CHAPTER 2. PROBLEM STATEMENT

Key Points

- Salmonid populations in the Scott River watershed have declined significantly from historic levels. Coho salmon in the watershed are listed as a threatened species under the federal and state Endangered Species Acts.

- Excessive sediment loads and elevated water temperatures have impaired many designated beneficial uses of the Scott River and its tributaries. Several of the primary beneficial uses impaired are those uses associated with the cold water salmonid fishery, which are the primary focus of this TMDL Action Plan.

- Excessive sediment loads and elevated water temperatures have caused the non-attainment of water quality objectives related to sediment and water temperature.

- Excessive sediment:
  - fills in pools, reducing available in-stream salmonid habitat;
  - fills and buries the gravels that salmonids require to spawn;
  - reduces the number of macroinvertebrates available as food for salmonids during rearing;
  - produces wider, shallower channels which are subject to increased solar heating and contribute to the non-attainment of the temperature objective.

- Available data on instream sediment conditions in the mainstem Scott River through Scott Valley show a consistent pattern of sediment impairment, though with indications of improving trends for some parameters.

- Available data on instream sediment conditions in Shackleford-Mill, Etna, French, and Sugar creeks show mixed conditions, with some parameters exceeding desired conditions, some meeting desired conditions, and some with stable or improving trends in fine sediment values.

- Available data on instream sediment conditions in Tompkins, Boulder, and Canyon creeks generally indicate sediment impairment.

- The recommended salmonid temperature criteria during the summer ranges from 16ºC (60.8ºF) to 20ºC (68ºF) 7-DADM, depending on salmonid life stage.

- Summer temperature conditions do not support suitable salmonid rearing habitat in the mainstem of the Scott River and the East Fork of the Scott River.

- Summer temperature conditions do not support suitable salmonid rearing habitat in the lower reaches of Kelsey, Shackleford, Kidder, Patterson (west side), French, Wildcat, Etna, and Big Carmen creeks and the upper reaches of Moffet Creek and Sissel Gulch.

- A suite of instream salmonid habitat and upslope watershed desired conditions is available to help determine water quality and the effectiveness of the TMDL and implementation actions.

- This chapter also includes information on salmonid populations and periodicity in the Scott River watershed.

2.1 INTRODUCTION

This chapter summarizes ways in which increased sediment loads and elevated water temperatures have contributed to the decline of the cold-water salmonid fishery. Increased sediment delivery is produced by management activities including road-related activities, silvicultural and agricultural practices, mining, and ranching. Temperature changes are produced by sediment delivery – through processes including channel aggradation and pool infilling – as well as by other processes, such as changes in riparian cover, increased solar heating, changes in surface flow, changes in channel geometry, and changes in streamside microclimates. This chapter includes a description of the water quality standards and salmonid habitat requirements related to sediment and temperature and a qualitative assessment of existing instream and watershed conditions in the Scott River watershed.

The primary adverse impacts produced by excessive sediment supply in the Scott River and its tributaries are adverse effects on the cold-water salmonid fishery. Excessive sediment fills pools, reducing available habitat. Fine sediment, which constitutes most of the additional sediment load, fills and buries the gravels that salmonids require to spawn. In addition, the influx of fine sediments reduces the number of macroinvertebrates available for food during salmonid rearing. Excess sediment produces wider, shallower channels which are subject to solar heating and contribute to the non-attainment of temperature objectives. Increased water temperatures decrease the area and volume of suitable habitat, and decrease salmonid survival during gestation, rearing, and migration.

The degradation of sediment and temperature conditions below water quality objectives adversely affects beneficial uses related to coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*), and steelhead trout (*O. mykiss*). The coho salmon population in this watershed is listed as threatened under the federal Endangered Species Act and the California Endangered Species Act. Additional adverse impacts affect recreational uses, agricultural and municipal water supplies, and ground water recharge.

This analysis is based on data that have been gathered by the Regional Water Board staff and data contributed by landowners and organizations in the Scott River watershed. Because information about habitat parameters in some areas of the watershed is not available, conservative assumptions based on professional judgment were made regarding factors that potentially limit salmonid populations in the basin. As additional data become available from sources such as local groups and government agencies, the TMDL and information contained in this chapter can be modified by the Regional Water Board.

2.2 WATER QUALITY STANDARDS

In accordance with the Clean Water Act, a TMDL is set at a level necessary to achieve applicable water quality standards. Under the Clean Water Act, water quality standards define designated uses, water quality criteria to protect those uses, and an anti-degradation policy. This section describes the State water quality standards applicable to the Scott River TMDL, using the State's terminology of beneficial uses and water quality objectives. The Scott River TMDLs for sediment and temperature are set at levels necessary to protect applicable water quality standards, including the beneficial uses listed in Section 2.2.1 and the water quality objectives listed in Section 2.2.2.

2.2.1 Beneficial Uses

The beneficial uses and water quality objectives for the Scott River are contained in the *Water Quality Control Plan for the North Coast Region* (Basin Plan) adopted, 1993, as amended in 2003 (Regional Water Board, 2003, Table 2-1). Beneficial uses are defined on the basis of two hydrologic subareas: the Scott Bar Hydrologic Subarea and the Scott Valley Hydrologic Subarea.

Existing beneficial uses for the Scott River are:
1. Municipal Water Supply (MUN)
2. Agricultural Supply (AGR)
3. Industrial Service Supply (IND)
4. Groundwater Recharge (GWR)
5. Freshwater Replenishment (FRSH)
6. Navigation (NAV)
7. Hydropower Generation (POW)
8. Water Contact Recreation (REC-1)
9. Non-Contact Water Recreation (REC-2)
10. Commercial or Sport Fishing (COMM)
11. Cold Freshwater Habitat (COLD)
12. Wildlife Habitat (WILD)
13. Rare Threatened or Endangered Species (RARE)
14. Migration of Aquatic Organisms (MIGR)
15. Spawning, Reproduction, and/or Early Development (SPWN)
16. Aquaculture (AQUA) (Scott Valley Hydrologic Subarea)

Potential beneficial uses are:
1. Industrial Process Supply (PRO)
2. Aquaculture (AQUA) (Scott Bar Hydrologic Subarea)

Table 2.1
Water Quality Objectives Applicable to the Scott River TMDL

Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect 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.
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.
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.
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 alteration in temperature does not adversely affect beneficial uses. At no time or place shall the temperature of any COLD water be increased by more than 5° F above natural receiving water temperature.

2.2.2 Water Quality Objectives

The Basin Plan (NCRWQCB, 2005b) identifies both numeric and narrative water quality objectives for the Scott River. Those pertinent to the Scott River TMDLs are listed in Table 2.1.

2.3 SALMONID POPULATIONS & PERIODICITY

Many of the beneficial uses most impaired by and sensitive to excessive sediment loads and elevated water temperatures are related to the cold water salmonid fishery. These uses include the commercial and sport fishing (COMM); cold freshwater habitat (COLD); rare, threatened, and endangered species (RARE); migration of aquatic organisms (MIGR); and spawning, reproduction, and/or early development of fish (SPWN) beneficial uses. The following sections provide some background information on the status of salmonid populations, the locations of salmonid habitat, and salmonid periodicity within the Scott River watershed.

2.3.1 Salmonid Populations

Anadromous fish populations currently utilizing the Scott River basin include fall chinook and coho salmon, and fall and winter steelhead trout (Hardy and Addley, 2001, p.12; Klamath River Basin Fisheries Task Force [KRBFTF], 1991, p. 4-10 and 4-11). Data indicate that the fall chinook population within the Scott River basin has experienced a decline since at least the

1960s (Hardy and Addley, 2001, p.12). Available data for coho and fall and winter steelhead runs are not entirely reliable for determining long-term trends, however both species are considered to have experienced declines from historic numbers throughout the Klamath River basin (Brown and Moyle, 1991, p.6, 36; Brown et al., 1994; CDFG, 2002, p.1; Hardy and Addley, 2001, p.12-13). Historically, there were summer steelhead and spring chinook runs in the Scott River, however those runs no longer occur in this basin although a few random summer steelhead have been observed in the Scott River (KRBFTF, 1991. p. 2-87, 2-99, and 4-15; USFS, 2000b, p.3-9; USFS, 2000a). This review focuses on adult return populations.

Information on the numbers of coho salmon and steelhead trout in the Scott River basin is limited. In the early 1960s, the California Department of Water Resources (CDWR) estimated 2,000 coho and 20,000-40,000 steelhead in the Scott River basin (CDWR 1965, as cited by Scott River Watershed Council [SRWC], 2004, p.6-5). An inventory of salmon and steelhead conducted by the California Department of Fish and Game (1965, p.373) estimated 800 coho, and 5,000 steelhead in the basin in 1965. There are data on juvenile coho numbers in the French Creek drainage, discussed below. No other population estimates could be found for coho and steelhead in this basin. Information on coho and steelhead numbers were found for various years from 1982-1991 (Shaw et al., 1997) however, no population estimates were made from this information. In addition, adult spawner population estimates were developed for selected reaches in French, Miners, Shackleford, and Mill Creeks by the Siskiyou County Resource Conservation District in 2004-2005. Depending on the method used to calculate estimates, adult coho population estimates in these select reaches total 713 or 940 adult fish (SRCD, 2005c, p.5). Due to the lack of spawner abundance estimates in other recent years, it is not possible to use these results to indicate trends in reaches of these creeks or in the watershed as a whole.

In the absence of quantitative data it is assumed that the trends in coho salmon and steelhead trout within the Scott River basin are similar to trends within the larger Klamath Basin (Hardy and Addley, 2001, p.12). Despite this lack of quantitative data, it is clear from the information available that coho and steelhead populations within the Klamath basin and statewide have undergone a dramatic decline from historic levels (Brown and Moyle, 1991, p.6 and 36; Brown et al, 1994; CDFG, 2002, p.1; Hardy and Addley, 2001, p.12 and 13). The National Marine Fisheries Service (NMFS) listed the Southern Oregon/Northern California Coastal (SONCC) Coho Salmon Evolutionarily Significant Unit (ESU), which contains the Scott River basin, as threatened in 1997 (NMFS, 2004). The California Department of Fish and Game (CDFG) commission proposed the listing of this ESU as threatened in August of 2004, and this proposal will become effective upon approval by the Office of Administrative Law (CDFG, 2004b). Brown et al. (1994) state that California coho populations are probably less than 6% of what they were in the 1940s, and there has been at least a 70% decline since the 1960s. Coho salmon occupy only 61% of the SONCC Coho ESU streams that were previously identified as historical coho salmon streams (CDFG, 2002, p.2).

Historically, sustainable populations of spring chinook were present in the Scott River watershed but these stocks are either no longer present or occur very infrequently in low numbers (USFS, 2000b, p. 3-9). There have been occasional sightings of spring chinook in the Scott River, although the only true run in the Klamath basin exists in the Salmon River (KRBFTF, 1991, p 4-12). Snyder (1931, p. 19) wrote that the spring chinook migration in the Klamath basin, “was once very pronounced," but "has now come to be limited as to the number of individuals, and is of relatively little economic importance." The cause of the disappearance or depletion of the early spring migration in the Klamath River is attributed by some to heavy sediment loads unleashed by hydraulic mining operations (KRBFTF, 1991, 4-2), while others cite over fishing both in the river and at sea, and irrigation (Snyder, 1931, p.33).

Fall chinook salmon are the predominant run in the Klamath River basin and are the only chinook run believed to currently exist in the Scott River basin. The Scott River produces approximately 9.2% of the natural fall Chinook salmon in the Klamath River basin (SRWC, 2004, p.6-1). An historic population estimate from CDFG (1965, p. 373) estimated that there were 8,000 fall chinook in the Scott River basin in 1965. Fall chinook salmon spawning escapement has been monitored by the CDFG annually since 1978 (Figure 2.1). Since this time, spawning populations have ranged from 445 fish in 2004, to a high of 14,477 fish in 1995. Fall chinook numbers remained high in 1996 (12,097) and then decreased to between 3,327-6,253 from 1997-2002, but rebounded again in 2003 to 12,053 fish.

Juvenile coho salmon surveys have been conducted in French Creek in most years from 1992 to the present, in conjunction with an intensive road rehabilitation effort conducted in this drainage in the early 1990s. Effects of this effort on V*, a measure of instream sediment conditions, are discussed in Section 2.4.2.7. Juvenile coho salmon have been found regularly in several French Creek reaches as part of annual September electroshock monitoring initiated in 1992 and overseen by Department of Fish and Game fisheries biologist Dennis Maria. These surveys have been conducted each year since 1992 except for 1998. Since 1992 the surveys have been done in the same five reaches, except for 1996 when one reach was not surveyed. These survey data (Figure 2.2) provide the single best data set on coho salmon in the Scott River system.

Coho return as adults three years after they are spawned. Thus a fry hatched from the 1999 spawn, if it survived, returned as a spawning adult in 2002. We designate 1992, 1993, and 1994 as Brood Years 1, 2, and 3. When each brood year is looked at separately trends are apparent:

- Brood Year 2 (1993, 1996, 1999, 2002) is by far the strongest of the three with data through 2002.
- Brood Years 1 and 3 are much weaker than Brood Year 2
- All Brood Years show positive trends with Brood Years 1 and 3 now showing numbers and trends similar to those shown by Brood Year 2 approximately ten years ago.
- Given that Brood Years 1 and 3 were the best ever documented in 2004 and 2005, it can be reasonably anticipated that the juvenile survey taken in September of 2005 will also be strong.

2.3.2 Salmonid Habitat

A habitat survey performed by the CDFG (1965, p. 373) found that there were 59 miles of habitat in the Scott River basin suitable for chinook, 126 miles suitable for coho, and 174 miles of habitat suitable for steelhead in 1965. A more current survey by Hardy and Addley (2001, p.13) estimates that there are 59 miles of fall chinook, 88 miles of coho, and 142 miles of steelhead habitat in the basin. Stream diversions have reduced the amount of available salmon and steelhead habitat in the Scott River basin, and may have been the primary cause for the loss of the summer steelhead and spring chinook runs in this basin (KRBFTF, 1991, 2-99).

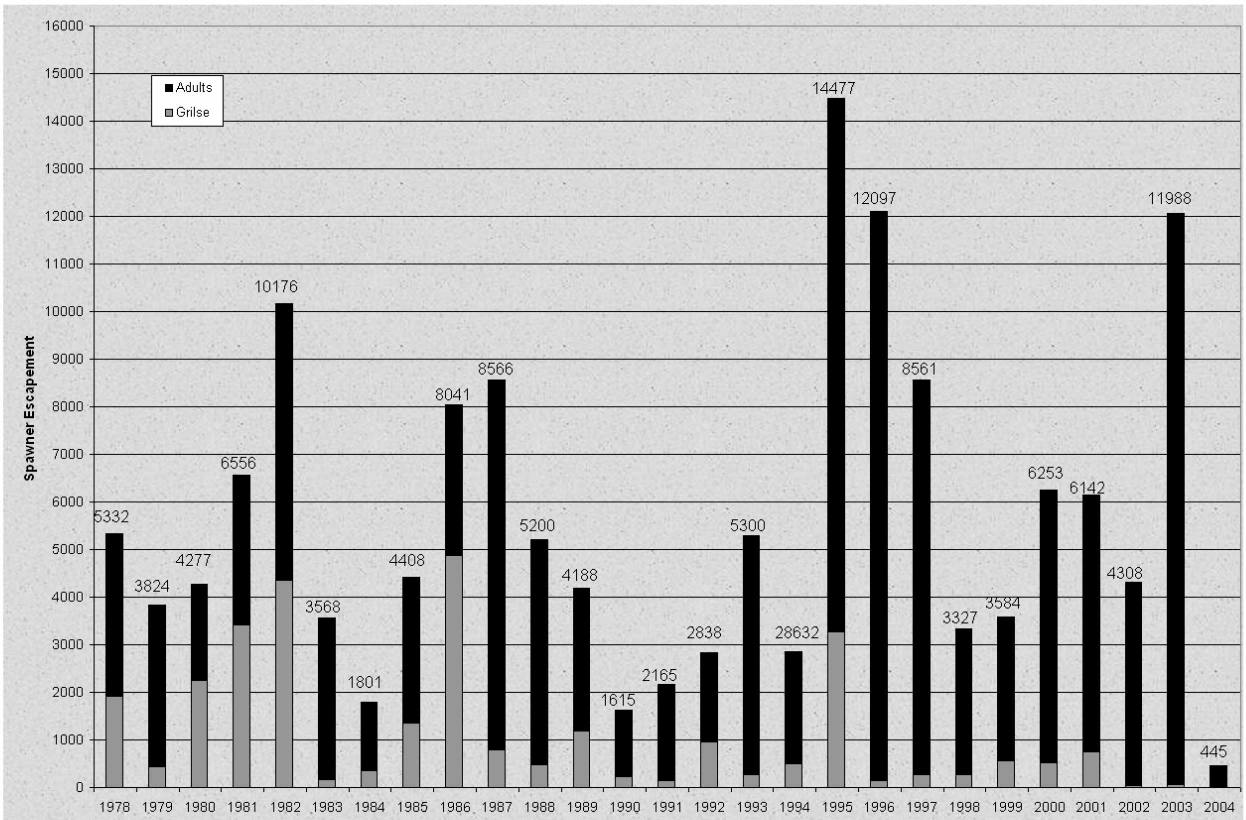

Figure 2.1. Scott River Fall Chinook Spawner Escapement (Source: CDFG data)

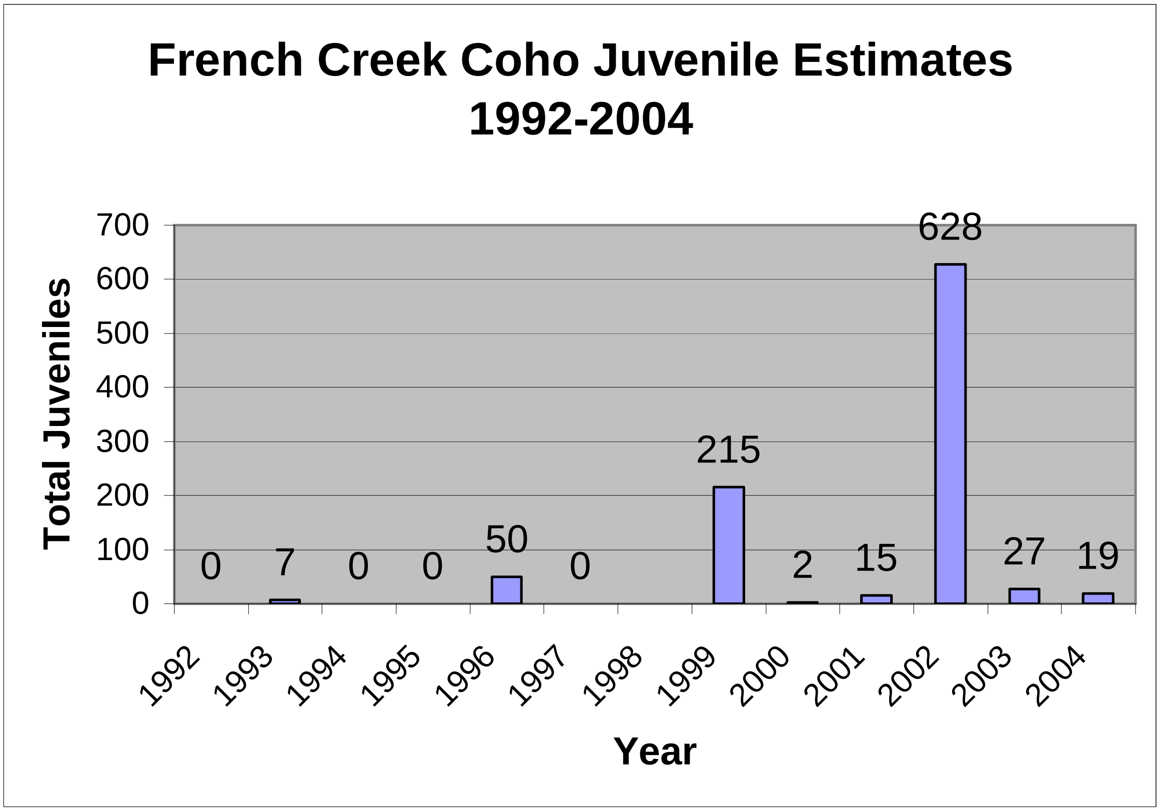

Figure 2.2. Juvenile coho estimates from electroshocking surveys on five reaches of French Creek from 1992-2004.

2.3.3 Salmonid Periodicity

Six runs of anadromous salmonids use the Klamath River, four of which are found in the Scott River basin. Fall run chinook, coho, and fall and winter run steelhead all are found in the Scott River basin, while spring chinook and summer steelhead runs are not currently present except for a few random summer steelhead. Together these four runs result in year round utilization of the Scott River basin by various life stages of salmonids (Figure 2.2).

Periodicity (presence of salmonids at varying life stages throughout the year) information for the runs is fairly easy to interpret with the exception of data for the fall and winter run steelhead. At times references do not distinguish between fall and winter steelhead, some calling all fish winter run steelhead (see for example Leidy and Leidy, 1984), while others only refer to fall fish (see for example Hardy and Addley 2001, p.12). In other references the discussion of fall and winter run steelhead is combined (see for example KRBFTF, 1991, p. 4-11; SRWC, 2004, p.6-18). Finally, some documents discuss the fall and winter steelhead separately (Shaw et al., 1997). For this reason, periodicity information for fall and winter steelhead in this document are combined into one group. Information from the above literature sources, Chesney (2000, p. 1-5, 19-27, and 33-37, 2002, p. 23-38, 2003. p. 21-39, 2004, p. 21-37), and the SRWC (2004, p. 6-3, 6-4, 6-17, and 6-18) were used to produce Figure 2.3.

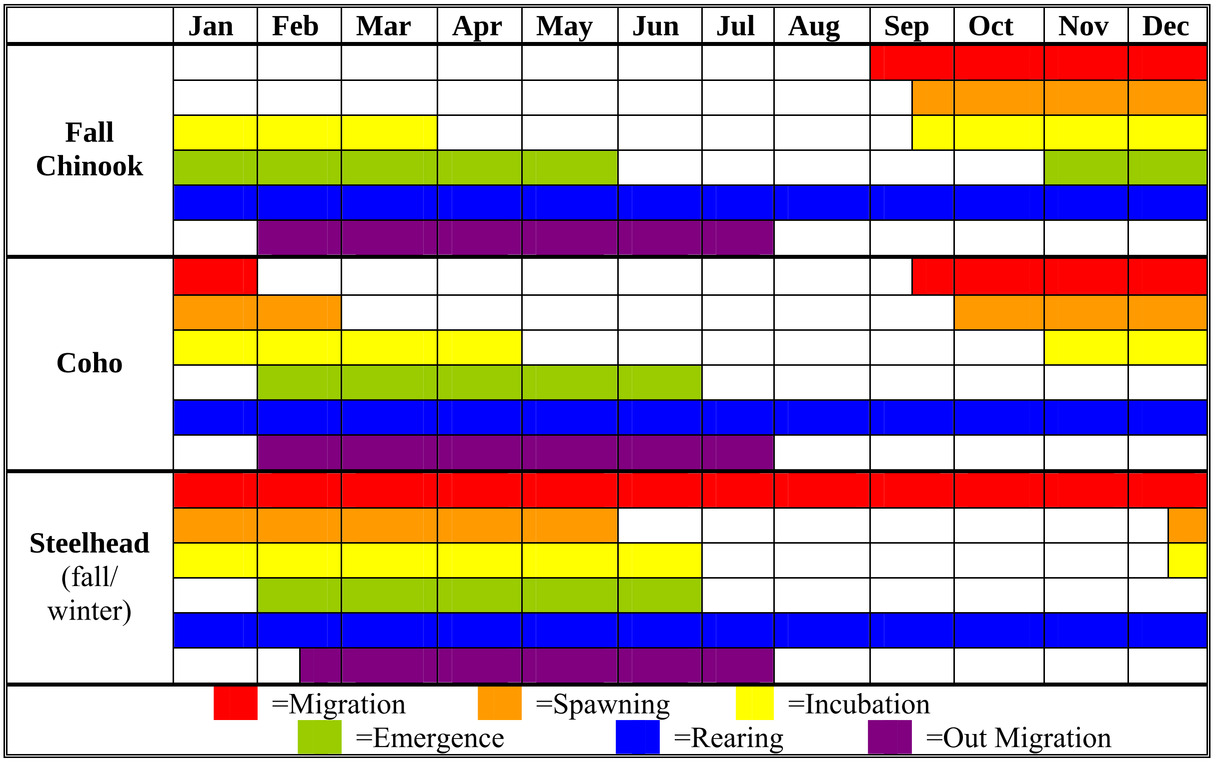

Figure 2.3. Salmonid Periodicity in the Scott River Watershed.

2.4 SEDIMENT PROBLEM STATEMENT

The primary adverse impacts produced by excessive sediment supply in the Scott River and its tributaries are adverse effects on the cold-water salmonid fishery. Excessive sediment fills pools, reducing available habitat. Fine sediment, which constitutes most of the additional sediment load, fills and buries the gravels that salmonids require to spawn. In addition, the influx of fine sediments reduces the number of macroinvertebrates available for food during salmonid rearing. Excess sediment produces wider, shallower channels which are subject to solar heating and contribute to the non-attainment of temperature objectives.

2.4.1 Sediment Desired Conditions

This section identifies desired conditions for salmonid freshwater habitat and upslope settings. These indicators are interpretations of the water quality standards presented in two categories, instream conditions and watershed conditions.[1] For each parameter, a desired condition value is identified. These parameters, and their associated desired condition values, although not directly

[1] Turbidity is the only exception as turbidity is a water quality objective listed in the Basin Plan.

enforceable, have proved to be a useful reference in determining the effectiveness of a TMDL and implementation measures toward attaining water quality standards.[1]

The instream desired conditions relate to the quality and size distribution of sediment and are important as measures of stream health. The watershed desired conditions focus on the environment upslope of the streams and reflect either predictors of or protection against future degradation of water quality. Watershed parameters focus on imminent threats to water quality that can be detected and corrected before sediment is delivered to the stream. Watershed parameters are often easier to measure than instream parameters and identify conditions that are needed in the watershed to protect water quality as it relates to sediment conditions.

Desired conditions values of both instream and watershed parameters are set at levels associated with well-functioning stream systems. Instream parameters reflect present conditions, but these conditions may take years or decades to respond to changes higher in the watershed. Watershed parameters reflect processes upslope from the streams in the watershed at the time of measurement, and may respond relatively quickly to induced changes. The linkages relating production of sediment upslope, delivery of that sediment to a stream, and what happens to that sediment in the stream are complex. Time lags between production and delivery of sediment, instream storage, and times and processes of transport through the system are not always well known. Accordingly, watershed desired conditions potentially can be achieved sooner than instream desired conditions, and can serve as checks on the progress toward achievement of water quality standards.

No single parameter adequately describes water quality with relation to sediment; instead, a suite of instream conditions and a suite of watershed conditions are identified. Because of the inherent variability associated with stream channel conditions, and because no single indicator applies in all situations, attainment of the desired conditions is evaluated using a weight-of-evidence approach. Experience shows that the parameters, when considered together, provide good evidence of the condition of the stream and of progress toward attainment of sediment-related water quality standards.

2.4.1.1 Instream Desired Conditions for Sediment

Tables 2.2 and 2.3 list the instream salmonid habitat desired conditions for the Scott River TMDL and their respective desired condition values. In several cases, desired conditions are expressed as improving trends, because information on watershed processes is not adequate to develop thresholds specific to the Scott River watershed. These parameters and their application are discussed by Fitzgerald (2004), which also includes a discussion of the literature on these indicators, their importance in characterizing instream conditions suitable for salmonids, and desired condition values for the indicators.

2.4.1.2 Watershed Desired Conditions for Sediment

Table 2.4 lists the watershed desired conditions for the Scott River TMDL and their respective desired condition values. More information on each parameter is found in the following sections. Watershed desired conditions are indicators of potential future sediment contributions to the stream system. The information on watershed desired conditions includes reported conditions taken from several publicly funded inventories including surveys in French Creek (Sommarstrom et al., 1990), Etna Creek (Resource Management, 2003), Moffett Creek (SHN Consulting Engineers & Geologists, 2003), Shackleford and Mill creeks (Siskiyou Resource Conservation District, 2003), and others. In several cases, desired conditions are expressed as improving trends, because information on watershed processes is not adequate to develop thresholds specific to the Scott River watershed.

Stream Crossings with Diversion Potential or Significant Failure Potential

Desired Condition: <1% of all stream crossings divert or fail as a result of a 100-year or smaller flood

Most roads, including skid trails, cross ephemeral or perennial streams. Crossings are built to capture the stream flow and safely convey it through, under, or around the roadbed. However, stream crossings can fail, adding sediment from the crossing structure (i.e., fill), or from the roadbed, directly into the stream. Stream crossing failures are generally related to culverts that are undersized, poorly placed, plugged, or partially plugged. When a crossing fails, the total sediment volume delivered to the stream usually includes both the volume of road fill associated with the crossing and sediment from collateral failures such as debris torrents that scour the channel and stream banks.

Diversion potential is the potential for a road to divert water from its intended drainage system across or through the road fill, thereby delivering road-related sediment to a watercourse. The potential to deliver sediment to the stream can be eliminated from almost all stream crossings by eliminating inboard ditches, outsloping roads, or installing rolling dips (M. Furniss, pers. comm., in USEPA, 1998). Generally, less than one percent of stream crossings have conditions where modification is inappropriate because it would endanger travelers or where modification is impractical because of physical constraints (D. Hagans, pers. comm., 1998, in USEPA, 1998).

Table 2.2
Instream Desired Conditions for Sediment*

Parameter	Desired Condition	Applicability	Monitoring/Sampling Notes
Benthic Macroinvertebrate Assemblage	≥ 18 Index Score per the Russian River Index of Biological Integrity (IBI). See Table 2.3 for the Russian River IBI.	1st, 2nd, and 3rd Order Streams.	Monitoring and calculation should occur in the spring according to the protocols found in the *California Stream Bioassessment Procedure* (CA Department of Fish and Game, 2003).
Embeddedness	Increasing trend in the number of locations where gravels and cobbles are ≤ 25% embedded.	All wadeable streams and rivers.	Monitoring should occur according to the protocols found in the *California Salmonid Stream Habitat Restoration Manual, Third Edition* (Flosi et al., 2004).
Large Woody Debris (LWD)	Increasing trend in the volume and frequency of LWD and key pieces of LWD.	Streams and rivers with bankfull channel widths > 1m.	Monitoring should be done according to the protocols found in the *California Salmonid Stream Restoration Manual, Third Edition* by Flosi et al. (2004), or in the Washington State *Method Manual for the Large Woody Debris Survey* (Shuett-Hames et al., 1999).
Pools –	Increasing trend in	Wadeable streams and rivers with	Monitoring should occur periodically during

Table 2.2
Instream Desired Conditions for Sediment*

Parameter	Desired Condition	Applicability	Monitoring/Sampling Notes
Backwater Pool Distribution	the number of backwater pools.	channel morphology that supports the development of backwater pools. Steep, v-shaped valleys with little floodplain connection generally do not exhibit this type of habitat and are exempt from this index.	the low-flow period and after a heavy winter storm according to the protocols found in the *California Salmonid Stream Restoration Manual, Third Edition* (Flosi et al., 2004).
Pools – Lateral Scour Pool Distribution	Increasing trend in the number of lateral scour pools.	Wadeable streams and rivers with channel morphology that supports the development of backwater pools. Steep, v-shaped valleys with little floodplain connection generally do not exhibit this type of habitat and are exempt from this index.	Monitoring should occur during the low-flow period, after a heavy winter storm, once every five to ten years according to the protocols found in the *California Salmonid Stream Restoration Manual, Third Edition* (Flosi et al., 2004).
Pools – Primary Pool Distribution	Increasing trend in the number of reaches where the length of the reach is composed of ≥ 40% primary pools.	All wadeable streams and rivers.	Monitoring should occur once every five to ten years during the low-flow period and after a heavy winter storm according to the protocols found in the *California Salmonid Stream Restoration Manual, Third Edition* (Flosi et al., 2004). Reported data should include length and depth of pools, and the number of primary pools.
Percent Fines	≤ 14% fines < 0.85 mm in diameter. ≤ 30% fines < 6.40 mm in diameter.	Wadeable streams and rivers with a gradient < 3%.	Monitoring should use a McNeil sediment core sampler similar to the specifications found in *Success of Pink Salmon Spawning Relative to Size of Spawning Bed Materials* (McNeil and Ahnell, 1964), except the diameter of the sampler's core should be at least 2-3 times larger than the largest substrate particle usually encountered. Monitoring should occur according the protocols found in *Stream Substrate Quality for Salmonids: Guidelines for Sampling, Processing, and Analysis* (Valentine, 1995), and use the methodology for the redd or pool/riffle break sampling universe. A 0.85 mm a 6.40 mm sieve should be used during sample processing. The wet volumetric method is recommended with the use of the wet volumetric method and the dry gravimetric method on 10% of the samples.
Thalweg Profile	Increasing variation in the thalweg elevation around the mean thalweg profile slope.	Streams and rivers with slopes ≤ 2%.	Monitoring should occur during the low-flow period, after a heavy winter storm, once every five to ten years. The monitored stream segments should be at least 20, but usually 30 to 40, times as long as the average bankfull channel width. Points that should be surveyed include the thalweg, all breaks-in-slope, riffle crests, maximum pool depths, tails of pools, and surface water elevation. Acceptable monitoring protocols include the Channel

Table 2.2
Instream Desired Conditions for Sediment*

Parameter	Desired Condition	Applicability	Monitoring/Sampling Notes
			Geometry Survey of *Water in Environmental Planning* (Dunne and Leopold, 1978).

* Adapted from Fitzgerald, 2004.

Table 2.3
Russian River Index of Biological Integrity

Biological Metric	Score			How to use the Russian River Index of Biological Integrity
	5	3	1	
Taxa Richness	> 35	35-26	< 26	Obtain a sample of benthic macroinvertebrates following the state standard procedures in *California Stream Bioassessment Procedure. Protocol Brief for Biological and Physical/Habitat Assessment in Wadeable Streams* (CA Dept. of Fish and Game, 2003). There must be at least three replicate samples collected at each monitoring location. The samples should be processed by a professional bioassessment laboratory using the Level 3 Taxonomic Effort. Determine the mean values for the six listed biological metrics, compare them to the values in the columns, and add the scores listed in the column headings. The total score will be between a low of 6 and a high of 30. Determine biotic condition of the monitoring location from the following categories: Excellent 30-24; Good 23-18; Fair 17-12; Poor 11-6
% Dominant Taxa	< 15	15-39	> 39	
EPT Taxa	> 18	18-12	< 12	
Modified EPT Index	> 53	53-17	< 17	
Shannon Diversity	> 2.9	2.9-2.3	< 2.3	
Tolerance Value	< 3.1	3.1-4.6	> 4.6	

1.Taken from *Measuring the Health of California Streams and River. A Methods Manual for: Water Resource Professionals, Citizen Monitors, and Natural Resources Students* by Harrington & Born (1999).

Table 2.4
Watershed Desired Conditions for Sediment

Parameter	Desired Condition	Comments	Purpose	References
Watershed	Monitoring recommendations: prior to winter			
Diversion & Stream Crossing Failure Potential	≤ 1% of crossings divert or fail in 100 yr storm.	Measured prior to winter.	Estimate of potential for reduced risk of sediment delivery from hillslope sources to the water body.	Weaver and Hagans, 1994; Flanagan et al., 1998.
Hydrologic Connectivity of Roads	Decreasing length of connected road to ≤ 1%.	Measured prior to winter.	Estimate of potential for reduced risk of sediment delivery from hillslope	Ziemer, 1998; Flanagan et al., 1998; Furniss et al., 2000.

Table 2.4 Watershed Desired Conditions for Sediment				
Parameter	**Desired Condition**	**Comments**	**Purpose**	**References**
			sources to the water body.	
Annual Road Inspection & Correction	Increasing proportion of road to 100%.	Roads inspected and maintained, decommissioned or hydrologically closed prior to winter. No migration barriers.	Estimate of potential for reduced risk of sediment delivery from hillslope sources to the water body.	USEPA, 1998.
Road Location, Surfacing, & Sidecast	Decreasing length next to stream, increased % outsloped, and hard surfaced roads	See text	Minimize sediment delivery.	USEPA, 1998.
Activities in Unstable Areas	Avoid or eliminate.	Subject to geological / geotechnical assessment to minimize or show that no increased delivery would result.	Minimize sediment delivery from management activities.	Dietrich et al., 1998; Weaver and Hagans, 1994; PWA, 1998.
Disturbed Areas	Decrease	See text.	Measure of chronic sediment input.	Lewis, 1998.

Hydrologic Connectivity

Desired Condition: decreasing length of hydrologically connected roads to $\leq$*1%*
A hydrologically connected road drains water directly to the adjacent stream, which increases the intensity, frequency, and magnitude of flood flows and suspended sediment loads in the stream. This process can destabilize the stream channel and produce a devastating effect on salmonid redds and growing embryos (Lisle, 1989). The hydrologic connectivity can be reduced by outsloping roads, creating road drainage that mimics natural drainage as much as possible, and other factors (M. Furniss, pers. comm., 1998 in USEPA, 1998; Weaver and Hagans, 1994). The reduction of road densities and the reconstruction of roads to reduce the miles of inboard ditches, for example, can reduce the amount of water that is directly delivered to watercourses, as well as associated sediment load.

Annual Road Inspection and Correction

Desired Condition: increasing proportion to 100%
U.S. EPA's analysis indicates that in watersheds with road networks that have not experienced excessive road-related sedimentation, roads are either (1) regularly inspected and maintained; (2) hydrologically maintenance free (i.e., they do not alter the natural hydrology of the stream); or (3) decommissioned or hydrologically closed (i.e., fills and culverts have been removed and the natural hydrology of the hillslope has largely been restored). Roads that do not meet one of these conditions are potentially large sources of sediment (D. Hagans, pers. comm., 1998, cited in USEPA, 1998). In general, road inspection should be done annually and could in most cases be accomplished with a windshield survey. The areas with significant potential for sediment delivery should be corrected before the onset of winter conditions. This desired condition calls for an increase in the proportion of roads that are either (1) inspected annually and maintained before winter, (2) hydrologically maintenance free, or (3) decommissioned or hydrologically closed.

Road Location, Surfacing, & Sidecast

Desired Condition: decrease road length next to streams and increase proportion of out-sloped or hard surfaced roads This indicator is intended to address the highest risk sediment delivery from roads that are not covered in other indicators. Roads in inner gorges and headwall areas are more likely to fail than roads in other topographic locations. Other than along ephemeral watercourses, roads should be removed from inner gorge and potentially unstable headwall areas, except where alternative road locations are unavailable and the road is clearly needed. Road surfacing and use intensity directly influence sediment delivery from roads. Rock surfacing or paving is appropriate for frequently used roads. Sidecast on steep slopes can trigger earth movements, potentially resulting in sediment delivery to watercourses. These factors reflect the highest risk of sediment delivery from roads, and should be the highest priorities for correction (Flanagan et al., 1998).

This desired condition calls for several conditions: (1) elimination of roads alongside inner gorge stream reaches and in potentially unstable headwall areas, unless alternative road locations are unavailable and the road is clearly needed, (2) road surfacing, drainage methods, and maintenance should be appropriate to the road's use patterns and intensities, and (3) sidecast or fill on slopes of greater than 50 percent grade, and potentially unstable slopes that could deliver sediment to a watercourse, should be stabilized or re-graded to fifty percent grade or less.

Activity in Unstable Areas

Desired Condition: avoid or eliminate, unless detailed geologic assessment by a Certified Engineering Geologist concludes there is no additional potential for increased sediment loading
Unstable areas are those areas that have a high risk of landsliding, and include steep slopes, inner gorges, headwall swales, stream banks, existing landslides, and other locations identified in the field. Because of the high risk of landsliding inherent in these features, any activity that might trigger an erosional event should be avoided, if possible, and kept to a minimum if unavoidable. Such activities include road building, timber harvesting, yarding, terracing for vineyards, etc.

Analysis of chronic landsliding in the Noyo River basin indicated that landslides observed on aerial photographs largely coincide with predicted chronic risk areas including steep slopes, inner gorges, and headwall swales (Dietrich et al., 1998). Several other studies have shown that landslides are larger or more common in some harvest areas, particularly in inner gorges (Graham Matthews & Associates, 2001). Weaver and Hagans (1994) also suggest methods for eliminating or decreasing the potential for road-related sediment delivery.

Disturbed Areas

Desired Condition: decrease in disturbed area, or decrease in disturbance index
The areal extent of disturbed areas is an indication of increased sediment loads, particularly chronic sediment discharges that are not associated with large storms or floods. Studies in Caspar Creek (Lewis, 1998) indicate a statistically significant relationship between disturbed areas and the corresponding suspended sediment discharge rate (Lewis, 1998; Mangelsdorf and Clyde, 2000). In addition, studies in Caspar Creek indicate that clear cutting causes greater increases in peak flows (and, by extension, increased suspended sediment loads) than does selective harvest (Ziemer, 1998). As with the "hydrologic connectivity" desired condition, increases in peak flows, annual flows, and suspended sediment discharge rates negatively affect the potential survivability of salmonid eggs in redds (Lisle, 1989).

Available information is not sufficient to identify a threshold below which effects on the Scott River watershed would be insignificant. Accordingly, the desired condition calls for a reduction in the amount of disturbed area or in the disturbance index. In this context, "disturbed area" is defined as the area covered by urban development or management-related facilities of any sort, including: roads, landings, skid trails, fire lines, timber harvest areas, animal holding pens, and agricultural fields (e.g., pastures, vineyards, orchards, row crops, etc.). The definition of disturbed area is intentionally broad to include managed agricultural areas, such as pastures and harvest areas, where the management activity (e.g., logging or grazing) results in removal of vegetation sufficient to significantly reduce rainfall interception and other soil protection functions. Agricultural fields or harvest areas in which adequate vegetation is retained to perform these ecological functions are not considered disturbed areas. Dramatic reductions in the amount of disturbed area can be made by reducing road densities, skid trail densities, clearcut areas, and other management-produced bare areas.

Human intervention can affect both the frequency and the intensity of fires, but staff have not made an attempt here to address this complex issue. For the purpose of this study, fire is assumed to be a natural process and is not taken into account.

Road density is also considered by many researchers to be an important indicator of the potential for sediment delivery to streams. Roads create impervious surfaces which result in increased surface runoff and peak flows. A watershed analysis performed as part of a long term strategy for Lassen National Forest Land (Armentrout et al., 1998) cited a road density of 2.5 miles of road per square mile of land as a watershed management objective indicating overall system conditions on at the subwatershed scale. The Scott River TMDL Action Plan does not propose road density as a specific desired condition for the Scott River watershed, although a decreasing trend in road densities would be beneficial. Information on road density by subwatershed is presented in Chapter 3.

2.4.2 Instream Sediment Conditions in the Scott River Watershed

Available data on instream sediment conditions mostly represent the mainstem Scott River, several tributaries in the canyon reach (Tompkins, Boulder, and Canyon creeks) and several westside tributaries (Shackleford-Mill, Etna, French, and Sugar creeks). Available data on instream sediment conditions on the mainstem Scott River through Scott Valley show a consistent pattern of impairment, through with indications of improving trends for some parameters. Westside tributaries show mixed conditions, with some parameters exceeding desired conditions, some meeting desired conditions, and some with stable or improving trends in fine sediment values. For canyon tributaries, available data are generally indicative of sediment impairment.

A summary of instream sediment conditions in the Scott River watershed is listed in Table 2.5, which also includes desired conditions values taken from Table 2.2. A more detailed discussion of instream sediment conditions for individual parameters is found in the following sections. These sections are presented in alphabetical order. The order is not intended to convey relative importance of any individual parameter.

2.4.2.1 Benthic Macroinvertebrate Assemblages

Quigley (2001) conducted a macroinvertebrate survey at five localities on the mainstem Scott in October, 2000 and April, 2001. The sites are:

a) Red Bridge, just below where the South Fork and the East Fork meet and upstream of the dredge tailings.
b) ISSCR (T44N R9W Sec 26), in the middle part of Scott Valley downstream of the dredge tailings and in the major agricultural area.
c) Meamber (T44N R10W Sec 26), eight miles downstream of Fort Jones, just upstream of the mouth of the canyon. This site was chosen to show the cumulative impact of upstream farming practices.

Table 2.5
Instream Sediment Conditions in the Scott River Watershed

Parameter	Desired Condition	Applicability	Assessment of Available Data
Benthic Macroinvertebrate Assemblage	≥ 18 Index Score per the Russian River Index of Biological Integrity (IBI). See Table 2.3 for the Russian River IBI.	1^{st}, 2^{nd}, and 3^{rd} Order Streams.	Quigley concludes that benthic data indicate degraded water quality through the valley during the summer months, although conditions improve over the course of the winter.
Embeddedness	Increasing trend in the number of locations where gravels and cobbles are ≤ 25% embedded.	All wadeable streams and rivers.	Data limited. Results from 1989 for Scott River and streams in the canyon reach show high percent of locations exceed 25% embedded. Scott River results indicate watershed-scale impairment for this indicator.
Large Woody	Increasing trend in	Streams and rivers with bankfull	Data collected for Siskiyou RCD available but

Table 2.5
Instream Sediment Conditions in the Scott River Watershed

Parameter	Desired Condition	Applicability	Assessment of Available Data
Debris (LWD)	the volume and frequency of LWD and key pieces of LWD.	channel widths > 1m.	cannot be evaluated against LWD key piece criteria.
Pools – Backwater Pool Distribution	Increasing trend in the number of backwater pools.	Wadeable streams and rivers with channel morphology that supports the development of backwater pools. Steep, v-shaped valleys with little floodplain connection generally do not exhibit this type of habitat and are exempt from this index.	No data.
Pools – Lateral Scour Pool Distribution	Increasing trend in the number of lateral scour pools.	Wadeable streams and rivers with channel morphology that supports the development of backwater pools. Steep, v-shaped valleys with little floodplain connection generally do not exhibit this type of habitat and are exempt from this index.	No data.
Pools – Primary Pool Distribution	Increasing trend in the number of reaches where the length of the reach is composed of ≥ 40% primary pools.	All wadeable streams and rivers.	Available data on both the mainstem Scott and tributaries do not meet the desired condition in any reach measured.
Percent Fines	≤ 14% fines < 0.85 mm in diameter. ≤ 30% fines < 6.40 mm in diameter.	Wadeable streams and rivers with a gradient < 3%.	Available data indicate stable or improving trends in the 0.85 mm indicator and that the desired condition is generally met. The 6.4 mm desired condition is generally not met, including in the mainstem from French Creek to Shackleford Creek, and in French, Sugar, Canyon and Tompkins Creeks. The 6.4 mm desired condition was met in Etna Creek.
Thalweg Profile	Increasing variation in the thalweg elevation around the mean thalweg profile slope.	Streams and rivers with slopes ≤ 2%.	Data not adequate for assessment.

d) Johnson Bar (T45N R 10W Sec 21), just above the mouth of the Scott River. This site is in the first spawning reach available to Chinook salmon in the fall.
e) Below the mouth of Middle Creek (T44N R11W), below the mouth of Canyon and Kelsey Creeks. Site chosen to show influence of water contributed by free-flowing canyon tributaries that mitigate some of the effects of agriculture.

The biotic indices used by Quigley (2001, p. 6) are:

Taxa Richness - This reflects the number of distinct taxa within a sample. The more diverse the sample, the healthier the habitat indicated. Taxa richness values decrease as the diversity of the sample decreases.

EPT Taxa - Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These are the most common taxa of intolerant invertebrates. This number also decreases with disturbance of habitat.

Tolerance Value - This value is a measure of the number of species considered tolerant to pollution. As the health of the habitat decreases, this value increases.

%Dominance - Measures the dominance of the single most abundant taxon. As the habitat quality gets worse, the most tolerant species will increase in numbers, and the % Dominance value will increase.

Modified EPT and Shannon Diversity indices were also reported.

Quigley (2001, p. 8) concludes that samples collected for the project demonstrate degraded water quality through the valley during the summer months, although conditions improve over the course of the winter.
Another measure of the biological health of a stream is the Russian River Index of Biological Integrity (Table 2.3). This measure uses the same biological metrics as the work of Quigley and combines all the metrics into a single score. If the work of Quigley (2001) is considered to be background information, future studies might build upon it by using the Russian River Index of Biological Integrity. Ongoing work on macroinvertebrates by the State Water Board and researchers at Utah State may also provide indicators appropriate to the North Coast.

2.4.2.2 Embeddedness Conditions

The U.S. Forest Service has compiled embeddedness figures for the Scott River and four tributaries within the Klamath National Forest (Table 2.6). The Scott River, with an average of thirty-five percent embeddedness and fifty-four percent of sites exceeding the desired condition value of ≤ 25% embeddedness, showed that the basin as a whole was impaired at the time the measures were made in 1989. Results for Tompkins and Canyon Creeks indicated high embeddedness values at most sites, and average values above the desired condition. Two tributaries, Shackleford and Mill Creeks, showed only mild impairment.

Quigley (2003) reports data on embeddedness from 4 mainstem locations and 24 locations on 8 tributaries (Boulder, Emigrant, French, Mill/Shackleford, Miner's, Sugar and Wildcat Creeks). Results indicate generally high values except in Miner's Creek, Wildcat Creek, the tailings reach, and some locations in French Creek.

Table 2.6
Embeddedness of Gravels in the Scott River & Four Tributaries*

USFS Survey #	Name of Stream	# of Measure-ments	Average % Embeddedness	Range of % Embeddedness	# >25% Embedded	% >25% Embedded
39	Scott River	239	35	0-95	128	54
119	Tompkins Creek	12	33	0-50	10	83

101	Canyon Creek	25	48	0-75	23	92
33	Shackleford Creek	46	13	5-40	2	4
25	Mill Creek	12	10	10-50	1	8

* Data supplied by the USFS. Data gathered in 1989.

2.4.2.3 Large Woody Debris (LWD) Conditions

No systematic analysis of LWD conditions in the Scott River watershed is currently available. Table 2.7 shows an accepted procedure for determining LWD effectiveness. A protocol such as is shown in Table 2.7 would be an appropriate beginning to evaluate the status of LWD in the Scott River and tributaries.

2.4.2.4 Pool Distribution and Depth Conditions

Habitat data cited in the Noyo River Total Maximum Daily Load for Sediment (USEPA, 1999, p. 38-39) all indicate that pool frequency and/or pool depth may be factors limiting the success of salmonids. Deep and frequent pools are necessary as summer rearing habitat, particularly for coho salmon, which are less able than steelhead trout to compete for food supplies in the absence of deep pools (Harvey and Nakamoto, 1996).

Flosi et al. (2004, p. V-15) reported:

> DFG habitat typing data indicate the better coastal coho streams may have as much as 40 percent of their total habitat length in primary pools. In first and second order streams a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low-flow channel, and be as long as the low-flow channel width. In third and fourth order streams the criteria is the same, except maximum depth must be at least three feet.

A review of habitat typing data collected since 1993 indicates that the better coho streams in California generally have about 40 percent of their total habitat length in primary pools (USEPA, 1999, p. 39). Using this criterion, the numeric desired condition for pool frequency/depth requires that at least forty percent of the total habitat length be in three-foot-deep pools.

Table 2.7
LWD Key Piece Volume Criteria
(taken from Schuett-Hames et al., 1999; modified with results from Fox, 2001)

Min. Diameter in meters	Minimum Length of LWD in meters			
	BFW > 0 to < 5	BFW 5 to < 10	BFW 10 to < 15	BFW 15 to < 20
0.20	32			
0.25	21			
0.30	15	36		
0.35	11	26		
0.40	8	20		
0.45	7	16	38	
0.50	6	13	31	
0.55	5	11	26	
0.60	4	9	22	32
0.65	3	8	19	28
0.70	3	7	19	24
0.75	3	6	14	21
0.80	2	5	12	18
0.85	2	5	11	16
0.90	2	4	10	15
0.95	2	4	9	13
1.00	2	4	8	12
1.05	2	3	7	11
1.10	2	3	7	10
1.15	1	3	6	9
1.20		3	6	8
1.25		3	5	8
1.30		2	5	7
1.40		2	4	6
1.55		2	4	5
1.60		2	3	5
1.70		2	3	4
1.80		1	3	4
2.00			2	3
2.40			2	2
2.80			1	2
3.40				1

Meter/Feet conversion: meters x 3.281 = feet

Minimum LWD Volume to Qualify as a Key Piece

BFW (m)	Volume (m^3)
0 to < 5	1
5 to < 10	2.5
10 to < 15	6
15 to < 20	9
20 to < 30	9.75
30 to < 50	10.5*
50 to 100	10.75*

* Wood piece must have an attached root wad.

Procedure:
1. Select segment bankfull width (BFW) category.
2. Measure diameter of candidate pieces and round to nearest 0.05 m (5 cm)
3. Follow matrix across to find the minimum length requirement.

Key Log Example:
1. Segment has an average BFW of 12 m (use BFW column of 10 to < 15 m).
2. Candidate log diameter is measured/ estimated to be 0.53 m (round to 0.55 m).
3. Log must be a minimum of 26 m long (measure/estimate log length to assess if it is a key piece).

Key Rootwad Example:
1. Segment has an average BFW of 4 m (use BFW column of 0 to < 5 m).
2. A rootwad Key Piece must have a minimum diameter of 1.15 m and length of 1 m.

The Siskiyou RCD (2003) recorded pool occurrence in five reaches of the Scott mainstem and five tributaries. The five reaches of the mainstem ranged from nine percent to thirty percent pools by length and averaged twenty percent. Twenty reaches recorded on the five tributaries ranged from zero percent to fifteen percent pools by length, and averaged six percent pools. This study did not specify depth of pools and some pools may have been less than three feet deep.

Quigley (2003) included data on pools in four reaches of the Scott mainstem and twenty-four reaches on eight tributaries. In this study, the four reaches of the mainstem ranged from nine percent to thirty-four percent pools by length (with the highest value in the tailings reach), and by reach from forty-seven percent to 100 percent of these pools were three feet deep or deeper. In the twenty-four tributary reaches, values ranged from zero percent to twenty percent pools by length.

2.4.2.5 Percent Fines Conditions

In this section, the discussion is broken out by drainage first. Within each drainage discussion, results related to the 6.4mm desired condition are discussed first, followed by results related to the 0.85 mm desired condition. Most of this discussion is based on results presented in Sommarstrom and others (1990) and Sommarstrom (2001), reporting on sampling performed in 1989 and 2000. All samples in both years were collected with a McNeil sampler.

Mainstem Scott River

Sediment size was analyzed from twelve sites in the mainstem Scott River distributed from River Mile (RM) 23.5 to RM 55.7 (in 1989 and 2000. This part of the river is of low gradient and passes through the open agricultural part of Scott Valley Analyses showed more than 30 percent fines <6.3 mm at 9 of 11 sites in 1989 (one site not sampled) and at 10 of 12 sites in 2000. In 1989 the fraction <6.3 mm ranged from 26.8 percent to 92.7 percent; in 2000 that size category ranged from 18.3 percent to 84.3 percent. A comparison of the two sample sets shows increases at 4 sites, decreases at 3 sites, and values about the same at 4 sites. Sediment in the mainstem Scott does not reach the desired condition of $\leq$ 30 percent fines < 6.4 mm in the reach between French Creek and Shackleford Creek. Sommarstrom and others (1990) showed that much of the sand-sized sediment is generated in the areas of decomposed granitic soil in areas on the west and south sides of the watershed, and that disturbance of these areas by management greatly increases their sediment contribution.

At the same sites on the mainstem Scott River, analyses showed more than 14 percent fines <0.85 mm at four of 11 sites in 1989 (one site not sampled) and at 2 of 12 sites in 2000. In 1989 the fraction <0.85 mm ranged from 6.4 percent to 21.6 percent, but in 2000 the range of that size category ranged had decreased to 4.0 percent to 16.8 percent. The biggest improvements were measured in the reach between Etna Creek and Moffett Creek.

Etna Creek

In 2000, samples were collected at one site in Etna Creek, two in French Creek, and one in Sugar Creek, for comparison to sites sampled in 1989. The Etna Creek site, at the Highway 3 bridge, showed the fraction ≤ 6.3mm to be 28.3 percent in 1989 and 16.9 percent in 2000. These values meet the desired condition of ≤ 30 percent in both years and show an improving trend. The fraction ≤ 0.85mm was 5.1 percent in 1989 and 7.4 percent in 2000. These values met the desired condition of ≤ 14 percent in both years.

French Creek

In 1989, three locations were sampled in French Creek. Two of the three samples exceeded 30 percent sediment <6.3mm and did not meet the desired condition of ≤ 30 percent < 6.4mm. Sommarstrom (2001) reported sampling of locations at the Highway 3 and Miner's Creek Road bridges over French Creek. At both locations the fraction of sediment ≤ 6.3mm exceeded 30 percent in 1989 and 2000. All of the three locations sampled in 1989 showed < 14 percent sediment < 0.85mm, meeting the desired condition of ≤ 14 percent. Samples from the two locations resampled in 2000 also met the desired condition.

Sugar Creek

Samples were collected near the mouth below the Highway 3 bridge in 1989 and 2000. The fraction of sediment ≤ 6.3mm was 30.8 percent in 1989, and 33.8 percent in 2000. The fraction ≤ 0.85 mm was < 14 percent in both locations in both years, though slightly higher in 2000.

Canyon Creek

Lester (1999) analyzed sediment from nine sites in Canyon Creek, which drains an area containing some granitic soils. Lester did not use a 6.4 mm screen, but instead used 4.75 mm and 8 mm screens. These data show >30 percent sediment ≤6.4 mm at four of 12 sites and >14 percent fines ≤0.85 mm at none of 9 sites. This creek appears somewhat impaired in regard to fine sediment.

Tompkins Creek

Lester (1999) analyzed sediment from nine sites in Tompkins Creek, which drains an area containing some granitic soils. These data show >30 percent sediment ≤6.4 mm at four sites and >14 percent fines ≤0.85 mm at one site. In summary, results at the locations sampled appear to indicate improving trends from 1989 to 2000 for the fraction <0.85 mm, but show continued patterns of exceedance and no clear trend of improvement for the fraction <6.4 mm.

2.4.2.6 Thalweg Profile Conditions

No systematic information on thalweg profiles is available in the Scott River watershed. One study by University of California Davis (2003) surveyed reaches in Mill Creek (4), Emigrant Creek (3), French Creek (5), Sugar Creek (5), and the East Fork (5). Example results of longitudinal profiles and cross sections are presented, though comparisons through time are not made. Sommarstrom and others (1990, p. 3-9 to 3-14) measured cross sections at 15 locations from above Callahan to the Scott River gage station near Fort Jones. The report (Figure 3-10) compares cross sections at the Highway 3 bridge from 1956 and 1989, and finds the thalweg elevations are similar.

2.4.2.7 V* Conditions

Before 1992 excess fine sediment was acknowledged to be a significant problem in French Creek. V* analyses were done in French Creek yearly from 1992 to 1997 and again in 1999 and 2001 (Figure 2.4). The number of pools sampled each year ranged from 11 to 13.

More than sixty percent of the French Creek drainage basin is underlain by DG, which ravels and contributes abundant sediment to streams (e.g. Sommarstrom, 1992). By the early 1990s management activities had disturbed large areas in the basin. In 1992 a major restoration and reclamation effort began that included, among other steps, repairing and redesigning road crossings, outsloping roads, and decommissioning some roads. A major decline in fine sediment in the following years appears to be the direct result of that initiative. In 1997, a major storm led to flooding and abundant sediment contribution. However, the V* values rose to only about fifty percent of what they had been in 1992. The restoration work that began in 1992 appears to be quite effective in decreasing the sediment contribution to French Creek.

The U.S. EPA, in the South Fork Trinity River and Hayfork Creek TMDLs (U.S. EPA, 1998a, Table E-2), includes a mean V* desired condition value of ≤ 0.10 for tributaries that drain watersheds composed of the metamorphic and intrusive basement of the Klamath Mountains geologic province, which includes the Scott River watershed. The U.S. EPA states that background values of 0.10 to 0.15 would be expected for Klamath Mountains geology (Lisle, USFS, pers. comm., 1998, as cited in U.S. EPA, 1998a, Table E-1). Assuming that a mean V* value of ≤ 0.10 represents healthy background conditions in the Scott River watershed, data from French Creek indicate improving trends in V*, and values that meet or are near to meeting the ≤ 0.10 value. There are no data available for the mainstem Scott River or other tributaries.

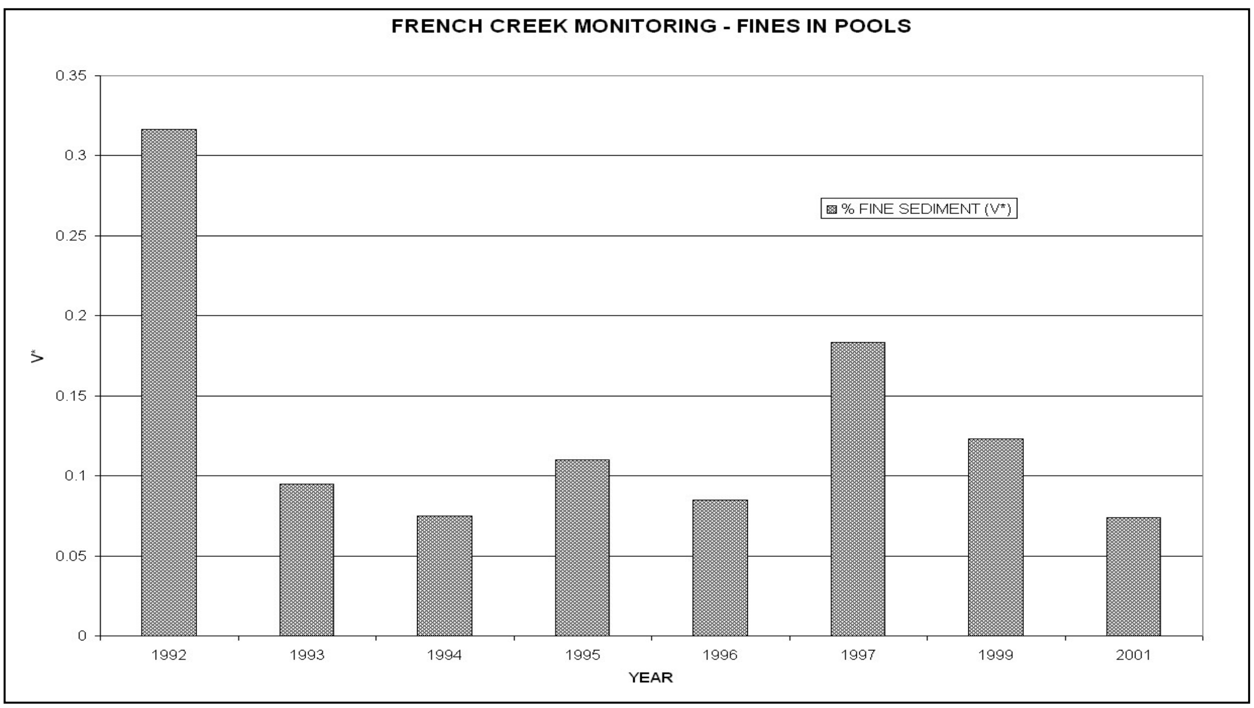

Figure 2.4. French Creek Monitoring Results – Fine Sediment in Pools (V*)

Juvenile coho surveys done in French Creek from 1992, the time of the French Creek Project, are discussed in Section 2.3 and indicate an increasing trend in coho coincident with the beginning of improvement in sediment conditions in the stream.

2.4.3 Watershed Sediment Conditions in the Scott River Watershed

The hydrology and surface conditions in the Scott River watershed have been affected over time by several intense management activities. The upslope conditions in the Scott River watershed have been altered by human activities in many ways, some of them reversible and some, such as effects of some aspects of mining activities, virtually irreversible. The following sections describe some of these processes, the conditions they create, and recently documented trends.

2.4.3.1 Stream Crossings with Diversion Potential or Significant Failure Potential

The USFS has done a road sediment source inventory that includes sites in the Scott River watershed (USFS, 2001). Diversion potential was estimated at 38% of channel crossing sites in the Lower Scott survey area (mostly in the West Canyon subwatershed, as defined in chapter 3), and at 36% in the Upper Scott survey area (all in the West Headwater (South Fork) subwatershed).

A road erosion inventory in the Shackleford and Mill Creek watersheds (SHN Consulting Engineers & Geologists, 1999) mapped 107 miles of forest roads on private timberlands. The road density is approximately 8.9 miles per square mile. Culverts, crossings, gullies, slides, and road surface erosion were inventoried and evaluated for past erosion and possible future erosion. Sites and road segments farther than ¼ mile from a fish-bearing stream were not considered. Features surveyed included 164 culverts, 186 crossings, 82 gullies, and 50 slides. Estimated volume of past erosion, not including mass movement, was 19,700 cubic yards. This inventory identifies 487 features in the four point-source categories, of which 121 are evaluated as high or medium-high priority for treatment.

The follow-up Shackleford-Mill Road Erosion Reduction Project (Siskiyou Resource Conservation District, 2003) treated 30 miles of roads to reduce sediment production. The program hydrologically decommissioned 6.9 miles of road and improved the remainder to reduce sediment contribution. Measures consisted primarily of storm-proofing road segments and crossings, and out-sloping roads. The 219 sites treated had the potential to deliver 73,000 cubic yards of sediment.

A road survey in the upper Etna Creek drainage and adjacent areas in Clark Creek, North Fork French Creek, and upper French Creek (Resource Management, 2003) examined approximately 100 miles of road. The area has had extensive timber harvest, and harvest continues, but we do not know the most recent harvest history. Generalizations summed up in this study are:

- 91% of past erosion has been on 25 percent of the road miles.

- Only 20-30% of smaller culverts in the area (12, 18, 24 inch) pass for a 100-year flow design; however small errors in drainage area calculations or assumptions regarding infiltration can have large effects on results, so more investigation is needed.
- Culverts 36" and larger passed 100 year flow design at 50% and higher.
- New road construction and ongoing maintenance techniques are effective.
- Effective use of low water crossings and bridges reduced diversion potential and increased the number of crossings passing 100-year flows.

The Preliminary Road Maintenance Action Plan calls for a) specific erosion site plans, b) company 5-year planning schedule, c) company road maintenance procedures, d) workable cooperative road agreements. The report notes and prioritizes specific problem sites.

2.4.3.2 Hydrologic Connectivity

SHN (1999) recommends upgrading major segments of roads in the Mill and Shackleford Creek drainages. The SHN (1999) road inventory does not record whether a road segment has inboard ditches, but their map of Erosion and Crossing Locations shows many culverts that are not in natural drainages, suggesting an extensive inboard ditch system and little outsloping. They do not describe the culverts and to what degree they are "shotgunned."

The USFS has done a road sediment source inventory that includes sites in the Scott River watershed (USFS, 2001). The results indicate hydrologic connectivity values of 12.3% and 21.8% in the upper and lower Scott survey areas, respectively.

2.4.3.3 Annual Road Inspection and Correction

The USFS and timber companies maintain roads on a project basis, repairing and upgrading roads in limited areas on a project rather than on a widespread annual basis. Over time, the trend is toward an increasing proportion of outsloped roads, although a large proportion of roads remain in ditch-and-culvert design. One timber company is currently embarking on a long-term road management plan as part of a Habitat Conservation Plan. Other private roads appear to be maintained on an as-needed basis. The SHN study (SHN 1999, p. 14) survey notes that many road segments have had little or no annual maintenance for years.

2.4.3.4 Road Location, Surfacing, & Sidecast

The road erosion inventory of Shackleford and Mill Creek watersheds (SHN Consulting Engineers and Geologists, 1999) does not quantify the miles of road adjacent to streams, but the included map shows gravel surface roads in inner gorges within 600 feet of both Shackleford and Mill Creeks. In this heavily roaded area many logging roads lie on lower slopes and in headwall areas. The inventory document recommends much upgrading of culverts and crossings, and sets priorities, but does not address outsloping of roads.

Information on road proximity to streams was developed as part of the sediment source analysis and is presented in Chapter 3.

2.4.3.5 Disturbed Areas

The earliest major disturbance in the Scott River watershed was placer mining for gold, which started at Scott Bar in 1850 and soon spread throughout much of the watershed. The story of this mining, summarized by the Scott River Watershed CRMP Committee (1995), is a story of placer mining that included deep dredging and hydraulic mining. Resulting sediment plumes impeded fish surveys as late as 1934, and in 1934 a federal fishery biologist reported that upstream of Callahan food and spawning grounds had been destroyed. During development of mining, extensive ditches were constructed. Later, these ditches were used for developing agriculture. Much of the agriculture is grazing and hay cropping, which does not qualify as disturbed areas under the present definition. Timber harvest began along with mining, and continues on an industrial scale to the present. Logging roads are a major source of sediment, and they contribute a particularly large amount in areas of decomposed granite (DG) soils (Sommarstrom et al., 1990; Sommarstrom et al., 1999).

2.5 TEMPERATURE PROBLEM STATEMENT

This section describes the freshwater temperature requirements for salmonids, recommended criteria for summer salmonid rearing, desired conditions, and temperature conditions in the Scott River watershed.

2.5.1 Salmonid Temperature Requirements

Temperature is one of the most important factors affecting the success of salmonids and other aquatic life. Most aquatic organisms, including salmon and steelhead, are poikilotherms, meaning their temperature and metabolism are determined by the ambient temperature of water. Temperature therefore influences growth and feeding rates, metabolism, development of embryos and alevins, timing of life history events such as upstream migration, spawning, freshwater rearing, and seaward migration, and the availability of food. Temperature changes can also cause stress and mortality (Ligon et al., 1999).

Much of the information reported in the literature characterizes temperature requirements with terms such as “preferred” or “optimum” or “tolerable.” Preferred temperatures are those that fish most frequently inhabit when allowed to freely select temperatures in a thermal gradient (McCullough, 1999). An optimum range provides for feeding activity, normal physiological response, and normal behavior (without symptoms of thermal stress) (McCullough, 1999). A tolerable temperature range refers to temperatures at which an organism can survive.

Most interpretations of water temperature effects on salmonids and, by extension, water temperature standards, have been based on laboratory studies. Many studies have also looked at the relationship of high temperatures to salmonid occurrence, abundance, and distribution in the field.

As discussed above, several species of anadromous fish utilize the Scott River watershed at some point within in their life cycle, including various salmonid species. A complete review of the literature pertaining to the temperature requirements for the various life stages of steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*) and chinook salmon (*O. tschawytscha)* is presented in *The Effects of Temperature on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and Function by Life Stag, Implications for Klamath Basin TMDLs* (Carter, 2005*)*. When possible, species-specific requirements were summarized by four life stages: migrating adults, spawning, embryo incubation and fry emergence, and freshwater rearing. Some of the references reviewed covered salmonids as a general class of fish, while others were species specific.

2.5.1.1 Temperature Metrics

It is useful to have measures of chronic and acute temperature exposures for assessing stream temperature data. An USEPA document*, Temperature Criteria for Freshwater Fish: Protocol and Procedures* (Brungs and Jones, 1977) discusses development of criteria for assessing temperature tolerances of fish for several different life stages. Two measures of exposure are developed and applied: maximum weekly average temperature (MWAT) as a measure of chronic exposure and short-term maximum temperature as a measure of potentially lethal effects.

The MWAT is the maximum value of the mathematical mean of multiple, equally spaced, daily temperatures over a 7-day consecutive period (Brungs and Jones, 1977). In different words, this is the highest value of the 7-day moving average of temperature. Brungs and Jones developed MWAT metrics for the growth phase of fish life, as growth appears to be the life stage most sensitive to modified temperatures and it integrates many physiological functions. They also developed life stage MWAT metrics for spawning.

Sullivan and others (2000) review sub-lethal and acute temperature thresholds from a wide range of studies, incorporating information from laboratory-based research, field observations, and risk assessment approaches. The authors report calculated MWAT metrics for growth ranging from 14.3° C to 18.0° C (57.7° F to 64.4 ° F) for coho salmon, and 14.3° C to 19.0° C (57.7° F to 66.2° F) for steelhead trout. The risk assessment approach used by Sullivan and others (2000) suggest that an upper threshold for the MWAT of 14.8° C (58.6° F) for coho and 17.0° C (62.6° F) for steelhead will reduce growth 10 percent from optimum, and that thresholds for the MWAT of 19.0° C (66.2° F) for both coho and steelhead will reduce growth 20 percent from optimum.

While these thresholds relate to reduced growth, temperatures at sub-lethal levels also can effectively block migration, inhibit smoltification, and create disease problems (Elliot, 1981). Further, the stressful impacts of water temperatures on salmonids are cumulative and positively

Table 2.8
Recommended Criteria for Summer Maximum Water Temperatures

Use	**Criteria**	
	7-DADM	**MWAT**
Salmon / Trout "Core" Juvenile Rearing (*Salmon adult holding prior to spawning may also be included in this use category*).	16°C / 60.8°F	14.5°C / 58.1°F
Salmon/Trout Migration	18°C / 64.4°F	16.1°C / 70.0°F

plus Non-Core Juvenile Rearing.		
Salmon/Trout Migration.	20°C / 68.0°F	17.7°C / 63.9°F

Notes:
1) "Salmon" refers to chinook, coho, sockeye, pink, and chum salmon. "Trout" refers to steelhead and coastal cutthroat trout.
2) "7-DADM" refers to the Maximum 7-Day Average of the Daily Maximums.
3) Source: U. S. Environmental Protection Agency (2003a, p.25).

correlated to the duration and severity of exposure. The longer the salmonid is exposed to thermal stress, the less chance it has for long-term survival (Ligon et al., 1999).

Jobling (1981) reported that the upper lethal limit, that is, the temperature at which death occurs within minutes, ranges from 27° C to 30° C (80.6 F to 86.0° F) for salmonids. Sullivan and others (2000) report acute threshold values, that is, temperatures causing death or total elimination of salmonids from a location, that range from 21.0° C to 25.5° C (69.8° F to 77.9° F) for coho, and 21.0° C to 26.0° C (69.8° F to 78.8° F) for steelhead.

The MWAT is used as the primary statistical measure for interpretation of stream temperature conditions in the summary of stream temperature data in the Scott River watershed. USEPA Region 10 has issued guidance regarding temperature criteria protective of cold water fish for various species and life-stages. These values are included here to aid with interpretation of watershed data. Because USEPA values are presented for the maximum 7-day averages of daily maxima (7-DADM), an MWAT equivalent value is included in Table 2.8 using correlation equation developed using temperature data from the Scott River watershed. The values in Table 2.7 are used for comparison to measured stream temperatures to characterize the temperature quality of surface waters in the Scott River watershed.

2.5.2 Temperature Desired Conditions

2.5.2.1 Effective Shade

Desired condition: Adjusted Potential Effective Shade Conditions from Riparian Vegetation
Effective shade is defined as the percentage of direct beam solar radiation attenuated and scattered before reaching the ground or stream surface from topographic and vegetation conditions. The desired shade conditions are those that result from achieving the natural mature vegetation conditions that occur along stream channels in the watershed, approximated as adjusted potential shade conditions as described in Section 4.5.1. The distribution of adjusted potential shade values is presented in Figure 4.29. A second approach to identifying the potential shade conditions at a site is detailed below.

To determine potential shade conditions provided by riparian vegetation for a particular stream reach in the watershed requires correlation of vegetation type, stream aspect, and active (unvegetated) channel width with effective shade. These relationships are functions of vegetation type, channel geometry, topography, and solar position.

Two models used to predict shade given channel characteristics as input were tested for use in estimating potential shade on a reach-by-reach basis. ODEQ has developed an Excel-based spreadsheet that allows calculation of effective shade as a function of vegetation height, stream aspect, active channel width, stream buffer width and buffer density. The spreadsheet is based on equations presented by Boyd (1996) and expanded for TMDL applications. USGS (Bartholow, 1999) also has a shade model.

The ODEQ spreadsheet, named SHADE, was selected for use in developing desired condition shade curves for different vegetation types occurring along riparian corridors of the Scott River and its tributary streams because it is better adapted for TMDL applications and has been used in the development of an approved temperature TMDL (ODEQ, 2000).

Effective shade desired conditions for the vegetation classes occurring in the watershed were set at 90% of the potential vegetation height for the class. Effective shade curves are presented for Douglas Fir (DFR) and Mixed Hardwood-Conifer (MHC) forest (40m), Klamath Mixed Conifer (KMC) and Ponderosa Pine (PPN) forest (35m), and Oak Woodland (20m) (Figures 2.5, 2.6 and 2.7) as an indicator of riparian conditions relative to a potential condition. Buffer widths are assumed to be 30m. The curves were developed for the July 22 solar path. The curves presented in Figures 2.4, 2.5 and 2.6 constitute the numeric targets for the temperature TMDL.

2.5.2.2 Thermal Refugia

Desired condition: Increased volume of thermally stratified pools
The desired condition is an increased volume of thermal refugia. Thermal refugia are sites that provide cold water habitat. The depth and degree of stratification is partly a function of stream flow and is expected to vary depending on site conditions. Thermally stratified pool volume can be expected to increase as existing stratified pools become deeper and shallow pools become deep enough to stratify in response to reduced sediment supply. Thermal refugia are also commonly found at the mouths of cold tributaries.

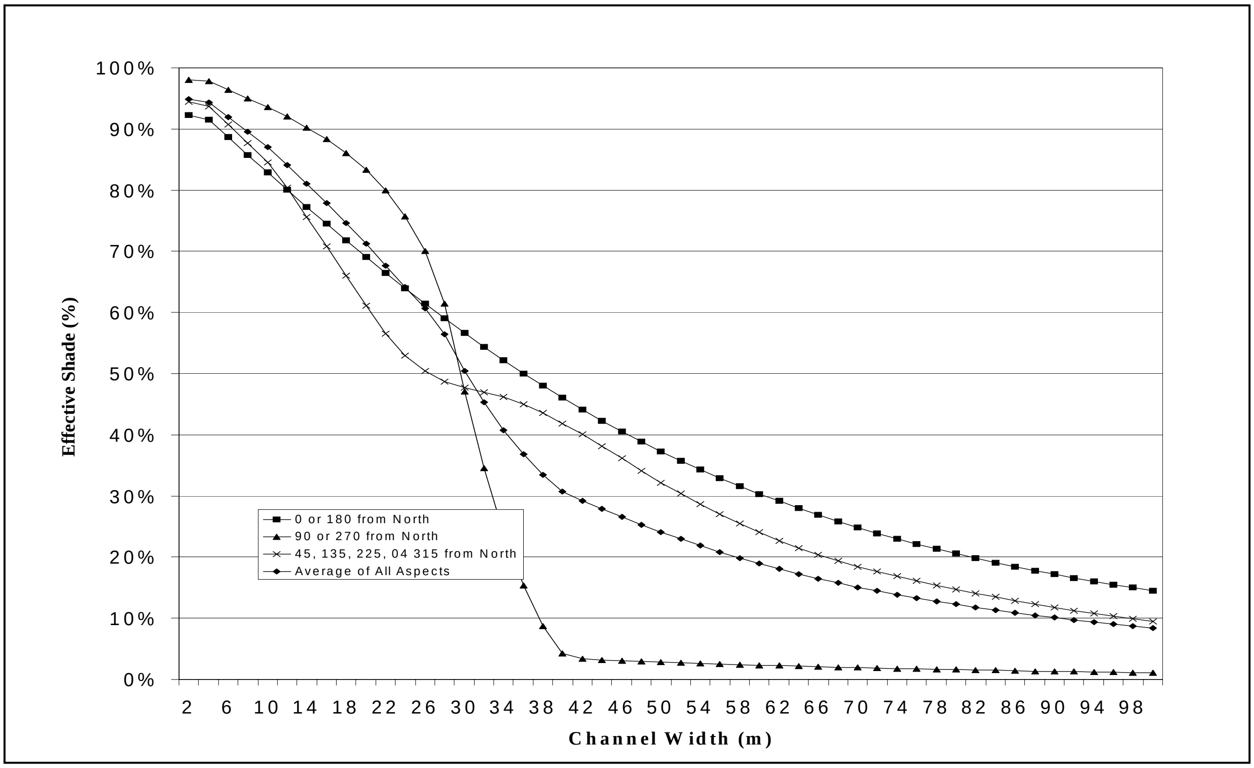

Figure 2.5: Effective Shade vs. Channel Width, Douglas Fir Forest (DFF) and Mixed Hardwood – Conifer Forest, Buffer Height = 40m

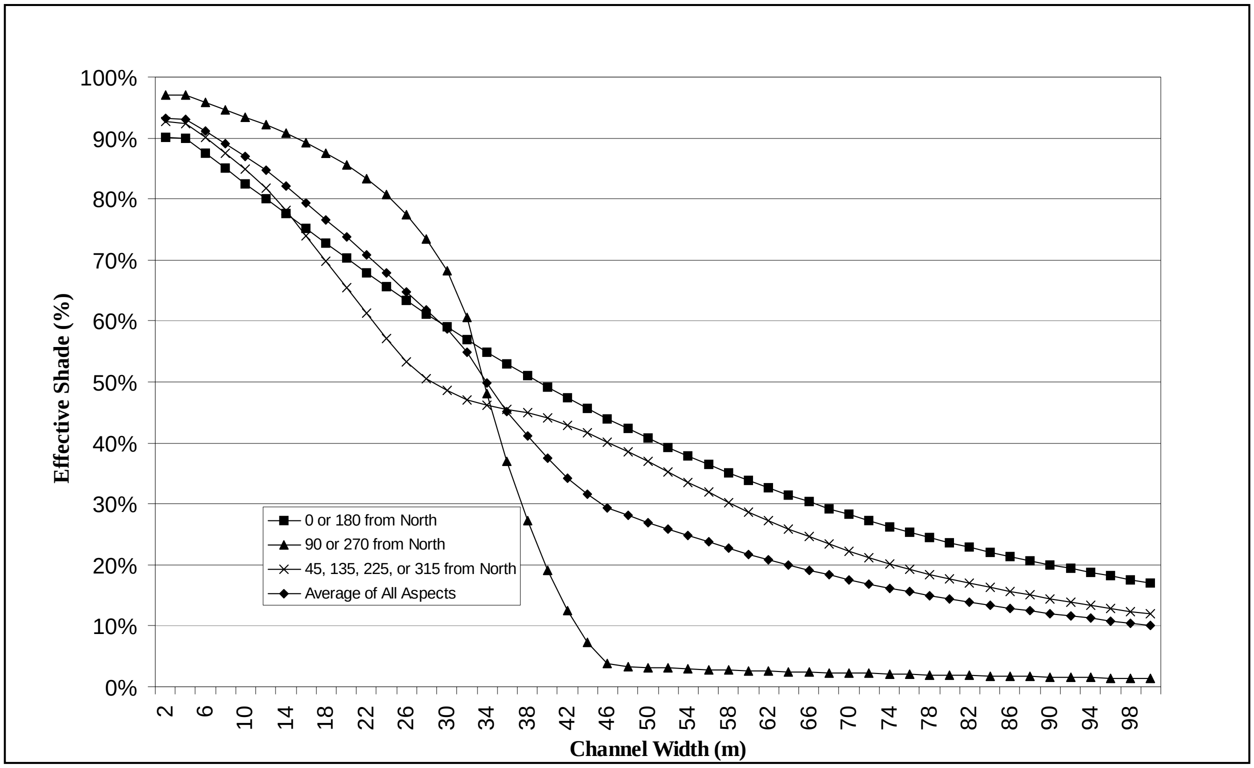

Figure 2.6 Effective shade vs. channel width, Klamath Mixed Conifer Forest (KMC) and Ponderosa Pine Forest (PPN), buffer height =35m

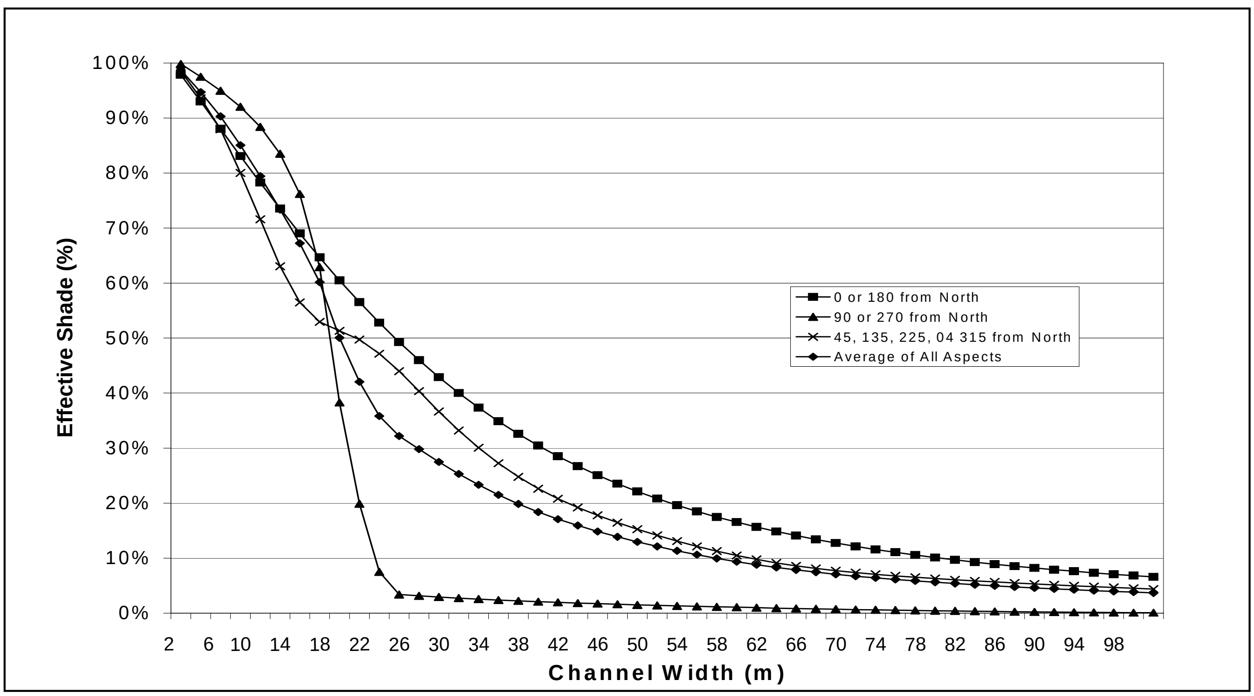

Figure 2.7. Effective shade vs. channel width, Oak woodland, buffer height =20m

2.5.3 Temperature Conditions in the Scott River Watershed

Unlike sediment-related objectives, stream temperature is a directly measurable water quality parameter and requires no indicator for interpretation of the water quality objective.

2.5.3.1 Summary of Temperature Conditions

Stream temperature data collected in the Scott River watershed since 1995 indicate that conditions vary throughout the watershed. A few generalities can be drawn based on these data:

1. Summer temperature conditions in the mainstem of the Scott River do not support suitable rearing habitat for salmonids.
2. Summer temperature conditions in the East Fork of the Scott River do not support suitable rearing habitat for salmonids.
3. Summer temperature conditions in the South Fork of the Scott River support suitable rearing habitat for salmonids in some years.
4. Summer temperature conditions in the upper reaches of many tributary streams in the Scott River watershed support rearing habitat for salmonids. These tributary streams include Lower Mill, Kelsey, Canyon, Boulder (canyon), Sniktaw, Shackleford, Mill (Shackleford tributary), Kidder, Etna, Etna-Mill, Clark, French, Sugar, Jackson, Fox, Boulder (west headwaters), Rail, and Kangaroo Creeks
5. Summer temperature conditions in the lower reaches of some tributary streams in the Scott River watershed, including Kelsey, Shackleford, Kidder, Patterson (west side), French, Wildcat, Etna, and Big Carmen Creeks do not support suitable rearing habitat for salmonids.
6. Summer temperature conditions in the upper reaches of Moffett Creek and Sissel Gulch do not support suitable rearing habitat for salmonids.

Stream temperatures vary considerably throughout the Scott River watershed in response to geomorphic and hydrologic characteristics. Quigley and others grouped streams in the Scott River watershed into six areas with similar geomorphic and hydrologic characteristics: the East Headwaters (East Fork watershed), West Headwaters (South Fork watershed), Scott Valley, Eastside, Westside, and Canyon. Water Board staff has summarized stream temperature conditions using the same groupings, except that the valley category has been replaced by the mainstem of the Scott River.

2.5.3.2 Scott River Mainstem

The temperatures in the Scott River are too high for suitable salmonid habitat conditions from the confluence of the East and South Forks to the mouth at the Klamath River. Starting at the confluence of the East and South Forks, the Scott River begins relatively warm. At river mile 55 the MWAT ranged from 20.4^{o} C (68.7^{o} F) to 17.1^{o} C (62.8 ^{o} F) in the years monitored (Table 2.9). The lowest MWAT measured in the Scott River was 17.0^{o} C in the tailings reach, near the upstream end of the river during 1998. The highest MWAT measured in the Scott River was 23.9 at Roxbury Bridge, near the mouth of the river, in 2003.

2.5.3.3 West Headwaters / South Fork Scott River

The West Headwaters of the Scott River, which consists of the South Fork Scott River and its tributaries, are located in the southwestern extremity of the Scott River Watershed. The West Headwaters have beneficial temperature conditions for salmonids, though the temperature rises into the unsuitable range in some years near the mouth of the South Fork of the Scott River (Table 2.10).

2.5.3.4 East Headwaters

The East Headwaters of the Scott River, which consists of the East Fork Scott River and its tributaries, are located in the southeastern extremity of the Scott River Watershed. The East Fork Scott River has temperatures that are warmer than the South Fork (Table 2.11). The East Fork MWATs are in the unsuitable range for salmonids. The middle and upper reaches of many of the perennial tributaries have temperatures cool enough to support salmonids.

2.5.3.5 Westside Tributaries

The Westside sub-basin tributaries have a wide range of measured MWAT temperatures (Table 2.12). Temperatures at three sites are suitable for salmonid habitat, while other sites have unsuitable temperatures, and yet others have suitable temperatures in some years and unsuitable temperatures in other years.

2.5.3.6 Eastside Tributaries

There is very little data for the eastside tributaries. There is only data available for two sites, both in the upper reaches of the Moffett Creek drainage (Table 2.13). Data from these two sites indicate that temperature conditions are unsuitable for salmonid habitat in most years.

2.5.3.7 Canyon Tributaries

The Canyon sub-basin tributaries exhibit a wide range of temperatures, from 10.9^{o} C in Patterson Creek, to 20.0^{o} C in Deep Creek (Table 2.14). The majority of measured tributary stream temperatures in this sub-basin indicate these tributaries are not fully supportive of salmonid habitat.

Table 2.9: Stream MWATs, Scott River Mainstem, 1995 – 2004

River Mile	LOCATION	Maximum Weekly Average Temperature (C)									
		1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
0.5	at Steelhead Bridge		22.8								
0.5	at Roxbury Bridge									23.9	
6.5	at McGuffy Creek		21.9	22.9	**21.8**						
10.8	at Townsend Gulch									22.6	
13.2	at Deep Creek			21.8						22.5	
14.3	below Kelsey Creek									22.2	
15.8	below Canyon Creek		21.2		**21.1**					22.4	
16.1	above Canyon Creek			22.7						23.3	
18.8	at Jones Beach		22.4		**22**					23.3	
21.6	at USGS Gaging Station	20.2			**21**					22.7	
	above Shackleford Creek							*18.6*			21.6
22.6	below Meamber Gulch								*21.2*		21.3
	at Meamber Creek 1					**19.8**	21.8				
	at Meamber Creek 2			23.1						22.5	
24.9	at Meamber Bridge								*21.4*	22.5	
25	at Meamber School			21.0		**19.8**					
31.9	at Eiler Ranch			21.7	**21.1**	**19.9**	22.5				
31.9	below Kidder								*23.7*	23.3	23.3
32.5	above Kidder Creek									23.6	
33.1	at Highway 3 Bridge			22.8		**21.2**					
35.1	at Island Road			23.1		**21**	23.6			23.2	
39.4	near Black Bridge								*22.0*	21.9	
41.5	at Eller Lane			22.1	**20.5**	**19.9**	22.5				
41.8	at Sweazey's Bridge									21.0	
42.3	above Sweazey's Bridge									20.3	
42.6	below Etna Creek			20.6	**20**		20.6				
42.9	above Etna Creek			20.7	**19.7**		17.2	*18.0*	*17.6*		
44.6	at Horn Lane			19.5			19.4				
47.9	below French Creek			20.9	**18.2**	**18.7**	19.1	*19.7*	*19.0*	20.3	
48.2	above French Creek			20.8	**19.7**	**18.5**	19.8	*20.9*	*20.0*	20.3	
50.2	at Fay Lane			19.6	**19.2**		20	*19.3*		20.2	19.7
50.2	above Fay Lane (bottom)									19.3	
50.2	above Fay Lane (surface)									20.1	
52.8	Alexander				**17**	**19.9**					
53.2	at Alexander's (bottom)									20.2	
53.2	at Alexander's (surface)									21.0	
53.6	Scott River tailings						20.3				19.8
54.5	at Red Bridge				**18.3**	**17.1**					
54.5	Scott River in tailings									20.4	

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.10: Stream MWATs, West Headwaters Sub-Basin, 1996 - 2004

LOCATION	Maximum Weekly Average Temperature (C)								
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
South Fork at Baker's			**16.3**	**13.8**	17.3	*17.8*	*17.3*	17.4	
South Fork at Blue Jay Creek			**14.8**	**13.5**	15.4	*15.9*	*15.3*	15.9	15.6
Boulder Creek	16								
Fox Creek	14.9								
SF Scott at road 40N21Y								15.8	
Jackson Creek	14.6								

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.11: Stream MWATs, East Headwaters Sub-Basin 1998 – 2004

LOCATION	Maximum Weekly Average Temperature (C)						
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
E.F at Callahan	**14.4**	**19.4**	21.6	*21.9*	*21.8*	22.1	21.8
Grouse Creek		**16**	18.5				
E.F at Masterson Road	**21**		21.4	*20.9*	*21.7*	22.7	21.5
Kangaroo Creek		**11.6**	12.3				
Rail Creek 1	**16**	**15.1**	17.3	*16.7*	*17.9*	17.7	17.3
Rail Creek 2				*17.0*			
Rail Creek 3			17.4				
Upper East Fork below Houston Creek						17.0	

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.12: Stream MWATs, westside tributaries of Scott River, 1996 – 2004

LOCATION	Maximum Weekly Average Temperature (C)					
	1996	**1997**	**1998**	**1999**	**2000**	**2003**
Mill Creek - Scott Bar	16.2	16.5	**16.3**	**15.2**	17.1	
Upper Mill Creek					14.2	
Tompkins Creek		16.9	**17.6**			17.6
Tompkins Creek - Potato		17.3				
Middle Creek at Mouth						18.5
Deep Creek Mouth						20.0
Lower Kelsey	16.8	17.4	**16.6**			17.8
Upper Kelsey	10.9					
Lower Canyon		15.4	**15.2**			15.8
Upper Canyon	15.5	15				
Lower Boulder Creek	14.4	14				

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.13: Stream MWATs, eastside tributaries of Scott River, 1997 – 2001

LOCATION	Maximum Weekly Average Temperature (C				
	1997	**1998**	**1999**	**2000**	**2001**
Sissel Gulch			**16.3**	18.6	*16.9*
Moffett Creek	16.9	**16.8**	**15.8**	17.6	*17.5*

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.14: Stream MWATs, tributaries of canyon section of the Scott River, 1996 – 2003.

	Maximum Weekly Average Temperature (C)					
LOCATION	**1996**	**1997**	**1998**	**1999**	**2000**	**2003**
Mill Creek - Scott Bar	16.2	16.5	**16.3**	**15.2**	17.1	
Upper Mill Creek					14.2	
Tompkins Creek		16.9	**17.6**			17.6
Tompkins Creek - Potato		17.3				
Middle Creek at Mouth						18.5
Deep Creek Mouth						20.0
Lower Kelsey	16.8	17.4	**16.6**			17.8
Upper Kelsey	10.9					
Lower Canyon		15.4	**15.2**			15.8
Upper Canyon	15.5	15				
Lower Boulder Creek	14.4	14				

High discharge years are in **bold,** low discharge are shown in *italics* .