U.S. Environmental Protection Agency
Region IX

Lower Eel River
Total Maximum Daily Loads
for
Temperature and Sediment

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CHAPTER 1: INTRODUCTION

1.1. OVERVIEW OF THE TMDL PROGRAM

The primary purpose of the Total Maximum Daily Loads (TMDLs) for the Lower Eel River is to assure that beneficial uses of fresh water habitat (such as salmonid habitat) are protected from elevated levels of sediment and temperature. The TMDLs set the maximum levels of pollutants that the waterbody can receive without exceeding water quality standards for the Lower Eel River basin.

The major water quality problems in the Lower Eel River and tributaries addressed in this report are reflected in the decline of salmon and steelhead populations. While many factors have been implicated in the decline of west coast salmon and steelhead, we are concerned here with two water quality considerations: increases above natural sediment and temperature. The Lower Eel River (along with many other watersheds in California and throughout the nation) has been included in a list of “impaired” or polluted waters for sediment and temperature. The listing led to these TMDLs. Development of measures to implement the TMDLs is the responsibility of the State of California.

Background

The Lower Eel River Total Maximum Daily Loads (TMDLs) for sediment and temperature have been established, under Section 303(d) of the Clean Water Act, because the State of California has determined that the water quality standards are not met due to excessive sediment and temperature. In accordance with Section 303(d), the State of California periodically identifies “those waters within its boundaries for which the effluent limitations ... are not stringent enough to implement any water quality standard applicable to such waters.” In 1992, EPA added the Lower Eel River to California’s 303(d) impaired waters list due to elevated sedimentation/ siltation and temperature, as part of listing the entire Eel River basin. The North Coast Regional Water Quality Control Board (Regional Board) has continued to identify the Lower Eel River as impaired in subsequent listing cycles, the latest in 2006.

In accordance with a consent decree (Pacific Coast Federation of Fishermen’s Associations, et al. v. Marcus, No. 95-4474 MHP, 11 March 1997), December 31, 2007 is the deadline for establishment of these TMDLs for the Lower Eel River. Because the State of California will not complete adoption of TMDLs for the Lower Eel River by this deadline, EPA has established these TMDLs. Under this consent decree, EPA has already established TMDLs for many watersheds in the North Coast of California, including the South Fork Eel, North Fork Eel, Van Duzen, Middle Fork Eel, Upper Eel River, and Middle Main Eel River (USEPA, 1999a, 1999c, 2002, 2003, 2004, 2005). This is the final watershed within the Eel River Basin for which TMDLs will be established.

The purpose of the Lower Eel River TMDLs is to identify the total amount (or load) of sediment and heat that can be delivered to the Lower Eel River and tributaries without exceeding water quality standards, and to subsequently allocate the total amount among the sources of sediment or heat in the watershed. EPA expects the Regional Board to develop an implementation strategy that meets the requirements of 40 CFR 130.6. The allocations, when implemented, are expected to achieve the applicable water quality standards for sediment and temperature for the Lower Eel River and its tributaries.

These TMDLs apply to the portions of the Lower Eel River watershed governed by California water quality standards. They do not apply to lands under tribal jurisdiction. This is because tribal lands, as independent jurisdictions, are not subject to the State of California's water quality standards.

Summary of Changes to this Document

Several changes were made to the final document as a result of public comments. These include:

- Various editorial changes and clarification of details regarding sediment and temperature problems, the Eel River Estuary, and current information on the status of fish species.
- Additional implementation and monitoring recommendations and background.
- Text to address two FWS-listed species that are present in the Lower Eel River area and could be affected by implementation efforts.
- Updated information on Chinook, steelhead, and coho.

1.2. WATERSHED CHARACTERISTICS

The Lower Eel River watershed is located in Humboldt County in Northwestern California. Highway 101 follows the Eel River in this area through the urban areas of Scotia and Fortuna. The nearly 300 square-mile watershed is approximately 200 miles north/northwest of San Francisco. The boundary of the watershed, as defined by these TMDLs, corresponds to the State of California's Lower Eel River Hydrologic Area (111.10), which is composed of the Ferndale (111.11), Scotia (111.12), and Larabee Creek (111.13) Hydrologic Subareas (HSAs). This portion of the Eel River basin extends from the South Fork Eel River tributary of the mainstem Eel River to the ocean, and includes the Larabee Creek drainage area and all of the smaller tributaries (see Figure 1); however, the larger tributaries of the South Fork Eel River and the Van Duzen River are not included, as TMDLs were previously completed for these waterbodies in 1998 and 1999, respectively (USEPA, 1998, 1999a). The United States Geological Survey (USGS) and Pacific Lumber Company (PALCO) also describe parts of the Lower Eel River watershed. While these areas have the same name as the State of California Hydrologic Area, they encompass slightly different boundaries. The USGS cataloging unit (or 8 digit HUC 18010105 – Lower Eel) includes the State of California's Lower Eel River Hydrologic Area (111.10) as well as the Middle Main Eel River (111.40), North Fork Eel River (111.50), and Van Duzen River (111.20) Hydrologic Areas. PALCO, which is the major timber company in the area, refers to its holdings as the Lower Eel (part of the Scotia HSA) and Upper Eel (part of the Larabee Creek HSA). In these TMDLs, we are referring to the State's Lower Eel River Hydrologic Area (111.10), as described above.

There are three distinctive areas within the Lower Eel River watershed, which correspond roughly to the upper, middle, and lower sections of the watershed: Larabee Creek, small tributaries, and the Salt River area (see Figure 1). The first area, Larabee Creek, occupies the upstream and eastern portion of the watershed, and corresponds with the Larabee Creek HSA.

Larabee Creek is a large tributary where open grasslands, oak, and associated ranching lands dominate the headwater tributaries. Closer to its confluence with the Lower Eel River, the landscape of the Larabee Creek drainage area transitions from Douglas-fir to redwood forest. PALCO is the primary owner of the redwood forest areas of Larabee as well as some of the Douglas-fir forest areas. The second area of the watershed consists of small tributaries that feed directly into the Lower Eel River. These small tributaries (such as Bear, Stitz, Jordan, and Greenlaw creeks) are located downstream of the confluence of the South Fork Eel River (within both the Scotia and Ferndale HSAs) and upstream of the estuary. They are dominated by redwood forest, and most of this area is also owned by PALCO. The third area in the watershed includes the Salt River, and is in the western half of the Ferndale HSA. This is a completely different landscape than the other two areas, composed of dairy lands and small towns in the flat delta area, while the headwaters are predominately composed of conifer and hardwood trees.

The analysis for these TMDLs focused on the watershed areas in the HSAs that define the Lower Eel River Hydrologic area, and the upland influences of sediment and temperature on the waterbodies within that area. EPA did not specifically analyze ocean influences to the waterbodies, or the complex interactions between river runoff and tidal action in the estuary. A recent evaluation of the estuary as part of an effort to consider alternatives to the City of Ferndale's wastewater disposal determined that the tidal influence, and thus the estuary itself, may reach as far inland as Fortuna (Eureka Times-Standard, October 24, 2007). This does not influence the sediment or temperature analyses for the TMDLs. The Regional Water Board or the City of Ferndale may decide to undertake a more detailed analysis in the future, in conjunction with efforts to finalize decisions related to the waste water treatment plant (WWTP), which is currently under a 2003 cease-and-desist order.

Most of the eastern portion of the watershed is rural and remote, while the western (coastal) region is more accessible, with the towns of Scotia, Fortuna, Ferndale, and Loleta. Fortuna is the largest of these communities with approximately 11,000 residents (USCB, 2006). In the Larabee Creek and small tributary areas, the steep topography and privacy afforded by mostly private lands and dirt roads make the area unknown to most Californians. Most of the watershed is forested, with conifers dominating 37%, hardwoods dominating 9%, and a mix of conifer and hardwoods covering 20% of the landscape. Agricultural land (14%) and herbaceous cover (12%) also have a large presence, while barren, shrub, urban, and water make up the remaining 8% of the landscape (USDA, 1998).

The area's geology consists of nearly equal parts of old geology (such as Yager formation and Franciscan mélange, totaling 142 square miles) and young geology (such as Wildcat Group, totaling 157 square miles). In the old geology areas, 86% of the land area (or 122 of 142 square miles) is dominated by conifer and hardwood trees, while only 49% of the young geology area (or 77 of 157 square miles) is forested (see Table 8 in Section 4.1.1). Much of the watershed's summer climate is dominated by coastal fog, especially the western half of the watershed. Fog is less influential on air temperatures in the eastern portion near Larabee. The watershed has highly seasonal precipitation, with approximately three quarters of the 40 to 50 inches of annual rainfall occurring between November and April. Many smaller tributaries dry up in the later summer. The precipitation patterns vary with distance from the ocean and elevation, among other factors, and higher rainfall is generally observed closer to the ocean and at higher elevations.

Flow in the main channel of the Lower Eel River is altered by the Potter Valley Project upstream of the confluence with the Middle Fork Eel River. The major tributaries have no dams or major diversions. The Potter Valley Project has two dams: the larger Scott Dam (which is associated with Lake Pillsbury) and, 12 miles downstream, the smaller Cape Horn Dam (which is associated with the Van Arsdale Reservoir), where water is diverted for the Potter Valley Irrigation District and Sonoma County through Lake Mendocino and the Russian River. The diverted flow released from the dam at Lake Pillsbury is thought to be greater than the natural summer flow of the Eel River. The Potter Valley Project has been in operation for approximately 90 years and is licensed by the Federal Energy Regulatory Commission (FERC). FERC issued Pacific Gas and Electric (PG&E) a new hydropower license in 1983, including certain flow requirements on the Eel River. These flow requirements were increased with the most recent FERC order amending the license (FERC, 2004), which adopted the National Marine Fisheries Service (NMFS) Biological Opinion Reasonable and Prudent Alternatives for the project under the Endangered Species Act (NMFS, 2002). The new flow regime included in the 2004 licensing called for a 30 percent reduction in the diversion from the Eel River to the Russian River, as well as variable flow in the summertime based on water year type (i.e., wet year versus dry year). Thus, on an average annual basis, since 2004, the FERC license called for approximately 30 percent more water in the Eel River. The modeling analysis for the Biological Opinion suggested a 15 percent reduction, and PG&E operated according to the modeling for the first year, but, since the last year, has operated according to the license, which reflects a 30 percent reduction in the diversion (Jahn, NMFS, personal communication, 2007). Thus, flows in the Lower Eel River have increased since 2004 by about 15 percent on an annual average basis relative to the pre-2004 period, and by 30 percent since 2006 (Jahn, NMFS, personal communication, 2007). Moreover, the 2004 FERC order called for variable summer flows: previously, summer flows were set at 5 cfs. Under the current licensing order, the flows vary from 3 to 35 cfs, more closely reflecting natural flows: less water in a dry year and more water in a wet year (Jahn, NMFS, personal communication, 2007).

1.3. ENDANGERED SPECIES ACT CONSULTATION

EPA has initiated informal consultation with the National Marine Fisheries and the U.S. Fish and Wildlife Services on this action, under Section 7(a)(2) of the Endangered Species Act (ESA). Section 7(a)(2) states that each federal agency shall ensure that its actions are not likely to jeopardize the continued existence of any federally-listed endangered or threatened species.

EPA's consultation with the Services has not been completed. EPA believes it is likely that the Services will conclude that these TMDLs will not violate ESA Section 7(a)(2); the TMDLs and allocations are calculated in order to meet water quality standards, which are expressly designed to "protect the public health or welfare, enhance the quality of water and serve the purposes" of the Clean Water Act. These purposes are "to restore and maintain the physical, chemical, and biological integrity of the Nation's water." Additionally, this action will improve existing conditions. However, EPA retains the discretion to revise this action if the consultation identifies deficiencies in the TMDLs or allocations.

1.4. DOCUMENT ORGANIZATION

This report is divided into six chapters. Chapter 2 (Problem Statement) describes the nature of the environmental problems addressed by the TMDLs: fish population, stream temperature problems, sediment problems, and water quality standards. Chapter 3 (Temperature TMDLs) describes the modeling used to evaluate the temperature changes from differing amounts of shade and identifies the TMDLs and allocations. Chapter 4 (Sediment TMDL) describes the sediment source analysis used to evaluate the proportion of human-caused and natural sources of sediment and identifies the TMDL and allocations. Water quality indicators for sediment are also identified in this chapter. Chapter 5 (Implementation and Monitoring Recommendations) contains recommendations to the State regarding implementation and monitoring of the TMDLs. Chapter 6 (Public Participation) describes public participation efforts conducted during development of the TMDLs. Appendices A and B provide further details on the temperature modeling and Thermal Infrared (TIR) analyses, respectively. Appendix C provides the Sediment Source Assessment results, which were used to calculate the sediment TMDL.

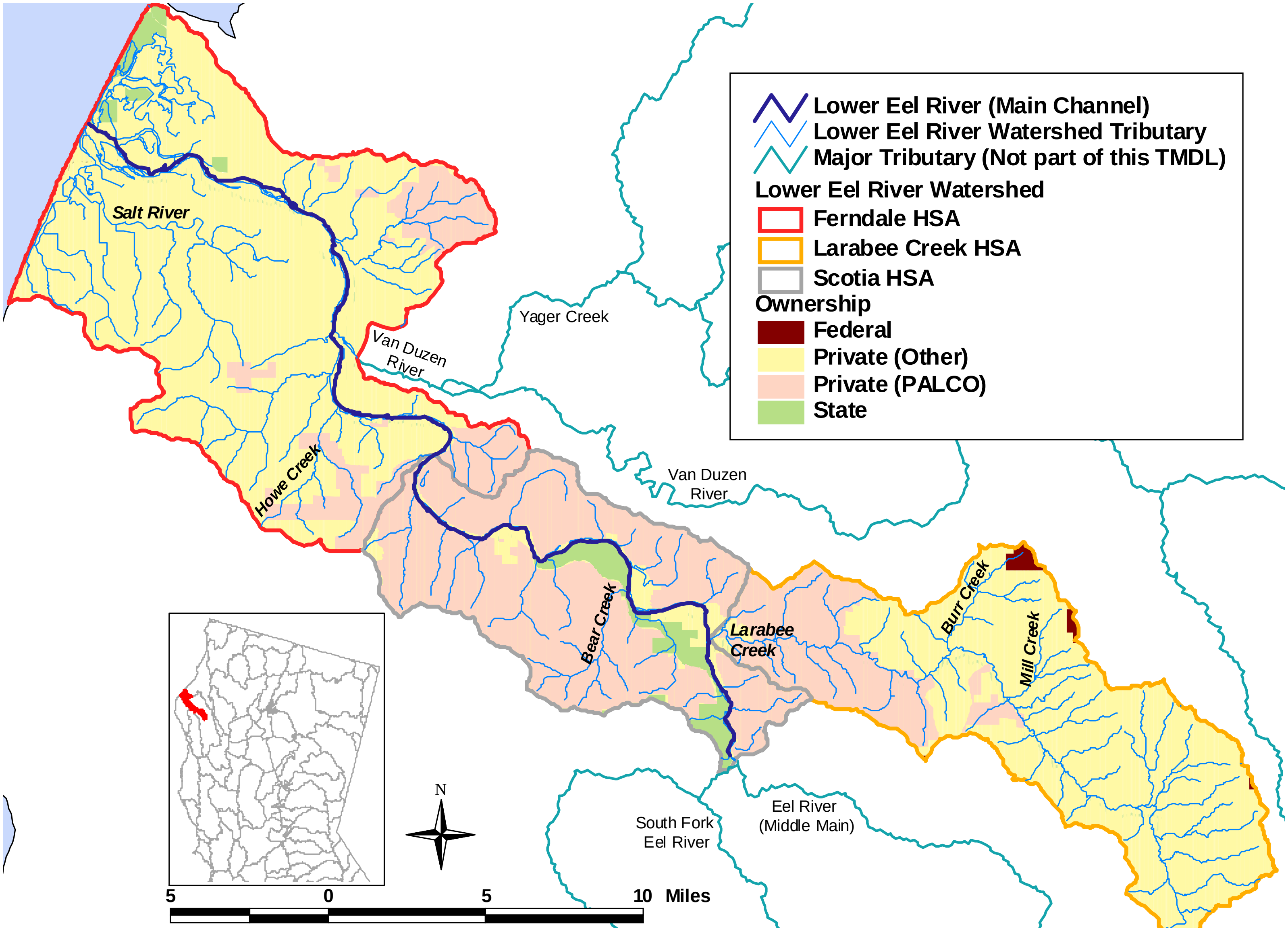


Figure 1. Major features of Lower Eel River TMDL area

CHAPTER 2: PROBLEM STATEMENT

This chapter summarizes what is known about how temperature and sediment are affecting the beneficial uses associated with the decline of the cold water salmonid fishery in the Lower Eel River and tributaries. It includes a description of the water quality standards and salmonid habitat requirements related to temperature and sediment.

2.1. WATER QUALITY STANDARDS

In accordance with the Clean Water Act, TMDLs are set at levels necessary to achieve the applicable water quality standards. Under the federal Clean Water Act, water quality standards consist of designated uses, water quality criteria to protect the uses, and an antidegradation policy. The State of California uses slightly different language (i.e., beneficial uses, water quality objectives, and a non-degradation policy). This section describes the State water quality standards applicable to the Lower Eel River TMDLs using the State's terminology. The remainder of this document simply refers to water quality standards.

The beneficial uses and water quality objectives for the Lower Eel River are contained in the Water Quality Control Plan for the North Coast Region (Basin Plan) (NCRWQCB, 2007a). Table 1 identifies existing and potential beneficial uses for the Lower Eel River Hydrologic Area.

Table 1. Beneficial Uses (NCRWQCB, 2007a)

Beneficial Use	Ferndale HSA (111.11)	Scotia HSA (111.12)	Larabee Creek HSA (111.13)
Municipal and Domestic Supply	E*	E	E
Agricultural Supply	E	E	E
Industrial Service Supply	E	E	E
Industrial Process Supply	P*	P	P
Groundwater Recharge	E	E	E
Freshwater Replenishment	E	E	E
Navigation	E	E	E
Hydropower Generation	P	P	P
Water Contact Recreation	E	E	E
Non-Contact Water Recreation	E	E	E
Commercial and Sport Fishing	E	E	E
Cold Freshwater Habitat	E	E	E
Wildlife Habitat	E	E	E
Rare, Threatened, or Endangered Species	E	E	E
Marine Habitat	P		
Migration of Aquatic Organisms	E	E	E
Spawning, Reproduction, and/or Early Development	E	E	E
Shellfish Harvesting	E		
Estuarine Habitat	E		
Aquaculture	P	P	P
Native American Culture	E		

*E = existing beneficial use; P = potential beneficial use

The water quality objectives pertinent to temperature and sediment TMDLs are listed in Table 2. In addition to water quality objectives, the Basin Plan includes two prohibitions specifically applicable to logging, construction, and other sediment-producing nonpoint source activities:

- the discharge of soil, silt, bark, sawdust, or other organic and earthen material from any logging, construction, or associated activity of whatever nature into any stream or watercourse in the basin in quantities deleterious to fish, wildlife, or other beneficial uses is prohibited; and
- the placing or disposal of soil, silt, bark, slash, sawdust, or other organic and earthen material from any logging, construction, or associated activity of whatever nature at locations where such material could pass into any stream or watercourse in the basin in quantities which could be deleterious to fish, wildlife, or other beneficial uses is prohibited (NCRWQCB, 2007a).

Table 2. Water Quality Objectives (NCRWQCB, 2007a)

Parameter	Water Quality Objectives
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affects beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface water shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Turbidity	Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.
Temperature	The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such an alteration in temperature does not adversely affect beneficial uses.
	At no time or place shall the temperature of any COLD (water with a beneficial use of cold freshwater habitat) water be increased by more than 5˚F above natural receiving water temperature.

The narrative water quality standards described above focus on not adversely affecting beneficial uses. These TMDLs for sediment and temperature have been established to protect the most sensitive beneficial use from adverse effects: the cold freshwater habitat beneficial use. The cold freshwater habitat (COLD) includes the "uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates" (NCRWQCB, 2007a). In addition, the narrative standards above allow for some increases in the pollutant loads over natural conditions, provided that the beneficial uses are not adversely affected. Thus, the TMDLs focus on the human-related portion of temperature and sediment conditions.

2.2. FISH POPULATION AND ENDANGERED SPECIES CONCERNS

The primary beneficial use of concern for these TMDLs is the cold freshwater habitat (COLD), defined as uses that “support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates” (NCRWQCB, 2007a). These TMDLs focus on salmonids as the aquatic species that are most sensitive to elevated sediment and temperature conditions, and for which data are available. Many different habitat conditions are crucial for the survival of salmon and steelhead. Salmonid populations are affected by a number of factors, including commercial and sport harvest, food supply, availability of cover, and ocean conditions. These TMDLs focus only on the achievement of water quality standards related to temperature and sediment within the Lower Eel River watershed. These will facilitate, but not guarantee, population recovery.

Salmon Species

Evidence of salmon population declines is contained in the listing of all the major species under the Endangered Species Act by NMFS. Salmon populations are listed under their geographic area. The Endangered Species Act listing that applies to the Lower Eel River is as follows:

- Southern Oregon/Northern California Coast coho salmon Evolutionary Significant Unit (ESU)
- California Coastal Chinook salmon ESU
- Northern California steelhead Distinct Population Segment (DPS)

Data on population trends for the entire California Coastal Chinook and Northern California steelhead are limited (NMFS, 2005a, 2007). A recent scientific review of the information on salmonid abundance under the Endangered Species Act (NMFS, 2005a, 2007) concluded that the California Coastal Chinook, Northern California steelhead, and California Coast coho (which include the salmonid populations in the TMDL area) are “likely to become endangered in the foreseeable future,” thus reconfirming the “threatened” status of the two ESUs and the steelhead DPS.

Records indicate that the three main species of cold water fish (Chinook, coho, and steelhead) were present in the watershed historically. Information indicates that the populations have declined in numbers and their geographic extent has been reduced. Thus, the available information indicates problems with the COLD beneficial use.

Chinook, coho and steelhead populations “continue to exhibit depressed population sizes relative to historic abundance,” and trends have continued downward (NMFS, 2005a, 2007). Newer presence/absence studies by the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service (NMFS) on coho indicate that 30–59% of historic coho streams in the Eel River had current coho presence (NMFS, 2005a). No specific information on the TMDL area of the Eel River was presented by NMFS; therefore, this section summarizes the presence/absence information and historical abundance information for this smaller area.

All three species are threatened by a wide variety of land use and management activities, including agricultural operations, artificial barriers and loss of hydrologic connections, dams, erosion-control and flood-control structures, gravel mining, forestry operations, road crossings, streambed alteration, suction dredging, substandard screens or unscreened water diversions, and illegal harvest (NMFS, 2007). In some cases, hatchery operations are employed to facilitate species recovery, and in others, hatchery operations may be hindering recovery (NMFS, 2007).

The Eel River basin, along with some nearby watersheds, was the focus of a CDFG fish rescue program in 1938. This rescue program was undertaken because of the experiences and observations of fish rescue crews and others working in the Eel River basin at the time (Shapovalov, 1938). The reports associated with this work provide historical information on the Lower Eel River and Larabee Creek. In the summer of 1938, CDFG crews rescued fish from pools throughout the Eel River basin and moved them out of pools that were drying up. Specifically, in late June 1938, over 7,000 juvenile fish were netted and moved in the Lower Eel River near Fernbridge (90% of these fish were steelhead). Further upstream nearly 2,000 young fish were netted in early July 1938 (75% steelhead and salmon). This process continued along the Eel River through August 1938 and many fish were rescued from drying ponds. Pools in Larabee Creek were also netted and produced approximately 3,000 steelhead and salmon in June 1938. These fish were moved to the Van Duzen River near Grizzly Creek (Shapovalov, 1938). In addition to the fish rescue operations, stream improvement work was conducted. This involved removal of log jams and debris, improving accessibility at entrances to tributary streams, and opening channels cut off from the main streams.

Coho

Historically, the entire Eel River basin was thought to have had around 14,000 adult coho (NMFS, 2005a). Among coastal California rivers, the Eel River basin has the highest amount of habitat for coho, but ranks second in production (Hassler, 1992). Most of the coho in the Eel River basin are in the South Fork Eel River and in some of the cooler fog and redwood areas of the Lower Eel River watershed. CDFG Stream Inventory Reports indicate the presence of coho in Carson Creek (tributary to Larabee), Chadd Creek, and Bear Creek, although only a few coho were observed in the surveys conducted and some of these were carcasses (CDFG, 1991, 1992c, 1998). None of the other streams in the Lower Eel River watershed with CDFG Stream Inventory Reports noted coho observations; however, coho were observed in Newman Creek in 1963 and Poison Oak Creek in 2005 (PALCO, 2006) as well as Strongs, Chadd, Bear, and Jordan creeks (Hart Crowser, 2005). Additionally, coho use the Lower Eel River as part of their migration route to spawning and rearing tributaries in Outlet Creek and the South Fork Eel River, among other waterbodies. The South Fork Eel River has the greatest number of coho of any stream in the Eel River system. Surveys in the Salt River in 1977 indicated the presence of coho; however, none were observed in a 1995 survey (Downie and Lucey, 2004). A single coho was also observed in 1972 in the lower portion of Reas Creek, but, until recently, there have been no coho sightings in the Salt River system for over 20 years (Downie and Lucey, 2004). Specifically, coho juveniles were observed in Francis Creek in 2006 (Downie, CDFG, personal communication, 2007). In the Eel River in general, the decline of coho was recently reconfirmed (NMFS, 2005a): “Coho populations continued to be depressed relative to historical numbers, and we have strong indications that breeding groups have been lost from a significant percentage of streams within their historical range.”

NMFS assigns a recovery priority number to each listed species. This number is based on the magnitude of threat, recovery potential, and the presence of conflict between the species and development or economic activities. There are twelve recovery priority numbers, with one being the highest priority and 12 being the lowest (50CFR 17: Vol. 71 FR pp 24296-24298, June 15, 1990). A Recovery Priority Number of 1 was assigned to the Southern Oregon/Northern California Coast coho salmon ESU, "based on a high magnitude of threat, a high potential for recovery, and anticipated conflict with current and future land disturbance and water-associated development" (NMFS, 2007). Coho populations now occupy only 50 percent of their historic range (NMFS, 2007).

Chinook

Historically, the Eel River basin had much greater abundance of Chinook salmon than nearby watersheds (NMFS, 2005a). Specifically, in 1965, 55,000 Chinook salmon were estimated to be in the Eel River, based on habitat conditions and professional opinion. Redwood Creek, Mad River, and Mattole River were estimated to have 5,000 Chinook salmon each. This estimate of 55,000 adults in 1965 declined to 17,000 adults in 1987 (NMFS, 2005a). No separate estimates are available for the specific TMDL area. NMFS' assessment of the TMDL area (CALWATER Ferndale, Scotia, and Larabee Creek HSAs) is that the conservation value for Chinook is medium in all three HSAs. Seventy-seven out of 417 total stream miles (or 18% of all stream miles) are estimated to be currently used by Chinook (NMFS, 2005b). Chinook salmon are reported in Howe, Strongs, Chadd, Bear, and Monument creeks, which drain directly to the Lower Eel River (Hart Crowser, 2005) as well as Larabee (up to Smith Creek), Carson, and Newman creeks (PALCO, 2006). CDFG Stream Inventory Reports also noted the presence of Chinook in Chadd and Bear creeks, as well as in Carson Creek, which is tributary to Larabee Creek (CDFG, 1991, 1992c, 1998). Surveys in the Salt River in 1977 and 1995 indicated the presence of Chinook; however, the numbers were very few (Downie and Lucey, 2004).

A Recovery Priority Number of 3 was assigned to the California Coastal Chinook salmon ESU, "based on a high degree of threat, a low-to-moderate recovery potential, and anticipated conflict with development projects or other activity" (NMFS, 2007). It is thought that the spring-run Chinook may have been completely eliminated from this ESU. Population trends in the Eel River and throughout most of the ESU appear to be negative, and some local populations may have been extirpated. There is also concern about limited data (NMFS, 2007).

Steelhead

The historical estimate of steelhead in the entire Eel River Basin is 82,000 adults (NMFS, 2005a). The adult steelhead data are sparse, but steelhead populations upstream were known to be at least 4,000 during the 1930s-1950s. In the early 1950s, adult steelhead (20 to 40 inches in length) were observed in the lower river (DPH, 1951).

The distribution of juvenile steelhead is of special interest as summer temperatures are an important facet of their distribution and abundance. In the TMDL study area, juvenile steelhead are widely distributed in the tributaries but not in the main channel. NMFS summarized the conservation value of the Ferndale and Scotia HSAs as medium and the Larabee Creek HSA as high. Specifically, 129 out of 417 stream miles (31%) were designated as critical habitat for steelhead (NMFS, 2005b).

Data collected in 1973 indicate that adult steelhead were caught in the Lower Eel River between the Van Duzen River and the South Fork Eel River (DWR, 1974). Between 1991 and 2003, CDFG's Stream Inventory Reports reported juvenile and/or adult steelhead in several tributaries, although the number of fish observed varied widely. In the Larabee Creek HSA, these streams include: Larabee Creek and its tributaries, Martin Creek, Carson Creek, and Scott Creek (biological inventories on other Larabee Creek tributaries, such as Arnold and Balcom creeks, found no fish, likely due to barriers) (CDFG, 1992a-e, 2000a, 2000c-d). In addition, several tributaries to Larabee Creek (Scott, Pond, Boulder, and Arnold creeks) have resident populations of rainbow trout upstream of salmonid barriers (PALCO, 2006). Steelhead were also identified on Chadd and Bear creeks, both of which drain directly to the Lower Eel River in the Scotia HSA (CDFG, 1991, 1998). Stream inventory reports in the Salt River watershed (in the Ferndale HSA), were available for Francis and Williams creeks. Steelhead were observed in Francis Creek, which is tributary to the Salt River; however, a biological inventory on Williams Creek, which was previously a tributary to Salt River and now drains to the Old River (Downie and Lucey, 2004), found no fish (CDFG, 2003a, 2003c). Surveys in the Salt River in 1977 and 1995 indicated the presence of steelhead; however, the numbers were very few (Downie and Lucey, 2004). In addition, similar to the CDFG stream inventory reports, while Francis Creek is known to support steelhead, none have been detected in Williams Creek or Reas Creek (Downie and Lucey, 2004).

A Recovery Priority Number of 5 was assigned to the Northern California steelhead DPS, "based on a moderate degree of threat, a high recovery potential, and anticipated conflict with development projects or other economic activity" (NMFS, 2007). Concerns included a lack of data, particularly for the winter run, and abundance and productivity. The steelhead hatchery program on the Mad River was terminated in 2004 due to concerns about the negative influences on the DPS (NMFS, 2007).

In summary, this information indicates that cold freshwater beneficial uses have declined in the Lower Eel River watershed. The evidence is especially evident in the Salt River area, and for loss of rearing salmonids in the main channel. Recent reviews under the Endangered Species Act reconfirmed the populations of coho, Chinook, and steelhead in the area as "threatened."

Tidewater Goby and Western Snowy Plover

Two species listed under the Endangered Species Act by the U.S. Fish and Wildlife Service (USFWS), the endangered tidewater goby (*Eucyclogobius newberryi*), and the threatened western snowy plover (*Charadrius alexandrinus nivosus*), were not specifically addressed in the draft of this document, but were the subject of comments by the USFWS during the public comment period. Tidewater goby are known to be present in Eel River estuarine habitat, and several of the Lower Eel River gravel bars are important snowy plover nesting sites. In its comments, USFWS indicated that attainment of the TMDL targets will not affect, or may be beneficial, to these species, but raised the concern that impacts to these species need to be considered in future planning efforts and development of implementation plans for the TMDLs.

According to the U.S. Fish and Wildlife Service (USFWS) office in Arcata, California, the tidewater goby, which is listed as endangered, is endemic to California, found primarily in waters of coastal lagoons, estuaries, and marshes (USFWS, 2007a). The goby now resides at fewer locations than it was found in historically, having been extirpated from some sites as a result of drainage, water quality changes, introduced predators, and drought. It only lives for about a year, and reproduces throughout the year. Peak activity occurs in late April through early May, when male gobies dig a vertical nesting burrow 10 to 20 centimeters deep in substrate that usually contains a coarse sand component; however, they can also be found on rock, mud, and silt substrates. The species lives at the bottom of shallow, brackish bodies of water in lagoons and in lower stream reaches where the water is fairly still but not stagnant. It is found in the Eel River delta, which is proposed by USFWS as Critical Habitat (50CFR 17: Vol. 71 FR pp 68914-68995); this location is of particular importance because it lies at the northern boundary of one of the largest, natural gaps in the geographic range of the species (the next location of the species is at the mouth of the Ten Mile River in Mendocino County, over 135 miles to the south). Known threats to the species at this location include discharge of agricultural and sewage effluents, cattle grazing and feral pig activity that results in increased sedimentation, removes vegetation, and increases ambient water temperatures (50CFR 17: Vol. 71 FR pp 68914-68995). Gobies can occur in water up to 15 feet deep in large lagoons, and have a wide tolerance for varied salinity, oxygenation, and temperature, especially for short periods. Threats to the tidewater goby include habitat loss from coastal development, stream channelization, water diversion, groundwater overdrafting, and alteration of flows. Potential threats also include increased sedimentation or alteration of natural sediment flows and watercourse contamination from vehicles, agricultural and sewage effluents, and introduction of predatory fishes and plants (USFWS, 2007a).

The western snowy plover is listed as threatened, and it is a Bird Species of Special Concern in California. The USFWS office in Arcata describes the range of the Pacific coast population in Del Norte, Humboldt, and Mendocino counties as Recovery Unit 2, which has ranged in population from 60 to 74 adults (USFWS, 2007b). They forage for invertebrates in beach sand, among tide-cast kelp, and within foredune vegetation. Some plovers use dry salt ponds and river gravel bars, and they breed from spring through early fall, laying a clutch of eggs in shallow depressions in the sand, above the high tide line on coastal beaches, sand spits, dune-backed beaches, sparsely vegetated dunes, beaches at river mouths, and salt pans at lagoons and estuaries. Less commonly, this also includes bluff-backed beaches, dredged material disposal sites, salt pond levees, dry salt ponds, and river bars. Threats to the population include human disturbance, predation, and loss of nesting habitat to encroachment of non-native beachgrass and urban development. Human recreational activities, which tend to coincide with the nesting season, are key factors in the ongoing decline in breeding sites and populations (USFWS, 2007b).

Habitat requirements of these two species are different than those of salmonids. Efforts to achieve water quality standards are not expected to adversely affect these species, and they may also be beneficial (Long, M., U.S. Fish and Wildlife Service, 2007), by facilitating a return to more natural sediment and temperature conditions.

2.3. STREAM TEMPERATURE PROBLEMS

This section presents the available information on stream temperature problems for salmonids in the Lower Eel River and tributaries. Stream temperature directly governs almost every aspect of the survival of Pacific Salmon (Berman, 1998). Temperature is such an important requirement that coho, steelhead, Chinook, and rainbow trout are known as “cold water fish.” Metabolism, food requirements, growth rates, timing of adult migration upstream, timing of juvenile migration downstream, sensitivity to disease, and direct lethal effects are affected by stream temperatures (Spence et al., 1996).

The most sensitive period in the Lower Eel River is the summer, when stream temperatures are hottest and young salmonids rear for several summers before migrating to the ocean. Thus, this is the period analyzed in the temperature TMDLs. Of primary interest to water quality standards and the temperature TMDLs is the extent to which warm summer stream temperatures reflect natural conditions, as opposed to temperatures that have been influenced (i.e., warmed) by land management activities. Chapter 3 (Temperature TMDLs) investigates whether the stream temperatures monitored in the Lower Eel and tributaries are natural. This section summarizes the literature on stream temperatures and salmonids, regardless of whether those temperatures are natural.

Stream temperature representation – max7daat

In order to summarize stream temperatures, which are often monitored hourly or more and fluctuate daily and seasonally, the temperature TMDLs use the maximum value of the 7-day running average of all recorded temperatures. Although the term MWAT (maximum weekly average temperature) is used often in the literature, it is an inexact term and is used inconsistently. The abbreviation max7daat is used herein for the maximum 7-day running average of all recorded temperatures.

Evaluation of effects of stream temperatures on juvenile steelhead

EPA summarizes the condition of streams for steelhead summer rearing based on the max7daat. This evaluation, shown in Table 3, categorizes the quality of summer stream habitat in regard to temperature based on previously compiled reviews of the literature. The literature on which this evaluation is based investigated salmonid response in both the laboratory and the field. These temperature habitat evaluations (adequate, lethal, etc.) are not precise in the stream or literature because salmonids are affected by many factors, including the degree of temperature fluctuation, presence of competition and disease, food availability, and access to cool water refugia areas.

Based on the literature review and data analysis, EPA concludes that any increase to natural stream temperatures is adverse to the success of steelhead rearing. The temperature categories in Table 3 can be used as a guideline. Specifically, monitored max7daat temperatures are optimal in the “good” category (less than 15˚C). Temperatures above this range (greater than 15˚C; or in the fair to stressful categories) are not optimal and temperatures above about 20˚C are extremely detrimental for juvenile steelhead. Highest temperatures generally occur during the summer months; therefore, the TMDLs focus on stream temperatures during the summer as the most sensitive period. Specifically, EPA focused on the effects of incremental changes to very warm summer stream temperatures.

Table 3. Evaluation of Effects of Stream Temperatures on Juvenile Steelhead

Stream temperature evaluation	**Stream temperature monitoring period (max7daat)** ***maximum 7 day average of all monitored temperatures***	**References/Notes** **(a) USEPA, 2001a, 2001b** **(b) Sullivan et al., 2000** **(c) Myrick and Cech, 2001** **(d) Washington DOE, 2002** **(e) Neilsen et al., 1994**
GOOD	13-15℃ (55-59℉)	optimal range maximum growth occurs with limited food (up to 16℃) (a)
FAIR	15-17℃ (59-63℉)	within preferred range >16℃ growth enhanced under optimal conditions (a) 13-17℃ no more than 10% reduction from maximum growth (b)
MARGINAL	17-19℃ (63-66℉)	17.2-19℃ growth maximized with unlimited food and constant temps (d)
STRESSFUL	19-20℃ (66-68℉)	20℃ upper end of preferred range
STRESSFUL	20-22℃ (68-72℉)	22℃ cessation of feeding increased risk of disease
STRESSFUL	22-24℃ (72-75℉)	22-24℃ temperature range which eliminates salmonids from an area (a, d)
LETHAL (within days)	24-25℃ (75-77℉)	lethal within days (7day LT50) (a, b, c) steelhead presence noted in water with temperatures >24℃ when cool water refugia areas are present (e) "*continuous exposure of 3-30 hours are necessary to cause mortality at temperatures between 24°C to 26°C" (b)*
LETHAL	25-26℃ (77-79℉)	*"The duration of time necessary to cause mortality decreases sharply with small increments of temperature above approximately 26°C. Short duration excursions (less than 2 hours) above 27°C are very likely to cause mortality of some individuals..." (b)* lethal - 6 hour LT10 (a)
LETHAL (within hours)	> 26℃ (>79℉)	lethal - 26.5℃ 1 hour LT10 (a) critical thermal max (28-32℃) instantaneous loss of equilibrium (b) "*With cautious acclimation…rainbow trout may not experience LT50 (50% mortality) until a week at 26°C. Even with careful acclimation, 27°C results in high or complete mortality in less than 24 hours… and temperatures of 29-30°C result in 50% mortality in 1-2 hours" (a)*

Causes of increased stream temperatures

Stream temperature is the result of many physical factors, such as air temperature, solar radiation, shade (i.e., riparian vegetation and topography), channel geometry (i.e., width to depth ratio), and surface water and groundwater flow. Many of these factors can be altered by human activities and result in increases to stream temperature. However, the degree of change to stream temperature varies by stream and by the magnitude of the change to these factors.

Stream temperatures in the Pacific Northwest provide a wide range of summer conditions for rearing salmonids. However, removing riparian vegetation during timber harvesting, road building, grazing, and urbanization can increase stream temperatures by removing stream shade. Streamflow changes affect travel time, strongly influencing stream temperatures; longer travel time increases the opportunity for solar radiation to heat water. In addition, changes in timing and volume of natural streamflow due to water diversions and impoundments can also change water temperatures downstream by increasing the amount of solar radiation relative to the volume of water. Increased sediment input can also change the stream channel and temperatures by widening streams, filling pools, and eliminating riparian vegetation during flood events.

EPA evaluated stream temperature problems in the Lower Eel River watershed through data reviews and modeling, summarized below. An evaluation of temperature data is presented in the following section. Previous studies of the Eel River system indicated that the main channel and the tributaries exhibit and respond to temperature influences very differently. Thus, the tributaries (see "Evaluation of stream temperature problems in the Lower Eel River watershed – tributaries" section) were evaluated separately from the main channel (see "Evaluation of stream temperature problems in the Lower Eel River watershed – main channel (South Fork to the estuary)" section).

In the Lower Eel River watershed, changes to shade were examined because it is the main source of stream temperature change within tributaries. The known shading issues are described below. Based on the available information in the watershed, flow diversions are not a known problem on most tributaries in the Lower Eel River watershed. If flow diversions are present, they are likely to increase stream temperatures because the same amount of solar radiation would be heating a smaller volume of water. Flow impacts on the main channel were evaluated, as discussed below (see "Evaluation of stream temperature problems in the Lower Eel River watershed – main channel (South Fork to the estuary)" section).

Permitted discharges

Most sources of heat in the Lower Eel River watershed are from diffuse, nonpoint sources. There are six pipe-end, individual point sources in the watershed permitted under the National Pollutant Discharge Elimination System (NPDES) that have potential to affect temperature: the Humboldt Creamery Fernbridge facility, and Waste Water Treatment Plants (WWTPs) in Ferndale, Fortuna, Loleta, Rio Dell, and Scotia. Permits are issued by the Regional Board. These sources are prohibited from discharging to the waters of the Lower Eel River watershed from May 15 to October 15. Since the critical time period for the temperature is in the summer, these TMDLs are written for the critical summer period, and the pipe-based discharges do not influence temperature for the summer. Therefore, these are not included for further consideration in the source analysis.

Municipal runoff (e.g., the collective effects of people hosing off driveways), municipal and industrial stormwater runoff, construction sites, and California Department of Transportation (CalTrans) facilities that discharge pursuant to NPDES permits are diffuse sources of potential heat to the waters. However, permitted discharges are required to result in no net temperature increase in receiving waters, as written into the permit requirements, and are therefore not expected to influence summer temperatures.

Evaluation of existing temperature data in the Lower Eel River watershed

Recent stream temperature data are available from the Humboldt County Resource Conservation District (HCRCD) database (HCRCD, 1996-2003, 2005) and PALCO (2005). The HCRCD locations have been monitored for multiple years, while data for the PALCO stations were only available for 2005. Table 4 identifies the monitoring station, max7daat, HSA, and agency that collected the data. The max7daat at each of these stations is illustrated in Figure 2. Most stream monitoring locations along the main channel have summer stream temperatures categorized as stressful, which is a fairly wide temperature range (19-24˚C – see Table 3). The tributaries exhibit much wider variability. Larabee Creek has max7daats in the marginal to stressful ranges, while tributaries to Larabee Creek are generally in the good to fair categories. Other tributaries draining directly to the Lower Eel River have max7daats in the fair to marginal categories. The creeks draining to the Salt River show the most variability among tributary subbasins, with max7daats ranging from 14.5-18˚C (good to marginal).

Table 4. Max7daat temperatures by HSA

Station Name or Number	Agency	Waterbody	max7daat			Data Period	
			Category	Temperature (degrees C)	Year	Start	End
Ferndale HSA							
201	HCRCD	Eel River	Stressful	21.92	1997	1996	1999
202	HCRCD	Eel River	Stressful	21.63	1997	1996	1999
205	HCRCD	Eel River	Stressful	22.40	1996	1996	1996
206	HCRCD	Eel River	Stressful	22.40	1996	1996	1996
210	HCRCD	Eel River	Stressful	22.21	1996	1996	1996
211	HCRCD	Eel River	Stressful	21.51	1996	1996	1996
221	HCRCD	Eel River	Stressful	22.83	1997	1997	1999
225	HCRCD	Eel River	Stressful	20.80	1999	1999	1999
229	HCRCD	Eel River	Stressful	20.40	1999	1999	1999
234	HCRCD	Eel River	Stressful	20.53	1997	1997	1997
1293	HCRCD	Strongs Creek	Marginal	17.57	1997	1997	1997
1324	HCRCD	Howe Creek	Stressful	19.55	1997	1997	2003*
1552	HCRCD	Unknown	Good	13.98	1996	1996	1996
1559	HCRCD	Francis Creek	Marginal	17.38	1997	1996	2003*
1564	HCRCD	Howe Creek	Stressful	19.69	2003	1996	2003*
1607	HCRCD	Price Creek	Stressful	19.41	2003	1996	2003*
8022	HCRCD	Howe Creek	Fair	15.60	2001	2001	2001
8029	HCRCD	Francis Creek	Good	14.80	2001	2001	2001
9614	HCRCD	Howe Creek	Marginal	18.20	1999	1999	1999
9647	HCRCD	Howe Creek	Marginal	18.54	2003	2001	2003*
9648	HCRCD	Atwell Creek	Fair	16.64	2003	2001	2003
9657	HCRCD	Strongs Creek	Fair	15.23	2003	2002	2003
9658	HCRCD	North Fork Strongs Creek	Fair	15.19	2003	2002	2003
Francis	HCRCD	Francis Creek	Good	14.53	2005	2005	2005
Reas	HCRCD	Reas Creek	Fair	15.63	2005	2005	2005
Williams	HCRCD	Williams Creek	Marginal	17.99	2005	2005	2005

Station Name or Number	Agency	Waterbody	max7daat			Data Period	
			Category	Temperature (degrees C)	Year	Start	End
Larabee Creek HSA							
1202	HCRCD	Larabee Creek	Stressful	23.32	1996	1996	1997
1299	HCRCD	Scott Creek	Good	14.38	1996	1996	2003*
1341	HCRCD	Tributary to Larabee Creek	Good	14.80	1997	1997	1997
1357	HCRCD	Tributary to Larabee Creek	Good	13.25	1997	1997	1997
1571	HCRCD	Larabee Creek	Marginal	18.81	1996	1996	2003*
9605	HCRCD	Larabee Creek	Stressful	20.60	1999	1999	1999
9621	HCRCD	Balcom Cr	Stressful	22.40	2001	1999	2003
9645	HCRCD	Larabee Creek	Stressful	22.32	2003	2001	2003
Balcom	PALCO	Balcom Creek	Good	14.94	2005	2005	2005
Chris	PALCO	Chris Creek	Fair	15.61	2005	2005	2005
Daughiny	PALCO	Daughiny Creek	Good	14.12	2005	2005	2005
Lower Carson	PALCO	Carson Creek	Fair	15.64	2005	2005	2005
Lower Larabee	PALCO	Larabee Creek	Stressful	21.51	2005	2005	2005
Scott	PALCO	Scott Creek	Good	14.41	2005	2005	2005
Upper Carson A	PALCO	Carson Creek	Good	14.69	2005	2005	2005
Upper Carson B	PALCO	Carson Creek	Fair	15.42	2005	2005	2005
Upper Larabee	PALCO	Larabee Creek	Stressful	21.69	2005	2005	2005
Scotia HSA							
1289	HCRCD	Bear Creek	Stressful	19.20	2000	1996	2001*
1295	HCRCD	Twin Creek	Fair	16.33	1996	1996	1996
1306	HCRCD	Monument Creek	Fair	16.80	1997	1996	1997
1330	HCRCD	Shivley Creek	Fair	16.55	1997	1997	1997
1345	HCRCD	Eel River	Stressful	22.01	1997	1997	1997
1507	HCRCD	Bear Creek	Stressful	19.42	1997	1996	1997
1508	HCRCD	Bear Creek	Stressful	20.08	1997	1996	2003
1523	HCRCD	Chadd Creek	Fair	16.68	1997	1996	2003
1567	HCRCD	Jordan Creek	Stressful	20.27	1997	1996	1997
9611	HCRCD	Monument Creek	Fair	15.80	1999	1999	1999
9613	HCRCD	Shivley Creek	Fair	16.70	1999	1999	1999
9620	HCRCD	Monument Creek	Fair	16.73	2003	1999	2003
9624	HCRCD	Shivley Creek	Fair	16.50	2001	1999	2003
9626	HCRCD	Stitz Creek	Marginal	17.43	2003	1999	2003*
9628	HCRCD	Eel River	Stressful	22.60	2000	2000	2000
9629	HCRCD	Eel River	Stressful	21.90	2000	2000	2000
9630	HCRCD	Eel River	Stressful	22.30	2000	2000	2000
9631	HCRCD	Eel River	Stressful	22.00	2000	2000	2000
9632	HCRCD	Eel River	Stressful	22.10	2000	2000	2000
9634	HCRCD	Eel River	Stressful	21.60	2000	2000	2000
9635	HCRCD	Eel River	Stressful	20.70	2000	2000	2000
9646	HCRCD	Jordan Creek	Fair	16.93	2003	2001	2003
9654	HCRCD	Bear Creek	Marginal	18.61	2003	2002	2003
Bear 203	PALCO	Bear Creek	Marginal	17.87	2005	2005	2005
Bear 89	PALCO	Bear Creek	Marginal	17.53	2005	2005	2005
Jordan 174	PALCO	Jordan Creek	Fair	16.24	2005	2005	2005
Upper Jordan 941	PALCO	Jordan Creek	Fair	15.03	2005	2005	2005
Upper Jordan 944	PALCO	Jordan Creek	Fair	15.75	2005	2005	2005

*Data were not collected for all years within the monitoring date range.

Source: HCRCD, 1996-2005; PALCO, 2005

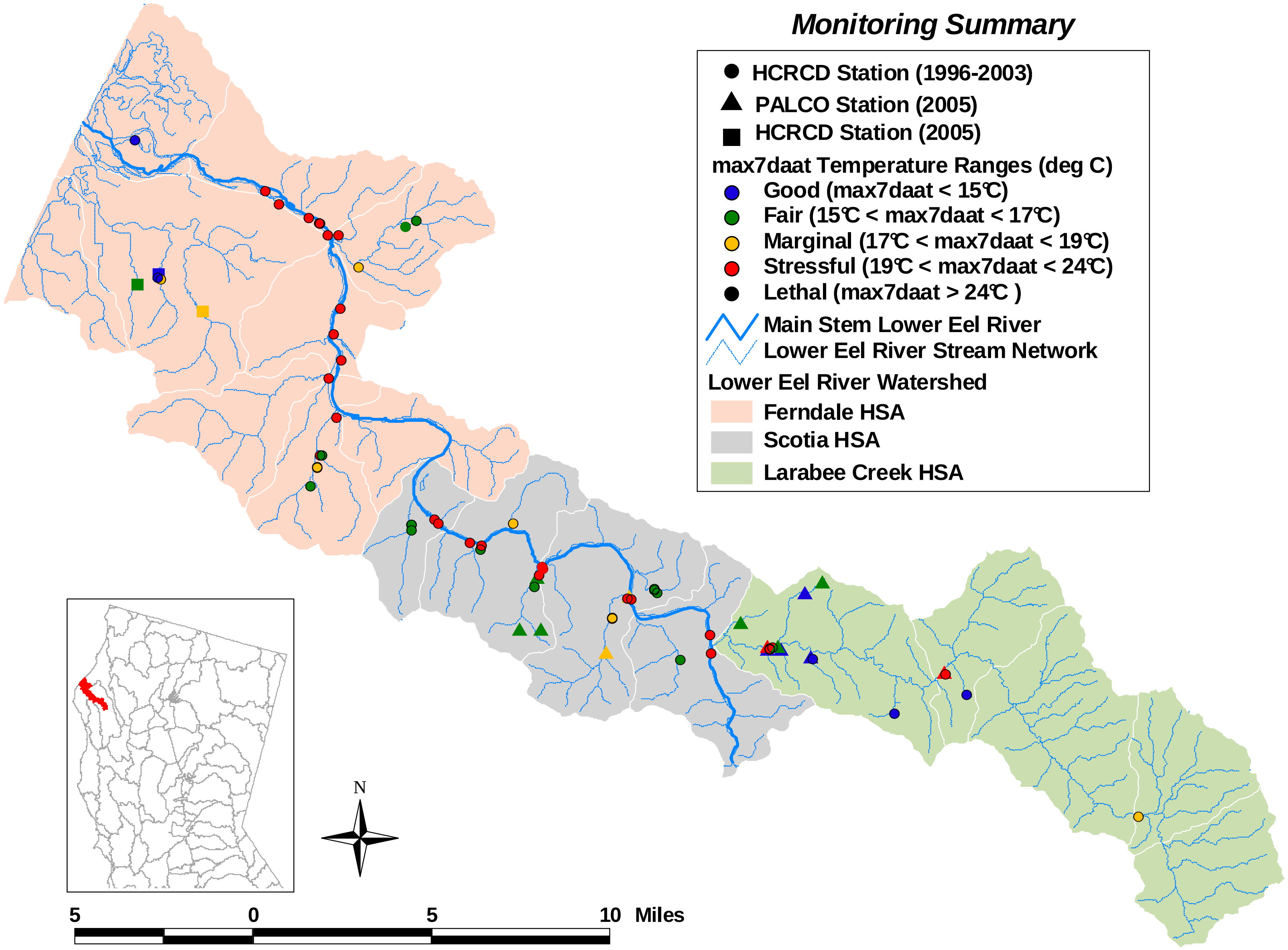
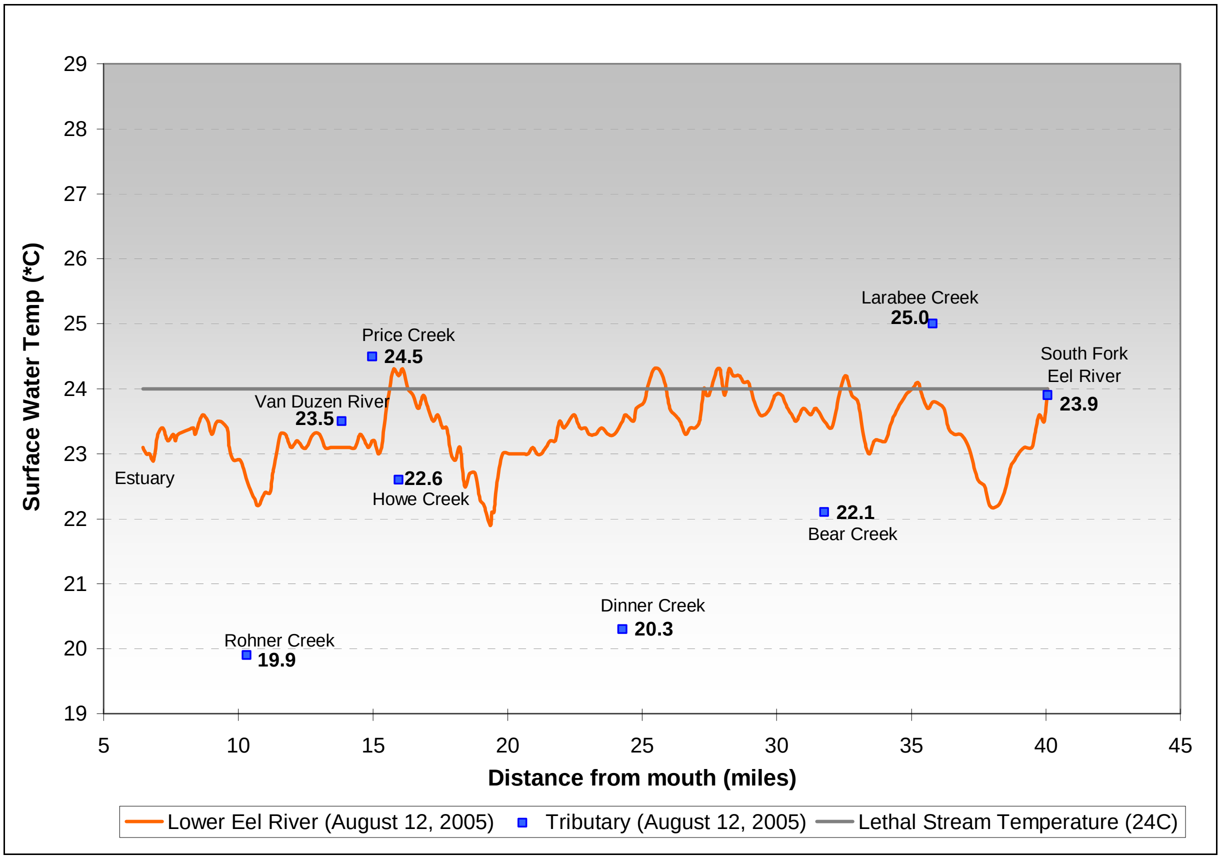


Figure 2. Max7daat temperatures in the Lower Eel River watershed

EPA funded additional data collection for the temperature TMDLs. An airborne Thermal Infrared Remote Sensing (TIR) study of the main channel was undertaken during the summer of 2005 (Watershed Sciences, Inc., 2005). This monitoring technique gathered one-time surface water temperatures over the entire length of the main channel of the Eel River. (The report is available as Appendix B.) The result of that monitoring for the Lower Eel River is provided in Figure 3. From the South Fork Eel (river mile 40) to the estuary, most of the main channel is 23-24˚C, which is just below the lethal category. There are pockets of warmer and cooler temperatures throughout the main channel, and the graph also illustrates the location and temperature of measured tributaries, which range from stressful to lethal. Note that these temperatures represent instantaneous conditions and not the max7daat as reported in the HCRCD and PALCO data above. The Lower Eel River main channel temperatures were cooler than the temperatures measured along the Middle Main Eel River (farther upstream on the main channel) on the previous day. This is likely because the Lower Eel River monitoring was conducted earlier in the day and did not necessarily capture the warmest part of the day (Watershed Sciences, Inc., 2005); however, cooler air temperatures closer to the coast may also have influenced the slightly cooler temperatures.



Note: the lowest temperatures on this figure represent the “stressful” category. Those over 24℃ are considered lethal (Table 3).

Figure 3. Median sampled temperatures by river mile for the Lower Eel River (based on TIR study)

Several other temperature monitoring studies for the Lower Eel River exist; none of these capture "historical" temperatures (i.e., before shade and flow alterations had taken place due to human impacts). Some of the earliest available temperature monitoring data were collected during 1973. These data showed the same patterns noted by the Humboldt County RCD database, namely that stressful and lethal temperatures are present in the main channel with limited cool water refugia (Kubicek, 1977). Monitoring data collected by the Department of Water Resources (DWR) in 1973 also follow these trends (DWR, 1974). The HCRCD (1998) conducted a comparison of 1996 stream temperatures to the 1973 temperatures reported by Kubicek (1977) in several locations throughout the Lower Eel River TMDL area. Maximum temperatures found in 1996 were similar to those in 1973 at all stations (HCRCD, 1998).

The historical presence of cool water pools in the Lower Eel River and Larabee Creek was noted by Shapovalov (1938). Other studies have also documented the presence of cool water refugia and seeps in the Lower Eel River (DPH, 1951; Halligan, 1999). Halligan (1999) noted stratified pools with little to no shade canopy (these were likely fed by cool groundwater). These studies did not quantify the frequency of pools throughout the main channel, nor did they note the temperatures of the refugia pools. However, the frequency and depth of pools may have decreased over time due to the influence of increased sediment in the watershed, which results in stream widening and filling of pools (as described below).

In summary, stream temperatures have been monitored in many locations in the Lower Eel River watershed. The monitoring shows that stream temperatures range from lethal to good, depending upon monitoring location; some tributaries and refugia pools have cool temperatures, but temperatures in the main channel Lower Eel River and Larabee Creek are quite warm. Based on the literature, EPA expects that incremental reductions in temperature to warm tributary streams, where the max7daat is 24-27˚C, would be beneficial, although improvements in juvenile populations that might be affected by such changes could be expected to be modest.

Evaluation of stream temperature problems in the Lower Eel River watershed – main channel (South Fork to the estuary)

This section describes the temperature analysis for the main channel of the Lower Eel River between the South Fork and the estuary. The results led to EPA's conclusion that neither shade nor flow alterations are altering natural stream temperatures in the range that adversely affects beneficial uses in the main channel. The SHADE model was used to evaluate the impact of possible shade alterations along the entire length of the Lower Eel River main channel. The Q2ESHADE model was used in a previous study for the Middle Main Eel River (the mainstem reach just upstream of the Lower Eel River), comparing the two most recent FERC flow requirements on the Eel River to a range of natural flow and temperature conditions, and concluded that these flow alterations did not influence stream temperatures along the Middle Main Eel River (USEPA, 2005), and are thus not expected to influence the Lower Eel River, which is even farther downstream from the flow alterations. Comparing the modeled results for shade and flow alterations to the water quality standard stating that "natural stream temperatures shall not be altered," EPA concluded that a temperature TMDL is not needed for the mainstem Lower Eel River. Appendix A provides the details of the Lower Eel River shade modeling, Appendix C describes the impact of sediment on the main channel, and the Middle Main Eel

River TMDL describes the flow modeling (USEPA, 2005). A summary of these analyses is provided below.

Effects of shade on the main channel

Riparian vegetation can be reduced by timber harvest, grazing, or road building. All of these factors are present in the Lower Eel River watershed. For the entire length of the main channel, EPA examined the potential for shade reductions by comparing current vegetation conditions with more natural conditions (60 inch diameter at breast height [dbh] trees) (Figure 4). Tetra Tech, Inc. used the SHADE model (see Appendix A) to vary the amount of shade that could potentially influence the main channel. Modeling estimated that changes in riparian vegetation do not result in significant changes in shade on the main channel, primarily because the channel is so wide (wetted width was approximately 40 to 140 meters in the freshwater segments, based on estimates obtained during the TIR analysis [Watershed Sciences, Inc., 2005]). Figure 4 illustrates the estimated increase in shade between current conditions and natural shade conditions. As indicated, 79% of the stream segments had a less than 1% difference in shade between modeled "historic" conditions (all conifer and hardwood trees 60 in dbh) and current conditions, and only about 5% of the modeled segments had an increase in shading greater than 2.5%; which would suggest that current temperatures are only incrementally warmer than historic temperatures (i.e., well under a 5°C difference), and in only a small number of stream segments. EPA considers this shade difference to be insignificant in magnitude and geographic extent. Any corresponding differences in temperature would be even smaller in magnitude than the shade differences.

Given that even the natural stream temperatures are in the stressful and lethal range, increased shade to achieve natural conditions would not be expected to provide notable benefits to salmonids. The TIR analysis along the main channel identified several segments with lower temperatures than their surrounding reaches (Figure 3 and Appendix A), especially near river miles 19 and 37, which showed temperature decreases of 2-2.5°C. This suggests that groundwater likely contributes cooler water to some pools in the main channel. It should be noted that the large scale use of groundwater resources in these areas could exacerbate temperature conditions by removing a source of cooler water.

Effects of sediment on channel changes in the main channel

Channel changes from sediment problems can also decrease stream shade. Channel widening or debris torrents that remove vegetation can both be factors in reduced shade. In the Lower Eel River TMDL area, EPA addressed this through an analysis of the channel migration zone (CMZ) along the main channel, which was conducted by Pacific Watershed Associates (PWA). This study, which was based on historical aerial photography and field reconnaissance, concluded that sediment input volume has decreased over time while the storage volume has increased; in other words, more sediment is stored in the channel area today than in the past. These increases in storage volume likely contributed to channel widening (Appendix C), thereby resulting in less shading over the channel, which can contribute to increases in stream temperature.

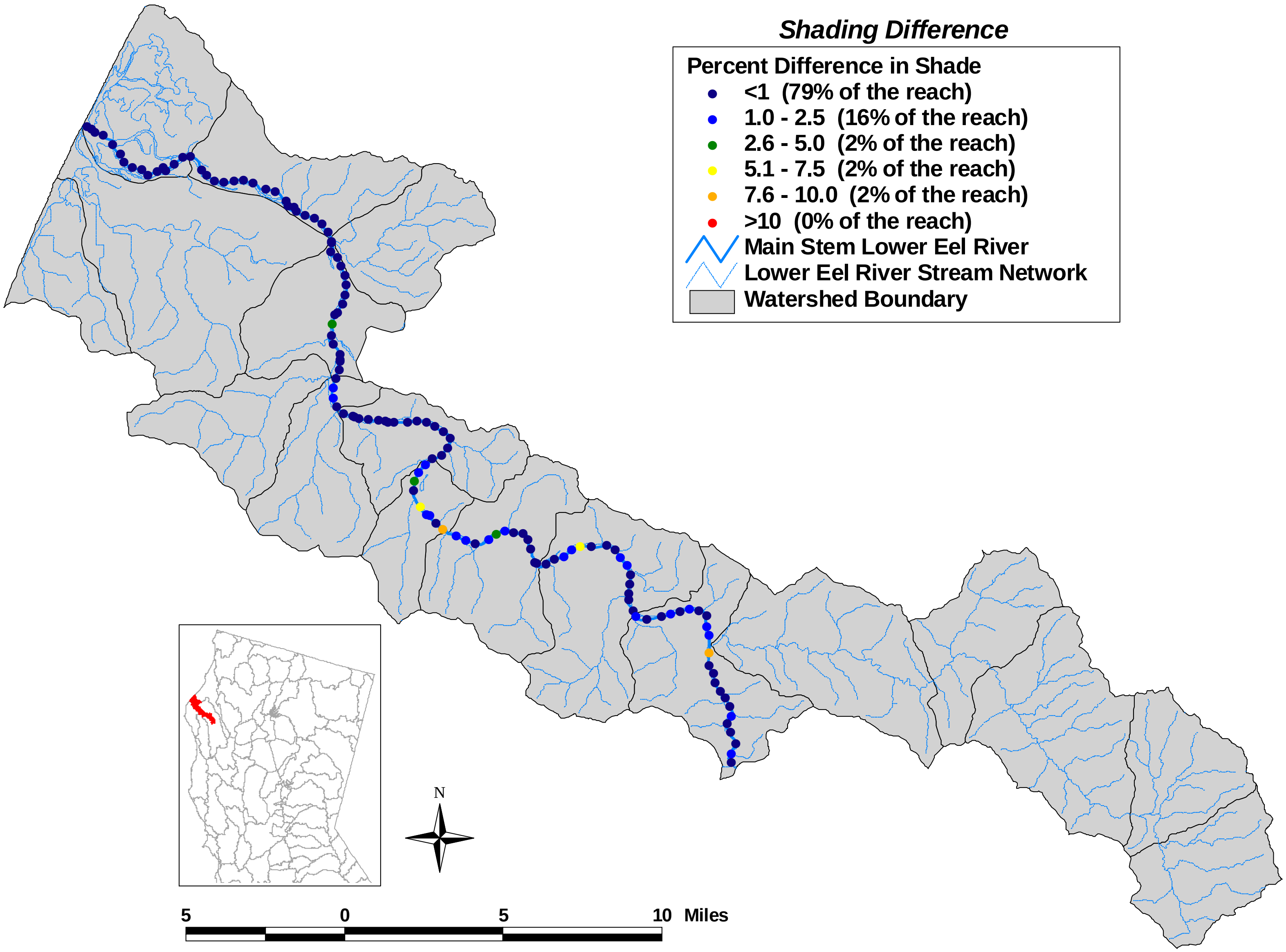


Figure 4. Main channel difference in shading between natural vegetation and current conditions

Main channel flow diversions

Given that flow is diverted from the Eel River at Van Arsdale, EPA investigated the significance of this diversion to water temperature. EPA compared both the pre-2004 flow requirements of 7 cubic feet per second (cfs), and the current flow requirements (initiated in 2004) of 30 cfs in very wet years to a range of natural conditions (50 to 60 cfs). EPA only compared very wet year requirements because previous modeling for the Upper Eel River concluded that stream temperatures for the main channel near Outlet Creek were not altered in drier years (USEPA, 2004); therefore, it is assumed that stream temperatures farther downstream on the main channel (i.e., Middle Main Eel River and Lower Eel River) were also not altered during drier years.

The water quality standard's goal of "natural stream temperatures" is challenging because stream temperatures were not monitored before 1914, when the diversions began. This would have provided a definitive description of "natural stream temperatures" if it were available. In addition, the Potter Valley Project's influence on stream temperature and cold-water habitat is complex. EPA modeled a range of natural flow conditions on the Middle Main Eel River (50-60 cfs), which is located farther upstream from the Lower Eel River, in various combinations with a range of natural conditions on the Middle Fork Eel River (50 and 80 cfs), a major tributary to the Middle Main Eel River (located approximately 80 river miles upstream of the confluence with the South Fork Eel River). These were combined with two possible natural stream temperature scenarios (warmer versus cooler upstream temperatures) to provide a context for meeting the water quality standard of "natural stream temperatures."

EPA concluded from this analysis that stream temperatures in the Middle Main Eel River have not been altered significantly due to changes to flow. A comparison of current flow requirements (30 cfs) and the estimated natural headwater and tributary stream temperatures predicts that there is no alteration of natural stream temperatures for most of the river modeled. Small increases in natural stream temperatures (less than 5˚C) were estimated for a portion of the reach; however, these sections of the Middle Main Eel River are estimated to be naturally warmer than a max7daat of 28˚C (i.e., without the flow alterations), and it is likely that salmonids did not historically utilize this portion of the river channel even under natural conditions. Given that the flow conditions in the Middle Main Eel River are not significantly affected by flow alterations, the Lower Eel River is even farther downstream than the Potter Valley Project (and thus less likely to be affected by flow alterations), and natural conditions in the mainstem Lower Eel River were probably very similar to those in the Middle Main Eel River (i.e., very warm), it is likely that any incremental increases in temperature do not adversely affect salmonids. In other words, even under natural conditions, the river temperatures would remain lethal within hours for salmonids. It is likely that, even historically, the fish would have sought refuge in the cooler tributaries as temperatures in the mainstem began to rise during the summer.

Thus, EPA concluded that altered conditions in this reach do not violate water quality standards. A full description of the flow modeling effort can be found in the Middle Main Eel River temperature TMDL (USEPA, 2005). Because shade and flow alterations were not found to adversely influence stream temperatures along the Middle Main Eel River, and because conditions in the Lower Eel River are similar, EPA concluded that the decision that was reached regarding temperature conditions in the Middle Main Eel River can be applied to the Lower Eel

River, i.e., that no temperature TMDL is required in the Lower Eel River because water quality standards for temperature are not being violated.

Evaluation of stream temperature problems in the Lower Eel River watershed – tributaries

This section evaluates the effects of shade and sediment changes to the tributaries of the Lower Eel River.

Effects of shade on tributary stream temperatures

To evaluate how stream temperatures change in relation to shade, which is highly influenced by the presence and size of riparian vegetation, EPA modeled two subwatershed areas to represent the Lower Eel River tributaries: Larabee Creek and the creeks draining to the Salt River system. Two areas were chosen to represent all of the tributary areas because they exhibit distinct characteristics of the watershed. Specifically, the Salt River subbasin has unique vegetation and meteorological characteristics, thus requiring a separate analysis. The Larabee Creek model represents all other tributaries in the TMDL area because its vegetation characteristics are similar to many other areas in the watershed.

The model was initially run to evaluate shade and stream temperature for current (i.e., existing) conditions. Subsequently, scenarios were performed to predict shade and stream temperatures assuming natural or historical vegetation. Model results between current and natural conditions were compared; changes to shade and temperature were found to be significant (i.e., natural stream temperatures are cooler than the temperatures estimated under current conditions), indicating that removing riparian vegetation by timber harvesting, road building, grazing, and/or urbanization has increased stream temperatures in the Lower Eel River watershed tributaries. Modeling results are summarized in Section 3.2 and described in detail in Appendix A.

Effects of sediment on channel changes in tributaries

Shade can be reduced in tributaries by debris flows and/or large landslides that remove riparian vegetation and widen the channels during storms. PWA's analysis (see Appendix C) concluded that since 1955, sediment loading to the tributaries by earthflow events (e.g., slow-moving, deep-seated landslides, generally in response to consecutive high rainfall years resulting in soil saturation and weathered bedrock) has increased. By contrast, non-earthflow events (e.g., shallow debris slides and translational, rotational, and complex deep seated landslides, which are generally considered episodic or rapid when compared to earthflow erosion rates) have decreased. Because earthflow sediment delivery contributes much less sediment overall than non-earthflow delivery, the net impact of increased earthflow and decreased non-earthflow deliveries has been a reduction in sediment to the tributaries relative to previous time periods. Accordingly, sediment delivery to tributaries has had less of an impact on available shade and stream temperatures in recent years; however, when sediment does reach the tributaries, it has potential to widen streams, fill pools, and eliminate riparian vegetation during flood events, which can cause increases in stream temperatures.

Conclusions

For the main channel of the Lower Eel River (i.e., from the South Fork to the estuary), the analyses of shade and flow effects on upstream areas (Middle Main Eel River; USEPA, 2005) indicate that while current summer temperatures may be slightly higher than historical temperatures, even the historical summer temperatures were so warm (in the lethal range for salmonids) that returning temperatures to historical conditions would not improve conditions for salmonids. In addition, shade modeling on the main channel of the Lower Eel River indicated that changes in riparian vegetation do not result in significant changes in shade, which would suggest that current temperatures are only incrementally warmer than historic temperatures, and in only a small number of stream segments. Thus, EPA concluded that a temperature TMDL is not needed for the main channel of the Lower Eel River.

Based on the data and information presented above, EPA concluded that tributary streams do not meet water quality standards for temperature; therefore, temperature TMDLs are established in Chapter 3 to achieve those standards. This conclusion is largely based on shade and temperature modeling, which compared current conditions to historical vegetation conditions and found significant changes in stream shading and temperatures (i.e., natural stream temperatures are cooler than the temperatures estimated under current conditions) (Section 3.2 and Appendix A).

2.4. SEDIMENT PROBLEMS

Salmon can be adversely affected by many different stream conditions related to sediment. The effects of sediment on the Lower Eel River are evident in the changes in river morphology after the 1964 flood. Like most of the Eel River, the Lower Eel River's sediment loading is very high and a portion of this loading is exacerbated by human activities.

Permitted discharges
Most sources of sediment in the Lower Eel River watershed are from diffuse, nonpoint sources, including runoff from roads, timber operations, and natural background. There are five Waste Water Treatment Plants (WWTPs) in the watershed that are permitted under the National Pollutant Discharge Elimination System (NPDES) to discharge total suspended solids (TSS) and suspended solids (SeS) in the watershed: Ferndale, Loleta, Fortuna, Rio Dell, and Scotia, which provide secondary or equivalent to secondary treatment. These permits are issued by the Regional Board. The permits for these facilities include the following monthly average concentration limits for TSS and SeS:

Ferndale: TSS 95 milligrams per liter (mg/l); SeS 0.1 milliliters per liter (ml/l)
Fortuna: TSS 30 mg/l; SeS 0.1 ml/l
Loleta: TSS 30 mg/l; SeS 0.1 ml/l
Rio Dell: TSS 30 mg/l; SeS 0.1 ml/l
Scotia: TSS 30 mg/l; SeS 0.1 ml/l

These discharges are relatively small compared to nonpoint sources in the watershed. The Humboldt Creamery Ferndale facility is not permitted to discharge any TSS or SeS.

Municipal runoff (e.g., the collective effects of people hosing off driveways), municipal and industrial stormwater runoff, construction sites, and CalTrans facilities that discharge pursuant to NPDES permits are diffuse sources of potential sediment to the waters. Unpermitted discharges that should be permitted, or are subject to future permitting, are also diffuse sources of sediment.

While these potential loads have not been specifically included as individual point sources, they are expected to generate and deliver sediment at rates that are similar to nonpoint sources, and they are included in the analysis as such.

Salmon requirements related to stream sediment

This section presents available information related to sediment problems in streams in the Lower Eel River and tributaries. Salmonids have different water quality and habitat requirements at different life stages (spawning, egg development, juveniles, and adults). Sediment of appropriate quality and quantity is needed for redd (i.e., salmon nest) construction, spawning, and embryo development. Excessive amounts of sediment or changes in size distribution (e.g., increased fine sediment) can adversely affect salmonid development and reduce available habitat.

Excessive fine sediment can reduce egg and embryo survival and juvenile development. Tappel and Bjornn (1983) found that embryo survival decreases as the amount of fine sediment increases. Excess fine sediment can prevent adequate water flow through salmon redds, which is critical for maintaining adequate oxygen levels and removing metabolic wastes. Deposits of these finer sediments can also prevent the hatching fry from emerging from the redd, resulting in smothering. Excess fine sediment can cause gravels in the water body to become embedded (i.e., the fine sediment surrounds and packs in against the gravels), which effectively cements them into the channel bottom. Embeddedness can also prevent spawning salmon from building redds.

An imbalance between fine or coarse sediment supply and transport can also adversely affect the quality and availability of salmonid habitat by changing the morphology of the stream. It can reduce overall stream depth and availability of shelter, and it can reduce the frequency, volume, and depth of pools. Pools provide salmon a resting location and protection from predators.

Excessive sediment can affect other factors important to salmonids. Stream temperatures can increase as a result of stream widening and pool filling. The abundance of invertebrates, a primary food source for juvenile salmonids, can be reduced by excessive fine sediment. Large woody debris, which provides shelter and supports food sources, can be buried. Increased sediment delivery can also result in elevated turbidity, which is highly correlated with increased suspended sediment concentrations. Increases in turbidity or suspended sediment can impair growth by reducing availability or visibility of food sources and the suspended sediment can cause direct damage to the fish by clogging gills.

Sediment conditions in the Lower Eel River watershed

Erosion and sediment delivery to streams result from a combination of natural factors combined with human disturbance and rainfall patterns. In general, the factors related to human activities that can increase erosion and sediment delivery include roads, grazing, and timber harvest. The sediment source analysis for the Lower Eel River sediment TMDL accounted for the significant sources of natural and human-related sediment delivery (Appendix C).

High sediment loading in the Eel River has been noted since the 1960s. A USGS study of sediment loading rates estimated that the Eel River had the highest average suspended sediment yield for any basin in the United States (Brown and Ritter, 1971). These estimates were made directly after the 1964 flood. In this stretch of the Eel River, the December flood of 1964 resulted in large-scale destruction of the Northwest Pacific Railroad, which parallels the Eel River for nearly the entire length of the main channel in the Lower Eel River watershed. The railroad sustained significant damage from erosion, landslides, and flooding.

The 1964 flood, as well as the 1955 and 1997 floods, caused channel widening by erosion of terraces along the Lower Eel River. Stream response was not spatially uniform; therefore, some reaches may be more susceptible to expansion than others. More than 30 years after the 1964 flood, locations with extensive widening had not returned to pre-flood widths (Sloan, 1997; Sloan et al., 2001). Five tributaries were studied. This research indicated that deposition in the tributary valleys and downcutting were the dominant processes occurring during flood events, although responses were not uniform between tributaries (Sloan, 1997; Sloan et al., 2001).

Channel changes (i.e., channel migration) on a 33-mile stretch of the Lower Eel River main channel (from 1 mile downstream of the confluence with the South Fork Eel River to the City of Fortuna) were investigated by PWA (Appendix C). Downstream of Fortuna, the Lower Eel River is bounded by extensive man-made levees, making a Channel Migration Zone (CMZ) analysis in this area unnecessary. This study provided a historical perspective of the changes in channel morphology based on an analysis of historical aerial photography and field reconnaissance. The analysis compared the channel, gravel bars/point bars, floodplains, and terraces within the analysis area. Using Geographic Information Systems (GIS) tools, changes between features in the 1954 and 1966 aerial photographs and the 1966 and 2003 aerial photographs were defined as either sediment storage or sediment input (mobilization) areas, and volumes were estimated from the measured height and estimated area. The total estimated sediment input volume between 1966 and 2003 was nearly 50% less than that of the 1954 to 1966 time period (likely because a huge volume of sediment was input to the system during the 1964 flood); while the total estimated storage volume was approximately 30% greater. The overall net increase in channel-stored sediment indicates that upstream areas are producing and transporting sediment into the Lower Eel River and, along with large flood events (such as the 1964 and 1997 floods), are causing additional sediment problems in the watershed (Appendix C).

Recent assessments of the Lower Eel River watershed indicate that natural conditions (i.e., non-management land uses) contribute 48% (7.5 million cubic yards) of the sediment loading in the watershed (Appendix C). An estimated 52% (8.1 million cubic yards) of the total sediment delivered to streams was attributed to human- and land management-related activities (Appendix C). Timber harvest was the primary management-related activity contributing sediment to the watershed; however, roads were also a significant source. In addition, it was found that the Lower Eel and Larabee Creek areas, especially those with older geology, have higher sediment loading than the Eel River floodplains and terraces and Salt River areas. Chapter 4, the sediment TMDL, reports this information in greater detail.

The Salt River area, once part of the estuary/delta system, has significant sediment problems. A tree fell into the Salt River and sediment has filled in the main channel, trapping additional sediment. This eventually diverted the stream in the eastern half of the subbasin, effectively cutting off 42% of the drainage area from the historic Salt River watershed. Specifically, Williams Creek now drains to Old River and is no longer accessible to salmonids. Wildcat tributaries are the largest source of sediment to the subbasin (Downie and Lucey, 2004).

The CDFG Stream Inventory Reports provide information on stream conditions for salmonids (CDFG, 1991, 1992a, 1992b, 1992c, 1992d, 1992e, 1992f, 1998, 2000a, 2000b, 2000c, 2000d, 2003a, 2003b, 2003c). Using pool embeddedness (estimated visually) as an indicator, variable conditions for salmonids were found by CDFG in the Lower Eel River TMDL area (Table 5). Embeddedness conditions were rated on a scale from 1-4, where 1 is the highest quality for spawning habitat and 4 is the poorest. Category 5 is considered completely unsuitable for spawning (i.e., log sills, bedrock, and boulders). In the Larabee Creek subbasin, an average of only 13% of tailouts sampled were within Category 1; however, this value is higher than that observed in the Salt River subbasin (average of 5% in Category 1) and the tributaries draining directly to the Lower Eel River (average of 6% in Category 1). Overall, the Salt River subbasin had the worst habitat, when compared with the other areas; however, individual streams within a study area displayed significant variability. Such variability is particularly evident when comparing streams with more than one survey. For example, Carson Creek was evaluated in 1992 and 2000 and, while neither survey identified any tailouts in Category 1, the other embeddedness rankings varied considerably (Table 5).

In summary, salmonids have particular biological needs related to stream sediment. The notable sediment delivery loads and erosion in the Eel River, including the Lower Eel River, result in sediment conditions that reduce the spawning and rearing success of salmonids. CDFG found that tributary sediment conditions for salmonids are variable in the Lower Eel River watershed.

Table 5. Embeddedness Ranking for Tailouts

Embeddedness Category (percent embedded)	**Category 1 (0-25%)**	**Category 2 (26-50%)**	**Category 3 (51-75%)**	**Category 4 (76-100%)**	**Category 5**
Spawning Potential	**Best** ⟶			⟶ **Worst**	**Unsuitable**
Stream Name	**Percent of All Tailouts**				
Larabee Creek Watershed					
Larabee Creek (CDFG, 1992d)	20	60	10	10	0
Larabee Creek (CDFG, 2000c)	21	38	22	5	12
Arnold Creek (CDFG, 1992a)	13	0	88	0	0
Balcom Creek (CDFG, 1992b)	0	0	29	71	0
Carson Creek (CDFG, 1992c)	0	27	65	8	0
Carson Creek (CDFG, 2000a)	0	9	27	50	15
Knack Creek (CDFG, 2000b)	43	14	0	0	43
Martin Creek (CDFG, 2000d)	20	23	11	3	43
Scott Creek (CDFG, 1992e)	0	29	57	14	0
Average	***13***	***22***	***34***	***18***	***13***
Salt River System					
Francis Creek (CDFG, 2003a)	2	20	43	32	4
Unnamed Francis Creek Tributary (CDFG, 2003b)	0	0	0	50	0
Williams Creek (CDFG, 2003c)	14	10	20	56	1
Average	***5***	***10***	***21***	***46***	***2***
Tributaries Draining Directly to the Lower Eel River					
Bear Creek (CDFG, 1991)	7	51	37	6	0
Chadd Creek (CDFG, 1992f)	12	36	34	17	0
Chadd Creek (CDFG, 1998)	0	34	53	7	6
Average	***6***	***40***	***41***	***10***	***2***

Note: values have been rounded.

CHAPTER 3: TEMPERATURE TMDLS

This chapter describes the analytical basis for the temperature TMDLs, along with the TMDLs and allocations. The analysis of temperature alterations for the Lower Eel River watershed is divided into two parts. The first part examined the effects of flow and shade on the main channel from South Fork to the estuary. The results of this analysis were described in Chapter 2 – Problem Statement. EPA concluded stream temperatures have not been altered significantly in the main channel; accordingly, EPA has determined that a temperature TMDL is not necessary for the main channel.

Chapter 2 discussed the effects of shade on representative tributaries – Larabee Creek and creeks draining to the Salt River system. The shade analysis indicated that stream temperatures have been altered in the tributaries, adversely affecting beneficial uses; therefore, EPA set TMDLs based on natural shade for two distinct tributary areas: tributary reaches in the Salt River subbasin and all remaining tributary reaches (which are represented by the Larabee Creek analysis). This chapter first describes EPA's interpretation of the narrative water quality standard for temperature and then describes the temperature modeling for solar radiation and shade. Finally, TMDLs are calculated for solar radiation (in terms of langleys/day) and shade allocations are identified for all tributary stream reaches.

3.1. INTERPRETING THE EXISTING WATER QUALITY STANDARDS FOR TEMPERATURE

The temperature TMDLs are calculated to attain the applicable water quality standards. The Basin Plan identifies the following two temperature objectives for surface water:

> "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such an alteration in temperature does not adversely affect beneficial uses."
>
> "At no time or place shall the temperature of any COLD <i.e., water with a beneficial use of cold freshwater habitat> water be increased by more than 5˚F above natural receiving water temperature."

EPA interpreted the above standards for the TMDLs as follows. EPA used a model to compare "natural stream temperatures" with both current stream temperatures and temperatures under a variety of management practices. In considering the first water quality objective, EPA examined whether these alterations (changes in stream temperatures) would adversely affect the most sensitive beneficial use – that is, cold water fish during the summer rearing period. EPA's evaluation of "adverse" effects is based on the scientific literature on steelhead temperature tolerances (summarized in Table 3). EPA evaluated whether the changes in stream temperature also negatively affected the quality of habitat from stream temperatures. In general, any increase (warming) of natural summer stream temperatures is adverse to rearing steelhead in temperatures between 15 - 27˚ C (see Table 3, in Chapter 2). The second water quality objective (i.e., not increasing the stream temperature more than 5˚ F) was evaluated by comparing every modeled point on the stream for exceedance of the 5˚ F objective.

3.2. TEMPERATURE MODELING AND SOURCE ANALYSIS

Stream temperature has been widely studied and the physics of heat transfer is one of the better-understood processes in natural watershed systems (TFW, 2000). Many factors affect stream temperature, including: solar radiation, air temperature, local shading, climate, stream flow and depth, channel morphology, groundwater inflow, and upstream temperatures. Modeling of stream temperature is a well-developed area of inquiry and many models are available to assist policymakers in understanding the factors controlling stream temperatures.

Most sources of heat in the Lower Eel River watershed are from diffuse, nonpoint sources. These lend themselves well to temperature and shade modeling, shade being typically the greatest factor influencing stream temperatures. There are six pipe-end, individual point sources in the watershed permitted under the National Pollutant Discharge Elimination System (NPDES) that have potential to affect temperature in the Lower Eel River watershed: the Humboldt Creamery Fernbridge facility, and WWTPs in Ferndale, Fortuna, Loleta, Rio Dell, and Scotia. The permits are issued by the Regional Board. These sources are prohibited from discharging to the waters of the Lower Eel River watershed from May 15 to October 15. Since the critical time period for temperature is in the summer, these TMDLs are written for the critical summer period, and the pipe-based discharges are not expected to influence temperature for the summer. Therefore, these are not included for further consideration in the source analysis.

Municipal runoff (e.g., the collective effects of people hosing off driveways), municipal and industrial stormwater runoff, construction sites, and California Department of Transportation (CalTrans) facilities that discharge pursuant to NPDES permits are diffuse sources of potential heat to the waters. However, the general permits require these discharges to result in no net increase in receiving water temperatures, and are therefore not expected to influence summer temperatures.

Tetra Tech, Inc. developed and ran a Q2ESHADE model for EPA to evaluate the influences of different shade scenarios. Q2ESHADE, a peer-reviewed, publicly-available model, allows EPA to examine how stream temperatures change in relation to different assumptions on flow, upstream temperatures, and shade (as influenced by the size of riparian vegetation, specifically conifers). Q2ESHADE combines elements of two models (QUAL2E and SHADE) to examine cumulative effects on stream temperature throughout all modeled areas in a stream network. QUAL2E, the first model, is a publicly-available model and is widely used in analyzing many water quality problems. Chen, et al. (1998) originally developed and published a model called SHADE that, when linked to other models, can provide basinwide (e.g., cumulative effects) information regarding streamside vegetation changes. The Tetra Tech version of SHADE is a simplification of certain components of the Chen model (see Appendix A). Inputs from the SHADE model are linked to QUAL2E to provide routing of local stream heating or cooling (from vegetation, flow changes, tributary cooling, etc.) downstream through the stream network.

GIS coverages, including the CALWATER 2.2 watershed boundary, were evaluated to identify appropriate subwatersheds to represent the Lower Eel River watershed. As described in Chapter 2, the SHADE model was applied to the main channel of the Lower Eel River. This modeling effort, along with previous analyses on the Middle Main Eel River (USEPA, 2005), concluded that stream temperatures have not been altered significantly in the main channel of the Lower Eel River. Accordingly, EPA has determined that a temperature TMDL is not necessary for the main channel and the remainder of the discussion on temperature TMDLs focuses on the watershed tributaries. Two tributary areas were selected for modeling during the summer of 2005: 1) Larabee Creek (part of the Larabee Creek HSA), and 2) the creeks draining to the Salt River system (part of the Ferndale HSA). Model configuration, calibration, assumptions, and data are described in detail in Appendix A. For Larabee Creek, all streams in the three downstream subwatersheds of the Larabee Creek HSA were simulated (see Figure A-2 of Appendix A), while three creeks draining to the Salt River system (Reas Creek, Francis Creek, and Williams Creek) were also simulated. (Williams Creek currently drains to the Old River, thus creating a new watershed as described by Downie and Lucey, 2004.) These areas were selected both because they adequately represented the Lower Eel River watershed and because of the availability of monitoring data for use in model configuration and calibration. As documented in Appendix A, the model's performance for Larabee Creek was determined to be very good; the average difference between observed and predicted max7daat was -0.21˚C (range of -0.43 to 0.38˚C at nine monitoring stations).

Modeling in the Salt River subbasin was more complicated, primarily because of the representation of Williams Creek. Specifically, the CALVEG coverage (USDA, 1998) does not appear to represent existing vegetation conditions along Williams Creek well, as noted in conversations with Regional Board staff (McFadin, personal communication, 2006). In addition, the observed data available for Williams Creek from the Resource Conservation District do not follow a consistent diurnal pattern during the modeling period (Figure 5). This is likely due to Williams Creek drying up during the heat of summer (near the end of July), while the temperature probe remained in a pool with fairly constant temperatures. Despite these limitations, the model predicted the overall max7daat results well (-0.53˚C difference between modeled and observed), although these two issues made it impossible for the model to capture the observed hourly pattern for Williams Creek. Because of these uncertainties for Williams Creek, EPA decided to exclude Williams Creek from the calculations for the shade allocations (the TMDLs themselves are based on solar radiation for the entire Salt River subbasin and does not take the temperature monitoring data into consideration; however, it is based on the CALVEG coverage). Therefore, the shading allocations for the Salt River basin are based entirely on Reas Creek and Francis Creek. Reas Creek is nearly four miles long and drains an area of approximately two square miles, while Francis Creek is just over four miles long and drains a slightly larger area of three square miles (Downie and Lucey, 2004).

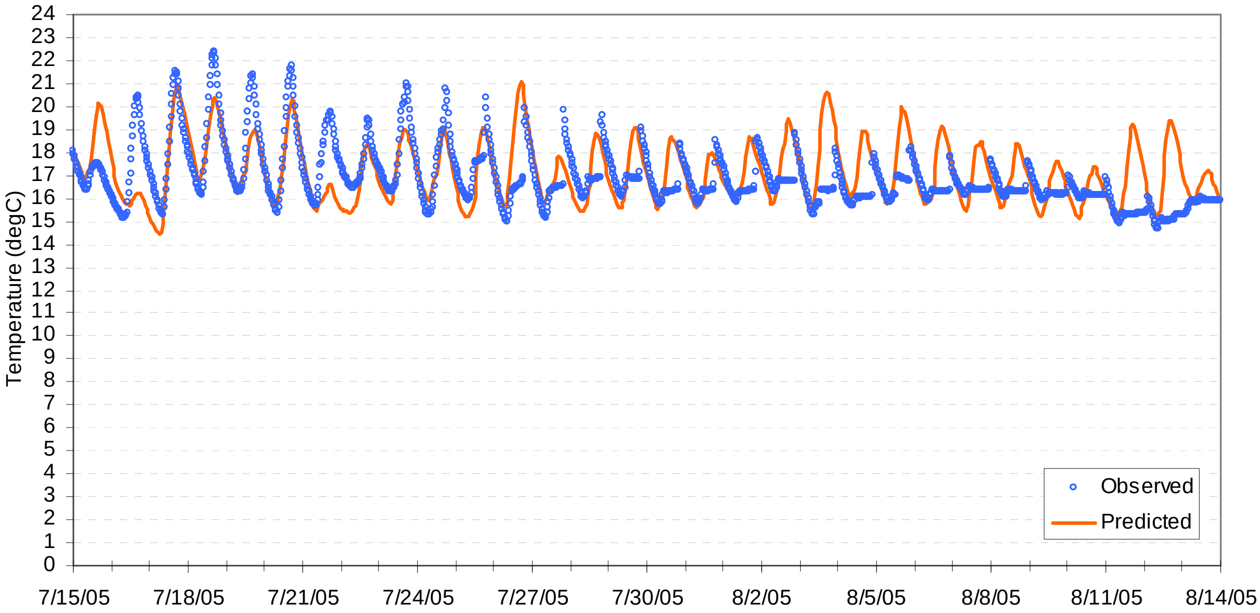


Figure 5. Modeled and observed hourly temperatures for Williams Creek

The model uses heat (the pollutant that causes high temperatures, and is addressed in the TMDLs) expressed in langleys/day (ly/day), and translates the heat load to temperature and shade, which are measurements that can be made directly by land managers. Heat is determined by estimating global solar radiation, and estimating reductions to global solar radiation from factors such as topography and vegetation shading characteristics. This reduction of heat from global solar radiation to heat at the stream surface can be expressed approximately as a percentage of shade over the stream: with no shade (i.e., 0% shade), heat would equal global solar radiation. With 50% shade, half of the global solar radiation would reach the stream. Heat that thus reaches the stream is translated to stream temperature using factors such as width and depth of the stream and temperature of incoming water. The model routes the temperatures through the stream network, to account for cumulative effects of upstream temperatures.

3.2.1. Temperature and Solar Radiation Modeling Scenarios

Larabee Creek and the creeks draining to the Salt River system were selected as representative of all tributaries based on their vegetation characteristics. The modeling compared the changes in stream temperature that result from several different conditions of riparian vegetation. Altering riparian vegetation is the only significant source of stream temperature changes, as large surface or ground water diversions or impoundments are not found in this sparsely populated area.

Streamside vegetation can be removed or altered by channel changes, grazing, vineyard development, housing development, roads, or timber harvest. Timber harvest is regulated under the State's Forest Practice Rules (FPR). The FPR specify 85% canopy retention and the retention of the ten largest conifers per 330 feet of stream, if the stream is anadromous fishbearing. Canopy retention for other streams is 50%. However, the canopy retention can be met while harvesting the tallest trees and, depending upon stream width and other site conditions, shade can be altered when the canopy retention requirement is met. In other words, the FPR do not specifically protect shade over the stream channel.

The analysis conducted for the TMDLs was designed to answer whether current practices and conditions are altering natural stream temperatures. For the modeling, EPA made the assumption that the current vegetation *types* are natural. This means that the type of vegetation is not changed in the modeling; only the *size* and *height* of the vegetation is changed in the modeling.

EPA evaluated seven management scenarios to determine changes to stream temperatures and beneficial uses of summer rearing habitat quality, using the Q2ESHADE model described above, for the Larabee Creek and Salt River stream system networks. The only factor that was varied was vegetation size, the size of conifers being the most influential factor in determining shade. Size of vegetation in the dataset is given a dbh because the model uses height (computed from dbh) to calculate shade characteristics over the stream surface. Appendix A describes the equations used to convert dbh to height. The seven scenarios that were modeled are as follows:

> **Scenario 1 – Current condition (baseline)**. This scenario is developed using the size of the vegetation as provided by the data and assumptions detailed in Appendix A.
>
> **Scenario 2 – Topographical shading only**. This scenario was developed to determine the general importance of vegetation shade in the watershed; it is not meant to reflect current or future conditions. In this scenario, the only shade over the stream is from unvegetated topography, such as adjacent hillslopes. All shade from trees (both conifer and hardwood) was eliminated from the model for this scenario.
>
> **Scenario 3 – 18 inch dbh conifer (private timber management)**. This scenario was one of two developed to illustrate California’s Forest Practice Rules (FPR). Management practices under the FPR have a requirement for 50-85% canopy retention. This results in a variety of trees left in the riparian zone after harvesting, so it is difficult to generalize with any precision what size tree would be left in the riparian zone, given this minimum requirement. Theoretically, an owner can harvest all trees as small as 12 inch dbh under the FPR, but generally it is not economical to do so. In addition, silvicultural management styles vary amongst different private landowners. This scenario represents the result if the entire watershed was harvested at the same time, resulting in 18 inch dbh trees after harvest. This was modeled because no information was readily available on the rate of Timber Harvest Plan (THP) approvals in a watershed. Scenario 3 and 4 both analyze effects of this type of timber management; in practice, the THP approval process may not allow so many THPs to be approved during the same decade. The actual stream temperature effects watershed-wide will result from a combination of the type of riparian management, the proportion of landowners choosing different types of riparian management, and the timing and frequency of riparian management.

Scenario 4 – 24 inch dbh conifer (alternative private timber management). Given the variety of private timberland management styles, EPA modeled a stand of 24 inch dbh trees as another possible representation of the temperature effects of basin-wide private timber management under the FPR.

Scenario 5 – Natural vegetation with 48 inch dbh trees. While it is difficult to generalize on the natural size of conifers and hardwoods given the range of site conditions, 48 inch dbh trees were chosen to represent one "natural" growth scenario for comparative purposes. Appendix A provides more details on tree size data. This "natural" growth scenario is compared to different management scenarios to examine the incremental temperature increases from timber harvest in the area. Riparian vegetation species were not modeled as part of this scenario.

Scenario 6 – Natural vegetation with 60 inch dbh trees. Given the presence of large conifers in the basin, EPA also modeled a stand of 60 inch dbh trees. Similar to the 48 inch dbh scenario, this "natural" growth scenario does not consider historical riparian vegetation.

Scenario 7 – Historical riparian vegetation (with 60 inch dbh trees). To further characterize "natural" conditions, this scenario was designed to add riparian tree species such as alder or willow in all areas modeled under grassland, brush, urban, or agriculture vegetation types. These riparian trees were assigned a constant height of 30 feet. In addition, as in Scenario 6, a maximum dbh of 60 inches was assigned to other trees.

Tables 6 and 7 present the modeling results for Larabee Creek and Salt River tributaries, respectively. Similarly, Figure 6 illustrates the modeled stream miles for each temperature category for Larabee Creek, while Figure 7 illustrates the results for the creeks draining to the Salt River system. Current stream temperatures in the tributaries appear to be an alteration (warming) of natural or historical stream temperatures. It is also clear that topographic shade does not contribute significantly to either of the two study areas; thus, vegetation plays a substantial role.

As shown in Table 6 and Figure 6, current stream temperatures in Larabee Creek are slightly warmer than would be expected under natural and historical stream conditions. The most significant change occurs in one of the "stressful" temperature categories, in which the model estimates that under current conditions, 9% of stream miles are between 21 and 22˚C. In the historical riparian vegetation scenario, this proportion decreases to 2%. Stream temperatures could be somewhat worse if more timber harvest were to occur under the Forest Practice Rules (FPR); both the 24 inch dbh and the 18 inch dbh scenarios would result in slightly warmer temperatures over current conditions.

Table 6. Stream Miles by Temperature Category for Larabee Creek

Temperature Category	Historical Riparian Vegetation		60 Inch dbh	48 Inch dbh	Baseline Conditions		24 Inch dbh	18 Inch dbh	Topo-graphic Shading
	Stream Miles	% of Total	Stream Miles	Stream Miles	Stream Miles	% of Total	Stream Miles	Stream Miles	Stream Miles
Good (max7daat < 15℃)	72.4	48%	71.8	71.5	69.3	47%	70.8	63.4	10.6
Fair (15℃ < max7daat < 17℃)	28.0	19%	28.3	28.6	28.9	19%	28.3	33.2	26.7
Marginal (17℃ < max7daat < 19℃)	14.9	10%	15.2	14.9	15.2	10%	13.0	13.4	26.7
Stressful (19.1℃ < max7daat < 20℃)	15.5	10%	15.2	9.6	5.9	4%	6.5	7.8	10.6
Stressful (20.1℃ < max7daat < 21℃)	14.3	10%	14.6	19.9	15.2	10%	9.6	6.5	10.9
Stressful (21.1℃ < max7daat < 22℃)	3.4	2%	3.4	4.0	14.0	9%	18.0	14.3	5.0
Stressful (22.1℃ < max7daat < 23℃)	0.0	0%	0.0	0.0	0.0	0%	2.2	9.9	5.6
Stressful (23.1℃ < max7daat < 24℃)	0.0	0%	0.0	0.0	0.0	0%	0.0	0.0	6.2
Lethal (max7daat > 24℃)	0.0	0%	0.0	0.0	0.0	0%	0.0	0.0	46.3
TOTAL	148.5	100%	148.5	148.5	148.5	100%	148.4	148.5	148.6
Solar Radiation (Langleys/day)	**118.3**		124.6	126.2	**143.3**		144.7	166.8	589.6
% Shade	**82.9%**		82.1%	81.9%	**79.5%**		79.3%	76.2%	17.2%

Table 7. Stream Miles by Temperature Category for Salt River Tributaries

Temperature Category	Historical Riparian Vegetation		60 Inch dbh	48 Inch dbh	Baseline Conditions		24 Inch dbh	18 Inch dbh	Topo-graphic Shading
	Stream Miles	% of Total	Stream Miles	Stream Miles	Stream Miles	% of Total	Stream Miles	Stream Miles	Stream Miles
Good (max7daat < 15℃)	5.9	58%	4.3	4.3	4.3	42%	4.3	4.3	0.0
Fair (15℃ < max7daat < 17℃)	4.3	42%	5.3	5.3	5.3	52%	5.3	5.3	6.8
Marginal (17℃ < max7daat < 19℃)	0.0	0%	0.6	0.6	0.6	6%	0.6	0.6	3.4
Stressful (19.1℃ < max7daat < 20℃)	0.0	0%	0.0	0.0	0.0	0%	0.0	0.0	0.0
Stressful (20.1℃ < max7daat < 21℃)	0.0	0%	0.0	0.0	0.0	0%	0.0	0.0	0.0
Stressful (21.1℃ < max7daat < 22℃)	0.0	0%	0.0	0.0	0.0	0%	0.0	0.0	0.0
Stressful (22.1℃ < max7daat < 23℃)	0.0	0%	0.0	0.0	0.0	0%	0.0	0.0	0.0
Stressful (23.1℃ < max7daat < 24℃)	0.0	0%	0.0	0.0	0.0	0%	0.0	0.0	0.0
Lethal (max7daat > 24℃)	0.0	0%	0.0	0.0	0.0	0%	0.0	0.0	0.0
TOTAL	10.3	100%	10.3	10.3	10.3	100%	10.3	10.3	10.3
Watershed-wide Solar Radiation (Langley/day)	**362.3**		400.5	400.7	**405.9**		406.4	412.8	530.4
% Shade - Francis Creek	**66.2%**		52.7%	52.7%	**50.7%**		51.5%	50.2%	17.8%
% Shade - Reas Creek	**50.2%**		38.5%	38.4%	**37.5%**		37.0%	35.7%	15.2%
% Shade - Average	**59.4%**		46.7%	46.6%	**45.1%**		45.3%	44.0%	16.7%

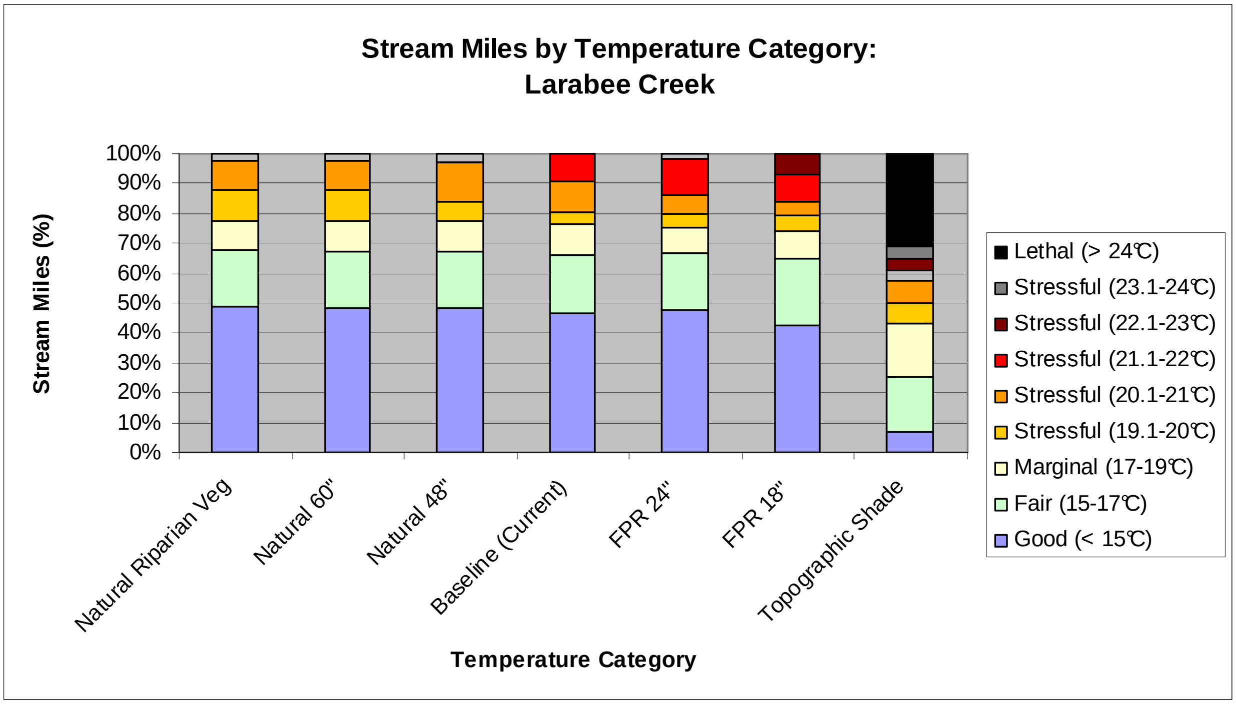


Figure 6. Larabee Creek Stream Miles by Temperature Category

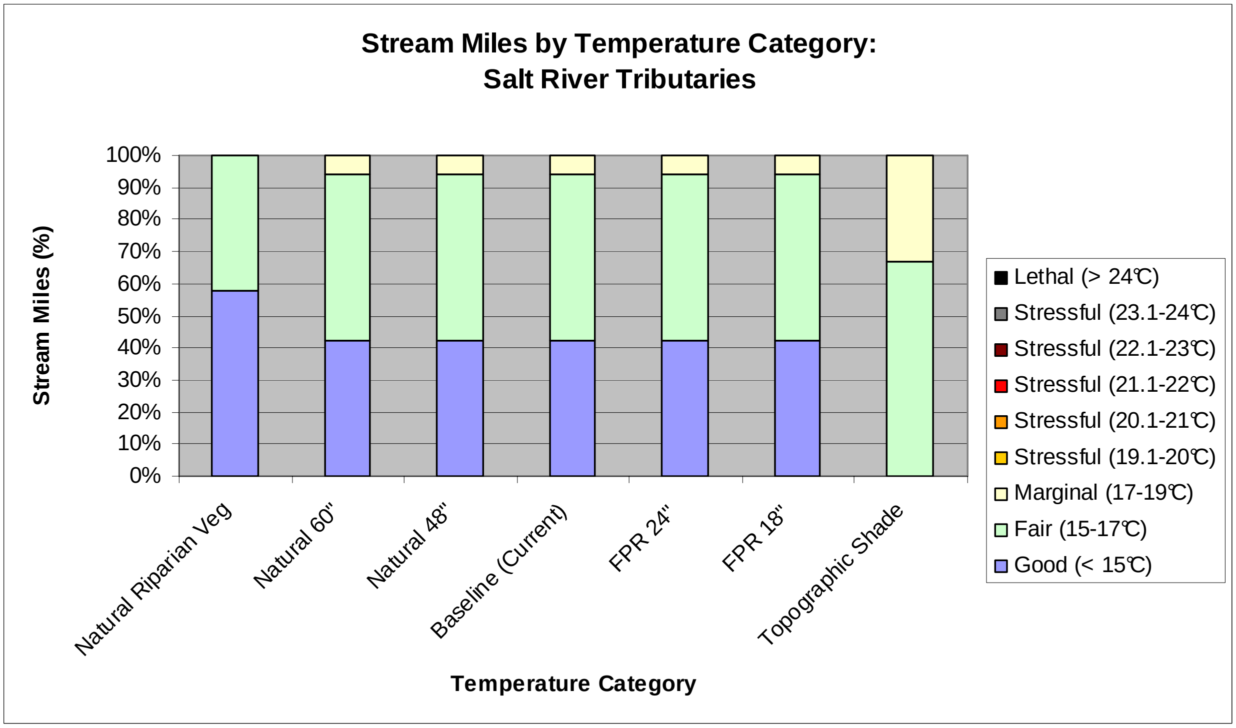


Figure 7. Salt River Tributaries Stream Miles by Temperature Category

Table 7 and Figure 7 show the same information for Reas and Francis creeks in the Salt River subbasin, which are noticeably cooler currently and historically. Under current conditions, 93% of stream miles in the tributaries are categorized as “good” (cooler than 15˚C) or “fair” (15-17˚C). The sample size is much smaller for this study area (10.3 total stream miles) than for Larabee Creek (149 miles). However, the total proportion of stream miles in the “good” category would be much higher under historical riparian conditions (58% historically compared to 42% today). No stream segments would be any warmer than the “fair” category under historical riparian conditions (i.e., all stream miles would be categorized as “good” or “fair,” including the small percentage of stream miles currently in the marginal category [17-19˚C]).

3.2.2. Selection of Scenario Corresponding to Water Quality Standards

The narrative water quality standard states “the natural receiving water temperature ...shall not be altered unless it can be demonstrated...that such an alteration in temperature does not adversely affect beneficial uses.” Natural receiving water temperatures are associated with a representation of natural habitat, which is identified as the environmental settings present before significant human impacts. These conditions are represented in the model by considering the realistic “site potential” or “natural” conditions throughout the watershed. The modeling scenario corresponding to water quality standards are described below.

For all tributaries in the Lower Eel basin, EPA concludes that the historical riparian vegetation scenario (Scenario 7) corresponds best to the phrase “natural stream temperatures shall not be altered” in the State’s water quality standard, and it provides for a Margin of Safety in meeting the water quality standards (see Section 3.3.3). Scenario 7 best represents the natural conditions throughout the majority of the watershed because it incorporates the influence of riparian vegetation along with the presence of large conifer trees. EPA concludes that the estimated magnitude and extent of increased stream temperatures in the tributaries is an alteration of stream temperatures. Furthermore, EPA finds that, based on the biological literature, this warming is adverse to salmonids. EPA recognizes that natural conditions do not necessarily provide optimal summer temperatures for salmonids.

EPA also examined the geographic extent and magnitude of the temperature changes. In Larabee Creek, under current conditions, 25% of the modeled stream segments are warmer than natural conditions by more than 0.5˚C, while 2% are warmer by more than 1.0˚C. For the creeks draining to Salt River, under current conditions, 24% of modeled stream segments are warmer than natural conditions by more than 0.5˚C, while 15% are more than 1.0˚C warmer. Figures 8 and 9 provide details on the magnitude and extent of the modeled improvements in conditions in Larabee Creek and the Salt River subbasin, respectively.

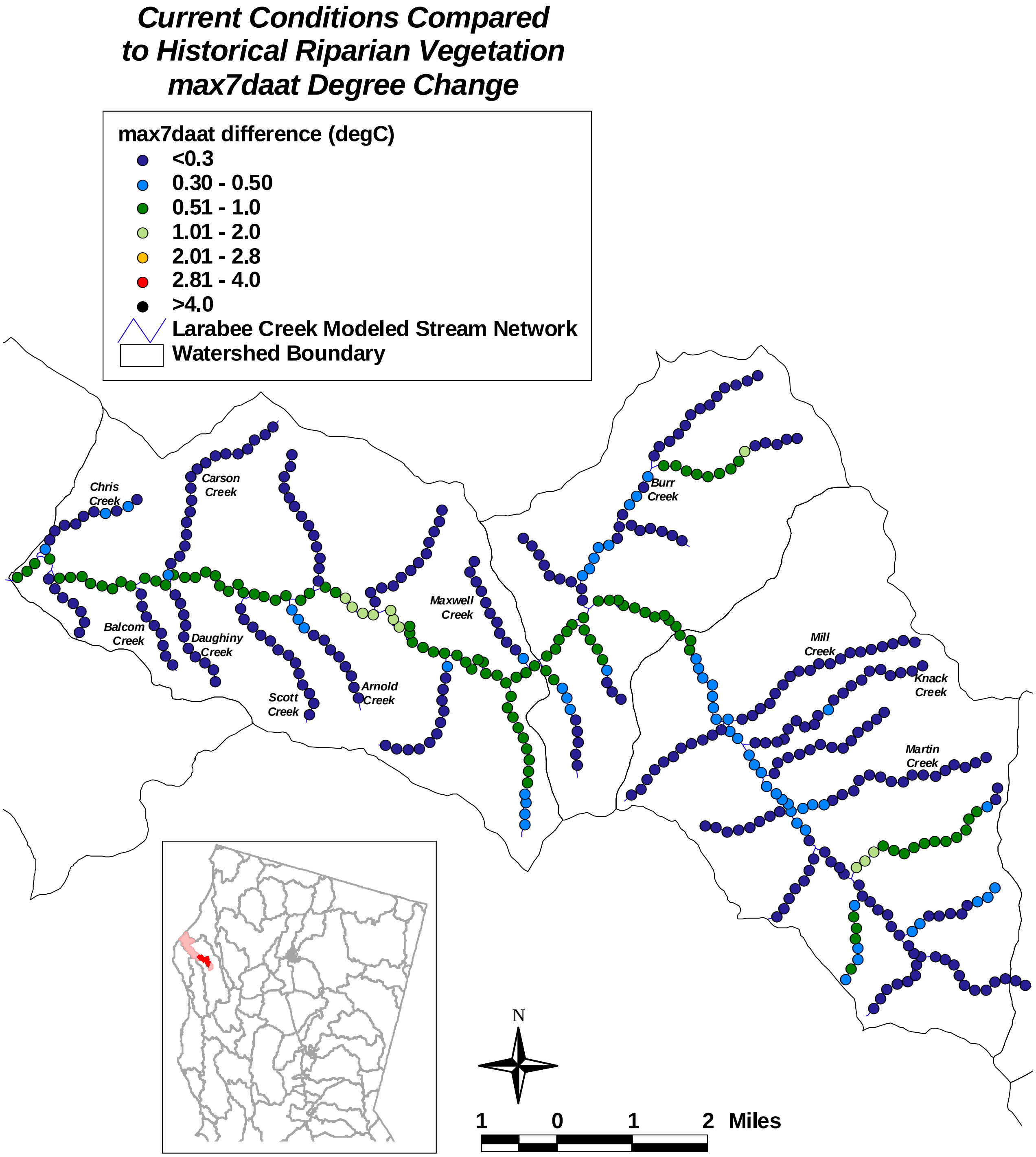


Figure 8. Temperature change between natural and current conditions in Larabee Creek

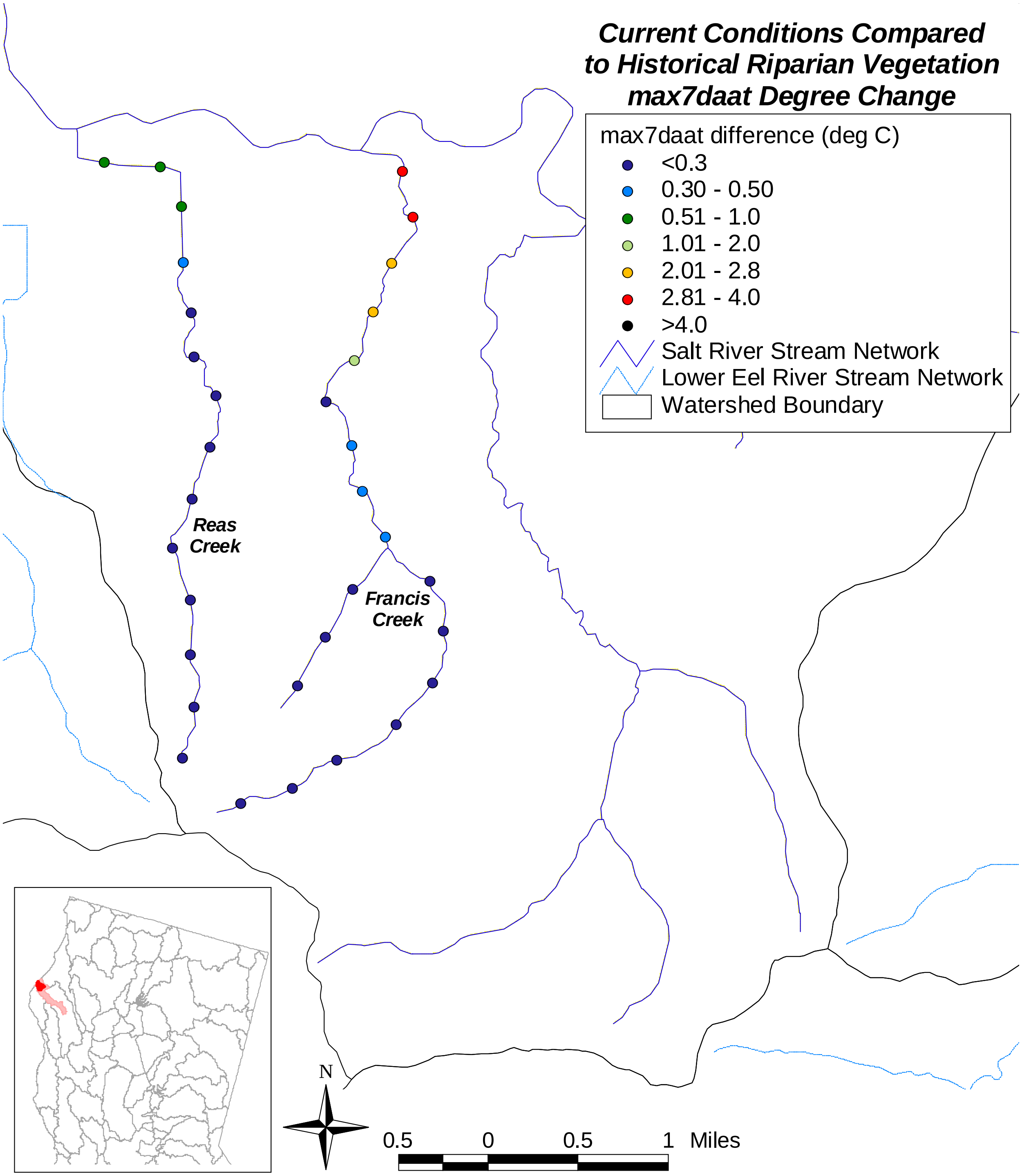


Figure 9. Temperature change between natural and current conditions in the creeks draining to the Salt River system

3.3. SOLAR RADIATION TMDLS FOR TRIBUTARIES IN THE LOWER EEL RIVER

Because our analysis indicates that water quality standards for temperature are generally not being attained in the tributaries, EPA has established TMDLs for the tributary streams as required by Section 303(d) of the Clean Water Act and EPA regulations. As described in Chapter 2, a TMDL is not needed for the main channel of the Eel River from the South Fork to the estuary. Two distinct tributary types were identified because of their different characteristics: tributary reaches in the Salt River subbasin and all remaining tributary reaches. These areas are identified in Figure 10, and TMDLs are established separately for each area. The Salt River subbasin is unique, and a TMDL is established for the Salt River subbasin based on the modeling for that subbasin. The other tributaries in the Lower Eel River TMDL area are represented by the Larabee Creek modeling. The Larabee Creek area is representative of the remaining tributaries because its vegetation characteristics are similar to many other areas in the watershed. Future modeling of additional subbasins, if undertaken, can be used to refine the TMDL for specific tributaries; otherwise, the loading for all tributaries shall apply.

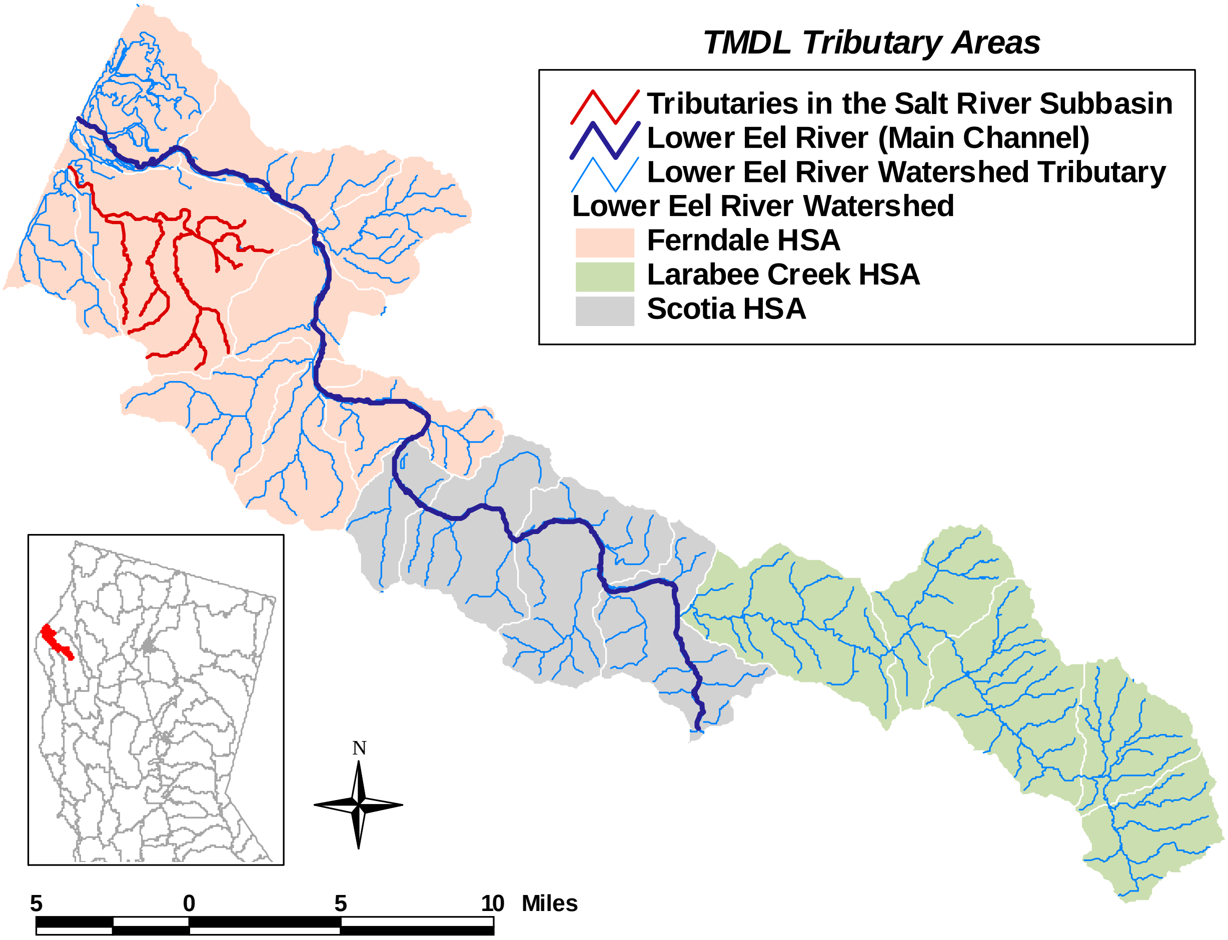


Figure 10. TMDL Areas

3.3.1. Loading Capacity and TMDLs – Solar Radiation

A TMDL is the total loading of a pollutant that the river can assimilate and still attain water quality standards. In these TMDLs, the pollutant is heat, measured in langleys/day (ly/day). Langleys are a measure of heat energy per surface area per time unit (or gram calories per cubic centimeter) and can be converted to metric units such as joules (1 ly = 41,850 joules/m^2) or watts or BTUs. We are setting the TMDLs equal to the amount of heat the waterbody would receive under the historical riparian vegetation scenario (i.e., Scenario #7). This is shown in Table 6 for Larabee Creek (which represents all the tributaries other than Salt River), and in Table 7 for Salt River.

The TMDLs are calculated using the natural scenario as described previously for the two TMDL areas (Figure 10). The modeled calculations (Tables 6 and 7), based on simulations performed during the critical period of July 15 through August 14, 2005, are used to express the TMDLs. These calculations are the result of several modeling steps. Global solar radiation over each stream segment (i.e., the solar radiation that exists above the vegetation at this latitude) is calculated. Next, the model calculates the actual amount of radiation (heat in langleys) that would reach each stream segment after accounting for topographical shading, stream orientation, stream width, and the potential height of the riparian vegetation. While the model calculates the amount of heat for each stream sampling point, the TMDL is expressed as an average of all stream sampling points in each TMDL area for summary purposes.

> **The temperature TMDLs for all stream reaches are set equal to the heat load that corresponds with natural shade conditions. The resulting heat load is calculated as 362 langleys/day in the Salt River basin and 118 langleys/day in all remaining tributary reaches.**

The TMDLs are mathematical averages of the amount of heat that would reach the stream surface for each stream segment modeled, after accounting for the natural size of conifers and hardwood trees and historical riparian vegetation. These TMDLs are set equal to the loading capacity of the streams and will allow water quality standards for temperature to be achieved. The TMDLs can also be expressed as equivalent to the heat reaching the streams in the watershed when every stream segment has “natural” shade. For the tributary reaches in the Salt River subbasin, this represents an 11% reduction in heat over current conditions; the current heat load is 406 langleys/day overall in the Salt River basin (Table 7). For the remaining tributary reaches in the Lower Eel River TMDL area, a 17% reduction in the heat load over current conditions is required; the current heat load is 143 langleys/day (Table 6).

3.3.2. Allocations

EPA regulations define a TMDL as the sum of wasteload allocations for point sources + the sum of the load allocations for nonpoint sources + the sum of load allocations for background (i.e., natural loading). Although nonpoint sources are responsible for most heat loading in the watershed, point sources may also discharge some heat in the watershed. Current and prospective future point sources that may discharge warm water in the watershed and are therefore at issue in these TMDLs include both stormwater (e.g., municipal and construction sites) and non-stormwater discharges.

Load Allocations

These TMDLs have an implicit margin of safety that is provided by conservative assumptions in the analysis (see Section 3.3.3). Therefore, the TMDLs are set equal to the loading capacity, and the load allocations are sufficient to result in the attainment of the water quality standards and TMDLs. Although the TMDLs are set in langleys, the load allocations are expressed as percent shade.

While it is theoretically possible to measure langleys/day for streams, in practice, shade is a more common application and widely understood concept. The percent shade in the TMDL allocations (based on simulations performed during the critical period of July 15 through August 14, 2005) uses a time component in the calculations. The shade values expressed here are equivalent to the calculation of the accumulated reduction in solar radiation during the modeling period, on a daily average. (The model calculates the accumulated heat as the sun's path moves throughout the day). Various measurement devices can approximate this value, such as a solar pathfinder. We have calculated the allocations using the model by translating the TMDLs in langleys/day into average shade allocations for the TMDL areas in the watershed.

The load allocations are expressed as the percent shade that corresponds with natural shade conditions. Percent shade is calculated in the model as the amount of solar radiation reaching the stream surface divided by the potential natural solar radiation (which is the solar radiation that would reach the stream surface with the historical riparian vegetation). The shade allocation for the tributary reaches for the Salt River subbasin is a 59% reduction of total global solar radiation, or the equivalent of a minimum 59% shade (see Table 7). This is approximately 14% more shading than what exists under current conditions (45%). The shade allocation for all remaining tributary reaches (Table 6) is 83% shade (approximately 3% more shading than what exists under current conditions).

Figures 11 and 12 provide the geographic distribution of the expected natural shade (the load allocations) for the stream reaches in Larabee Creek and the creeks draining to the Salt River system, respectively. Appendix A provides information on the geographic distribution for all modeled scenarios.

Wasteload Allocations

Diffuse discharges subject to General National Pollutant Discharge Elimination System (NPDES) permits:

- California Department of Transportation (CalTrans) facilities that discharge pursuant to the CalTrans statewide NPDES permit issued by the Regional Board,
- Construction sites larger than 1 acre that discharge pursuant to California's NPDES general permit for construction site runoff,
- Industrial facilities that discharge pursuant to California's NPDES general permit, and
- The City of Fortuna, permitted under the NPDES Municipal stormwater program.

Waste Water Treatment Plants (WWTPs) and other individual point sources subject to an NPDES permit:

- Ferndale,
- Loleta,
- Fortuna,
- Rio Dell,
- Scotia, and
- Humboldt Creamery Fernbridge facility.

For the diffuse permitted sources, such as municipal and industrial stormwater discharges, CalTrans facilities, construction sites, and municipalities, as well as for discharges that are subject to NPDES permits but are not currently permitted, the waste load allocation (WLA) is expressed as follows: 0 net increase in receiving water temperature.

For the WWTPs and other point sources (i.e., discharges from a pipe to the waters of the Lower Eel River), discharges are prohibited from May 15 to October 1; therefore, they are not expected to influence temperature in the Lower Eel River watershed during the critical period for salmonids, which is the period for which these TMDLs are written. **Thus, for the current and future WWTPs and other individual point sources, the WLA is 0.**

Instream Indicators

The stream temperatures expected to meet the narrative water quality standard “natural stream temperatures shall not be altered” are displayed in Figure 13 and Figure 14 for the representative tributary stream networks. The figures indicate that when the narrative water quality standard is attained, the measured stream temperatures will be variable. EPA recommends that given the wide range of natural stream temperatures, attainment of the TMDLs be monitored based on the progress toward natural shade.

3.3.3. Margin of Safety

Under EPA regulations, a margin of safety may be provided explicitly by not allocating a portion of the available TMDL or implicitly through use of conservative analytical assumptions. In these TMDLs, an implicit margin of safety is provided through some conservative analytical assumptions. First, refugia from groundwater sources and springs may be providing the crucial refugia for salmonids in these areas, and incremental increases in ambient stream temperatures from human influences may not be as detrimental as assumed. Second, the salmonid response to temperature differences in streams may be mitigated by the presence of habitat diversity, given that salmonids move to areas where conditions are more optimal for growth. Thus, the adverse effects of stream temperature increases will be less than predicted. Third, a conservative approach was used in selecting the historic riparian vegetation scenario to model and set the TMDLs. While extensive riparian trees may not have historically occurred throughout the entire Salt River drainage area, their presence in the upstream reaches justifies use of this scenario for TMDL development. Fourth, sediment control measures in the watershed will benefit stream temperature conditions, thus resulting in further stream temperature reductions. These assumptions provide an implicit margin of safety as required by 303(d) of the Clean Water Act.

An ongoing Salt River Ecosystem Restoration Project may result in unanticipated improvements to temperature conditions in the Salt River subwatershed. The results of this are not known at this time, but any unanticipated improvements are implicitly incorporated into this Margin of Safety.

3.3.4. Seasonal Variation and Critical Conditions

In accordance with EPA regulations, the TMDL must account for seasonal variations and critical conditions. In the Lower Eel River watershed, summer defines the critical period when stream temperatures are most likely to have adverse impacts on beneficial uses. To account for seasonal variations and critical conditions, the analysis is based on the warmest (summer period) max7daat (i.e. the maximum weekly average of the 7-day running average of all monitored temperatures). Temperatures are not limiting to beneficial uses during the winter period.

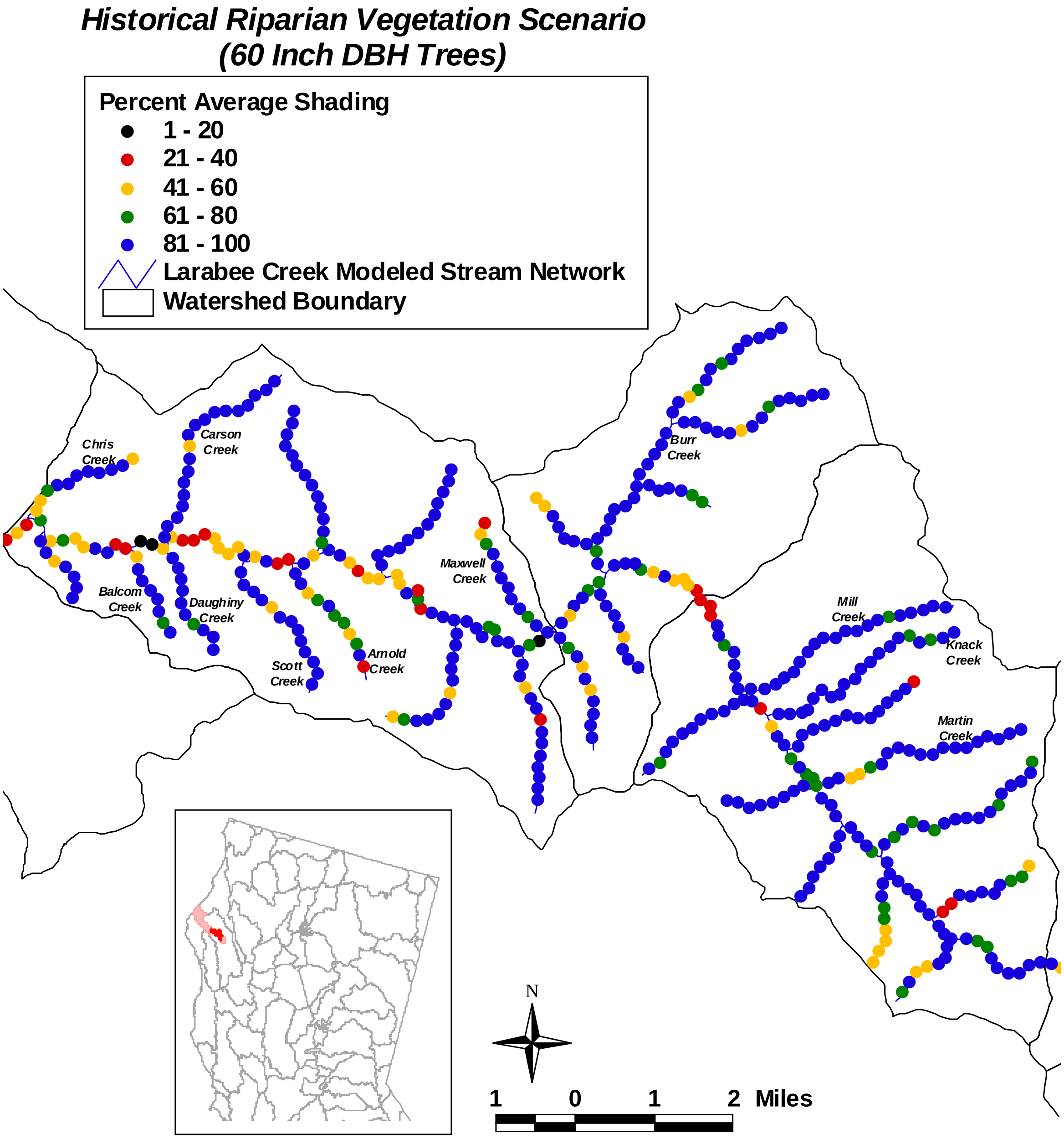


Figure 11. Percent average shading for natural vegetation (shade allocations) in Larabee Creek and other tributaries (other than Salt River) in the Lower Eel River TMDL area

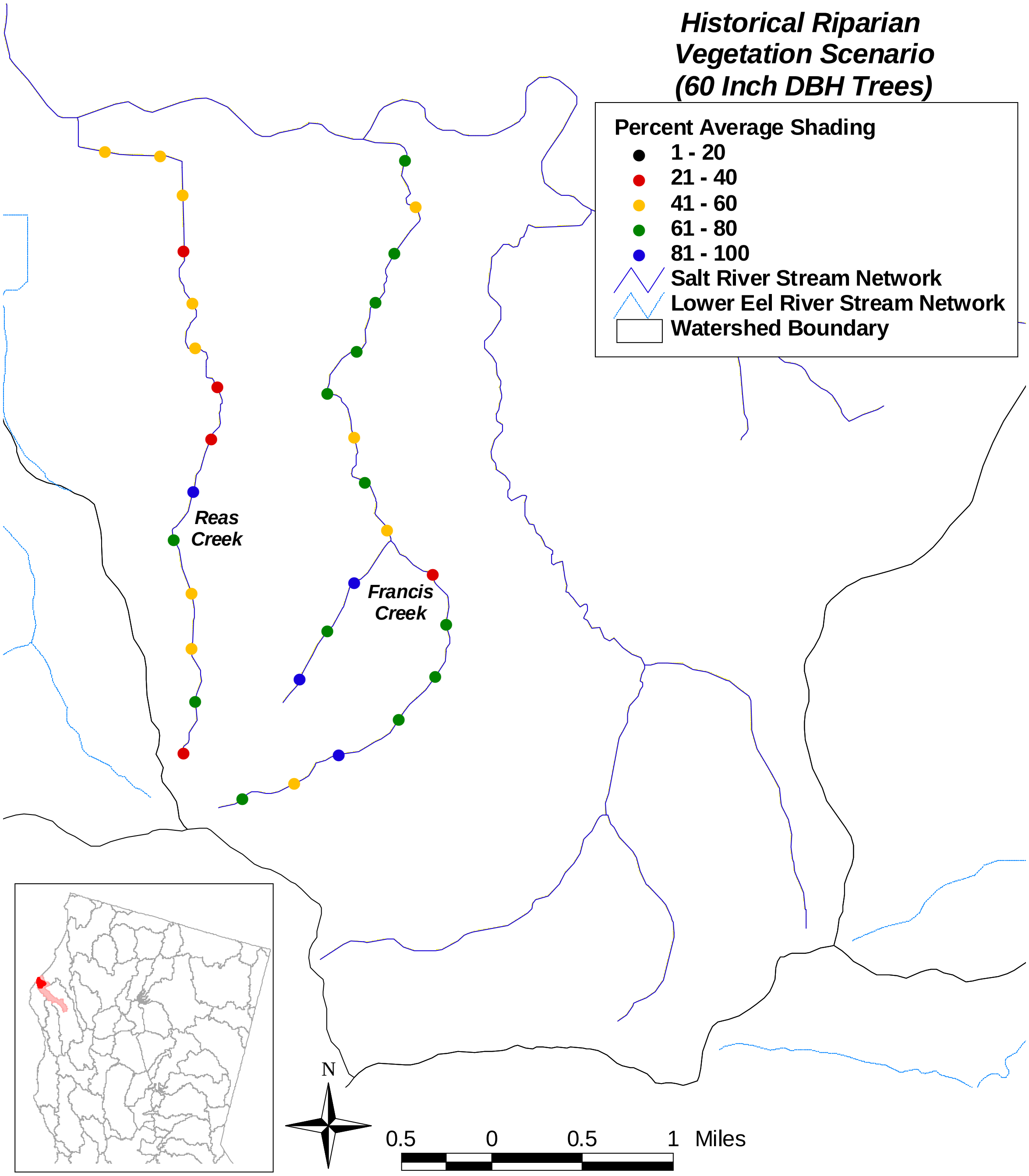


Figure 12. Percent average shading for natural vegetation (shade allocations) in the creeks draining to the Salt River system

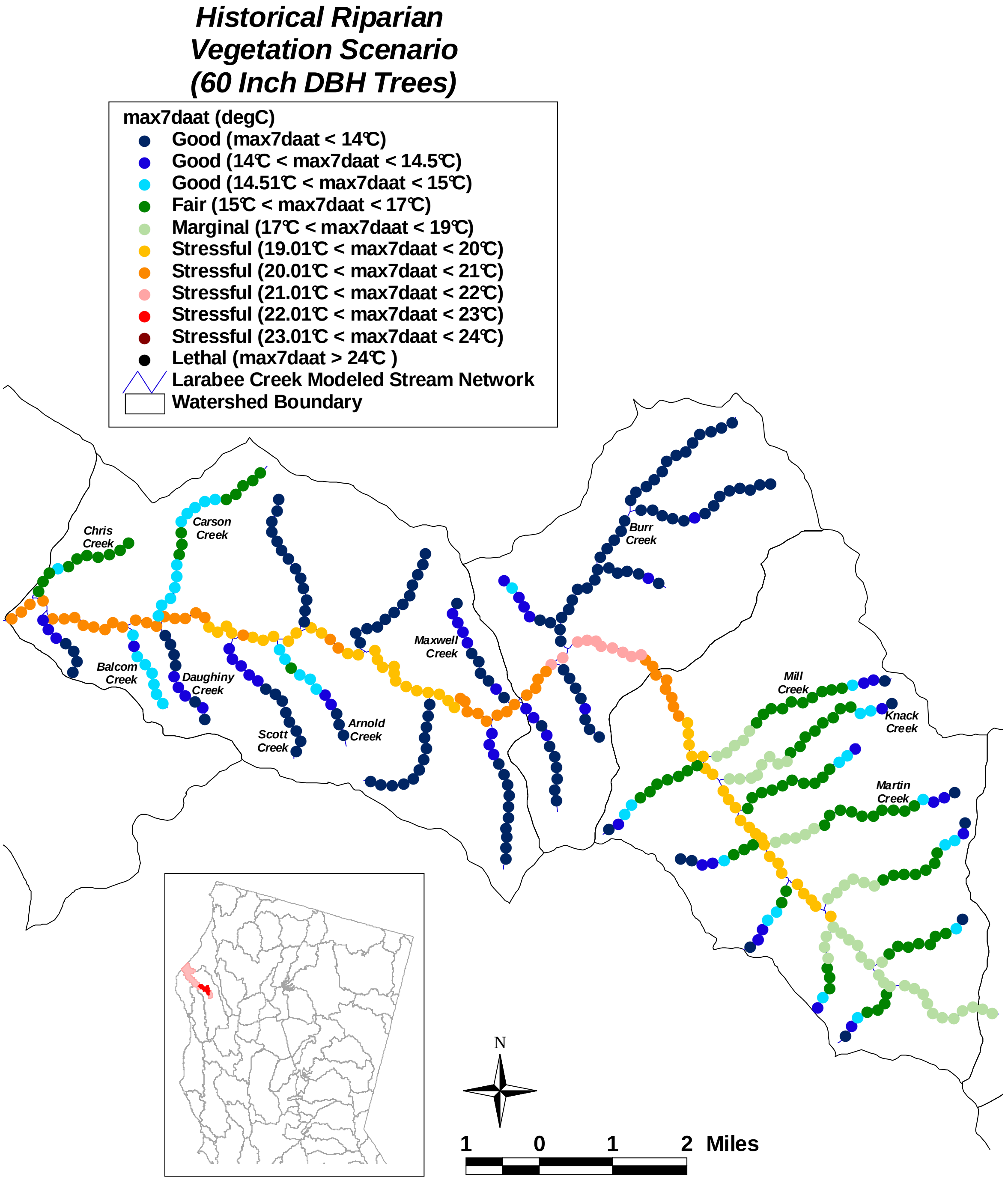


Figure 13. Natural stream temperatures (Temperature TMDL indicators) in Larabee Creek and other tributaries (other than Salt River) in the Lower Eel River TMDL area

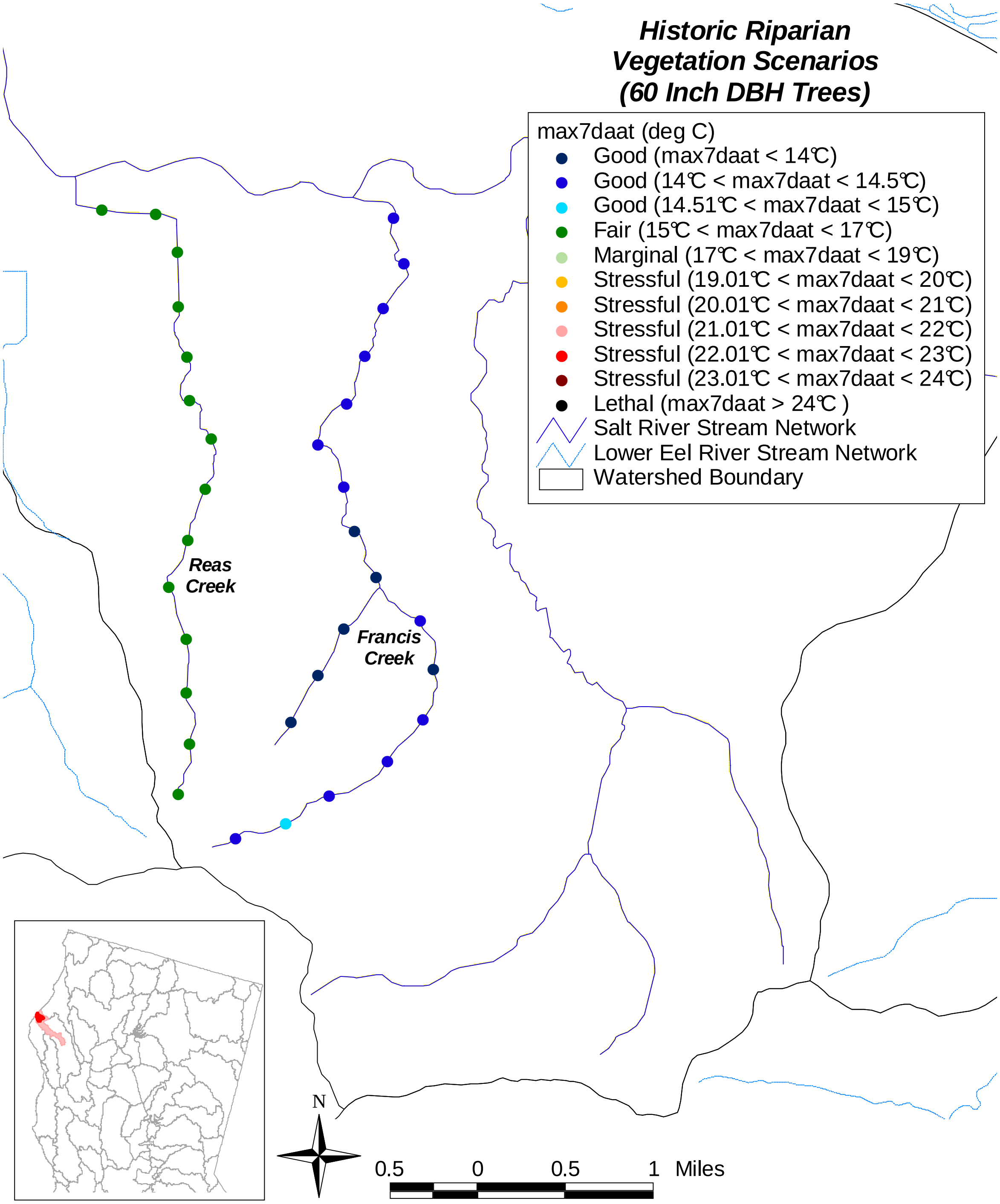


Figure 14. Natural stream temperatures in the creeks (Temperature TMDL indicators) draining to the Salt River system

CHAPTER 4: SEDIMENT TMDL

This chapter presents the sediment TMDL for the Lower Eel River watershed, along with the technical analysis. The first section summarizes the results of the sediment source assessment. The second section presents the TMDL and assumptions used to set the TMDL. The TMDL is the total loading of sediment that the Lower Eel River and its tributaries can receive without exceeding water quality standards. The third section identifies water quality indicators, which are interpretations of the narrative water quality standards. These indicators can also be used to evaluate stream conditions and progress toward or achievement of the TMDL.

The sediment source analysis for the Lower Eel River watershed was conducted for EPA by Pacific Watershed Associates (PWA) under subcontract to Tetra Tech, Inc. The analysis concludes that current sediment loading (based on average 1955 – 2003 rates) is 208% of natural loading. This is in excess of the TMDL, which is set at 125% of the natural sediment load (averaged over time to account for large storms). Sediment delivery and erosion from human disturbance is primarily related to timber harvest and, to a lesser extent, roads, while 48% of the total sediment load is not associated with anthropogenic activity.

4.1. SEDIMENT SOURCE ASSESSMENT

This section summarizes the results of the sediment source assessment. The purpose of the sediment source assessment was to identify and estimate the relative amounts of sediment from the various sediment delivery processes and sources in the watershed. This section is a summary of the methodology, results, and interpretation of the PWA sediment source assessment. Appendix C contains additional details on the results by geology, subwatershed, and type of erosional feature, as well as a detailed description of methodologies and assumptions.

Most sources of sediment in the Lower Eel River watershed are from diffuse, nonpoint sources, including runoff from roads, timber operations, and natural background. Additionally, there are five Waste Water Treatment Plants (WWTPs) in the watershed that are permitted under the National Pollutant Discharge Elimination System (NPDES) to discharge total suspended solids (TSS) and suspended solids (SeS). These permits are issued by the Regional Board. WWTPs in Ferndale, Loleta, Fortuna, Rio Dell, and Scotia, provide secondary or equivalent to secondary treatment. The permits for these facilities include the following monthly average concentration limits for TSS and SeS:

- Ferndale: TSS 95 mg/l; SeS 0.1 ml/l
- Fortuna: TSS 30 mg/l; SeS 0.1 ml/l
- Loleta: TSS 30 mg/l; SeS 0.1 ml/l
- Rio Dell: TSS 30 mg/l; SeS 0.1 ml/l
- Scotia: TSS 30 mg/l; SeS 0.1 ml/l

The Humboldt Creamery Fernbridge Facility is not permitted to discharge TSS or SeS.

Municipal runoff (e.g., the collective effects of people hosing off driveways), municipal and industrial stormwater runoff, construction sites, and California Department of Transportation (CalTrans) facilities that discharge pursuant to NPDES permits are diffuse, permitted sources of potential sediment to the waters. These potential loads are expected to generate and deliver sediment at rates that are similar to nonpoint sources.

4.1.1. Sediment Source Assessment Methodology

The sediment source assessment for the Lower Eel River and tributaries was conducted to identify the relative contribution of sediment delivered to stream channels. This involved identifying, quantifying, and classifying sediment sources and providing information pertaining to the controllability of sediment production. The sediment source assessment covers the period 1955 – 2003, in order to capture the sediment delivered during large storms (especially 1964 and 1997). There were two general components to the sediment source assessment: an analysis on lands not owned by PALCO (the largest private landholder in the basin) and a separate analysis on PALCO-owned land in the Lower Eel River watershed. The distinction was necessary because PALCO did not provide roads or mass wasting data for the source analysis; accordingly, two different methods were employed to determine sediment loading where data sources differed. PALCO-owned land dominates the western portion of the Larabee HSA, most of the Scotia HSA, and the Howe Creek subbasin located in southeast Ferndale HSA (see Figure 1). The results of these separate analyses were combined to quantify sediment loading in the entire TMDL study area (Appendix C).

For both analyses (PALCO and non-PALCO), the CALWATER 2.2 watershed layer was delineated into strata based on location, vegetation type (forested versus un-forested), and geology (young versus old). Young geology includes the Wildcat Group and younger lithologies (i.e., terrace and marine sediments and alluvium), while old geology includes the Yager Formation and older lithologies (i.e., Franciscan sandstone and mélange). The unique strata identified in the watershed are described in Table 8 along with their area and locations in the basin, while Figure 15 illustrates the strata distribution. In general, the Eel River Terraces and Floodplains, Salt River Terraces and Floodplains, and the Upper Salt River strata (1 through 6 in Table 8) all fall within the Ferndale HSA, while the Lower Eel River strata (7 through 10) are located in both the Ferndale and Scotia HSAs. Larabee Creek strata (11 through 14) are contained within the Larabee Creek HSA. Most of the PALCO lands are in the Lower Eel River strata (young and old geology) as well as the Larabee Creek old geology (Table 8).

Four types of sediment sources (episodic road erosion, stream bank erosion, mass wasting, and road surface erosion) were evaluated; however, the methods used to quantify sediment delivery were not always identical. Specifically, episodic road erosion and bank erosion were estimated on non-PALCO and PALCO lands using the same assumptions and methodologies; however, due to the lack of available information on PALCO lands, different methods were employed for PALCO lands to estimate mass wasting and road surface erosion. In all cases, PWA used the best information available to construct the sediment source analysis. Volumes of sediment were estimated by terrain type and management association; these were translated into unit loading rates (tons per square mile per year [tons/mi^2/yr]) using a conversion factor of 1.4 tons/yds^3.

Table 8. Strata Identified in the Lower Eel River Watershed

Strata Area Number	Location	Terrain/ Geology Type[1]	Vegetation Type[2]	Area (mi^2) Non-PALCO	PALCO	Total	Percent of Basin
1	Eel River Terraces and Floodplains	Young Geology	Un-forested	26.3	0.0	26.3	8.8%
2	Eel River Terraces and Floodplains	Young Geology	Forested	2.3	0.0	2.3	0.8%
3	Salt River Terraces and Floodplains	Young Geology	Un-forested	21.0	0.0	21.0	7.0%
4	Salt River Terraces and Floodplains	Young Geology	Forested	0.7	0.0	0.7	0.2%
5	Upper Salt River	Young Geology	Un-forested	1.4	0.01	1.4	0.5%
6	Upper Salt River	Young Geology	Forested	11.2	0.2	11.4	3.8%
7	Lower Eel River	Young Geology	Un-forested	28.2	2.3	30.5	10.2%
8	Lower Eel River	Young Geology	Forested	29.6	28.7	58.3	19.5%
9	Lower Eel River	Old Geology	Un-forested	3.9	2.0	5.9	2.0%
10	Lower Eel River	Old Geology	Forested	12.2	41.1	53.3	17.8%
11	Larabee Creek	Old Geology	Un-forested	12.9	1.3	14.2	4.7%
12	Larabee Creek	Old Geology	Forested	51.7	16.9	68.6	22.9%
13	Larabee Creek	Young Geology	Un-forested	0.0	0.5	0.5	0.2%
14	Larabee Creek	Young Geology	Forested	0.0	4.7	4.7	1.6%
Totals				**201.4**	**97.7**	**299.1**	**100%**

[1] Young geology pertains to Wildcat Group and younger lithologies (primarily Quaternary). Old Geology pertains to terrain older than the Wildcat Group (i.e., Yager terrain and Franciscan mélange). In general, old geology is more erodible than young geology.

[2] Forested terrain refers to areas dominated by conifers and hardwoods. Un-forested terrain is dominated by grasslands, scrub/brush, and areas not dominated by conifers and hardwoods.

Episodic road erosion

For both non-PALCO and PALCO lands, to estimate episodic road erosion and sediment delivery (i.e., for stream crossing washouts, road-related landslides, and road-related gullying), rates were determined from a field inventory (for Eel River floodplain and terrace and Salt River floodplain and terrace) and existing studies (all other terrain types) conducted in similar terrains. These rates were extrapolated to all roads within the study area by the fourteen strata. Estimates of sediment delivery for episodic road erosion were assigned to road-related causes and were reported by the fourteen strata and three air photo period time frames (described below). Appendix C provides additional details regarding the roads layer and studies used to determine the terrain-specific rates as well as the analysis results.

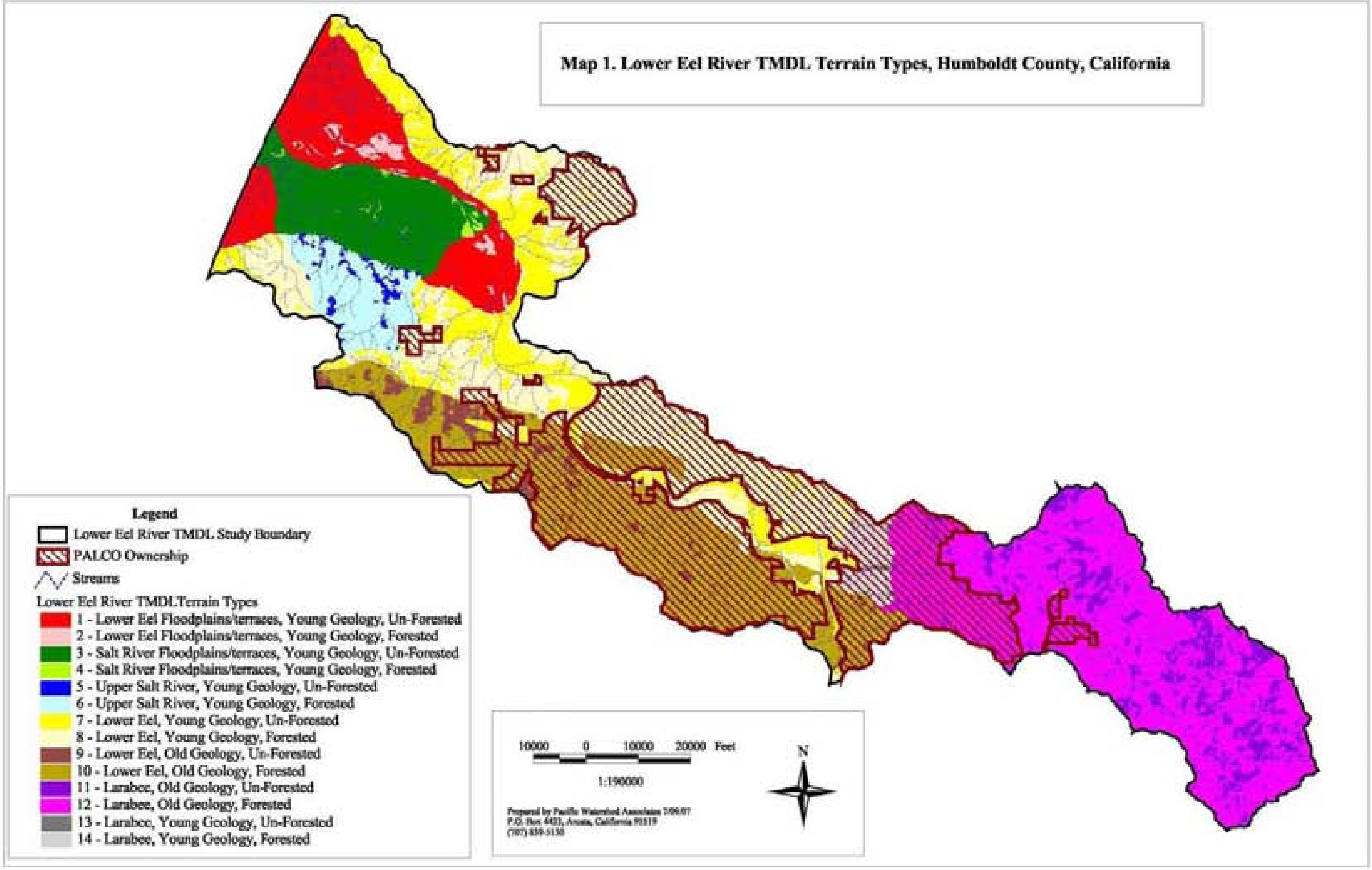


Figure 15. Strata in the Lower Eel River watershed

Stream bank erosion

Assumptions and methods associated with bank erosion were the same for non-PALCO and PALCO lands. Estimates were calculated using bank erosion rates developed from current and past bank erosion inventories conducted on similar terrain types in the study area and in nearby watersheds. The bank erosion rates were then extrapolated to the streams within the study area and the resulting sediment delivery estimates were reported by strata, management association (i.e., anthropogenic sources, which include timber harvest, grazing, and poorly-installed, man-made instream structures such as weirs and large woody debris placement), and air photo period time frames (Appendix C). Sediment delivery associated with management activities were assigned by multiplying the total extrapolated stream bank erosion sediment delivery by percent management allocation. The percent management allocations were obtained from previous bank erosion studies and recent field studies. These values varied by terrain type and did not differentiate between specific land uses (Appendix C).

Mass wasting

Mass wasting on the non-PALCO and PALCO lands was assessed using different assumptions and methodologies. For the non-PALCO lands, sequential historic air photo analysis was conducted to estimate the volume of sediment delivery from mass wasting features. Air photo analysis involved review of the 1966, 1988, and 2003 photos. Consistent with previous sediment source analyses, 1955 was selected as the beginning of the study period (USEPA, 1999a, 2002, 2004) because it is assumed that air photo analysis can readily identify mass wasting features that occurred in the previous one to two decades. Specifically, many of the landslide features on the air photos showed little to no re-vegetation and are therefore considered more recent. As a result, the time frames are defined as 1955-1966 (12 years), 1967-1988 (22 years), and 1989-2003 (15 years). Mass wasting feature attributes collected during the air photo analysis included: type of erosion process, land use association (sources with no management association were assumed due to natural causes), and geology. Volumes of erosion and sediment delivery were estimated. These data were analyzed according to strata, management association (i.e., anthropogenic sources), and time frame. Anthropogenic causes for mass wasting were broken down by land use type, including timber harvest, road-related, and skid trails. Earthflow erosion and sediment delivery were estimated using earthflow toe retreat or movement rates developed from previous studies in the Middle Fork Eel River.

To estimate mass wasting on the PALCO lands, average sediment delivery rates by air photo time frame were extrapolated to the entire watershed. These rates were obtained from previous studies conducted in the watersheds within and adjacent to the Lower Eel River watershed. Due to the lack of detailed data available, mass wasting sediment delivery rates could not be developed for each terrain type. Therefore a single weighted average for each time frame (1966, 1988, and 2003) was calculated based on previous studies (see Appendix C). Mass wasting sediment delivery estimates were then calculated by time period for each terrain type by applying the average sediment delivery rate by the area of each terrain type and the number of years within the time period. Estimates of anthropogenic sources were developed by applying an average rate (i.e., percent of sediment delivery that was management associated) obtained from existing studies. Non-PALCO earthflow erosion rates by terrain type were used to develop PALCO earthflow erosion estimates. Appendix C provides additional details regarding the non-PALCO and PALCO methodology and assumptions as well as the combined analysis results.

Road surface erosion

Road surface erosion methods and assumptions also differed for non-PALCO and PALCO lands. SEDMODL2 was used to estimate road surface erosion from roads on non-PALCO lands. This GIS-based computer model determines the portions of roads that directly and indirectly drain to streams. The roads layer used in the SEDMODL2 analysis was based on the California Department of Forestry and Fire Protection Fire and Resource Assessment Program (FRAP) roads layer, which was supplemented based on roads identified in the air photo analyses. These non-PALCO results were reported by strata and time frame. Similar road surface erosion analyses were performed in previous studies on the PALCO lands. These SEDMODL2 results were used to develop average road surface erosion rates by terrain type and were then extrapolated to existing roads on PALCO lands in the Lower Eel River watershed. Appendix C provides additional details regarding the roads layer and model input requirements as well as the analysis results.

After the PALCO and non-PALCO rates were quantified, they were combined to determine the total Lower Eel River sediment delivery and rates of erosion for different management associations, time periods, and strata, which are presented in Appendix C and summarized in the following section.

4.1.2. Results

Table 9 and Figure 16 summarize the results of the sediment source assessment. Landslides are the dominant process that produces sediment. In the Lower Eel River watershed, natural conditions (i.e., non-management land uses) contribute 48% of the sediment loading in the watershed. An estimated 52% of the total sediment delivered to streams was attributed to human and land management related activities (Table 9). Thus, the sediment loading in the watershed is 208% over the natural loading (1,493 tons/mi^2/yr total loading divided by 718 tons/mi^2/yr natural sediment loading). As discussed below, management associated sediment delivery is highest in the Lower Eel River and Larabee Creek areas (Table 10).

PWA also investigated differences by terrain type and the four major analysis areas in the watershed (Eel River floodplains and terraces, Salt River, Lower Eel, and Larabee Creek; see Figure 15 for an illustration of the terrain types). These results (Appendix C) generally indicate that the Lower Eel and Larabee Creek areas, especially those with older geology, have higher overall sediment delivery than the Eel River floodplains and terraces and Salt River areas (Table 10).

Sediment delivery rates associated with the different time periods were also investigated. Figure 16 and Table 10 identify all of the management- and non-management-associated sediment delivery rates by time period for each watershed area as well as the entire watershed. These indicate that sediment delivery rates have generally decreased since the 1955-1966 time period, which is not surprising since the largest flood of the entire 49-year period occurred during this period, in 1964, and delivered significant volumes of sediment to the system.

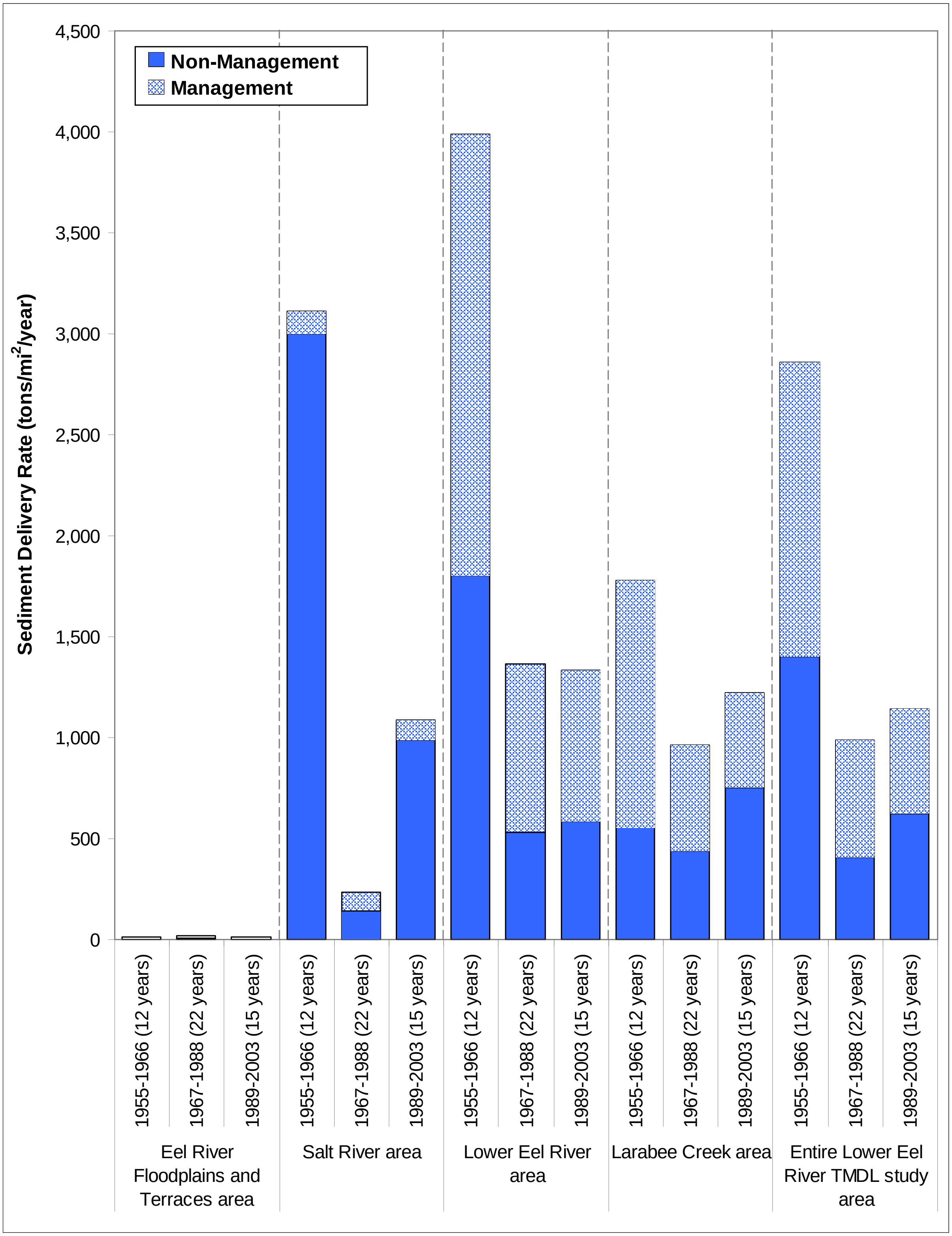
Table 9. Sediment Loading in the Entire Lower Eel River Study Area (1955-2003)

Sediment Source	Tons/mi^2/yr (49 year average)	Total (tons/mi^2/yr)	Percent of total
Natural – Non-earthflow	662		
Natural – Earthflow	56		
Total – Natural		**718**	**48%**
Episodic Road Erosion (Road-Related Mass Wasting and Fluvial Erosion)	43		3%
Chronic Road Erosion (SEDMODL Road-Related Surface Erosion)	115		8%
Timber Harvest	590		40%
Skid Trails	7		0%
Bank Erosion	21		1%
Total – Human and Land Management Related		**776**	**52%**
Total – All Sources		**1,493**	**100%**

Source: Appendix C, Table 7
Note: values have been rounded.

Table 10. Sediment Delivery and Delivery Rates by Time Period and Management Association

Terrain	Time period	Sediment Delivery (tons)		Sediment Delivery Rate (tons/mi^2/yr)	
		Management	Non-Management	Management	Non-Management
Eel River Floodplains and Terraces area (terrain 1 and 2)	1955-1966 (12 years)	2,829	934	8.2	2.7
	1967-1988 (22 years)	5,522	4,535	8.8	7.2
	1989-2003 (15 years)	3,951	1,168	9.2	2.7
	Total (1955-2003)	**12,302**	**6,636**	**8.8**	**4.7**
Salt River area (terrain 3 – 6)	1955-1966 (12 years)	46,728	1,244,201	112.7	3001.0
	1967-1988 (22 years)	68,275	109,878	89.8	144.6
	1989-2003 (15 years)	49,182	512,750	94.9	989.4
	Total (1955-2003)	**164,185**	**1,866,829**	**97.0**	**1102.7**
Lower Eel River area (terrain 7 – 10)	1955-1966 (12 years)	3,883,466	3,201,589	2,186.9	1,802.9
	1967-1988 (22 years)	2,712,338	1,725,370	833.1	530.0
	1989-2003 (15 years)	1,657,118	1,296,110	746.6	583.9
	Total (1955-2003)	**8,252,922**	**6,223,069**	**1,138.2**	**858.2**
Larabee Creek area (terrain 11 – 14)	1955-1966 (12 years)	1,292,827	586,071	1,224.5	555.1
	1967-1988 (22 years)	1,023,890	843,119	529.0	435.6
	1989-2003 (15 years)	614,408	996,916	465.6	755.4
	Total (1955-2003)	**2,931,125**	**2,426,106**	**679.9**	**562.8**
Entire Lower Eel River TMDL study area	1955-1966 (12 years)	5,225,850	5,032,794	1456.0	1402.2
	1967-1988 (22 years)	3,810,024	2,682,901	579.0	407.7
	1989-2003 (15 years)	2,324,659	2,806,944	518.1	625.6
	Total (1955-2003)	**11,360,534**	**10,522,639**	**775.2**	**718.0**



Source: Adapted from Appendix C, Table 9

Figure 16. Sediment delivery rate by management association and time period

Trends in sediment delivery rates are less discernable when comparing the two more recent time periods. However, in the most recent period, non-management rates have generally increased slightly, while management-associated rates generally remained about the same or decreased slightly over the previous period. Management-associated sediment delivery rates (upper portion of the bars in Figure 16) are generally decreasing through time in the Lower Eel and Larabee Creek areas (Table 10). This likely reflects differences in the frequency and magnitude of storms over time, which trigger widespread landslides, road failures, and washouts; but it may also be partly attributed to improvements in land management practices. For example, during the late 1960s/early 1970s, there were both formal shifts in management and changes instigated by the legal system. The main management changes are represented by the implementation of the Forest Practice Rules (FPR) on private lands in the 1970s. In addition, there were several lawsuits filed in the early 1970s regarding timber harvesting and the Endangered Species Act that appear to have resulted in informal changes in management practices. The Northwest Forest Plan, which formalized additional changes on public lands (United States Forest Service and Bureau of Land Management), was implemented 1990s.

While Figure 16 is useful because it provides a comparison of unit loading rates over time for each watershed, it tends to provide the impression that the Salt River area is a major contributor of sediment to the watershed. The unit rates are skewed by differences in the land areas of the subareas. When comparing overall total volume of sediment delivery since 1955 (nearly 22 million tons), the Lower Eel River area contributes the most sediment: 66% of the total, followed by the Larabee Creek area, which contributes 25% of the total (Table 10). The Salt River area contributes 9.3%, and the Lower Eel Terraces and Floodplains contributes only 0.1% of the total sediment (Table 10). The Lower Eel Terraces and Floodplains terrain types have the lowest total sediment delivery (19,000 tons) and unit loading rates (overall 13.5 tons/mi^2/yr) in the watershed, much lower than the other study areas, likely due to the flat-lying topography and depositional setting (only one debris landslide was identified in this terrain type). By contrast, the Lower Eel terrain types have both the highest sediment delivery (14.5 million tons) and the highest loading rates (overall 1,996 tons/mi^2/yr), as well as the highest rates and total volumes of management-associated delivery. The Salt River terrain types make up a small area – only 34.6 square miles (12% of the watershed) – and have fairly high unit loading rates (overall 1,200 tons/mi^2/yr), but low overall sediment delivery (2 million tons) when compared to the other study areas. The Larabee Creek area has similar loading rates (1,242 tons/mi^2/yr), but more than double the amount of overall sediment delivery (5.4 million tons) of the Salt River area.

Sediment delivery by land use association and terrain type

The management associated loading rates in the Salt River area are relatively low (97 tons/mi^2/yr). Most of the Salt River sediment is associated with non-management activities, particularly non-earthflow events located in terrain type 6 (Upper Salt River, forested young geology), as described in Table 11. In general, the Upper Salt River is prone to large, natural deep-seated landslides originating in the Rio Dell Formation.

Management-associated and non-management-associated sediment delivery is more evenly distributed in the other study areas (Table 10 and Figure 16). Management-associated sediment delivery is highest in the Lower Eel River (terrain types 7-10, delivering 1,138 tons/mi^2/yr) and Larabee Creek areas (terrain types 11-14, delivering 680 tons/mi^2/yr). These heavily influence the overall average management-associated rate of 775 tons/mi^2/yr. Management activities are generally focused in the forested terrain types located in the Lower Eel and Larabee Creek study areas; particularly terrain types 8, 10, and 12 (Table 11). Most of the sediment production appears to be related to older geologic types (e.g., Yager terrain and Franciscan mélange, which are more erodible that younger geologic types). Moreover, while natural sources account for 718 tons/mi^2/yr (48% of the total sediment production), timber harvest (primarily mass wasting) contributes the greatest portion of management-related sediment delivery: 590 tons/mi^2/yr, or 40% of the total, not including skid trails associated with timber harvest (see Table 9). Episodic and chronic road erosion and skid trails also contribute another 163 tons/mi^2/yr, or 11% of the total sediment delivery.

The variation in non-management loading rates among study areas is largely related to geology and tectonics. The lowest non-management rate is located in the Eel River Floodplains/Terraces, which consists of low-lying alluvial and river terrace areas. Although these sediments are unconsolidated, they are low-gradient and less prone to mass wasting. The highest non-management rate was observed in the Salt River area. The Salt River area sediment delivery rate includes both low-lying alluvial and terrace areas and the upper Salt River younger geology. The Upper Salt River geology consists of the undifferentiated Wildcat Group in the lower portions of the watershed and the Rio Dell Formation in the upper portions of the watershed. Like the Eel River Floodplain/Terrace areas, the Salt River Floodplain/Terrace areas exhibited low sediment delivery rates due to flat-lying lithology. In the Upper Salt River area, the Rio Dell Formation consists of interbedded mudstone, semi-consolidated sandstone, and siltstones. Mass wasting is common along the interface between the sandstone and mudstone beds.

In comparison, the Lower Eel study area (terrains 7-10) is composed of both younger (Scotia Bluffs Formation and Wildcat Formation [undifferentiated]) and older geologies (predominantly Franciscan Coastal Belt sedimentary rocks and lesser amounts of Yager Formation). The Scotia Bluffs Formation and the undifferentiated Wildcat Group do not exhibit high mass wasting rates as compared to the Rio Dell Formation. The older lithologies in terrains 9 and 10 are primarily Franciscan Coastal Belt sandstone, which is more deformed than the Yager Formation, and exhibits higher rates of mass wasting. This is likely the reason for higher sediment delivery rates in these terrain types (Table 11).

The Larabee study area is underlain primarily by Yager Formation with small amounts of Wildcat Group and Scotia Bluffs Formation in the lower portion of the watershed. About 25% of the Larabee watershed (upper watershed) is underlain by Franciscan Central Belt sandstone and mélange. The lower sediment delivery rate in Larabee Creek is likely due to the area underlain by less deformed Yager terrain, in comparison with Lower Eel terrains 9 and 10, which are underlain primarily by Franciscan Coastal Belt sedimentary rocks. Other geologic controls, such as faulting, likely contribute to the instability of some terrain types as compared with others.

Table 11. Sediment delivery from all sources (in cubic yards) by primary land use association and terrain type for Non PALCO + PALCO lands in the Lower Eel River TMDL study area.

	Non Earthflow							Earthflow	
Terrain	**No land use association** [1,2]	**Road Related Mass Wasting and Fluvial Erosion**[2]	**SEDMODL Road-Related Surface Erosion**	**Timber Harvest**[3]	**Skid**[3]	**Land Use Associated Bank Erosion**[4]	**Total non EF sediment yield**	**No land use association**	**Total non-Earthflow and Earthflow (yd^3)**
1	2,518	1,249	6,658	0	0	280	10,705	0	10,705
2	2,222	64	513	0	0	23	2,822	0	2,822
Subtotal	**4,740**	**1,313**	**7,171**	**0**	**0**	**303**	**13,527**	**0**	**13,527**
3	8,158	1,282	6,837	0	0	549	16,826	0	16,826
4	263	39	316	0	0	29	647	0	647
5	3,959	2,656	14,950	6,406	0	2,208	30,179	0	30,179
6	1,310,196	5,000	34,356	22,862	13,474	6,310	1,392,198	10,874	1,403,072
Subtotal	**1,322,576**	**8,977**	**56,459**	**29,268**	**13,474**	**9,096**	**1,439,850**	**10,874**	**1,450,724**
7	361,929	34,797	113,325	152,412	1,341	11,581	675,385	102,886	778,271
8	1,625,897	58,537	346,112	1,809,835	18,750	44,782	3,903,913	78,076	3,981,989
9	299,578	16,841	20,685	129,011	0	1,585	467,700	60,536	528,236
10	1,859,510	199,687	288,265	2,579,799	31,952	35,647	4,994,860	56,637	5,051,497
Subtotal	**4,146,914**	**309,862**	**768,387**	**4,671,058**	**52,043**	**93,595**	**10,041,858**	**298,135**	**10,339,993**
11	317,219	19,254	49,902	81,383	0	7,522	475,280	1,433	476,713
12	934,476	104,392	313,287	1,068,988	3,658	62,491	2,487,292	263,025	2,750,317
13	36,499	787	946	30,895	0	15,506	84,633	1,684	86,317
14	172,339	5,594	6,726	290,415	0	31,917	506,991	6,256	513,247
Subtotal	**1,460,534**	**130,027**	**370,861**	**1,471,681**	**3,658**	**117,436**	**3,554,196**	**272,398**	**3,826,594**
Total	**6,934,763**	**450,179**	**1,202,878**	**6,172,006**	**69,175**	**220,430**	**15,049,431**	**581,407**	**15,630,838**

[1] No land use pertains to all sediment sources with no apparent land use association.

[2] Sediment delivery derived from air photo analysis, existing studies and extrapolated field studies.

[3] Sediment delivery derived from air photo analysis and existing studies.

[4] Sediment delivery derived from extrapolated field studies. Bank erosion controllability for the Lower Eel and Larabee Creek terrains was determined as 60% no apparent land use and 40% land use associated based on field studies conducted as part of the PALCO Upper Eel River watershed analysis. Bank erosion controllability for the Salt River/Eel River Floodplains and Terraces terrain was estimated as 90% no apparent land use and 10% land use associated according to field studies conducted as part of the Lower Eel River TMDL study.

Source: Appendix C, PWA (2007)

4.2. TMDL AND ALLOCATIONS

4.2.1. Loading Capacity and TMDL

This TMDL is set equal to the loading capacity of the Lower Eel River watershed. The TMDL is the estimate of the total amount of sediment, from both natural and human-caused sources, that can be delivered to streams in the watershed without exceeding applicable water quality standards. EPA is setting the TMDL at 125% of natural sediment loading for this watershed. This approach to setting sediment TMDLs has been used in most of the watersheds in the North Coast of California. The approach focuses on sediment delivery, which can be influenced by direct management by landowners (e.g., roads can be well-maintained). Instream indicators (e.g., pool depth, percent fines), which are broad measures of how close watershed conditions are to achieving the TMDL, (see Section 4.3.1), are subject to upstream management that may not be under the control of local landowners. While it would be desirable to mathematically model the relationship between salmon habitat and sediment delivery, these tools are not readily available for watersheds with landslides and road failure hazards.

EPA is using a method of setting the TMDL and allocations similar to that employed in other basins (e.g., South Fork Eel, Noyo, Big, Albion Rivers, North Fork Eel, Middle Fork Eel, Upper Main Eel, and Middle Main Eel [USEPA, 1998, 1999b, 2000, 2001c, 2002, 2003, 2004, and 2005]). It is based on the assumption that a certain amount of loading greater than what is natural is acceptable, and will still result in meeting water quality standards. Prior TMDL studies of the relationship between sediment loading rates and fish habitat effects found that many North Coast waters supported healthy fish habitat conditions during periods in which sediment loads were up to 125% of natural loading rates. Thus, EPA is using this sediment loading rate as the level that meets the water quality objectives in Table 2. Those narrative objectives require that waters shall not contain sediment at levels that “adversely affect beneficial uses.” We have determined that the sediment loading that is not adverse to beneficial uses (i.e., the cold water use related to salmon) is interpreted to be 125% of natural sediment loading. EPA is setting the loading capacity and TMDL based on a calculation of 125% of natural loading.

EPA is using a long-term, watershed-wide loading rate because sediment movement in streams is complex both spatially and temporally. Sediment found in some downstream locations can be the result of sediment sources far upstream. Instream sedimentation can also result from land management activities from days to decades in the past. Poor instream habitat (i.e., high percent fines, embeddedness, pool filling, and channel morphology changes) is associated with adverse affects on salmonids, and elevated sediment delivery rates are linked with the degradation of these instream factors. The approach to setting this TMDL also assumes that salmon can be supported in streams with natural fluctuations of erosion rates that have been observed in the 20th century, with or without land management. Although sediment delivered to the streams has varied over time, salmon have adjusted to this natural variability by using the complex habitat created by the stream’s response to these changing sediment loads.

While EPA is calculating the TMDL based on the loading estimates for the entire period analyzed (representing the most accurate estimate of natural sediment loading), EPA expects progress toward the TMDL to be evaluated in the future by estimating the load of total sediment (both natural and management-related) relative to the natural (non-management-related) load. EPA recognizes that it is impractical for land managers to actually measure sediment loading on a daily basis. As noted in Table 9, natural sediment loading is calculated at 718 tons/mi^2/yr based on a 49-year average. Thus, the TMDL is most appropriately expressed as an average annual load, and should be evaluated as a long-term (e.g., 15-year) running average, in order to account for natural fluctuations and inaccuracies in estimations of sediment loads. In order to express the TMDL as a daily load, the average annual load can be divided by 365 days. Figure 16 suggests that management-related sediment delivery rates in the watershed are already making significant progress toward this goal; loading rates in the recent period (1989-2003) are lower than the 49-year average (1955-2003).

> **The sediment TMDL for all stream reaches is set equal to the sediment load that corresponds with 125% above natural sediment loading. The resulting sediment load is calculated as:**
>
> **TMDL = Loading Capacity = 125% x (718 tons/mi^2/yr) = 898 tons/mi^2/yr**
>
> **or TMDL = 898 tons/mi^2/year ÷ 365 days = 2.5 tons/mi^2/day, on a long-term (e.g., 15-year) running average**

4.2.2. Allocations

In accordance with EPA regulations, the loading capacity (i.e., TMDL) is allocated to the various sources of sediment in the watershed, with a margin of safety. That is:

TMDL = sum of “wasteload allocations” for individual point sources,

+ sum of the “load allocations” for nonpoint sources, and

+ sum of the “load allocations” for background sources

Load Allocations

The load allocations for the Lower Eel River sediment TMDL are presented in Table 12. The allocations clarify the relative emphasis and magnitude of erosion control programs that need to be developed during implementation planning. The load allocations are expressed in terms of yearly averages (tons/mi^2/yr) because sediment delivery to streams is highly variable on a daily and yearly basis. These annual averages were also divided by 365 to derive daily loading rates (tons/mi^2/day). EPA expects the load allocations to be evaluated on a 15-year rolling average, because of the natural variability in sediment delivery rates. In addition, EPA does not expect each square mile within a particular source category throughout the watershed to necessarily meet the load allocation; rather, EPA expects the watershed average for the entire source category to meet the load allocation for that category.

The specific load allocations were based on 75-90% reductions in timber harvest, road-related sediment loadings, and bank erosion. In general, sediment delivery from roads is high, and methods to reduce sediment are well known (Weaver and Hagans, 1994). Thus, the greatest reductions are required from road-related sources (including skid trails), and from chronic sources in particular (e.g., erosion from runoff on inappropriate road surfaces). Similarly, it is possible to reduce sediment delivery from timber harvest activities; however, these sources are more difficult to correct than road-related sources. Anthropogenic and natural bank erosion loading estimates were determined during the sediment source assessment (Appendix C); therefore, the natural bank erosion is incorporated into the total natural sediment load, while the anthropogenic sources of bank erosion have a specific allocation (Table 12).

Overall, the sediment load allocations reflect a 77% reduction over the 1955-2003 time period. The time period analysis (Figure 16) indicates that that significant reductions in delivery rates have occurred since the 1955-1966 time period and, while management-associated sediment loading continues to decline, it is now declining at a much slower rate than in the past. However, it is worth noting that while the TMDL and allocations are based on and expressed relative to the 49-year study period (1955-2003), human-related sediment loading in the most recent period, 1989-2003 (518 tons/mi^2/yr), already represents a reduction over the 49-year period (776 tons/mi^2/yr). Thus, while the total human-related allocations (179 tons/mi^2/yr) represent a 77% reduction over the 1955-2003 period, they represent an approximately 65% reduction over the 1989-2003 period.

Table 12. Sediment Load Allocations for the Lower Eel River Watershed

Sediment Source		Average Annual		Average Daily		Percent Reduction over 1955-2003 Period
		1955 – 2003 Loading (tons/mi^2/yr)	**Load Allocation (tons/mi^2/yr)**	**1955 – 2003 Loading (tons/mi^2/day)**	**Load Allocation (tons/mi^2/day)**	
Natural Load Allocation		718	718	2.0	2.0	0%
Road	Episodic	43	9	0.1	0.02	80%
	Chronic	115	17	0.3	0.05	85%
Timber Harvest		590	147	1.6	0.4	75%
Skid Trail		7	1	0.02	0.5	90%
Bank Erosion		21	6	0.1	0.03	70%
Total Human-related Load Allocation		775	180	2.1	0.5	77%
Total Load Allocations – Natural and Human-Related Sources		1,493	898	4.1	2.5	

Note: values have been rounded.

Wasteload Allocations

Although nonpoint sources are responsible for most sediment loading in the watershed, point sources may also discharge some sediment in the watershed. Current and potential future point sources that may discharge sediment in the watershed and are therefore at issue in these TMDLs include both stormwater (e.g., municipal and construction sites) and non-stormwater discharges:

Diffuse discharges subject to General National Pollutant Discharge Elimination System (NPDES) permits:

- California Department of Transportation (CalTrans) facilities that discharge pursuant to the CalTrans statewide NPDES permit issued by the Regional Board,
- Construction sites larger than 1 acre that discharge pursuant to California's NPDES general permit for construction site runoff,
- Facilities permitted under the NPDES Industrial stormwater program, and
- The City of Fortuna Municipal Storm Water Permit.

Wastewater Treatment Plants (WWTPs) and other point sources subject to an individual NPDES permit.

- Ferndale
- Loleta,
- Fortuna,
- Rio Dell, and
- Scotia.

The Humboldt Creamery Fernbridge facility is not permitted to discharge any suspended or settleable solids to the Lower Eel River.

To ensure protection of the cold water beneficial use, EPA has determined that it is appropriate to consider the load allocation rates set forth in this TMDL to also represent wasteload allocation rates for the diffuse, NPDES-permitted discharges in the watershed, as discussed below.

This TMDL identifies wasteload allocations for point sources and load allocations for nonpoint sources as pollutant loading rates (tons/mi^2/yr) for the Lower Eel River basin. The source analysis supporting these allocations evaluated sediment loading at a geologic terrain subarea scale, and did not attempt to distinguish sediment loading at the scale of specific land ownerships. Nor did the source analysis specifically distinguish between land areas subject to NPDES regulation and land areas not subject to NPDES regulation. Therefore, the TMDL includes separate but identical load allocations (LAs) for nonpoint sources and wasteload allocations (WLAs) for the diffuse, NPDES-permitted sources for each subarea. Both are expressed as loading rates (tons/mi^2/yr), as shown in Table 12. (See USEPA 2001e for additional details concerning the WLAs.)

For the diffuse permitted sources, such as municipal and industrial stormwater discharges, CalTrans facilities, construction sites, and municipalities, the waste load allocation (WLA) is expressed as equivalent to the load allocations (LA).

For the WWTPs and other non-diffuse individual point sources (i.e., discharges from a pipe to the waters of the Lower Eel River), discharges generally should not include sediment. The NPDES permits for the facilities include concentration-based limits for TSS and SeS, which address, in addition to organic discharges, any incidental colloidal discharges. Thus:

For the current and future WWTPs and other individual permitted point sources, the WLA are expressed as follows:

Ferndale: TSS 95 mg/l; settleable solids 0.1 ml/l monthly average concentrations
Fortuna: TSS 30 mg/l; settleable solids 0.1 ml/l monthly average concentrations
Loleta: TSS 30 mg/l; settleable solids 0.1 ml/l monthly average concentrations
Rio Dell: TSS 30 mg/l; settleable solids 0.1 ml/l monthly average concentrations
Scotia: TSS 30 mg/l; settleable solids 0.1 ml/l monthly average concentrations

For all WWTP facilities except Ferndale: weekly maximum TSS 45 mg/l
For all WWTP facilities: daily maximum TSS 60 mg/l

In this TMDL, while some sediment sources are currently considered to be nonpoint sources, future investigations may result in one or more of these nonpoint sources being identified as point sources, subject to NPDES permitting requirements; therefore, the corresponding load allocations would later become waste load allocations.

4.3. WATER QUALITY INDICATORS AND TARGETS

Indicators and targets can be used to represent attainment of water quality standards. This section identifies numeric water quality indicators and targets specific to the Lower Eel River watershed. For each indicator, a numeric or qualitative target value is identified to define the desired condition for that indicator.

Attainment of the targets is intended to be evaluated using a weight-of-evidence approach, because no single indicator applies at all points in the stream system, and stream channel conditions are inherently variable. In other words, when considered together, the indicators are expected to provide good evidence of the condition of the stream and attainment of water quality standards.

Instream indicators reflect sediment conditions that support healthy salmonid habitat. They relate to instream sediment supply and deposition, and are important because they are direct measures of stream "health." In addition to instream indicators, previous TMDLs included watershed indicators such as targets for stream crossing failures. However, EPA is not setting watershed indicators in this TMDL because the Regional Board's more recent review of habitat targets does not include watershed indicators (NCRWQCB, 2006). In addition, the Lower Eel River watershed is making progress toward the overall TMDL goal and instream indicators are more readily measured, so continued progress can be evaluated more regularly.

4.3.1. Summary of Indicators and Targets

Table 13 sets forth the indicators along with their targets, descriptions, and purposes. The background on these indicators is contained in the Regional Board's "Desired Salmonid Freshwater Habitat Conditions for Sediment-related Indices" (NCRWQCB, 2006) that has been developed as part of the basin planning process. EPA notes that the Regional Board's guidance document is intended to be updated as scientific information becomes available. Details on the applicability to different sizes and types of streams, along with monitoring notes, sampling notes, and background literature, are available in that document. EPA expects that future monitoring of these indicators will provide additional information to assess whether the water quality standards are being attained and whether the TMDL is effective in meeting water quality standards.

Table 13. Sediment Indicators and Targets

INDICATOR	TARGET	PURPOSE
Instream		
Substrate Composition - Percent fines	<14% < 0.85 mm ≤30% < 6.4 mm	Indirect measure of fine sediment content relative to incubation and fry emergence from the redd. Indirect measure of ability of salmonids to construct redds
Turbidity and Suspended Sediment	Turbidity ≤ 20% above naturally occurring background (also included in Basin Plan)	Indirect measure of fish feeding/growth ability related to sediment, and impacts from management activities
Riffle Embeddedness	≤25% or improving (decreasing) trend toward 25%	Indirect measure of spawning support; improved quality & size distribution of spawning gravel
V*	≤0.21	Estimate of sediment filling of pools from disturbance
Macroinvertebrate community composition	Improving trends	Estimate of salmonid food availability, indirect estimate of sediment quality.
Thalweg profile	Increasing variation from the mean	Estimate of improving habitat complexity & availability
Pools	Increasing trend in the number of backwater, lateral scour pools. Increasing trend in the number of stream reaches where the length of the reach is composed of ≥40% in primary pools	Estimates improving habitat availability

4.4. MARGIN OF SAFETY

The margin of safety must be included in a TMDL to account for uncertainties concerning the relationship between pollutant loads and instream water quality and other uncertainties in the analysis. The margin of safety can be incorporated into conservative assumptions used to develop the TMDL, or added as an explicit, separate component of the TMDL. This TMDL incorporates a margin of safety through use of conservative assumptions.

There is uncertainty concerning the interpretation of the amount of sediment delivery associated with management activities versus natural background sources. Conservative assumptions used throughout the sediment source assessment process varied by analysis method on the PALCO and non-PALCO lands. For the non-PALCO lands, these assumptions include:

- PWA generally attributed most or all of the sediment load of any landslide occurring within a recent harvest unit as being harvest or road related. This is a conservative assumption because some slides may have occurred naturally even if the land had not been harvested recently.

- The rates developed for the episodic road-related sediment delivery were based on PALCO road inventories. Due to the difference in use on PALCO lands (timber industry versus rural landowner), sediment delivery may be overestimated for non-PALCO lands.

Similar assumptions apply for the analyses conducted on PALCO land. The original air photo analyses, which were used to develop the average sediment delivery rates by time period, were attributed similar to the non-PALCO lands above. Specifically, most or all of the sediment load of any landslide occurring within a recent harvest unit was assumed to be harvest or road related. Since some slides may have occurred naturally even if the land had not been harvested recently, this would result in an overestimation of management-related sediment.

Because the sediment TMDL is calculated based on the amount of natural loading, these assumptions result in a more conservative TMDL calculation. Also, bank erosion was assigned to management causes, although some bank erosion is natural.

An ongoing Salt River Ecosystem Restoration Project may result in unanticipated improvements to sediment conditions in the Salt River subwatershed. The results of this are not known at this time, but any unanticipated improvements are implicitly incorporated into the Margin of Safety.

4.5. SEASONAL VARIATION AND CRITICAL CONDITIONS

The TMDL must describe how seasonal variations were considered. Sediment delivery in the Lower Eel River watershed has considerable annual and seasonal variability. The magnitudes, timing, duration, and frequencies of sediment delivery fluctuate naturally depending on intra- and inter-annual storm patterns. The analysis accounted for this seasonal and yearly variability by calculating the sediment delivery over the long term (1955 - 2003). This accounts for both the seasonal variation (winter producing the most sediment) and the critical conditions (large storms producing a large percentage of sediment). Adverse effects on instream conditions and salmonid habitat are the result of the accumulation of sediment, including the impacts from infrequent and large storms. Thus, EPA recommends that this TMDL be evaluated on a 15-year rolling average or longer-term average that accounts for the influence of large storms.

CHAPTER 5: IMPLEMENTING AND MONITORING RECOMMENDATIONS

The main responsibility for water quality management and monitoring resides with the State. EPA fully expects the State to develop implementation measures as part of revisions to the State water quality management plan, as provided by EPA regulations at 40 C.F.R. Sec. 130.6. The State implementation measures should contain provisions for ensuring that the allocations in the TMDLs will in fact be achieved. These provisions may be non-regulatory, regulatory, or incentive-based, consistent with applicable laws and programs, including the State's recently upgraded nonpoint source control program. The Regional Water Board may adopt and implement these TMDLs as they are, or may choose to revise the TMDLs if additional information becomes available, subject to EPA approval. Moreover, the Regional Water Board may choose to develop and implement TMDLs on a subwatershed basis if appropriate, and subject to EPA approval.

For the temperature TMDLs, EPA recommends that protection or restoration of shade be evaluated in timber harvest permits on private lands to assure compliance with the TMDL shade allocations, and thus water quality standards. The State should also assure that the THP process is protecting natural shade. Current standards and guidelines under the Northwest Forest Plan may be sufficient to attain riparian vegetation characteristics consistent with the temperature load allocations for shade on USFS lands.

As a practical matter and one that accounts for site-specific information, the TMDL calculations can be simplified during implementation as setting the TMDLs equal to no allowable changes to natural shade. In other words, current shade conditions should be improved to reflect natural shade conditions in order to meet the temperature TMDLs for the tributary areas. As discussed in Chapter 3, the stream temperatures expected to meet the narrative water quality standard are displayed in Figures 13 and 14 for Larabee Creek (representing all tributaries except for the Salt River) and the creeks draining to the Salt River system, respectively. EPA recommends that given the wide range of natural stream temperatures, attainment of the TMDLs be monitored based on the progress toward natural shade. In addition, EPA recommends that the Regional Board continue with their practice of taking into account site-specific conditions during implementation. This is consistent with the Regional Board's action plans for the Scott and Salmon River temperature TMDLs.

For the sediment TMDL, EPA specifically recommends that more instream information be gathered in tributaries throughout the basin. Collecting this information, using a random sampling approach, would assist the Regional Board in determining if the reduced human-related sediment loading seen in the recent past is confirmed by instream conditions. Specific data collection recommendations include: annual cross-sectional analyses in the Lower Eel River main stem and Salt River; road assessment; and monitoring of restoration activities. Other sediment-associated implementation activities that would be helpful to watershed restoration include: removal of sediment from the Salt River to restore flow, limit flooding, and restore fisheries; wetlands restoration; upgrading of deficient roads; and modification to restoration activities based on monitoring results. It is important, however, when considering these recommendations, to incorporate the needs of endangered species that inhabit the Lower Eel River and Salt River areas (see below).

The data and ongoing analysis from the Salt River Ecosystem Restoration Project appears to be consistent with the goals of achieving the sediment TMDL load allocations, and the project may very well facilitate attainment of the sediment TMDL in the Salt River area. An Environmental Impact Report (EIR) currently being prepared on the project will also address turbidity, expressed as suspended sediment, which is a component of total sediment, the pollutant addressed in these TMDLs.

EPA strongly urges that the habitat needs of the three species salmonid species listed by NMFS under the Endangered Species Act (ESA) (Southern Oregon/Northern California Coast coho salmon ESU, California Coastal Chinook salmon ESU, and Northern California steelhead DPS) and the two species that are listed by the U.S. Fish and Wildlife Service (USFWS) (tidewater goby and western snowy plover) that are found in the Lower Eel River be considered when developing implementation plans (including restoration plans, such as the Salt River Ecosystem Restoration Project, undertaken parallel to, but not a direct result of, TMDL implementation).

Steelhead, Chinook, and coho will undoubtedly benefit from lowered temperatures in tributaries and lower sediment loading throughout the watershed. The endangered tidewater goby (*Eucyclogobius newberryi*), which are found in the Eel River estuary, and the threatened western snowy plover (*Charadrius alexandrinus nivosus*), which are present on Lower Eel River gravel bars (Long, M., U.S. Fish and Wildlife Service, 2007), should also be considered when developing restoration plans, as their habitat needs are different than those of salmonids.

Given the fragile status of some salmonid species, it may be prudent to prioritize subwatersheds on that basis. NMFS has assigned Recovery Priority Numbers to the salmonid populations found in this watershed: the highest priority (1) to coho, based on a high magnitude threat and high potential recovery; recovery priority number of 3 to Chinook, based on a high magnitude threat and low-moderate recovery potential; and a recovery priority number of 5 to steelhead, based on a moderate degree of threat and high recovery potential (NMFS, 2007). Recovery outlines for steelhead and Chinook were recently published. NMFS has identified a number of priority recovery actions, including:

- working toward improvements to California’s Forest Practice Rules;
- improving freshwater habitat;
- improving agricultural and forestry practices, city and county planning, particularly for riparian protections, grading ordinances, road construction and maintenance;
- appropriate screening of water diversions;
- identification and improvements to wastewater treatment programs, including septic systems;
- removing artificial barriers; and
- improvements in hatchery programs; and additional research on distribution, status and trends.

Some of the specific programs that are underway include: working with the Five Counties Roads Program and State Board of Forestry; implementing the Fish Friendly Farming program; and coordination on programs such as gravel management plans, General Plan updates, grading ordinances, and riparian ordinances (NMFS, 2007).

Most of the draft TMDL's "Fish Population Concerns" analysis (Chapter 2), allocations and targets (Chapters 3 and 4) are based on habitat requirements for salmonids, and they do not specifically address the habitat requirements of the two USFWS-listed species. Attainment of the TMDL allocations will not affect, or may also be beneficial, for tidewater goby and western snowy plover. However, some potential activities, like gravel bar removal, tide gate replacements, or tributary channel and estuarine habitat modification, could impact them. Some restoration activities for salmonids may not as be beneficial for the tidewater goby, unless goby habitat is also addressed or enhanced as part to the project (Long, M., U.S. Fish and Wildlife Service, 2007).

Gravel mining can adversely affect both USFWS and NMFS-listed species, and should be addressed in implementation plans. The County of Humboldt Extraction Review Team (CHERT) has recently conducted numerous extensive analyses focused on historic and current channel conditions in the Lower Eel River. The data analyses and results of the 2008 CHERT study may provide a better understanding of the type and magnitude of channel morphologic changes and their effects on bed elevation, channel width, temperature, and turbidity. None of the data from these studies have been analyzed to date, and, therefore, no information is available for the Lower Eel River TMDL sediment source assessment.

EPA also encourages the Regional Board to use the information developed from the sediment source analysis in setting priorities for any new sediment reduction programs. The Regional Board is currently investigating how to set priorities in addressing sediment waste discharges on a watershed scale, and recently released a Public Review Draft "Work Plan To Control Excess Sediment In Sediment-Impaired Watersheds" (NCRWQCB, 2007b). EPA recommends that the Regional Board consider the relative progress and threats of different watersheds when setting priorities. Landslides are the dominant process that produces sediment, and reducing this risk may be the most cost-effective approach.

CHAPTER 6: PUBLIC PARTICIPATION

EPA provided public notice of the draft Lower Eel River Temperature and Sediment TMDLs by placing a notice in the Willits News and Eureka Times-Standard, papers of general circulation in Mendocino and Humboldt counties. EPA also discussed the TMDLs with various land owners in the watershed, beginning in early 2006. The public notice regarding availability of the draft Lower Eel River TMDLs was posted on EPA's web site, along with the document and associated appendices. The public notice was also mailed or emailed to additional parties.

A public meeting on the draft TMDLs was held on October 22, 2007 at the Six Rivers National Forest conference room in Eureka, California. EPA also responded to inquiries for information during the public comment period. EPA reviewed all written comments that were received during the public comment period, which ran from October 3 – November 2, 2007. EPA revised the final TMDLs as appropriate, and prepared a responsiveness summary that addresses the comments received.

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