPR 1999). For many years, insufficient funds and environmental regulations have limited levee maintenance activities. Thus, the levees have now deteriorated and their ability to contain a large flood is impaired. This objective integrates well with other IWS objectives that improve water quality, protect and restore salmonid populations, provide economic opportunity for Orick, and build partnerships.

Objective 4: Economic Opportunities – Environmental Justice

This objective provides economic opportunities for the Orick community and addresses environmental justice issues. It considers Orick's disadvantaged community status (Appendix F) and its effort to shift from a resource-based economy to a service-based economy. As a gateway community to RNSP, Orick is positioned to make this transition and benefit from the regional tourist industry. However, inadequate sewage treatment systems are hindering this transition which relies on sustainable businesses and planned residential growth. This objective complements all IWS objectives that improve water quality, and integrates nicely with the partnerships objectives.

Objective 5: Adaptive Management

This objective uses credible scientific data to ensure that actions are effective, implementation funds are spent wisely, and IWS objectives are met. It integrates well with all other IWS objectives by improving coordination, information, and data sharing between landowners, agencies, researchers, and non-profit groups. Adaptive management will rely on a monitoring program that collects biological, chemical, and physical data at the project and watershed scales. Monitoring data will determine project effectiveness, long-term watershed trends, and be used to reevaluate project priorities.

Objective 6: Partnerships

This objective ensures that the Redwood Creek IWS meets local needs and statewide priorities, and is implemented successfully and efficiently. It integrates well with other IWS objectives because cooperation forms the basis of partnerships. Partnerships broaden the resource base for projects which include people and financial support, and bring needed technical expertise for solving complex problems at both project and watershed scales. Partnerships also ensure various watershed interests are represented, and allow for multiple and sometimes competing views. The IWS envisions a partnership that extends outside of the Redwood Creek watershed and includes the North Coast Regional Water Management Group that encompasses northern California counties.

3. WATERSHED DESCRIPTION

The IWS uses the Redwood Creek watershed hydrologic boundary as the planning area or *region*. The entire watershed is a logical boundary for integrated water planning and management because of: 1) the vast amount of information available for the Redwood Creek watershed, 2) its relatively small size, 3) land use which is limited mostly to timber production, ranching, and recreation, 4) large ownership patterns, 5) significant public-trust resources found in the watershed and associated coastal areas, and 6) a long history of cooperative efforts. In recent years, this planning boundary has also been used by agencies for regional planning efforts in Redwood Creek such as the TMDL, Coho Recovery Strategy, and the North Coast Watershed Assessment Program. Water resources in the Redwood Creek watershed include freshwater streams, salt water (Pacific Ocean), brackish-water areas (estuary), and two state-designated groundwater basins.

Location

The Redwood Creek watershed is located in the northern Coast Ranges of California. It is in the Redwood Creek Hydrologic Unit of the North Coastal Basin of the North Coast Regional Water Quality Control Board Region 1 (NCRWQCB), and in the North Coast Hydrologic Region of the Department of Water Resources (DWR). This coastal watershed is located entirely within Humboldt County.

Redwood Creek flows into the Pacific Ocean near the unincorporated town of Orick, about 35 miles north of Eureka (Figure 1). The watershed is long and narrow and is oriented northwest-southeast. Redwood Creek drains a 285 mi^2 area and is about 67 miles long (Janda et al. 1975). The largest tributary to Redwood Creek is Prairie Creek (40 mi^2), located just upstream of Orick.

Internal Watershed Boundaries

The Redwood Creek watershed has been the focus of intensive scientific studies since the early 1970s. These studies have generally divided the watershed into three separate sub-basins based on differences in climate, vegetation, and/or land use (Best 1984). For this document, however, the watershed is divided into only two general areas (Figure 1). The upper watershed includes all areas upstream of RNSP. The lower watershed includes RNSP, Prairie Creek, the town of Orick, and the Redwood Creek estuary. Aside from the Orick community, there are no other political, socio-economic, or municipal boundaries in the watershed.

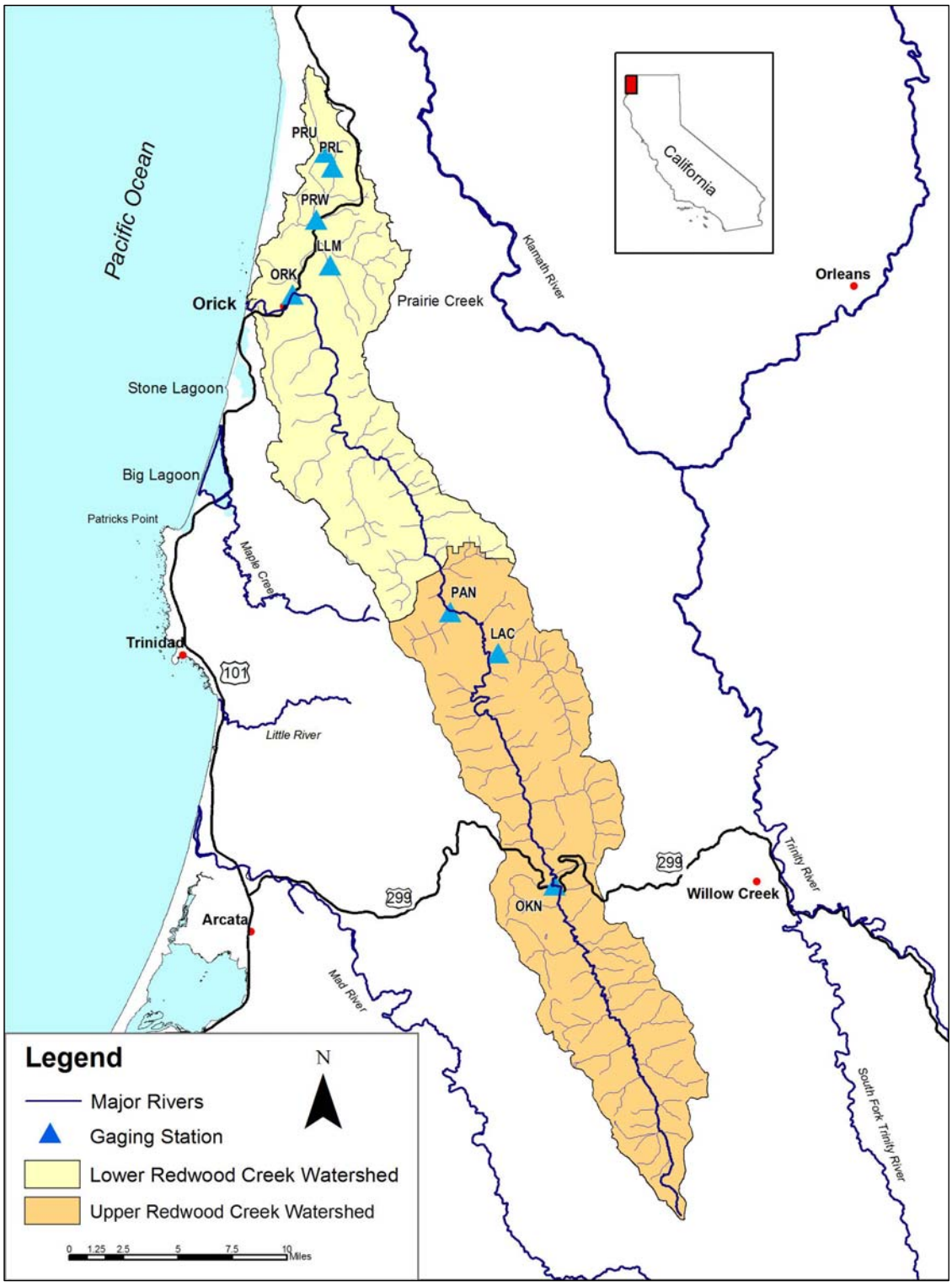


Figure 1. Redwood Creek watershed.

Ownership

Land ownership in the Redwood Creek watershed makes resource coordination and planning, and project implementation less complicated than for larger more developed and populated watersheds. The watershed is a mixed ownership of private (54 percent) and public (46 percent) lands (Figure 2). Figure 3 shows the ownership pattern in the Redwood Creek watershed.

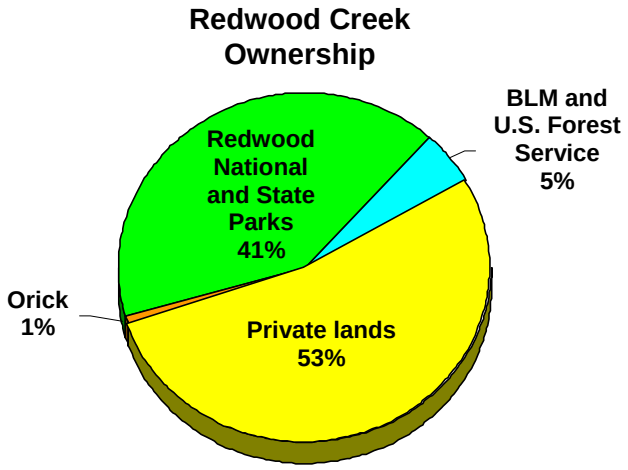


Figure 2. Distribution of ownership in Redwood Creek.

Upper Watershed

The upper watershed is mostly private lands and accounts for about 58 percent of the total watershed area. About 90 percent of these lands are managed for timber production and ranching by seven private landowners. These landowners along with state and federal agencies have actively participated in cooperative erosion control efforts within the watershed for over a decade (Bundros et al. 2004). The BLM manages about seven percent of the lands in the upper watershed, most of which are located in Lacks Creek, the second largest tributary to Redwood Creek. The remaining three percent of the upper watershed is composed of numerous, privately owned smaller parcels, and USFS land.

Downtown Orick

Photo courtesy of Redwood National and State Parks

Lower Watershed

The town of Orick and RNSP are located in the lower watershed. The lower watershed also includes Prairie Creek and the Redwood Creek estuary, and accounts for about 42 percent of the total watershed area. Flood control levees on Redwood Creek are also located in the lower watershed and are owned by Humboldt County. The Redwood Creek Flood Control Project consists of levees and channeled floodways that extend from upstream of Prairie Creek, downstream to the estuary within the park (Figure 4). Parts of the estuary are within RNSP, while other parts to the east are owned by two private landowners.

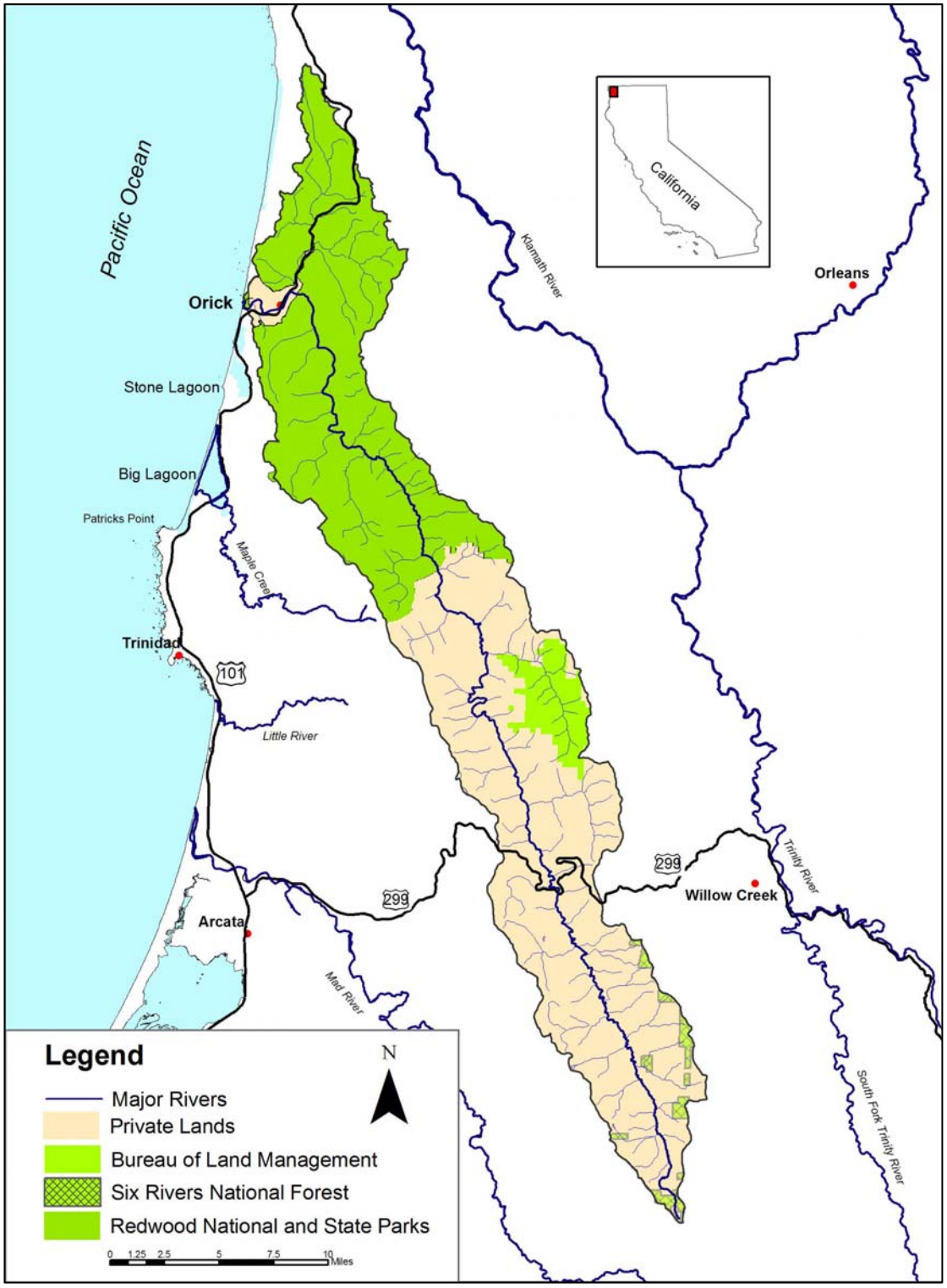


Figure 3. Ownership pattern in Redwood Creek.

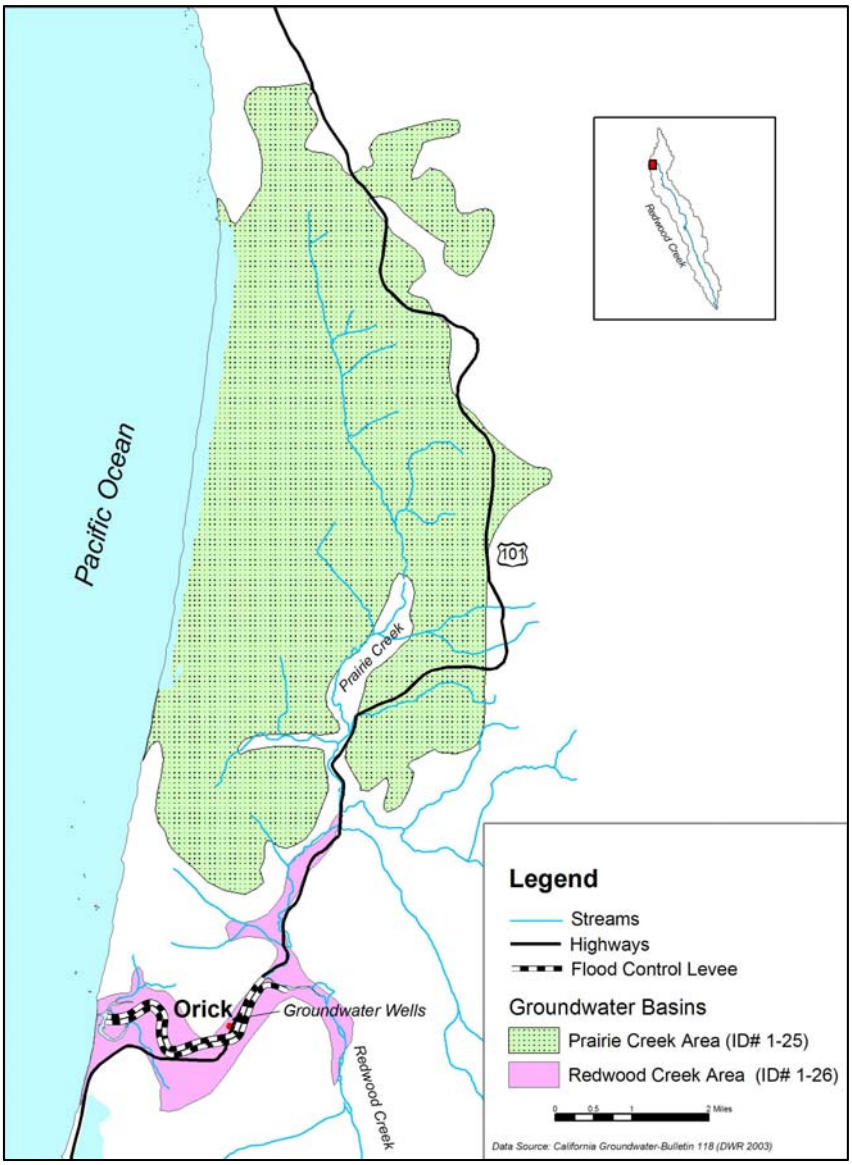


Figure 4. Levees and groundwater basins in Redwood Creek.

Socio-economics

The Orick community is the socio-economic center of the watershed. Located along the coast in a picturesque valley, Orick is the only recognized town site in the watershed. It is unincorporated and has a population of about 315 people (HC 2003). Orick is relatively isolated from other north coast communities and is the southern gateway to RNSP. The Orick valley contains the coastal floodplain of Redwood Creek and one of two groundwater basins identified in the watershed (Figure 4; DWR 2003). Orick once had a thriving community supported mostly by a resource-based economy associated with the timber industry. Today, Orick qualifies as a "disadvantaged community" based upon median household incomes (Appendix F).

1939 Chinook salmon caught in Redwood Creek

Photo courtesy of M. and M. Modrow

A sport fishery in Redwood Creek also once provided a valuable source of revenue to the local economy (Van Kirk 1994). However, recreational fishing is no longer as popular because fish populations have declined and fishing regulations have become more restrictive with zero bag limits (Cannata et al. 2006). Simpson Redwood Company operates one mill upstream of Orick, and provides local employment opportunity. RNSP provides opportunities for eco-tourism and draws visitors to the Orick area. Park visitation is about 500,000 visitors per year and has experienced an increase in annual visitation since 1970 (NPS-CDPR 1999).

Small rural neighborhoods exist in the upper watershed of Redwood Creek, generally located in the central portion of the watershed. The neighborhoods are a mixture of year-round residential and vacation homes.

The watershed community, as a whole, is rural and retains much of its historic culture that developed around land use, dating back many generations. Dairy and ranch operations in the Redwood Creek watershed were established at the end of the 19th century. With the exception of areas affected by the establishment and expansion of RNSP, many ranches still operate today. Timber production continues to be the primary land use on private lands in watershed. Timber harvest dates back to early settlement (Best 1984). The Redwood Creek IWS envisions a continuation of the rural culture and existing land uses.

Geology

The Redwood Creek watershed is underlain by the Franciscan assemblage (Cashman et al. 1995). The Grogan Fault bisects the basin, and movement along the fault has brought into contact different bedrock units on the west and east side of the watershed. For most of its length, the main channel of Redwood Creek follows the Grogan fault. The underlying geology is one of the main contributors to high erosion rates in the watershed (Cashman et al. 1995). Erodible bedrock and steep terrain coupled with periodic large floods make the watershed inherently prone to landslide and gully erosion (Harden et al. 1995). The geomorphic processes operating in the watershed are fully described in the U.S. Geological Survey Professional Paper 1454 (1995).

Hydrology

The quantity of the surface water and groundwater is based on the amount of annual precipitation. Mean annual basin-wide precipitation is about 80 inches and falls mostly as rain between November and March (Janda et al. 1975, NPS in-house data). Snow falls fairly frequently at elevations greater than 1,600 feet, but rarely at lower elevations (Janda et al. 1975). Two USGS gaging stations on Redwood Creek at Orick and

O'Kane (downstream of the state Highway 299 bridge, Figure 1) have measured rainfall and stream discharge since 1954, and sediment transport since 1972. Gaging stations operated by RNSP monitor selected tributary watersheds and measure stream discharge, sediment transport and turbidity (Klein 2005). A more detailed discussion on the hydrologic monitoring in Redwood Creek can be found in Klein (2005). Hydrologic data from gaging stations are available in Klein (2005) and in USGS Water Resource Data Reports.

There are no water development projects such as dams or surface water diversions that export water outside of the watershed.

Floods

Large floods occurred in 1953, 1955, 1964, 1972, and 1975. While the recurrence interval (RI) for these floods ranged from about 15- to 25-years (Rick Hunricks, personal comm.), peak flows were remarkably similar and ranged from 45,300 to 50,200 cfs (RNSP 1997). The relatively small range of peak discharges indicates the watershed physiography may limit peak discharges, though not the volume of floods

1950 Flood
Palm Cafe, Orick California

Photo courtesy of Jean Hagood Collection

near the mouth of Redwood Creek (Ricks 1995). Also, it is difficult to measure stream flow at flood stage and there may be significant measurement error for estimating peak flows. Flood peaks in the mid-20th century were not unusually large in comparison to long-term flood records (Janda et al. 1975). A storm and flood history study by Coghlan (1984) supported this conclusion, and indicated that these storms are a normal climatic feature. Peak stream flow can also be influenced by rain-on-snow events such as occurred in 1964.

Groundwater Basins

Identified groundwater basins in the watershed are the Redwood Creek Area (ID#1-26) and Prairie Creek Area (ID#1-25) groundwater basins (Figure 4; DWR 2003). The Orick Community Services District provides domestic water through a centralized distribution system that includes two wells located adjacent to Redwood Creek in the central part of town. Current groundwater extraction for municipal use is about 80 acre-feet per year (DWR 2003, DTB 2002). Groundwater supplies all of the agricultural, domestic, and industrial needs for the Orick community (OLA 1999). Current groundwater resources are adequate to accommodate future growth during the next 20-year planning horizon (DTB 2002).

Water Quality

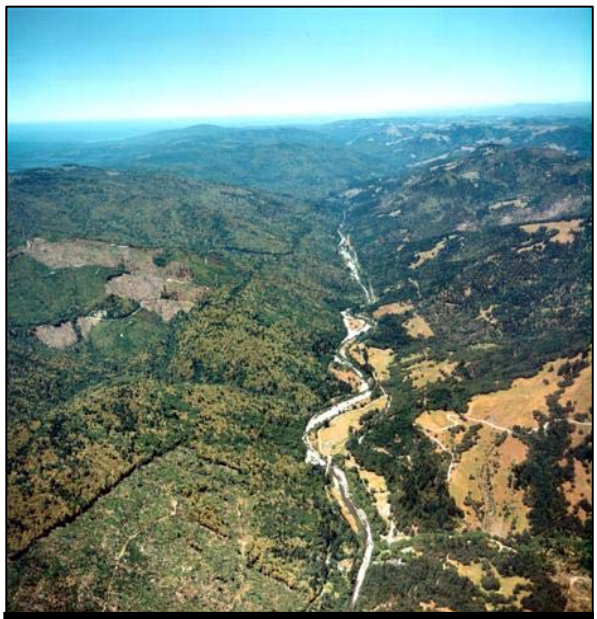
Water quality within the Redwood Creek watershed generally meets or exceeds the water quality objectives in the North Coast Basin Plan (NCRWQCB 2001). However, significant water quality problems exist in the watershed related to sediment, summer water temperatures, and contamination from failing septic systems. These problems are discussed in *Section 4 Watershed Resource Issues*.

Significant Watershed Resources

From the headwaters to the ocean, the Redwood Creek watershed contains signify-cant natural and public trust resources.

Fishery Resources

The watershed supports three federally listed as threatened salmonid species: Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and steelhead trout (*O. mykiss*) (USDC 1997, USDC 1999, USDC 2000) as well as the non-listed coastal cutthroat trout (*O. clarki*) and resident fish species (RNSP 1997). Salmon and steelhead trout provide an important sport fishery for the north coast and an economic benefit for local businesses (Cannata et al. 2006). There are no barriers to anadromous salmonids along most of the length of Redwood Creek (RNSP 1997, Cannata et al. 2006). Outside of Prairie Creek, the main channel of Redwood Creek represents about 70 percent of all accessible anadromous salmonid habitat in the Redwood Creek watershed (California Resources Agency 2002).



Redwood Valley

Photo courtesy of Redwood National and State Parks

Large, Unbroken Tracts of Private Land

The upper watershed contains a vast expanse of large, unbroken tracts of land that are managed for timber production and ranching and owned primarily by seven landowners. The ownership and management of these lands have slowed rural residential development in upland areas (RNSP 2001). Residential development can degrade water quality and cause impacts to the associated aquatic and riparian resources because regulations related to roads and water diversions in these subdivisions are difficult to enforce. In contrast, management of timberlands falls under the California Forest Practice Rules and is routinely reviewed by several state agencies. With proper management of road systems and prudent use of silvicultural and yarding methods, these large tracks of managed land can support long-term timber production, and achieve and maintain high quality water for all beneficial uses.

Redwood National and State Parks

Redwood National and State Parks and its public trust resources are a significant watershed resource. Perhaps the most superlative, world renowned groves of coastal redwood trees (*Sequoia sempervirons*) on earth exist on a series of narrow alluvial floodplains in the lower watershed. Redwood National Park was established in 1968 and expanded in 1978 to protect these significant resources. In 1982 the park received international recognition when it was designated as both a World Heritage Site and International Biosphere Reserve by the United Nations Educational, Scientific, and Cultural Organization. The protection of streamside redwoods along Redwood Creek was a central issue for the establishment and expansion of Redwood National Park and is linked to upstream watershed conditions. Three state parks and a recent 24,000-acre state acquisition in the Mill Creek watershed

Tall Trees Grove, Redwood Creek

Photo courtesy of Redwood National and State Parks

are located inside the legislated boundary of Redwood National Park. The national and state parks are managed cooperatively as Redwood National and State Parks.

Bureau of Land Management and U.S. Forest Service Lands

The BLM manages land in Lacks Creek, the second largest tributary to Redwood Creek. Land donations from Save-the-Redwoods League and other organizations in 2005 increased the publicly owned acreage in Lacks Creek to approximately 8,400 acres or most of the watershed. The BLM manages the watershed as an Area of Critical Environmental Concern (BLM 1995). Thirteen hundred acres of old-growth Douglas-fir forest are also designated as a Research Natural Area. The USFS manages about 1,000 acres in the most headwater region of Redwood Creek as late-seral reserves.

Coastal Area and the Redwood Creek Estuary

The coastline surrounding the mouth of Orick is scenic, relatively undeveloped, and provides recreational and research opportunities. North of Redwood Creek is 35 miles of magnificent coastline contained in RNSP (NPS-CDPR 1999). Coastline features of the parks range from broad sandy beaches in the south to stretches of steep rocky cliffs rising more than 1,000 feet above the ocean on the northern end. Broad alluvial valleys, floodplains, and estuaries are found near the mouths of the Klamath River and Redwood Creek. Numerous sea stacks are also found off the coast and provide nesting and roosting habitat for a variety of seabirds and haul-outs for marine mammals (NPS-CDPR 1999).

Photo courtesy of Cheryl Zuber

The estuary provides a unique and important aquatic resource in the Redwood Creek watershed. It serves as a transition zone from freshwater to saltwater and, visa versa, for anadromous fish. It provides important habitat for commercially valuable and federally listed salmonids that depend on the estuary for juvenile rearing, as a transition zone for smolts entering the ocean, and as a passageway for upstream migrating adult spawners. The Redwood Creek estuary also provides tangible and direct economic benefits through tourism, recreation, and fisheries.

State legislated protection has been assigned to these significant estuarine, marine, and terrestrial coastal resources (Figure 5). Designations include a Water Quality Protection Area (formerly known as Areas of Special Biological Significance) for the non-terrestrial marine and estuarine resources along the 35-mile coastline (SWRCB 2001, SWRCB 2003), and a Critical Coastal Area for Redwood Creek for its coastal reach and estuary (SCC 2003). More studies are needed to understand how products (e.g., water, sediment, and nutrients) from large coastal watersheds affect nearby coastal areas and associated marine resources.

Photo courtesy of Redwood National and State Parks

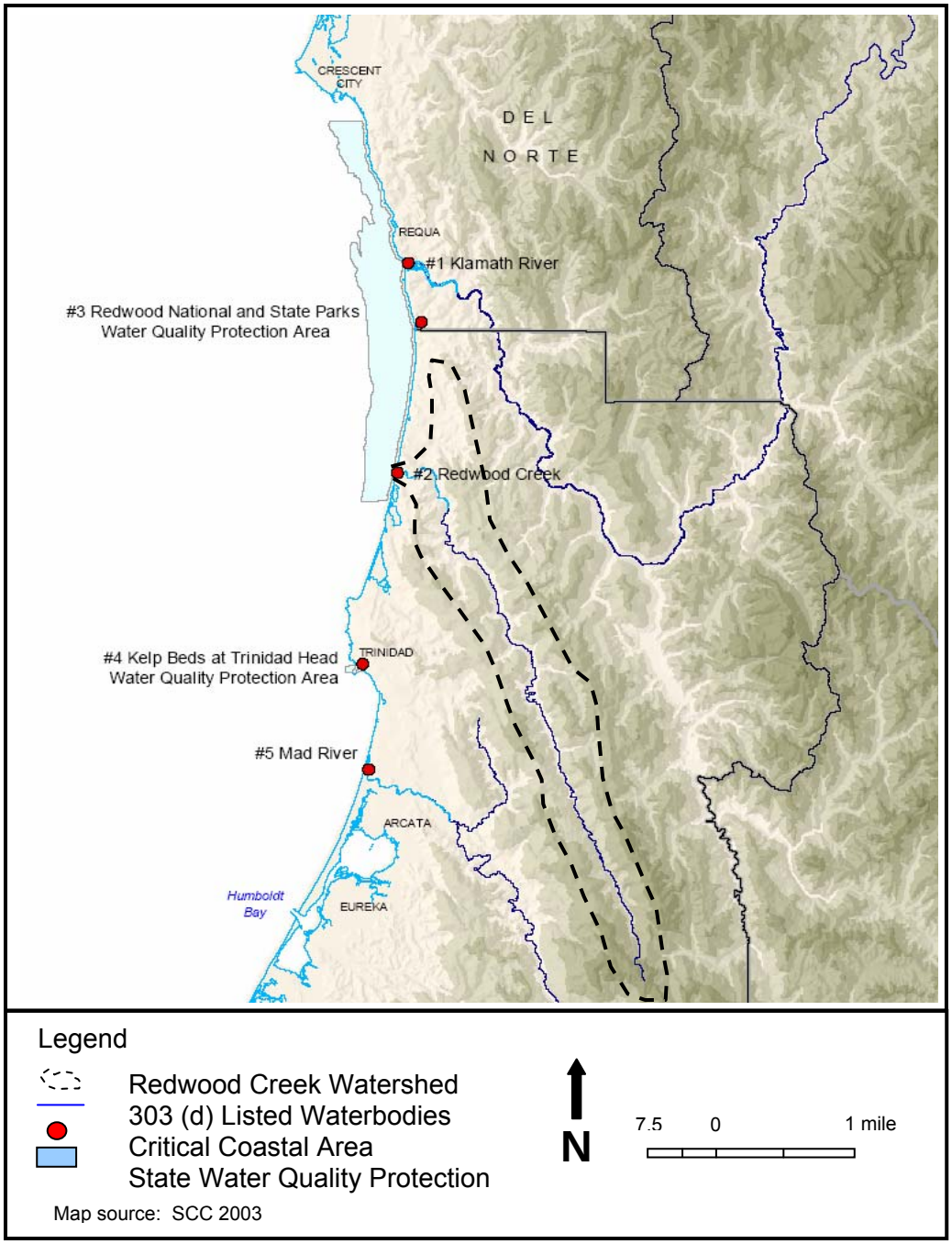


Figure 5. State Water Quality Protection Areas and Critical Coastal Areas.

4. WATERSHED RESOURCE ISSUES

The watershed resource issues in Redwood Creek affect both people and salmonid species in the watershed. Water quality is at the heart of the resource issues that include sediment, summer water temperatures, aquatic and riparian habitat, septic contamination, and flood control.

Sediment Impairment

Redwood Creek was listed as sediment impaired in 1992 (NCRWQCB 2001b) due to past timber harvest, removal of riparian vegetation, and widespread streamside landsliding and channel aggradation during past large floods (USEPA 1998, SWRCB 2003, Bundros et al. 2003, Cannata et al. 2006). A sediment TMDL for Redwood Creek was developed and promulgated by the U.S. Environmental Protection Agency on December 30, 1998 (USEPA 1998). Erosion from logging roads in the upper watershed was identified as a major source of sediment in Redwood Creek (RNSP 1997, USEPA 1998). A sediment implementation plan was written, but has not been adopted by either the regional or state water boards. Past studies have shown that excess sediment can raise water temperatures, bury spawning gravels, fill in pools, and degrade fish rearing and spawning habitat. Channel infilling can also increase bank erosion and streamside landslides during high winter flows. Klein (2003) found that turbidity increases as a function of both road density and annual timber harvest rates.

Water Temperature Impairment

In Redwood Creek, high summer water temperatures appear to be a limiting factor for salmonid health (Cannata et al. 2006). Redwood Creek was listed as temperature impaired in 2002 (SWRCB 2003b). A stream temperature TMDL for the Redwood Creek watershed has not been written, but other studies provide assessments that generally recommend the establishment and protection of mature streamside conifers to provide shade and regulate summer water temperatures (Bundros et al. 2003, CDFG 2004, Cannata et al. 2006). Madej et al. (in press) evaluated stream temperature data for Redwood Creek and found that stream temperature appears to influence juvenile coho distribution on Redwood Creek. An in-depth analysis of current stream temperatures for Redwood Creek can be found in Madej et al. (in press) and Ozaki and Anderson (2005). Studies of cold pools (thermally stratified pools) on lower Redwood Creek indicate that, although few in number, they provide concentrated areas of cold water and serve as a cold water refugia for salmonids (Keller et al. 1995, Ozaki 1988, Moses 1984, Keller and Hofstra 1983).

Aquatic and Riparian Habitat Quality

The lack of in-channel large woody debris (LWD) appears to be another limiting factor for salmonid health in Redwood Creek (Cannata et al. 2006). Functional LWD is an important channel component of aquatic habitat that adds complexity and structure for rearing and over-winter habitat. Recruitment of LWD occurs from riparian areas and relies on large, mature conifers that can withstand high winter streamflow and reside in the stream channel for decades. Originally dominated by mature (old-growth) coniferous forests, about 60 percent of the riparian corridor upstream of RNSP is now dominated by hardwood forests (Bundros et al. 2003). The mainstem of Redwood Creek lacks LWD (Cannata et al. 2006) and the riparian areas lack large, mature conifers for recruitment (Bundros et al. 2003, Cannata et al. 2006).

These conditions are lingering cumulative effects from past timber harvest.

Invasive weeds often use water courses as conduits to spread from upland to down-stream habitats and ultimately, estuarine environments. Invasive weeds can reproduce profusely, and out-compete other plants for water, light, and nutrients. Establishment of weeds dramatically reduces the diversity and presence of native plants, especially in disturbed or fragmented habitats. In Redwood Creek, the long history of disturbance and settlement has allowed invasive weeds to become established in upland and riparian areas.

Groundwater and Surface Water Pollution

Studies in Orick confirmed that effluent from septic tanks was contaminating ground and surface water supplies (OLA 1999). Contamination was attributed to old and failing septic systems on small parcels combined with high groundwater levels during winter months that can rise to within three feet of the surface. The investigators believed most of the contamination was of human origin. They recommended a modern-day wastewater facility to protect surface water and domestic groundwater supplies from sewage contamination, and allow for future community growth (OLA 1999).

Estuary Water Quality

The physical condition and resulting water quality of the Redwood Creek estuary are considered major limiting factors to anadromous salmonid production in the watershed (RNSP 1997, CDFG 2004, Cannata et al. 2006). Degradation of estuary water quality is directly related to the construction of the Redwood Creek Federal Flood Control Project. Completed in 1968, the levees provide beneficial flood protection to Orick, but significantly impact estuary function by drastically altering the physical configuration of the estuary and sloughs (RNSP 1997, CDFG 2004, Cannata et al. 2006). Levee construction eliminated natural water circulation patterns, disrupted sediment transport, and significantly reduced the overall size of the tidal prism and estuary volume (Ricks 1995). High summer water temperatures with low dissolved oxygen are other factors that limit salmonid production (RNP 1984-87, Anderson 1997-2000). Riparian clearing and channelization of estuary tributary streams, such as Strawberry Creek (Cannata et al. 2006), and effluent contamination from septic systems and grazing (OLA 1999) have likely contributed to reduced water quality.

Flood Control

A long-term solution for flood control is needed in the Orick community. The Redwood Creek Federal Flood Control Project provides flood protection to Orick and the surrounding agricultural lands. However, challenged by insufficient funds, permit restrictions, and concerns for threatened and endangered species, Humboldt County has been unable to routinely maintain the levees. Originally designed to contain an estimated 250-year RI flood of 77,000 cfs (Corps 1969), current levee flood capacity has decreased to about a 100-year RI flood of 65,200 cfs from channel aggradation, vegetation growth and levee subsidence (Corps 1998, HC 2005a). Thus, not only is the current level of flood protection greatly reduced from the original design, but the levee system continues to impact estuary function.

5. WATERSHED IMPLEMENTATION PROJECTS

The RCWG currently has identified nine watershed implementation projects which address water resource issues in Redwood Creek related to sediment, summer water temperature, groundwater contamination, and aquatic and riparian habitat quality. All of the implementation projects in the IWS are consistent with DWR/SWRCB statewide priorities which are described in Appendix C.

Watershed Projects

- Wastewater Treatment Facility
- Short-term Flood Control
- Long-term Flood Control
- Estuary Restoration
- Strawberry Creek Restoration
- Erosion Control and Prevention on Private Lands
- Erosion Control and Prevention on Public Lands
- Inner Gorge Protection and Restoration
- Riparian Restoration

The watershed implementation projects described in the Redwood Creek IWS are in various stages of planning and implementation. Most of the projects require a phased approach over multiple years to complete studies, planning, permitting, and full implementation. Thus, the IWS will be implemented through a combination of short- and long-term actions. Short-term actions will likely be implemented within the next one to three years, and long-term actions will likely be implemented within the next three or more years. All of the implementation projects are based on objectives that will improve and protect water quality in Redwood Creek over the long run. Table 5 lists the status of each implementation project and the associated short- and long-term actions.

Most of the projects currently identified in the Redwood Creek IWS are the responsibility of a member of the RCWG. The two exceptions are the estuary restoration and long-term flood control projects which will be implemented by the Corps after Congressional authorization and appropriations are secured, and if levee modification is agreed to by the affected landowners and agencies. While the Corps is not an official member of the RCWG, the Corps and RCWG have and will continue to collaborate on these projects. Project implementation by members of the RCWG ensures better integration between projects and a collaborative and coordinated approach to the IWS. Projects may be implemented using a contractor with particular expertise to carry out the project. Agency and landowner participation in project implementation is voluntary.

The Redwood Creek IWS is a living document. The RCWG will use adaptive management based upon watershed monitoring data to reevaluate implementation projects and priorities as conditions change. As projects described herein are implemented, additional projects may emerge. Future versions of the Redwood Creek IWS will describe changed conditions and future projects.

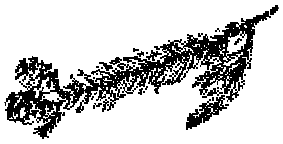
Table 5. Status of the Redwood Creek IWS implementation projects.

IWS Implementation Projects	Description	Short-term Actions	Long- term Actions
Wastewater Treatment Facility	Improve and protect groundwater and surface water, and drinking water supply in the Orick valley to support beneficial uses and planned community growth and economic development.	• Preliminary studies - completed • Implement feasibility study, site selection and design	Complete compliance, secure permits and build facility
Short-term Flood Control	Perform levee and channel maintenance to ensure flood protection until a long-term solution can be found.	• Secure all required permits – completed • Implement project according to permits	Maintain project and monitor
Long-term Flood Control	Provide flood protection for the Orick community that reduces long-term levee maintenance and does not preclude estuary restoration.	• Corps and County discussions – in progress • Landowner discussions - initiated • Secure Congressional authorization and appropriations for Corps General Investigation study – in progress • Seek estuary landowner agreements	Complete compliance, design, and build project
Estuary Restoration	Restore biological and physical functions of the Redwood Creek estuary. Depends on landowner/agency agreement.	• Landowner discussions - initiated • Secure Congressional authorization and appropriations for Corps General Investigation Study – in progress • Seek estuary landowner agreements	Complete EIS/EIR, compliance, design, and implement project
Strawberry Creek Restoration	Remove invasive exotic species, restore channel morphology, salmonid habitat and riparian conditions for this estuary tributary. Reduce erosion from roads in the upper Strawberry Creek watershed.	• Prepare restoration strategy - completed • Complete project design, compliance and secure permits – in progress • Implement project	Maintain and monitor
Private Lands Erosion Control and Prevention	Reduce erosion from roads by performing erosion control and prevention with willing landowners.	• Implement permitted and funded projects – in progress • Continue preparing projects focusing on high priority areas – in progress	Treat high priority areas described in the assessment report (Bundros et al. 2004)
Public Lands Erosion Control and Prevention	Same as Private Lands Erosion Control and Prevention.	• Implement permitted and funded projects – in progress • Complete compliance for high priority areas – in progress	Implement projects in accordance with RNSP GMP/GP (NPS-CDPR 1999), Five County Report (TCPD-MWA 2004)
Inner Gorge Protection and Restoration	Establish mature conifer trees on inner gorge slopes; seek higher protection for inner gorge areas than provided by forest practice rules. Depends on landowner/agency agreement.	• Initiate discussions with landowners • Explore options that will restore and protect inner gorge processes along Redwood Creek	Establish protective measures/BMPs with willing landowners
Riparian Restoration	Reestablish conifer dominance in riparian areas along Redwood Creek and its major tributaries. Depends on landowner/agency agreement.	• Initiate discussions with landowners • Evaluate riparian areas and prioritize for treatment	Treat high priority riparian areas with willing landowners

Two components of the IWS, watershed monitoring and education and public outreach, are overarching efforts common to all implementation projects.

Watershed Monitoring

Watershed monitoring provides information on project effectiveness and watershed conditions. It is a necessary component of adaptive management and is fundamental to support periodic evaluation of project priorities. The Redwood Creek watershed benefits from monitoring and research conducted by the USGS Cooperative Fish Research Unit, USGS Redwood Field Station, HSU, CDFG, and NPS. These agencies have provided a long history of scientific research and information that supports sound watershed management in Redwood Creek. As members of the RCWG, these agencies add significant value to this watershed effort. A monitoring strategy for Redwood Creek is being developed (Duffy et al. in progress) and is summarized in *Section* 6 *Technical Analysis and Plan Performance*.



Education and Public Outreach

Education and public outreach is a key element when planning watershed-wide efforts. It provides a mechanism to disseminate information, and allows the watershed community and general public to provide feedback to the RCWG regarding the direction of its planning efforts. The RCWG is highly capable of implementing education

Photo courtesy of Redwood National and State Parks

and public outreach activities due in part to the state and national park interpretive programs, the Wolf Creek Education Center located within the watershed, as well as, coordination with the Redwood Regional Watershed Center and the educational programs and resources of Humboldt State University. The details of education and public outreach will be developed during the planning stage for each project.

Implementation Project Descriptions

Each implementation project is described in detail in the section below:

Wastewater Treatment Facility for Orick

Project Description: Construction of a wastewater collection, storage, and treatment facility for the Orick community will protect surface water and groundwater quality in the Orick valley and the Redwood Creek estuary. Water quality monitoring will help determine the effectiveness of the new facility and ensure compliance with water quality regulations.

Background: The results of a pollution study for the Orick community indicate onsite wastewater systems are failing, and surface and groundwater quality are threatened (OLA 1999). The study recommends the Orick Community Services District investigate alternatives for wastewater treatment. Future community growth and sustainable business development rely on an improved sewage treatment in Orick. A wastewater treatment facility, or improvements to existing on-site sewage treatment, is a critical step towards developing a sustainable economy for Orick that will help the community overcome its current economically disadvantaged status.

Responsible Agency/Group: The responsibility of this project is shared by the OCSD and Humboldt County. The OCSD is the local governing body for the Orick community and responsible for services such as wastewater treatment. It has provided domestic water supply and fire protection for more than twenty years. Humboldt County is the regional governing body and is responsible for land use planning, among other things. The OCSD will be responsible for approving and managing all phases of project development, and providing long-term facility management and operations for the Orick community. The NCRWQCB has regulatory authority that ensures compliance with water quality standards and regulations.

Linkages to Other Projects: The project is linked to other IWS projects that improve and protect aquatic habitat and water quality. The projects include Long-term Flood Control, Estuary Restoration, and Strawberry Creek Restoration. These four projects are closely linked and project planning needs to consider the effects on other projects. Planning, decisions, design, and schedules for each project will be integrated across all projects as they move forward. For example, site selection for the treatment facility needs to consider future options that may modify the levees and restore the estuary and Strawberry Creek. Locating the wastewater facility close to the Redwood Creek estuary could limit

Arcata Marsh Project is a series of ponds that provide wastewater treatment for the City of Arcata.

Photo from city of Arcata website: http://www.arcatacityhall.org/arcata_marsh.html

options for levee modification and estuary /stream restoration.

Linkages to Local Planning: This project is linked to several local planning documents prepared by Humboldt County and Humboldt State University. They include:

- Humboldt 2025 General Plan, Building Communities A Discussion Paper for Community Workshops (DTB 2002) describes, among other things, existing and projected land use development, and public services such as water supply and sewage facilities needed for future population changes and associated community development.
- The Orick Community Action Plan (HC 2003a) describes the community's long-term vision which includes a clean, safe town with high quality housing, a diverse array of employment opportunities, and a balance between economic prosperity and a small town feel. An updated sewer system was a high priority for Orick to be able to build a sustainable economic future.
- Supplemental Environmental Impact Report 2003 Update of the Housing Element SCH #1996-052011 (HC 2003b) addresses environmental impacts of the Housing Element. Among other things, the Housing Element is designed to minimize visual impacts from development and maintain the rural character of local communities. The rural character of Orick includes forests, open spaces, agricultural lands, and a river system that define the scenic beauty for which Humboldt County is known.
- County of Humboldt Preliminary Redevelopment Report (HC 2005) provides information on the blighting conditions within the Orick area as well as information on how those conditions can be corrected through the use of redevelopment. The report includes reference to the findings of the OLA (1999) pollution study that describes the pollution caused by failing septic systems and deterrent to future growth caused by an outdated wastewater treatment system.
- A Wastewater Treatment Alternative for Orick, California (HSU 2005) presents a design for a treatment facility that utilizes a series of open ponds and wetlands for sewage treatment and disposal.

Economic and Technical Feasibility: The project is technically feasible, but financial resources might be a limiting factor. The Orick community is an economically disadvantaged community (Appendix F) and its residents cannot afford a significant rate increase to finance long-term debt from facility construction. Therefore, grants, rather

Wastewater treatment pond at Arcata Marsh

Photo from city of Arcata website: http://www.arcatacityhall.org/arcata_marsh.html

than long-term loans, will be the preferred funding source. The community could support rate increases for on-going facility operation and maintenance.

A completed feasibility study indicates this project is technically feasible (SHN 2004). The study recommends a low-pressure grinder pumps for the collection system and a septage (liquid and solid material) receiving station, pre-treatment screening, and double oxidation ditch for secondary treatment, composting facilities for sludge treatment, hypochlorite disinfection, and storage ponds. The study also proposes three sites for the facility - one site is on NPS lands and the other two sites are near the Redwood Creek estuary. This is just one of the potential alternatives for treating wastewater in Orick. Other alternatives will be explored.

Financing Project Implementation: California Housing and Community Development Block Grants funded an initial pollution study for Orick (OLA 1999) and a feasibility study for wastewater treatment (SHN 2004). Funding for site acquisition, facility design and construction is being sought from the Proposition 50 Grant Program. Other possible sources of funding include: Humboldt County Redevelopment funds, USDA Water and Waste Disposal Loan, Grant Program (administered by the Rural Utilities division of the USDA), USDA Economic Development Administration, Community Development Block Grant, long-term bond financing utilizing bonds and assessments, and loans available through various state loan funds for facilities.

Current Status: Cooperative efforts are currently underway that are exploring more innovative wastewater treatment designs. A Memorandum of Understanding is being prepared for the OCSD, National Park Service, Humboldt State University, and Humboldt County "*to collaborate regarding the planning of a wastewater collection, storage, treatment, and disposal facility in the community of Orick.*" A Humboldt State University engineering class has completed the initial design for an oxidation treatment system that utilizes a series of open ponds and wetlands, and a report has been prepared (HSU 2005) for OCSD.

The OCSD is cooperating with agencies and organizations to explore alternatives that ensure wastewater treatment achieves environmental and sustainable development objectives, and integrates well with projects described in this IWS. The next steps include further analyses of alternatives, site selection, system design, environmental compliance, and permits. Funds are needed to move this project into the next phases.

Timeline: The general feasibility study was completed in September 2004 (SHN 2004), and a preliminary design for one wastewater treatment alternative was completed in September 2005 (HSU 2005). A detailed feasibility analysis, site selection, facility design, CEQA compliance, permitting, and project construction are funding dependent. Project monitoring and maintenance will commence upon completion of facility construction.

Short-term Flood Control

Project Description: This project provides a short-term solution to flood control in Orick while a longer-term solution that provides flood control, reduces levee and channel maintenance, and does not preclude estuary restoration is explored. The project uses standard maintenance techniques which includes gravel extraction and vegetation removal at levels specified in existing permits. Maintenance requires monitoring gravel accumulations in the channel and changes in vegetation on the levee and in the channel.

Background: Completed in 1968, the Redwood Creek Federal Flood Control Project in Orick provides flood protection to the Orick community and surrounding agricultural lands. Challenged by insufficient funds, multiple permits and their restrictions, and concerns for threatened and endangered species, Humboldt County has been unable to routinely maintain the levees. Gravel extraction and vegetation removal conflict with protection of aquatic and riparian habitat under current environmental laws. Originally designed for an estimated 250-year RI flood, current estimates place flood capacity at about a 100-year RI flood due to channel aggradation, vegetation growth, and levee subsidence (Corps 1998, HC 2005a).

Standard levee maintenance methods may be unsustainable, because of the environmental impacts associated with gravel extraction and riparian vegetation removal, and the shortage of funds. The Corps, Humboldt County, California Coastal Commission, CDFG, NOAA Fisheries, and RCWG realize that levee maintenance is a short-term solution to a longer-term issue that will take several years to resolve.

Looking upstream at the Redwood Creek levees

Photo courtesy of Redwood National and State Parks

The Recovery Strategy for California Coho Salmon (CDFG 2004) recommends the levee maintenance manuals be changed "*to be consistent with habitat requirements of coho salmon while maintaining flood control*."

Responsible Agency/Group: Humboldt County is responsible for the operation and maintenance of this project. The CDFG, Corps, NOAA Fisheries, and the USFWS have regulatory authority and require environmental compliance and permits. The California Coastal Commission has permitting authority for actions that affect coastal zone areas. The levee reach downstream of the U.S. Highway 101 bridge falls within the coastal zone and RNSP.

Linkages to Other Projects: This project is linked to other projects, including Long-term Flood Control, Estuary Restoration, Erosion Control and Prevention, Inner Gorge Protection and Restoration, and Riparian Restoration.

Linkages to Local Planning: This project is linked to local planning efforts sponsored by the Corps and Humboldt County regarding flood control and levee maintenance. They include the:

- Orick Community Action Plan (HC 2003a) identifies the community's desire to be protected from floods and the need to work with the County to address levee repairs.
- Operation and Maintenance Manual (Corps 1969) describes procedures for maintaining levee flood capacity which is the responsibility of Humboldt County. Maintenance procedures use gravel extraction and vegetation removal to maintain flood capacity.
- Maintenance Work Plan Redwood Creek Flood Control Project (HC 2005b) describes specific locations and volumes of gravel extraction and vegetation removal for 2005 to aid in maintaining flood capacity. Maintenance work plans are developed each year.

Economic and Technical Feasibility: This project is technically feasible, but the economic feasibility depends on the local demand for gravel, and the terms imposed on gravel extraction. For example, Humboldt County could award a contract for gravel extraction in which the contractor must sell the gravel to realize profits. Therefore, the project would be feasible providing the contractor could deliver the gravel to the market at a competitive price. The demand for gravel in the Orick community is currently low. There is a reasonable demand for gravel in the Arcata and Eureka areas, about 35 miles south, and in the Crescent City area, about 45 miles north of Orick. Thus, the project will be economically feasible only if the total cost for gravel extraction, storage, and transport to northerly or southerly areas can compete with gravel sources in those areas.

This project is technically feasible for the short-term, because permits are in place through 2009. However, over the long-term, it might become more difficult to obtain permits to maintain flood capacity through gravel extraction and vegetation removal while still protecting aquatic and riparian habitat according to environmental laws. The inability by Humboldt County to identify suitable riparian mitigation projects adds to the uncertainty.

Financing Project Implementation: Humboldt County is the responsible party for this implementation project and relies on income generated from the sale of extracted gravel to finance this work. In 2004 and 2005, there was insufficient interest in the gravel from local markets to pay for hauling gravel extracted from between the levees. Gravel extracted in 2004 and 2005 is currently stockpiled in Orick waiting for market demand.

In absence of market demand for the gravel, the County may need to accept alternative approaches. Options include allowing contractors to extract gravel at reduced or no-payment to the County, and allow contractors to keep the gravel to sell when market conditions improve. The County may have to pay contractors to extract gravel or seek unspecified grant funding to cover extraction, transport and storage costs.

Current Status: Efforts to implement this project are currently underway. Citizens concerned about potential flooding formed the Orick Levee Committee which is a member of the RCWG. The committee performs voluntary levee maintenance through vegetation removal. The Orick Levee Committee, Humboldt County, and RCWG have worked with the California Coastal Commission to help secure a permit that allows gravel extraction within the levees

downstream of the U.S. Highway 101 bridge in the coastal zone. All necessary permits are in place that allow up to 90,000 cubic yards of gravel to be extracted annually from the levee channel. Gravel extraction began during the 2005 low flow season. Humboldt County will work with RNSP and other agencies to locate riparian mitigation sites. Gravel extraction permits expire in 2009, by which time the Corps' General Investigation Study (see Long-term Flood Control) for levee modification will hopefully be complete.

Timeline: Work began during the 2005 low flow season. The rate at which gravel can be extracted will depend on annual channel aggradation, agency evaluations of channel flood capacity, permit stipulations, weather, stream flow, and economic feasibility.

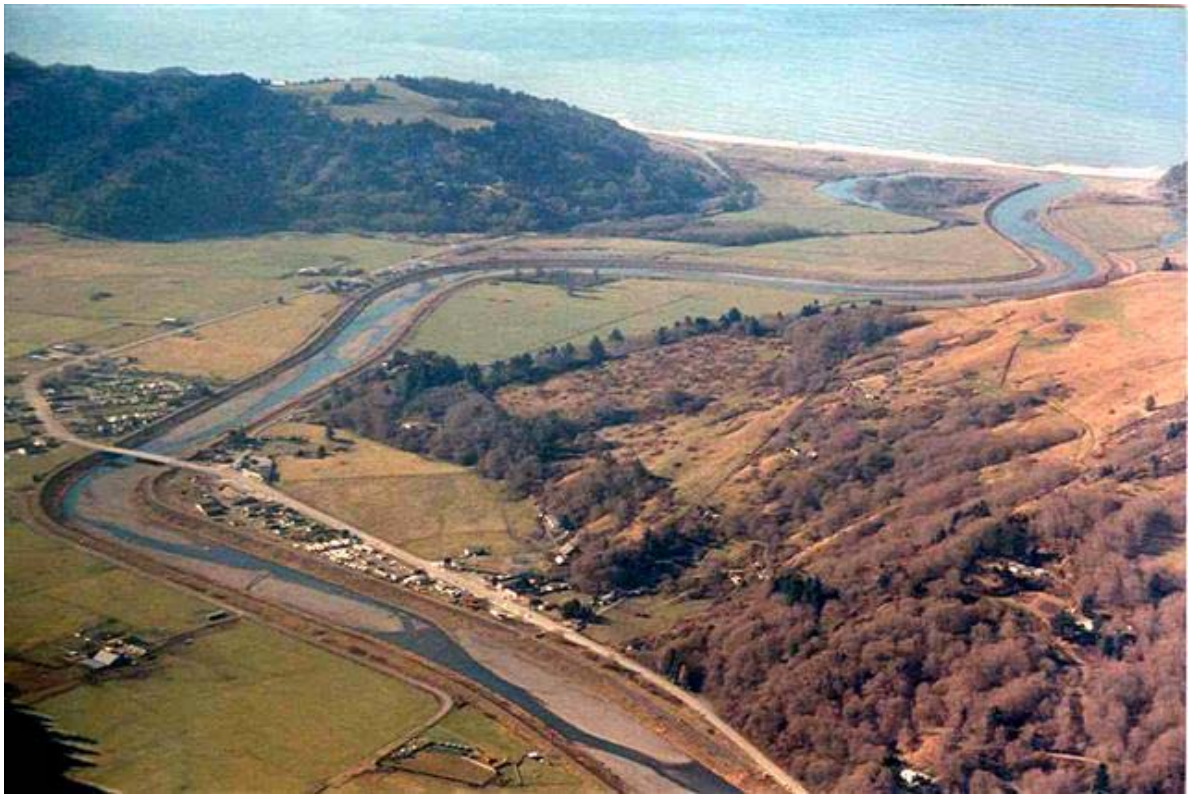


Photo courtesy of Cheryl Zuber

Long-term Flood Control

Project Description: This project provides long-term flood protection for the Orick community. It also significantly reduces the need for levee maintenance and the associated costs, the effects on aquatic and riparian habitat, and does not preclude the Redwood Creek estuary from being restored. Some degree of levee modification is needed to restore the estuary. A high priority in Long-term Flood Control is to preserve agricultural use of lands and a life style that affected landowners wish to maintain. Thus, levee modification options must be acceptable to landowners who border the estuary.

from: North Coast Journal 2002

Background: The background information for the Redwood Creek Federal Flood Control Project and levee maintenance issues have been covered in discussions above. This project is necessary because obtaining future permits for levee maintenance using standard gravel extraction and vegetation removal methods may be difficult due to threatened and endangered species concerns and uncertain maintenance funds. If the levees are modified in the future, some level of levee maintenance will be needed for portions of the levee upstream of the modified reach. However, modification of the levees could significantly reduce annual levee maintenance needs and costs, depending on how levees are modified.

This project requires a two-phase General Investigation Study be completed by the Corps. The study includes a Reconnaissance Study and a Feasibility Study. The Reconnaissance Study examines current problems and possible solutions, and determines if there is federal interest in the project. If there is federal interest and Congress funds the study, the Corps will then undertake, with a local sponsor such as the county, a more detailed two to three year Feasibility Study, with an Environmental Impact Statement/Report, as appropriate. The Feasibility Study is cost shared 50-50 with the appropriate non-federal sponsor. Study results are used to secure Congressional authorization and appropriations to implement the project. For more information refer to the Corp's planning website:
http://www.spn.usace.army.mil/planegr/detail.html

The Recovery Strategy for California Coho Salmon (CDFG 2004), the Redwood Creek Watershed Assessment Report (Cannata et al. 2006), and NOAA Fisheries (2004) biological opinion for issuance of permits place a high priority on levee modification for flood control and estuary restoration.

Responsible Agency/Group: The Corps and Humboldt County, in cooperation with the estuary landowners (private landowners and RNSP), are the responsible parties for this flood control project. The Corps is

responsible for major repair or modifications of the flood control structures while Humboldt County is responsible for the operation and maintenance. The California Coastal Commission has permitting authority for actions that affect coastal zone areas. The CDFG, USFWS, and NOAA Fisheries have regulatory authority and require environmental compliance and permits. The National Park Service manages land adjacent to and including the western portion of the Redwood Creek estuary which includes the terminus portion of the levee system.

Linkages to Other Projects: This project is closely linked to other projects, including the Wastewater Treatment for the Orick community, Short-term Flood Control, Estuary Restoration, Strawberry Creek Restoration, Erosion Control, Inner Gorge Protection and Restoration projects. Projects in the Orick valley (Wastewater Treatment, Short-term Flood Control, Estuary and Strawberry Creek Restoration) are inter-connected and it is important to consider the effect of each project on the others. Planning, design, and schedules for these projects will be integrated as they move forward. For example, if a decision is made that the levees can be modified without impacting adjacent landowner interests, locating the wastewater treatment facility close to the existing levees could limit how much the levees could be modified. Levee modifications will affect estuary and Strawberry Creek restoration options, as will decisions regarding location of the wastewater treatment facility.

Linkages to Local Planning: This project is linked to local planning efforts to provide long-term flood control for the Orick community and explore options for estuary restoration. They include:

- Orick Community Action Plan (HC 2003a) describes the community's desire for flood protection.
- Hydraulic Analysis of Alternative Levee Configurations for Lower Redwood Creek, Humboldt County, California (Moffatt & Nichol 2003) analyzes possible levee modifications that could provide for long-term flood control and estuary restoration opportunities.
- Local Coastal Plan Issue Identification Report (HC 2003) identifies issues for inclusion in the draft Local Coast Plan (LCP) anticipated in the near future. The issues are consistent with the state's Coastal Act of 1976 which considers, among other things, public access to and recreational use of the coast, protecting marine and land resources including wetlands, rare and endangered habitats, and stream channels, maintaining productive coastal agriculture lands, and protecting the scenic beauty of coastal landscape. The issues also consider improving commercial recreation facilities, local housing, levee maintenance and possible housing development constraints due to flood hazards and protection of agricultural lands.
- Strategies and Opportunities for the Restoration of Redwood Creek Estuary (Anderson in progress) integrates possible levee modifications that provide long-term flood control for the Orick community and estuary restoration opportunities.
- North Coast Farmland Conservation Study: Humboldt County Coastal Agricultural Lands (NRLT 2005) identifies agricultural land within the Orick valley for its value and contribution to a viable agricultural industry and economy in Humboldt County. The maps and descriptions in the study integrate well with this implementation project.

Economic and Technical Feasibility: The technical and economic feasibility of this project will not be known until the Corps completes its General Investigation Study. Among other things, the study will determine whether the project provides substantial environmental benefit which is required by Congress before it can authorize modifications and appropriate funds to an existing flood control project. The project will take several years and significant financial resources to fully implement, and require technical coordination between various agencies. There are also potential socio-economic considerations related to private land ownership that will require landowner agreements and/or compensation. The preferred levee modification alternative must be acceptable to landowners who would be affected by this project.

Financing Project Implementation:
Primary funding will come from Congressional appropriations for the Corps General Investigation study because the levee system is an existing federal flood control project. Required local matching funds from Humboldt County for project implementation will be necessary and will be sought through grant sources, such as the California Coastal Conservancy, salmon restoration funds, Headwaters Fund, various foundations, and conservation groups.

Current Status: Studies on alternative levee configuration in lower Redwood Creek have been funded by the California Coastal Conservancy and RNSP and modeled by Moffatt and Nichol Engineers (2003) and the Corps (1994). The RCWG and Orick community initiated discussions with the Corps, Congressional representatives, and other interested parties to secure Congressional authorization and funding for the General Investigation Study. A 2007 fiscal year budget request for the Reconnaissance Study has been submitted to Congress.

Timeline: This project could take about seven to nine years to complete. The Corps will complete the General Investigation Study in two to three years, once funded. Environmental compliance will be completed before project implementation and will take about one year. Levee modification will take one to two years, depending on the final levee design. The timeline depends upon Congressional authorization and appropriations for the necessary studies and negotiations with landowners who will be affected if levees are modified.

Estuary Restoration

Project Description: This project will restore critical aquatic habitat for threatened and endangered salmonids and other fish species while preserving agricultural land use and a life style that affected landowners wish to maintain. Restoration of the Redwood Creek estuary relies on some degree of modification to the existing flood control project. Because the RCWG supports voluntary efforts, proposed levee modifications must be acceptable to the landowners who would be affected by this project. Their acceptance of modification alternatives will affect how much and to what degree the estuary and adjacent wetlands can be restored.

Background: The Redwood Creek Federal Flood Control Project significantly impacts the biological and physical functions of the estuary by eliminating deepwater pools, natural water circulation patterns, disrupting sediment transport processes, and significantly reducing the overall size of the tidal prism, estuary, and lagoon (Ricks 1995). The estuary provides critically important rearing habitat for commercially valuable and federally listed as threatened salmonids (Chinook and coho salmon, and steelhead trout). Figure 6 shows the Redwood Creek estuary before and after levee construction.

The Recovery Strategy for California Coho Salmon (CDFG 2004) identifies lower Redwood Creek as the highest restoration potential in the watershed. The plan recommends "*restoring the historic form and function of the estuary/lagoon and slough channels, riparian forest, and adjacent wetlands*" and improving conditions in Strawberry, Dorrance and Sand Cache creeks. The Redwood Creek Watershed Assessment Report (Cannata et al. 2006) states, "*The present condition of the estuary/lagoon is considered a major limiting factor to the production of anadromous salmonids of the Redwood Creek basin*." It further states, "*Restoration efforts that move conditions and processes of the Redwood Creek estuary towards historic status should receive high*

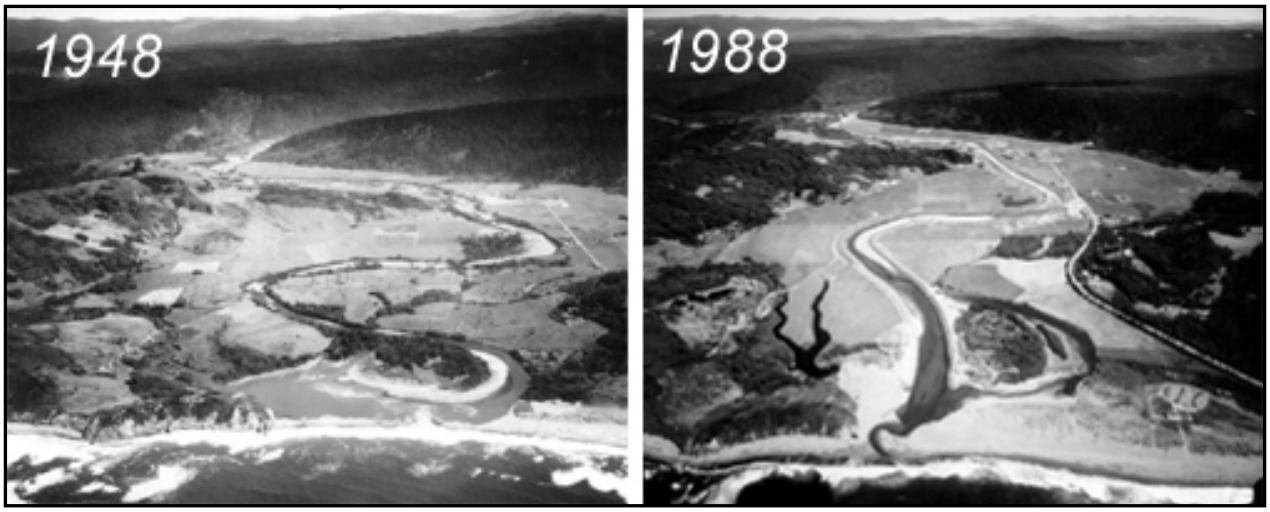


Photo courtesy of U.S. Army Corps of Engineers

Photo courtesy of Redwood National and State Parks

Figure 6. Redwood Creek estuary before and after levee construction.

ecosystem priority." The control of exotic and invasive vegetation species is also a concern.

Responsible Agency/Group: The same agencies/groups described in the Long-term Flood Control project are responsible for this project.

Linkages to Other Projects: The linkage between this project and others is the same as described for Long-term Flood Control. Projects in the Orick valley are all connected and it is important to consider the effects of each project on the others.

Linkages to Local Planning: This project is linked to local planning efforts much in the same way as Long-term Flood Control. In addition to the efforts previously cited, the following studies and plans are specific to the estuary:

- Redwood Creek Estuary Proposed Restoration Plans: Hydrologic and Hydraulic Analysis (Corps 1994) describes a range of levee modifications for restoring the estuary.
- Redwood National and State Parks General Management Plan/General Plan (NPS-CDPR 1999) describes approaches to restoring the estuary while seeking to retain current land uses in the Orick valley.

Economic and Technical Feasibility: We believe the project is technically and economically feasible but will not know until the Corps completes its General Investigation Study (see Long-term Flood Control). Projects that ensure long-term flood control and restore the Redwood Creek estuary may have differing objectives because of potential impacts to estuary landowners.

Financing Project Implementation: Primary funding will come from Congressional authorization and appropriations for the Corps General Investigation Study, because estuary restoration will require some form of modification to an existing federal flood control project. Required local matching funds for project implementation will be necessary and will be sought through grant sources, such as the California Coastal Conservancy, salmon restoration funds, Headwaters Fund, various foundations, and conservation groups.

Current Status: The RCWG members, which include the estuary landowners, are interested in seeing the estuary restored and are discussing restoration opportunities and options. Numerous studies on estuary conditions and function have been completed. RNSP will continue biological and physical monitoring of the estuary, which include summer juvenile fish population and growth estimates, water level and water quality monitoring, and cross section surveys. Estuary landowners are participating in discussions related to estuary restoration. They are ready for the General Investigation Study to begin and willing to listen to a description of various alternatives.

Timeline: The timeline for this project is the same as for Long-term Flood Control (about seven to nine years). Several estuary and watershed studies have been completed which should speed the Corp's General Investigation Study. Ultimately, restoration will rely on estuary landowner agreement, and Congressional authorizations and appropriations for levee modifications.

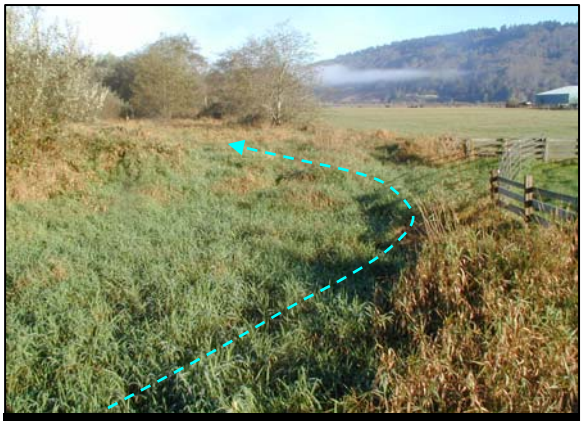
Strawberry Creek Watershed Restoration

Project Description: This project will implement a comprehensive watershed restoration strategy for Strawberry Creek, a tributary to the Redwood Creek estuary. The strategy (RCWG 2006) encompasses both channel restoration and upslope erosion control. Project implementation will improve water quality and aquatic habitat. Restoration options will preserve the agricultural use of lands. Stream restoration efforts will follow the California Salmonid Stream Habitat Restoration Manual (CDFG 2002).

Background: Strawberry Creek restoration has been envisioned by various stakeholders for many years. Historically, Strawberry Creek was a locally important cutthroat trout stream. It still supports small runs of cutthroat and steelhead, but the lack of riparian vegetation and cover, spread of invasive reed canary grass, and channel modifications have impaired aquatic habitat quality and function. The Recovery Strategy for California Coho Salmon (CDFG 2004) identifies lower Redwood Creek as having the highest restoration potential in the watershed. The strategy recommends "*improving the conditions of sloughs and tributaries to the estuary (Strawberry, Dorrance and Sand Cache creeks).*"

Potential erosion from abandoned logging roads in the upper Strawberry Creek watershed may threaten downstream restoration efforts and will be addressed. The sediment TMDL for Redwood Creek (USEPA 1998), the Recovery Strategy for California Coho Salmon (CDFG 2004), and the Redwood Creek Watershed Assessment Report (Cannata et al. 2006) all encourage road assessments followed by road decommission and upgrade projects. The last two documents also recommend restoration of this and other coastal tributaries to the Redwood Creek estuary.

Responsible Agency/Group: The agencies and landowners who manage lands in the Strawberry Creek watershed, in partnership with USFWS, CDFG, and the RCWG, are the responsible parties. Private landowners own most of Strawberry Creek in the lower floodplain. Humboldt County also owns land in the downstream area. Redwood National and State Parks manage land in the upper reaches of Strawberry Creek and most of the



Strawberry Creek downstream of Highway 101

Strawberry Creek upstream of Highway 101

Photos courtesy of Redwood National and State Parks

upper hillslopes in the watershed. The California Coastal Commission has permitting authority for actions that affect coastal zone areas. The CDFG, Corps, NOAA Fisheries, and USFWS have regulatory authority and require environmental compliance and permits.

Linkages to Other Projects: Strawberry Creek restoration is linked to other projects, including Wastewater Treatment, Long-term Flood Control, and Estuary Restoration. Two sites currently being investigated for the new wastewater facility are located near the main channel of Strawberry Creek. While the wastewater facility will be designed to avoid impacts to Strawberry Creek, conflicts could arise for either project at the time of implementation due to logistics and access limitations. The connectivity of Strawberry Creek to the Redwood Creek estuary is another consideration for Long-term Flood Control and Estuary Restoration if levees are modified. Cooperative efforts and discussions between landowners and RCWG will ensure that planning and design for each project is integrated to avoid potential conflicts.

Linkages to Local Planning: This project is linked to local planning efforts to restore aquatic and riparian habitat and salmonid species. These efforts are described by:

- Grading, Erosion Control, Geological Hazards, Streamside Management Areas, and Related Ordinance Revisions (HC 2002). These county ordinances describe implementation measures that should be incorporated into restoration projects.
- Basin-wide Aquatic and Riparian Habitat Restoration Strategy for Strawberry Creek near Orick, Humboldt County (RCWG 2006). The strategy includes the history, affected environment, desired conditions for Strawberry Creek, and describes a strategy for restoring the hydrology and aquatic habitat of the system.

Economic and Technical Feasibility: Preliminary assessments indicate the project is economically and technically feasible, but more information is needed. This project is supported by the affected landowners and potential funding agencies have indicated a strong interest in this project. There are no technical barriers to this project, but a significant amount of work is still needed to survey existing channel conditions and design the restoration work. Strawberry Creek is easily accessed from local highways and roads. PCFWWRA and RNSP both have extensive restoration and contracting experience. Long-term monitoring and management of reed canary grass will be required after it is removed.

Financing Project Implementation:
This project will be funded by restoration grants and landowner contributions. PCFWWRA and/or the private landowners will be the applicants for grant funds. Possible sources of funding for removal of exotic/invasive species, channel restoration, and riparian planting include California Salmon Restoration Program, California Trout, California Coastal Conservancy, California Coastal Commission, and the USFWS Coastal Program. Possible funding sources for Erosion Control and Prevention on public lands in Strawberry Creek include the California Salmon Restoration Program and National Park Service.

Current Status: Strawberry Creek landowners, agencies, and the RCWG have developed a comprehensive restoration strategy for the entire watershed (RCWG 2006). Project planning is underway to restore 12,000 feet of main channel and riparian area, and treat potential sediment sources related to roads in the watershed.

CDFG adaptive funds have been granted for reed canary grass removal. Additional grant proposals are being prepared for project design. An inventory of abandoned logging roads has been completed and data will be analyzed. The next steps are to obtain a coastal development permit so that reed canary grass can be removed from selected channel reaches. Channels will then be surveyed for restoration needs, and upslope road treatment projects, based upon completed road assessments, will be developed.

Timeline: Assuming the coastal development permit, and CDFG 1600 Agreement are secured by fall 2006, reed canary grass will be removed late fall 2006. Surveys will be completed shortly thereafter followed by project design during winter 2006-2007. Restoration of Strawberry Creek's main channel will begin late summer 2007. It will take about three years to treat all reaches (RCWG 2006). Upslope erosion control and prevention on roads in the watershed is anticipated to be completed by summer 2010 (RCWG 2006).

Private Lands Erosion Control and Prevention

Project Description: Erosion control and prevention on private lands in the watershed will reduce sedimentation from roads, and improve and protect water quality, and aquatic and riparian habitat. This project will be carried out on privately-owned industrial and non-industrial timberlands, and ranches. Roads will be either decommissioned or upgraded. Treatments will be based on results of a completed basin-wide road assessment (Bundros et al. 2004) and landowner's management objectives. Similar work has been completed in Redwood Creek since 1995 and landowner participation is voluntary.

The RCWG wishes to preserve current land use. Proper management of road systems and prudent use of silvicultural and yarding methods will ensure these lands achieve and maintain high quality water for all beneficial uses while supporting long-term timber production.

Background: The Redwood Creek Watershed Analysis (RNSP 1997), the sediment TMDL for Redwood Creek (USEPA 1998), and the Redwood Creek Watershed Assessment Report (Cannata et al. 2006) all identified sedimentation from roads, especially logging roads, as the primary nonpoint source pollutant in the watershed. The primary processes associated with the delivery of road related sediment are landslides, stream diversion gullies, and stream crossing failures during large storms. There are more than 1,100 miles of roads in the upper watershed (Figure 7). Of the total road mileage, more than 90 percent of the roads are logging roads. Road density averages 6.9 miles/mile^2 and ranges from 3.6 to 11.3 miles/mile^2 (Bundros et al. 2003).

Removal of failing log bridge and replacement with new steel bridge on private lands in upper Redwood Creek.

Photos courtesy of Redwood National and State Parks

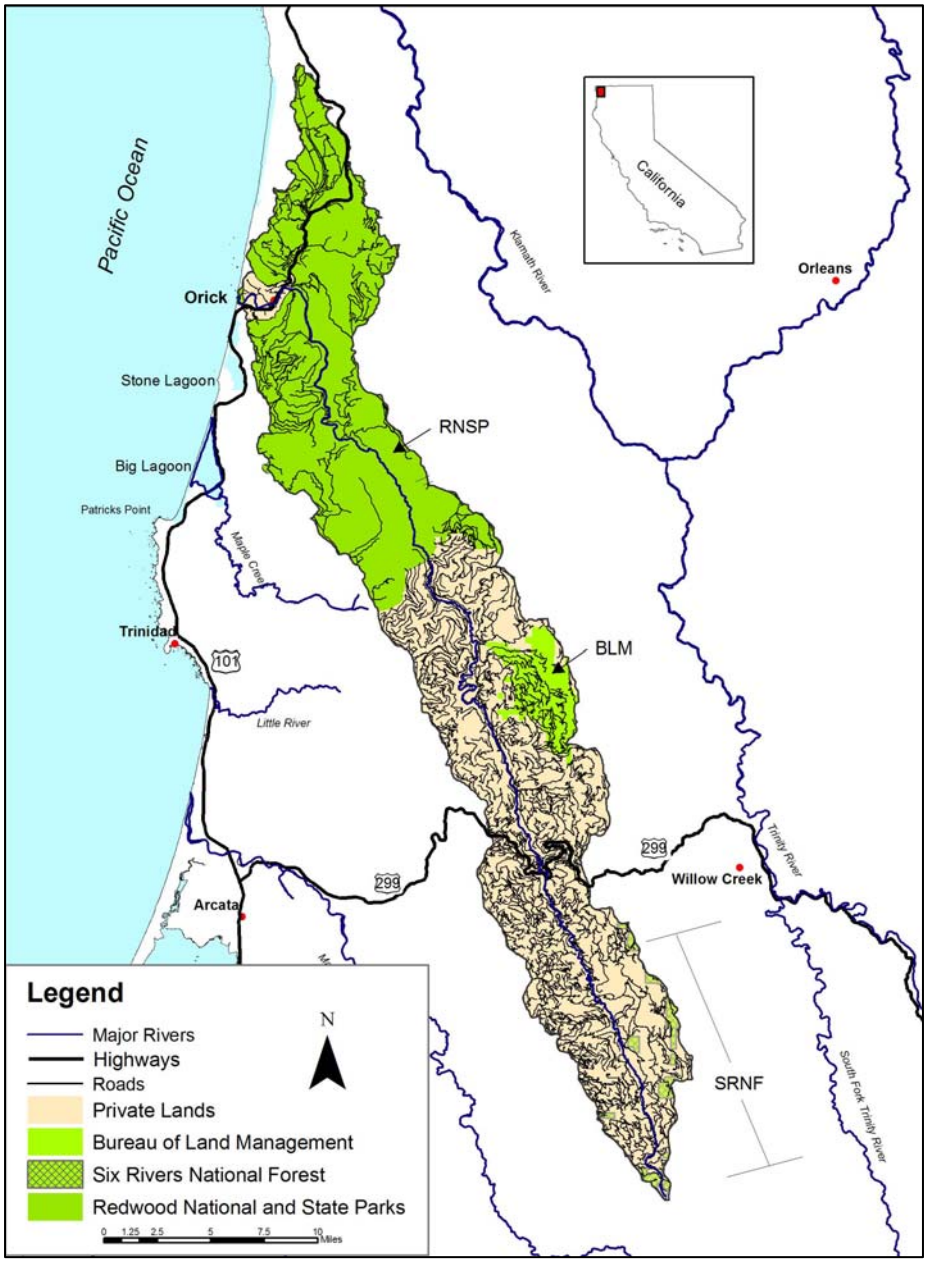


Figure 7. Roads in the Redwood Creek watershed (2006).

A sediment budget for Redwood Creek identified erosion from roads during past large flood events as the largest controllable source of sediment in the watershed (USEPA 1998). Channel stability studies have documented that erosion and sedimentation from past floods impact the channel for decades and affect many life cycles of anadromous salmonids. Based on the results of these studies, the best protection to aquatic ecosystems is to prevent human-induced erosion from entering streams. The sediment TMDL for Redwood Creek (USEPA 1998), the Recovery Strategy for California Coho Salmon (CDFG 2004), the Redwood Creek Watershed Assessment Report (Cannata et al.

2006), and the RNSP General Management Plan/General Plan (NPS-CDPR 1999) all encourage completion of road assessments, and implementation of road decommission and upgrade projects.

Responsible Agency/Group: The responsible agency/group for this project is the private landowners, private contractors, and non-profit organizations, such as PCFWWRA, in cooperation with RNSP. In 1995 and again in 2000, the private landowners upstream of the park and RNSP signed agreements to work cooperatively to find and treat active and potential sediment sources in the watershed. Those agreements were complemented by another agreement between RNSP and PCFWWRA signed in 1999 and 2004 to expand efforts to assess roads, and implement erosion control and prevention projects based on the results of the assessments. PCFWWRA and RNSP provide technical support and ensure integration with other projects. The California Department of Forestry (CDF), CDFG, NCRWQCB, USFWS, NOAA, Corps, and State Historic Preservation Office have regulatory authority.

Linkages to Other Projects: This project is linked to other projects that improve and protect water quality, and aquatic and riparian habitat, and provide flood control (Short-term Flood Control, Long-term Flood Control, Estuary Restoration, and Riparian Restoration). Unlike other projects, however, this project is programmatic. Thus, a series of projects will be implemented over the next several years.

Linkages to Local Planning: This project is linked to local planning efforts to improve and protect water quality by addressing nonpoint source pollution from roads. These efforts include:

- Five Counties Road Erosion Inventory (TCPD-MWA 2004) is part of the Five Counties Salmonid Conservation Program, a comprehensive effort to address sedimentation from roads. It describes the results of road erosion inventories and provides information for treating potential erosion sites on county maintained roads. Most of the county roads in the Redwood Creek watershed are described in the inventory and the information integrates well with this implementation project.
- Water Quality and Habitat Protection Manual for County Road Maintenance (HC 2002a) is also part of the Five Counties Salmonid Conservation Program. This document provides guidelines for road maintenance to protect and restore water quality and stream habitat.
- Grading, Erosion Control, Geological Hazards, Streamside Management Areas, and Related Ordinance Revisions (HC 2002) codifies and describes comprehensive provisions dealing with grading, erosion control and potential impacts to streamsides.
- Upper Redwood Creek Watershed Road Assessment: Updated Summary Report (Bundros, et al. 2004) presents the results and analysis of road assessments performed mostly on private lands in the upper watershed, and prioritizes areas for treatment. Assessment results have been used to develop and implement projects for private lands erosion control and will be used to implement projects in the upper watershed on BLM lands.

Economic and Technical Feasibility:
Erosion control and prevention on private lands in the watershed is economically and technically feasible. Current erosion control projects are funded annually by landowners and competitive grants. Future work will be funded through the same process.

Private landowners, PCFWWRA, and RNSP have a long successful history of planning and implementing cooperative erosion control and prevention work in the Redwood Creek watershed. More than 70 percent of all roads in the upper basin have been assessed for erosion potential, and specific areas have been prioritized for treatments (Bundros et al. 2004). Erosion control and prevention work is implemented through agreements between landowners, PCFWWRA, CDFG, and RNSP. Projects are developed quickly from designs and specifications developed during the road assessment. Environmental compliance is completed once a project has been defined and funded.

Financing Project Implementation:
This project will continue to be funded by grant funding and landowner contributions. Private landowners, PCFWWRA, the RCWG, or other non-profits will be the applicants for public and/or private funding. Cost-share will come from individual landowners in the form of cash, in-kind services or materials, or other grants. Public funding sources include California Salmon Restoration Grant Program, Clean Water Act 319(h) water quality grants, and Proposition 50.

Programmatic funding is needed to fully implement this project and substantially reduce potential sediment delivery to channels before the next large flood. The Redwood Creek Watershed Assessment Report (Cannata et al. 2006) determined that Redwood Creek "*is an excellent candidate for a successful long-term, programmatic watershed improvement effort.*"

Current Status: A thorough road assessment that identifies active and potential sediment sources on more than 70 percent (700 miles) of all roads in the upper watershed was completed in 2004. Watershed areas have been prioritized for treatment based on analyses of the road assessment data (Bundros et al. 2004). As of 2005, 32 miles have been decommissioned and 31 miles upgraded under a cooperative erosion control program. Many more miles have been upgraded by landowners through voluntary efforts and as part of approved timber harvest plans. Road projects are currently being funded by CDFG and landowners. These projects are planned with willing landowners and treat the highest priority areas based on the completed road assessments.

Timeline: Programmatic funding is needed to fully implement this project. It will allow effective and efficient planning, scheduling, and integration of high priority projects across mixed ownership boundaries in the watershed. Based on completed road assessments, the total cost to treat the privately owned roads is estimated at about $26 million. When properly funded, a well planned and coordinated work schedule could complete treatments within 10 years.

Public Lands Erosion Control and Prevention

Project Description: Erosion control and prevention on public lands will occur throughout the watershed. This work has been conducted on BLM, RNSP, and USFS lands. This effort will continue and will integrate work on county and state roads. This project will reduce sedimentation from roads, and improve and protect water quality, and aquatic and riparian habitat.

Background: Erosion control and prevention on public lands has a strong ecosystem restoration component. It considers, among other things, second-growth management, invasive and exotic plant species, and habitat improvement for various threatened and endangered species. Road removal on public land is generally a more extensive treatment than erosion control on private lands. It restores the natural shape of hillslopes and stream channels crossed by roads.

Most of the roads in RNSP were acquired during the 1978 park expansion which included 38,000 acres of cutover lands in Redwood Creek. The parks' management objectives are different than for private lands and extensive road systems are not needed. At the time of park expansion, the density of roads in RNSP was similar to private lands in the watershed, but RNSP has removed about 220 miles of roads and another 130 miles are slated for removal (Figure 7). The parks' resource management staff has planned and implemented successful ecosystem restoration projects for more than 25 years. Many of the techniques used across the nation to plan and implement road removal were developed by park staff.

In 2005, the Save-the-Redwoods-League purchased about 4,500 acres in Lacks Creek that adjoined existing BLM lands. The property was subsequently transferred to BLM for long-term management. Lacks Creek has the highest total potential sediment yield from logging roads and the greatest diversity of salmonid species of all tributaries in the upper watershed (Bundros et al. 2004). The recent BLM acquisition of Lacks Creek lands provides significant watershed restoration opportunities.

Fill failure at culvert in RNSP

Photo courtesy of Redwood National and State Parks

Humboldt County manages about 30 miles of roads in the Redwood Creek watershed. The California Department of Transportation (Caltrans) manages about 10 miles of highways in the upper watershed.

The sediment TMDL for Redwood Creek (USEPA 1998), the RNSP General Management Plan/General Plan (NPS-CDPR 1999), the Recovery Strategy for California Coho Salmon (CDFG 2004), and the Redwood Creek Watershed Assessment Report (Cannata et al. 2006) all encourage continued road removal and upgrade on public lands in the watershed.

Road removed in Redwood National and State Parks

Photo courtesy of Redwood National and State Parks

Responsible Agency/Group: The BLM, RNSP, and USFS are responsible for project on federal lands. Humboldt County and Caltrans are responsible for the roads they manage. All of these agencies work with other agencies to plan and permit road construction, reconstruction, upgrade, and removal projects. The CDFG, NCRWQCB, Corps, NOAA Fisheries, and USFWS have regulatory authority.

Linkages to Other Projects: This project is linked to other projects as described above for Erosion Control and Prevention on Private Lands, and projects that improve and protect water quality and aquatic habitat. This project differs from Erosion Control and Prevention on Private Lands, because road removal on public lands generally treats the surrounding hillslopes and channels more extensively, and has an ecosystem restoration component.

Linkages to Local Planning: This project is linked to local planning efforts to improve and protect water quality, and restore ecosystems on public lands. Similar efforts previously described for private lands also apply to public lands. Planning efforts that focus specifically on public lands include:

- Basin-wide Aquatic and Riparian Habitat Restoration Strategy for Strawberry Creek near Orick, Humboldt County (RCWG 2006) recommends erosion control treatments through road upgrading and decommissioning on RNSP land.
- Biological Opinion Annual Routine and Non-Routine Road Maintenance Program (NMFS 2003) is the planning document that provides management practices and guidelines for implementing road maintenance in RNSP. The described methods protect water quality and aquatic habitat.
- Lost Man Creek Watershed Restoration Plan and Environmental Assessment (RNSP in progress) is the planning and compliance document that describes proposed erosion control and prevention in the Lost Man Creek watershed, the highest priority tributary watershed in RNSP.
- Road Strategy: Access and Treatment Priorities for Parkland in the Redwood Creek Watershed (RNSP 2004) describes the information and basis used to prioritize road treatments in RNSP. This document formed the basis to the Lost Man Creek Watershed Restoration Plan and EA currently under development.

Economic and Technical Feasibility: This project is economically and technically feasible. Agencies have used program and competitive grant funds to perform work on the lands and roads they manage. Agency funds are scarce and there is now greater reliance on competitive funding sources. The BLM, RNSP, and USFS have successfully competed for project funding.

The BLM, RNSP, and USFS have a proven capability to plan complex projects and carry

them forward through all project phases including design, permitting, contracting, and on-the-ground implementation. This project is consistent with the management strategies for BLM's Lacks Creek Management Area (BLM 1995), NPS policies, and RNSP General Management Plan/General Plan (NPS-CDPR 1999), the Forest Plan (FEMAT 1993), the Five County Salmonid Conservation Program (TCPD-MWA 2004), and a fish passage study commissioned by Caltrans (Lang 2005).

Financing Project Implementation:
Funding will come from the managing land agency (NPS, BLM, USFS, CDPR, Humboldt County or Caltrans) and other sources. Other sources include agency competitive grants, and cyclic road maintenance funding from NPS and BLM, California Salmon Restoration Grant Program, Clean Water Act Section 319(h) water quality grants, and Proposition 50. Programmatic funding is needed to fully implement this project and substantially reduce potential sediment delivery to channels before the next large flood.

Current Status: Erosion control and prevention on BLM, RNSP, and USFS lands is an on-going program. Road assessments of potential erosion have been completed on BLM, RNSP, and USFS roads. Fish passage at culverted stream crossings has been assessed for county roads and state highways in the watershed. BLM will soon develop a restoration plan for newly acquired lands in Lacks Creek. Road removal work on parklands in Redwood Creek has been prioritized at the tributary scale (RNSP 2004). RNSP is currently preparing environmental documents and securing permits for the next large road removal project in Lost Man Creek.

Timeline: Funding has been secured through NPS sources to treat 23 miles of road in Lost Man Creek (a tributary to Prairie Creek) over the next seven-year period. Environmental compliance for the project is underway. Road treatment work and monitoring will be implemented 2006-2012. The RCWG will work with all agencies to prioritize project proposals that will compete for restoration funds to avoid potential conflicts with funding opportunities for other projects described in this IWS.

Inner Gorge Protection and Restoration

Project Description: The RCWG has identified the protection and restoration of inner gorge slopes in the Redwood Creek watershed as a priority to improve and protect water quality and aquatic and riparian habitats. This project will use a proactive management approach to reduce human-induced landslide erosion along inner gorge slopes of Redwood Creek and its major tributaries during large storms, and ensure that effective LWD is recruited to streams if inner gorge debris slides occur.

Inner gorge in Lacks Creek

Photo courtesy of Redwood National and State Parks

The desired outcome is that large, mature conifers be reestablished on inner gorge slopes and land use does not destabilize inner gorge slopes. Restoration measures may require creating openings in the riparian areas that allow for conifer reestablishment and/or release. Measures will limit, but may not preclude, timber harvest activities on inner gorge slopes. This project should not be confused with the Riparian Restoration project (see below). While inner gorges contain riparian areas, not all riparian areas contain inner gorges.

Background: Inner gorge slopes are naturally unstable geomorphic features. Kelsey (1988) defined an inner gorge as steep, unstable, and potentially unstable hillslopes adjacent to stream channels that have formed over time by coalescing debris slides and deliver sediment directly to the channel. Kelsey performed his study in Redwood Creek where he identified about 22 miles of inner gorge slopes in the upper watershed (Figure 8). There are about 14 river miles (2,670 acres) of inner gorge slopes along the mainstem of Redwood Creek, mostly upstream from State Highway 299. Lacks Creek contains about five river miles (1,325 acres) and Minor Creek contains about three miles (850 acres) of inner gorge.

Inner gorge slopes occur where Redwood Creek has cut a steep canyon along the Grogan Fault Zone and where competent bedrock is juxtaposed against less competent bedrock as in Lacks and Minor creeks. These slopes are naturally unstable and geologically active. Kelsey et al. (1995) identified the inner gorge reach on Redwood Creek as a high sediment input reach and attributed the high erosion rates to the narrow canyon, steep inner gorge, and erodible bedrock units. Kelsey et al. (1995) also noted that all volumetrically significant debris slides in the watershed occurred on inner gorge slopes.

Although landslides are naturally occurring processes on inner gorge slopes, Kelsey et al. (1995) associated past timber harvest activities, including road construction, in the inner gorge with increased landslide rates. Refer to Kelsey et al. (1995) for a complete discussion of past landslides along the main channel of Redwood Creek, and Pitlick (1995) for a complete discussion of landslides along tributary streams.

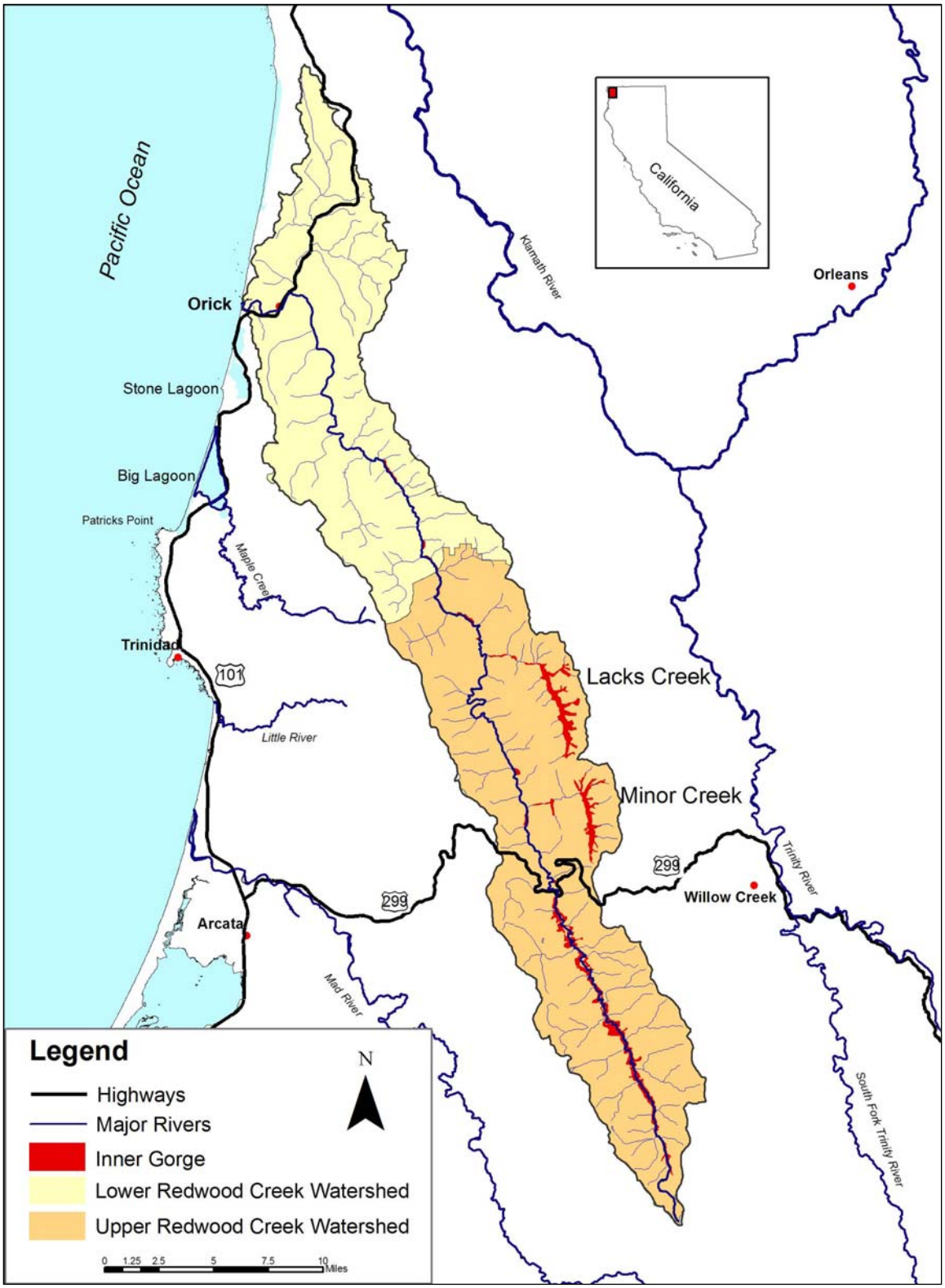


Figure 8. Redwood Creek inner gorges.

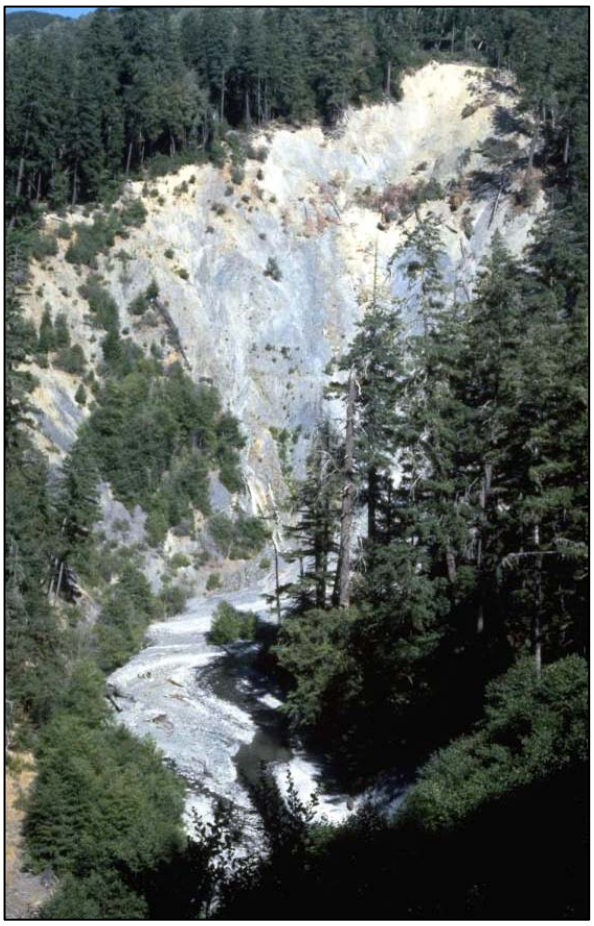


Photo courtesy of Redwood National and State Parks

In unmanaged watersheds, inner gorge landslides contribute large woody debris (LWD) in many forms, including large old-growth trees. Mature conifer trees, large in diameter and tall (long) enough to span and lodge into a channel when they fall, are important because they have a long residence time and provide functional aquatic habitat for years to come. In managed watersheds, such as Redwood Creek, clearcutting and road building on inner gorge slopes occurred before modern-day forest practices were established. While there is no official record of stream clearing activities in Redwood Creek, limited clearing of debris jams for fish passage may have occurred following the 1964 flood. Today, LWD is a missing component of channel structure in Redwood Creek and there are few large, mature streamside conifers available for recruitment to streams (USEPA 1998, Cannata et al. 2006). Bundros et al. (2004) and Cannata et al. (2006) identify management strategies such as conservation easements and tree planting to protect riparian areas, which include the inner gorges in Redwood Creek.

Current forest practice rules provide a 150-foot wide Watercourse and Lake Protection Zone (WLPZ) along fish bearing streams in which harvest activities are limited. A Special Management Zone (SMZ) can be established where inner gorge slopes extend above the WLPZ. The SMZ can extend up to 300 feet from the stream and evenaged cutting methods in the SMZ are prohibited. The timber harvest review and approval process requires a geologic assessment of inner gorge slopes when harvest activities are proposed in or adjacent to those areas. Protection measures can range from avoidance to selective harvest. Thus, the rules offer protection to these sensitive areas, but do not necessarily promote or encourage the restoration or long-term management of inner gorge slopes. Current rules apply to watersheds with threatened and impaired values and might expire in the near future (CDF 2006).

Responsible Agency/Group: The RCWG, in cooperation with the inner gorge landowners are responsible for this project. The RCWG will initiate discussions with landowners to seek their support for this effort. If agreement in concept is reached, efforts will then determine what type of management activities and protective measures could be used and what parts of the inner gorges in the Redwood Creek watershed could be included, given existing conditions and the landowner's management objectives. Other entities, such as The Nature Conservancy or Save-the-Redwoods League could also initiate this discussion with landowners and implement the project. The

CDF, California Geological Survey, CDFG, and the NCRWQCB have regulatory authority.

Linkages to Other Projects: This project complements other projects that improve and protect water quality and aquatic and riparian habitat. For example, the Erosion Control and Prevention project reduces sediment delivery from hillslopes that contain miles of logging roads and potentially threaten water quality and aquatic habitat. This project focuses restoration efforts on the steep inner gorge slopes adjacent to the main channels of Redwood, Minor, and Lacks creeks. It addresses a specific geomorphic feature that can have a profound effect on aquatic habitat, channel forming processes, and water quality.

Linkages to Local Planning: This project is linked to local planning efforts to improve and protect water quality and salmonid habitat and prevent impacts from activities that can destabilize inner gorge slopes. These efforts include:

- Grading, Erosion Control, Geological Hazards, Streamside Management Areas, and Related Ordinance Revisions (HC 2002) codifies and describes comprehensive provisions dealing with grading, erosion control and potential impacts to streamsides.
- Upper Redwood Creek Watershed Road Assessment Summary Report (Bundros et al. 2003) describes inner gorge conditions along the mainstem of Redwood Creek, and recommends restorative actions.
- Redwood Creek Watershed Assessment Report (Cannata et al. 2006) details the significant volume of sediment that originates from inner gorge landsliding.

Economic and Technical Feasibility: This project is economically and technically feasible, but whether the project can be implemented will not be known until discussions occur with inner gorge land-owners. Participation is voluntary and relies on landowner interest, agreement, and ability to participate. Incentives to encourage landowner participation can be developed, and landowners can be compensated if protection is gained through lost, deferred or reduced harvests, conservation easements, or fee ownership. Incentives could also take the form of BMPs that, when followed, provide regulatory relief.

The technical challenge to this project will be the delineation of inner gorges that need protection and restoration. The slope length of inner gorges and the lateral boundaries of these features will vary from location to location. Delineation will not conform conveniently to property boundaries that traditionally follow straight lines. Thus, the layout and legal surveys for inner gorge protection, if needed, will be costly, but possible.

Financing Project Implementation:
Individual landowners could shoulder the burden of this project by delaying or significantly reducing harvest operations on inner gorge areas. Approved BMPs that provide regulatory relief could compensate landowner voluntary actions. If conservation easements are acceptable, funding will be needed for evaluations, surveys, legal documents and easement costs. Funding could be sought from various grant sources including the Off Highway Vehicle Grant Program, the Coastal Conservancy, Save-the-Redwoods League, and other sources.

Current Status: This project is in the concept phase and no efforts are currently underway to implement this project.

In 2005, the Save-the-Redwoods League purchased land in Lacks Creek that contains

the entire inner gorge of this large tributary stream. The lands were transferred to BLM for long-term management. This action is consistent with the management strategy for BLM's Lacks Creek Management Area (BLM 1995). These lands will be managed to promote inner gorge protection and restoration.

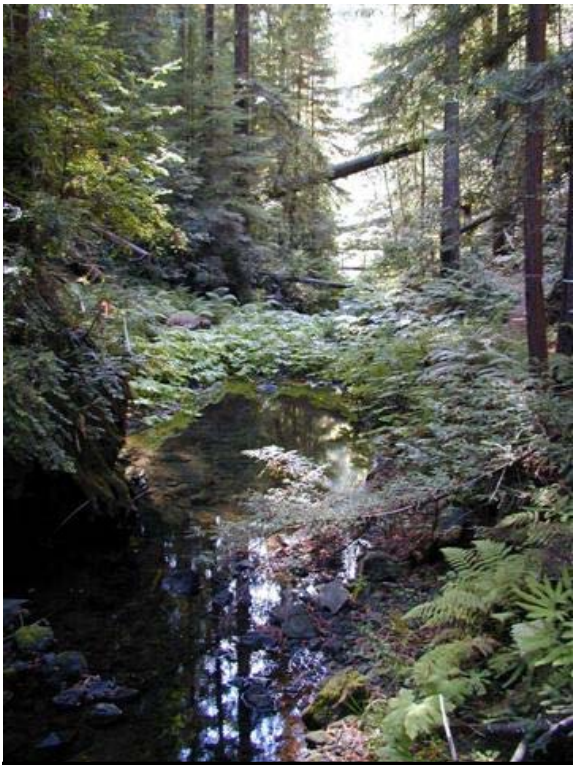
Timeline: Discussions with landowners will occur within the next year. If interest is expressed by willing landowners, the finer details will be explored thereafter. The benefits of implementing this project will take several decades to be fully realized. It will take time to grow large, mature conifer trees on inner gorge slopes that provide stability and future LWD recruitment.

Riparian Restoration

Project Description: Riparian restoration along Redwood Creek and its major tributaries, such as Prairie Creek, will reestablish conifer dominance, where appropriate, to provide future LWD recruitment and shade to reduce summer water temperatures. Assessments of riparian areas will be completed to evaluate riparian conditions and identify areas in need of treatment. Forest openings will be created and conifers planted in areas currently dominated by hardwoods with no conifer understory. Conifer release will occur in areas where a conifer understory resides below a hardwood canopy. Either restoration method could be implemented by use of contracts or nearby timber harvest activities when they occur along stable streamside areas. This project will improve and protect water quality and aquatic and riparian habitat in the watershed in the long term. Landowner participation is voluntary.

Background: The lack of large, mature recruitable conifers along the mainstem of Redwood Creek and its larger tributaries is a lingering cumulative effect from past land use. In 1948, 86 percent of the length of riparian zone along Redwood Creek was dominated by old-growth (mature) conifers (Urner and Madej 1998). By 1978, about 80 percent of the mature conifer forests in Redwood Creek (Best 1995) and more than 80 percent of the riparian areas along Redwood Creek (Bundros et al. 2003) had been harvested. By 1997, nearly 60 percent of the riparian area along Redwood Creek had become hardwood-dominated (Bundros et al. 2003). Forest practice rules that recognized the importance of retaining some streamside trees for the protection of aquatic habitat and water quality were not adopted until 1983 (CDF 1983) after much of the watershed had already been harvested. Landmark studies of cumulative watershed effects (U.C. Committee 2001) and the California Forest Practice Rules (Ligon et al. 1999) led to significant advances in forest practice rules in 2001 (CDF 2001) that improved stream and riparian forest protection in water quality impaired watersheds.

Large woody debris is a necessary component of a functional stream system and benefits aquatic habitat, channel forming processes, and water quality. It meters sediment as it is routed through stream channels, aids nutrient cycling, and provides over-wintering shelter and low flow cover for salmonid species. Statewide priorities documents such as the Recovery Strategy for California Coho



Old growth riparian zone

Photo courtesy of Redwood National and State Parks

Salmon (CDFG 2004) and the Redwood Creek Watershed Assessment Report (Cannata et al. 2006) identify the lack of LWD in the main channel of Redwood Creek as a potentially limiting factor to salmonid production. Bundros et al. (2003) described the lack of recruitable conifers in the riparian areas upstream of State Highway 299. All three documents recommend some form of riparian restoration.

In 2002, Redwood Creek was listed as impaired for high stream temperatures under Section 303(d) of the Clean Water Act. Past timber harvest, removal of riparian vegetation, widespread streamside landsliding, and channel aggradation have been recognized as contributing to higher stream temperatures. The listing by the SWRCB and approval by the USEPA is based on seven years of monitoring data that indicate stream temperatures in Redwood Creek exceed state water quality standards.

Lack of large streamside trees along Redwood Creek

Photo courtesy of Redwood National and State Parks

Current forest practice rules recognize the importance of riparian conifers for the improvement and protection of water quality and aquatic habitat. They also recognize that some watersheds that support listed salmonid species, such as Redwood Creek, have threatened or impaired values that require additional protection measures (CDF 2006). The rules, therefore, place importance on the restoration and maintenance of the beneficial uses of water and habitat of anadromous salmonid species. However, restoration is slow because it occurs on a plan by plan basis. Riparian restoration may require management activities to speed the growth to mature conifer trees.

Responsible Agency/Group: The RCWG in cooperation with the private landowners and RNSP are responsible for this project. Several agencies have regulatory authority, including CDF, CDFG, NCRWQCB, NOAA, and USFWS.

Linkages to Other Projects: Restoring large riparian conifer trees along Redwood Creek complements other projects that improve and protect water quality, and aquatic and riparian habitat. For example, Erosion Control and Prevention focuses on reducing sediment delivery from logging roads that potentially threaten water quality and aquatic habitat. Inner Gorge Protection and Restoration also targets reduction of human-induced sediment and provides for future LWD recruitment when debris slides occur.

Linkages to Local Planning: This project is linked to local planning efforts that improve and protect aquatic habitat and water quality by preventing erosion and restoring riparian areas. Nearly all of the local agencies planning efforts previously cited apply to this project as well, because of the physical linkage of riparian areas to aquatic habitat and water quality.

Economic and Technical Feasibility: This project is economically and technically feasible, but whether the project can be implemented will not be known until discussions occur with private landowners.

Assessments of riparian areas along Redwood Creek and its major tributaries will identify where restoration efforts are needed. There are about 40 river miles of Redwood Creek in the upper watershed. Based on knowledge of the watershed, we estimate that at least 50 percent (20 miles) of the riparian along Redwood Creek will need treatment. A preliminary estimate for a riparian assessment that evaluates the first 200 feet on each side of Redwood Creek will cost about $850-$1,300 per mile of river or $34,000-$52,000 (Cohoon, personal comm.).

Restoration methods will use manual and/or mechanized conifer release or site recovery followed by conifer planting. Restoration could be implemented through fixed-price contracts or by using the services of nearby timber harvest activities, if this action was supported by regulatory agencies. Based upon estimates that do not include overhead costs, manual conifer release will cost about $7,200 per mile or about $300,000 (Bundros et al. 2003) if all 40 river miles are treated. Incentives will be needed to offset restoration costs if done through an approved timber harvest plan, because there will likely be no economic recovery from this type of work. Incentives could take the form of BMPs that, when followed, provide regulatory relief.

Financing Project Implementation:
The funding mechanisms for this project will be the same as that described for the Inner Gorge Protection and Restoration project.

Current Status: For private lands in the upper watershed, this project is only in the concept phase. In the lower watershed, various projects have been completed along Prairie Creek in the last 20 years. Restoring the riparian areas along Strawberry Creek is in the planning phase with implementation expected to begin in summer 2007.

Timeline: Discussions with private landowners will occur within the next year. If landowners are willing to participate, project details will be explored. Full implementation will likely take about five to ten years. Benefits derived from this project will take decades to realize, because it will take time to grow large, mature conifer trees.

6. TECHNICAL ANALYSIS AND PLAN PERFORMANCE

Technical Analysis

Technical analysis for the Redwood Creek IWS relies on extensive monitoring data and analyses available for the Redwood Creek watershed. Since the early 1970s Redwood Creek has been the subject of numerous data collection efforts on both physical attributes and biological conditions. Most of these monitoring programs were established by the USGS and are still in operation today.

Redwood Creek watershed assessments originated in the early 1970s to describe the physical conditions of the watershed and determine processes modifying or threatening to modify the aquatic ecosystems of Redwood National Park (Janda 1975). Baseline inventories of the aquatic biota also complemented these early physical studies in Redwood Creek (Iwatsubo and Averett 1981). The 1978 expansion legislation for Redwood National Park directed the Park Service to conduct hydrologic studies on erosion and sedimentation in the Redwood Creek watershed. The NPS continues several monitoring studies established by the USGS.

Long-term studies in Redwood Creek have dominantly focused on physical processes and watershed response. The focus of the park's physical monitoring and research has been to evaluate the effects of large storms and land use on watershed process. Long-term aquatic monitoring (>25 years) has focused on estuary juvenile fish population trends and water quality, salmonid distribution, and estimating summer steelhead populations in Redwood Creek.

Results from various physical and biological studies are summarized in the Redwood National Park technical report series, NPS in-house reports, USGS publications, published articles and conference proceedings. Results from these studies have been used to guide current protection and restoration efforts, and the development of the Redwood Creek IWS. Monitoring data and watershed studies in Redwood Creek have also been used by state and federal agencies in watershed level planning efforts including the Clean Water Act 303(d) listings, TMDL, the state Coho Recovery Strategy, and Redwood Creek Watershed Assessment Report. Technical analyses for these watershed initiatives were also used to develop the Redwood Creek IWS.

Long-term studies used to support the Redwood Creek IWS

- Physical and hydrological conditions and processes in the estuary and lower reach of Redwood Creek
- Biological function of the estuary related to salmonid rearing and water quality conditions
- Hydrology and sediment transport in Redwood Creek and selected tributaries
- Fish presence, abundance, and distribution in the main channel and selected tributaries
- Sedimentation and channel response along the main channel of Redwood Creek
- Watershed erosion and sediment delivery
- Erosion and sedimentation from road systems

Project/Plan Performance

Monitoring

A Redwood Creek monitoring strategy (Duffy et al. in progress) is being prepared to measure project performance and determine if IWS objectives are met. Monitoring efforts associated with the Redwood Creek IWS will focus on both effectiveness monitoring of specific IWS implementation projects (Table 6) and also long-term watershed monitoring to track changes in water quality and aquatic habitat (Table 7).

Monitoring Program

The monitoring program will collect biological, chemical and physical data in an attempt to:

- Assess the effectiveness of individual implementation projects
- Track conditions and trends in water quality, aquatic and riparian habitat, fish and hillslope response to disturbance events (floods, fire, wind) in Redwood Creek
- Link physical and biological trends and response
- Coordinate basin-wide monitoring and data sharing with agencies and landowners
- Provide essential data and analysis to support and guide adaptive management in Redwood Creek

Most of the trend monitoring projects identified in Table 7 are established programs with more than five years of data. The monitoring program will integrate the extensive physical and biological monitoring that currently exists for Redwood Creek by more closely coordinating projects, sharing expertise, and data. The RCWG will coordinate basin-wide monitoring efforts, data sharing, and management with agencies and landowners annually.

Monitoring requires covering a range of temporal scales that include annual, periodic, and post-disturbance event monitoring. Most of the elements for monitoring identified in the IWS are currently unfunded and will require programmatic funding (greater than five years) to be successful (Cannata et al. 2006).

Methodology

Standardized techniques already exist for the current monitoring studies in Redwood Creek and are described by Duffy et al. (in progress). Monitoring data are analyzed and summarized on an annual basis by various agencies. New monitoring programs will utilize standardized methodologies where available. Refer to Duffy et al. (in progress) for methodologies.

Downstream migrant trap in Redwood Valley monitors juvenile salmon and steelhead populations.

Photo courtesy of Mike Sparkman

Monitoring stream discharge and sediment transport on Redwood Creek.

Photo courtesy of Redwood National and State Parks

Monitoring Reports

Parties responsible for IWS implementation projects will also be responsible for project monitoring, data analysis, and summary reports. The frequency at which reports are prepared will depend on the nature of the project implemented. For example, annual reports will be prepared for erosion control and prevention work, because changes can be detected one year after implementation. In contrast, five-year summary reports will be prepared for long-term watershed monitoring, because more time is needed to detect changes and trends at the watershed scale. Monitoring reports will include: monitoring objectives, a map of monitoring locations, methodology, results, and digital data that conform to state data management protocols. Reports will be submitted to the RCWG and will facilitate evaluation of plan performance and adapting project operations and IWS implementation.

Adaptive Management

The Redwood Creek IWS will utilize adaptive management to ensure IWS objectives are being met. Adaptive management in the IWS requires the best available science to support sound decision making. Monitoring results will provide the necessary feedback for altering project operations, implementation and, potentially, IWS implementation priorities. The RCWG will evaluate monitoring results with landowners and agencies, as appropriate, and recommend changes, if needed. The RCWG may also consider contracting for the integration and analysis of long-term biological and physical trend monitoring by an impartial scientific panel.

Data Management

Existing monitoring efforts are identified in Table 3 and include physical and biological data. RNSP is the data repository for most of these studies.

The intent is to make data management and quality assurance/quality control procedures used in the Redwood Creek monitoring program for water quality consistent with the Quality Assurance Management Plan (Puckett 2002) for California's Surface Water Ambient Monitoring Program (SWAMP). However, a recent review of SWAMP by an independent scientific panel (SPARC 2005), identified technical issues with the program (e.g., study design) that need to be addressed, along with broader issues of program purpose and strategy. Assuming these issues are resolved and funding for Redwood Creek monitoring is available, water quality data will be submitted to SWAMP for archiving and distribution to interested parties. Refer to the Redwood Creek monitoring plan (Duffy et al., in progress) for more detailed information.

Table 6. Effectiveness monitoring for implementation projects in the Redwood Creek IWS.

Effectiveness Monitoring		
IWS Projects	**Monitoring Objective** ***Monitoring Questions***	**Monitoring Elements**
Wastewater Treatment Facility	Monitor water quality in the Orick valley. Document changes in water quality from operation of a new wastewater facility. ***Has the new wastewater treatment facility reduced groundwater and surface water bacteria and nitrogen content so they are not a human health concern?*** (see also Strawberry Creek restoration)	• ground and surface water quality monitoring in the Orick valley
Short-term Flood Control	Monitor flood capacity and channel response to gravel extraction and vegetation removal ***Are current levee and channel management actions maintaining the flood capacity of the levees?***	• channel cross-section and longitudinal surveys • riparian vegetation surveys • levee subsidence surveys
Long-term Flood Control	Monitor changes in aquatic and riparian habitat, estuary function, flood control (see also estuary restoration objectives) ***Has levee modification maintained flood protection for the Orick valley?***	• channel cross-section and longitudinal surveys of leveed reach • riparian vegetation surveys (see estuary restoration monitoring)
Estuary Restoration	Monitor physical and biological response to estuary restoration. ***Did estuary water quality improve following estuary modifications?*** ***Did estuary modifications increase water depth and volume in the estuary?*** ***Did survival and production of juvenile salmonids increase following estuary modifications?*** ***Are exotic/invasive plants colonizing in the estuary following modifications?***	• estimate juvenile fish population and growth • monitor summer water quality • survey estuary cross-sections to determine variation and changes in estuary volume • monitor timing of opening and closing of the stream mouth with surface water elevations • survey presence/absence of birds and terrestrial species • monitor and manage exotic plant species

Effectiveness Monitoring		
IWS Projects	**Monitoring Objective** ***Monitoring Questions***	**Monitoring Elements**
Strawberry Creek Restoration	Monitor physical and biological response to restoration activities in Strawberry Creek. ***What is the channel response to restoration of Strawberry Creek?*** ***What is the distribution and extent of reed canary grass and exotic species in Strawberry Creek following restoration?*** ***Are there changes in Strawberry Creek water quality as a result of operation of the new wastewater treatment plant? **** ***How is storm water overflow into Strawberry Creek from the wastewater treatment facility affecting the hydrology of the creek? **** ***Are fish populations improving?*** ***Is fish distribution improving?*** * These questions depend on where a wastewater treatment facility is built in Orick, and how storm water from the facility is delivered to streams.	• survey channel cross-section and longitudinal streambed profile pre- and post- treatment. • monitor riparian vegetation • monitor exotic plant species and manage • monitor water quality related to discharge from future wastewater treatment plant • monitor discharge to determine effects of storm water contribution from future wastewater treatment plant on Strawberry Creek hydrology • survey presence/absence of salmonid species • survey distribution of salmonid species
Private Lands Erosion Control and Prevention	Document changes in erosion and sedimentation from upgraded and decommissioned roads. ***Has road decommissioning and upgrading decreased sediment delivery to Redwood Creek during storm events?*** ***Did road treatments perform as expected during large storm events (>10-year RI)?***	• perform site visits • document conditions with photos • measure post-treatment erosion
Public Lands Erosion Control and Prevention	Document changes in erosion and sedimentation following road removal. ***How do road treatments affect turbidity and suspended sediment?*** ***If sediment effects are observed from road treatment activities, how long do they persist?***	• perform site visits • document conditions with photo • measure post-treatment erosion • measure turbidity changes following stream crossing removal in Lost Man Creek

Effectiveness Monitoring		
IWS Projects	**Monitoring Objective** ***Monitoring Questions***	**Monitoring Elements**
Inner Gorge Protection and Restoration	Determine long-term landslide frequency. Monitor distribution of large, mature conifer trees on inner gorge slopes. ***Has inner gorge protection and restoration increased slope stability of inner gorge slopes?*** ***Has inner gorge restoration activities increased the number of mature conifer trees?***	• Map inner gorge landslides • Determine the number and distribution of mature conifer trees on inner gorge slopes
Riparian Restoration	Document long-term changes in riparian conifer tree size and distribution and riparian vegetation. ***How has riparian restoration changed conifer distribution and size along Redwood Creek?*** ***What is the future large wood recruitment to Redwood Creek from riparian restoration?***	• conduct riparian tree and vegetation surveys on private lands to determine conifer tree distribution and size • determine overstory canopy closure above the streams

Table 7. Trend monitoring for the Redwood Creek watershed.

Trend Monitoring		
	Monitoring Objective ***Monitoring Questions***	**Monitoring Elements*** **(date established)**
Water Quality and Aquatic Habitat	Track long-term trends in water quality and aquatic habitat ***How is water quality in Redwood Creek changing through time?*** • *sediment load in Redwood Creek* • *summer water temperature* • *nutrients/contaminants* • *estuary* ***How is aquatic habitat, including riparian conditions, changing through time?*** • *channel morphology/complexity* • *substrate* • *LWD* • *riparian composition* • *overstory shade canopy* ***What is the status and trend of salmonid populations in Redwood Creek?*** • *escapement of adult salmonids* • *outmigrant juvenile salmonid populations* • *estuary salmonid populations* ***What is the hillslope and channel response following disturbance events (floods, fire, wind)?*** • *inner gorge landslides* • *road-related failures* • *sedimentation* • *channel morphology* *see Effectiveness Monitoring. Many of the Effectiveness Monitoring Elements will contribute to long-term watershed trend monitoring. They have not been repeated here to avoid redundancy.	**Physical Monitoring** • stream discharge and sediment in mainstem and selected tributaries to document long-term discharge and sediment transport trends (USGS stations monitored since 1954 at Blue Lake and 1973 at Orick) • channel cross-sections (1973) and longitudinal profiles on mainstem (1975) • summer stream temperature of mainstem and selected tributaries to document long-term spatial and temporal temperature trends (1997) • LWD size, volume and distribution • LWD recruitment potential • acquire aerial photography of watershed every five years to map landslides and channel changes **Biological Monitoring** • operate two downstream migrant traps on mainstem to estimate fish populations (upper trap established in 2000 and lower trap in 2003) • annual summer steelhead surveys along mainstem to determine long-term trends (1981; from Lacks Creek downstream to Hayes Creek) • Opportunistic mainstem spawning surveys to determine number, species, and distribution of adults (1980) • fish distribution in tributaries and Redwood Creek mainstem (1980) • juvenile coho studies in Prairie Creek (1995)

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APPENDIX A: Agreement of Intent for the Redwood Creek Watershed Group

AGREEMENT OF INTENT

between
BUREAU OF LAND MANAGEMENT
and
HUMBOLDT COUNTY
and
ORICK COMMUNITY SERVICES DISTRICT
and
ORICK LEVEE COMMITTEE
and
PACIFIC COAST FISH, WILDLIFE, AND WETLANDS RESTORATION ASSOCIATION
and
REDWOOD CREEK ESTUARY LANDOWNERS
and
REDWOOD CREEK LANDOWNERS ASSOCIATION**
and
REDWOOD NATIONAL AND STATE PARKS
and
REDWOOD REGIONAL WATERSHED CENTER
and
U.S. FISH AND WILDLIFE SERVICE
and
U.S. GEOLOGICAL SURVEY COOPERATIVE FISH RESEARCH UNIT
and
U.S. GEOLOGICAL SURVEY WESTERN ECOLOGICAL RESEARCH CENTER

within the
REDWOOD CREEK WATERSHED, HUMBOLDT COUNTY

to
develop an integrated watershed strategy
for Redwood Creek and Proposition 50 grant applications.

** Membership in the Redwood Creek Landowners Association includes Barnum Timber Company, Estate of Herb Russ, Green Diamond Resources Company, Kahn Properties, Russ Ranch, Sierra Pacific Industries, and the Stover Ranch.

1. BACKGROUND AND OBJECTIVES

The Redwood Creek watershed contains a rich blend of agricultural lands, industrial and non-industrial timber lands, national and state parks and the unincorporated town of Orick. Redwood Creek is the common thread in this watershed community, supporting threatened salmonid species, and providing domestic water supplies and recreational opportunities. Limited maintenance of the Redwood Creek Flood Control Project has resulted in modified sediment transport, increased vegetative growth and reduced levee capacity in the lower portion of Redwood Creek. Levee construction at the mouth of Redwood Creek has significantly compromised estuary function. Past land use in the watershed has impacted water quality and aquatic habitat. Redwood Creek is listed as sediment and temperature impaired under Section 303(d) of the federal Clean Water Act.

The United States Department of Interior Bureau of Land Management (BLM) manages land in California and throughout the western United States to sustain the health, diversity and productivity of the public lands for use and enjoyment of present and future generations. The BLM Arcata Field Office has a long history of managing public lands in Lacks Creek, the second largest tributary to Redwood Creek. This land has been managed for watershed and old-growth protection, enhancing forest health and providing dispersed recreational opportunities. BLM has collaborated with private landowners, Redwood National and State Parks and other public agencies to achieve these goals.

Humboldt County is the regional governing body whose jurisdiction covers the entire Redwood Creek watershed. It is responsible for land use planning, and operation and maintenance of the Redwood Creek Flood Control Project. The County supports the concept, purpose and need of Proposition 50, and understands the importance of collaboration and communication to secure funds for water related projects that benefit communities, and improve and protect water quality.

The Orick Community Services District is the local governing body that provides municipal services, including drinking water and fire protection to the community. The Orick community is located on the coastal floodplain of the watershed, where Redwood Creek flows through the center of town and rich agricultural lands. A prosperous and sustainable future for Orick depends on future commercial and residential development, flood control, and a modern wastewater storage and treatment facility that can accommodate future growth.

The Orick Levee Committee is a community-based organization comprised of Orick landowners. Its goal is to provide for the health and safety of Orick residents and their property by assuring maintenance of the Redwood Creek levee system in conformance with current agreements. The County has assumed levee maintenance responsibility as per the maintenance agreement with the U.S. Army Corps of Engineers, and the committee is organized to assist in whatever ways possible to ensure levee capacity is maintained.

The Pacific Coast Fish, Wildlife, and Wetlands Restoration Association (PCFWWRA) is a public benefit not-for-profit organization incorporated in the state of California under Section 501(c)(3). PCFWWRA is experienced in the development and implementation of programs for the conservation and protection of soil, water and associated biological resources in northwestern California watersheds. It has conducted extensive sediment source inventories on private lands

in the Redwood Creek watershed and, based on inventory results, has implemented numerous road decommissioning and upgrade projects.

The Redwood Creek Estuary Landowners own lands immediately adjacent to the Redwood Creek estuary. Situated behind the Redwood Creek levees, agriculture including dairy farming, and cattle and sheep ranching, has been the primary use of lands that surround the estuary since the 1940s. Agricultural use of these lands has a significant cultural history that represents small family business interests, and a life style that landowners and the community wish to maintain.

The Redwood Creek Landowners Association is comprised of private landowners who own and manage lands in the Redwood Creek watershed. Its members represent ranching and forestry interests. Its combined ownership accounts for about 90 percent of the privately owned portion of the watershed upstream of Redwood National Park. The association, Redwood National Park and PCFWWRA have a long history of planning and implementing erosion control and prevention work on private lands in Redwood Creek.

Redwood National and State Parks are managed by the National Park Service and California Department of Parks and Recreation under a joint management agreement signed in 1994. The parks were established to preserve significant examples of primeval coastal redwood forest, and the streams and seashore with which they are associated. The parks occupy most of the lower-third of the Redwood Creek watershed. Through agreements originally signed in 1995, Redwood National Park and upper basin landowners have cooperated on several projects to reduce or prevent erosion from logging roads.

The Redwood Regional Watershed Center is a non-profit organization. Its mission is to connect people and watershed-based scientific and practical field programs, thereby connecting people with the natural world and responsible actions to sustain it. The center has worked with private landowners in the Orick community, including the elementary school, and has a General Agreement with Redwood and National State Parks to create watershed-based education, research and interpretation programs within the park and surrounding areas.

The U.S. Fish and Wildlife Service works with others to conserve, protect and restore fish, wildlife, plants and their habitats for the continuing benefit of the public. It has several voluntary programs available to fund habitat restoration projects on private lands that benefit fish and wildlife, while balancing the needs and interests of landowners and local communities. The Service has funded several restoration projects on private lands in upper Redwood Creek. It recognizes the importance of the Orick valley to its residents, and to fish and wildlife.

The U.S. Geological Survey California Cooperative Fish Research Unit (USGS Cooperative Fish Unit) works with federal and state agencies to provide research information needed by natural resource managers. It collaborates with Humboldt State University to train graduate students in natural resource sciences. The unit conducts research in Redwood Creek on watershed restoration, as well as on other topics. It recognizes the social and resource values of the Redwood Creek watershed.

The U.S. Geological Survey Western Ecological Research Center, Redwood Field Station (USGS Redwood Field Station) works with others to provide scientific understanding and technologies needed to support sound management and conservation of the Nation's biological resources. The station has conducted several sediment transport and salmon habitat studies in the Redwood Creek watershed, and currently has several water quality monitoring programs in place.

Proposition 50, passed by California voters in November 2002, authorizes the Legislature to appropriate $500 million for the Integrated Regional Water Management Grant Program to fund projects that improve and protect water quality. Cooperative efforts between the Bureau of Land Management, Department of Fish and Game, Fish and Wildlife Service, USGS Cooperative Fish Unit, USGS Redwood Field Station, Humboldt County, Orick Community Services District, Orick Levee Committee, PCFWWRA, Redwood National and State Parks, Redwood Creek Estuary Landowners, Redwood Creek Landowners Association, and the Redwood Regional Watershed Center (collectively, the REDWOOD CREEK WATERSHED GROUP) can facilitate the development of an Integrated Watershed Strategy for Redwood Creek and grant applications that meet requirements of Proposition 50, or other funding opportunities.

The Redwood Creek watershed is one of the most intensely studied watersheds in California, and the need for improved flood control and sewage treatment in Orick and improved water quality and aquatic habitat throughout the watershed is clear. This cooperative effort would improve and protect water quality and aquatic habitat in Redwood Creek, provide economic opportunities and improved flood control in Orick, increase park resource protection, and increase competitiveness in securing various grant-funded opportunities. The watershed is largely "whole" in that it contains no major cities, upland sub-divisions, water projects or stream diversions. The ownership pattern in the Redwood Creek watershed lends itself to this cooperative effort.

All parties therefore understand and agree as follows:

2. STATEMENT OF WORK

The REDWOOD CREEK WATERSHED GROUP (RCWG) shall voluntarily cooperate to develop an Integrated Watershed Strategy (IWS) for the Redwood Creek watershed. The RCWG shall also develop Proposition 50 grant applications that detail proposals to implement or plan projects that improve and protect water quality consistent with the IWS. The IWS shall be prepared for the expressed purpose of securing funds for improvement and protection of water quality in the Redwood Creek watershed. This voluntary effort should not result in additional regulatory burden to landowners in the watershed.

3. VOLUNTARY NON-BINDING AGREEMENT

This is a voluntary non-biding agreement. It shall not be construed as a grant of access to or interest in RCWG lands, nor does it relinquish or compromise any private property rights. The RCWG agrees to the general intent of this effort, but reserves the right to: 1) review specific project proposals on an individual basis; 2) decide their level of involvement, and; 3) cease involvement at any such time if the best interest of any party or their client is not served.

Signing this agreement does not necessarily indicate agreement with any project that might be implied in this agreement, nor is it a commitment of any party's time and/or resources.

4. TERM OF AGREEMENT

The IWS shall be a living document periodically reviewed and refined as projects are identified and implemented, and watershed conditions change. Therefore, this agreement will remain in effect unless terminated by provisions in this agreement or any applicable State or Federal law or regulation. The agreement may be renewed or otherwise amended by the mutual written agreement of the RCWG. The effective date of the agreement shall be the date of its execution by the parties (or their delegate).

Additional parties who wish to join this effort can be added in the future.

5. TERMINATION

Any party may terminate their participation with this agreement at any time by a written statement to the RCWG.

6. SIGNATORIES TO THIS AGREEMENT

(see cover page)

APPENDIX B: Relation to Local Agency Planning

The Redwood Creek Watershed Group has an established relationship with local agencies, such as the Orick Community Service District and Humboldt County, as well as federal and state agencies, such as the NOAA Fisheries, NPS, USFWS, and CDFG. This relationship has spawned broad discussions regarding community and watershed needs. In consideration of these discussions and state water management initiatives, the RCWG has attempted to integrate infrastructure (community) and natural resource (watershed) needs at the watershed scale. The implementation projects described in this document reflect the integration of community and watershed needs.

The Redwood Creek IWS goals and objectives compliment local planning efforts to improve watershed conditions in Redwood Creek and provide economic opportunity for the Orick community. Humboldt County staff and Supervisors have actively participated in RCWG meetings to help articulate issues, and coordinate and develop implementation projects. Parties responsible for specific implementation projects have also met with county staff to clarify county policy and goals relevant to the projects. The RCWG will continue to coordinate projects with local agencies to ensure consistency and integration with local planning. The broad membership of the RCWG provides regular interaction between local planners and representatives from the Orick community, local conservation groups, and state and federal agencies.

Local Agency Planning

The Orick Community Services District is the local governing body in the watershed that provides municipal services to the Orick community. Humboldt County is the regional governing body with land use jurisdiction for the entire Redwood Creek watershed.

Humboldt County has contributed to local area planning for the Orick community by developing the Orick Community Action Plan (HC 2003), and supporting studies that identified the need for wastewater treatment improvements (OLA 1999, SHN 2004). Through a collaborative effort, the Orick Community Services District, Humboldt County, Humboldt State University, and RNSP are exploring wastewater treatment alternatives that are consistent with local planning efforts and include recreational opportunities (HSU 2005). The BLM and RNSP have developed management plans and strategies that address improvement and protection of water quality and salmonid populations on both public and private lands in Redwood Creek. The Northcoast Regional Land Trust (NRLT) has also completed the Northcoast Farmland Conservation Study (NRLT 2005), a local planning effort that includes the Orick area. Table 8 lists the local planning efforts that support the implementation projects described in this document.

Table 8. Local agency planning and Redwood Creek IWS implementation projects.

Local Agency Planning Documents and Programs
General Land Use: • Humboldt 2025 General Plan, Building Communities A Discussion Paper for Community Workshops (DTB 2002) • Supplemental Environmental Impact Report 2003 Update of the Housing Element SCH #1996-052011 (HC 2003b) • County of Humboldt Preliminary Redevelopment Report (HC 2005) Watershed Planning: • Redwood Creek Estuary Proposed Restoration Plans: Hydrologic and Hydraulic Analysis (Corps 1994) • Arcata Planning Area Resource Management Plan Amendment and Environmental Assessment (BLM 1995) • Redwood Creek Watershed Analysis (RNSP 1997) • RNSP General Management Plan/General Plan (NPS-CDPR 1999) • Hydraulic Analysis of Alternative Levee Configurations for Lower Redwood Creek (Moffatt and Nichol 2003) • North Coast Farmland Conservation Study: Humboldt County Coastal Agricultural Lands (NRLT 2005) • Basin-wide Aquatic and Riparian Habitat Restoration Strategy for Strawberry Creek near Orick, Humboldt County (RCWG 2006) • Redwood Creek Watershed Assessment Report (Cannata et al. 2006) • Strategies and Opportunities for the Restoration of Redwood Creek Estuary (Anderson in progress) Wastewater Treatment for Orick Community: • On Site Pollution Study Final Report (OLA 1999) • Orick Community Action Plan (HC 2003) • Feasibility Study Wastewater Collection, Treatment, and Disposal (SHN 2004) • A Wastewater Treatment Alternative for Orick, California (HSU 2005) Erosion Control and Prevention: • Grading, Erosion Control, Geological Hazards, Streamside Management Areas, and Related Ordinance Revisions (HC 2002) • Water Quality and Habitat Protection Manual for County Road Maintenance (HC 2002a) • Biological Opinion Annual Routine and Non-Routine Road Maintenance Program. Action Agency: RNSP (NMFS 2003) • Local Coastal Plan Issue Identification Report (HC 2003) • Five Counties Road Erosion Inventory (TCPD-MWA 2004) • Road Strategy: Access and Treatment Priorities for Parkland in the Redwood Creek Watershed (RNSP 2004) • Maintenance Work Plan Redwood Creek Flood Control Project (HC 2005b) • Upper Redwood Creek Watershed Road Assessment Summary Report (Bundros et al. 2003) • Upper Redwood Creek Watershed Road Assessment: Updated Summary Report (Bundros et al. 2004) • Lost Man Creek Watershed Restoration Plan and Environmental Assessment (RNSP in press)

APPENDIX C: Statewide Water Priorities

The DWR and SWRCB have identified statewide priorities that consist of projects, policies and programs (DWR-SWRCB 2004). When implemented, the priorities will better ensure the improvement and protection of beneficial uses of water. The Redwood Creek watershed is identified as a high priority in several state water quality and salmonid protection and recovery programs. This section describes how the Redwood Creek IWS will meet the statewide priorities listed in Table 9.

Table 9. Statewide priorities addressed by the Redwood Creek IWS.

Statewide Priorities
• Redwood Creek Sediment TMDL (USEPA 1998) • Recovery Strategy for California Coho Salmon (CDFG 2004) • North Coast Watershed Assessment Program (NCWAP 2002, Cannata et al. 2006) • California Salmonid Stream Habitat Restoration Manual (CDFG 2002) • Plan for California's Nonpoint Source Pollution Control Program (SWRCB 1999) and applicable management measures (USEPA 2001, USEPA 2002, USEPA 2003) • Areas of Special Biological Significance: California's Marine State Water Quality Protection Areas (SWRCB 2003) • California 2002 Critical Coastal Areas Draft Strategic Plan (SCC 2003) • Watershed Management Initiative (NCRWQCB 2005) • California Floodplain Management Report - Final Recommendations (FMTF 2002) • Surface Water Ambient Monitoring Program (NCRWQCB 2004, Puckett 2002) • Publicly Owned Treatment Works Program Priorities (NCRWQCB 2005a)

Description of Statewide Priorities

Redwood Creek Sediment Total Maximum Daily Loads (TMDL)

The Redwood Creek sediment TMDL identified accelerated erosion from past land use (timber harvest and road construction) has impacted the water quality and the beneficial uses in the watershed, particularly the cold water fishery (USEPA 1998). The TMDL includes several instream and hillslope numeric targets along with allowable loads and loading allocations that, when implemented, are intended to result in attainment of applicable water quality standards for sediment. It also recommended a few key implementation strategies that include: 1) promote and facilitate cooperative private-public implementation and monitoring efforts; and 2) treat active and potential erosion sites on roads.

The Redwood Creek IWS directly addresses several of the TMDL targets and implementation recommendations to protect water quality. The private and public land erosion control and prevention projects reduce sediment delivery primarily from roads by removing those that are failing and abandoned, and upgrading those that are necessary for management purposes. For example, PCFWWRA and RNSP will continue to work cooperatively with private landowners in the upper watershed to identify and fix road-related erosion problems. Similarly on public lands, managers will continue to seek funding to remove failing roads and restore watershed conditions. Both erosion control programs, on private and public lands, will prioritize sub-watersheds and sites where limited funds can be targeted to achieve the greatest water quality benefit. Other projects identified in the IWS, such as inner gorge protection and restoration, and riparian restoration will also reduce sediment delivery to Redwood Creek and contribute to the attainment of TMDL load allocations and water quality objectives. Additionally, the IWS calls for the continuation of monitoring throughout the watershed which will help determine whether water quality in the watershed is improving over time.

Recovery Strategy for California Coho Salmon (Recovery Strategy)

The Recovery Strategy was developed as a guide to help recover coho salmon populations on the north and central coasts of California, and identified Redwood Creek as a high priority watershed for restoration (CDFG 2004). The prioritization process considered information on coho salmon populations, watershed conditions, and risks to coho salmon. As a high scoring watershed, Redwood Creek should be given priority in the expenditure of restoration funds, according to the Recovery Strategy.

The Recovery Strategy recommended the following actions in Redwood Creek to assist in the recovery of coho populations (pg. 8.23-24). The projects identified in the Redwood Creek IWS (in parentheses) implement many of the recommendations from the Recovery Strategy.

- "*Work with RNSP, private landowners and interested parties to improve coho salmon habitat conditions of the estuary while protecting Highway 101 and the Town of Orick…*" (long-term flood control, estuary restoration)
- "*Work with Corps, RNSP, and Humboldt County to modify levee maintenance manuals to be consistent with habitat requirements of coho salmon while maintaining flood control…*" (short-term and long-term flood control)
- "*Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring large woody debris and shade …*" (inner gorge protection and restoration, riparian restoration, Strawberry Creek restoration, long-term flood control)
- "*Encourage completion of assessments of sediment sources and upgrade deficient assessments; then encourage implementation of the recommendations contained in the assessment, paying particular attention to road assessment and implementation of road improvement projects; and the incorporation of measures to preclude sediment delivery to stream systems…*" (private and public erosion control and prevention)
- "*Develop and implement measures to reduce water temperatures, improve the quality and quantity of deep pools, spawning gravels, and cover…*" (riparian restoration)
- "*Coordinate a long-term, concerted effort between landowners, interested parties, and responsible agencies to determine the current population size and trends of coho salmon of Redwood Creek*" (trend monitoring).

North Coast Watershed Assessment Program (NCWAP)

The NCWAP was established to provide a consistent scientific foundation for collaborative watershed restoration efforts and to better meet California's needs for protecting and restoring salmonid species and their habitat under state and federal laws (NCWAP 2002). Redwood Creek was identified as a high priority for NCWAP and one of the few watersheds for which an assessment was completed.

The most frequent recommendations in the Redwood Creek Implementation Summary Report draft (Cannata et al. 2006) address sediment, water temperature and LWD recruitment. The report recommends treating roads and failing stream banks to reduce sedimentation. On steep and/or potentially unstable slopes, such as the inner gorges in Redwood Creek, the report recommends limiting road construction and reconstruction, and the use of lower impact silvicultural prescriptions with cable or helicopter yarding to reduce the potential for mass wasting. The report also recommends promoting growth of conifers in the riparian large enough to develop cool microclimates to reduce water temperatures and increase LWD recruitment to streams.

Several of the projects in the Redwood Creek IWS address the recommendations in the summary report. They include erosion control and prevention on private and public lands, inner gorge protection and restoration, riparian restoration and Strawberry Creek and estuary restoration. After considering the problems, recommendations, advantages and challenges, the report states, "*The Redwood Creek Basin is an excellent candidate for a successful, long-term programmatic watershed improvement effort.*"

California Salmonid Stream Habitat Restoration Manual

The CDFG Salmonid Stream Habitat Restoration Manual provides an approach and technical methods for restoration of anadromous salmonid habitat. Part X Upslope Assessment and Restoration Practices identifies restoration strategies and protocols to reduce and prevent erosion from roads. The strategies and protocols have been used in Redwood Creek on public lands since 1978 and private lands since 1995, and will continue to be used by IWS projects that implement erosion control and prevention on private and public lands. The IWS approach to erosion control and prevention is consistent with the following key elements in the restoration manual:

<u>Inventory and Assessment</u>:

- Training field crews
- Analyzing aerial photos
- Collecting field data
- Measuring future erosion volumes
- Database management
- Analyzing costs
- Prioritizing restoration by cost-effectiveness

Implementing Restoration Work:

- Strategies including control and prevention
- Road decommissioning treatment
- Road upgrading treatment
- Heavy equipment guidelines (production rates, flow and diversion guidelines)
- Quality control measures
- Documentation
- Monitoring (effectiveness and trend)

The steps outlined in the CDFG Restoration Manual are implemented on private lands in Redwood Creek utilizing a unique partnership between landowners, a non-profit organization (PCFWWRA), RNSP and other funding and regulatory agencies.

Part XI Riparian Habitat Restoration of the CDFG Restoration Manual identifies strategies and protocols to restore riparian areas. The Redwood Creek IWS contains several projects that will restore riparian habitat by reestablishing large conifers for shade, bank stabilization and recruitment of instream LWD. The IWS projects include Strawberry Creek restoration (invasive/exotic weed removal and native planting), estuary restoration including tributary sloughs, and riparian restoration along Redwood Creek and tributaries.

Plan for California's Nonpoint Source Pollution Control Program (Nonpoint Source Program Plan)

Nonpoint source pollution or polluted runoff in the form of sedimentation primarily from logging roads is a leading cause of impairment to Redwood Creek according to the CWA 303(d) list and the sediment TMDL (USEPA 1998). California's Nonpoint Source Program Plan provides a single, coordinated statewide approach to deal with Nonpoint Source pollution. The plan uses 61 management measures that serve as general goals to control and prevent pollution generated from key activities generating polluted runoff. Site-specific management practices are then used to achieve the goals of each management measure (SWRCB 1999). The plan also describes a three-tiered approach to address polluted runoff ranging from Tier 1: self-determined implementation of management practices, also known as voluntary implementation to Tier 3: effluent limitations and enforcement actions.

The Redwood Creek IWS embraces a Tier 1 approach to reduce erosion from roads and other ground disturbing activities, as indicated by the existing collaborative partnership between landowners, a non-profit organization and RNSP to assess road-related sediment sources and implement road decommission and upgrade projects on private lands. Several projects of the Redwood Creek IWS incorporate Nonpoint Source Program Plan management measures, particularly those related to silviculture, roads, hydromodification, wetlands, riparian areas, and monitoring, as illustrated in Table 10 below.

Table 10. Nonpoint Source Program Plan management measures addressed by Redwood Creek IWS implementation projects.

Nonpoint Source Program Plan Management Measure	***Redwood Creek IWS Implementation Projects***
Silviculture	
2A. Pre-harvest Planning	Private Lands Erosion Control and Prevention
2B. Streamside Management Areas	Private Lands Erosion Control and Prevention, Inner Gorge Protection and Restoration Riparian Restoration
2C. Road Construction/Reconstruction	Private Lands Erosion Control and Prevention
2D. Road Management	Private and Public Lands Erosion Control and Prevention
2E. Timber Harvesting	Private Lands Erosion Control and Prevention
2F. Site Preparation/Forest Regeneration	Private Lands Erosion Control and Prevention
2H. Regeneration of Disturbed Areas	Private and Public Lands Erosion Control and Prevention
2J. Wetlands Forest	Private and Public Lands Erosion Control and Prevention
2K. Post-harvest Evaluation	Private Lands Erosion Control and Prevention
2L. Education/Outreach	Education/Outreach common to all IWS projects
Hydromodification	
5.1 Channelization/Channel Modification	
A. Physical and Chemical Characteristics of Surface Waters	Short-term Flood Control Long-term Flood Control Orick Wastewater Treatment Facility Estuary Restoration Private and Public Lands Erosion Control and Prevention
B. Instream and Riparian Habitat Restoration	Short-term Flood Control Long-term Flood Control Estuary Restoration Strawberry Creek Restoration Riparian Restoration Inner Gorge Protection and Restoration
5.3A Eroding Streambanks and Shorelines	Inner Gorge Protection and Restoration Riparian Restoration Strawberry Creek Restoration Private and Public Lands Erosion Control and Prevention Estuary Restoration
Wetlands, Riparian Areas, and Vegetated Treatment Systems	
6A. Protection of Wetlands/Riparian Areas	Inner Gorge Protection and Restoration Riparian Restoration Strawberry Creek Restoration Private and Public Lands Erosion Control and Prevention Estuary Restoration
6B. Restoration of Wetlands/Riparian Areas	Strawberry Creek Restoration Estuary Restoration Orick Wastewater Treatment Facility
6D. Education/outreach	Education/Public Outreach common to all IWS projects
Implement TMDLs	
	Private and Public Lands Erosion Control and Prevention Strawberry Creek Restoration
Monitoring	
	Effectiveness and Trend Monitoring common to all projects

California's Marine State Water Quality Protection Areas and Critical Coastal Areas

The Pacific Ocean coastline along RNSP, including the mouth of Redwood Creek, is a designated State Water Quality Protection Area (SWQPA) (also known as an Area of Special Biological Significance (ASBS)) for the purpose of protecting marine species or biological communities from undesirable alterations in water quality (SWRCB 2003). The SWQPA encompasses 35 miles of coastline including a variety of intertidal and subtidal habitats. A reconnaissance survey report by the SWRCB (1981) provides a general characterization of the habitat types, biota and dynamic processes between the rivers and nearshore waters within the SWQPA. The SWRCB completed a survey of discharges, outlets and springs/seeps into the RNSP SWQPA in 2003 (SWRCB 2003a). Humboldt State University is currently conducting an assessment and synthesizing existing information regarding coastal and marine resources in the 35 miles of coastline in RNSP (HSU 2004).

Administered by the California Coastal Commission, the Critical Coastal Area (CCA) program is a separate but related state program intended to "*foster collaboration among local stakeholders and government agencies, to better coordinate resources and focus efforts on coastal-zone watershed areas in critical need of protection from polluted runoff*." Similar to the Nonpoint Source Management Plan, the CCA Program focuses on the application of management measures to address existing or potential pollution impacts to coastal and marine resources.

The Redwood Creek IWS is functionally equivalent to a CCA Action Plan. The IWS integrates the findings from several watershed-based assessments and plans such as the Redwood Creek Watershed Analysis (RNSP 1997), Redwood Creek sediment TMDL (USEPA 1998), NCWAP studies (NCWAP 2002, Cannata et al. 2006) and Upper Redwood Creek Watershed Road Assessment Summary Report (Bundros et al. 2003 and 2004) to develop IWS projects. The Redwood Creek IWS:

1. Identifies and evaluates existing and potential polluted runoff impacts to Redwood Creek, which directly affect coastal and marine resources, by compiling and analyzing available data, and;
2. Develops an Action Plan (IWS projects) that identifies several steps necessary to address polluted runoff and improve water quality conditions in the Redwood Creek watershed, including application of appropriate Management Measures (as described above in the nonpoint source section).

Watershed Management Initiative (WMI)

The Watershed Management Initiative was designed to integrate several surface and groundwater state regulatory programs while promoting cooperative and collaborative efforts within watersheds (NCRWQCB 2005). The Redwood Creek IWS supports the WMI efforts to promote cooperative and collaborative efforts, and reduce the need for additional regulatory programs.

The WMI identifies the following broad goals for the Humboldt Watershed Management Area, which includes Redwood Creek: 1) improve coordination, education, outreach, assessment, and monitoring, 2) protect surface and groundwater uses for municipal supply, recreation, and industrial shellfish harvest, and 3) protect and enhance the anadromous salmonid resources. The Redwood Creek IWS achieves each of these goals as follows:

- The formation of the RCWG has improved coordination among many watershed stakeholders. The IWS is now serving as the road map for ensuring that projects, education, outreach, assessment and monitoring are conducted in an integrated and coordinated manner.
- Each prioritized project in the IWS is intended to protect surface and/or groundwater thereby achieving the WMI's second goal.
- The erosion control and prevention, estuary restoration, riparian restoration, Strawberry Creek restoration, and inner gorge protection and restoration implementation projects will all serve to protect and enhance the anadromous salmonid resources through sediment reduction and habitat improvement.

The WMI acknowledges some of the unique characteristics that highlight Redwood Creek as a statewide priority:

> *"This protected park [Redwood National Park and Prairie Creek Redwoods State Park] is a world famous attraction for tourists and researchers. Prairie Creek and its tributaries are considered by some as 'reference watersheds' or ones that are in the most pristine condition for comparison to lands that have been altered by human presence. …This watershed has won worldwide acclaim and is most likely one of the best-studied watersheds…"*

The IWS is building upon the research base recognized in the WMI to integrate implementation projects and protect and improve water quality in the Redwood Creek watershed.

Final Recommendations from the California Floodplain Management Task Force

The California Floodplain Management Task Force (Task Force) was authorized in 2000 by Assembly Bill 1147 and was assembled in 2002 by the Department of Water Resources (FMTF 2002). Its goal was to develop floodplain management strategies designed to reduce flood losses and maximize the benefits of floodplains. The Task Force's final report (FMTF 2002) states that, "*Local, state and federal agencies should consider the risk to life and property from reasonably foreseeable floods when making their land use and floodplain management decisions. To accomplish this objective, decision makers need better information and improved tools.*"

The three IWS implementation projects that will apply strategies from the Task Force report include the short- and long-term flood control and the Orick wastewater treatment projects. Implementation of the short- and long-term flood control projects will improve the information base and "tools" for future land management and planning decisions regarding the Redwood Creek floodplain in the Orick valley. Implementation of the Orick wastewater treatment facility project, with consideration of floodplain dynamics in the Orick valley, will prevent future surface and groundwater contamination posed by floods, high winter groundwater levels and failing septic systems.

The Redwood Creek IWS implementation projects will integrate several strategies from the Task Force report. For example, the long-term flood control project identified in the IWS calls for the implementation of a General Investigation Study, according to Corps guidelines, that will consider the risk to life and property from flooding as well as opportunities for improving the ecological function of the estuary. This study, in combination with overarching watershed monitoring and wastewater treatment studies, will incorporate the following Task Force

strategies: Floodplain Mapping, GIS-based Flood Maps, Stream Gaging and Monitoring, Multi-Objective Management, Flood Management Approaches to Ecosystem Restoration and Agricultural Conservation, Nonstructural Approaches, Restoration and Conservation of Agricultural and Natural Lands, Protection of Floodplain Groundwater Recharge Areas, Multi-jurisdictional Partnerships, Watershed Monitoring, Proactive and Adaptive Management of Floodplains, Best Management Practices, and Coordination Among Agencies and Groups.

Surface Water Ambient Monitoring Program

Administered by SWRCB, the Surface Water Ambient Monitoring Program, or SWAMP, is a statewide monitoring effort designed to assess the conditions of surface waters throughout California (NCRWQCB 2004). Responsibility for implementation of monitoring activities resides with the nine regional water boards that have jurisdiction over their specific geographical areas of the state.

The monitoring component in the Redwood Creek IWS will monitor biological, chemical and physical processes useful in identifying trends in aquatic habitat, fish populations, water quality and hillslope conditions. Data management and quality assurance/quality control procedures used in the Redwood Creek monitoring program for water quality will be consistent with the Quality Assurance Management Plan (Puckett 2002) for California's Surface Water Ambient Monitoring Program (see Data Management discussion). Water quality data will be submitted to SWAMP for archiving and distribution to interested parties. Refer to the Redwood Creek monitoring plan (Duffy et al., in progress) for more detailed information.

Publicly-Owned Treatment Works (POTW) Program Priorities

The NCRWQCB (2005a) has identified upgrades to POTWs as "targeted projects" as follows:

> "*Projects which upgrade POTWs in small disadvantaged communities with a threat to public health or impaired water bodies, or under compliance and or enforcement orders and support Storm water program in Humboldt Bay Watershed Management Area.*"

The Redwood Creek IWS addresses this regional board priority because it includes the development of a wastewater collection, treatment and disposal facility for the community of Orick. The treatment facility will prevent surface and groundwater pollution. Orick is a small economically disadvantaged community.

APPENDIX D: Statewide Water Management Strategies and Integration

The California Water Plan Update (DWR 2005) presents an assortment of resource management strategies to meet the water related resource management needs in regions throughout the state. These water management strategies can be combined and integrated in various ways to fit the water management objectives and to achieve multiple resource benefits.

The Redwood Creek IWS uses eleven statewide water management strategies to provide broad watershed protection, restoration and planned community development (Table 4). The IWS integrates multiple perspectives and issues across mixed-ownership boundaries, and allows for coordinated project planning, implementation, and monitoring. Table 11 lists the combination of the water management strategies used to meet the objectives of the Redwood Creek IWS.

Table 11. Statewide water management strategies used to meet Redwood Creek IWS objectives.

Statewide Water Management Strategies	IWS Objectives					
	Water Quality Protection	***Protection & Restoration of Salmonids Species***	***Flood Control***	***Economic Opportunities***	***Adaptive Management***	***Partnerships***
Ecosystem restoration	•	•	•	•		•
Environmental & habitat protection/ improvement	•	•	•	•		•
Water supply reliability	•	•		•		
Flood management	•	•	•	•		•
Recreation & public access				•		•
Water quality protection/ improvement	•	•	•	•		•
Water recycling	•	•		•		
Wetlands enhancement and creation	•	•	•	•		•
Nonpoint Source pollution control	•	•	•	•	•	•
Watershed planning	•	•	•	•	•	•
Wastewater treatment	•	•		•		•

Description of Statewide Water Management Strategies

Below is a description of how the statewide water management strategies integrate with the Redwood Creek IWS objectives and implementation projects.

Ecosystem Restoration

An ecosystem restoration strategy meets IWS objectives related to water quality protection, protection and restoration of salmonid species, flood control, economic opportunities and partnerships. Ecosystem restoration directly benefits all beneficial uses of water by reducing sedimentation and improving water quality and habitat conditions for federally threatened salmonid species. Ecosystem restoration directly benefits flood control by creating wetlands that buffer peak flows, and reducing sediment that accumulates in levee reaches. Indirect benefits include potential reestablishment of a recreational sport fishing industry in Orick which will contribute to economic development opportunities.

Many of the implementation projects identified in the IWS use this strategy to benefit salmonid species. The restoration of the Redwood Creek estuary and Strawberry and Sand Cache creeks, erosion prevention on private and public lands and riparian restoration are examples of such projects. These projects involve many different stakeholders that directly meet the partnerships objective.

Environmental and Habitat Protection and Improvement

An environmental and habitat protection and improvement strategy meets IWS objectives related to water quality protection, protection and restoration of salmonid species, long-term flood control, economic opportunities and partnerships. Environmental and habitat protection and improvement directly benefit water quality by reducing erosion from roads and inner gorge landslides, which in turn directly benefit salmonid habitat and riparian areas. Salmonid restoration objectives are also met by restoring critical habitat such as the Redwood Creek estuary, and restoring watershed processes such as LWD recruitment. Flood control objectives are met indirectly by reduced sedimentation in levee reaches of Redwood Creek. Economic opportunity objectives are met by improving beneficial uses of water that provide recreational opportunities.

Many of the proposed projects in the IWS implement this strategy. The restoration of the Redwood Creek estuary and Strawberry and Sand Cache creeks, erosion prevention on private and public lands and riparian restoration are examples of such projects.

Water Supply Reliability

A water supply reliability strategy meets IWS objectives related to water quality protection, protection and restoration of salmonid species, and economic opportunities for Orick. Groundwater is the main water supply for the Orick community. The quantity of available groundwater for municipal purposes is adequate to meet growth for at least the next 20-year planning horizon (DTB 2002). However, failing septic tanks, leach fields and pits currently pose a risk to surface water and groundwater quality (OLA 1999) and could directly impact Orick's water supply. Water supply reliability not only directly benefits water quality for domestic use in this economically disadvantaged community, but also meets salmonid protection objectives by improving surface water and groundwater quality in the lower reaches of Redwood Creek and

the estuary. It also directly benefits economic opportunities in Orick that relies on sustainable business and planned residential growth. The construction of a wastewater treatment facility for Orick will protect water supply reliability.

Flood Management

A flood management strategy in the Redwood IWS meets objectives related to flood control, protection and restoration of salmonid species, economic opportunities and partnerships. The IWS incorporates both short- and long-term flood management strategies. The short-term strategy uses existing methods to maintain flood capacity through the aggraded levee reaches. The long-term management strategy envisions levee modifications that provide flood control, reduces levee maintenance and incorporates estuary restoration. Thus, flood management will provide direct benefits to water quality and salmonids, assuming estuary landowner agreements can be reached and long-term flood control restores the Redwood Creek estuary. This strategy also directly benefits economic development by providing long-term flood control to the Orick community and, if estuary restoration occurs, increased eco-tourism opportunities through improved sports fisheries and expanded recreational opportunities. Flood management efforts will involve many different stakeholders that directly meet the partnerships objective.

Recreation and Public Access

A recreation and public access strategy directly benefits the economic opportunities and partnerships objectives in the Redwood Creek IWS. Each year about 500,000 people visit RNSP (NPS-CDPR 1999) and the Orick community. Improved water quality and aquatic habitat in Redwood Creek will provide economic development opportunities through improved recreation beneficial uses, including fishing, swimming, kayaking, hiking, biking and bird watching (NCRWQCB 2001). Improved partnerships between the Orick community and RNSP can expand and integrate eco-tourism opportunities in the Orick community and nearby parklands. If implemented, long-term flood control will improve the levee system and restore the estuary, enhancing recreational opportunities and visitor enjoyment on lower Redwood Creek and the coastal area. A new wastewater treatment facility in Orick could serve as a visitor destination for bird watching and walking if constructed with open ponds and wetlands. All of these activities will improve ecotourism opportunities and socio-economic conditions in and around the Orick community, and provide tangible economic benefits.

Water Quality Protection and Improvement

Water quality protection and improvement is one of the main strategies of the Redwood Creek IWS. Water is the common thread in this watershed community, and its protection and improvement contributes either directly or indirectly to all of the Redwood Creek IWS objectives. Sediment reduction is a key priority of the IWS and occurs through several implementation projects, including inner gorge protection and restoration, riparian restoration, and erosion control and prevention. Current erosion prevention efforts vary depending on differences in land ownership and management objectives, but the resulting benefits to water quality are essentially the same. The construction of a new wastewater treatment facility in Orick is another implementation project that will protect and improve surface water and groundwater quality in the lower watershed, estuary and nearby coastal areas.

Water Recycling

The Redwood Creek IWS uses a water recycling strategy to meet objectives related to water quality, protection and restoration of salmonid species, and economic development opportunities for Orick. A recent wastewater feasibility study (SHN 2004) concluded that agricultural irrigation in Orick is the most appropriate and feasible use of treated wastewater. Recycling treated wastewater reduces groundwater extraction rates, and conserves this valuable resource for domestic use and future community growth. It also directly benefits salmonids in the lower reaches of Redwood Creek and the estuary by replenishing groundwater supplies normally consumed for agricultural, domestic and municipal uses. As a result, improved groundwater supplies may lower water temperature and dilute pollutants during summer low flow conditions.

Wetlands Enhancement and Creation

The Redwood Creek IWS uses a wetlands enhancement and creation strategy to meet objectives related to water quality protection, protection and restoration of salmonids, flood control, economic opportunities, and partnerships. For example, the lower reach of Strawberry Creek is a lower perennial riverine wetland system. The Strawberry Creek Watershed Restoration project described in the IWS will restore this reach by removing invasive exotic species such as reed canary grass, reestablishing riparian vegetation, and improving stream flow. Excavation of stream crossings on abandoned logging roads removes potential sediment sources while reestablishing natural drainage patterns and function. Stream crossings will be removed throughout the Redwood Creek watershed, thereby reestablishing aquatic, wetland, and riparian habitats at stream crossings and reconnecting stream channels. These projects also involve many different stakeholders thereby meeting the IWS partnerships objective.

Nonpoint Source Pollution Control

A nonpoint source pollution control strategy is fundamental to nearly all of the Redwood Creek IWS objectives. Nonpoint source pollution is the leading cause of water quality problems in the state (SWRCB 2001a). Sedimentation from roads, especially logging roads, has been identified as the primary nonpoint source pollutant in the Redwood Creek watershed (RNSP 1997; USEPA 1998; Cannata et al. 2006). Current efforts to control and prevent erosion from logging roads are described in the Water Quality Protection and Improvement Strategy above. Inner gorge protection and restoration, and riparian restoration will also reduce sediment delivery to stream channels. The RCWG supports a Tier I voluntary approach to controlling nonpoint source pollution as described in the statewide Nonpoint Source Pollution Plan (SWRCB 1999).

Watershed Planning

Watershed planning through the RCWG is a key strategy that directly benefits all of the IWS objectives. Watershed level planning through the RCWG incorporates multiple perspectives and identifies key watershed issues across mixed-ownership boundaries. This allows solving issues at a watershed scale and provides coordinated project planning, implementation, and monitoring. The California Watershed Council's Principles for Integrated Planning in Watersheds (2004) is being used as a guide for this planning process. For the past decade, private landowners upstream of the park and RNSP have cooperated in efforts to control and prevent erosion from private lands in the upper watershed.

Wastewater Treatment

A wastewater treatment strategy meets IWS objectives related to water quality protection, protection and restoration of salmonid species, economic opportunities, and partnerships. Improved wastewater management in the Orick community will directly benefit surface water and groundwater quality, drinking water supplies and future economic development for Orick. Wastewater treatment strategies are fully described in the Water Supply Reliability and Water Recycling sections above.

Other Strategies Considered But Not Used

The Redwood Creek IWS considered other water management strategies, including groundwater management, storm water capture and management, and water conservation. However, given the nature of the watershed and its water management issues, we believe these strategies do not apply at this time. Groundwater management strategies are commonly reserved for efforts that develop, recharge or manage larger groundwater basins. Protection of groundwater is an objective of the Redwood Creek IWS, but it is more appropriately discussed within the water supply and reliability, and water recycling strategies.

A storm water capture and management strategy was not used to meet IWS objectives, because it is commonly applied to urban areas where increased storm surface runoff leads to difficulties, including storm drainage control, stream channel maintenance, and stream water quality. Orick is the only municipality in the watershed and its population is about 315 (HC 2003). A storm water capture and management strategy will be used during future local planning efforts as the community develops and grows.

A water conservation strategy also was not used to meet IWS objectives, because ample water supplies exist in the Redwood Creek watershed for the next 20-years (DTB 2002), and its use will be somewhat redundant with the water recycling strategy already incorporated into the IWS. There are no water projects or water diversions that export water outside of the watershed. Ninety percent of the watershed is managed as private timberlands and/or ranches, or public lands managed for conservation, preservation and recreation. Groundwater supplies in Orick are adequate to sustain growth (DTB 2002).

Added Benefits to Integration

Integrating multiple water management strategies creates synergistic effects where benefits resulting from integration far outweigh the benefits of any one strategy or project. Many of the IWS objectives utilize multiple water management strategies to be successful.

A good example can be demonstrated by the IWS economic opportunities objective. This objective allows for sustainable business and planned growth in the Orick community. All of the water management strategies in the IWS are used to achieve this objective (Table 11). This suggests that significant economic benefits to the Orick community will occur when the IWS for Redwood Creek is fully implemented and multiple projects both within and upstream of the Orick valley are successfully completed.

When fully implemented, the Redwood Creek IWS will meet stated objectives to improve water quality, protect and enhance salmonid species, provide flood control and estuary restoration, and improve economic opportunities for Orick.

APPENDIX E: Potential Impacts and Benefits

This section describes the potential impacts and benefits at a coarse screening level that may result from implementation of the Redwood Creek IWS. Both benefits and impacts will affect the people and resources in the Redwood Creek watershed, but may also occur in areas adjacent to the watershed. The objectives, strategies and priorities of the Redwood Creek IWS are common themes in other northern California coastal watersheds and coastal areas, and will complement work described in the North Coast Integrated Regional Water Management Plan (NCRP 2005).

The IWS for Redwood Creek is not a land use plan but a strategic document that identifies priorities and opportunities for watershed improvements. It can be used by landowners and agencies within the watershed to improve decision-making and coordination for restoring and improving the watershed. Each implementation project in the Redwood Creek IWS will undergo CEQA/NEPA analysis prior to implementation, as appropriate.

The implementation of the Redwood Creek IWS will provide benefits at the watershed and larger regional scales. In Redwood Creek, the old-growth redwoods and associated stream corridors are a major visitor attraction within RNSP and are an international trust (World Heritage Site and International Biosphere Reserve). Improving watershed conditions will enhance the quality of this important tourism resource and protect these internationally recognized natural treasures. Improved watershed conditions will also benefit sport fishing in Redwood Creek. Restoring the commercial fisheries in the larger north coast region requires a regional solution. The implementation of the Redwood Creek IWS is a step to achieving it.

Key Impacts and Benefits

The Redwood Creek IWS contains nine integrated implementation projects located throughout the watershed. Table 12 lists the IWS projects and briefly describes the key impacts and benefits that may result from IWS implementation. Project details and final designs for several of the implementation projects have not been determined at this time. As such, the descriptions of benefits and impacts are approximate. The Short-term Flood Control and Erosion Control and Prevention projects are the only currently active projects. All other implementation projects are in various stages of planning, evaluation and project design.

Mitigation measures developed through environmental compliance and permitting phases will be used to lessen all environmental impacts. The combined beneficial effects of implementing the Redwood Creek IWS will be long-term improvement and protection of water quality and aquatic habitat throughout the watershed.

Table 12. Summary of key impacts and benefits from IWS implementation projects.

IWS Project	Impacts	Benefits
Wastewater Treatment Facility	Potential loss of rural character of Orick community from population growth; potential loss of agricultural lands in the Orick valley from increased residential construction.	Improves and protects groundwater and domestic water supplies for the Orick community; improves surface water quality in Orick and estuary; helps Orick become a destination point with improved service industry; potentially provides wildlife habitat, supports recreation and eco-tourism industry.
Short-term Flood Control	Short-term increase in turbidity following gravel extraction; loss of aquatic habitat, channel complexity and riparian vegetation in specific locations determined on an annual basis.	Provides flood control for Orick community until a long-term solution is developed and implemented.
Long-term Flood Control	Increases turbidity and suspended sediment during project implementation; potentially limits grazing during periodic flooding; possible loss of agricultural lands by channel migration; possible loss of agricultural lands to levee modifications.	Reduces levee maintenance costs; provides flood control for Orick community; allows estuary to be restored; improves recreational opportunities and supports eco-tourism industry. (see also estuary restoration benefits)
Estuary Restoration	Short-term increase in turbidity and suspended sediment if sloughs are dredged; potentially limits grazing during periodic flooding.	Restores natural biological and hydrologic processes and estuary function; improves floodplain soil productivity, improves water quality; increases size and volume of estuary; restores connectivity between Sand Cache Creek and estuary; improves aquatic habitat; benefits threatened and endangered salmonids and other fish and wildlife using the estuary; improves recreational opportunities and supports eco-tourism.
Strawberry Creek Restoration	Seasonal loss of grazing lands during flooding; short-term increase in turbidity and suspended sediment following channel excavation; loss of grazing lands to riparian restoration and stream buffer.	Restores stream channel shape and function; reduces seasonal flooding of grazing lands; removes and controls invasive exotic plant species; provides salmonid habitat, including riparian vegetation; improves water quality in long term by reducing erosion in the watershed.
Erosion Control and Prevention (Private and Public lands)	Short-term increase in turbidity and suspended sediment; short-term decline of invertebrates and amphibians in areas of stream crossing excavations when roads are decommissioned or upgraded.	Improves water quality in the long term; improves aquatic and riparian habitats; reduces sediment threats to alluvial groves in RNSP.
Inner Gorge Protection and Restoration	Potential reduction of harvest levels or harvestable area on private timber lands.	Reduces landslide rates from unstable inner gorge slopes; increases LWD recruitment to Redwood Creek; improves water quality and aquatic habitat in the long term; protects groves in RNSP.
Riparian Restoration	Temporary reduction in overstory canopy along Redwood Creek where conifers are planted or released.	Lowers stream water temperature through increased shading; provides Redwood Creek with recruitable conifers for LWD; improves water quality and aquatic habitat in the long term.

Air Quality

Impacts: All construction related projects will have a temporary impact to air quality. There will likely be short-term, localized minor impacts from increased dust particles and heavy equipment emissions. The impacts will be spread out spatially and temporally.

Energy

Impacts: The implementation of all projects will have an impact on energy use. Construction related projects will have the greatest impact, because they require the use of heavy equipment such as excavators, bulldozers and dump trucks. Workers who commute to and from Orick, or to and from remote locations in the watershed will consume more fuel. The wastewater treatment facility will place a higher demand on electricity because community waste will be pumped to the treatment facility.

Benefits: Energy consumption will be reduced through long-term flood control projects by decreasing heavy equipment use for removing and transporting sediment from between the levees in Orick. Decommissioned roads will use less energy since the road will require no maintenance.

Soils

Impacts: Nearly all of the projects in the Redwood Creek IWS will create soil disturbance through construction activities. There will likely be short-term, localized minor impacts associated with the construction of the wastewater treatment facility. There would be minor amounts of runoff and surface soil erosion associated with erosion control and restoration work throughout the watershed. Short-term, localized increases in turbidity will likely follow stream crossing excavations when roads are decommissioned or upgraded, Strawberry Creek and estuary restoration, and levee modification.

Benefits: There will likely be numerous long-term benefits resulting from the IWS implementation. Over the long term, soil erosion will be reduced by preventing erosion and sedimentation from roads that can adversely impact downstream resources such as aquatic and riparian habitats, water quality, and the alluvial redwood groves in RNSP. Soils in the inner gorges of Redwood Creek will be better protected by reduced impacts from timber harvest activities. Reduced soil erosion will benefit and improve water quality throughout the watershed and in the Redwood Creek estuary which provides critical rearing habitat for threatened salmonid species.

Water Quality

Impacts: All projects related to flood control, levee modification and erosion control will likely cause impacts to water quality. These construction-related activities could result in minor, short-term increases in suspended sediment and turbidity. Mitigation measures and BMPs will be used to lessen water quality impacts.

Benefits: There will likely be long-term, major benefits to water quality after the Redwood Creek IWS projects are fully implemented. A new wastewater treatment facility will improve and protect groundwater and surface water by eliminating contamination from failing septic sewage

systems. Levee modifications will restore adjacent wetlands and riparian areas that buffer streamside erosion and reduce water temperature and may filter contaminants. Estuary restoration will reduce water temperatures and increase dissolved oxygen by restoring water circulation patterns and depth, tidal prism size, and sediment transport throughout the estuary. Isolated from the estuary by accumulated sediment, Sand Cache Creek's water quality and habitat will improve by reconnecting it to the estuary. Strawberry Creek Restoration will restore channel shape and function, and reestablish riparian areas that will lower water temperature, increase dissolved oxygen and filter out nutrients and other contaminants from nearby grazing. Over the long term, erosion control activities, protection of inner gorge slopes, and riparian restoration along Redwood Creek will reduce erosion and sedimentation, and water temperatures throughout the watershed. All projects that improve water quality could have a long-term, major benefit to coastal resources.

Floodplains, Wetlands and Riparian Areas

Impacts: Short-term flood control activities will have a short-term impact on riparian areas when vegetation is removed during gravel extraction, but could be lessened by mitigation measures required by extraction permits. The long-term flood control project is likely to cause minor, long-term impacts to wetland areas if wetland areas are within the modified levee area. Erosion control projects will likely have minor, short-term impacts on riparian vegetation that is removed during stream crossing excavations.

Benefits: Nearly all of the projects in the Redwood Creek IWS will likely cause long-term, major benefits to floodplains, wetlands and riparian areas. Long-term Flood Control and Estuary Restoration will cause a net increase in the amount of floodplains and wetlands if Redwood Creek is allowed to meander and reoccupy some portion of its historic floodplain. It has been estimated that estuary wetlands could increase by 25 acres and palustrine wetlands could increase by 175 acres, depending on the levee system modifications (NPS-CDPR 1999). Natural riparian areas will also be established and maintained. Strawberry Creek restoration will reestablish a naturally functioning floodplain, riparian vegetation and wetlands along the main channel. Erosion Control and Prevention, and Inner Gorge Protection and Restoration will provide long-term stability to riparian areas along Redwood Creek by reducing erosion, especially landslide erosion that can rapidly fill channels with sediment, causing lateral channel erosion and loss of riparian areas during large storms. Riparian Restoration will provide major benefits to riparian vegetation and wetlands along the mainstem of Redwood Creek over the long term.

Vegetation and Wildlife

Impacts: Nearly all IWS projects will likely create short-term, minor impacts to vegetation and wildlife. There will be medium-term local impacts to understory shrubs, hardwoods (tan oak, madrone, maple, and alder), grasses, and small conifers. Impacts will generally be limited to work sites. Vegetation in these areas has previously been disturbed by timber harvest, road building, grazing or other activities. Early succession vegetation will reestablish quickly.

Construction and earthmoving related impacts to wildlife will include localized noise and disturbance which might cause wildlife to leave the work site area when work occurs. This impact will most likely be related to erosion control projects, because they occur in unpopulated

areas where wildlife is most common. However, heavy equipment will move to different work sites fairly quickly and not remain in the same area for extended periods of time. Impacts to wildlife are less likely from the large-scale construction projects such as the wastewater treatment facility and long-term flood control, because these projects generally will be situated around Orick or active ranch operations. There could be short-term, minor impacts to fish and aquatic species by increased turbidity from these projects.

Benefits: There will likely be minor and major benefits to vegetation and wildlife from the IWS projects over the long term. Erosion control and most construction-related projects could cause long-term, major benefits when treated areas are planted with native vegetation, reducing habitat fragmentation. The Wastewater Treatment Facility might utilize wetlands for secondary treatment and could cause long-term, major benefits by providing riparian and wetland habitats. Estuary Restoration will have similar effects as the wastewater facility, except the benefits could be at a large scale depending on how the levees are modified and to what extent the estuary is restored. Riparian Restoration along Redwood Creek will likely cause long-term, major benefits to terrestrial riparian dependant species and to aquatic species. Wildlife will benefit from improved and more stable riparian vegetation as riparian areas often serve as biological corridors.

Threatened and Endangered Species Compliance

The combined effects of the IWS implementation projects will provide minor and major benefits for threatened and endangered (T&E) species over the long term. The RCWG will work with appropriate local, state and federal agencies to prevent impacts to listed or proposed T&E species. All projects capable of causing impacts to T&E species will include appropriate measures to prevent and/or minimize impacts.

Threatened and endangered species are protected by several federal and state laws. The primary laws governing species protection include the Endangered Species Act of 1973, as amended (16 U.S.C. 460 et seq.) and the Californian Endangered Species Act of 1985 (California Fish and Game Code, Sections 2050 et seq.). As required by law, T&E species investigations of project sites will be completed by qualified resource specialists during the compliance and permitting phase of the project. Necessary Biological Assessments will be completed and operating stipulations imposed in conjunction with NOAA fisheries and USFWS to ensure that projects are implemented in a manner that minimizes impacts to listed species.

Cultural Resource Compliance

The Redwood Creek IWS will implement watershed projects on both private and public lands. As required by law, cultural resources investigation of project sites will be completed by a qualified cultural resource specialist during the compliance and permitting phase.

Cultural resources are protected under several state and federal laws. These laws were enacted to ensure consideration of historic values and to protect significant resources from destruction or theft. The major federal laws include: the National Historic Preservation Act, as amended in 1992 (PL 102-575); Archaeological Resources Protection Act of 1979 (16 U.S.C. 470ii); the Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. § 3001-3005), and; the American Indian Religious Freedom Act of 1978 (42 U.S.C. § 1996). State-level cultural

resource protection is regulated through the provisions of Appendix K of the California Environmental Quality Act (CEQA). Paleontological resource protection is regulated through the 1906 Antiquities Act.

Environmental Justice

Environmental justice is based on the fair treatment and meaningful involvement of all people regardless of all race, culture, and income as it relates to the development, implementation, and enforcement of environmental laws, regulations, and policies. It is achieved when everyone enjoys the same degree of protection from environmental and health hazards, and can participate in the decision-making process to have a healthy environment in which to live, learn, and work. The Redwood Creek IWS objectives ensure environmental justice will be served by public funds earmarked for infrastructure development in Orick, an economically disadvantaged community. Rural and isolated communities, such as Orick, rarely receive public support because of their small population base and limited political strength. A reliable water supply protected by effective wastewater treatment can improve the basic quality of life for residents and provide an economic stimulus in this community.

Socio-Economic Considerations

Impacts: The Wastewater Treatment Facility, Long-term Flood Control and Inner Gorge Protection and Restoration projects could cause short- and long-term impacts. Improved sewage treatment could cause moderate, long-term impacts from sustained business and residential growth in the Orick community. To some, growth and the associated changes in the community might have unwelcome effects such as increased traffic and a loss of the rural character. This impact will be lessened by appropriate community planning that considers the preservation of community's rural setting. Long-term Flood Control could cause long-term minor impacts if the flood control levees are modified in such a way as to cause continued seasonal flooding of agricultural lands. The impacts to individual landowners could be offset by financial compensation. Inner Gorge Protection and Restoration may cause minor, long-term impacts from potentially reduced timber harvest on inner gorge slopes. However, timber harvest activities on inner gorge slopes are becoming increasingly difficult to conduct under current forest practice rules. Thus, the impact is expected to be minor, especially if landowners are properly compensated for lost future revenue.

Benefits: All of the proposed IWS projects will likely create major, long-term benefits when fully implemented. All of the projects will provide jobs, especially erosion control and prevention. Erosion control projects have provided jobs on the north coast for almost 30 years. Coastal communities will also benefit, because their economy relies on the recreation and tourism industries which, in turn, are linked to the quality of the region's aquatic and riparian habitats and water. The Wastewater Treatment Facility will support an improved service industry in Orick. Expanded services in Orick will attract national and state parks visitors to use the facilities and increase spending in this economically disadvantaged gateway community. The Wastewater Treatment Facility, Long-term Flood Control, and Strawberry Creek and Estuary restoration projects will support eco-tourism, and provide educational and recreational opportunities that will generate local revenue and integrate nicely with RNSP's visitor programs. Long-term Flood Control could also significantly reduce levee maintenance costs. Watershed-wide erosion control, protection and restoration of inner gorge slopes and riparian areas will help restore and protect downstream aquatic and riparian habitat and water quality in the long term.

APPENDIX F: Disadvantaged Community Status for the Orick Community

The Orick community is economically disadvantaged when compared to the general population of the state. DWR and SWRCB assign a disadvantaged status to a community when its annual median household income (MHI) is less than 80 percent of the statewide annual MHI (DWR-SWRCB 2005). Orick easily meets the disadvantaged status, because its MHI is $25,417 or 54 percent of the MHI for the state (USCB 2000). Table 13 lists several economic indicators for Orick and compares them to indicators for Humboldt and Del Norte counties and the entire state.

Table 13. Orick, local and state economic indicators (USCB 2000).

Indicator	Orick	Humboldt County	Del Norte County	California
Population	487	126,518	27,507	35,893,799
Median age	41.7	36.3	36.4	33.3
Disability status[1]	34%	21.2%	25%	19%
Total housing units	247	55,912	10,434	12,214,549
Median household income	25,417	31,226	29,642	47,493
Median family income	29,479	39,370	36,056	53,025
Per capita income	13,041	17,203	14,573	22,711
Families below poverty rate	24.8%	12.9%	16.4%	10.6%
Individuals below poverty rate	26.6%	19.5%	20.2%	14.2%

Direct Benefits to the Orick Community

All of the proposed implementation projects will directly benefit Orick's economic opportunities. Orick is the gateway community to RNSP and is positioned to make a transition from a resource-based to a service-based economy that will benefit from the local and regional tourist industry. The transition will rely on a new wastewater treatment facility to provide a stable business climate and allow for planned community growth. It will also rely on watershed projects that improve and protect water quality and aquatic and riparian habitats, and provide improved recreational opportunities.

A complete discussion of benefits to the Orick community from IWS implementation is found in *Section 2 Objectives*, and *Appendix E Potential Impacts and Benefit*s. How the Orick community participated in the development of the Redwood Creek IWS is described in *Section 1 Overview*.

Calculations for Reduced Funding Match

DWR and SWRCB require a funding match of 10 percent of the total project cost. A reduction in the funding match may be allowed if the project directly benefits a disadvantaged community.

[1] percent of population that is disabled and five years or older.

To determine the reduced funding match for a disadvantaged community, the Disadvantaged Community Ratio (DCR) and Benefit Factor (BF) must first be computed (DWR-SWRCB 2005). The DCR is the ratio between the total population in the disadvantaged community (P_D) and the total population of the watershed, or region (P_R). The BF is based on the percentage of disadvantaged communities within the region receiving direct benefits from the implementation project.

Using 2000 Census data with *place* census geography, the total population of Orick is 487. Orick is the only concentrated population center in the Redwood Creek watershed. The total population of the Redwood Creek watershed was estimated by summing the population of Orick and the population of the more remote areas in the upper watershed. Because the 2000 Census does not report population by individual watershed areas, the population in the upper watershed was estimated using Humboldt County assessor parcel information. Excluding the larger timberland and ranch owners, there are about 95 smaller property owners in the upper watershed that account for about 10 percent of the total watershed area (Figure 9). Assuming one residence per property and an average household size of 2.43 (USCB 2000), the population in the upper watershed is about 230. Thus, the total population estimate of the watershed is 717.

The disadvantaged community BF is determined from the Table 14 below.

Table 14. Disadvantaged community Benefit Factor (DWR-SWRCB 2005).

Percentage of Disadvantaged Communities in the Region Directly Benefited by the Proposal	Benefit Factor
More than 50%	1.00
25%-50%	0.50
More than 0% but less than 25%	0.25

The Reduced Funding Match Factor (RFMF) can now be computed using the following formula:

RFMF = 0.10 – (0.10 x DCR x BF) where,
DCR = P_D/P_R, or 487/717 = 0.68, and
BF = 1.0 (Table 14) because Orick is the only disadvantaged community in the watershed.

Thus, the RFMF = 0.10 – (0.10 x 0.68 x 1.0) = 0.032 or 3%.

As an example, if the Orick community requests a reduced funding match for a $5 million grant proposal to construct a new wastewater treatment facility, Orick would provide a match of:

Orick Match = Total Project Cost x RFMF = $5 M x 0.03 = $150,000, and would receive a:
Grant Amount = Total Project Cost – Orick Match = $5 M – $150,000 = $4.85 M.

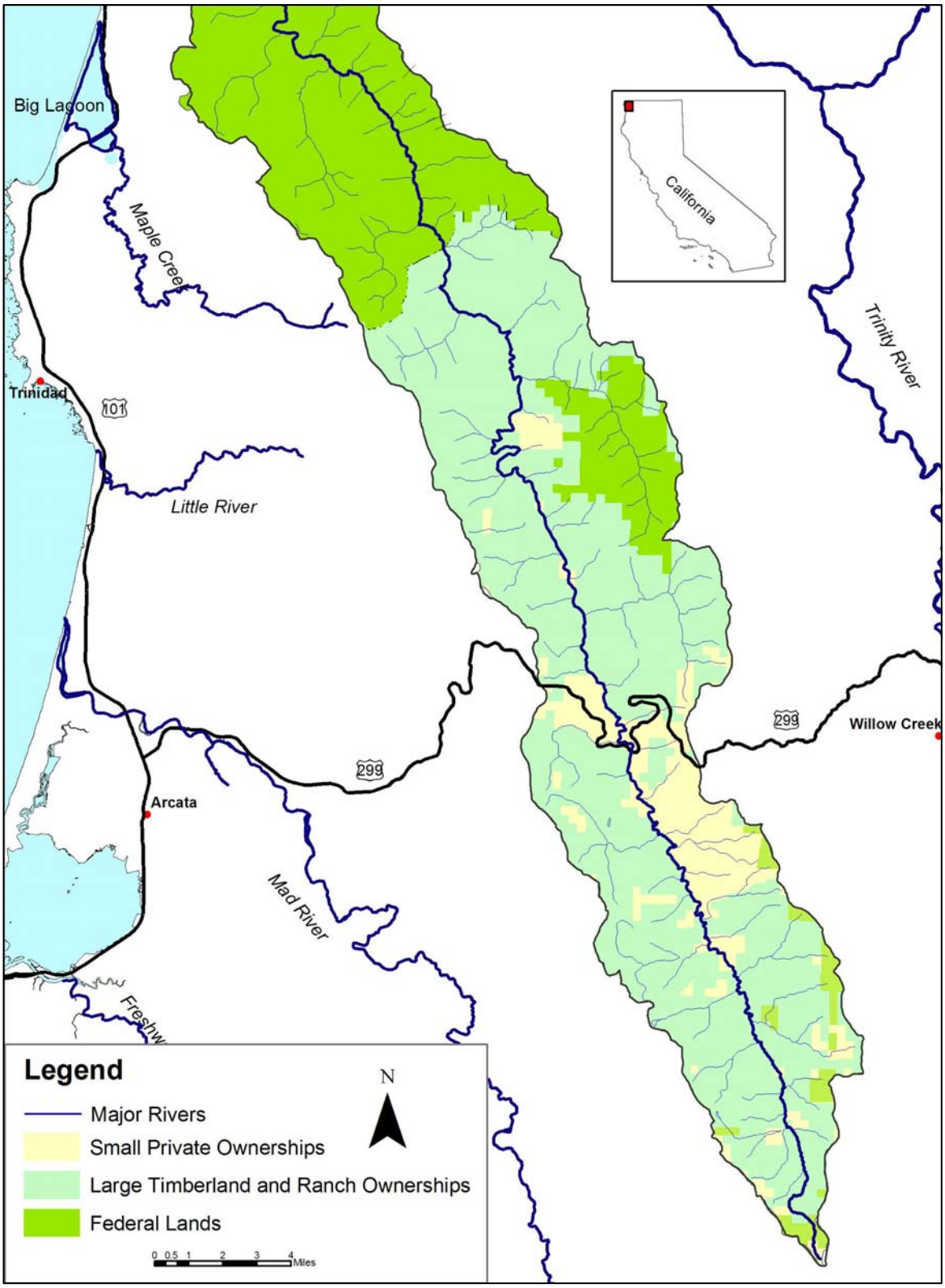

Figure 9. Large and small landownership in the upper Redwood Creek watershed.