Water Quality Monitoring Report | 2000-06

Summary Report for the North Coast Region (RWQCB-1) for years 2000-2006

March 2008

California Water Quality Control Board, North Coast Region
5550 Skylane Blvd, Suite A
Santa Rosa, Ca, 95403
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www.waterboards.ca.gov/swamp

Surface Water Ambient Monitoring Program (SWAMP)

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List of Acronyms

ARM	Aggregate Resources Management
ASBS	Areas of Special Biological Significance
BLM	Bureau of Land Management
CCA	Critical Coastal Area
CDF	California Department of Forestry and Fire Protection
CDFG	California Department of Fish and Game
CDHS	California Department of Health Services
CTR	California Toxics Rule
CVP	Central Valley Project
CWA	Clean Water Act
CZM	Coastal Zone Management
DO	Dissolved oxygen
DWR	Department of Water Resources
ESHA	Environmentally Sensitive Habitat Areas
ESU	Evolutionarily Significant Unit
FESA	Federal Endangered Species Act
FY	Fiscal Year
HA	Hydrologic Area
HSA	Hydrologic Sub-Area
HU	Hydrologic Unit
LWD	Large woody debris
MDL	Method Detection Limit
MRC	Mendocino Redwood Company
MWAT	Maximum weekly average temperatures
MWCD	Montague Water Conservation District
NCR	North Coast Region
NCRWQCB	North Coast Regional Water Quality Control Board
NCWAP	North Coast Watershed Assessment Program
NEP	National Estuary Program
NERR	National Estuarine Research Reserve
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRA	National Recreation Area
NTU	Nephelometric turbidity unit
PALCO	Pacific Lumber Company
PCB	Polychoronatedbiphenol
PCE	Perchloroethylene
PCP	Pentachlorophenol
PG&E	Pacific Gas and Electric
POTW	Publicly Owned Treatment Works
PVP	Potter Valley Project
RL	Reporting Limit
RM	River mile

RNSP	Redwood National and State Parks
RWQCB	Regional Water Quality Control Board
SCWA	Sonoma County Water Agency
SPW	Super Planning Watershed
SWAMP	Surface Water Ambient Monitoring Program
SWQPA	State Water Quality Protection Area
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
TPZ	Timber Production Zone
TRD	Trinity River Diversion
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
VOC	Volatile organic compound
WMA	Watershed Management Area
YOY	Young of year

Beneficial Use Designations

AGR	agricultural supply
COLD	cold freshwater habitat
COMM	commercial or sport fishing
EST	estuarine habitat
FRSH	freshwater replenishment
GWR	groundwater recharge
IND	industrial service supply
MAR	marine habitat
MIGR	migration of aquatic organisms
MUN	municipal and domestic supply
NAV	navigation
RARE	rare, threatened, or endangered species
REC-1	water contact recreation
REC-2	non-contact water recreation
SHELL	shellfish harvesting
SPWN	spawning, reproduction, and/or early development
WARM	warm freshwater habitat
WILD	wildlife habitat

Units

af y^{-1}	acre-feet per year
cfs	cubic feet per second
mi	mile(s)
miles mi^{-2}	miles per square mile
mg/L	milligrams per liter
ng/L	nanograms per liter
t mi^{-2} yr^{-1}	tons per square mile per year
ug/L	micrograms per liter

1. Introduction

The Porter-Cologne Water Quality Control Act and the federal Clean Water Act (CWA) direct that water quality protection programs be implemented to protect and restore the integrity of waters of the State. California Assembly Bill 982 (Water Code Section 13192; Statutes of 1999) requires the State Water Resources Control Board (SWRCB) to assess and report on the State's water quality monitoring programs.

AB 982 required the SWRCB to prepare a proposal for a comprehensive surface water quality monitoring program. The SWRCB report to the Legislature entitled, "Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program" (November 2000 Legislative Report) proposed to restructure existing water quality monitoring programs into a new program, the Surface Water Ambient Monitoring Program (SWAMP). The SWAMP was envisioned as an ambient monitoring program that would be independent of, yet coordinated with, other water quality regulatory programs, and serve as a measure of: (1) the overall status of the beneficial uses of the State's water resources, and (2) the overall effectiveness of the prevention, regulatory, and remedial actions taken by the State Water Board and the nine Regional Water Quality Control Boards (RWQCB). To implement this directive, funding for ambient surface water quality monitoring was allocated to the State Water Board (and thereby to the Regional Water Boards) beginning in State Fiscal Year 2000–2001.

1.1. Overview of the Surface Water Ambient Monitoring Program

The SWAMP calls for a combination of (1) regional monitoring to provide a picture of the status and trends in water quality and (2) site-specific monitoring to better characterize areas of degraded water quality versus those locations where water quality is suitable. This approach balances the two important monitoring needs of the SWRCB and serves as a unifying framework for the monitoring activities being conducted by the SWRCB and RWQCBs. The coordinated SWRCB and RWQCB involvement in study design and sampling is critical to providing a comprehensive, effective monitoring program that results in identifying degrading and improving conditions in waterways.

1.1.1. Statewide SWAMP Program goals

The SWAMP is a comprehensive environmental monitoring program focused on providing the information the SWRCB and RWQCBs need to effectively manage the State's water resources. The SWAMP integrates all existing water quality monitoring occurring at the SWRCB and RWQCBs and coordinates with monitoring programs at other agencies, permitted facilities, and citizens groups. The RWQCBs establish monitoring priorities for the water bodies within their jurisdictions, in coordination with the SWRCB. This monitoring is done in accordance with protocols and methodologies laid out in the SWAMP program.

The SWAMP was created to meet four goals:

1. Establish an ambient monitoring program that addresses all hydrologic units of the State using consistent and objective monitoring, sampling and analytical methods; consistent

data quality assurance protocols; and centralized data management. Provide a comprehensive environmental monitoring program that monitors and interprets that data for each hydrologic unit at least one time every five years.

2. Document ambient water quality conditions in potentially clean and polluted areas. The scale for these assessments ranges from the site-specific to statewide.

3. Identify specific water quality problems preventing the SWRCB, RWQCB's, and the public from realizing beneficial uses of water in targeted watersheds.

4. Provide the data to evaluate the overall effectiveness of water quality regulatory programs in protecting beneficial uses of waters of the State.

The SWAMP program is essential to the success of the Total Maximum Daily Load (TMDL) program. Extensive monitoring data and information on the quality of the waters of the State are the backbone of the TMDL program. The SWAMP program also produces water quality data to improve RWQCB's abilities to place waterbodies on and remove them from the 303(d) List.

1.1.2. The SWAMP Goals in the North Coast Region FYs 2000-2006

In the North Coast Region (NCR), the SWAMP uses a two-component approach to address regional and site-specific monitoring: 1) long-term monitoring sites for trend analysis, and 2) rotating intensive basin surveys. The rotation schedule is designed to collect and analyze data within each hydrologic unit on at least one occasion every five years. The SWAMP was also closely coordinated with the North Coast Watershed Assessment Program (NCWAP) and the TMDL program schedule to provide additional and current information on water quality parameters to the NCWAP assessment and the TMDL process.

1.1.3. Regional Monitoring

The overall goal of the SWAMP's Regional Monitoring is to develop a statewide and regionwide picture of the status and trends of the quality of California's surface water resources. It is intended that this portion of the SWAMP will be implemented in each hydrologic unit (including coastal waters) of the State at least one time every five years. This portion of the SWAMP is focused on collecting information on water bodies for which the State presently has little information and to determine the effects of diffuse sources of pollution and the baseline conditions of potentially clean areas.

The SWAMP implements a rotating basin framework where each Region will be divided into five areas consisting of one or more hydrologic units. The major watercourses and tributaries in one of these areas would be monitored for a one-year period at least once every five years.

The regional monitoring component will allow the SWRCB and RWQCBs to complete the comprehensive monitoring required to satisfy CWA Section 305(b) requirements and will contribute to the achievement of the State's various water quality programs. These programs allow the State and USEPA to track trends in water quality. This in turn may be used to track the effectiveness of the SWRCB and RWQCB water quality control programs. The regional monitoring component complements the site-specific monitoring effort in two ways. First, it provides additional information that can be used to put the data from targeted sites into a broader regional context. Equally important, the regional component can serve as a periodic screening mechanism to identify new problem areas that were not previously known.

1.1.4. Site-specific Monitoring

The overall goal of the SWAMP's site-specific monitoring is to develop information on sites that are (1) known or suspected to have water quality problems and (2) known or suspected to have good water quality. This portion of the SWAMP is targeted at specific locations in each region. The SWAMP is focused on collecting information from sites in water bodies of the State that could be potentially listed or delisted under CWA Section 303(d). The RWQCBs are given significant flexibility to select the specific locations to be monitored. The RWQCBs may, at their discretion, perform monitoring at sites with good water quality to determine baseline conditions.

The site-specific monitoring provides flexibility for RWQCBs to focus monitoring resources in specific waterbodies to better understand what the water quality issues are and how they are impacting beneficial uses. Site-specific monitoring allows for the verification of problems identified in statewide surveys. Additionally, locations may be monitored to document their pristine water quality for use in determining background or natural conditions. This assessment and documentation of a site's water quality status is a key component of the Section 303(d) listing process.

1.2. Related Water Quality Programs

1.2.1. North Coast Watershed Assessment Program (NCWAP) 1999-2003

In 1999, the California Resources Agency and the California Environmental Protection Agency developed an interagency watershed assessment program for California's North Coast. The purpose of the program was to develop consistent, scientifically credible information to guide landowners, agencies, watershed groups, and other stakeholders in their efforts to improve watershed and fisheries conditions. The resulting NCWAP was to provide a process for collecting and analyzing information to answer a set of critical questions designed to characterize current and past watershed conditions. It was designed to cover approximately 6.5 million acres of private and state lands within the 12 million acre North Coast Hydrologic Region. NCWAP was scheduled to assess approximately one million acres a year for a 7-year period. Programmatic delays and alterations to the NCWAP necessitated changes to the NCWAP schedule as outlined in Table 1. The State Legislature ceased to fund NCWAP after FY 2002-03.

Table 1. Schedule of NCWAP assessments as originally envisioned and after programmatic changes.

NCWAP Watersheds	Watershed Management Area (WMA)	Synthesis Reports were to be completed by December of given year								
		Original NCWAP Schedule (2001)			Revised NCWAP Schedule (2002)			Revised NCWAP Schedule (2003)		
		2001	2002	2003	2002	2003	2004	2003	2004	
Redwood Creek	Humboldt Bay	X			X			X		
Gualala River	North Coast Rivers	X			X			X		
Mattole River	North Coast Rivers	X			X			X		
Big River	North Coast Rivers	X			X			X		
Albion River	North Coast Rivers	X			X			X		
Middle Klamath River	Klamath River					X				
Scott River	Klamath River	X					X		X	
Shasta River	Klamath River	X					X			
North Fork Eel River	Eel River	X								
Middle Fork Eel River	Eel River		X			X			X	
Trinity River	Trinity River		X							
North Coastal Streams	North Coast Rivers		X							
Upper Mainstem Eel River	Eel River			X						
Middle Mainstem Eel River	Eel River			X						
South Coastal Streams	North Coast Rivers			X						

1.2.2. Total Maximum Daily Load (TMDL) program

The Federal Clean Water Act (CWA) contains two strategies for managing water quality. One, a technology-based approach that envisions requirements to maintain a minimum level of pollutant management using the best available technology. The other, a water quality-based approach, relies on evaluating the condition of surface waters and setting limitations on the amount of pollution that the water can be exposed to without adversely affecting the beneficial uses of those waters. Section 303(d) of the CWA bridges these two strategies. Section 303(d) requires that the states make a list of waters that are not attaining standards after the technology-based limits are put into place. For waters on this list (and where the US EPA administrator deems they are appropriate), the states are to develop TMDLs. A TMDL must account for all sources of the pollutants that caused the water to be listed. Federal regulations require that the TMDL, at a minimum, account for contributions from point sources (federally permitted discharges) and contributions from nonpoint sources.

The requirement to develop TMDLs has been in the Clean Water Act since 1972. In the 1970's, point source pollution was considered the most significant problem affecting water quality in rivers and streams. During the 25 years following the enactment of the Clean Water Act, the technology-based effort received the highest priority and the vast majority of funding. In California, the State and Regional Boards also used state authorities provided by the Porter-Cologne Act to implement smaller scale corrective actions for nonpoint source pollution problems.

By the late 1980s, programs focusing on treatment facilities resulted in better controls of point source pollution. However, the concerns over general water quality were elevated again due to the growing impacts of nonpoint source pollution. In 1996, the Coast Action Group and the

Sierra Club Legal Defense Fund sued the United States Environmental Protection Agency for the development of Clean Water Act Section 303(d) TMDLs, as identified in the Consent Decree, Pacific Coast Federation of Fishermen's Associations v. Marcus, U.S. District Court for the Northern District of California, No. 95-4474 MHP, requiring timely development of TMDLs for certain named watersheds in the North Coast Region. An abbreviated schedule and listing of North Coast watersheds are identified in Table 2, however many of the timelines have changed from this original schedule.

Table 2. Original Schedule of TMDL completions (1997 Consent Decree Waterbodies)

Waterbody	Lead Agency	Watershed Management Area (WMA)	2001	2002	2003	2004	2005	2006	2007
Consent Decree Watersheds									
Trinity River	EPA	Trinity River	X						
Albion River	EPA	North Coast Rivers	X						
Gualala River	NCRWQCB	North Coast Rivers	X						
Big River	NCRWQCB	North Coast Rivers	X						
Mattole River	NCRWQCB	North Coast Rivers		X					
North Fork Eel River	EPA	Eel River		X					
Middle Fork Eel River	EPA	Eel River			X				
Upper Eel River	EPA	Eel River				X			
Upper Lost River	NCRWQCB	Klamath River				X			
Lower Lost River	NCRWQCB	Klamath River				X			
Klamath River	NCRWQCB	Klamath River				X			
Salmon River	NCRWQCB	Klamath River				X	X		
Scott River	NCRWQCB	Klamath River					X		
Shasta River	NCRWQCB	Klamath River					X		
Middle Eel River	EPA	Eel River					X		
Lower Eel River	EPA	Eel River						X	

1.3._______The SWAMP in the North Coast Region

The watershed evaluation process employed by the NCR is responsive to the Watershed Management Initiative as called for in the State Water Resources Control Board Strategic Plan (June 22, 1995). It essentially involved designating Watershed Management Areas (WMAs) and performing the following steps:

- Assessing water quality related issues on a watershed basis
- Developing prioritized water quality goals for watersheds from the issues
- Addressing the issues with various programs through a multi-year implementation strategy
- Evaluating progress at the end of a specified time period

The NCR uses a two-component approach to address the regional and site-specific monitoring requirements of the SWAMP:

1) Long-term monitoring sites for trend analysis.
2) Rotating intensive basin surveys on a planned basis, as resources allow.

This allows the NCR to focus on a few watersheds at a time, which is considered the best use of resources. Additionally, monitoring will cycle through WMAs every five to seven years as identified by the guiding goals of the SWAMP. The monitoring cycles for the WMAs are prioritized based on a number of factors, including the known water quality impairment, adequacy of existing data, the extent of development and/or land use change, likelihood for problems to increase, and the availability of management tools for the problems.

The overall goal for the SWAMP is to develop site-specific information on locations that are

- Known or suspected to have water quality problems.
- Known or suspected to have good water quality.

The SWAMP monitoring will target specific locations in each WMA, and collect information from sites in waterbodies of the State to support remedial actions as well as the listing/delisting process under Clean Water Act Section 303(d). Information collected through this program was used in the development of NCWAP assessment products and is currently being used in the development of TMDLs. In addition, the SWAMP coordinates with other programs within the Regional Water Boards purview.

1.3.1. Long-term Trend Monitoring Station Selection

Long-term monitoring sites were chosen from both impaired (303(d) listed) and unimpaired (non 303(d) listed) waterbodies within each of the WMAs. This component of the SWAMP monitoring plan is designed to monitor trends in water quality to evaluate improvement or degradation to water quality through time. The long-term monitoring sites are located at the bottom of large drainage areas in order to reflect the impacts of management activities occurring within the basins.

1.3.2. Rotating Monitoring Station Selection.

The rotating basin component in the NCR was driven by the NCWAP and TMDL programs. In FY2000-01, the NCR focused on the Coastal Watersheds WMA to gather data for NCWAP and the TMDL program and collect baseline information on water quality conditions of these watersheds. In FY 2000-01, the SWAMP also focused on the Russian River WMA to collect background and baseline information. In FY 2001-02, the SWAMP in the NCR focused on four WMAs: Trinity River, Eel River, Klamath River, and Humboldt Bay. The Trinity River WMA and Eel River WMA were monitored to provide information to the NCWAP process. Data collected from the Eel River WMA and Klamath River WMA was used for the TMDL process, and the Humboldt Bay WMA was monitored to provide baseline information. During FY 2002-03 the NCR focused on collecting additional data in the Trinity River WMA and Klamath River WMA for NCWAP, and data collected in the Klamath River WMA was provided to the TMDL program. In FY 2004-05, NCR focused the rotating basin approach on the Russian River WMA, providing data for upcoming TMDLs. In FY 2005-06, funding limitations necessitated the abandonment of the rotating basin approach and focus exclusively on maintaining our long-term monitoring sites.

1.4 Overview of the North Coast Region

The text presented within this section includes information that has been previously published by North Coast Regional Water Quality Control Board 2005 (Watershed Planning Chapter), USEPA 1999 (Noyo River Total Maximum Daily Load for Sediment), Entrix et al. 1998 (Navarro River Restoration Plan), USEPA 2001 (Gualala River Total Maximum Daily Load for Sediment), North Coast Regional Water Quality Control Board 2001 (Technical Support Document for the Gualala River Watershed Water Quality Attainment Action Plan for Sediment) and references included therein.

The NCR comprises all of the watershed basins draining into the Pacific Ocean from the California-Oregon state line (including Lower Klamath Lake and Lost River basins) south to the southern boundary of the watershed of the Estero de San Antonio and Stemple Creek in Marin and Sonoma Counties (Figure 1). The NCR covers all of Del Norte, Humboldt, Trinity, and Mendocino Counties, major portions of Siskiyou and Sonoma Counties, and small portions of Modoc, Glenn, Lake, and Marin Counties. The NCR encompasses a total area of approximately 19,390 mi^2; including 340 miles of scenic coastline, 362 miles of designated Wild and Scenic Rivers, 416 mi^2 of National Recreation Areas, and 1627 mi^2 of National Wilderness Areas, as well as urbanized and agricultural areas.

1.4.1. Natural History of the North Coast Region

The NCR is characterized by steep, mountainous forested terrain with distinct temperature and precipitation zones. The climate along the coast is mild and foggy, experiencing moderate variations in seasonal temperatures. In these temperate areas, coastal redwoods and Douglas fir-tanoak forests dominate the landscape. Inland areas, away from the coastal influence, undergo more extreme seasonal temperature ranges with seasonal maximums of more than 100°F. Oaks and pines interspersed with grasslands and chaparral are more common inland. The region experiences significant amounts of rainfall, with precipitation exceeding 100 inches annually in coastal areas, and can have as little as 10 inches annually fall on the Modoc Plateau. This large amount of precipitation can create significant flooding in the region, and has produced three devastating floods in the 20th century.

Distinct temperature zones characterize the NCR. Along the coast, the climate is moderate and foggy and the temperature variation is not great. For example, at Eureka, the seasonal variation in temperature has not exceeded 63°F for the period of record. Inland, however, seasonal temperature maximums in excess of 100°F have been recorded.

Rocks of the Franciscan Complex, many of which are highly erodible and mechanically weak, underlie many of the watersheds in the NCR. The Franciscan Complex is composed mainly of marine sandstone and shale with lesser amounts of marine chert and basaltic rocks some of which have been altered to serpentinite. Significant seismic activity in the area further weakens the sedimentary rocks. Thus, the watersheds are naturally prone to storm-induced erosion and other natural sediment delivery processes, such as mass movement (also known as mass wasting, or landslides), and produce large amounts of sediment even in the absence of human activity.

The NCR is rich in wildlife resources. Deer, elk, bears, mountain lions, and many upland bird and mammal species can be found in the region. Additionally, the region is home to several species listed as threatened or endangered under the Federal Endangered Species Act (FESA). Aquatic systems are a valuable resource. Tidelands and marshes provide important nursery and foraging habitat for many species of waterfowl and shore birds, fish, and marine invertebrates. Numerous streams, rivers, and reservoirs support both coldwater and warmwater fish.

The North Coast Regional Water Quality Control Board (NCRWQCB) faces numerous water quality issues. Overarching issues are protection of the coastline, protection and restoration of anadromous fish populations, protection of drinking water, and pollution prevention. More specifically, water quality problems include contamination of surface water due to nonpoint source pollution from storm water runoff, erosion and sedimentation (roads, agriculture, and timber harvest), failing septic tanks, channel modification, gravel mining, dairies, and MTBE and dioxin contamination.

Ground water contamination from perchloroethylene (PCE) from drycleaners, leaking underground tanks containing hydrocarbons and PCEs, and health and safety issues from contaminated areas that are open to the public are also priority issues. High priority water quality problems due to point sources include chronic violations by some Publicly-Owned Treatment Works (POTWs) and lack of permit compliance. Lack of or limited funding for water quality monitoring and watershed assessment compounds the difficulty of addressing these issues.

1.4.2. Salmonids

Salmonids are particularly important in the NCR. The family Salmonidae includes salmon, trout, and char. In the NCR, the most common salmonids are coho (or silver) salmon (Oncorhynchus kisutch), Chinook (or king) salmon (O. tshawytscha), steelhead trout (O. mykiss), and coastal cutthroat trout (O. clarki). Chum (or dog) salmon (O. keta), pink (or humpback) salmon (O. gorbuscha), and sockeye (or red) salmon (O. nerka) are rare in the NCR. These fish are anadromous, i.e., they are born in fresh water, migrate to the ocean to mature, and return to their natal streams to spawn. Many populations of cutthroat trout are anadromous; some are freshwater residents, while others travel between the brackish estuaries and the fresh water tributaries. Non-anadromous fish, such as rainbow trout (O. mykiss), reside in fresh water streams their whole lives.

Anadromous salmonids have a five-stage life cycle:

1) Adult salmonids lay their eggs in nests (known as redds) in clean streams. The eggs incubate for about 35-60 days depending on water temperature.
2) The eggs hatch into alevins, which live in the gravel for two to three weeks until their yolk sacs are absorbed. During these first two lifestages, the eggs and alevins are very sensitive to intergravel water quality conditions which may become impaired due to siltation, depressed oxygen concentrations, desiccation, nest movement, and other water quality impairments. Once the yolk sacs are absorbed, the young fish (known as fry at

this stage) emerge from the gravel and enter the stream to begin the fresh water rearing stage, seeking shelter in pools and adjacent wetlands; pools and banks provide the fry with cool areas of slow moving water needed by the younger fish.

3) The juvenile fish leave their natal streams and migrate downstream to the estuary where they undergo smoltification, the process of physiological transformations that will allow them to survive in the saline environment of the ocean. Smolts may reside in the estuary to feed and adjust to saltwater for up to a year before continuing on to the ocean. Residence in the estuary may be particularly important for Chinook and steelhead in terms of growth, survival, and reproductive fitness.
4) The juvenile fish mature in the ocean.
5) Adult fish return to their home stream to spawn. Pacific salmonids, with the exception of steelhead and cutthroat trout, die after spawning; their total energies are devoted to producing the next generation, and their bodies help enrich the stream for that generation.

Life history specifics vary with each species. Coho generally spend 18 months in fresh water and 18 months in the ocean, before returning to spawn in their natal stream in their third year. This three-year cycle is fairly rigid, and spawning years with relatively poor reproductive success can result in poor spawning runs three years later. Upstream migration and spawning usually occur in late fall and early winter when low stream flow may limit the ability and extent of their migration. Coho spawn at the heads of riffles, or in riffles, with gravel substrate of sufficient size. This placement may lead to the destruction of the redds during high winter storm flows. The fertilized eggs incubate for 35-50 days with the fry emerging from their gravel nests between early March and mid-May. The fry first congregate along stream margins, in shallow pools, and in backwaters and eddies. As they mature into juveniles, they seek out the heads of deep pools where there is an optimum mix of high food availability and good cover with low swimming effort. In the following April or May, when temperatures are rapidly warming, they migrate downstream to the estuary where they undergo smoltification. After coho return to their natal streams to spawn, they die.

Chinook typically migrate to sea within the first three months of life, but they may spend up to a year in fresh water prior to emigration to the sea and can spend between 2 and 5 years in the ocean before returning to spawn in their natal streams. The average is a three-year cycle and a spawning year with relatively poor reproductive success can result in a poor spawning run three years later. Chinook salmon return to their natal streams or rivers during two distinct “runs,” a spring run and a fall run. Spring run Chinook enter the fresh water system beginning in late spring, continuing through late summer and typically spawn in September and early October. Fall run Chinook typically begin their migration in early to mid-October and proceed to spawn when arriving at their nesting grounds. This usually takes place beginning in late October and is generally completed by early December. Emergence timing of Chinook salmon fry is highly dependent on water temperature during egg incubation (Piper et al., 1982) as well as time of spawning. Fertilized eggs incubate for 35-50 days; fry generally emerge from their gravel nests between early March and mid-May. Chinook salmon tend to use estuaries and coastal areas more extensively than other pacific salmonids for juvenile rearing. Out-migration by Klamath River Chinook has been determined by Sullivan (1989) to follow three separate paths:

- Type I - rear in fresh water for several months before migrating to the ocean during the summer months.
- Type II - rear in fresh water for an extended time period and migrate to the ocean in the autumn or as late as mid-winter. This type includes both juveniles that rear in the tributaries until autumn rains, and those that migrate into the main river in spring or early summer and then rear in either the mainstem or estuary until ocean entry.
- Type III - rear in fresh water through the summer, autumn, and winter before entering the ocean in the following spring as yearlings.

Timing of escapement depends on rearing conditions during the summer months in the mainstem and tributaries. After Chinook return to their natal streams to spawn, they die.

Steelhead have the greatest diversity of life history patterns of any Pacific salmonid species, including varying degrees of anadromy, differences in reproductive biology, and plasticity of life history between generations. They generally spend one to three years in fresh water before migrating to the ocean where they remain for one to two years before returning to spawn for the first time. Steelhead exhibit variability in the state of sexual maturity at the time of river entry and upstream migration. Fall steelhead enter the fresh water system during early summer through late summer, in a sexually immature condition and require several months to mature and spawn. They typically spawn from December through February. Winter steelhead typically begin their migration in November though April and enter the fresh water with well-developed gonads, spawning shortly thereafter. The steelhead migration is timed when stream levels are higher, which may increase the distance upstream they can travel. They spawn in habitat similar to that of coho, except the gravels that steelhead use for spawning may be smaller. They spawn after winter storms, reducing the likelihood that the redds will be washed out. Unlike other anadromous pacific salmonids, steelhead may survive spawning, return to the ocean and spawn in later years. Young of year (YOY) steelhead often utilize riffle and run habitat during the growing season, and move to deeper, slower water habitat during the high flow months. Larger steelhead, usually yearlings or older, have been observed to use heads of pools for feeding. Out-migration typically occurs between March and June

1.4.3. Salmon Habitat and Anthropogenic Impacts

The text presented within this section includes information that has been previously published by Humboldt Watersheds Independent Scientific Review Panel 2003(Phase II Report: Independent Scientific Review Panel on Sediment Impairment and Effects on Beneficial Uses of the Elk River and Stitz, Bear, Jordan and Freshwater Creeks), North Coast Regional Water Quality Control Board 2000 (Reference Document for the Garcia River Watershed Water Quality Attainment Action Plan for Sediment), USEPA 2001 (Gualala River Total Maximum Daily Load for Sediment), North Coast Regional Water Quality Control Board 2001 (Technical Support Document for the Gualala River Watershed Water Quality Attainment Action Plan for Sediment) and references included therein.

The success of salmonids depends on many factors, including:

- Cool stream temperatures.
- Adequate dissolved oxygen (DO) levels in the water column and redds.
- Unimpeded access to abundant, appropriately sized spawning gravels with few fines.
- Adequate food.
- Adequate cover as protection from predators.
- Protection from winter and spring freshets, including adequate availability of deep pools, backwater pools, and in-stream and bank cover.

Waters also need to be free from high concentrations of chemical constituents, pesticides, and toxic substances. These criteria apply at all salmonid life stages.

Temperature influences growth and feeding rates, metabolism, development of embryos and alevins, timing of life history events such as upstream migration, spawning and incubation, fresh water rearing, seaward migration, and the availability of food.

Cool winter water temperatures promote spawning (4.4-9.4 °C) and embryo incubation (4.4-13.3 °C). When fry begin their lives as free-swimming fish in the late spring or early summer, they are immediately confronted with low summer flows and the summer water temperatures. Higher water temperatures can result in decreased growth and reproductive fitness, increased susceptibility to disease, and ultimately, mortality. In warmer water, fish require more abundant food because of increase in metabolic rate. Increased foraging can increase exposure to predation.

Juvenile steelhead can typically tolerate warmer temperatures than coho; temperatures between 12^{o} and 14°C are considered optimal for coho while the preferred temperature range for steelhead is 12.8-15.6°C. Maximum weekly average temperatures (MWAT) over 17°C are unsuitable for coho and over 19°C are unsuitable for steelhead. Salmonids can use areas of cooler water, when they are present, as an avoidance strategy to survive during periods of elevated temperatures. Discrete areas of colder water, called thermal refugia, can be created by tributaries, groundwater seeps, inter-gravel flow, deep pools, and areas separated from currents by obstructions. The existence of these thermal refugia allows salmonids to persist in these reaches of otherwise poor or marginal habitat.

Inadequate DO can cause physiological stress, limiting growth and reproductive fitness and mortality. Minimum oxygen requirements of spawning fish vary from 5.0-6.3 mg/L with at least 80% saturation. Salmonid embryos need inter-gravel oxygen concentrations of 7 to 9 mg/l for successful development and emergence. DO below 6.5-7.0 mg/l can impede adult and juvenile coho swimming performance, DO below 4.5 mg/l can inhibit adult migration (Bjornn and Reiser, 1991 in USFS, 2003), and DO below 4-5 mg/l can cause juvenile coho salmon growth rates, food consumption rates, and efficiency of food utilization to decline. The solubility of DO in water is affected by water temperature; higher temperatures result in lower DO saturation, i.e., less oxygen is needed to saturate the water to the same degree. Generally, rearing salmonids function without impairment when DO is >7.75 mg/l with percent saturation increasing from 76% to 93% as the temperature increases from 0^{o} to 25°C (Bjornn and Reiser, 1991 *in* USFS, 2003).

Salmonids need different habitat types in different parts of their lifecycle to accommodate different life stage functions. They need clean, abundant gravel and cobble for successful spawning. Steelhead and coho salmon generally prefer substrate sizes of 0.5 to 6 inches dominated by 2- to 3-inch gravel, while Chinook salmon require substrate from 0.5 to 10 inches dominated by 1- to 3-inch gravel. To build the redd, the female turns horizontally, parallel to the channel bed, and uses her tail fin to slap the gravel, moving it downstream. She lays her eggs in the excavated area, while the male swims beside her to fertilize the eggs. She then covers the nest with gravel from just upstream. When flows are adequate, the process of moving the gravels to build and cover the nest helps to clean them as well.

Steelhead spawn in relatively small pockets of gravel, but Chinook and coho generally require larger areas of gravel. The gravel must be clean so that flowing, oxygenated water can permeate the gravel to reach the embryos and remove metabolic waste. High turbidity can lead to increased sedimentation, which reduces the quantity of oxygenated water able to percolate through the gravel and covers nests, preventing emergence.

Juvenile coho require pools for both summer and overwinter rearing. In the summer, pools provide cool, quiet habitat where coho feed and hide from predators. At depth, pools can be 3-9°C cooler than surface waters (Nielsen et al., 1994), thus providing cool refuge at the bottom when air and surface water temperatures are above the optimal range. Steelhead prefer riffles for rearing during their first summer but make more regular summer use of pool habitat as they grow. During the winter, off-channel pools provide habitat in which Chinook, coho, and steelhead can get out of flood flows to avoid being washed down river and out to sea.

Other important habitat components are in-stream cover and riparian buffer zones to shade the stream, and to provide food supply. Complex in-stream structure in the form of woody debris, overhanging or undercut banks, root wads, overhanging terrestrial vegetation, aquatic vegetation, boulders, and bedrock ledges provides microhabitats essential in the rearing and social structure of salmonids. Juvenile and adult fish use this in-stream cover as shelter from predators, territorial niches, and eddies where they can rest and conserve energy during high flows.

Large woody debris (LWD; any tree component that is 12 inches or more in diameter) is particularly important in structuring stream habitats and communities and is linked to the diversity of juvenile salmonid populations. LWD affects stream morphology, sediment movement, organic matter retention, and biological productivity. LWD can be instrumental in gravel bar formation and stabilization and pool formation by directing or concentrating stream flow in such a way that the bank or bed is scoured, or by impounding water upstream from the obstruction. Gravel collects in these pools and they become suitable for spawning. LWD and other large obstructions also provide shelter from high flows.

Small woody debris trapped by LWD is the food base for benthic invertebrates such as larval or nymph stage mayflies, caddisflies, midges, stoneflies, dragonflies and damselflies on which rearing salmonids feed. Excessive fine sediment in the channel may reduce insect production, limiting the food base available to fish. When insect production is low, higher stream temperatures become significant. The increased water temperatures increase the metabolic rate of the salmonids, and they require a greater abundance of food. Under conditions of both increased stream temperatures and reduced food availability, the ability of salmonids to survive is compromised.

Native vegetation in riparian zones along streams is crucial to the health and stability of a river system. Riparian trees and under-story plants stabilize stream banks and control erosion, provide canopy cover that reduces solar radiation and maintains low stream temperatures, contribute material to enhance fish cover and habitat, and provide nutrient inputs that stimulate primary production. The riparian corridor also filters upland runoff, reducing the quantity of sediment entering the stream.

The amount of rearing habitat in the tributaries for coho and steelhead, which is determined by stream flow, is generally considered to be the limiting factor of population size. Stream flow is also a critical factor affecting other water quality measures such as temperature, DO, and sedimentation. Adequate flow is required for successful upstream migration, spawning¸ incubation, rearing, and out-migration. High flows help to prevent increases in temperature and reductions in dissolved oxygen. High flows also move LWD and gravel downstream and remove silt from gravel, creating suitable spawning habitat. Alternatively, flow can be too high, preventing fish from migrating upstream, scouring nests, or washing juveniles downstream too early.

Human efforts to manage the land in the NCR have accelerated natural sediment generation and delivery processes and compromised the abilities of the waterways to efficiently transport sediment downstream and out of the systems. Major land use activities in the North Coast region today that contribute to the local economies include logging and timber milling; aggregate mining; agriculture, including livestock and dairy production, vineyards, and wineries; residential development; commercial fisheries; and tourism and recreation, including sport fishing. The timber, mining, agriculture, and construction industries – along with the associated building and use of roads – contribute to increased erosion in the watershed, leading to excessive sedimentation of streams, which in turn threatens water quality and aquatic habitat.

Timber harvesting, for example, results in greater volumes of sediment delivered to streams than is delivered in the absence of timber harvest and harvest-related activities. Coastal redwoods and associated vegetation can intercept as much as 0.5 inches of rainfall per event, thus reducing the amount of precipitation that penetrates the soil or runs off. Removing vegetation increases soil moisture levels, and less rainfall is required to saturate soils compared to vegetated areas. Removal of vegetation, especially by clear-cutting, also decreases the strength of the roots that hold the soil together and increases the amount of bare ground. These factors increase the likelihood of mass wasting; there is a significant positive relationship between rates of timber harvest and rates of landsliding.

The heavy machinery used in timber harvest can compact soils, decreasing infiltration rates and increasing runoff, which increases erosion of ground bared by the removal of vegetation. The direct sedimentation of stream channels by heavy equipment use occurred frequently prior to enactment of the Z'berg-Nejedly Forest Practice Act in 1973 (Forest Practice Act), which prohibited the practice of building roads and yarding logs that resulted in the direct sedimentation of stream channels. The increase of sediment delivery has an effect on stream morphology. For example, pools are much more frequent and their average depth is greater in the channels surrounded by old-growth forests compared to second-growth areas that have been previously harvested. Logging also reduces the availability and delivery of LWD to streams, significantly altering channel morphology and fish habitat.

A large number of roads and skid trails generally accompany silviculture as well as residential and commercial development. As the percentage of land covered by impervious or compacted surfaces (such as homes, roads, and driveways) increases, the area available for infiltration decreases and surface runoff increases. Parking lots, drainage ditches, roads, and storm drains concentrate storm runoff and increase the rate and volume of runoff to streams. This tends to increase the magnitude and frequency of peak flows, which increases erosion rates along streambanks.

Sediment delivery also typically increases during construction activities, particularly during the wet winter months. Road construction increases the potential for surface erosion and slope instability by increasing the area of bare soil exposed to rainfall and runoff, by obstructing stream channels and by altering subsurface flow pathways. Residential and commercial development and road construction also increase the likelihood of water quality pollution due to runoff of substances such as oil, grease, and heavy metals.

Agriculture, including row crops, orchards, and vineyards can also increase sediment production and delivery to streams. The clearing of vegetation for viticulture, which is continually expanding in the NCR, may considerably increase surface erosion through exposure of bare earth to rainfall and runoff. Many vineyards are being developed on hillsides where there is increased erosion potential and delivery of sediment to nearby streams. Livestock grazing can also affect sediment delivery.

The removal of natural vegetation and modification of soil characteristics affects the hydrologic and erosional processes. Reduction of vegetative cover exposes soils, increases surface erosion and runoff velocities, and reduces soil strength provided by roots. Trampling can compact soils and decrease infiltration rates, thereby increasing runoff and surface erosion. Livestock often congregate in riparian areas for water and shade and their trampling can cause stream banks to collapse, leading to increased sedimentation and changes in channel morphology. Grazing can also change the structure and composition of riparian vegetation, thus indirectly increasing sediment delivery.

Natural events have had significant impacts on sedimentation in the North Coast region as well. In December of 1964, several days of very heavy rain on top of an early snowpack in the higher mountains created the greatest flood on record on the North Coast. The Russian, Eel, Klamath, and Rogue Rivers all rose to unprecedented heights. Dozens of small towns were inundated, and several were completely swept away. This flood was a major structuring force in streams throughout the region. In general, massive amounts of sediment were mobilized from hillsides and deposited in streams. Deposition to the depth of the tens of feet occurred in some areas. Extensive riparian vegetation was lost along stream channels. Sedimentation in streams continued for years after the flood as sediments from upstream areas were mobilized and deposited further downstream. In a number of watersheds, the flood of 1964 negatively impacted salmonid populations, which were already beginning to suffer declines from anthropogenic impacts. By the 1990s, some areas showed evidence of recovery both in terms of stream channel characteristics and biological resources.

The effects of sediment on salmonids are different from effects of other pollutants like trace metals or toxic substances. These latter constituents often directly affect organisms' physical well-being, and laboratory experiments can determine the level of exposure resulting in deleterious effects and mortality. In contrast, sedimentation generally affects salmonids indirectly by reducing the quality and quantity of aquatic habitat available rather than directly affecting their physical health. For example, excess fine sediment surrounds and fills in streambed gravels, causing them to become embedded (defined as >50% covered in fine material), which effectively cements them into the channel bottom. Embeddedness can prevent the spawning salmon from building their redds. Excessive fine sediment can reduce egg and embryo survival and juvenile salmonid development; embryo survival decreases as the amount of fine sediment increases. Deposits of these finer sediments can also smother the redds and prevent the fry from emerging. Chronic exposure to high levels of suspended sediment can reduce smolt body size, which directly affects survival and reproduction rates.

Sedimentation may affect behavior as well. Adult salmon migrating upstream to spawn may avoid turbid waters, limiting or delaying their ability to return to their natal stream. Feeding rates and success may also be reduced, negatively impacting the fish. For example, the abundance of invertebrates, a primary food source for juvenile salmonids, can be reduced by excessive fine sediment. LWD, which provides shelter, can be buried. Lastly, suspended sediment can cause direct damage to the fish by clogging gills.

Removal and disturbance of vegetation, particularly the riparian canopy, reduce shading and increase the amount of solar radiation reaching streams, resulting in higher average summer stream temperatures and increased daily temperature fluctuations. Removal of riparian canopy also often results in streambank instability and increased sedimentation, which can increase stream temperatures in several ways:

- Sedimentation can reduce the frequency, volume, and depth of pools that serve as thermal refugia. There is a direct link between sediment storage in pools and thermal impacts on anadromous fish. Coho in Northern California tend to be found in streams in which ~40% of the area consists of pools that are at least two to three feet deep.
- Sedimentation can reduce overall stream depth and cause channels to widen, which increases the amount of surface area exposed to solar radiation. This is compounded by loss of riparian canopy, which, left intact, would provide shade and reduce solar heating. Riparian vegetation can have an indirect effect on in-stream temperatures as well because riparian conditions can influence local air temperature, wind speed, relative humidity, and ground temperature. Shady locations are typically cooler, less windy, and more humid than open areas.
- Sedimentation may also eliminate cold water seeps.

Agricultural activities that divert water during summer low flow periods also serve to increase stream temperatures and reduce or even eliminate aquatic habitat. Groundwater, particularly in flat alluvial areas, usually contributes to the baseflow of streams during the summer months. Groundwater extraction for irrigation can lower water tables and reduce baseflow contributions. Not only does this result in less water for aquatic habitat, but it may also cause stream temperatures to increase because groundwater inputs to streams are generally cooler than surface inputs. Road construction and urban development contribute to this problem as well. As vegetation is replaced by impervious surfaces and surface runoff is increased, groundwater storage is decreased, and the associated groundwater inputs to summer baseflows decrease. The problem may be compounded by extraction of drinking water from wells and springs.

Seasonal and permanent dams pose additional threats to anadromous fish by preventing both upstream and downstream migration and blocking access to habitat. The migration of adult salmon upstream requires that there be no impassable barriers between the ocean and their spawning streams. Similarly, once the fry emerge from the gravel, there must be no barrier to the passage of these small fish from the spawning reaches to and among rearing habitats, particularly during the summer when flows may be low and temperatures warm. Finally, once the juveniles are ready to return to the ocean, their passage from their rearing reaches to the estuary and out to the ocean must be unimpeded. In addition, dams alter river flow and temperature and block sediment transport, which can cause a stream to incise and/or erode its banks downstream. Lastly, the dams create habitat for other species, often predatory warmwater fish, that threaten salmonids.

1.4.4. Current Status of Salmon Populations in the NCR

> *The text presented within this section includes information that has been previously published by USEPA 2004 (Upper Main Eel River and Tributaries (including Tomki Creek, Outlet Creek and Lake Pillsbury) Total Maximum Daily Loads for Temperature and Sediment), USEPA 2003 (Middle Fork Eel River Total Maximum Daily Loads for Temperature and Sediment), USEPA 2003 (Mattole River Total Maximum Daily Loads for Sediment and Temperature), USEPA 2001 (Gualala River Total Maximum Daily Load for Sediment), North Coast Regional Water Quality Control Board 2001 (Technical Support Document for the Gualala River Watershed Water Quality Attainment Action Plan for Sediment) and references included therein.*

Populations of anadromous fish have declined dramatically throughout the state of California over the last 50 years. California coho populations have declined approximately 94% since the 1940s and 70% since the 1960s. There were an estimated 200,000 to 500,000 native coho spawning statewide in the 1940s; that number declined to ~100,000 in the 1960s, ~30,000 by 1985, and <5,000 in 1994. Historically, at least 582 California streams supported coho salmon populations at some time; today, coho are found in just 51% of those streams, and many current populations have less than 100 individuals.

In the early 1960s, California Department of Fish and Game (CDFG) estimated that 256,000 Chinook and 573,000 steelhead spawners returned each year to the coastal rivers of California.

Over the 1940s, 1950s, and 1960s, North Coast counting stations showed declines of ~65% in Chinook salmon and steelhead spawners. West coast steelhead stocks in northern California are very low relative to historic estimates, and recent data confirm the downward trend. Many of these populations are threatened or endangered under FESA (Table 3). Steelhead are generally more abundant than coho, perhaps due to their ability to spawn multiple times and timing of spawning, tolerance to warmer water temperatures, and ability to use more habitat types. Chinook and steelhead in the upper Klamath River basin, and the Trinity River, have not yet warranted listing under FESA.

Reasons for the decline of coho and Chinook salmon and steelhead trout in California include loss of stream habitat due to natural and anthropogenic causes, breakdown of genetic integrity of native stocks, increased competition, increased disease, over-harvest, and climatic change.

Table 3. Salmonid populations listed as threatened or endangered under the Federal Endangered Species Act.

Species	Coho Salmon (Oncorhynchus kisutch)		Chinook Salmon (Oncorhynchus tshawytscha)	Steelhead Trout (Oncorhynchus mykiss)	
Evolutionary Significant Unit (ESU)	Southern Oregon/ Northern California	Central California Coast	California Coastal	Northern California	Central California Coast
Range (inclusive)	Cape Blanco, OR to Punta Gorda, Humboldt County, CA	Punta Gorda to San Lorenzo River, Santa Cruz County and populations in tributaries to San Francisco Bay with the exception of the Sacramento-San Joaquin River system	Redwood Creek in Humboldt County to Russian River	Redwood Creek to Gualala River in Mendocino County	Russian River to Aptos Creek in Santa Cruz County
Status	Threatened	Threatened; endangered	Threatened	Threatened	Threatened
Date of Listing	1997	1996; 2005	1999	2000	1997
North Coast Watersheds					
Albion River		X	X	X	
Big River		X	X	X	
Eel River	X		X	X	
Garcia River		X	X	X	
Greenwood Creek		X	X	X	
Gualala River		X	X	X	
Klamath River (including Scott and Shasta Rivers)	X				
Mad River	X		X	X	
Mattole River	X		X	X	
Navarro River		X	X	X	
Noyo River		X	X	X	
Redwood Creek	X		X	X	
Russian River		X	X		X
Smith River	X				
Ten Mile River		X	X	X	
Trinity River	X				

2._______NCR Watershed Descriptions

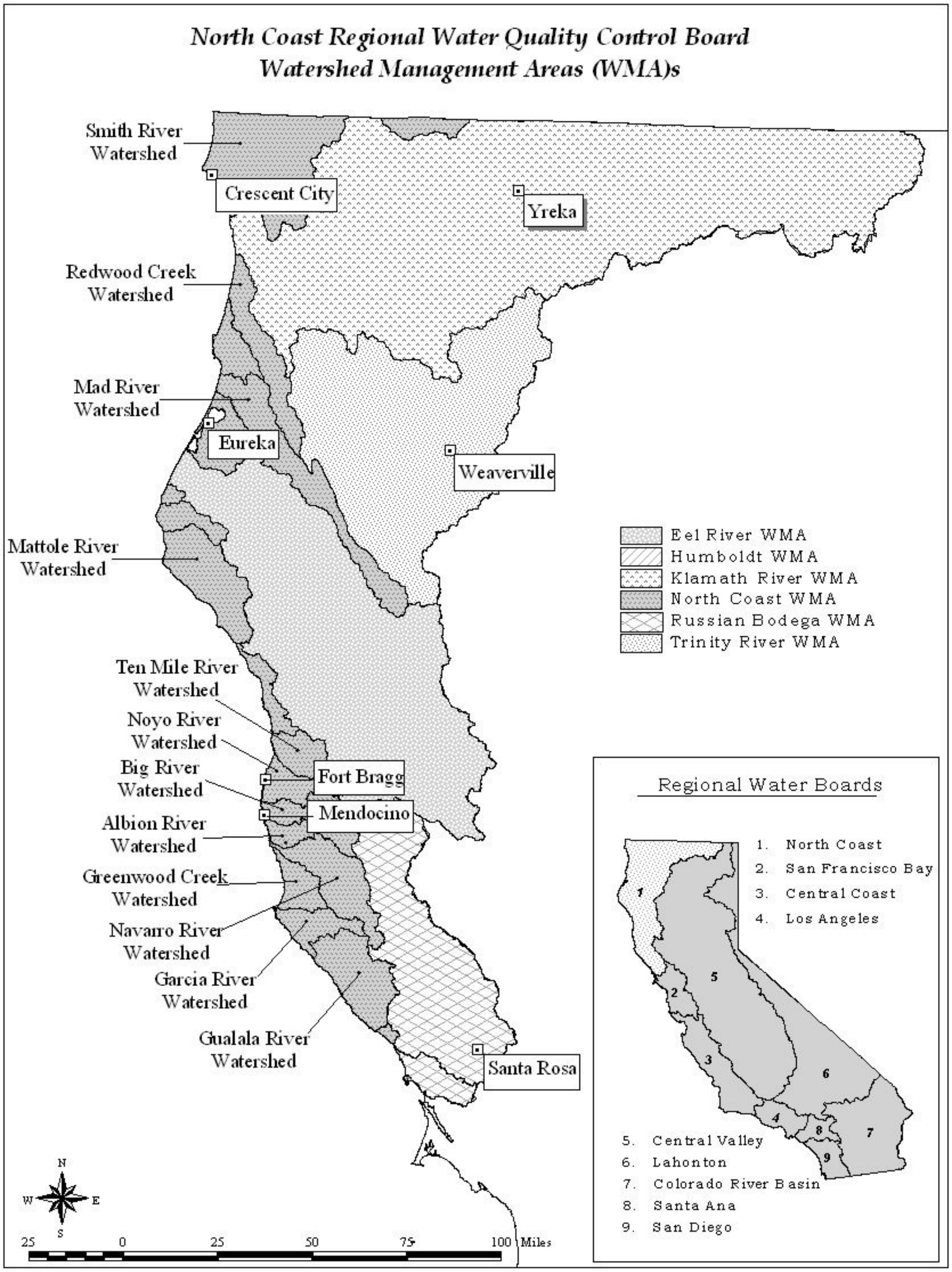


Figure 1. Watershed Management Areas of the North Coast Regional Water Quality Control Board

The text presented within this section includes information that has been previously published by the North Coast Regional Water Quality Control Board 2005 (Watershed Planning Chapter), Entrix et al. 1998 (Navarro River Restoration Plan) and references included therein.

For management purposes, water resources are divided into "management areas", which may contain one or more drainage basins or watersheds, or a portion of a drainage basin or watershed. The Watershed Management Areas (WMAs) of the NCR are:

- Klamath WMA
    - Lost River
    - Klamath River
    - Shasta River
    - Scott River
    - Salmon River
- Trinity River WMA
- Humboldt Bay WMA
    - Redwood Creek
    - Mad River
- Eel River WMA
- North Coast Rivers WMA
    - Smith River
    - Mattole River
    - Ten Mile River
    - Noyo River
    - Big River
    - Albion River
    - Navarro River
    - Garcia River
    - Gualala River
- Russian/Bodega WMA
    - Russian River
    - Americano Creek
    - Stemple Creek
    - Salmon Creek

2.1.________Klamath River WMA (Hydrologic Unit [HU] 105.00)

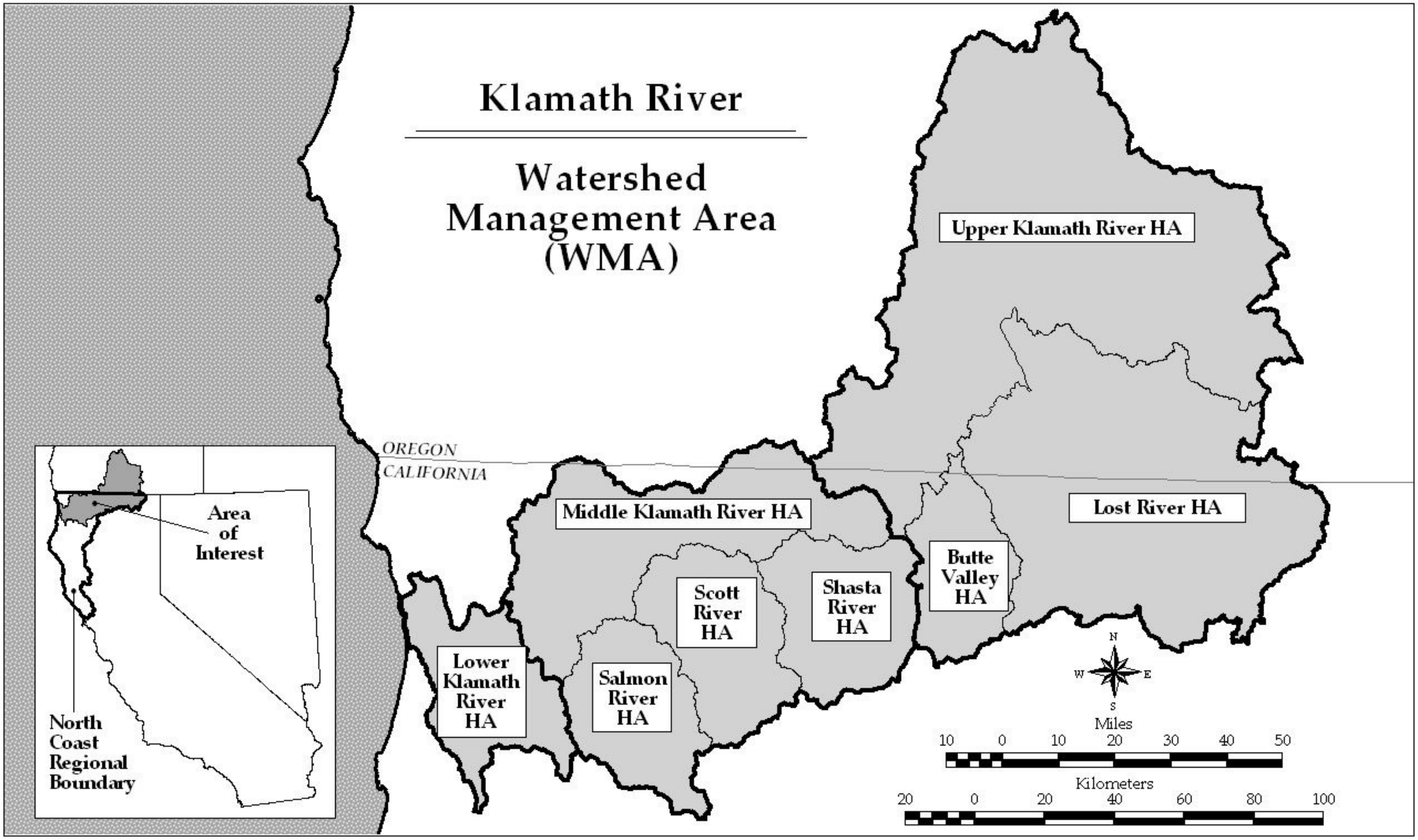


Figure 2. Hydrologic Areas of the Klamath River WMA

2.1.1.________Overview

The Klamath River WMA is divided into three sub-basins: Lower Klamath, Middle Klamath, and Upper Klamath. The Trinity River HU (106.00) lies within the overall Klamath River basin but is not included in the Klamath WMA; it is its own WMA. The Klamath River WMA includes several hydrologic areas (HAs) within HU 105.00: Lower Klamath River HA (HA (105.10), Salmon River HA (HA (105.20), Middle Klamath River HA (HA (105.30), Scott River HA (HA (105.40), Shasta River HA (HA (105.50), Upper Klamath River HA (HA (105.60), Butte Valley HA (HA (105.80), and Lost River HA (HA (105.90) (see Figure 2).

The Klamath River, which starts in Oregon, travels for approximately 250 miles through Oregon and California before flowing into the Pacific Ocean near Crescent City. The Klamath River WMA HU (105.00) covers ~12,100 mi^2 in southern Oregon and northern California and is home to six federally-recognized tribes and several National Wildlife Refuges, Parks, and Forests. Roughly 53% of the watershed lies in California and 47% lies in Oregon. Major tributaries to the Klamath include the Shasta, Scott, Salmon, and Trinity rivers. The Klamath River has historically been the third-largest producer of salmon on the West Coast, following closely behind the Sacramento and Columbia rivers. In 2002, a massive fish kill occurred in which over 33,000 adult Chinook and coho salmon died (California Department of Fish and Game [CDFG] 2004).

The Human population in the Klamath River basin was estimated in the 2000 US Census to be about 114,000 (United States Census Bureau [USCB] 2000). The largest population concentrations lie in the upper Klamath agricultural area, the Shasta River valley, and Scott Valley. The largest population center is Klamath Falls in Oregon (population 19,462) followed by Yreka, CA (population 7,290).

More than two thirds of the Klamath River watershed is in federal ownership including lands managed as National Forests, National Wildlife Refuges, National Parks, and Bureau of Land Management (BLM) land. The largest blocks of private ownership are agricultural areas in the upper Klamath watershed, agricultural and timber properties in Shasta and Scott Valleys, Tribal lands, and privately owned land in the Klamath River valley near the mouth.

2.1.1.________Climate

The geographic extent and topographic relief of the Klamath River watershed combine to produce a wide variety of climate. On average, the climate is characterized by dry summers with high daytime temperatures and wet winters with moderate to low temperatures. The mean annual precipitation ranges from more than 80 inches in the high elevations to 10 inches in the broad inland valleys. About three quarters of the annual precipitation falls between October and March, producing a snowpack in the higher mountain ranges that feeds streamflow in many lower areas through the summer. The Klamath River watershed is characterized by patterns of floods and droughts. During a drought in 1976-77, precipitation was only 20 percent of normal in the Scott

River watershed and 40 percent of normal in the upper Klamath River basin. The largest floods occurred when relatively warm storm systems melted a pre-existing snow pack such as occurred in 1861, 1955, 1964, 1974, and 1997.

2.1.3 Water Resources

The Klamath River basin is intensely managed with respect to water resources. Federal, state and local agencies store and distribute water in the Klamath River and Lost River watersheds. The Klamath is impounded by five dams, which create reservoirs for water delivery and hydroelectric generation. More than 1,400 miles of canals and drains provide service to water users. The waters are used for agriculture, logging, transportation, hydroelectric generation, and wildlife refuge management interests, and by tribes and municipalities.

Water movement within the Klamath River basin is complex. For example, the Lost River Diversion Canal carries water in either direction between Klamath and Lost Rivers, while the Klamath Straits Drain carries water in either direction between Klamath River and Lower Klamath Lake. The standing water bodies, especially Upper Klamath Lake in Oregon, are eutrophic and undergo wide variations in dissolved oxygen concentration and pH.

The Klamath watershed supports an active recreational industry, including activities that are specific to the Wild and Scenic portions of the river designated by both the state and federal governments in both Oregon and California. Additionally, the watershed continues to support what historically were once significant mining and timber industries.

2.1.4. Fishery

The upper Klamath River basin above Iron Gate Dam is home to four species of suckers; shortnose, Lost River, Klamath smallscale, and Klamath largescale. The shortnose and Lost River suckers are large, long-lived, late-maturing fish that live in lakes but spawn primarily in streams. Historically, shortnose and Lost River suckers were present in the Lost River and Klamath River and their tributaries above Iron Gate Dam, though their current distribution and numbers have decreased significantly. These fish were a primary food source for the Klamath and Modoc Indians throughout historic times until the 1980s, when severe declines in the fish populations caused the Klamath Tribes to close their fishery. Both species are currently on the federal, Oregon, and California endangered species list.

Redband trout persist in the basin above Iron Gate Dam because of their ability to thrive in lake and stream conditions that would be lethal to most salmonids. Currently, redband trout numbers are high in both lakes and rivers of the upper Klamath River basin, and these trout support a highly productive and self-sustaining summer fishery.

Bull trout have been extirpated, or are at risk of extirpation, from most of the areas where they once existed in the Klamath River basin. Current distribution of bull trout is limited to headwaters upstream of Upper Klamath Lake. Populations are listed as threatened by the federal government, critical by Oregon, and endangered by California.

Anadromous salmonids in the Klamath River basin are limited to the area of the basin within California below Iron Gate Dam, which is a barrier to anadromy. Anadromous salmonid runs currently utilizing this portion Klamath River basin include spring and fall Chinook, coho salmon, and spring/summer, fall, and winter steelhead. All six salmonid runs in the Klamath River basin have experienced declines in populations and distribution since the early 1900's. The decline of anadromous species in the basin can be attributed to a variety of factors including over harvest, land-use practices, mining, stream habitat alterations, agriculture, and changes in water quality and temperature. Significant effects are also attributed to water allocation practices and dam construction, which has altered flow regimes.

Historically, anadromous species within the basin extended above Upper Klamath Lake in Oregon, and into the Sprague and Williamson River systems and other tributaries. Chinook salmon historically migrated into tributaries of Upper Klamath Lake, and steelhead were found in the Klamath River basin above Iron Gate Dam as well. Coho salmon distribution extended at least to the vicinity of Spencer Creek in Oregon.

Spring/summer steelhead were once widely distributed in the Klamath River and Trinity River basins and were present in the headwaters of most larger tributaries. Their numbers have declined from historic levels, and the National Marine Fisheries Service (NMFS) considers stocks depressed and in danger of extinction. Fall and winter steelhead are currently widely distributed in the basin below Iron Gate Dam. Current population estimates for steelhead in the Klamath River basin have not been conducted on a regular basis, though their numbers are believed to be declining from historic levels. Although NMFS considers winter steelhead to be in low abundance and at some risk of extinction, they are not currently on the state and federal endangered species list.

Historic and current records reflect that Chinook salmon were, and continue to be the most abundant anadromous species in the Klamath River basin. Spring and fall run Chinook populations and distribution have decreased dramatically since the early 1900's.

Fall Chinook population estimates from the late 1800's and early 1900's range from 300,000 to 500,000 fish annually. For the years 2004-2006, the estimated number of fall Chinook natural spawners in the basin has fallen below the Pacific Fishery Management Council goal of a minimum of 35,000, with returns averaging 28,800 per year.

Spring Chinook historically were found in tributaries throughout the Klamath River basin, although they are now only present in the Salmon and Trinity Rivers. In the early 1900's as many as 100,000 spring Chinook were found in the basin, but current populations range from 100 to 1000 fish.

Coho were once abundant and widely distributed in the Klamath River and its tributaries. Current population estimates for coho in the Klamath River basin have not been conducted, although combined adult coho return numbers to the Iron Gate Hatchery, Trinity River Hatchery, and Shasta River Fish Counting Facility have averaged 5,949 fish during the last 42 years. Coho in the Klamath River basin are currently on the state and federal endangered species lists due to the long-term decline in numbers and distribution.

Other Anadromous species present in the Klamath River basin below Iron Gate Dam include pink and chum salmon, coastal cutthroat trout, eulachon, white and green sturgeon, and Pacific lamprey.

- Pink salmon probably once existed in the Klamath River, although they appear to be extirpated from all areas in California and only occasionally stray into streams along the California coast.
- Chum salmon are periodically observed in the basin, and maintain a small population in the Klamath River. Historically chum were more abundant than present, although their numbers were never very large.
- Coastal cutthroat trout mainly occur in smaller tributaries in the lower 22 miles of the Klamath River.
- Eulachon were historically present in large numbers in the lower 8 miles of the river. However, since the 1970's their numbers have been too low to support the once flourishing tribal fishery.
- It is estimated that 70-80% of all green sturgeon are produced in the lower Klamath and Trinity Rivers where several hundred are taken every year by the tribal fishery. There is some evidence that green sturgeon numbers in the basin below Iron Gate Dam have decreased in recent years. At the present time they are listed as a species of special concern by the federal government.
- The historic distribution of Pacific lamprey is unknown, however it is certain that they have entered the area above Klamath Falls, Oregon in the basin above Iron Gate Dam at least occasionally. Today Pacific lamprey populations are declining in all coastal rivers, and they are listed by the federal government as a species of concern.

Non-anadromous species common in the Klamath River below Iron Gate Dam and its low gradient tributaries include speckled dace, Klamath smallscale suckers, lower Klamath marbled sculpin, threespine stickleback, and Klamath River lamprey. Dace, stickleback, sculpin, and suckers probably utilize nutrients brought into the streams by anadromous species, and may suffer heavy predation by juvenile salmonids.

2.1.5. Topography and Geology

Elevations range from sea level at the river mouth to 14,179 feet at the summit of Mount Shasta. The Klamath River watershed crosses four recognized geomorphic provinces, each of which is defined and shaped by its unique geologic history. From east (upstream) to west (downstream), these provinces are the Modoc Plateau, Cascade Range, Klamath Mountains, and Coast Ranges.

Headwaters of the Klamath gather in the Modoc Plateau, an area of flat valleys punctuated by volcanic cones. The rolling valley bottoms are at about 4000 to 5000 feet in elevation and the volcanic cones rise a thousand feet higher. Although rainfall is low, the flat and rolling valley bottoms of rich volcanic and organic soils combine with an abundance of water entering from higher surrounding country to create historically vast freshwater wetlands. Much of this wetland area has been converted to productive farmland. The volcanic soils are naturally rich in phosphorus, and the conversion of wetlands to farmland and other landuses has exposed the nutrient and organic rich soils to oxidation, resulting in the release to the water column of nitrogen and phosphorus previously stored in the soil and wetland vegetation.

The Cascade Range is a belt of mainly volcanic rocks that are younger than rocks of most of the Modoc Plateau and form higher relief. The border between the Cascade province and the Klamath Mountains province is spanned by the Shasta Valley. The Klamath Mountains province is very steep and rugged for the most part and in the Klamath River watershed consists of several irregularly oriented ranges – the Trinity Alps, Scott Bar Mountains, Siskiyou Mountains, and Marble Mountains. Shasta and Scott Valleys have broad flat valley bottoms that support agriculture, while other valleys are narrower and steeper and therefore less developed. Most of the land in the Klamath Mountains province is in federal ownership, and this rugged landscape lends itself more to timber harvest and cattle grazing than to crops.

The Coast Ranges form about 20 miles of the lower Klamath River valley and part of the west side of the valley of the lower Trinity River and South Fork Trinity River. The Coast Ranges are steep, but are generally more rounded and not as high as the Klamath Mountains.

2.1.6. Hydrologic Areas of the Klamath River WMA

2.1.6.1.______Upper Klamath River HA (HA (105.60)

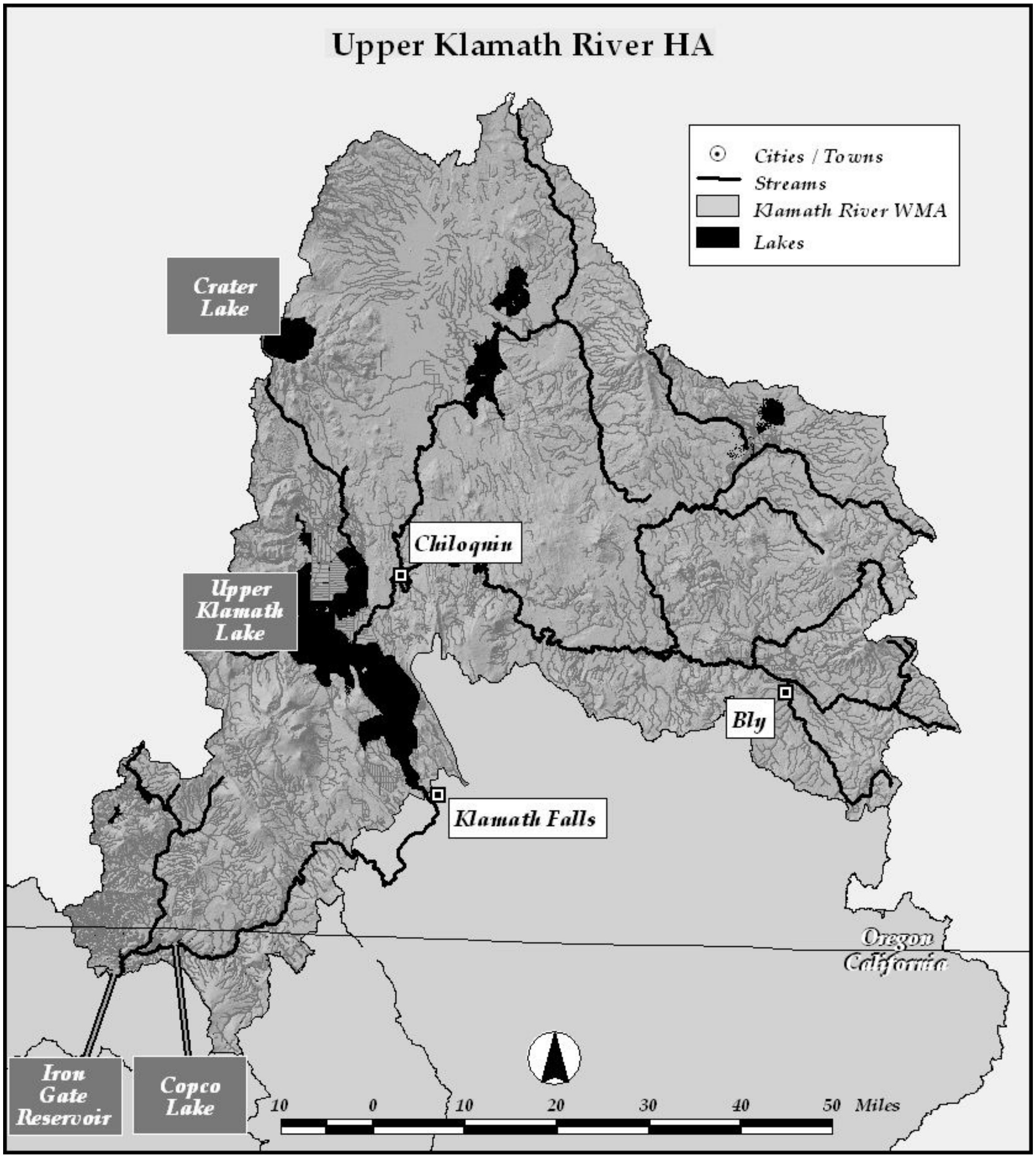


Figure 3. Map of the Upper Klamath River HA

2.1.6.1.1.____Overview

The Upper Klamath sub-basin covers roughly 7,438 mi^2, extending from the headwaters of the Klamath River in Oregon, above Upper Klamath Lake, to Iron Gate Dam in California (see Figure 3). Approximately 75% of the sub-basin is in Oregon, encompassing the Lost River sub-watershed and areas upstream of Iron Gate Dam in

California. Water is released from Klamath Lake through hydropower systems and a modified natural channel known as the Link River. The Klamath River then enters Lake Euwana, the outflow of which is controlled by Keno Dam. Below Keno Dam, the river flows through rugged canyon areas into California passing through the John Boyle hydropower structures along its way.

Upon entering California, the Klamath River flows into Copco Reservoir, through its hydropower system and then into Iron Gate Reservoir. Dams created these reservoirs for power generation and to regulate flow regimes down stream. Permanent residences and cabins dot the shoreline of Copco Lake. Both cold- and warm-water fishing are popular in the nutrient-rich waters. Iron Gate Dam blocks upstream salmon migration at this point in the Klamath River. Iron Gate Hatchery is located just downstream of the dam.

Above Iron Gate Dam, the Straits Drain contributes un-ionized ammonia and nutrient-rich suspended particulate materials to the Upper Klamath. The Straits Drain contains water that has been used and retained in the Lower Klamath Wildlife Refuge in diked-off cells to benefit resident and migratory waterfowl. The cells are shallow areas of water that may sit for long periods of time. Because of the differences in timing of waters routed through the Klamath River/Lake Euwana system versus the Straits Drain system and the concentrating processes that occur before water is pumped from the Straits Drain, this drainage discharge is usually of much lower quality than the river. This discharge combined with summer heat contributes to robust algal growth (eutrophication) in areas downstream. Water in Copco and Iron Gate reservoirs becomes thick with algae in the summer months, leading to complaints about aesthetic conditions from the public, and to health related concerns regarding the abundance of blue-green algae. The Straits Drain discharge contributes to the non-attainment of desired water quality conditions in the river and is an issue to be addressed by Oregon in a TMDL process pursuant to Clean Water Act section 303(d).

Many natural and human-altered watershed elements above Iron Gate Reservoir in California and Oregon affect the quality and quantity of water that exits Iron Gate Reservoir to supply the Klamath mainstem flow, and affect (both support and jeopardize) the beneficial uses of the river within California. The complexity of this sub-basin is magnified by jurisdictional issues associated with water delivery/utilization infrastructures (including the Federal Klamath Project), irrigation, hydropower, endangered species, tribal rights, lake-level-management demands for Upper Klamath Lake, the waters criss-crossing the California-Oregon border, and minimum flow requirements in the Klamath river below Iron Gate Dam. Hydromodifications (dams, levees, irrigation diversion, and drain-water removal works) that have been constructed since 1860 in the Klamath River basin upstream of Iron Gate Dam have resulted in:

- Diminished river flow rates in the dry season.
- Increased summer/fall water temperatures and impairments to WARM and RARE beneficial uses.
- Arrested migration of anadromous fish.
- Endangerment of fish species native only to this basin.

- Development of an extensive agricultural community in Oregon and California, including the development of extensive private property on once underwater lake/marshes and once inhospitable canyon lands.
- Development of extensive hydropower resources.
- Preservation of managed migratory waterfowl refuges.
- Ground water augmentation of surface flows.

2.1.6.1.2.____Lost River HA (HA (105.90)

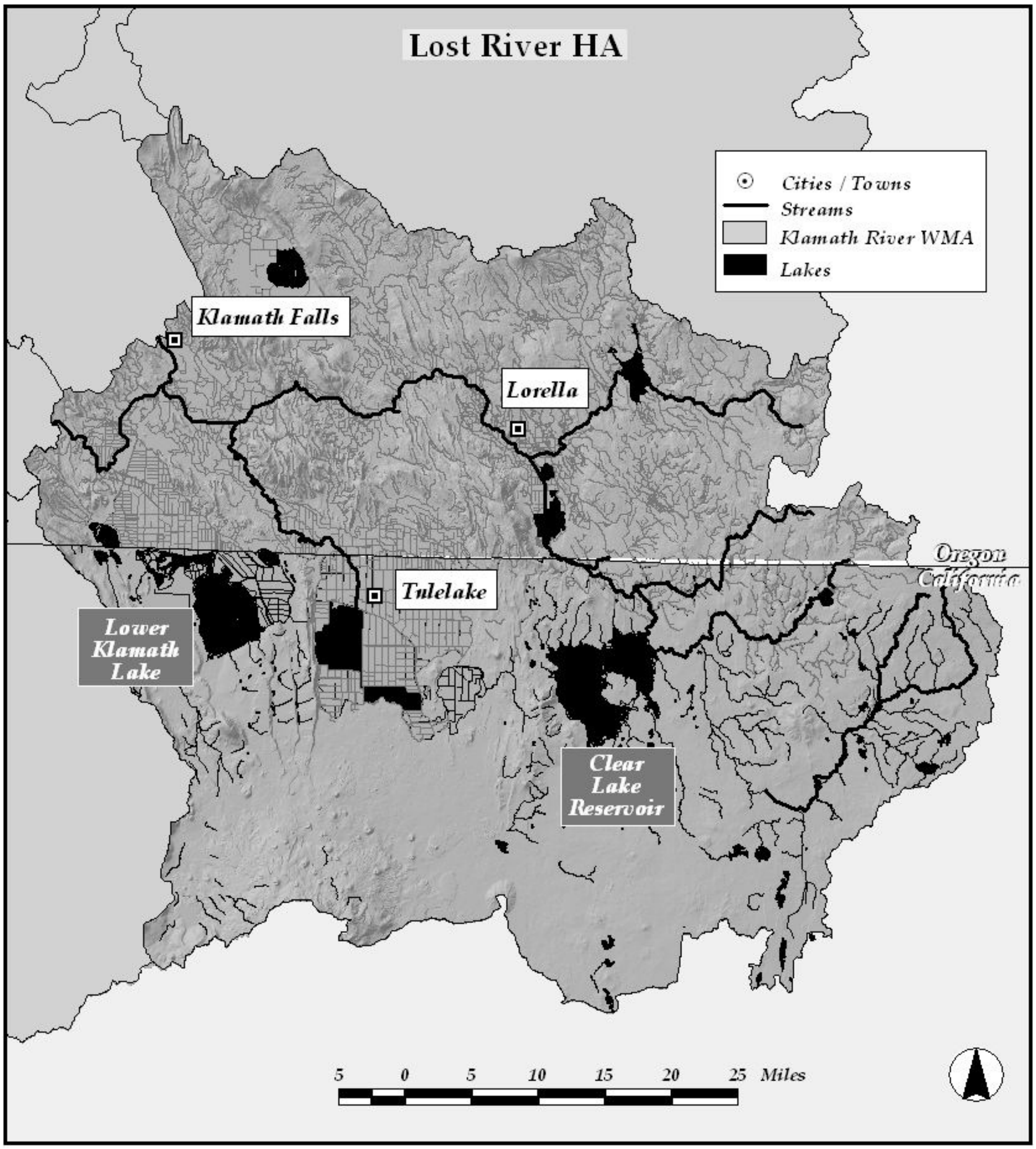


Figure 4. Map of the Lost River HA

The Lost River HA covers ~3000 mi^2 in southern Oregon and northern California. Roughly 56% of the watershed lies within the boundaries of California while the remaining 44% lies in Oregon. The upper Lost River watershed encompasses Clear Lake Reservoir and its tributaries. The area is characterized by high desert stream systems and is sparsely settled. Agricultural activities in the area adversely affect water quality. Cattle grazing on both United States Forest Service (USFS) and private lands have free access to streams that flow into Clear Lake. The livestock trample stream banks causing increased sediment discharge and accelerated loss of riparian vegetation, which in turn leads to increased nutrient release, increased water temperature. Un-shaded, sediment laden eutrophic streams are poor-to-unsuitable habitat for RARE species.

The severity of degradation to Clear Lake tributaries varies by location, but Boles, Willow, and Mowitz Creeks have been assessed and are receiving remedial efforts. Lost River below Clear Lake Dam in California is substantially impaired. Land uses in the lower Lost River basin are primarily crop agriculture such as grains, potatoes, and onions, along with grazing and lands administered for the National Wildlife Refuge. Land use in Oregon is predominantly agricultural. Ground water is now part of the surface water system, since numerous high production wells were brought online in 2001 to augment surface flows.

Land uses and associated hydrologic and water quality factors in the Klamath basin change dramatically moving downstream through the watershed areas. Drainage from agricultural lands and wetlands conveys nutrient-rich suspended particulate and dissolved materials into waterbodies that are long standing nutrient traps. Evaporation and isolation cause these waters to have very high nutrient levels, support very high phytoplankton (algae) populations, and have large diel fluctuations in dissolved oxygen, pH, and ammonia levels. For example, the Tule Lake sump system is highly eutrophic with concomitant low dissolved oxygen levels, high pH levels, high un-ionized ammonia levels, and high water temperatures. This water quality is perceived as impaired and may become or remain toxic to and uninhabitable by native fish species, including the FESA listed shortnose sucker and Lost River sucker. Whether irrigated agriculture and lake wetland modifications have exacerbated this eutrophic condition to a measurable degree such that water quality beneficial uses are impaired is yet undetermined.

2.1.6.2.______Middle Klamath River (HA 105.30)

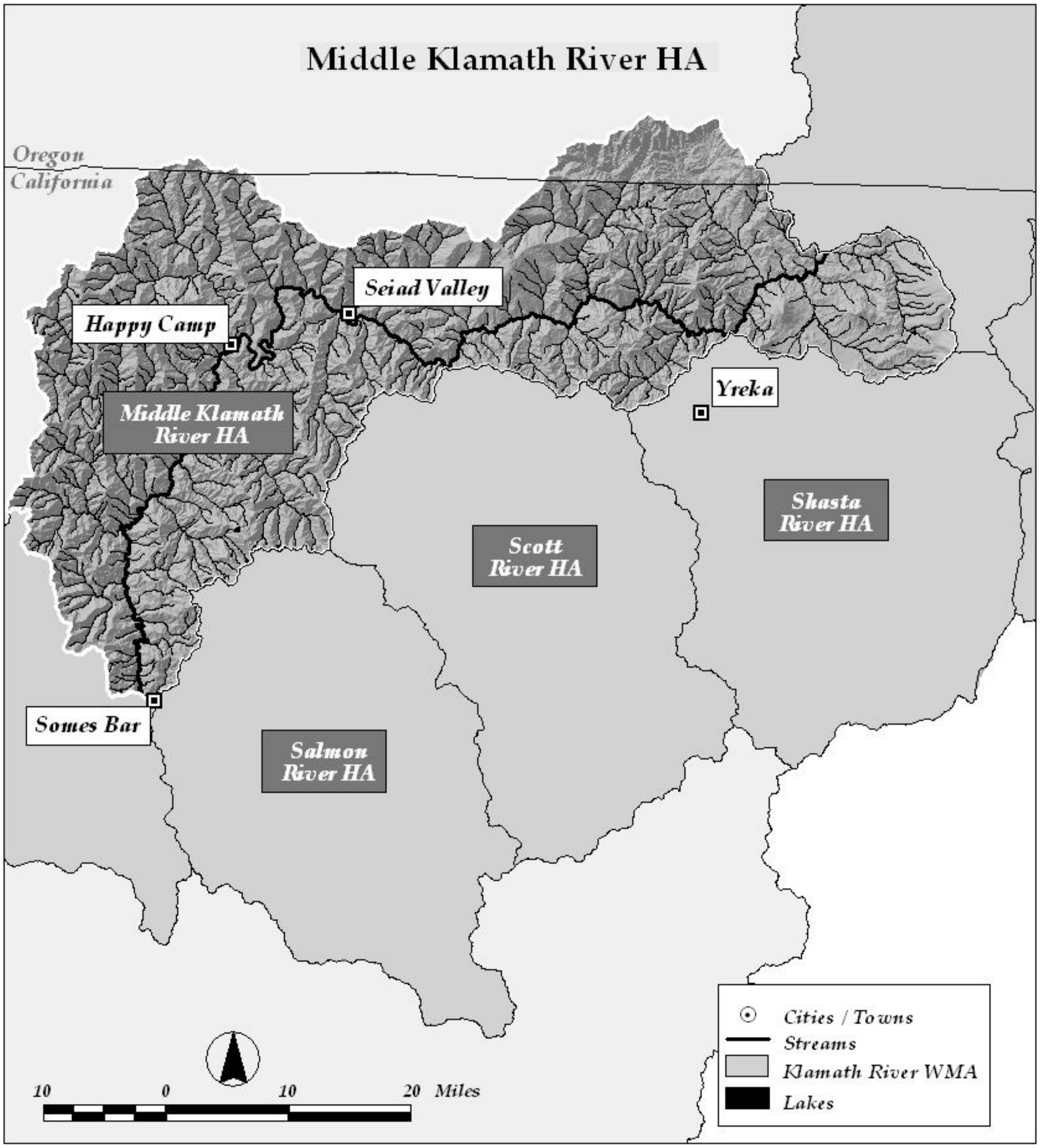


Figure 5. Map of the Middle Klamath River HA

The Middle Klamath River HA begins at Iron Gate Dam and extends to the confluence of the Klamath and Salmon Rivers. The sub-basin is 1,537 mi^2 and includes the mainstem of the Klamath River and is bordered to the south by the watersheds of the three major tributaries – the Shasta HA (HA (105.50), Scott HA (HA (105.40) and Salmon Rivers HA (HA (105.20) (see Figure 5).

2.1.6.3.______Shasta River HA (HA (105.50)

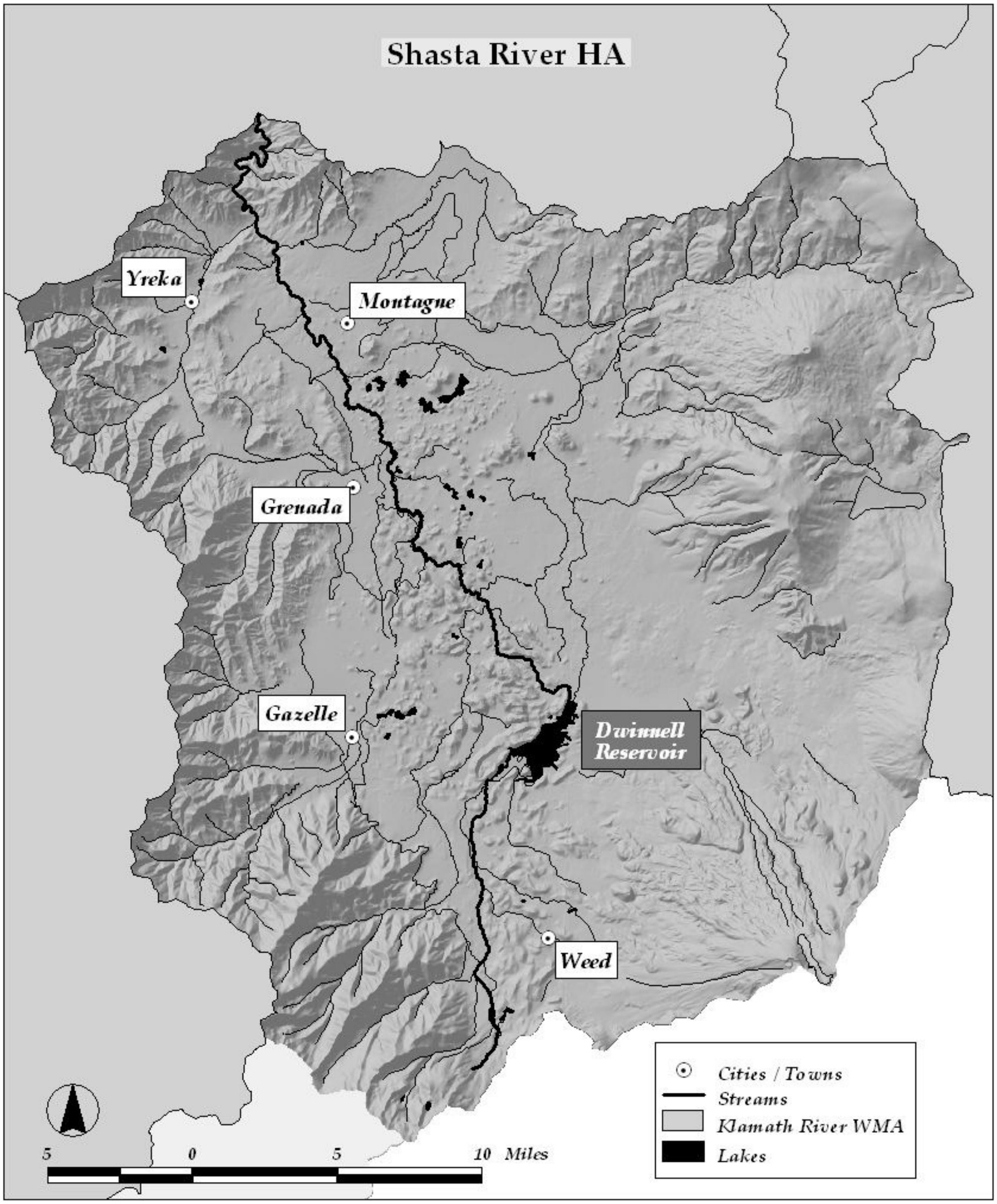


Figure 6. Map of the Shasta River HA

The text presented within this section includes information that has been previously published by North Coast Regional Water Quality Control Board 2006 (Staff Report for the Action Plan for the Shasta River Watershed Temperature and Dissolved Oxygen Total Maximum Daily Loads) and references included therein.

2.1.6.3.1. Overview

The Shasta River HA drains a 795 mi^2 watershed in northern California within Siskiyou County. The Shasta River originates within the higher elevations of the Eddy Mountains lying southwest of Weed and flows for approximately 50 river miles in a northerly direction, passing through the Shasta Valley. After leaving the valley, it enters a steep-sided canyon where it flows for seven river miles before emptying into the Klamath River, 176.6 river miles upstream from the Pacific Ocean (SSRT 2003). The Shasta River watershed is bounded to the north by the Siskiyou Range, to the west by the Klamath Mountains, to the east by the Cascade Range, and to the south by Mt. Shasta and Mt. Eddy. The watershed shares divides with the Scott River to the west, Butte Creek to the east, and the Trinity and Sacramento Rivers to the south.

The population of the Shasta River basin is estimated at about 16,000 people. The majority of the population in this basin is centered around the towns of Yreka, Weed, Montague, Grenada, and Gazelle. Because of its geology, vegetation, and climate, the Shasta River Watershed is considered part of the Great Basin, with conditions similar to those typical of Eastern Washington, Eastern Oregon, Northern Nevada, and those parts of California east of the Sierra Nevada (SSRT 2003).

2.1.6.3.2. History and Land Use

The Shasta Nation ancestral territory included much of the Shasta Valley. The first European exploration of Siskiyou County and the Shasta basin was in the late 1820's, when fur trappers from the Hudson's Bay Company entered the area in search of pelts. These explorers were soon followed by cattle drovers, bringing cattle from the Sacramento Valley to the Oregon settlements. With the exception of small military missions, these were the only explorers to the area until the 1849 gold rush, which established the first permanent settlers in the basin. The first discovery of gold in Siskiyou County was near the town of Yreka in 1851, and in a few months there were over 2,000 miners working in the area. Mining for gold in Yreka Creek and the lower 7 miles of the Shasta River continued through the 1930s. In addition to gold, gravel was extracted along the mainstem Shasta. Many ranchers, farmers, and businessmen followed the gold rush settling in the area. With the increased population came an increased need for food, supplies, and lumber. Both agriculture and mining activities were dependent on the development of water diversion systems to meet their needs. By the early 1900's, farming, ranching, and timber harvest were the dominant land uses within the basin.

Today the economy of the Shasta River basin is mainly supported through agriculture and ranching, although lumber mills in the Shasta Valley also contribute. Cattle operations extend throughout much of the Shasta basin, supported by irrigated pasture and hay fields, as well as dry upland grazing lands. Due to local springtime flooding and a short growing season, crops grown in the Shasta Valley are limited to alfalfa and small grains and a small selection of row crops.

Timber harvest and associated road building were widespread and intense in parts of the watershed into the 1960's. Today only limited timber harvest occurs in parts of the watershed on both USFS and private lands. Currently two sawmills are active within the watershed, though much of the logs milled are harvested outside the watershed.

Recreation has become an important industry for the area. Mount Shasta is popular for downhill and cross-country skiing during the winter and for hiking and mountain climbing in the summer. Lake Shastina, mountain lakes, and streams are kept stocked with trout, and wildlife is abundant.

Though still dominated by agricultural land and open space, the Shasta Valley is experiencing increased residential development and associated urbanization. Urbanization is most evident within established urban areas such as the City of Yreka, but is also occurring in lower elevation areas throughout the basin, along the Interstate 5 corridor, and around Lake Shastina. Lot splits and subdivision of agricultural land are increasing.

2.1.6.3.3.____Vegetation

The vegetation of the Shasta River watershed is heterogeneous and reflects the climatic differences in the watershed. Conifers are the most abundant vegetation in the mountains. Herbaceous plants, including agricultural crops, dominate the valley region. Woody riparian vegetation along the Shasta River varies both in its extent and location, ranging from areas completely absent of woody vegetation to areas where woody riparian vegetation forms roughly continuous rows of trees lining the riverbanks; these rows are not very deep however. Although some reaches of the river have continuous vegetation, it generally occurs in intermittent areas and on one side of the river or the other. In the area of the Shasta River between Highway A-12 and Montague-Grenada Road, woody riparian vegetation is generally absent.

2.1.6.3.4.____Climate

The Shasta River basin is predominantly a low rainfall, high desert environment characterized by hot, dry summers and cool winters. Temperatures range from above 100°F in the summer to below freezing in the winter. Annual precipitation ranges mostly from 13 to 69 inches, with much of the winter precipitation falling as snow. Average annual precipitation is as high as 45 inches in the Eddy and Klamath Mountains and reaches 85-125 inches on Mt. Shasta; however, moist air masses are stripped of their water as they move eastward from the Pacific and climb over the Klamath Mountains. Thus, the Shasta Valley is in the rain shadow created by these mountains and receives a mean of only 9-18 inches of precipitation annually. Some low-lying areas of the Valley receive less than 9 inches annually.

2.1.6.3.5.____Water Resource Management

From its origin in the Scott Mountains, the Shasta River flows north and northwestward for approximately 60 miles before entering the Klamath River at Klamath RM 176.6. At Shasta RM 40.6 Dwinnell Dam impounds Lake Shastina (also called Dwinnell Reservoir) to provide water storage for agricultural use, municipal supply for the town of Montague, and recreational use.

Shasta River basin water resources are highly managed and controlled. Uses include irrigation and stock watering, municipal drinking water supply, and small hydropower generation. The first hydroelectric power generation facility was built in the Shasta canyon in 1892. One small hydro facility is in operation today. Agricultural use of water in the Shasta River basin began with the settlement of miners in the early 1850s. By the 1940s, gold mining had diminished in the basin, and agricultural development became the economic focus, resulting in increased irrigation and water use. In the early 1900s, four water service agencies were formed in the Shasta basin to manage water supply for municipal and agricultural use. The Shasta River is fully appropriated from May 1 through October 31. Since 1934, the Department of Water Resources (DWR) Watermaster Service has managed the delivery of the adjudicated water rights, apportioning available water in order of priority of right, based upon the flows at the weir located at RM 15.5. Water users along the riparian zone of the Shasta River below Dwinnell Dam and groundwater withdrawals are not subject to the adjudication.

The Construction of Dwinnell Dam, which forms Lake Shastina on the upper Shasta River, was completed in 1928 as part of a water supply project for the Montague Water Conservation District (MWCD). MWCD owns 60 miles of canals (the main canal is approximately 35 miles long) and lateral ditches to serve water rights owners during the irrigation season. Although a relatively small reservoir, with a capacity of approximately 50,000 acre-feet, the reservoir fills only in above-normal runoff years due to the relatively modest yield from upstream watershed areas, seasonal water use, and appreciable seepage loss (6,500 to 42,000 acre-feet) from the reservoir.

Relatively high precipitation in the area of the watershed above Lake Shastina creates precipitation-based flow in Dale and Eddy Creeks and the Shasta River. Spring flows from the flanks of Mount Shasta to Boles Creek, Beaughton Creek, and Carrick Creek account for much of the inflow to Lake Shastina. Flows can be flashy in Dale Creek, Eddy Creek, and the Shasta River, while flows in the spring fed creeks tend to be more stable and provide reliable base flows in wet and dry years. Parks Creek is spring fed from Mt. Eddy, and flows are diverted into the Shasta River above Dwinnell Dam for storage in Lake Shastina under a MWCD water right.

Between Dwinnell Dam (RM 40.6) and the canyon (RM 7.3) the Shasta River meanders along the Valley floor and is slow moving and sluggish with much of the shoreline characterized as cattail marsh. Numerous accretions from tributaries (including Big Springs, Parks, Willow, Julian, and Yreka Creeks, and Oregon Slough and the Little Shasta River), springs, and agricultural diversions, and return flows in this portion of the river contribute to a complex flow regime. During summer months, Big Springs Creek inflow accounts for up to 50% of the flow in the river below Big Springs Creek.

2.1.6.3.6.____Fishery

Anadromous fish populations currently utilizing the Shasta River watershed include fall Chinook (Oncorhynchus tshawytscha), coho salmon (O. kisutch), and fall and winter steelhead trout (O. mykiss). Historically, summer steelhead and spring Chinook runs utilized the Shasta River, but those runs no longer occur. Considered together, under various life stages, fall Chinook, coho, and fall and winter steelhead are present year-round in the Shasta River basin.

The Shasta River was once one of the most productive streams of its size for anadromous fish in California. Historically, the spring Chinook run in the Shasta River was estimated to be at least 5,000 fish and was one of the largest runs in the Klamath basin. However, by the early 1930s increased summer water temperatures caused by the effects of Dwinnell Dam and habitat degradation resulted in the disappearance of the spring Chinook run in the Shasta basin.

In the Klamath River basin, the fall Chinook salmon are the predominant run and are the only Chinook run believed to currently exist in the Shasta River basin. However, this population has also experienced a sharp decline since the 1930s. Fall Chinook spawning populations, as measured at the Shasta River Fish Counting Facility located near the mouth of the Shasta River, have ranged from a high of 81,848 fish in 1930 to fewer than 750 fish in 1990-1992. Fall Chinook numbers have since rebounded. In 2000 and 2001 fall Chinook numbers were over 11,000 fish, but declined again in to fish 6,818 in 2002 and 4,289 in 2003.

Available data for coho and fall and winter steelhead runs are not entirely reliable for determining long-term trends, but both species are considered to have experienced dramatic declines from historic numbers throughout the Klamath River basin. Known problems for coho in the Shasta River include degradation and loss of spawning and rearing habitat, barriers to passage, high water temperatures, turbidity, agricultural diversions, and low in-stream flows (SSRT 2003). Similarly, an estimated 8,513 fall steelhead migrated up the Shasta River in 1932, and the estimated average annual population of fall and winter steelhead in the Shasta River basin from 1959 to 1963 was 6,000. However, in 1970 the fall population was estimated to be 860 adult fall steelhead, though this number is probably an underestimate.

The Shasta River watershed hosts numerous populations of non-migratory fish species. Native fish persisting in the river include a variety of sculpin species, including marbled sculpin and speckled dace. Introduced species include yellow perch, brown bull, blue gill, largemouth bass, mosquito fish, green sunfish, and brook and brown trout. Populations of both native and introduced non-anadromous species persist in the Shasta River basin above Dwinnell Dam. The California Department of Fish and Game (CDFG) regularly plants rainbow trout in Lake Shastina and Boles Creek, and brown trout brood stock is occasionally placed in Lake Shastina.

2.1.6.3.7.____Topography and Geology

The watershed consists of two major types of topography, the low-gradient floor of the Shasta Valley, and surrounding steep mountains, punctuated by Mt. Shasta at the southern border of the basin. The river drops about 220 feet in elevation in the valley. In the canyon section of the watershed, downstream of the valley, the Shasta River descends approximately 370 feet in approximately 7 miles to its confluence with the Klamath River. Watershed elevations range from approximately 2020 feet at the confluence with the Klamath River to a peak elevation of 14,179 feet at the summit of Mt. Shasta.

The Shasta River watershed spans the junction between two major geologic/geomorphic provinces. Mount Shasta and the mountains on the east side of Shasta Valley are formed of relatively young Cenozoic volcanic and intrusive rocks and are part of the Cascade Range volcanic province. The mountains on the west side of the watershed are older Franciscan rocks of the Klamath Mountains province. The valley floor between these major provinces consists of deposits that are mostly alluvium. However, a single area stands out as unique: a gigantic landslide deposit that covers about 180 mi^2.

A large area along the axis of Shasta Valley is hummocky with many closed depressions and little integrated drainage in many parts. It is underlain by unsorted rocky debris. This area is the result of the deposit of a gigantic debris avalanche, or avalanches, that originated on the north slope of Mount Shasta in Pleistocene time (Crandell 1989). The deposit extends northward to where the Shasta River meets the Klamath. The implication of the underlying geology of the Shasta basin is that much of the soil in the basin is of volcanic origin, and therefore can have high levels of phosphorus. These natural sources of phosphorus contribute to relatively high concentrations of inorganic phosphorus in the Shasta River.

2.1.6.4.______Scott River HA (105.40)

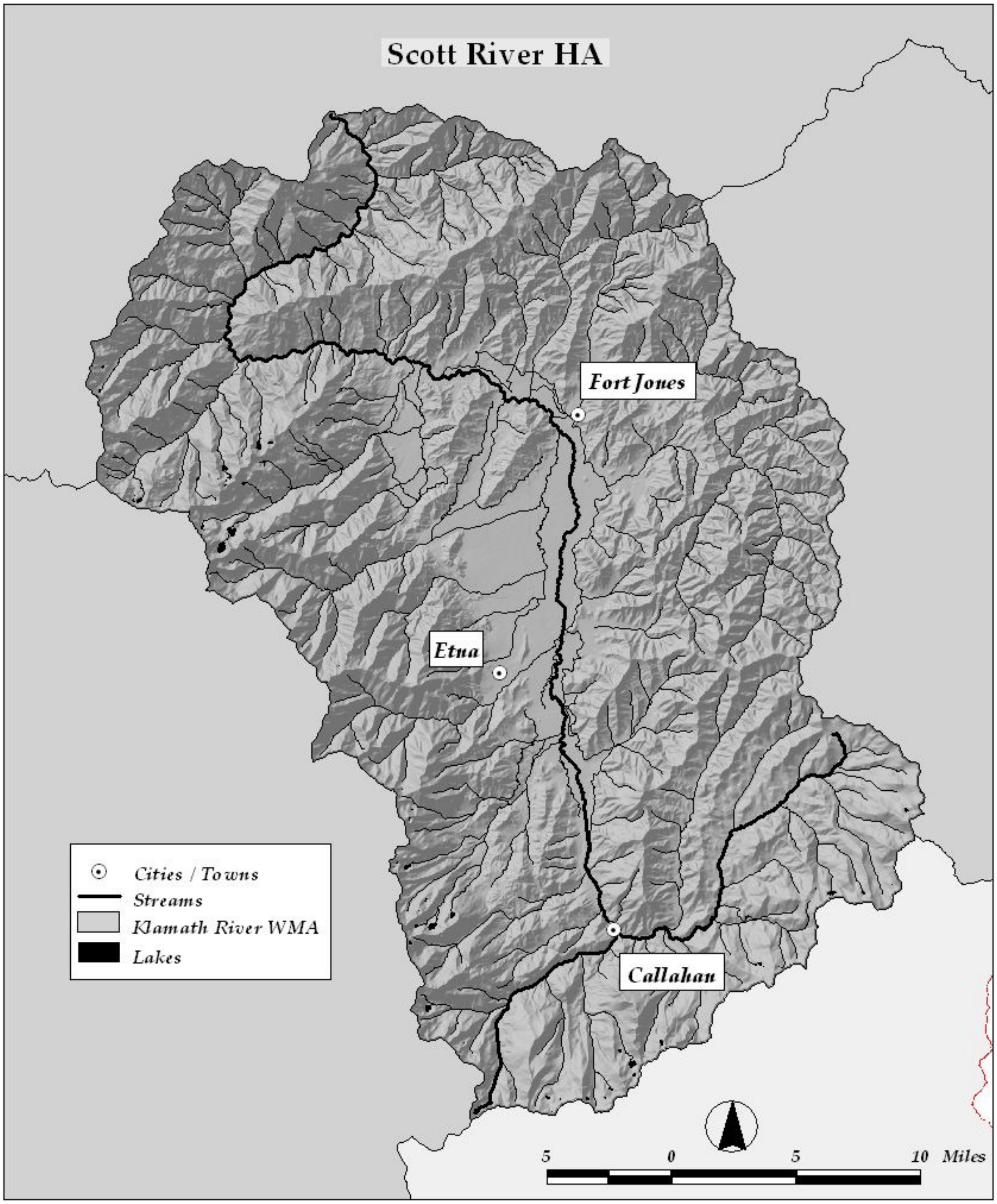


Figure 7. Map of the Scott River HA

The text presented within this section includes information that has been previously published by North Coast Regional Water Quality Control Board 2005 (Staff Report for the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads) and references included therein.

2.1.6.4.1.   Overview

The Scott River HA drains an 813 mi^2 watershed in the Klamath Mountains in Siskiyou County in California, flowing generally northward into the Klamath River at river mile 143. The watershed shares divides with the Shasta River to the east, the Trinity River to the south, and the Salmon River to the west. The total resident population in the Scott River watershed in the 2000 census was estimated at approximately 8,000. Four population centers in the watershed from north to south are Fort Jones (pop. 670), Greenview (pop. 175), Etna (pop. 790), and Callahan (pop. 200) (SRWC, 2004; NationMaster.com, 2005).

2.1.6.4.2.   History and Land Use

The Scott River watershed's longest standing residents are Native Americans. The Quartz Valley Indian Community, federally recognized in 1983, includes members of the Shasta, Karuk, and Upper Klamath tribes. Tribal trust lands include the Quartz Valley Indian Reservation.

The hydrology and surface conditions in the Scott River watershed have been affected over time by several intense human activities. From about 1820 into the 1850s, systematic trapping removed a large population of beavers in the watershed. Beaver ponds provided lag time in runoff and sources of infiltration to recharge groundwater.

Rich placer gold deposits beneath the streams and floodplains, and in the gravels of river terraces, led to extensive placer mining beginning in 1850. Riparian areas along the mainstem Scott River, the South Fork, the East Fork, Oro Fino Creek, and many tributaries to the west and south of Scott Valley were greatly disturbed by placer mining. Large areas adjacent to streams were stripped of vegetation and the stream deposits hydraulically or mechanically worked to retrieve gold. These techniques left behind un-vegetated, worked river and terrace deposits, many of which persist today as piles of boulders and cobbles that still lack soil and harbor little vegetation. Water from virtually all tributaries was diverted for use in mining. Much of the resulting ditch system has remained in use, and parts have been expanded as agriculture developed.

Agricultural activities have cleared land and created a large demand for diverted stream water and shallow ground water. Once-dense riparian vegetation has been radically reduced, except in areas where riparian fencing excludes stock from the riparian area and stream channel. By the early 20th century, most of the floor of Scott Valley, and tributary valleys that were not too steep had been cleared and converted to agriculture. There is approximately fifty square miles of irrigated land in the watershed. To protect farmland from bank erosion and reduce flooding, the mainstem Scott River has been straightened, rip-rap placed along the channel through much of the valley, and the river further constrained by levees along some stretches.

Timber harvest began along with mining, but large-scale timber harvest for export from the area has been ongoing only since 1950. The extensive network of roads, skid trails, and landings, along with other associated timber harvest activities, have led to increases in sediment contributions to the stream system. Large areas underlain by decomposed granite soil are particularly prone to chronic raveling when disturbed, and produce large amounts of sand-sized sediment.

Current land-use activities in the watershed include timber harvest on both private and public lands, irrigated agriculture (primarily alfalfa, pasture, and grain), and livestock grazing. Irrigated agricultural lands comprise about 32,000 acres, or 6%, of the watershed area. In the basin, one or more of these activities have the potential to affect water quality through increased sediment loads to streams, increased solar radiation from loss of near-stream shade warming water, consumptive water use, and loss of large woody debris in streams.

2.1.6.4.3. Vegetation

The vegetation of the Scott River watershed is heterogeneous and reflects the climatic variation in the watershed. Conifer tree species are the most common vegetation in the mountains of the north, west, and southern areas of the watershed. The southwestern area of the watershed is known to have the greatest diversity of conifer species in the world. The eastern areas of the watershed reflect the drier climate, with most conifers primarily found on north-facing slopes. However, western Junipers are found scattered throughout the eastern areas of the watershed.

Hardwood tree species, such as oak and madrone, compose a small portion of the vegetation of the watershed and are most common in the northern and eastern areas of the watershed. Grassland and agricultural crops compose just over ten percent of the watershed, and are primarily found in Scott Valley and areas in the East Fork Scott River watershed.

2.1.6.4.4. Climate and Hydrology

The Scott River watershed has the typical hot, dry summers and cool, wet winters characteristic of Mediterranean climates. However, because the watershed lies at the northern extreme of the Mediterranean climate zone, and is located in a mountainous region, the watershed has colder winters than the average Mediterranean region. The Scott River watershed mainly falls within the Mediterranean highland climate region with much of the winter precipitation falling as snow.

The Scott River hydrology depends largely on precipitation stored as snow at higher elevations in the mountains to the west and south of Scott Valley, where annual precipitation ranges from 60-80 inches. Streams leaving the mountains emerge into the valley and recharge the high capacity aquifer of sand and gravel that underlies the valley. Many of the streams entering from the west form alluvial fans where they enter the valley. These alluvial fans are areas where groundwater recharge occurs, and the streams often go completely dry as water percolates into the permeable gravels.

In the mountains of the east side of the watershed precipitation ranges from 12-15 inches. This eastern area is much drier because it lies in the rain shadow of the mountains to the south and west. Many of the eastside streams are ephemeral for most of their length, flowing only during precipitation events. However, in the headwater reaches, many of the streams flow perennially.

The hydrologic conditions of the Scott River watershed vary widely from year to year, experiencing both floods and droughts regularly. The largest floods occur when relatively warm storm systems melt a pre-existing snow pack. The Scott River watershed is susceptible to these rain-on-snow events due to the topographic characteristics of the basin. A significant portion of the basin is between 4,500 and 5,500 feet in elevation, which is the range of elevation most susceptible to rain-on-snow. The largest floods of record (1861, 1955, 1964, 1974, and 1997) were associated with rain-on-snow events. Drought years have occurred in 1944, 1955, 1977, 1990, 1991, 1992, 1994, 2001, and 2002.

2.1.6.4.5.____Fishery

Anadromous fish populations currently utilizing the Scott River basin include coho salmon, fall and winter steelhead trout, and fall Chinook salmon. Historically, there were summer steelhead and spring Chinook runs in the Scott River. Those runs no longer occur in this basin, although a few random summer steelhead have been observed. In the early 1960s, the California Department of Water Resources (CDWR) estimated populations of 2,000 coho and 20,000-40,000 steelhead in the Scott River basin. In the absence of additional quantitative data, it is assumed that the trends in coho and steelhead within the Scott River basin are similar to the declining population trends within the larger Klamath basin.

Fall Chinook salmon are the only Chinook run currently observed in the Scott River basin. Data indicate that the fall Chinook population within the Scott River basin has experienced a decline since at least the 1960s. CDFG estimated that there were 8,000 fall Chinook in the Scott River basin in 1965. Fall Chinook spawning escapement has been monitored by the CDFG annually since 1978, and spawning populations have ranged from a high of 14,477 fish in 1995, to a low of 445 fish in 2004.

2.1.6.4.6.____Topography and Geology

The Scott River watershed consists of two major types of topography. The gently graded floor of Scott Valley, about 75 mi^2, is traversed by some thirty miles of the mainstem Scott River and the lower reaches of tributaries. Surrounding this valley are steep mountains incised by steep-sided valleys carrying rushing streams. Elevations range from above 8,542 feet at China Mountain in the Scott Mountains on the southern boundary of the watershed, down to the 2,500-3,200 foot range in the floor of Scott

Valley. In the canyon section, downstream of Scott Valley, the Scott River descends to 1,600 feet in elevation where it enters the Klamath River.

The valley of the mainstem Scott River can be divided into two major reaches. The lower Scott River, from River Mile (RM) 0 to RM 21, known as the “canyon section,” flows mostly on bedrock and is confined in a steep-sided, rocky canyon at a gradient in the range of 45-55 ft/mi. From RM 21 to about RM 50 – through flat, open, agricultural Scott Valley – is the “valley section” of the river, which flows across the gentle plain of the floor of Scott Valley. Through this section, the gradient is in the range of 4-8 ft/mi.

The Scott River watershed is underlain by complex, highly deformed rocks intruded in places by granite. The deformed bedrock is greatly varied and includes high and medium grade metamorphic rocks, slightly metamorphosed sedimentary rocks and volcanics, granite and diorite, mafic and ultramafic rocks that are largely altered to serpentine, and small amounts of limestone. Scott Valley has been down-dropped and broken by faulting during late Tertiary and Quaternary time. In consequence, bedrock under the middle part of the valley is several hundred feet below bedrock near the downstream end of the valley. This great depression has been filled by sediments, mostly gravel and sand, that have been washed in and deposited by streams during the subsidence. This basin-fill deposit is a high capacity aquifer that carries a large amount of ground water that allows the abundant irrigation that supports much of the agriculture in Scott Valley.

2.1.6.5.______Lower Klamath River HA (105.10)

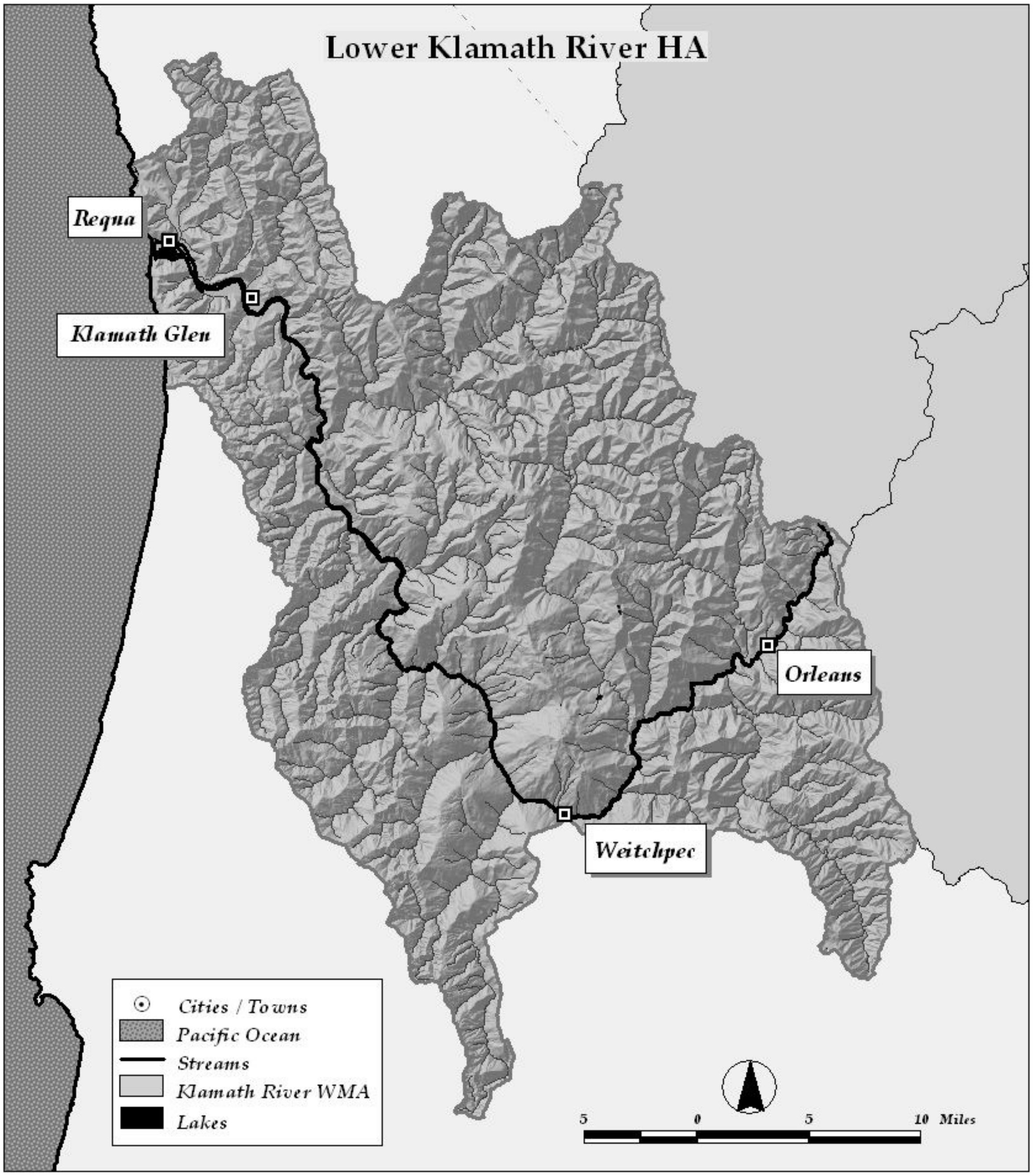


Figure 8: Map of the Lower Klamath River HA

The Lower Klamath River HA is the portion of the Klamath River and its tributary watersheds downstream from the confluence of the Salmon River to the Pacific Ocean (excluding the Trinity River), and is 771 mi^2. Included in the watershed are Salmon River, Blue Creek, numerous smaller perennial streams, and the Klamath River delta/estuary. The area is characterized by mountainous terrain and rugged, steep forestland with highly erodible soils. Silviculture occurs on both USFS and private lands. Timber sales occur in the Klamath National Forest, and logging is particularly heavy on private corporate lands in the redwood region of the lower basin. The population of the area is small and scattered and communities along the Klamath are almost all timber-based. The Hoopa and Yurok Tribes live along the lower Klamath River, with fishing being an important part of their cultures. The Lower Klamath River is an active and popular recreational salmon fishery.

2.1.7. Water Quality Issues in the Klamath River WMA

2.1.7.1. Klamath River Mainstem

Many natural and human-altered watershed elements above Iron Gate Reservoir in California and Oregon affect the quality and quantity of water that exits Iron Gate Reservoir, supply the Klamath River mainstem flow, and both support and jeopardize the beneficial uses of the river within California. The complexity of this basin is magnified by jurisdictional issues associated with water delivery/utilization infrastructures including not only the Federal Klamath Project, but also:

- Irrigation
- Hydropower
- Endangered species
- Tribal rights
- Lake-level-management demands for Upper Klamath Lake
- The waters crossing and re-crossing the California-Oregon border
- Minimum flow requirements in the Klamath river below Iron Gate Dam

Hydromodifications – dams, levees, irrigation diversion, and drain-water removal works – that have been constructed beginning in 1860 in the Klamath River basin upstream of Iron Gate Dam have resulted in the following changes:

- Diminished dry season river flows.
- Increased summer/fall water temperatures and impairments to WARM and RARE beneficial uses.
- Arrested the migration of anadromous fish.
- Endangerment of fish species native only to this basin.
- Development of an extensive agricultural community in Oregon and California, including the development of extensive private property on once underwater lake/marshes and once inhospitable canyon lands.
- Development of extensive hydropower resources.
- Preservation of managed migratory waterfowl refuges.
- Ground water augmentation of surface flows.

The Klamath River is the second largest river by volume in California, flowing southwestward from the Cascade Mountains for approximately 263 miles through Oregon and California to its final four river miles within the California coastal zone. Primary uses of this river include domestic, agricultural, and industrial water supply; cold and warm water fisheries; and recreation.

The quality of water from Iron Gate reservoir is a chief concern in the basin; the low DO and high nutrient concentrations of water released from Iron Gate Dam can be considered detrimental to salmonids. Agricultural land use contributes nutrients (primarily from grazing, dairies, and irrigated agriculture in the upper watershed), bacteria, and sediment. Unauthorized discharges and inadequately treated residential sewage have also likely contributed to these issues. In the middle to lower watershed, historic and current timber harvesting is a source of increased sedimentation. Active and inactive mines may also contribute metals.

The NCRWQCB is currently developing TMDLs for the Klamath River basin for impairment due to low dissolved oxygen, elevated temperature, and organic enrichment.

Primary water quality issues in the Klamath WMA include:

- Salmonid habitat destruction
- High water temperatures
- Sedimentation of streams
- Soil erosion
- Mass wasting
- Hydromodification
- Forest herbicide applications
- Low flows
- High nutrient levels
- Low dissolved oxygen

As in many of the North Coast watersheds, the beneficial uses associated with coldwater fishery appear to be the most sensitive of the beneficial uses in the watershed because of the sensitivity of salmonid species to habitat changes and water quality degradation. Accordingly, protection of these beneficial uses is presumed to protect any of the other beneficial uses that might also be harmed by sedimentation and high water temperatures.

2.1.7.2. Shasta River

Elevated water temperatures and low dissolved oxygen levels in the Shasta River and its tributaries produce impairment of designated beneficial uses of water and non-attainment of water quality objectives, specifically those associated with the cold water fishery. These beneficial uses include the migration, spawning, reproduction, and early development of cold water fish including coho and Chinook salmon and steelhead. The coho salmon population in this watershed is listed as threatened under FESA and the California Endangered Species Act. Elevated water temperatures and low dissolved oxygen levels also affect recreational uses, and elevated water temperatures may contribute to impairment of the municipal and domestic water supply beneficial use.

The Shasta River Valley has a substantial cattle grazing industry on private lands irrigated extensively by streams in the watershed. Cattle grazing affecting riparian habitat and bank stability, along with flood irrigation return flow that is warm are the primary causes of high water temperatures and low dissolved oxygen at times during the summer. Restoration of riparian habitats and reuse of irrigation return flow may alleviate these problems.

Other water quality issues are related to surface water and groundwater contamination from treatment plants and toxic chemical discharges in the Weed and the Yreka areas. Treatment plants at Yreka, Weed, Montague, Shastina, and Granada use a combination of oxidation and percolation ponds. In Weed, the Roseburg Forest Products and the J.H. Baxter Paper Company are Superfund sites where treated groundwater is used to water log decks and adjacent fields.

In 2007, the NCRWQCB established TMDLs for the Shasta River basin to address the impairment of beneficial uses and non-attainment of water quality standards due to elevated temperature and low dissolved oxygen.

2.2.________Trinity River WMA HU (106.00)

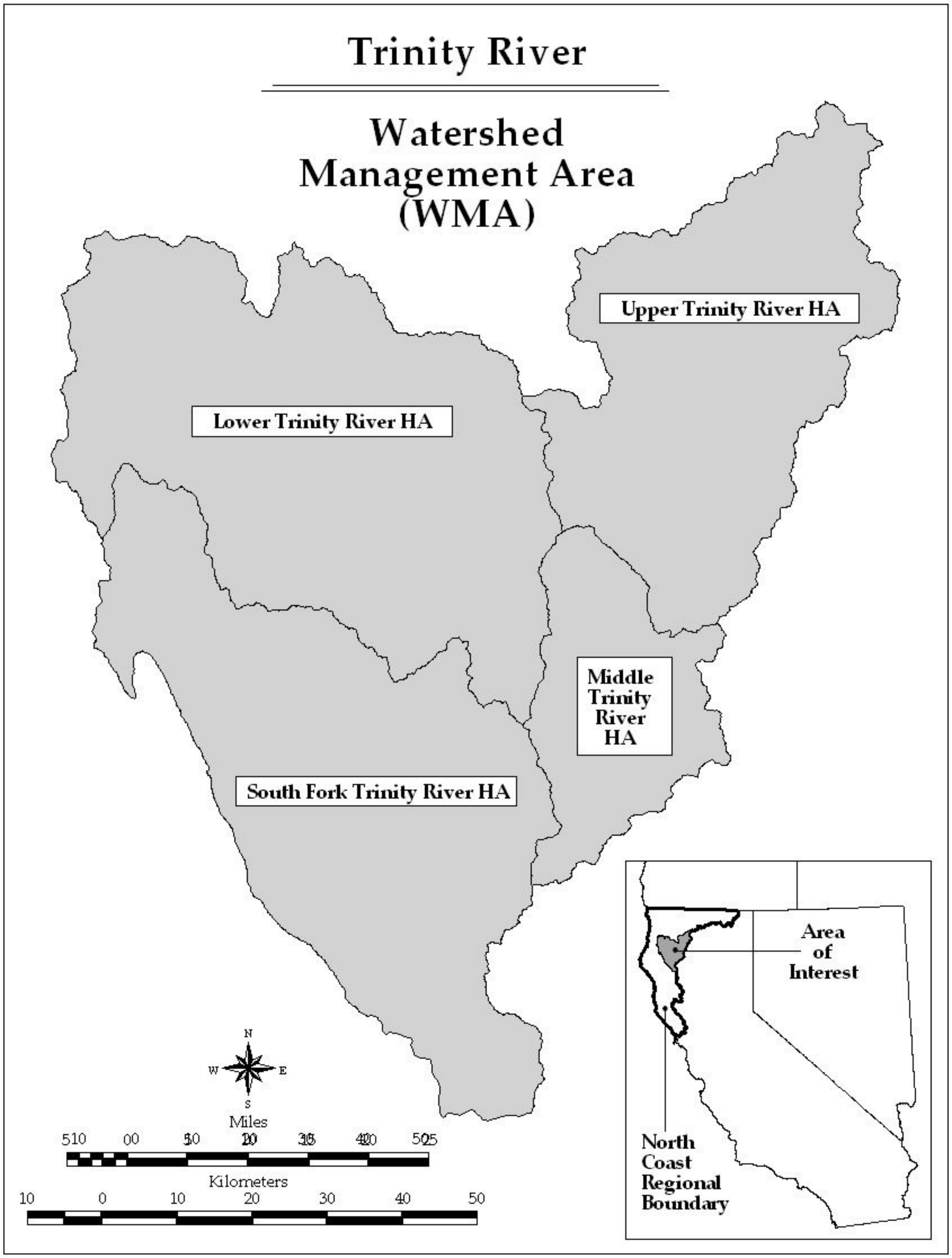


Figure 9. Hydrologic Areas of the Trinity River WAM/HU

The text presented within this section includes information that has been previously published by BLM 1995 (Mainstem Trinity River Watershed Analysis), USEPA 1998 (South Fork Trinity River and Hayfork Creek Sediment Total Maximum Daily Loads), USEPA 2001 (Trinity River Total Maximum Daily Load for Sediment), USFS 2003(Mainstem Trinity Watershed Analysis), and references included therein.

2.2.1. Overview

The Trinity River WMA HU (106.00) lies within the overall Klamath River basin but is not included in the Klamath WMA; it is its own WMA. The Trinity River WMA includes four hydrologic areas (HAs) within HU 106.00: Upper Trinity River HA (HA (106.40), Middle Trinity River HA (106.30), Lower Trinity River HA (106.10), and South Fork Trinity River HA (106.20), (see Figure 9).

The Trinity River WMA is approximately 2900 mi^2 in northwestern California; the Trinity is the largest tributary to the Klamath River. It originates in the Klamath and Coast Ranges and flows 172 miles south and west through Trinity County, then north through Humboldt County and the Hoopa Valley Indian reservation. The confluence with the Klamath River at Weitchpec is about 43 miles upstream from the Pacific Ocean. Lewiston Dam and Trinity Dam form Lewiston Reservoir and Trinity Lake, on the Trinity River. The entire mainstem of the Trinity River was designated a National Wild and Scenic River in 1981. The mainstem is also classified as recreational and scenic under the California Wild and Scenic Rivers Act. Bald eagles and northern spotted owls, both federally listed threatened species, are found in the WMA.

Approximately 80% of the Trinity River basin is under public ownership by the USFS and BLM, including the Trinity Alps Wilderness areas, the Shasta-Trinity National Forest, and the Six Rivers National Forest. The Hoopa Valley Tribe occupies 144 mi^2 of the lower basin, and the remainder of the watershed is privately owned by three timber companies, and individuals for residences and agricultural operations, particularly in the Hayfork Valley.

2.2.2. History and Land Use

The discovery of gold in the Trinity River watershed at Reading Bar, near Douglas City, in 1848 led to a massive influx of miners and settlers and the eventual demise of Native Americans. There were extensive mining operations—in-stream gravels were dredged and the river was often diverted entirely out of the channel. Huge hydraulic mining operations for gravel at the confluence of the South Fork and mainstem Trinity River in the 1930-40s introduced enormous amounts of sediment into the river. These operations resulted in the first long-term impact to the salmonid habitats of the Trinity River. Today, gold mining is limited to suction dredging in the streambed and is predominately recreational. Placer mining occurs in a few tributary watersheds.

The timber industry began in the mid-1850s when numerous small sawmills began operating sporadically, usually in conjunction with mining activities. Timber harvest at that time was very selective, taking only the largest and most easily accessible trees for the supply of a local market. Logging was an important industry by the mid-1940s, but significant volumes were not taken until after WWII, when modernization and improved technologies occurred. Most of the forested areas have been cut at least once and many areas twice. In the South Fork sub-watershed, logging began in 1949 and intensified in the 1960s, probably exacerbating the detrimental effects of the 1964 flood. Of the 80% of the South Fork basin originally occupied by forest, about half had been logged by 1977. Today, timber is harvested on federal lands but production is considerably less than in the past. About 10% of the watershed is currently used for industrial timber harvest. However, historical and current road building and logging on steep slopes has accelerated erosion and sedimentation.

The Trinity River basin is mostly undeveloped and has only the small scattered towns of Trinity Center, Weaverville, Lewiston, Hayfork and Hyampom. Land use, in addition to timber and mining, includes recreation, such as fishing, tourism, and agriculture. Agricultural activity consists of cattle grazing, small produce farms, orchards, and vineyards. Crops grown include peaches, pears, grapes, corn, tomatoes, peppers, squash, melons, flowers, herbs, oat hay, and alfalfa.

2.2.3. Vegetation

The Trinity River basin is on the southern boundary of a biologically complex area, the Klamath Mountain Province. It supports a wide range of flora and fauna, and is one of the most diverse river ecosystems on the west coast. The highest elevations in the Trinity WMA, above the treeline, are steep, bare mountains. Below about six thousand feet, the landscape is dominated by conifer forests and mixed conifer/hardwood forests. Common tree species include tanoak, Douglas fir, white fir and red fir. Complex riparian vegetation, evergreen brush, rangeland, meadows, and chaparral are present at the lower elevations. Shrubs dominate many south-facing slopes.

2.2.4. Climate

Precipitation is highly seasonal, with 90 % falling between October and April. Overall, average rainfall is 57 inches/yr but can vary from 15-100 inches in extreme years. At higher elevations, a portion of the annual precipitation falls as snow. Annual precipitation ranges from 37 inches in Weaverville and Hayfork to 75 inches in Trinity Center and 85 inches in the Hoopa Mountains and on the west side of the South Fork sub-watershed. Occasional summer thunderstorms produce extensive runoff to streams and the river and can start wild fires. The wildfire frequency interval of 7 to 35 years is relatively high.

2.2.5._______Water Resources

In the early 1950s, construction of Lewiston Dam and Trinity Dam began above RM 112 and the community of Lewiston. The dams were completed in 1963 and formed Lewiston Reservoir and Trinity Lake. These dams and reservoirs are known collectively as the Trinity River Diversion (TRD) of the Bureau of Reclamation's Central Valley Project (CVP). There are 719 mi^2, about 25% of the watershed, upstream of Lewiston Dam. Water stored and released from Trinity Lake is used for power-generation, and a majority of the upper-basin's water yield is diverted out of the basin at Lewiston Reservoir for multiple uses, including agriculture, throughout the Central Valley of California. The TRD determines stream flow in the Trinity River. Before the dams were built, the average annual stream flow of this watershed from 1912 to 1960 was about 1.2 million acre feet. In 1995, the maximum annual flow allocation from Lewiston Dam was 340,000 acre feet; 800,000-1,000,000 acre feet are diverted annually to the CVP.

The TRD had a major impact on the flow, function, and use of the Trinity River. Historically, flow in the Trinity River fluctuated seasonally, resulting in a channel with extensive gravel bars and little established riparian vegetation. Seasonal flushing flows moved fine-grained sediment downstream, removed emerging riparian vegetation, and created a diverse habitat of pools, riffles, runs, and point bars that provided high quality salmonid and amphibian habitat. Flow regulation at Lewiston Dam reduces the highest peak-flows and generally increases summer and fall flows above naturally low background levels. Overall, streamflow, sediment transport, and channel complexity have been substantially reduced. The current flow regime neither mobilizes sediment sufficiently in the channel nor prevents the establishment of dense, mature riparian vegetation. Acres of riparian vegetation along the main stem Trinity River increased by 282% between 1960 and 1989 as an indirect result of the dams. Open water and gravel bar habitats have decreased by 45% and 95% respectively. In-channel habitat diversity for salmonids and other aquatic species has been greatly simplified. Control of the river's flow has allowed residential and commercial developments to encroach onto the historic floodplain, bringing sources of sediment and pollution closer to the waterways and limiting potential increases in flow releases from the dam for salmonid population restoration purposes.

2.2.6._______Fishery

The Trinity River has historically been recognized as a major producer of Chinook and coho salmon and steelhead trout. The fishery sustained the Hoopa people for several thousand years. Five known stocks and runs of anadromous fish utilize the South Fork Trinity River watershed: spring and fall Chinook, coho, and summer and winter steelhead.

Populations of coho, Chinook, and steelhead have declined significantly from historical levels due in part to habitat degradation caused by the TRD. Prior to dam construction, Chinook runs from 1944-1956 ranged from 19,000 to 67,115, with a mean of 38,154, and the annual fall Chinook salmon run averaged 45,600 fish in the 1960s. From 1982-2000, natural runs varied from <5,000 to >50,000 but averages of 11,932 and 13,465 were reported. The average run of natural spring Chinook salmon from 1982-1999 was 2,370. Coho runs from the 1990s varied from 0 to ~1,000 and averaged 390 fish. Steelhead runs averaged 1870 fish from 1992-1996; current native stock populations are well below restoration goals. Coho salmon are currently listed as threatened under FESA, though Chinook and steelhead are not

The TRD changed the distribution of the fish as well. The dams blocked access to approximately 59 miles of Chinook habitat, 109 miles of steelhead habitat, and an undetermined amount of coho salmon habitat. Before dam construction, an estimated 5,000 coho salmon spawned above Lewiston; winter steelhead spawners ranged from 6,900 to 24,000 and summer steelhead averaged 8,000. Annual natural steelhead escapement above Lewiston from 1980-1999 averaged 4,400 fish. However, tributaries from the North Fork upstream to Deadwood Creek appear to be supporting stable or recovering populations of salmonids. Chinook, coho, and steelhead are also known to inhabit the lower portions of Mill Creek, Horse Linto Creek, and Sharber/Peckham Creek. Summer steelhead are found in the North Fork, South Fork, Canyon Creek, and the New River. In the 1990s, 307-804 summer steelhead were counted in the New River, making it one of the larger populations in California.

A hatchery was built at Lewiston to mitigate the loss of anadromous salmonid habitat upstream blocked by the dam. This hatchery produces spring and fall Chinook, coho, and steelhead. However, a significant portion of the hatchery-produced fish stray and spawn with the naturally-produced fish in the river and tributaries below the dam. These hatchery-produced fish compete with the natural fish for the available spawning and rearing habitat. Crossbreeding of hatchery and wild fish reduces the genetic integrity of wild populations, which can lead to loss of fitness in local populations and loss of diversity among populations.

The flood of 1964 also contributed to the decline of salmonids. This can be seen clearly in the South Fork, which is not dammed. Heavy rainfall, unstable geology, and erosion-causing land use practices contributed to the many mass wasting events triggered by that flood that resulted in dramatic in-stream changes including channel widening, aggradation, deposition of fine sediment, loss of deep pools, and associated increases in temperatures, all of which adversely affected the fishery. In 1963 and 1964, before the flood, the spawning spring Chinook population was estimated at >10,000 fish; complete surveys were not conducted in the 1960s following the December 1964 flood, but in the 1970s and 1980s estimates were as low as a dozen in some years. Fall-run Chinook spawners were estimated at over 3,300 in 1963. Later counts estimated <500 fish in the late 1980s. Steelhead also declined in number. The Chinook salmon spawning runs increased slightly in the 1990s suggesting the beginnings of a recovery. From 1988-1997, spring Chinook spawners averaged 400-700 annually and the fall spawners averaged 800-1,400 annually.

Other fish found in the Trinity River WMA include white and green sturgeon, anadromous Pacific lamprey, rainbow trout, speckled dace, three-spined stickleback, Klamath small-scale sucker, sculpins, and introduced eastern brook trout, Brown trout, American shad, brown bullhead, golden shiner, and green sunfish. Green sturgeon migrate upstream in late February and spawn in spring and early summer. Similar to salmon, they require deep pools and suitable substrate quality for spawning, and their reproductive success can be impeded by excessive fine sediment. Pacific lamprey populations have probably also declined dramatically over the last several decades. Brown trout compete directly for food and cover with all native salmonids in the river. They become territorial and the larger fish tend to dominate areas of suitable salmonid habitat. Brown trout also prey on juvenile salmon and steelhead. Trinity Reservoir supports a trophy smallmouth bass fishery and provides sport fishing for largemouth bass, rainbow trout, kokanee salmon, landlocked Chinook salmon, and other gamefish.

2.2.7. Topography and Geology

The Trinity River watershed is steep, mountainous, and highly erodible. Elevations range from 250 feet at the confluence of the Trinity and Klamath Rivers near Weitchpec to 9,000 feet in the Trinity Alps. Much of the Trinity WMA is prone to seismically induced landslides due to rapid ground acceleration from local and coastal seismic activity, especially during winter months when slope soils are saturated. Valley inner gorges, which are over-steepened slopes adjacent to stream courses, are commonly highly unstable. Areas of granitic soils are productive but highly erosive; granitic soils contain a high percentage of sand, which embeds gravel in stream beds. Ground water resources are relatively plentiful throughout the geologic systems, but are not well defined.

The South Fork Trinity River drains an area containing steep, unstable slopes. The South Fork basin straddles the boundary between the Coast Ranges and the Klamath Mountains geologic provinces. The Coast Ranges are underlain by the Franciscan Assemblage, a highly deformed, faulted and sheared complex of partly metamorphosed marine sedimentary and volcanic rocks. Geologic units in the Coast Range Province include the South Fork Mountain Schist, which is highly erodible. The Klamath Mountains geomorphic province contains major rock units ranging from 330 to 125 million years in age from the Devonian to Jurassic. Areas to the east of the South Fork, including most of the Hayfork Creek sub-basin, are generally more stable than the steep slopes of South Fork Mountain and the lower basin. The west side of the South Fork is dominated by more erodible and unstable geologic terranes, which occupy 32 % of the South Fork basin land area but generate 89 % of the total mass wasting in the basin.

2.2.8. Sedimentation

Sediment load in the Trinity River watershed varies with area, from the highest average annual yield of 2,963 t mi^{-2} yr^{-1} in the lower portion of the watershed to less than half that in the upper middle section (1,332 t mi^{-2} yr^{-1}). The relative contributions from natural background sources and land management activities also vary with area. The natural background contribution to total sediment production varies from 43% in the upper middle section to 81% in the lower middle section. In the lower watershed, half the sediment input is natural and half is anthropogenic. The majority of management associated inputs is from roads and timber harvesting; mining and agriculture are not significant sources.

In the South Fork, annual sediment production averaged 1,053 t mi^{-2} yr^{-1} from 1944-1990; within the South Fork watershed, sediment production varied with sub-basin area from 361 t mi^{-2} yr^{-1} to 2,385 t mi^{-2} yr^{-1}. Throughout the whole basin, mass wasting contributed 64% of the sediment, most of which was not associated with management activities, and natural background processes contributed 65% of the total sediment load. Roads were responsible for 18% of the total sediment yield, timber harvest contributed 9%, and another 8% came from unspecified management-related processes. Road-related sediment delivery has continued to increase from 1944 to the present.

2.2.9. Hydrologic Areas of the Trinity River WMA

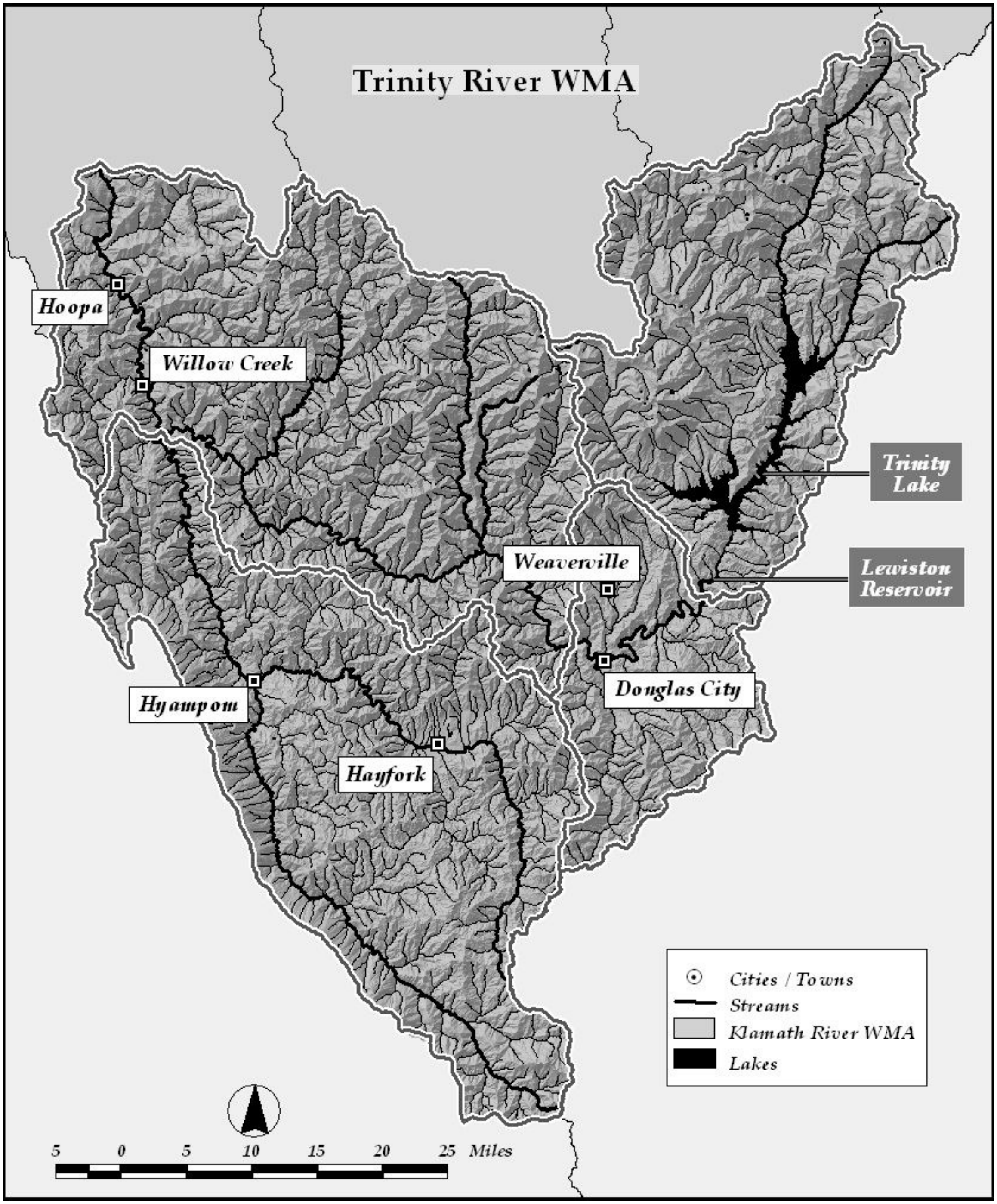


Figure 10. Map of the Trinity River WMA/HU

2.2.9.1. Upper Trinity River HA (106.40)

The upper Trinity HSA includes the area upstream of Weaverville (including Trinity and Lewiston Lakes). About half of this area is designated as wilderness area. The USFS controls the wilderness area where some grazing is still allowed. Logging on both private and USFS land causes erosion of many areas and sedimentation in the streams and lakes. Several of the tributaries west of Trinity Lake are important for spawning of kokanee salmon and resident trout. In the 1970s, these tributaries provided relatively good habitat, having largely recovered from the impact of hydraulic mining that occurred until 1939. The Trinity River Diversion (TRD) decreases the amount of water in the Trinity River basin by diverting water to the Sacramento Valley and the Bureau of Reclamation's Central Valley Project (CVP). This diversion leads to increases in the temperature of the remaining water in the river and disrupts physical cues for migration and spawning of salmon. The Trinity River Fish Hatchery was constructed at the base of Lewiston Dam to help mitigate the loss of fish habitat resulting from the project, but the hatchery has not been effective in sustaining fish populations.

2.2.9.2. Middle Trinity River HA (106.30)

This area extends from Junction City to the Lewiston Dam and is the area of highest human population in the Trinity WMA (Weaverville). The terrain in this area is relatively flat and as such is an area of sediment deposition. Logging operations and road building and use have caused erosion, sedimentation, and elevated turbidity of streams and the river. Many tributaries have also been subject to historic hydraulic mining and water diversion. The most abundant salmonids in the tributaries are steelhead, followed by Chinook then coho.

2.2.9.3. Lower Trinity River HA (106.10)

2.2.9.3.1. Overview

The Lower Trinity HSA contains the sub-watersheds of the New River, North Fork Trinity River, Canyon Creek, and the canyon area and lower portion of the mainstem Trinity River. The Hoopa tribe, which is recognized as a sovereign nation, is located in this area. The Horse Linto Creek sub-watershed is relatively un-impacted compared to other sub-watersheds in the area. It is a Key Watershed in the Northwest Forest Plan and is intended to provide high quality water and critical refugia for at-risk fish species and stocks; Chinook, coho and steelhead are found in its lower reaches. Historically, hydraulic mining occurred in the Lower Trinity River, while current mining practices consist of small placer sluicing and hard rock milling operations.

2.2.9.3.2. New River HSA (106.14)

The New River sub-watershed is 74 mi^2 of mostly undeveloped, forested land that drains into the mainstem Trinity River near the community of Hawkins Bar. Approximately half of the area is designated as wilderness and half is USFS land. The New River is designated as a Wild and Scenic River and is refugia for summer steelhead. It is a Key Watershed in the Northwest Forest Plan. The New River has had a significant summer steelhead population since the 1970s; in the 1990s, 307-804 summer steelhead were counted in the New River, making it one of the larger populations in California. In-stream and riparian habitat in the New River are considered good to excellent, despite the high level of historic mining activity and the fact that 5-44 % of the gravel and cobble in the New River and tributaries is embedded more than 50%. There is a history of lightening-caused wild fires in the area; in 1999, 53% of the watershed burned, but the aquatic ecosystem did not appear to suffer significant negative impact. On USFS land there are limited timber sales and roads that contribute to erosion and sedimentation. Intensive mining occurred historically and suction dredge mining occurs today, causing unstable channel and gravel conditions.

2.2.9.3.3. Helena HSA (106.15)

The Helena HSA includes the North Fork Trinity River sub-watershed which is 15.8 mi^2 of largely undeveloped, forested land that drains into the main Trinity River near the community of Helena. The area contains rugged terrain with stream reaches of relatively steep gradient. The North Fork is identified as a Key Watershed in the Northwest Forest Plan. The North Fork has had a significant summer steelhead population since the 1970s; the 1990s population was estimated at 300-800 fish, similar to the New River. Most of the area is designated as wilderness and little timber harvesting is conducted. Some mining occurs in the lower part of the sub-watershed. Wild fires also occur in this sub-watershed.

The Canyon Area lies along both sides of the mainstem from the Trinity/Humboldt County line east to Junction City. Most of this area is under the jurisdiction of the USFS. The flow of the river keeps sediment from depositing on the streambed. Along this corridor are homes, mills, the ranger station, and Highway 299. Timber harvest is limited, but chronic landslides block the highway and create the problem of soil deposition in the river. Logging and roads create erosion hazards and potential sedimentation to the streams and the river. This area has been subjected to placer and hydraulic mining in the past.

2.2.9.4. South Fork Trinity River HA (106.20)

The South Fork Trinity sub-watershed is ~1,000 mi^2 and constitutes 31% of the Trinity River sub-basin and 6% of the Klamath basin. The South Fork Trinity River is the largest un-dammed river in California and the watershed is a Key Watershed in the Northwest Forest Plan. The South Fork originates in the North Yolla Bolly Mountains about 50 miles southwest of Redding and runs northwest for approximately 90 miles before reaching its confluence with the Trinity River near Salyer. Elevations range from more than 7,800 feet in the headwater areas to less than 400 feet at the confluence with the Trinity. It flows mostly through Trinity County, forming the boundary between Trinity and Humboldt Counties in its lower 12 miles. The 56-mile stretch from Forest Glen to the mouth is protected by the California Wild and Scenic Rivers Act.

The South Fork Trinity is primarily mountainous, forested land, with two broad agricultural valleys occupied by the towns of Hayfork and Hyampom. This area is a mix of private and USFS administered public land. It was extensively harvested for timber in the past, which caused erosion and sedimentation of streams and the river. In addition, the area is susceptible to naturally occurring landslides and other mass-wasting events because of steep terrain, loosely consolidated soils (decomposed granite) and heavy precipitation. There is a history of wild fires and the subsequent erosion and salvage logging issues. Hayfork Creek is the largest tributary to the South Fork. Historically, it was the spawning area for steelhead and spring and fall Chinook salmon. However, in the South Fork Trinity, past and present land use practices have accelerated erosion, resulting in increased sedimentation and decreased salmonid habitat; the spring Chinook salmon run has declined by 90% and the fall run by 50%.

2.2.10. Water Quality Issues in the Trinity River WMA

The quality of water in the basin ranges from the highest-quality pristine waters that emerge from the Trinity Alps wilderness into the northern mainstem tributaries, to various degrees of human-caused impairment in the mainstem and southern tributaries, which contributes to the degradation of fish habitat. Natural events and multiple land uses are responsible to varying degrees for sediment contributions. The causes of accelerated erosion and mass wasting include timber production and harvest, road construction, road use and maintenance, grazing, and gravel mining.

Impacts of accelerated erosion on water quality in the South Fork sub-watershed are not equally distributed throughout the basin. The worst effects have been found in the upper and lower sub-basins, which are more erodible, particularly west of the mainstem, and in areas where land management practices are most intense. Generally, smaller tributaries have been less affected than the mainstem lower gradient reaches. The impacts have been most intense in the Hyampom Valley, with most of the sediment being delivered from South Fork Mountain tributaries, where heavy logging has occurred since the 1940s.

Increased water temperatures in some parts of the watershed are also an issue. Temperatures in the lower South Fork and selected tributaries, particularly the lower portion of Hayfork Creek, may be too high to fully support aquatic habitat. Average daily summer maximum water temperatures of the Trinity River at Hoopa from 1964-1983 were 66.6-73.3°F; in some years temperatures were >75°F, which is lethal to salmonids. More recently, summer maximum temperatures in Willow Creek in the lower portion of the watershed in 2001 ranged from 61-69°F, which exceeds optimal ranges but can be considered adequate or marginal. Aside from direct effects on fish, high water temperatures can have secondary effects. In 2002, there was a spring Chinook fish kill in the Trinity River. The fish were infected with bacteria and protozoan parasites that caused increased fish mortality at higher temperatures, and water temperatures as high as 72°F were measured. The cause of high temperatures may include natural conditions, but anthropogenic factors included water diversions (particularly in Hayfork Creek), loss of riparian vegetation in selected locations, and excess sedimentation resulting in channel widening and decreased water depths.

The hydrologic changes wrought by the TRD project and the geologic conditions of the basin have resulted in altered stream-channel conditions and fish habitats for many miles below Lewiston. The once diverse channel was converted into a structurally uniform channel, in some places choked with sediment and in other places deprived of sediment, thereby eliminating or modifying critical habitat elements for anadromous salmonids. The dams block the supply of coarse sediment needed by salmon for spawning in the mainstem below Lewiston Dam. The channel has degraded two feet in this area. In other areas, due to inadequate flood flows, sediment has not been mobilized. This lack of sediment movement produces sediment accumulation at the deltas of tributaries, decreased substrate complexity, and reduction in the number and quality of alternate bar sequences. Alternate bar sequences are the successions of bars and riffles with associated pools that provide cover from predators and cool resting places for juvenile and adult salmonids. Also missing are gravelly riffles where adults typically spawn; open gravel/cobble bars that create shallow, low-velocity zones important for emerging fry; and slack water habitats for rearing juveniles.

Other factors, taken singly and in combination, degrade the quality of habitat as it relates to salmonid survival and success:

- Sediment has filled in mainstem pools, eliminating deep pool habitat important for adult salmonids holding over the summer. Before the TRD, the bottom waters of deep pools were as much as 7°F cooler than the surface, providing thermal refugia for both migrating adult salmonids and rearing juveniles. The change in channel morphology due to the altered flow regime has decreased or eliminated the temperature stratification in pools, particularly in the summer and early fall months.
- Spring Chinook and summer steelhead compete for pools now that the spring Chinook can no longer use the areas above the dams during the summer.
- Fine sediments interfere with egg and fry development, and sedimentation has reduced the dynamic nature of the riparian zone.
- Changes in channel structure and substrate quality have reduced total habitat areas suitable for the production of food organisms, primarily benthic macroinvertebrates.

Additional concerns include:

- Recreational in-stream suction dredging for gold especially in the mainstem and canyon area
- Acid mine drainage from abandoned mines.
- Mercury from historic gold mining.
- Sediment inputs from subdivisions and eroded roads in areas with unstable soil and decomposed granite.
- Septic tank use.
- Releases from aboveground and underground tanks.
- Lumber mills.

Specifically, drainage discharges from the Kelly Mine on McCovey Gulch in Hayfork in the South Fork watershed contain chromium and arsenic, affecting domestic diversions downstream. The Trinity County Health Department has posted the creek for metals contamination and notified homeowners not to drink the water. Releases from underground storage tanks have occurred at 12 sites in the Hoopa/Willow Creek area, 14 sites in the South Fork watershed, 21 sites in Weaverville, and 12 sites upstream of Weaverville. In Weaverville, the releases resulted in significant gasoline contaminant plumes, some containing MTBE.

Additionally:

- In the Hyampom area, several domestic wells were contaminated with MTBE from an underground fuel tank release.
- Heavy metals, fuels, and wood treatment chemicals were discharged from an abandoned mill site near Douglas City.
- Trinity and Lewiston Lakes are heavily used for recreational boating and personal watercraft and are at risk for releases of fuels and fuel oxygenates, especially MTBE.
- Mineral oil containing PCBs may have been released from PG&E electrical substations in Hoopa, Willow Creek, Weaverville, Hyampom, and Wildwood, and storm water discharges from these facilities are also of concern.
- In the Lower Trinity River, the Copper Bluff Mine continues to emit toxins in the form of acid.
- Celtor chemical works, located on the Hoopa Valley Reservation, is a USEPA Superfund site. Groundwater and surface water contamination are suspected at former and existing mill sites that historically used wood treatment chemicals.

The USEPA developed and adopted a TMDL for sediment in the South Fork Trinity River in 1998. The sediment TMDL for the Trinity River watershed (Upper, Middle, and Lower) was adopted by USEPA in December 2001.

The primary water quality issues in the Trinity River WMA are:

- Sedimentation of streams
- High water temperatures
- Mercury contamination in fish
- Historic wood treatment facility contamination

The primary adverse impacts associated with excessive sediment in the Trinity River pertain to anadromous salmonid fish habitat. Beneficial uses impaired by excess sediment in the Trinity River are primarily those related to fish habitat. As in many of the North Coast watersheds, the most sensitive beneficial uses appear to be those associated with coldwater fishery, because salmonids are very sensitive to habitat changes and water quality degradation. Accordingly, protection of these beneficial uses is presumed to protect other beneficial uses that might also be harmed by sedimentation and high water temperatures.

2.3.________Humboldt Bay WMA

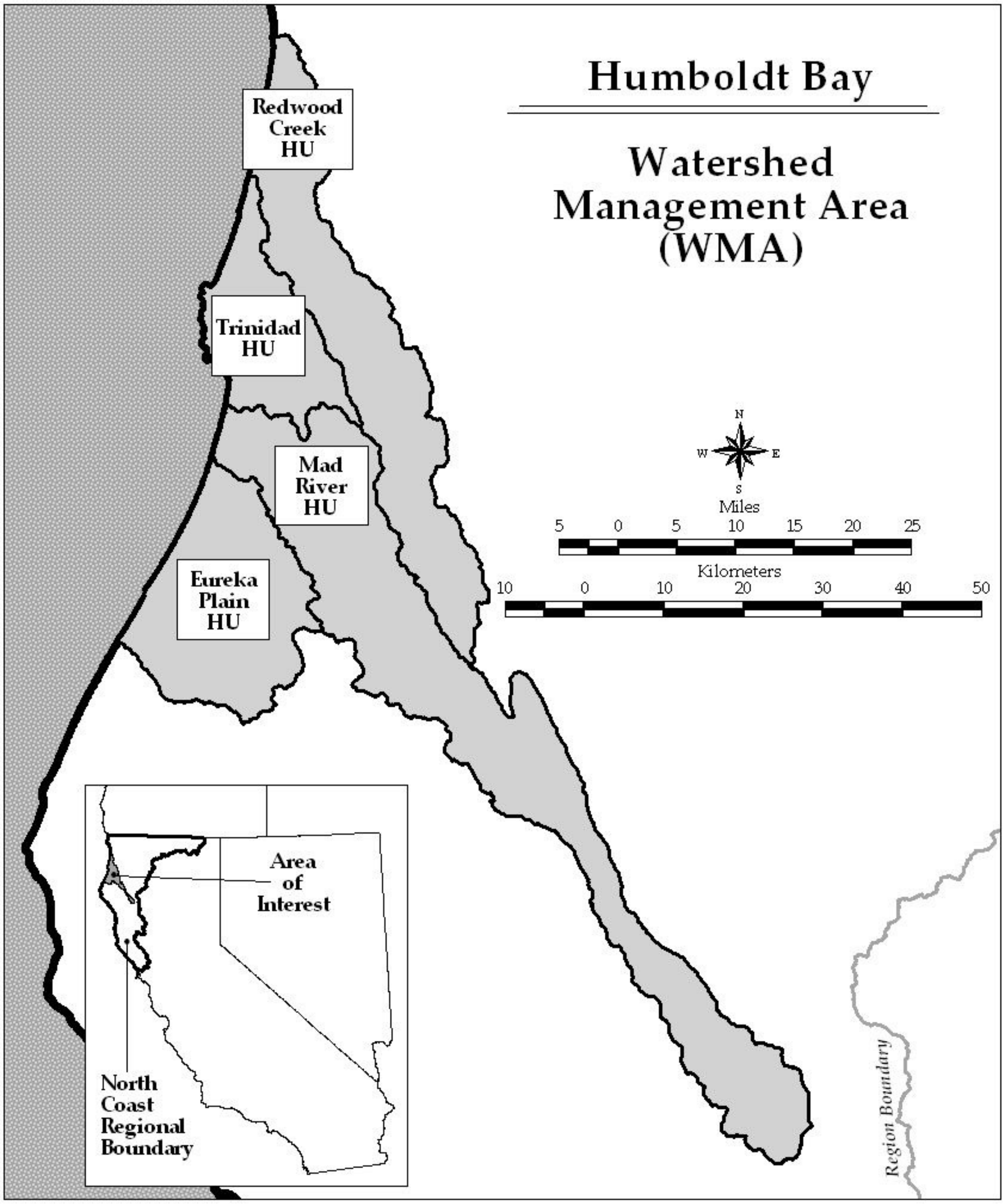


Figure 11. Hydrologic Areas of the Humboldt Bay WMA

The text presented within this section includes information that has been previously published by USEPA 1998 (Total Maximum Daily Load for Sediment Redwood Creek, California), Humboldt Watersheds Independent Scientific Review Panel 2003 (Phase II Report: Independent Scientific Review Panel on Sediment Impairment and Effects on Beneficial Uses of *the Elk River and Stitz, Bear, Jordan and Freshwater Creeks), North Coast Regional Water Quality Control Board 2000 (Staff Report for Proposed Regional Water Board Actions in the North Fork Elk River, Bear Creek, Freshwater Creek, Jordan Creek and Stitz Creek Watersheds), and references included therein.*

2.3.1._______Overview

This management area encompasses tributaries to the Pacific Ocean from Humboldt Bay north to Redwood and Prairie Creeks and all groundwater within that area. Major drainage systems in this area are Redwood Creek (HA107.00) and the Mad River HA (109.00). Other major waterbodies include Humboldt Bay and Mad River Slough, numerous coastal lagoons (Big Lagoon, Stone Lagoon, Freshwater Lagoon), and coastal streams (Elk River, Freshwater, Jacoby, and Maple Creeks, and Little River).

Urbanized areas include Trinidad on the ocean, McKinleyville and Blue Lake on the Mad River, and Arcata and Eureka on Humboldt Bay. Rural residential developments are scattered throughout the timber/grazing interface. The majority of the population in this WMA lives in the Humboldt Bay area, which has a population of about 65,000. Suburban growth is occurring in the unincorporated community of McKinleyville, north of Arcata. A small population lives in Orick near the mouth of Redwood Creek.

The terrain is elevated hillslope in the east with coastal plain to the west. Vegetation consists of redwood and Douglas fir interspersed with some hardwoods and meadows. The climate and soils in the region promote high redwood and Douglas fir production. Precipitation ranges from 32 to 98 inches yr-1 with 70 to 80 inches as rain. The area is underlain by bedrock units that uplift periodically. In combination with the high level of precipitation, this contributes to significant sediment generation even in the absence of human activity.

Waterbodies in the Humboldt Bay WMA support many different uses. Fresh water streams throughout the Humboldt Bay WMA support production of anadromous salmonids, including Chinook and coho salmon and steelhead trout which are listed as threatened under the FESA. The Mad River supplies drinking and industrial water for the Humboldt Bay Area, and other coastal streams provide drinking water for local communities and individual homes. Humboldt Bay is a deep-water port and a major shipping center for the North Coast as it is the largest such center between San Francisco, California and Coos Bay, Oregon. Humboldt Bay is also a valuable ecosystem that supports a significant commercial oyster industry and is popular for recreational shellfishing. The deltas of the Elk River and Mad River Slough also support commercial and sport shellfish production and harvesting.

2.3.2._______History and Land Use

Timber production and harvest are primary land uses in the Humboldt Bay WMA. An estimated 25% of the timber harvesting along the North Coast occurs in this WMA. Coast redwood is the most harvested species. PALCO, the largest of many timber companies in the area, owns approximately 211,700 acres of forestland in Humboldt County, encompassing lands within 22 watersheds including the Bear Creek, North Fork Elk River, Freshwater Creek, Jordan Creek, and Stitz Creek watersheds. PALCO owns 77-100% of each of these watersheds, and they were harvested heavily from 1987-1997. Forty miles of new roads were constructed in Freshwater Creek between 1995-1998, at a rate of 10 mi yr-1. Current road density in Freshwater Creek watershed is approximately 6.0 mi mi-2.

A sediment budget for Freshwater Creek for 1988-1997, a period during which 35% of the 31 mi^2 watershed was harvested, indicated that 56% of the sediment inputs to streams were from management sources, 37% were from natural background sources and 7% were due to legacy situations. Of the management related sources, roads were responsible for 88% of the sediment load (59% from surface erosion and 29% is from road related landslides). Shallow landslides in harvest units accounted for another 9% of the management-related input, and the rest was due to surface erosion from harvest units and other effects.

During the winter of 1996-97, timber harvest and related activities caused significant volumes of sediment from landslides and road networks on timber company lands to enter Freshwater Creek, Elk River, Jordan Creek, Bear Creek, and Stitz Creek. There were significant cumulative adverse impacts to beneficial uses of these waterbodies including filling of stream channel pools, loss of fish habitat, and degradation of water supplies. Bear Creek, Jordan Creek, and Stitz Creek are listed as sediment impaired.

Agriculture, primarily livestock grazing and dairies, occurs in the non-forested areas. Flat land areas around the bay are predominantly pastureland with some limited cultivation, primarily lily bulb farms. Lily bulbs are also grown in the McKinleyville area.

2.3.3. Redwood Creek HU (107.00)

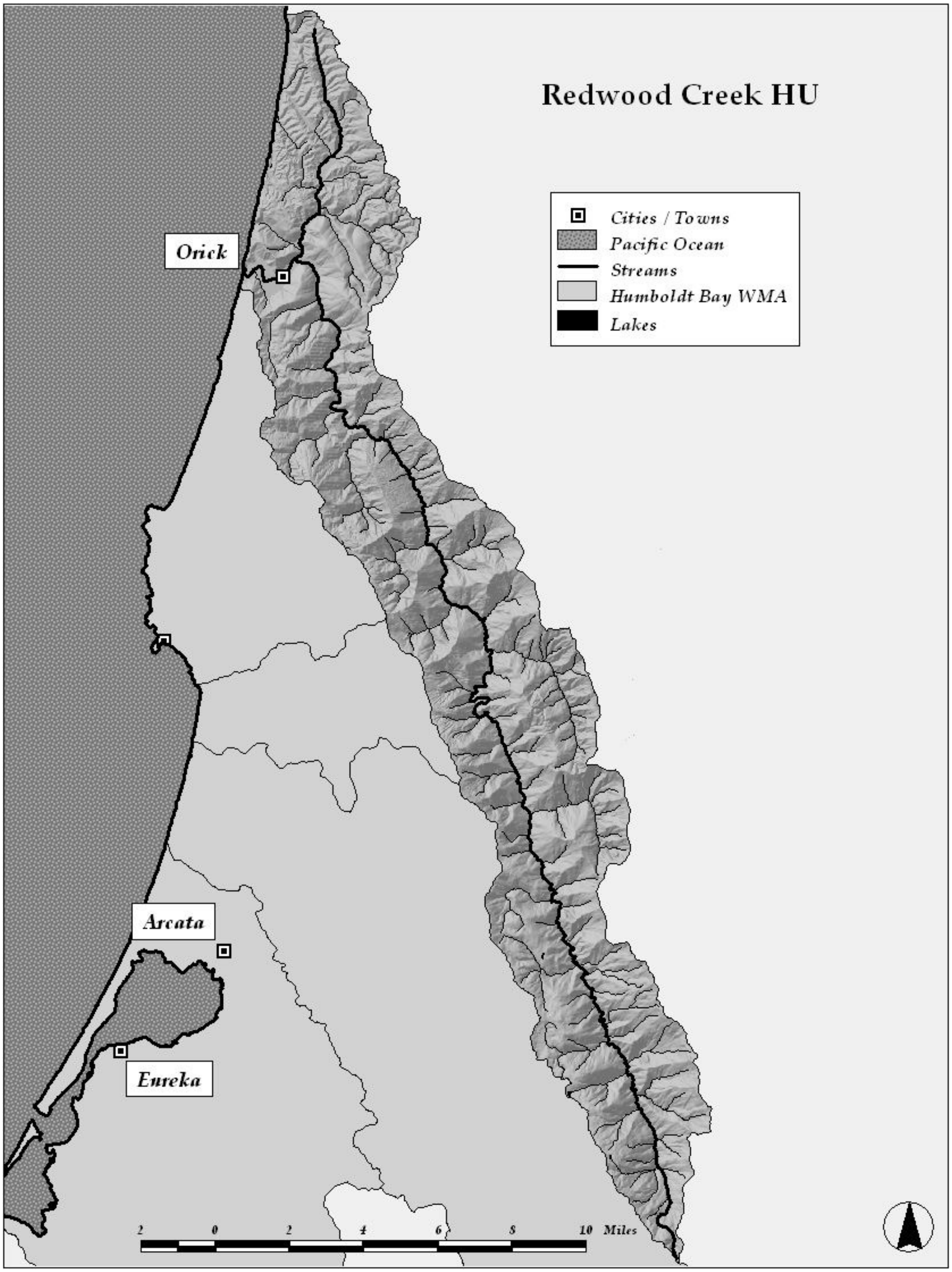


Figure 12. Map of the Redwood Creek HU

2.3.3.1.______Overview

The Redwood Creek watershed in the Humboldt Bay WMA has been well studied. It is 285 mi^2 and drains into the Pacific Ocean near the town of Orick. The watershed is about 65 miles long and 4-7 miles wide and consists mostly of mountainous, forested terrain from sea level to about 5,300 feet. Primary land uses in the lower portion, which is part of Redwood National and State Parks, are tourism and fishing; timber management and livestock production dominate in the upper watershed.

2.3.3.2.______History and Land Use

Timber harvesting is the most widespread land use in Redwood Creek basin. Over 85% of the basin upstream of the park has been logged, including about 30% that was logged between 1978-1992. About three-quarters of this recently logged area was logged using intensive silvicultural methods that remove all or almost all trees from the harvest area. Substantial areas of the park were intensively logged prior to their inclusion in the park. Timber harvesting of second growth timber in the upper basin is expected to continue in the future. Harvested areas remain at greater risk of increased erosion (principally through landsliding) for at least a year or two following harvest, and possibly for longer periods.

2.3.3.3.______Vegetation

The natural vegetation of the Redwood Creek watershed consists mostly of coniferous forest. In 1998, old-growth forest covered 24,315 acres in the watershed, or 14% of its total area. Near the coast, the most common forest tree is the Sitka spruce, but most of the lower basin is dominated by coast redwoods. Farther inland, where summer temperatures are higher and fog is less frequent, Douglas fir is more common than redwood. Several hardwood species grow in association with both redwood and Douglas fir; these include bigleaf maple, red alder, tanbark oak, madrone, and bay. Prairies and oak woodlands occur on south- and west-facing ridgetops and hillslopes on the east side of Redwood Creek.

2.3.3.4.______Climate

The Redwood Creek watershed has a Mediterranean climate with mild, wet winters (November to March) and warm, dry summers. Mean annual precipitation is roughly 80 inches, mostly as rain with snow frequently at altitudes above 1,600 feet. Streamflow in Redwood Creek varies annually due to rainfall variations and seasonally due to the highly seasonal distribution of rainfall. Snowmelt can increase streamflow peaks during rain-on-snow events. Winter flood flows can be as much as four orders of magnitude higher than summer low flows. Floods are critical events for the resources of Redwood Creek because they erode hillslopes, reshape channels, and transport large proportions of fluvial sediment loads. Recent large floods occurred in 1953, 1955, 1964, 1972 (two floods), and 1975. The 1964 storm was a regionally significant event that caused significant hillslope erosion and changes in channel morphology—many mainstem pools were filled by sediments.

2.3.3.5.______Fishery

Approximately 250 species of fish, amphibians, reptiles, mammals, and birds are known to exist in the Redwood Creek watershed. Thirty-three species are species of special concern (threatened, endangered, or sensitive to human activities). Redwood Creek historically supported large numbers of coho and Chinook salmon and steelhead trout. In 1965, CDFG roughly estimated spawning escapement of 5,000 Chinook, 2,000 coho, and 10,000 winter steelhead. However, anadromous fish populations in Redwood Creek have diminished substantially over the past 40 years, and dropped as much as 90% since the 1990s. In 1994, five fish species found in Redwood Creek were classified as threatened or endangered by U.S. Fish and Wildlife Service (USFWS) and/or CDFG: tidewater goby, coastal cutthroat trout, coho salmon, spring run Chinook salmon, and summer steelhead trout. Other fish species in the watershed include rainbow trout, Humboldt sucker, threespine stickleback, coast range sculpin, Pacific lamprey, and eulachon.

2.3.3.6.______Topography and Geology

Geologic structure in the Redwood Creek watershed is governed by several parallel north-northwest trending faults. For much of its length, the channel of Redwood Creek closely follows the Grogan Fault. Hillslopes are relatively steep and unstable, and the inner gorge slopes are very steep along much of the mainstem and some tributaries. Most of the watershed has undergone uplift over the past several hundred thousand years. The basin is underlain by the Franciscan complex of un-metamorphosed sandstones, mudstones, schists, and scattered blocks of other rock types. In general, slopes west of Redwood Creek are underlain by schist, and slopes east of the creek are underlain by sandstones and mudstones. The schists and mudstones that underlie much of the basin are relatively weak and susceptible to erosion and mass soil movements. Remaining areas of the watershed that are underlain by more competent rock types, such as interbedded sandstone/mudstones, are somewhat more resistant to erosion, but they form steep slopes that are susceptible to rapid, shallow landslides.

2.3.3.7.______Sedimentation

Redwood Creek is particularly prone to storm-induced erosional events and would probably be subject to extensive erosion under natural conditions. However, land management activities have accelerated this natural process, overwhelming the stream channel’s ability to efficiently move the delivered sediment. Streamside landsliding and fluvial hillslope erosion may be the most important sediment-generating processes in the watershed. Much erosion is associated with a dense road network (7.3 mi/mi^2) on private lands, improperly designed and maintained roads and skid trails, and timber harvesting. Roughly 1,400 miles of forest roads and over 5,000 miles of skid trails have been built within the basin, of which about 445 miles of roads and 3,000 miles of skid trails were included within the national park boundaries. About half the roads and a very high percentage of skid trails upstream of the park are not properly maintained or have been abandoned.

The long term average annual sediment delivery in the Redwood Creek watershed from 1954-1997 was about 4,750 t mi^{-2} yr^{-1}, which is almost twice the amount for more pristine "reference" watersheds for this time period. In Redwood Creek, 54% of the sediment load was from fluvial and surface erosion, and 46% was associated with mass wasting processes. Road-related erosion accounted for approximately 50% of the total load, and roughly 10%-20% was associated with timber harvesting (not including harvest related roads and skid trails). Thirty to forty percent was naturally occurring, or at least were not associated with specific land management causes. Therefore, about 60% of the erosion in the Redwood Creek basin was controllable.

The volume of stored sediment in Redwood Creek has increased, and consequently:

- The frequency of deep pools has increased.
- Overall stream depth has decreased.
- Channel width has increased.
- Recruitment and volume of LWD has been reduced.
- Increased deposition of fine sediments covering the bottom and embedding spawning gravels.

The mainstem lacks adequate pool-riffle structure and cover. Coarse sediment deposited in the mainstem allows a large proportion of summer base flows to infiltrate and flow subsurface, thereby limiting the surface water available to fish and increasing surface water temperatures. Aggraded sediments have formed large deltas at the mouths of some tributaries, blocking tributary mouths and preventing fish migration. A lack of suitable rearing habitat in the mainstem and tributaries has forced juvenile fish to inhabit the estuary, where they are subject to the impacts of sudden, extreme changes in salinity resulting from breaching of the sandbar by ocean waves and currents.

2.3.4._______Mad River HU (109.00)

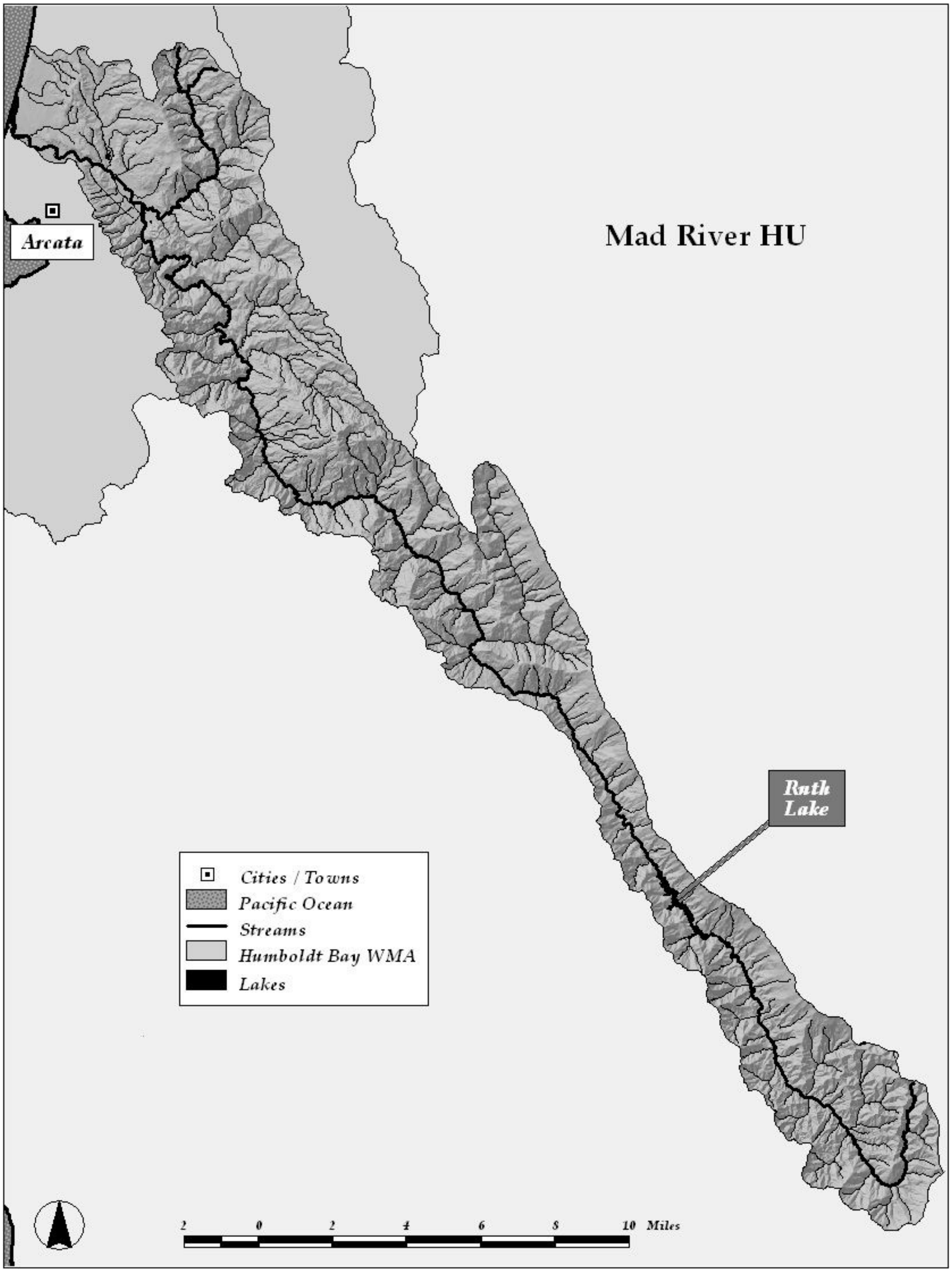


Figure 13. Map of the Mad River HU

The Mad River is located just north of Arcata in Humboldt County. Its watershed extends inland about 100 miles to the southeast and is a mix of private and USFS timberland with a long history of timber harvest. Other major land uses in the watershed include agricultural grazing lands, gravel extraction, and rural-residential/urban development. Gravel mining, which impacts channel morphology, occurs in the lower portions of the watershed. The Mad River supplies water for municipal and industrial use in the Humboldt Bay region.

For the Mad River and its tributaries, discharge of waste is allowed only under NPDES permit. Under the NPDES permit, discharge is only permitted during the period of October 1 through May 14 and at 1% of the flow of the receiving water. The McKinleyville Community Services District uses percolation ponds instead of discharging to the river during summer low flows. The City of Blue Lake does not discharge directly, disposing of effluent in percolation/evaporation ponds.

The lower 5.5 miles of the Mad River lies in the coastal zone. Much of the spit separating the Mad River estuary and the ocean has been incorporated into the 150-acre Mad River County Beach. The State manages both the 30-acre Azalea State Preserve on the north side of the river, and the Mad River Fish Hatchery, where anadromous fish are raised for release along the North Coast. A portion of the town of McKinleyville lies within the coastal zone, and much of the coastal zone bottom lands and floodplain that are not in public ownership are grazed. The Mad River and its estuary have problems of sedimentation/threat of sedimentation and threat of fish population decline. The pollutants are siltation and turbidity from industrial and municipal sources, silviculture, and other nonpoint sources.

2.3.5. Water Quality Issues in the Humboldt Bay WMA

The Humboldt Bay WMA is threatened by sedimentation from the effects human activity on naturally unstable substrate. Major activities in the area that generate erosion and mass movement are past and present land use practices including urbanization, roads, agriculture, timber harvest, construction, gravel mining, and industrial site activities. Sedimentation has been documented in Redwood Creek, Freshwater Creek, Elk River, Mad River, and the coastal tributaries between Redwood and Salmon Creeks. Sedimentation is the major cause of salmonid habitat degradation in the Redwood Creek watershed. In Freshwater Creek and Elk River, stream aggradation and sediment discharges have reduced channel capacity, thereby increasing the frequency and magnitude of flooding and impacting domestic water supply. Impairment of tributaries to Humboldt Bay can also impact uses in the bay.

Bacteria from point sources and nonpoint source runoff from urban and rural areas reduce water quality in the bay and impact commercial and sport shellfish resources. Historically, wastewater discharges to the bay impacted the shellfish uses. Recent emphasis on improved treatment methods and reliability of facilities, and the consolidation and relocation of the Eureka wastewater plants, has significantly reduced the problem. Contamination from collection system overflows of raw sewage during high intensity rainfall events is a continued threat to commercial and recreational uses of the bay. Storm water runoff from all watersheds draining to the bay is contaminated with bacteria that impact shellfish harvest. Deleterious effects of nonpoint source runoff cause seasonal and rainfall-based shellfish harvesting closures.

In the past, the Eureka Waterfront was the site of several industrial operations including lumber mills, bulk oil storage and handling facilities, wrecking yards, and railroad yards. These operations produced both soil and ground water contamination with heavy metals, petroleum products, and pentachlorophenols (PCPs). The Waterfront is currently undergoing cleanup and redevelopment. The City of Eureka is coordinating the redevelopment with several responsible parties including Union Pacific Railroad, Simpson Timber Company, Chevron, Unocal, and Tosco oil companies, and a few others. The City is also cleaning up two brownfield sites on the Waterfront.

Activities that threaten surface and ground waters include waste disposal, vehicle and railroad maintenance yard operations, herbicide application, gravel extraction, timber harvesting, dairy operations, automotive wrecking yard or metal recycling activities, wood treatment facilities, publicly owned treatment works, construction activities, and many others. Pesticide and herbicide applications along roadways, in agricultural operations, in urban areas, and in lily bulb farming and forestlands threaten ground and surface waters. Chemical pollutants such as nutrients, petroleum, metals, and organic chemicals are of concern, particularly for groundwater. Potential sources are improper and illegal disposal of waste, spills from leaking underground storage tanks, dry cleaners, grazing and dairy operations, logging activities, industrial and construction sites, auto wrecking yards, fleet maintenance yards, inactive mill sites, and highways. Petroleum products of concern are solvents, MTBE, and gasoline. These pollutants can have adverse effects on all domestic water supply systems as well as other beneficial uses.

The primary water quality issues in the Humboldt WMA are:

- Salmonid habitat degradation
- Sedimentation of streams
- Flooding
- Impaired domestic water supplies
- Bacterial contamination

Overall, concerns about water quality in the Humboldt Bay WMA focus on recovery of threatened and endangered species of coho and Chinook salmon and steelhead trout, and protection of water quality beneficial uses, including domestic water supply and commercial and recreational shellfish uses. Stream sedimentation from various land use activities such as rural subdivisions, grazing, and logging roads limits coldwater aquatic uses. The condition of Redwood Creek estuary is critical because it serves as a nursery for newly hatched salmonids that sometimes stay in the estuary as long as three years before leaving to the ocean. In the Redwood Creek basin, a lack of canopy cover and large woody debris combines with shallow pools and high temperatures to impact spawning and rearing habitat for threatened and endangered salmonid species.

2.4. Eel River WMA HU (111.00)

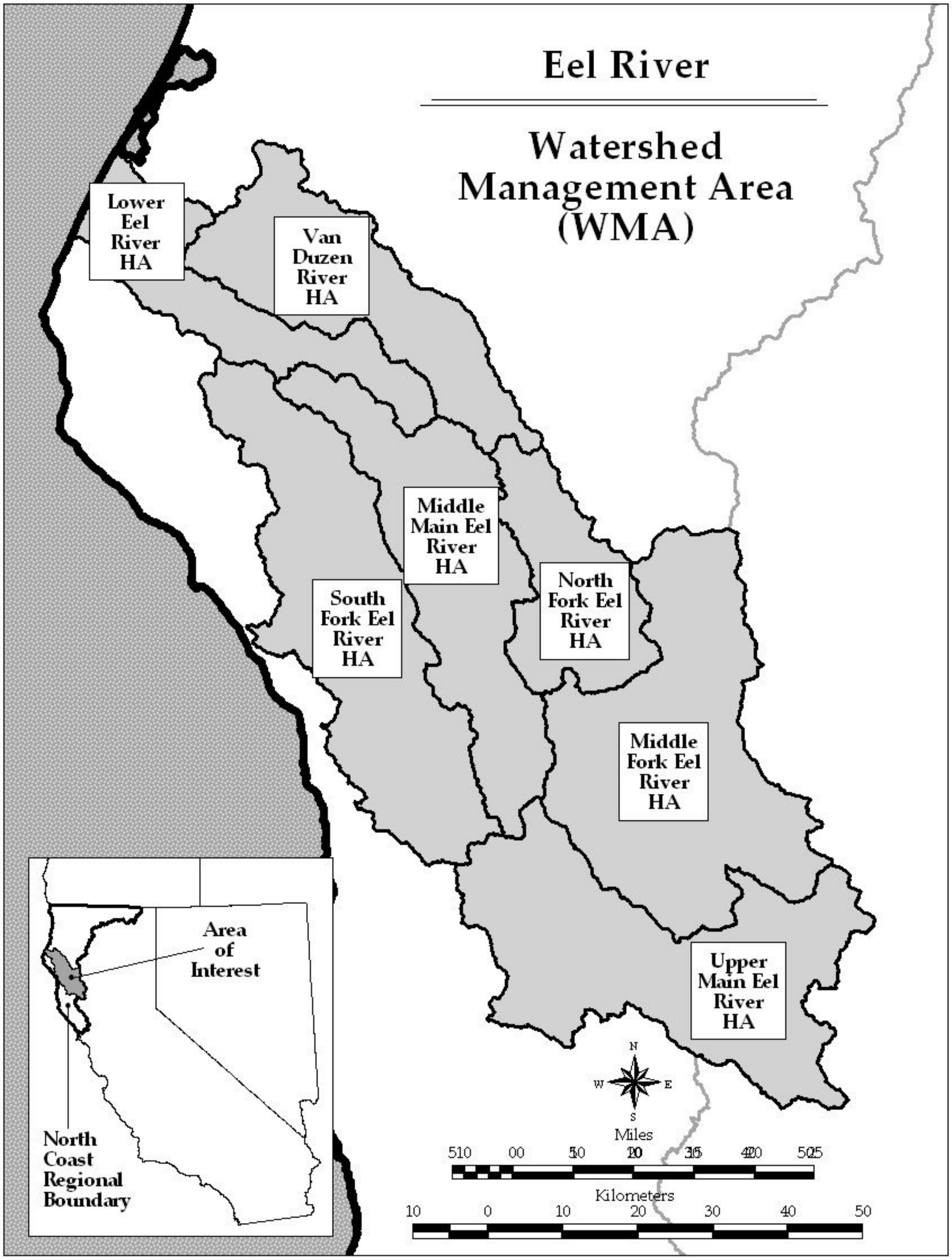


Figure 14. Hydrologic Areas of the Eel River WMA

The text presented within this section includes information that has been previously published by Fuller, et. al. 1996 (North Fork Eel River Watershed Analysis), USEPA (Middle Main Eel River and Tributaries [from Dos Rios to the South Fork] Total Maximum Daily Loads for Temperature and Sediment), DFG 2002 (Status Review of California Coho Salmon North of San Francisco), and references included therein. Other information was synthesized from http://www.eelriver.org/ (2007), and http://www.hits.org/salmon98/ (2007).

2.4.1. Overview

The Eel River WMA is approximately 3,684 mi^2 located in northern coastal California; it is the state's third largest watershed. The Eel River flows over 800 river miles northwest from its headwaters in southeastern Mendocino County and Lake County, through Mendocino and southern Humboldt Counties, to the Eel River Delta 10 miles south of Humboldt Bay. The Eel River has four forks: the North, Middle, South, and Main, which is divided into Middle Main and Upper Main sections. There are also several large tributaries: the Van Duzen River, the Bear River, and Yager, Larabee, Bull, and Salmon Creeks.

The Eel River watershed is characterized by steep coastal mountains with highly erodible soils, and is heavily forested. The upper watershed is vegetated by redwood, Douglas fir interspersed with some hardwoods, and meadows. Toward the coast, the river spreads out on an alluvial plain where the Salt River joins it. The Eel River empties into the Clem Miller State Seashore and is a designated State Wildlife Area. In 1972, sections of the Eel River were designated by the California Wild and Scenic Rivers System. In 1981, the Eel River was designated a National Wild and Scenic River.

Timber production is a major land use activity in the Eel River WMA. Extensive timber harvesting occurs in the lower Eel River and Van Duzen River watersheds including Bear, Stitz, and Jordan Creeks. Cattle grazing on timber-harvested land combine with many poorly maintained roads to contribute sediment to local creeks causing aggradation, flooding, and domestic water supply problems.

The Potter Valley Project (PVP) includes a 9.4-megawatt hydroelectric generating station in the upper Russian River basin, using water from the Eel River to generate power. Scott Dam, constructed in 1921, created Lake Pillsbury, and 12 miles downstream the Cape Horn Dam impounds the Van Arsdale Reservoir. Water from the Van Arsdale Reservoir flows either northwest in the Eel River approximately 150 miles to the Pacific Ocean, or is diverted south through the PVP where it generates electricity and goes on into the Russian River drainage, where it maintains river flow through the summer. An average of about 160,000 acre-feet are diverted annually from the Eel River basin into the Russian River basin

The alluvial plain of the lower Eel River supports livestock grazing, dairies, gravel mining, and residential communities. There are approximately 85 dairies located in the

Eel River alluvial plain and 11 gravel-mining sites within the lower Eel River. The towns of Ferndale, Fortuna, and Loleta are on the alluvial plain. Other population centers in the WMA are Scotia, Garberville, Laytonville, and Willits.

The Eel River WMA is a prime recreational area with many state and private campgrounds; related beneficial uses include water contact and non-contact recreation such as boating and swimming. The Eel River is the third largest producer of salmon and steelhead in the State of California and supports a large recreational fishing industry. Additional beneficial uses include municipal and agricultural supply. Surface and ground waters in the Eel River watershed are closely connected and significantly influence each other.

2.4.2. Fishery

The Eel River supports anadromous populations of steelhead trout, coho and Chinook salmon, and possibly cutthroat trout, though numbers are significantly reduced from historical levels when these fish numbered in the tens of thousands or hundreds of thousands. A commercial salmon industry thrived in the area from 1850-1890, as evidenced by numerous canneries in the Eel River estuary. Eel River salmon production in 1857 is said to have equaled that of the Sacramento River and far exceeded the production of the Columbia River and Vancouver Island combined. An estimated 44,688 fish were taken in 1857 and 585,200 in 1877. In 1964, CDFG estimated the annual spawning escapement in the entire Eel River System at approximately 82,000 steelhead, 23,000 coho, and 56,000 Chinook for a total of 161,000 fish. The most recent estimate of the average annual salmon and steelhead spawning populations in the Eel River system was made in the late 1980s and indicated that steelhead trout had declined to 20,000, Chinook to 10,000, and coho to 1,000, for a total of 31,000 fish. This is an 80% decline from the early 1960s. At the Van Arsdale Reservoir fish ladder in the 2000-2001 winter season, the count of spawners arriving in the upper river was 303 Chinook, 651 steelhead, and 1 coho; in 2001-2002, the count was 955 Chinook, 311 steelhead, and 4 coho. Coho, Chinook and steelhead in the Eel River WMA are each listed as threatened under FESA.

Salmonids are threatened by many factors including sedimentation and elevated stream temperatures. Many stream channels were greatly damaged during the 1964 flood. Streams were filled with sediment, channels were widened and many areas lost riparian vegetation. The Eel River is one of the highest sediment producing rivers in the world, carrying 15 times as much sediment, in tons of sediment per square-mile of drainage area, as the Mississippi River (Brown & Ritter, 1971).

Physical barriers to fish migration limit their habitat as well. Cape Horn Dam has upstream and downstream fish passage facilities, enabling salmon and steelhead to use the reach between Cape Horn Dam and Scott Dam. However, Scott Dam has no fish passage facilities so that fish are prevented from accessing prime spawning and rearing habitat above the dam. Split Rock, on the North Fork Eel River downstream of Hull's Creek, is a partial barrier to anadromous fish, depending on the flow and the species of fish. In addition, the invasive predatory pikeminnow, *Ptychocheilus grandis*, found throughout the watershed, may negatively impact salmonid populations by preying on juvenile fish. *P. grandis* may be thriving in the warm waters of Lake Pillsbury. *P. grandis* is not found in the North Fork above Split Rock; Split Rock may be a barrier preventing pikeminnow from preying on anadromous fish in the North Fork, which contains much of the best remaining fish habitat and lowest water temperatures in the Eel River basin.

2.4.3.______Upper Main Eel River HA (111.60)

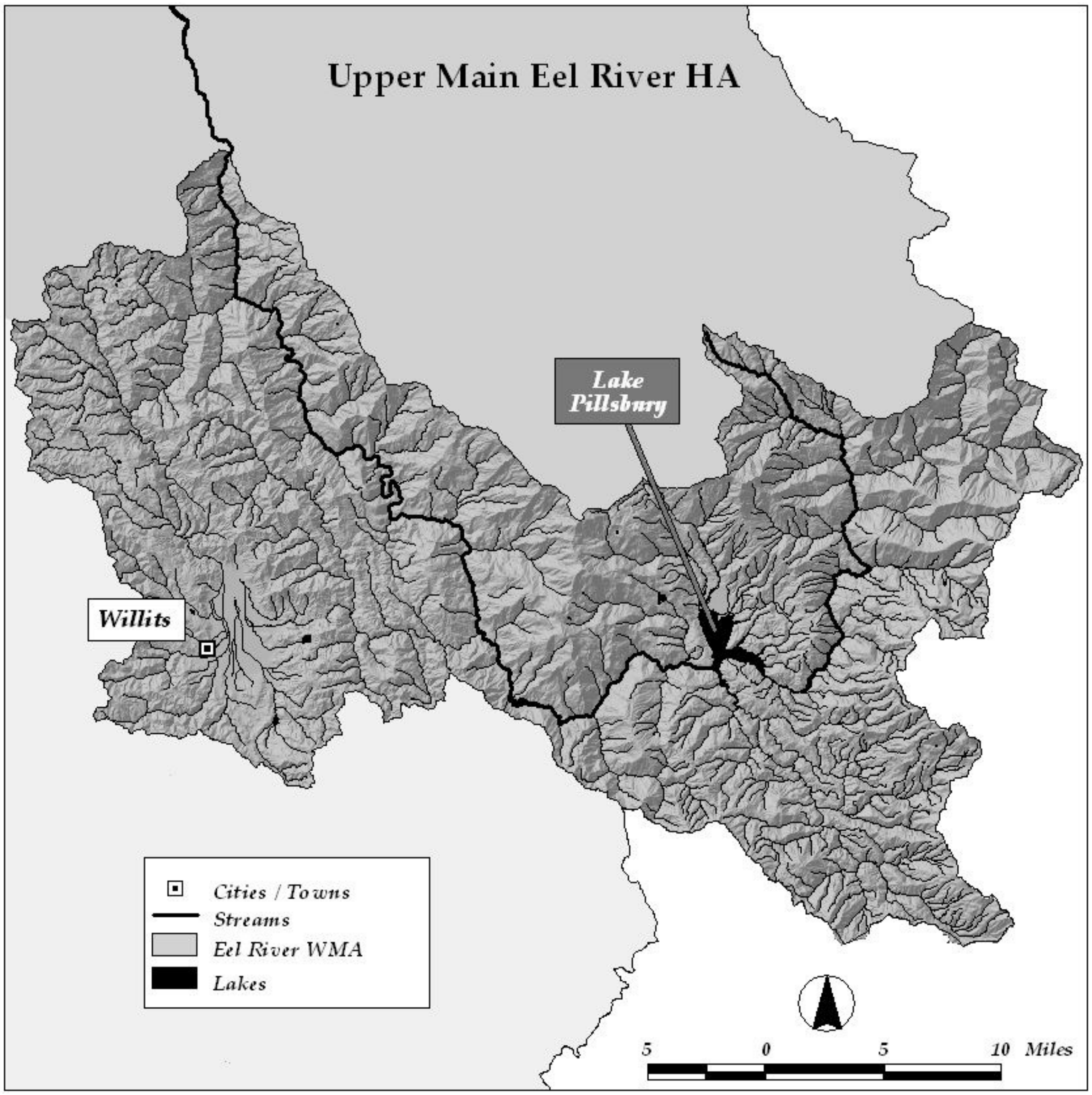


Figure 15. Map of the Upper Main Eel River HA

The text presented within this section includes information that has been previously published by USEPA 2004 (Upper Main Eel River and Tributaries (including Tomki Creek, Outlet Creek and Lake Pillsbury)

Total Maximum Daily Loads for Temperature and Sediment), and references included therein.

2.4.3.1.______Overview

The Upper Main Eel River HA is 688 mi^2 located primarily east of Highway 101 in Mendocino and Lake Counties and includes the town of Willits (see Figure 15). The sub-watershed is defined as the area from the headwaters of the Eel River in Mendocino National Forest above Lake Pillsbury down to Dos Rios, where the Middle Fork meets the mainstem Eel River. The main tributaries to the upper mainstem are Tomki and Outlet Creeks. The Potter Valley Project (PVP) and its two dams are located in the Upper Eel River sub-watershed. Scott Dam is the larger dam and impounds Lake Pillsbury. Twelve miles downstream, the smaller Cape Horn Dam impounds Van Arsdale Reservoir, from which water is diverted for hydroelectric generation at the power station in Potter Valley and then discharged to the East Fork Russian River.

Land ownership in the Upper Eel River sub-watershed is about half Mendocino National Forest, and half private. Land use activities include rural development, ranching, recreation, timber production, agriculture, and some urbanization in the Willits area. Riparian zones on public land are managed according to the Northwest Forest Plan, which limits timber harvest and promotes natural riparian vegetation. On private lands, riparian vegetation can be removed or altered by grazing, vineyard development, housing development or timber harvest.

2.4.3.2.______History and Land Use

Historical land use activities have contributed to erosion and sedimentation. Many roads were built in the 1930s and are part of the current transportation network in the watershed. Road building accompanied increases in logging operations as well, but many of the roads were not designed to withstand heavy precipitation. Grazing and fire both reduced vegetation, thus making soil available for erosion. Grazing controls have been in place since 1907 with the creation of the Mendocino National Forest; however, fire has increased erosion in several sub-watersheds, especially during the 1987 fire season. During the 1964 flood, over one-half of all the sediment transported during a 10-year period upstream of Scott Dam was mobilized.

2.4.3.3.______Climate

The Upper Main Eel watershed is inland, away from the influence of coastal fog, and is relatively dry and warm. Annual average rainfall is 40 inches, and most of it occurs between November and April. The flow of the Eel River and its tributaries above Lake Pillsbury is unregulated and highly influenced by rain events. Many of the smaller tributaries dry up in late summer.

2.4.3.4. Fishery

Historically, there may have been more than ten thousand Chinook salmon and steelhead trout in the Upper Eel River sub-watershed. Present populations are reduced from historical levels but recent Chinook and steelhead returns to Cape Horn Dam show increases in populations, some of which may be due to hatchery plants. Chinook are found throughout the watershed below Scott Dam, particularly in Outlet and Tomki Creeks. They are excluded from areas above Scott Dam, which are estimated to contain 30-150 miles of potential habitat. Chinook spawners may have been more abundant before the 1964 flood. Steelhead are widely distributed throughout the watershed, except above Scott Dam where rainbow trout are resident. Juvenile steelhead are found in tributaries to Outlet Creek, Tomki, and Cave Creeks, in streams in the Mendocino National Forest, and in the area between Lake Pillsbury and Van Arsdale Reservoir. Juvenile steelhead were also more abundant before the 1964 flood. Coho salmon are only found in a few locations in the sub-watershed, such as Outlet Creek and its tributaries, and are not seen consistently year to year. Populations are small, but coho may not have been abundant historically.

Salmonid abundance in the Upper Eel River is affected by excess sediment, elevated temperatures, a lack of LWD, and possibly pike minnow predation. Excessive sediment limits salmonid habitat in the Upper Eel River sub-watershed. Stream conditions for salmon vary, from good in two of 18 streams to poor or completely unsuitable for spawning in three streams, depending on the degree of embeddedness. The majority of streams were in between.

The most critical period for water temperature in the Eel River is the summer, when stream temperatures are highest and young salmonids rear before migrating to the ocean. The Upper Main Eel River is relatively warm compared to other reaches of the river. In the main channel of the Eel River below Van Arsdale, the point at which water is diverted for the PVP, summer temperatures can be as high as 24-28°C. Low flows resulting from the diversion contribute to these high water temperatures, which can be lethal to juvenile salmonids. Within this reach, steelhead can be found in the cool water refugia created by cool springs, stratified pools, and inputs from cooler tributaries. Increased water temperatures may also be due to less shade over stream channels since the 1964 flood, which destroyed significant amounts of riparian vegetation and widened streams.

The PVP's influence on stream temperature and cold water habitat is complex. Lake Pillsbury currently provides cold water habitat for rainbow trout and does not appear to be temperature impaired, however, Scott Dam blocks access to many miles of summer cold water habitat for steelhead, and to spawning habitat for Chinook and steelhead. Lake Pillsbury is vertically stratified over the summer and its cool bottom water is released into the Eel River during the summer; temperatures in the 12 mile stretch between Scott Dam and Van Arsdale Reservoir are approximately 2-4°C cooler than those upstream of the lake. Summer flow between Lake Pillsbury and Van Arsdale Reservoir averages about 100 cfs, and this large block of water resists heating. Below

Cape Horn Dam, however, only about 7 cfs was released until the summer of 2004, and stream temperatures quickly became lethal. As of 2004, flow below Van Arsdale Reservoir ranges from 9-30 cfs depending on the amount of rainfall that occurred during the water year. Higher flows should decrease stream temperatures.

2.4.3.5. Topography and Geology

The area is underlain by the Franciscan Complex, which dominates most of California's North Coast. This is a region of recent and ongoing uplift, and the Franciscan forms steep and unstable slopes in this environment. Consequently, slopes are generally sensitive to human disturbance. Much of the bedrock in the Upper Eel River sub-watershed is sedimentary and metamorphic rock along with ultramafic and volcanic rocks of Jurassic age. Weathering, which is impacted by slope, aspect, wind, rainfall, temperature, bedrock composition, and biological activity (including decomposition of organic matter), produces soils that may be subject to landslides and erosion. Soils with a high tendency to slump or slide cover about 40 % of the watershed, and slides, slumps, and erosion are fairly common in the watershed.

2.4.3.6. Sedimentation

The long-term (1940-2004) annual sediment production rate for the Upper Main Eel River watershed is 462 t mi-2 yr-1 (67% natural, 33% management-related). Sixty-seven percent of the sediment delivered to the Upper Eel River system from 1940-2004 occurred before 1970. Most of the natural background sediment-delivery was from landslides, which had a higher rate of delivery on public lands than on private lands. Post-1970 sediment yields are considerably lower, and natural background processes account for roughly two thirds of the sediment load on both private and public lands. One third of the total sediment load is related to human activity, primarily from roads and timber harvest. Upstream of Van Arsdale Reservoir, there are over 175 miles of trails (including about 100 miles of designated off-highway vehicle trails) and over 760 miles of road (about 3,900 road/stream crossings) that facilitate the transport of sediment to streams. Decreases in sediment yield after 1970 may reflect differences in the frequency and magnitude of storms as well as improvements in land management practices.

Much of the sediment that erodes from the most northern portion of the Upper Eel River sub-watershed is trapped in Lake Pillsbury. The lake's storage capacity decreased at least 14 % from 94,400 acre-feet in 1921 to 86,780 in 1959 and 80,700 in 1984. Loss of storage capacity in Lake Pillsbury can be used as a surrogate measure of the amount of sediment delivered to the upstream tributaries over time. Lake Pillsbury has chronic turbidity problems due to fine-grained clays that stay in suspension for extended periods. Coarse materials are trapped in the reservoir, resulting in the lack of gravel delivery to downstream areas.

2.4.4. Middle Fork Eel River HA (111.70)

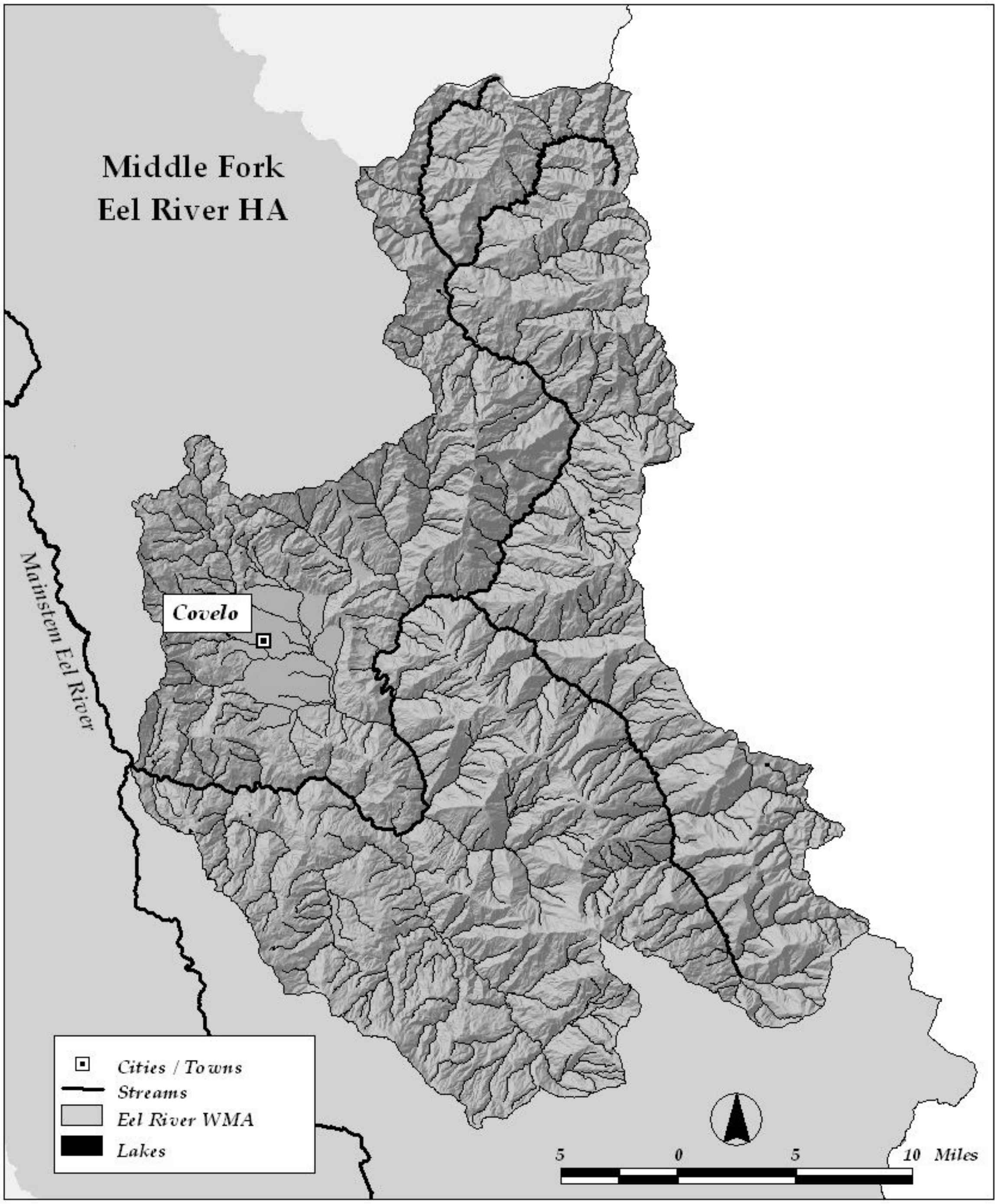


Figure 16. Map of the Middle Fork Eel River HA

The text presented within this section includes information that has been previously published by USEPA 2003 (Middle Fork Eel River Total Maximum Daily Loads for Temperature and Sediment), and references included therein.

2.4.4.1.______Overview

The Middle Fork Eel River HA encompasses 753 mi^2 in northeast Mendocino County and southern Trinity and Glenn Counties. It lies east of Highway 101, approximately 150 miles north of San Francisco, and includes the town of Covelo. The Middle Fork is the Eel River's largest tributary. It begins in the Yolla Bolly Mountains in Trinity County, is joined by Black Butte River just east of Covelo in Round Valley, and travels 70 miles to the west through some of the most rugged wilderness in the state to join the mainstem Eel River at Dos Rios. The Middle Fork sub-watershed encompasses all tributaries of the Middle Fork and Upper Middle Fork Eel, including the Black Butte watershed, and 16% of the Yolla Bolly Middle Eel wilderness. The Upper Middle Fork Eel is sometimes referred to as the Wilderness Fork. Additional tributaries are Mill, Short, Williams, Thatcher, and Elk Creeks.

About half the sub-watershed is public land (Mendocino National Forest and BLM land), 4% is owned by the Round Valley Tribe, and 45% is privately owned. Most of the 2,000 residents in the watershed live in the Round Valley area in the town of Covelo and surrounding Round Valley tribal lands.

2.4.4.2.______History and Land Use

Human activities in the Middle Fork sub-watershed have contributed to:

- Increased erosion and sedimentation.
- Direct removal of riparian vegetation.
- Secondary impacts resulting from bank erosion and decreased vegetation in the watershed.

Human activities causing a great increase in sediment contribution began with severe overgrazing by sheep and cattle in the late 1800s and early 1900s. This caused significant damage including permanent soil loss and vegetation changes. Recovery has been limited, despite the cessation of sheep grazing and reduced intensity of cattle grazing. Small-scale logging near Covelo began about 1862, and continued until after World War II, when private lands were extensively cut and burned. Timber harvest on lands of the Mendocino National Forest began in 1958. It is estimated that 46 % of the timbered land in the basin (23 % of the basin) was logged by either clear-cut or partial cut from 1950-1981. Past timber harvest practices that would not meet current standards were used on intermittent and perennial streams, resulting directly and indirectly in increased stream temperatures. Current land uses in the Middle Fork sub-watershed include light grazing and other agriculture, timber harvest, recreation, and residences.

2.4.4.3.______Climate

The Middle Fork Eel watershed is inland, away from the influence of coastal fog, and is relatively dry and warm. The mean maximum temperature in July in Covelo is in the mid 90's. Annual average rainfall is 40 inches with significantly more rainfall at the higher elevations, and most of it occurring between November and April. In the winter, there is often snow at the higher elevations. Many smaller tributaries dry up in late summer.

2.4.4.4. Fishery

Historically, the Middle Fork Eel River had populations of fall-run steelhead, which enter the watershed shortly before spawning in the fall, and summer steelhead and spring Chinook, which enter the watershed in the spring and summer, waiting until fall to spawn. Fall steelhead were found spawning in most of the Middle Fork Eel River tributaries in the 1960s, and in 1963 CDFG estimated the annual spawning population in the Middle Fork watershed at 23,000 individuals though they did not distinguish between the summer and fall runs. In the 1980s steelhead appeared to avoid downstream sites that were open and had high water temperatures, but they were abundant in cool, well-shaded sites in the upper reaches of the sub-basin. Compared to historical levels, fall steelhead distribution appears to have been stable for the last few decades.

The Wilderness/Upper Middle Fork Eel River is home to one of the few populations of summer steelhead in California; however, the current population is much smaller than historical estimates. Prior to 1955, the mainstem Middle Fork Eel provided summer habitat for summer steelhead, and before the 1964 flood there were thought to be 3,500 adult summer steelhead. Following the 1955 and 1964 floods, summer steelhead were confined to the uppermost reaches of the mainstem and cool tributary streams or well-shaded streams. Since 1966, the greatest estimated population was 1601 fish and in the period 1998-2007 the estimated population has ranged from 306-771 individuals.

Spring Chinook in the Middle Fork Eel River have also experienced declines. They spawned in the lower Middle Fork Eel and at least as far upstream as the confluence of the Black Butte River, and in the lower reaches of Mill, Short, Williams and Elk Creeks. There are anecdotal reports of thousands of Chinook in these tributaries in the first half of the 1900s. Prior to 1955, spring Chinook and summer steelhead inhabited the mainstem Middle Fork Eel, but following the 1955 and 1964 floods the spring Chinook were extirpated. The streams around Round Valley may have had 5,000 Chinook migrants in the early 1960s, and in 1963, CDFG estimated the annual spawning population in the Middle Fork watershed at 13,000 individuals. In 1998, however, Chinook populations were estimated at only 40 adults in Elk Creek, 20 in Thatcher Creek, 40 in Mill Creek, and 20 in Williams Creek. Similarly, only small populations (~100 adults) were thought to exist in the Black Butte and Wilderness/Upper Middle Fork watersheds in 1998.

In 1996-1998 and 2002, stream temperatures in the Middle Fork Eel River and tributaries were generally marginal (>17°C) to inadequate (>19°C) for summer rearing salmonids, although a few tributaries had good (<15°C) or adequate (<17°C) conditions. Temperatures in much of the length of the exposed main channels are close to lethal during the hottest part of the summer, when young salmonids are growing before migrating to the ocean and are most sensitive to increased temperatures. Current main channel temperatures are not different from those measured in the 1960s and 1970s, but less thermal refugia may be available today, limiting the opportunities for salmonids to escape high temperatures.

The 1964 flood caused large morphological changes to stream channels and may be the primary cause of today's higher sedimentation rates and stream temperatures. Although the rainfall that caused the flood was natural, its effects were exacerbated by management activities in the basin. After the flood, the area used by summer steelhead on the Wilderness/Upper Middle Fork Eel River was filled with 3-12 meters (10-40 feet) of rock, gravel, and sand. Pools previously used by summer steelhead were almost entirely obliterated. This area began to recover as early as the 1970s and much of it had recovered by 2003. In the Black Butte River, sediments have fluctuated but there has been net aggradation since 1964. Recovery from the 1964 flood has not been complete; channels show wider gravel bars, more meandering due to less channel gradient, and less riparian vegetation than in 1961.

2.4.4.5. Sedimentation

The majority of sediment production in the Middle Fork sub-watershed is natural and mostly from landslides. Over 4,000 landslides occurred from 1940-2000, with 77% of the number and 81% of the volume occurring prior to 1969. Most of the sediment probably was generated from the 1964 flood, which is known to have caused significant changes in the watershed. Sediment production from human disturbance in the basin is associated mostly with cattle grazing and road networks. The recent (1985-2002) annual sediment production rate for the Middle Fork sub-watershed is 656 t mi-2 yr-1 (88% natural, 12%management-related). Overall, the basin is less disturbed by anthropogenic sediment than most other watersheds in the North Coast region, probably because there is little land management activity in the basin.

2.4.5. North Fork Eel River HA (111.50)

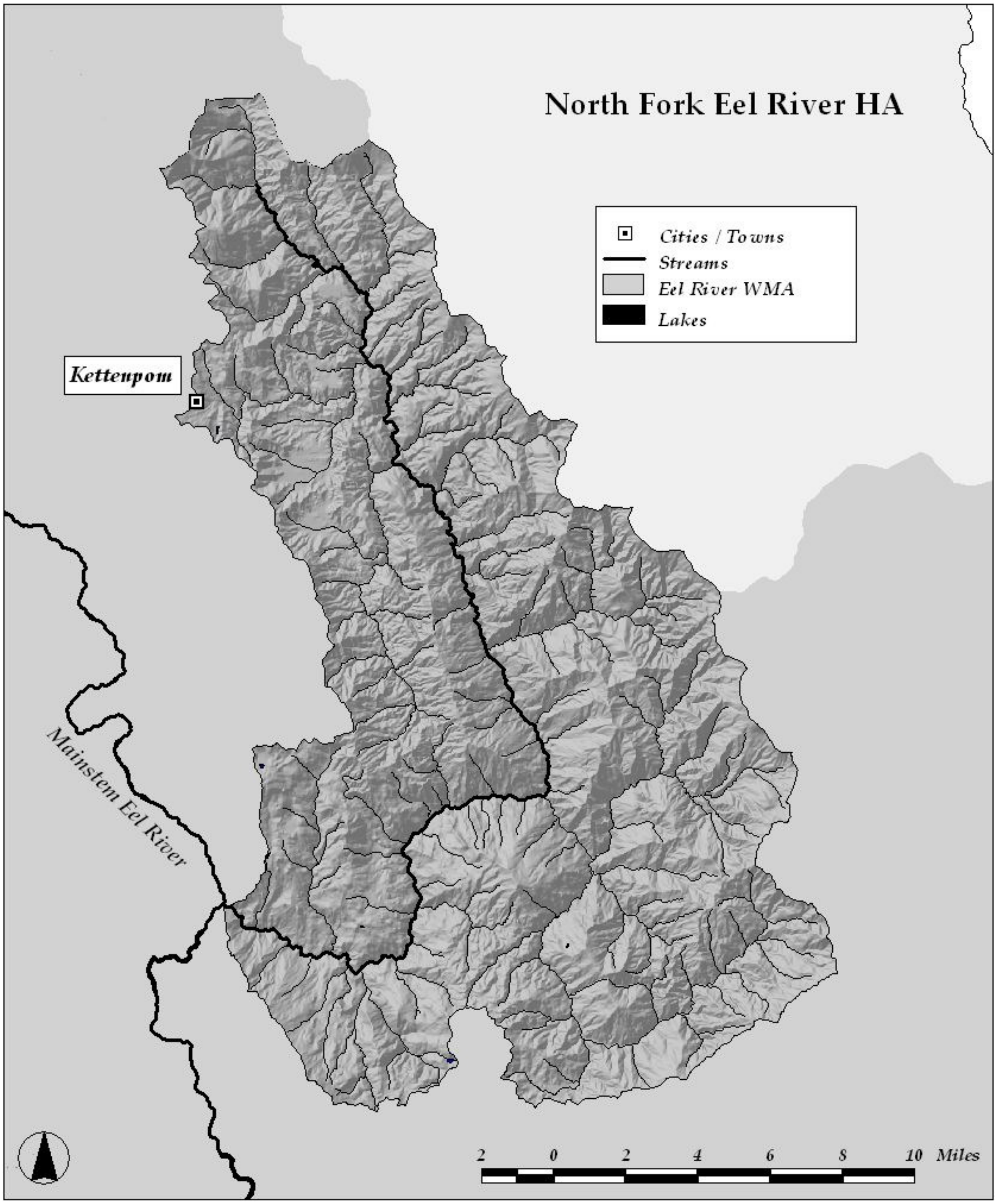


Figure 17. Map of the North Fork Eel River HA

The text presented within this section includes information that has been previously published by Fuller, et. al. 1996 (North Fork Eel River Watershed Analysis), USEPA 2002 (North Fork Eel River Total Maximum Daily Loads for Sediment and Temperature), and references included therein.

2.4.5.1. Overview

The North Fork Eel River HA covers 289 mi^2 in northeast Mendocino County and southern Trinity County and is the smallest of the Eel River sub-basins. The North Fork is about 35 river miles in length. Half of the North Fork sub-basin is owned by USFS and BLM and the other half is owned by the State, Tribes, or private parties. Elevations range from 600 feet at the mouth of the river to 5,900 feet in the Yolla Bolly Wilderness.

2.4.5.2. History and Land Use

Large numbers of sheep, possibly as many as 60,000, grazed in the North Fork Eel River sub-watershed between 1860 and 1900, and cattle have grazed the watershed since the 1900s. Historically, livestock impacts on riparian vegetation decreased stream channel shading and may have impeded re-growth after storm events removed vegetation, thereby opening the channel to more solar radiation and increasing water temperature. Stream bank trampling increased sedimentation and decreased bank stability. Large amounts of animal waste caused an increase in nutrients to the stream system, which, along with warm water temperatures, increased algal growth and resulted in oxygen depletion.

Current land uses in the North Fork sub-basin include grazing, timber harvest, recreation, and scattered residences. Grazing pressure is much less than it was historically. There are few paved roads, with only 1.7 mi/mi^2 on public lands. Timber harvest on public lands was relatively light prior to 1964, and logging peaked on USFS lands during the 1970s when approximately 1200 acres were clear-cut. Today, much of the public land is protected and there has been relatively little disturbance in the last few decades. However, the degree of disturbance on privately owned land is not known.

2.4.5.3. Vegetation

The North Fork Eel River sub-watershed contains forested areas, oak woodlands, oak savannahs and grasslands. There are many conifer and hardwood forests consisting of mixed hardwood-conifer stands, Douglas-fir, Klamath mixed conifer, white fir, and pines, including ponderosa pine, Jeffrey pine, and closed cone pine, and cypress. The hardwoods are white oak and black oak. Herbaceous plants, which include annual grasses, cover three percent of the area. Other plant communities in this watershed include chaparral, live oak, gray pine, and western juniper.

2.4.5.4. Climate

The North Fork Eel watershed is inland, away from the influence of coastal fog, and is relatively dry and warm. Annual average rainfall is 50 inches, and most of it occurs between November and April. In the winter, there is often snow in the higher elevations. Many smaller tributaries dry up in late summer, and the mainstem North Fork is intermittently dry in some summers.

2.4.5.5. Fishery

The native fish assemblage of the North Fork Eel River is comprised of Chinook salmon, steelhead and rainbow trout, Sacramento sucker, and Pacific lamprey. There is no indication that there were native stocks of coho salmon in the North Fork, and none are currently present. While there are little quantitative data on salmon populations in the North Fork, it is generally accepted that populations have declined since the 1940s. Steelhead are found throughout the sub-basin today and Chinook are found in the lower five miles below Split Rock, a possible natural fish passage barrier under low flow conditions. California roach (an introduced species) is quite common in the North Fork mainstem.

The most sensitive period for salmonids is the summer when young salmon are growing before migrating to the ocean. Summer stream temperatures in the mainstem from 1996-1998 and 2001 were very high (>19°C) and almost lethal (>24°C) for rearing steelhead. The North Fork Eel does not have discharges of water from industries, large water diversions, agricultural return flows, nor dams. Changes in riparian vegetation and increases in stream width have decreased shade and increased solar radiation, leading to increased water temperatures. There is evidence of thermal refugia produced by intra-gravel flow, pools, springs, or groundwater seeps, as juvenile steelhead are often only found in pools in the North Fork in the summer. The tributaries of the North Fork Eel provide better habitat with regard to temperature. Good summer stream temperatures (<15°C) were measured at several locations.

2.4.5.6. Topography and Geology

The landscape of the North Fork Eel River sub-watershed consists of an older, subdued upland terrain that has been well-dissected by steep river canyons. Inner gorges are moderately well-developed in the middle and lower canyon sections. The basin is underlain by three main types of Franciscan rocks. Competent greywacke typically forms sharp ridges and steep, eroding hillslopes with shallow to moderately deep, poorly developed soils. Less competent greywacke forms deeply weathered in-place soils and inter-bedded sandstone/shale that typically form moderately-steep, forested slopes and deep, gravelly loam to clay loam soils with good drainage and good water-holding capacity.

Mélange areas typically have hummocky topography related to chronic instability; soils are mostly deep with somewhat restricted drainage. Minor bedrock types include chert and metavolcanic rocks that generally form small, elongate, resistant outcrops, and ultramafic rocks and associated soils that occur principally around Red Mountain where they support distinctive vegetation and form slopes that are commonly subject to mass wasting. The North Fork sub-watershed has a high rate of mass wasting and erosion because of rapid uplift and the abundance of unstable geologic material. Large deep-seated slides are not common but shallow slides are common, especially on south-facing slopes, perhaps because of the sparser vegetation. Most recent landslides appear to be in canyons away from roads and cutblocks.

2.4.5.7.______Sedimentation

Much sediment was deposited throughout the North Fork Eel River in the 1964 flood, but many areas have since recovered. Approximately 30% of the current sediment load is related to human activity and occurs in the form of road- and timber harvest-related land slides. Large amounts of sediment are currently stored in the mainstem and major tributaries. Aggradation of sediments, especially in parts of the mainstem channel, has reduced spawning and rearing habitat, decreased aquatic invertebrate production, and increased water temperatures. There is evidence of recent downcutting through this material in many places. Geologically rapid stream incision in much of the watershed has resulted in relatively narrow riparian zones. Also, there is very little perennial flow in most headwater streams, which limits the extent of riparian vegetation.

2.4.6._______Middle Main Eel River HA (111.40)

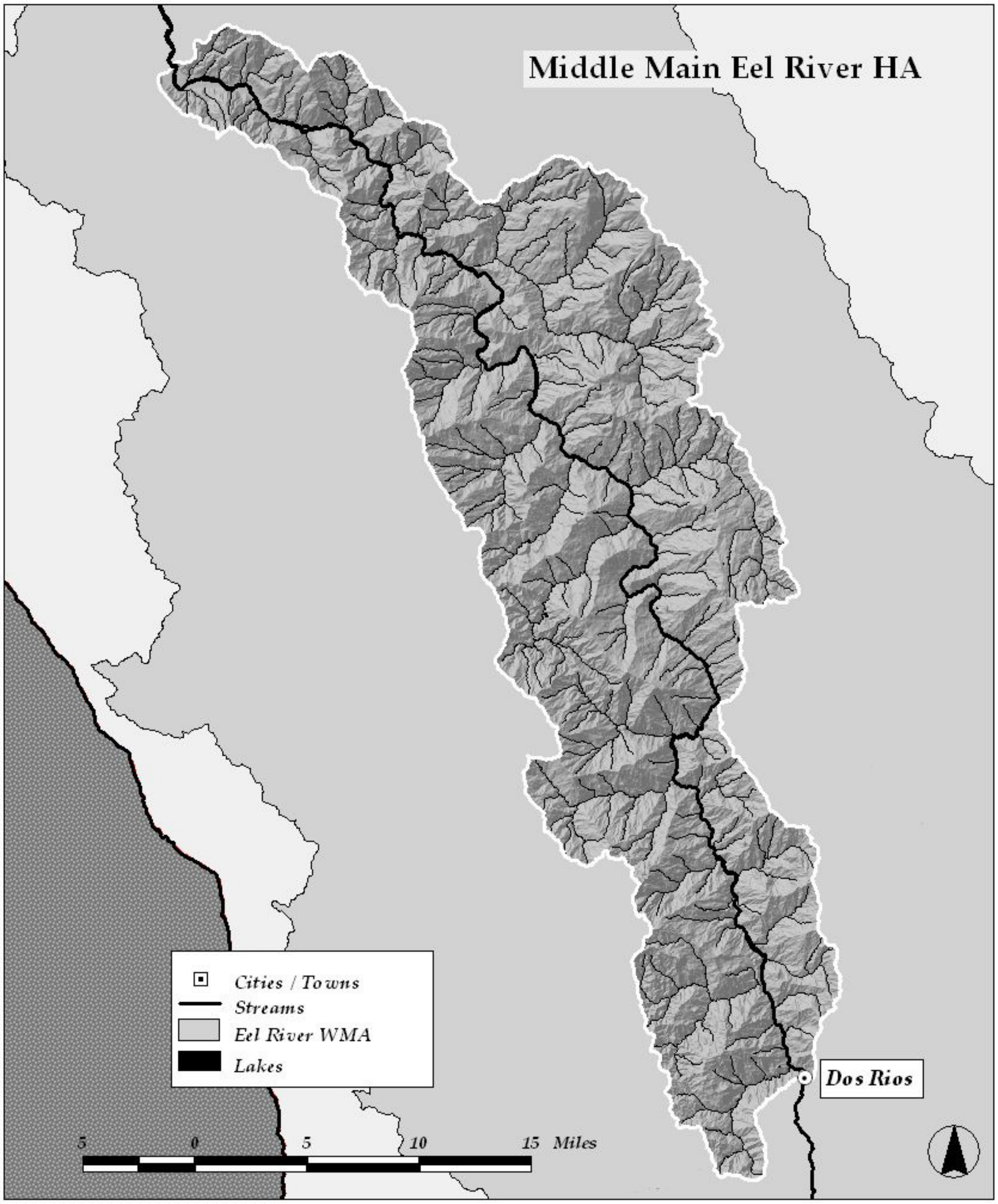


Figure 18. Map of the Middle Main Eel River HA

The text presented within this section includes information that has been previously published by USEPA (Middle Main Eel River and Tributaries [from Dos Rios to the South Fork] Total Maximum Daily Loads for Temperature and Sediment), and references included therein.

2.4.6.1. Overview

The Middle Main Eel River HA covers 521 mi^2 in Mendocino, Trinity, and Humboldt Counties in northwestern California. It lies east of Highway 101, approximately 150 miles north northwest of San Francisco, and includes the towns of Alderpoint and Fort Seward. The Middle Main Eel River HA is defined as the area from Dos Rios to where the Eel River meets the South Fork, and includes all of the smaller tributaries. The reach of river is also often referred to as the lower Eel River or the main Eel River. All but the very downstream portion of the watershed is inland, away from the influence of coastal fog, and is relatively dry and warm.

The Middle Eel River sub-watershed is rural and remote, and much of the land is privately owned. This portion of the river is inaccessible for most of its length. Public roads cross near Dos Rios and Alderpoint, which are 65 river miles apart, but not in between. The land use consists primarily of large ranches and dispersed rural residences and some industrial timber production.

2.4.6.2. Vegetation

Sixty percent of the natural vegetation area is shrub, grassland, and oak woodlands. Conifers dominate only 14% of the landscape, mostly near the coast downstream of Eel Rock, while the rest is mixed conifer and hardwood. The topography of the Middle Eel River sub-basin is steep. The area's geology is underlain by the Franciscan Group that dominates most of California's North Coast. Naturally unstable and prone to landslides, this terrane is sensitive to human disturbance.

2.4.6.3. Fishery

Salmonids are rarely found in the Middle Main Eel River except near cool springs; they are more likely to be found in tributaries. Historically, coho salmon did not reside in the Middle Main Eel but did use scattered, isolated creeks year-round. They also used the Middle Main Eel as part of their migration route to spawning and rearing tributaries further upstream. Coho populations have declined from historical levels and are presently only known to rear in Thompson and Kapple creeks downstream of McCann.

Chinook salmon find valuable habitat in the Middle Main Eel. They are thought to use as much as 123 stream miles. Steelhead trout find critical habitat in 157 miles of the Middle Main Eel River HSA. Juvenile steelhead are not commonly found in the Middle Main Eel but are widely distributed in the tributaries, though isolated groups may exist in the mainstem near cool water tributaries or seeps. California roach and Sacramento suckers are common in the Middle Eel River.

Stream temperatures in many parts of the Middle Main Eel sub-watershed are stressful to lethal to juvenile salmonids. Data from 1996-2003 and 2005 show temperatures >26°C in the main channel, which may kill steelhead within hours. Temperature conditions in the tributaries ranged from good to stressful. Temperatures were highest at the mouths of tributaries and decreased with distance upstream.

2.4.6.4. Sedimentation

Currently, erosion and sediment delivery to streams result from a combination of natural factors combined with human disturbance, such as roads, grazing, and timber harvest. Natural landslides are the dominant erosional process in the Middle Eel River watershed and account for 68% of the total annual sediment production (753 t mi^{-2} yr^{-1}) in the 65 year period from 1940-2005. Human activity contributes 32% of the sediment input, mostly in the form of landslides as well. Considerably less natural and human related sediment has been produced after 1970 than before, probably due to differences in the frequency and magnitude of storms that trigger widespread landslides, road failures, and washouts, and improvements in land management practices.

Along the Middle Main Eel River, the flood of 1964 resulted in large-scale destruction of the Pacific Northwestern Railroad, which parallels the main channel of the river for miles. The railroad sustained significant damage from erosion, landslides, and flooding. North of Alderpoint the tracks were covered with as much as 10-12 feet of sediment, and at McCann huge mudslides wiped out and covered tracks and houses.

2.4.7. South Fork Eel River HA (111.30)

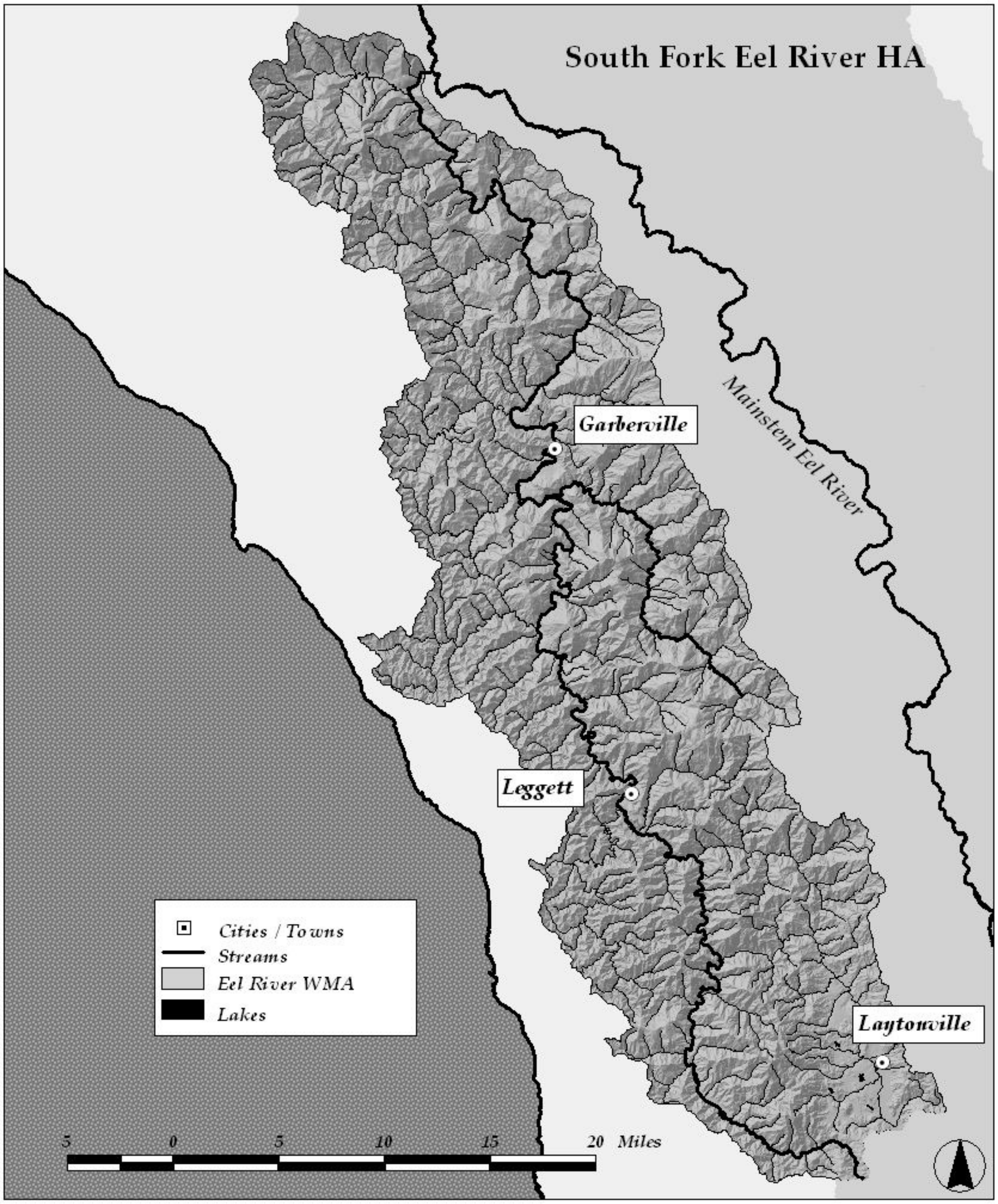


Figure 19. Map of the South Fork Eel River HA

The text presented within this section includes information that has been previously published by USEPA 1999 (South Fork Eel River Total Maximum Daily Loads for Sediment and Temperature), and references included therein.

2.4.7.1.______Overview

The South Fork Eel River HA in northern Mendocino and southern Humboldt Counties covers 688 mi^2 and ranges from 100 to 4,500 feet in elevation. It is the second largest sub-basin in the Eel River watershed and stretches approximately 58 miles from the Laytonville area in Mendocino County up US Highway 101 through Humboldt Redwoods State Park and the famed Avenue of the Giants in Humboldt County. The South Fork flows northward for nearly 100 river miles, joining the mainstem Eel River near Weott, about 40 river miles from the Pacific Ocean. As the closest sub-basin to the coast, the South Fork has the most coastal influence.

About 81 % of the South Fork sub-watershed is under private ownership and is used for intensive timber harvesting, livestock grazing, and dispersed rural development. Large timber companies own a relatively small percent of the watershed compared with many other North Coast watersheds; timber company holdings are concentrated west of Highway 101. State lands make up about 12 % of the South Fork Eel River watershed and mostly lie within Humboldt Redwoods State Park. BLM land makes up the remaining seven percent of the watershed.

2.4.7.2.______History and Land Use

Land management practices, including timber harvesting, road building, and rural development, in combination with the flood events in 1955 and 1964, have exacerbated the high natural erosion rates and resulted in considerable sediment loads. While the South Fork Eel River carries proportionally less sediment than other tributaries, the levels are still substantial. In sections of the main channel of the South Fork, local and upstream sediment inputs have led to increases in streambed elevation of 1.6-11 feet from 1968 to 1998. In tributaries of the South Fork, sedimentation has buried several bridges under more than 30 feet of sediment and widened the channel from 10s to 100s of feet. Increases in stream width and loss of riparian vegetation have increased solar radiation leading to increased stream temperatures. Consequently, many locations in the South Fork Eel River have summer stream temperatures that exceed the tolerances of salmonids.

2.4.7.3.______Fishery

The South Fork Eel River historically was one of the most productive sub-basins in the Eel River watershed for anadromous fish and may have supported about half of the total coho run for the State of California before the 1900s. Salmon abundance in the Eel River just below Garberville at Benbow Dam averaged 20,000 Chinook salmon and 15,000 coho salmon annually in the 1940s. By 1975 coho stocks had declined by 88% to about 1,800 adults annually. Currently, about 1,000 adult coho salmon return annually to the South Fork Eel River. While greatly reduced from historical levels, this population is significant, particularly because it is one of the last remaining coho salmon populations in California that consists of mostly wild stock with little hatchery influence.

Other anadromous fish species found in the South Fork Eel River include steelhead and coastal cutthroat trout, chum salmon, green sturgeon, Pacific lamprey, and American shad. The west side of the watershed has better habitat for salmonids than the east side because the tributaries are larger, and the surrounding slope vegetation provides more canopy and allows less direct afternoon sun exposure.

2.4.7.4. Topography and Geology

The geology of the South Fork sub-watershed is naturally unstable and contributes to high natural sedimentation rates. The watershed is underlain by three types of geological formation. The Yager and coastal belt Franciscan terranes are characterized by moderate to steep slopes and forested hillsides with straight profiles. The vegetation in these areas is dense stands of redwood and fir. Franciscan mélange underlies parts of the eastern portion of the basin and has little, if any, associated timber production; the area primarily consists of rolling hills with open grasslands and oak woodland.

2.4.8. Van Duzen River HA (111.20)

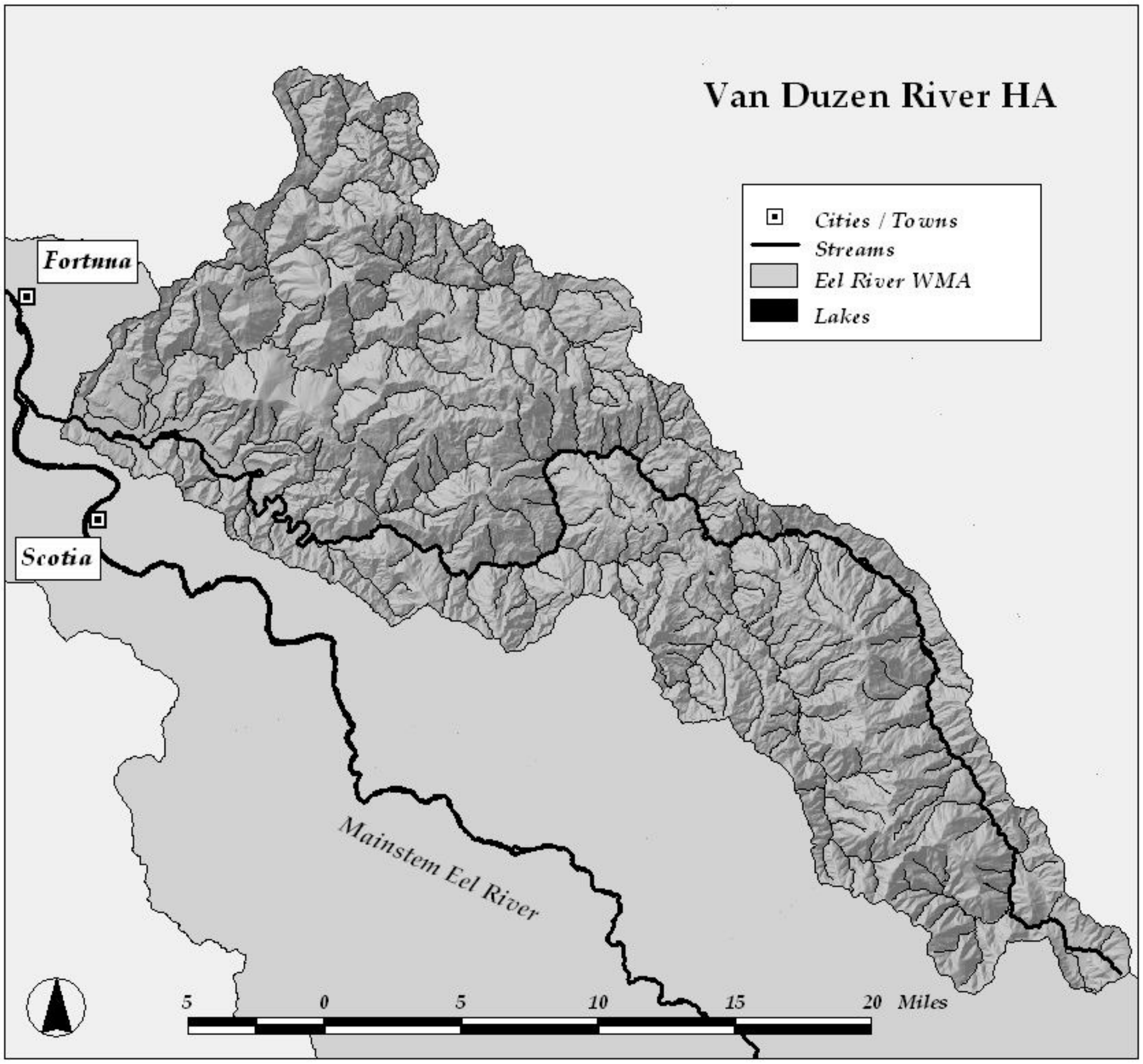


Figure 20. Map of the Van Duzen River HA

> *The text presented within this section includes information that has been previously published by USEPA 1999 (Van Duzen River and Yager Creek Total Maximum Daily Load for Sediment), and references included therein.*

2.4.8.1. Overview

The Van Duzen River HA is 429 mi^2 in California's North Coast Range, southeast of the City of Eureka. The Van Duzen River begins in the northern end of the Hettenshaw Valley and enters the mainstem Eel River just south of Fortuna in Humboldt County. The Van Duzen River is 73.5 miles long and one of the few remaining free flowing rivers in California. Elevations range from 62 feet at its confluence with the Eel River to 5,906 feet at its headwaters at Red Lassic peak. The primary population centers in the watershed include the towns of Hydesville, Carlotta, Bridgeville, and Dinsmore.

Seventeen percent of the watershed is public land managed by USFS, BLM, and State and County Parks; 26% is used for industrial timber production, 31% for non-industrial ranching and timber production, and 26% for rural residential. Industrial timber production is concentrated primarily in the lower basin. Farming, gravel mining, recreation, and residential use also occur in the lower basin; sand and gravel mining do not appear to contribute significantly to sedimentation in the lower basin. Ranching, livestock grazing, and some silviculture occur in the middle basin. The Six Rivers National Forest is located in the upper basin, where the USFS is the largest land manager.

2.4.8.2. History and Land Use

Timber harvesting began in the lower basin redwood zone in the late 1800s and then intensified in the late 1940s, as technology and the demand for lumber increased following WWII. Portions of the lower basin were heavily harvested in the 1990s. In the upper basin, post WWII timber harvesting and road building on USFS land are the most intensive management actions. Timber harvesting of Douglas-fir in the Six Rivers National Forest started in 1960, but harvesting on private lands began much earlier. No logging or road building had occurred in the headwaters of the basin at the time of the 1964 flood. USFS managed most of the upper basin for timber production until the early 1990s.

2.4.8.3. Vegetation

There are three major vegetation zones within the watershed, including redwood forest, oak woodland/prairie, and coniferous forest.

The lower basin harbors Redwood forests, particularly at lower elevations that are influenced by summer fog. Most of the redwood forest is managed for industrial timber production, although a few old growth groves are preserved in Grizzly Creek State Park and Humboldt County Park. The drier upper slopes and ridges of the redwood zone are characterized by Douglas fir and tanoak forests.

The middle basin is primarily grassland and oak woodland including tanoak, madrone, and California black oak, as well as mixed conifer forest. The grasslands have historically been used for sheep grazing and are now used primarily for beef cattle grazing.

The upper basin is characterized by coniferous forests composed of Douglas fir, Jeffrey pine, ponderosa pine, incense cedar and white fir. The coniferous forest is mostly managed by the USFS for multiple-use objectives.

2.4.8.4. Climate

Coastal fog in the lower basin provides cooler temperatures in the summer while the middle and upper basins are warmer and drier. Precipitation throughout the Van Duzen

River basin ranges from 50-100 inches yr-1 and most of it occurs between October and April. Some precipitation occurs as snowfall. Two to six intense rainstorms typically occur each winter, causing widespread flooding and modification of stream channel morphology. The largest recorded floods occurred in 1861, 1955, and 1964.

2.4.8.5.______Fishery

Coho salmon, Chinook salmon and steelhead trout live in the Van Duzen River watershed. There is little quantitative information regarding historical anadromous and resident fish populations in the Van Duzen River watershed. Anecdotal reports indicate that salmonids were more abundant in the late 1800s-early 1900s than the late 1900s, with the most serious declines following the 1955 and 1964 floods. In 1965, CDFG estimated that there were 2,500 Chinook and 500 coho adult salmon in the annual Van Duzen River runs. The summer steelhead run is probably less than 100 fish.

Today, coho, Chinook, and steelhead are found in the lower basin, where stream gradients and aquatic habitat conditions, such as riparian vegetation and temperatures, are naturally capable of supporting a relatively higher diversity and abundance of anadromous fish than the rest of the basin. Chinook and steelhead are present in the middle basin, where channel gradients are generally steeper and more confined than in the lower basin. Chinook salmon are able to utilize portions of lower North Fork and South Fork Yager Creek as well as the mainstem Van Duzen River as far as “Salmon Hole”. Juvenile Chinook salmon generally leave the river by June of the year they hatch, which makes them less vulnerable to summer habitat conditions. Winter run steelhead are more widely distributed and populations are more viable; there may be as many as 10,000 winter steelhead. Steelhead are in the upper basin; steelhead are able to migrate throughout areas of the South Fork, while the upper mainstem supports resident trout.

Other resident native fish species in the watershed include rainbow trout, pacific lamprey, West Coast three-spined stickleback, Sacramento sucker, Coast Range sculpin, prickly sculpin, and Coastal cutthroat trout. Introduced species in the watershed include California roach, speckled dace, and Sacramento pike minnow. Western roach and Sacramento pike minnow appear to thrive in the aggraded channel conditions and warmer stream temperatures that have persisted since the 1964 flood. Their presence in much of the lower mainstem Van Duzen River and some lower gradient tributaries may be causing mortality to juvenile salmonids and forcing them to use less suitable habitat.

2.8.4.6.______Topography and Geology

The Van Duzen River basin is approximately 50 miles from the Mendocino Triple Junction where the American, Pacific, and Gorda tectonic plates come together near Cape Mendocino. This is one of the most erodible watersheds in the United States due to relatively weak bedrock units that are easily eroded and subject to mass wasting, high uplift rates in this tectonically active setting, and significant rainfall.

There is a high incidence of landsliding adjacent to stream channels, including large slump-earthflows and extensive zones of debris sliding. In the upper basin the contribution to total historical sediment loads from natural sources were approximately 80%, in the middle basin 84% and in the lower basin 64%. Overall, 77% of the historical sediment load in the Van Duzen River watershed is attributable to natural sources.

2.8.4.7. Sedimentation

The 1964 storm mobilized huge quantities of sediment that had significant and lasting effects on stream channel morphology throughout the Van Duzen River watershed. Widespread debris landsliding in the headwater drainages of the upper basin resulted in substantial aggradation and destroyed riparian vegetation in upper channel reaches of the South and West Forks. Up to 15 feet of sediment was deposited in the upper reaches; much sediment moved downstream, and several feet of sediment was deposited in some stream reaches. Aggradation continued after 1964 due to a continued supply of sediment from aggraded reaches upstream. During the 30 year period from 1968-1998, stream reaches in the lower basin aggraded an additional 2-3 feet. It is estimated that 49% more sediment entered the Van Duzen River basin during 1941-1975 than would have without the 1964 storm, and that no channel aggradation would have occurred without the 1964 storm.

The annual suspended sediment load from 1941-1975 varied two orders of magnitude from 270-26,600 t mi-2 yr-1 with an average of 6,700 t mi-2 yr-1 and a typical range of 2,500 to 9,000 t mi-2 yr-1. Large inputs of sediment, such as those that occurred during the 1964 flood and in other years with high rainfall, have degraded salmonid habitat. Erosion, sedimentation, and aggradation have resulted in the filling of formerly incised channels, channel widening, loss of riparian vegetation and thus loss of LWD, increased bank erosion, loss of deep pools and consequent increased water temperatures. All these changes degrade the quality of the fish habitat.

Sedimentation has decreased the quality and quantity of pools and spawning gravels for salmon and steelhead, particularly in tributaries to the lower basin and the South Fork Van Duzen River. Embeddedness of gravels has been scored at 40-83%; embeddedness < 25% is optimal. Aggradation of coarse material in the lower reaches of the mainstem impedes the migration of anadromous fish to and from spawning sites and reduces channel complexity necessary for rearing. Fish passage problems in the lower mainstem have been observed, particularly during low-flow years in the early 1990s. In the middle basin, recent stream incision in alluvial reaches indicates recovery from earlier influxes of sediment, but sedimentation is still a problem in tributaries to the middle mainstem Van Duzen River. Some stream reaches in the middle basin such as Butte Creek, tributary to South Fork Van Duzen River, presently have relatively suitable habitat, especially for steelhead.

2.4.9. Water Quality Issues in the Eel River WMA

Salmonids in the Eel River WMA are threatened by many factors including sedimentation and elevated stream temperatures. Many stream channels were greatly damaged during the 1964 flood. Streams filled with sediment, channels widened, and many areas lost riparian vegetation. Physical barriers to fish migration limit their habitat as well. In addition, the invasive predatory pikeminnow, *Ptychocheilus grandis*, found throughout the watershed, may negatively impact salmonid populations by preying on juvenile fish.

The watershed is located in steep forested terrain with highly erosive soils and high rainfall. These factors, in combination with timber harvest and associated roads and other land use activities have led to high erosion and sediment delivery rates. Sediment fills in deep pools, making thermal refugia unavailable. Water diversion for the PVP may also be hurting the Eel River cold-water fishery. Overall, salmonid habitat is limited by surface flow, the number and depth of pools, elevated water temperatures, increased sedimentation, low DO, lack of LWD, and lack of rearing habitat.

Water quality issues other than sediment and temperature include ground water contamination, dairies in the delta area near the ocean, and localized contamination of surface and ground waters. These issues vary among different parts of the watershed.

- Based on mercury bioaccumulation in warm water fish in Lake Pillsbury the lake was placed on the 303(d) list of impaired waterbodies for mercury.
- Sedimentation is a problem and storage capacity of Lake Pillsbury is decreasing over time due to silt and sediment from the upper reaches of the watershed.

In the Van Duzen River watershed, certain land-use activities, particularly road construction and maintenance and intensive timber management in sensitive watershed areas, have accelerated sediment delivery. Intensive management activities continue to threaten critical spawning and rearing habitat in lower basin tributaries. There is a lumber mill operated by Louisiana Pacific at Van Arsdale where a cleanup is partially complete, but dioxin and furans are still detected in the mainstem of the river.

The primary water quality issues in the Eel River WMA are:

- Sedimentation of streams
- Salmonid habitat degradation
- High water temperatures
- Ground water contamination

The cold water fishery is the most sensitive of beneficial uses in the watershed. Consequently, protection of these beneficial uses is presumed to protect any of the other beneficial uses that might also be harmed by sedimentation or increased temperature.

2.5.________North Coast Rivers WMA

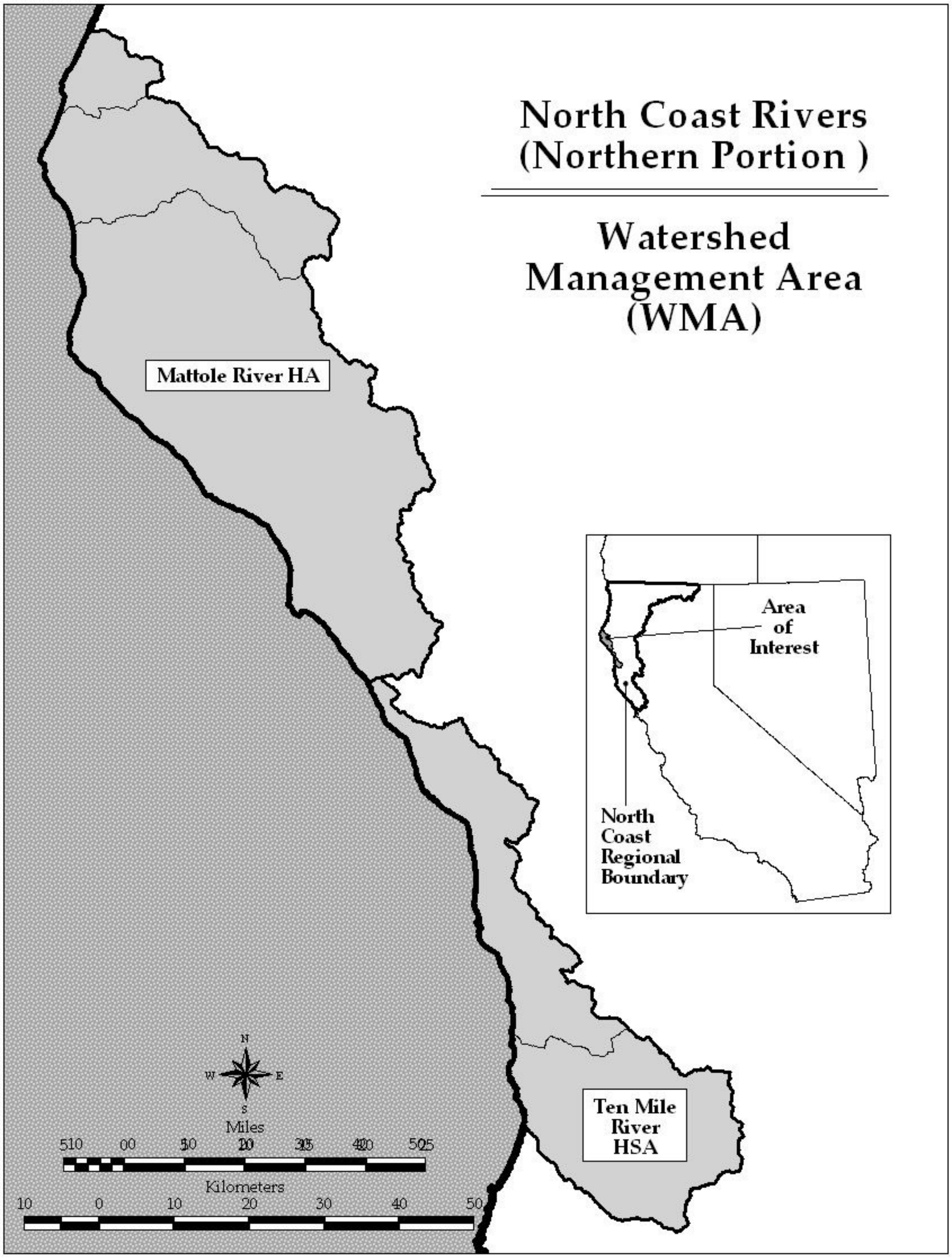


Figure 21. Hydrologic Areas of the North Coast Rivers WMA – Northern Portion

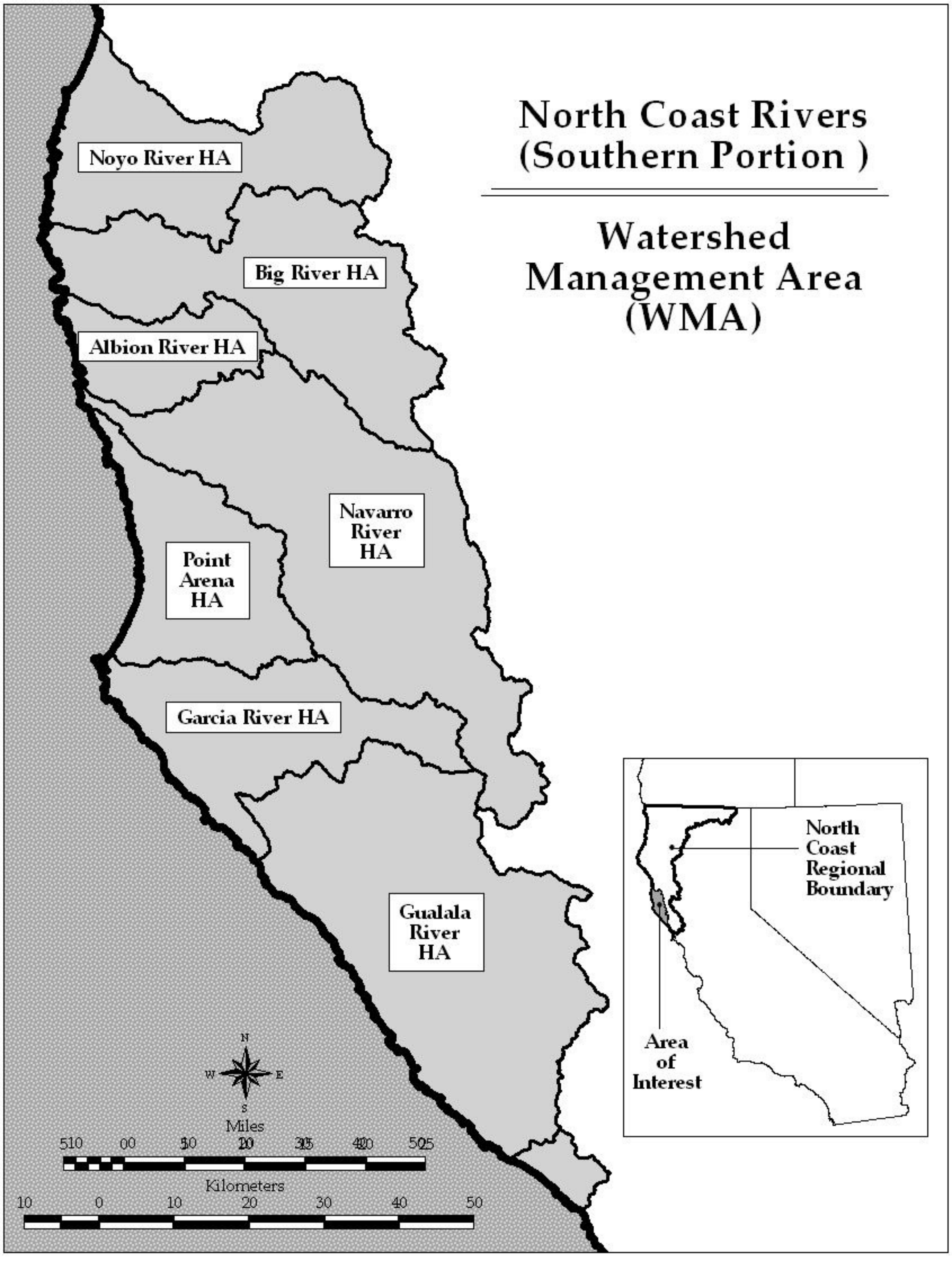


Figure 22. Hydrologic Areas of the North Coast Rivers WMA – Northern Portion

2.5.1._______Overview

This management area includes North Coast rivers not specifically included in other WMAs. The major watersheds from the Oregon border south include:

- Smith River
- Mattole River
- Ten Mile River
- Noyo River
- Big River
- Albion River
- Navarro River
- Garcia River
- Gualala River

Coho salmon (Oncorhynchus kisutch) are a federally listed threatened species in all of the rivers in the North Coast WMA. Coho are state listed endangered species in all rivers in this WMA except the Smith, Bear, and Mattole Rivers. Chinook salmon (O. tshawytscha) and steelhead trout (O. mykiss) are federally listed threatened species in all except the Smith River.

Approximately 25% of the timber harvest in the NCR occurs in Mendocino County, which comprises the majority of the North Coast WMA. Thus, the NCRWQCB is largely concerned with water quality issues tied to logging, such as erosion and sedimentation, and other nonpoint source pollution. Timber harvest plans are inspected to assure compliance with Basin Plan standards, implementation of the Forest Practice Rules and best management practices to ensure protection of water quality and beneficial uses. The primary water quality issues associated with timber harvesting activities are recovery of threatened and endangered species of coho, Chinook, and steelhead. There are also potential impacts of timber harvesting on the water supply for the coastal communities of Elk, Gualala, and Fort Bragg.

The following waterbodies are listed as impaired on the 303(d) list:

- Mattole River (sediment and temperature)
- Ten Mile River (sediment and temperature)
- Big River (sediment and temperature)
- Albion River (sediment)
- Navarro River (sediment and temperature)
- Garcia River (sediment and temperature)
- Gualala River (sediment and temperature)

2.5.2. Smith River HU (103.00)

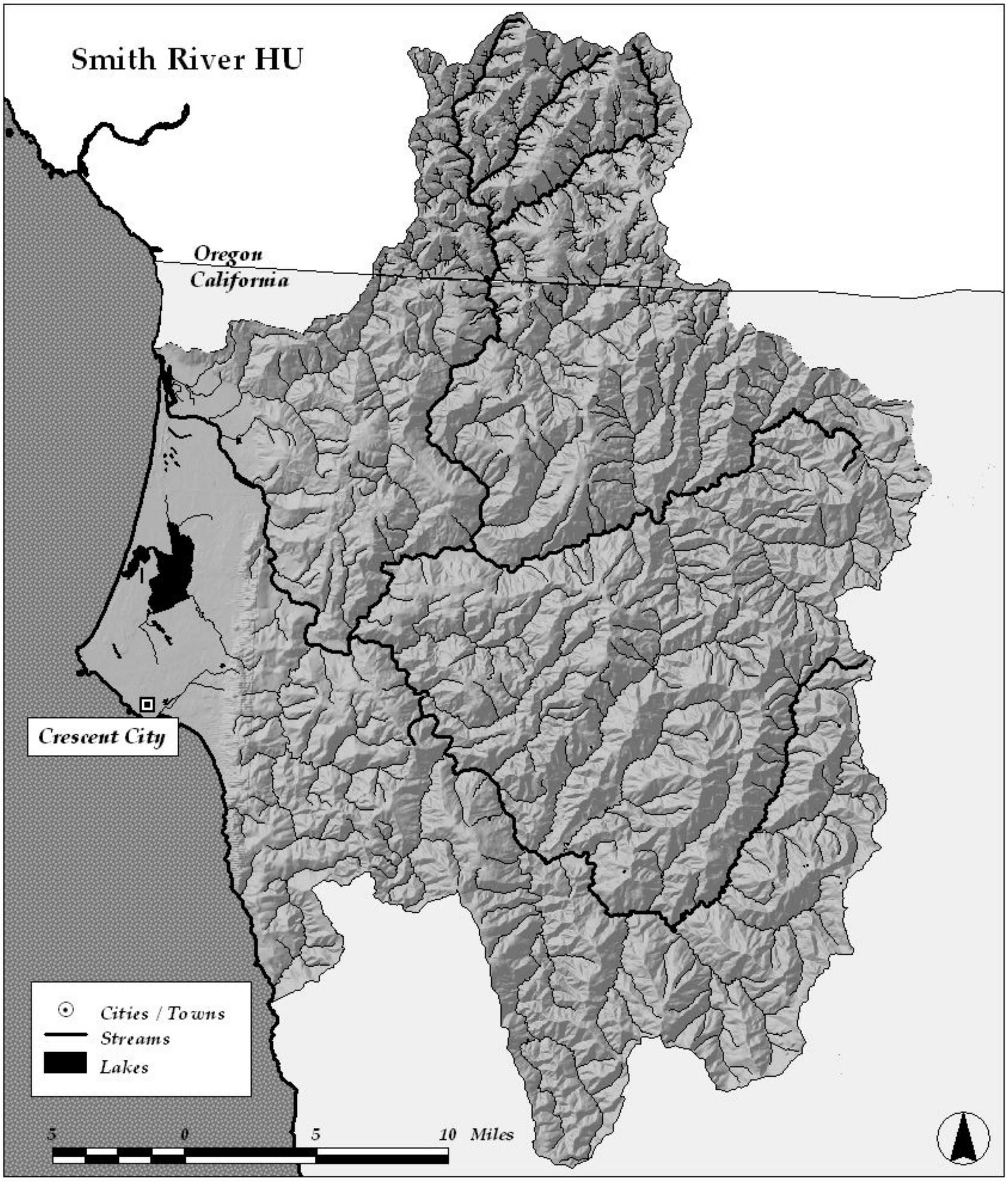


Figure 23. Map of the Smith River HU

The text presented within this section includes information was synthesized from http://www.savetheredwoods.org/protecting/pdf/mp_b_smith.pdf (2006), and http://www.shastacascade.org/forest/sixriver/smithr.htm (2006).

2.5.2.1.______Overview

The Smith River HU drains an area of approximately 703 mi^2 in Del Norte County. This hydrologic area includes the Smith River watershed and the coastal Wilson Creek watershed. The Smith River watershed is a 696 mi^2 basin that reaches the reaches the Pacific Ocean north of Crescent City, approximately 4 miles south of the California-Oregon border. It originates in Oregon and is bounded by Oregon's Rogue River watershed to the north and the Klamath River watershed to the east and south. The Smith River is one of the most "pristine" rivers in the NCR and is a designated Wild and Scenic River.

The North Fork Smith River is considered one of the most beautiful whitewater and wilderness rivers in the country, but it is infrequently visited because access is limited and summer flows are low. The North Fork is known for its outstanding water quality and for its ability to clear quickly following storms. Low turbidity and lack of pollutants contribute to the river's excellent habitat and high fisheries value. The fishery is dominated by trout and salmon including winter steelhead and anadromous cutthroat trout and populations of coho and Chinook salmon, (both fall and spring run). The North Fork provides seven miles of near-pristine steelhead spawning and rearing habitat and is a significant source of the high-quality water on which the anadromous fishery of the Smith River depends. The Middle Fork (32 miles long) is characterized by steep rapids, a scenic rocky gorge, and several clear, deep pools. It is popular with anglers, sunbathers, swimmers, and snorkelers. The South Fork Smith (39 miles long) is popular for canoeing, kayaking, and rafting in winter and spring when the water levels are the best. The Smith River is one of the last un-dammed rivers in California and has exceptional water quality. It provides high quality fish habitat and hosts some of California's strongest salmon and steelhead runs. The estuary remains open year-round, allowing fish passage in all seasons.

Small communities in the watershed include Smith River, Hiouchi, Gasquet, and Big Flat. Crescent City, population 8,805, is located several miles outside the watershed and lies about 10 mi. south of the Smith River mouth. Traditionally the local economy has relied on the timber industry and commercial fishing; today, recreation and tourism are becoming increasingly important.

Much of the land in the watershed is publicly owned. Redwood National and State Parks (RNSP) encompass 206 mi^2 along the northern California coast just below the Oregon border; 61 mi^2 of RNSP are old-growth forest. Six Rivers National Forest lies east of RNSP; it encompasses 1496 mi^2 of National Forest land and 208 mi^2 of land under other ownership. The Smith River National Recreation Area (NRA) was established in 1990; it comprises 469 mi^2 of land in the Six Rivers National Forest. Large timber companies hold most of the privately owned land.

2.5.2.2.______Land Use and History

Mining and prospecting for minerals have been an important part of the history of the Smith River area since the 1850s. Mining operations within the Smith River drainage historically have been small-scale placer gold exploration and recovery operations within the bed and banks of the Smith River and its main tributaries. Today, panning, sluicing, and dredging operations occur predominantly during the summer months. In recent years, large, low-grade nickel-cobalt deposits in the uplands of the Smith River watershed have attracted attention. As of May 1997, there were approximately 305 mining claims, covering about 12 mi^2 of National Forest Service lands within the Smith River NRA.

The Low Divide copper mining district is located approximately 13 mi northeast of Crescent City and 7 mi east of the town of Smith River in Del Norte County. The district is contained within the Six Rivers National Forest. Copper was discovered in the Low Divide district at the head of Copper creek in 1853 and a number of mining camps were established. The mines in this district have been inactive for more than 50 years. In the late 1900s, it was found that massive sulfide bodies rich in troilite, an iron sulfide, were common in the area. While troilite occurs worldwide, it is a very rare mineral.

2.5.2.3.______Vegetation & Wildlife

The Smith River watershed contains lush coastal redwoods, dense stands of mixed conifers and hardwoods, ancient redwood groves and other old growth forests in RNSP and the Smith River NRA. These forests provide habitat for the Northern spotted owl and marbled murrelet, both of which are Federally Threatened species. The unique and diverse geology of the watershed allows for high botanical diversity. The watershed supports four distinct botanical areas:

- The North Fork Smith Botanical Area is one of the most botanically significant areas in the Six Rivers National Forest, containing plant habitat for one Federally Endangered species, nine Sensitive plants, and an estimated 40 rare plant species.
- Bear Basin Butte and Broken Rib Botanical Areas are noted for the presence of enriched mixed conifer stands including the Brewer's spruce, a Klamath Mountain endemic.
- Myrtle Creek is both a botanical and cultural area. Ecologically, this area marks the boundary between the redwood forest and Douglas fir-mixed evergreen forest.

2.5.2.4.______Topography and Geology

The topography of the area is typical of the northern California Coast Ranges. There are steep, rugged mountains with deeply incised drainage systems, high areas with little relief that represent the remnants of a late Tertiary erosion surface known as the Klamath peneplane. Landslides, some still active, have occurred on a large scale, particularly along streams that cut soft, easily eroded serpentinite.

This region of northwestern California and southwestern Oregon contains one of the largest intact ophiolites known, the Josephine Ophiolite, with an areal extent of more than 309 mi^2. The Josephine Ophiolite and the overlying Galice Formation are part of the Western Jurassic Belt of the Klamath Mountains geomorphic province.

2.5.2.5.______Water Quality Issues

Highway 199 bisects the Smith River watershed with much of the roadway located within the inner gorge of the mainstem where it has the potential to impact a variety of resources including water quality and aesthetics. The highway is a primary transportation artery carrying much of the region's traffic, including hazardous materials with potential for catastrophic spills into the Smith River (Del Norte County's primary water supply). Plans to widen the road will result in larger cut-banks and fill areas, degrading scenic quality. Many roads on private and public lands are in poor condition and contribute sediment to streams, impacting fish habitat.

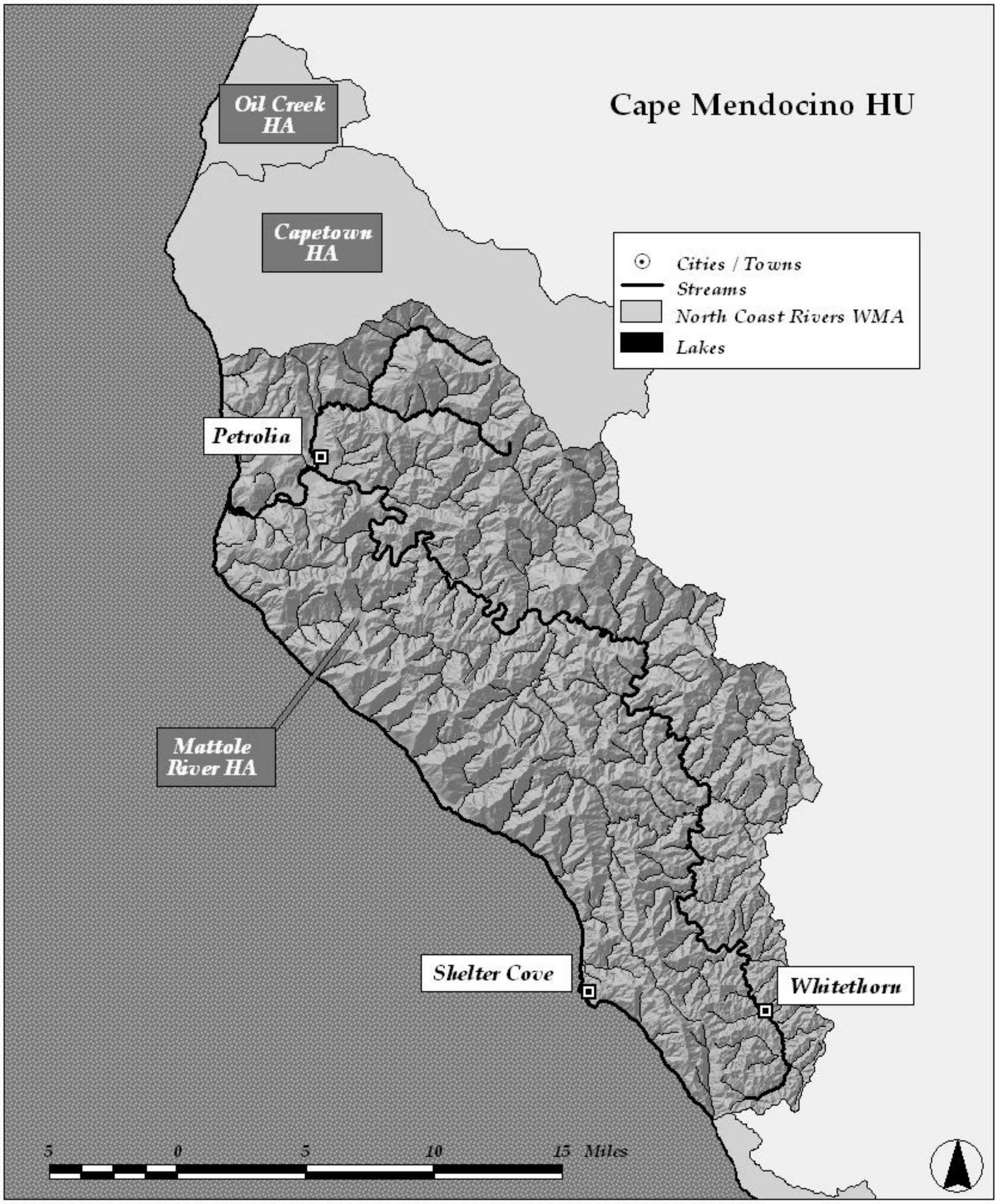
Gravel extraction on private lands downstream of the Smith River NRA, particularly the practice of trenching (digging out the channel vs. scraping off the top of the channel deposits), has impacted aquatic habitat, gravel bars, and salmon spawning habitat. In addition, noxious, non-native weeds such as scotch broom, English ivy, pampas grass, cottoneaster, acacia, knapweed, and gorse are becoming established on gravel bars along the river.

In the Smith River NRA, river-oriented unmanaged dispersed recreation threatens water quality. Campers at undesignated dispersed sites located directly adjacent to streams dump trash, defecate, and cut trees in these areas. These activities can lead to the loss of riparian vegetation, bank destabilization, and consequent impairment of water quality and aesthetics.

Rowdy Creek Fish Hatchery currently stocks 100,000 steelhead smolts annually at the boat ramp by the forks. This practice creates a risk of displacing the wild juvenile steelhead that may be rearing downstream of the release site. The potential impacts to wild steelhead genetics are also of concern.

As in many of the North Coast watersheds, the beneficial uses associated with coldwater fishery appear to be the most sensitive of the beneficial uses in the watershed because of the sensitivity of salmonid species to habitat changes and water quality degradation. Accordingly, protection of these beneficial uses is presumed to protect any of the other beneficial uses that might also be harmed by sedimentation and high water temperatures.

2.5.3. Cape Mendocino HU (112.00) - [Mattole River HA (112.30)]



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