California Department of Forestry and Fire Protection

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Fax:	916-341-5620	Date:	Jan 31, 2006
Phone:		CC:	
Re:			

☐ Urgent For Review ☐ Please Comment ☐ Please Reply ☐ Per Your Request

● Comments:

STATE OF CALIFORNIA—THE RESOURCES AGENCY ARNOLD SCHWARZENEGGER, Governor

DEPARTMENT OF FORESTRY AND FIRE PROTECTION
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303 (d) Deadline:
1/31/06

January 31, 2006

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Ms. Tam M. Doduc, Chair
c/o Selica Potter, Acting Clerk to the Board
State Water Resources Control Board
1001 I Street, 24th Floor
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Dear Chair Doduc:

Subject: Request for Comment on the Draft Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments.

Thank you for the opportunity to comment on the Draft Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments. We would like to comment specifically on the proposed 303(d) listing of the Noyo River Hydrologic Area (HA) for water temperature. This draft proposal would affect the Jackson Demonstration State Forest (JDSF), which includes most to the South Fork Noyo River watershed upstream of its confluence with Kass Creek.

The draft 303(d) water temperature guideline is 14.8°C based on a 7-day mean for the protection of coho salmon, and cites "An Analysis of the Effects of Temperature on Salmonids of the Pacific Northwest with Implications for Selecting Temperature Criteria (Sullivan et. al., 2000)" (emphasis added).

The California Department of Forestry and Fire Protection (CDF) urges the State Water Resource Control Board (SWRCB) not to adopt this listing as currently proposed for the following reason. The proposed temperature guideline for the Noyo River watershed, which is located at 39.5° North latitude, is based on Sullivan et al., 2000 which was specifically written for conditions in the Pacific Northwest, primarily Washington State, which is North of 45.5° North latitude. Five degrees south of the Noyo River at 34.5° North latitude lies the Santa Ynez River near Santa Barbara. It is no more appropriate to apply a temperature guideline developed for conditions in Washington State to conditions in northern California, than it would be to apply a temperature guideline developed for conditions in northern California to conditions in southern California. (1)

If SWRCB decides to adopt this listing as currently proposed, CDF strongly urges the SWRCB to exclude the South Fork of the Noyo River above its confluence with Kass Creek near the boundary of the JDSF. The South Fork of the Noyo River watershed above its confluence with Kass Creek is primarily comprised of the state forest lands managed under a JDSF Management Plan. There is ample water temperature data for the South Fork above its confluence with Kass Creek, none of which was cited in the Fact Sheet as being used in the proposed 303(d) listing. Basically the South Fork Noyo was excluded from the analysis on which the proposed listing was based; it should therefore be excluded from the proposed listing. The proposed listing did not and could not establish that there is a water temperature problem affecting salmonid habitat on the either in the South Fork or downstream portions affected by the South Fork without analyzing this data. (2)

Moreover, this data was analyzed and used in the preparation the new JDSF Management Plan and Environmental Impact Report (EIR) now in public review. The JDSF Management Plan and EIR fully address water temperature and salmonid habitat protection in the South Fork Noyo. The maximum weekly average temperature (MWAT) is defined as the highest average of mean daily temperatures over any 7-day period. In the JDSF Management Plan an MWAT value of 16.8°C was chosen as a threshold of significance. The National Marine Fisheries Services (NMFS) originally established 16.8° C as an MWAT threshold for coho (BOF 2005).

The Fact Sheet quotes the North Coast Basin Plan water quality objectives for 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 Quality Control 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 (2.8C°) above natural receiving water temperature." The receiving water from the South Fork is the mainstem of the Noyo River, and this standard is being met. In fact, water exiting the JDSF and then entering the mainstem seven miles downstream of the JDSF boundary "appears to have a moderate cooling effect on water temperatures in the lower Noyo River depending upon the relative flow of the two streams (BOF 2005)."

For all of the above reasons, the South Fork Noyo River watershed above its confluence with Kass Creek near the JDSF boundary should be excluded from consideration for 303(d) listing for water temperature.

In conclusion, the 303(d) listing of the Noyo River watershed for water temperature should not be approved as proposed. Indeed, it may not be necessary at all if local climatic conditions are properly considered. In any, case the South Fork of Noyo River watershed above Kass Creek near the JDSF boundary should not be included in the listing without (at a minimum) considering the available water temperature data from the South Fork Noyo River watershed.

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APPENDIX 12

STREAM TEMPERATURE

Background

Water temperature is an important habitat parameter potentially influencing reproductive success and survival during all freshwater life stages for coho salmon, steelhead, and many amphibians, aquatic macro-invertebrates, and other organisms (Bjornn and Reiser 1991). Water temperature influences metabolism, behavior, and mortality of fish and other organisms in their environment. Coho salmon tend to be relatively intolerant of elevated summer water temperatures and may therefore be absent from streams that can still support steelhead. Although fish may survive at temperatures near the extremes of the suitable range, growth is reduced at low temperatures because all metabolic processes are slowed and at high temperatures because most or all food energy must be used for maintenance (Bjornn and Reiser 1991).

Stream temperature is influenced by external factors, the internal structure associated with channel morphology, and the riparian zone. The internal factors are reduced vegetative shading (allowing more solar radiation to reach streams), changes in channel morphology, altered streamflows, and heating of unvegetated near-stream soils and alluvial substrates (Poole and Berman in press, Johnson and Jones 2000). The external factors include: topographic shade, upland vegetation, precipitation, air temperature, wind speed, solar angle, cloud cover, relative humidity, phreatic groundwater temperature, tributary temperatures and flow (Poole and Berman 2000). In addition, water temperatures generally increase in a downstream direction even in fully shaded streams (Sullivan et al. 1990). As streams become progressively larger and wider, riparian vegetation shades a progressively smaller proportion of the water surface (Beschta et al. 1987; Spence et al. 1996; Murphy and Meehan 1991). Figure 1 illustrates how stream temperatures in a watershed tend to increase in the downstream direction and increase with increasing watershed area.

Land management activities can influence water temperature by exerting changes on channel characteristics (Table 1). In forested landscapes, incoming solar radiation represents the dominant form of energy input to small and medium size streams during the summer months (Bescheta 1987, Sullivan et al. 1990). Canopy cover is important in reducing direct solar radiation to the channel and can be directly influenced by forest management. Removal of a streamside riparian canopy typically increases solar radiation intensity, summer water temperature, and diurnal temperature fluctuations throughout the year (Chamberlin et al. 1991, Hetrick et al. 1998). Removal of too much canopy can adversely affect growth and survival of rearing salmonids. The more canopy removed, the greater the exposure to solar radiation, which then increases stream temperature.

Data not included in Factsheet b/c decision wouldn't Δ.

There is uncertainty regarding the optimal riparian buffer to shade a stream, or whether there is any single configuration that is most beneficial or desirable. The relative degree of shading provided by a buffer strip depends on species composition, age of stand, density of vegetation, and sun angle. Spence et al. (1996) concluded buffer widths of approximately 0.75 site potential tree heights are needed to provide full protection of stream shading. FEMAT (1993) reported that nearly all shade to a stream can be maintained by a buffer width equal to approximately 0.8 potential tree height. According to the Record of Decision for FEMAT (FEMAT ROD 1994), a site potential tree equals the average maximum height of the tallest dominant trees (200 years or older) for a given site class. For a coast redwood on Site I or II land, it is likely that a "mature" tree would be at least 250 feet tall.

In a comprehensive review of the FEMAT (1993) standards, CH2M-Hill and Western Watershed Analysts (1999) reported that nearly 80 percent of the cumulative riparian shade effectiveness is reached within approximately 0.5 site-potential tree heights (e.g., for a 250 foot site potential tree, this distance would be 125 feet, 25 feet less than the current width of a Class I WLPZ). Beschta et al. (1987) and Murphy (1995) state that buffer strips with widths of 30 m (approximately 100 feet) or more generally provide the same level of shading as that of an old-growth stand.

The stream temperature at any given point can be taken as an indicator of the cumulative spatial and temporal effects of numerous factors upstream of that point. As discussed above, there are numerous natural and anthropogenic factors that determine stream temperature. Since stream temperature is such a robust cumulative effect indicator, it is an important parameter to measure on an ongoing basis. It is also important to try to understand the state, over space and time, of the determinants of temperature. Stream canopy is one of the most important and most readily measurable of stream temperature determinants. It also is a stream temperature determinant that has been significantly affected by land management activities in the North Coast region since the last half of the 19th century.

Regulatory Setting and Regional Context for Use of the MWAT Criterion for Assessing Impacts

The North Coast Regional Water Quality Control Board (NCRWQCB) is responsible for implementing and regulating water quality control plans for the North Coast Hydrologic Unit Basin Planning Area. The Basin Plan provides a definitive program of actions designed to preserve and enhance water quality and to protect beneficial uses of water. The US EPA and NCRWQCB have identified 22 North Coast water bodies as having beneficial uses impaired by elevated water temperatures (Table 2). These water bodies, with a total watershed area of 8.7 million acres, are listed as temperature impaired under section 303(d) of the federal Clean Water Act.

Table 2. Temperature Impaired Water Bodies and Watershed Area in the North Coast Hydrologic Unit.

Water Body	Watershed Area (acres)	Water Body	Watershed Area (acres)
Big River	115,840	Shasta River	505,542
Eel River (6 units)	2,356,802	Russian River	949,986
Garcia River	73,223	Klamath River (including)	
Gualala River	191,145	*Salmon River*	480,805
Redwood Creek	180,700	*Scott River*	521,086
Ten Mile River	76,800	*South Fork Trinity River*	596,480
Mattole River	189,440	*Upper & Lower Lost River*	1,917,782
Navarro River	201,600		
Mad River	322,200	**TOTAL AREA**	**8,679,431**

The NCRWQCB has listed Big River for temperature and sediment. The Noyo is listed for sediment, but not temperature, although reaches of the Noyo are subject to relatively high water temperature, especially in the main channel. This impairment designation is assigned to streams where established water quality objectives as specified in the Basin Plan are not being met or where beneficial uses are not sufficiently protected. Total Maximum Daily Loads (TMDLs) must be developed for water quality listed streams, as required in Section 303d of the Clean Water Act (CWA). A TMDL is a planning document designed to identify the causes of impairment and establish a framework for restoring watershed impairments. Sediment TMDLs have been developed for both the Noyo and Big River, but a temperature TMDL has not yet been developed for the Big River watershed, nor has a completion date for one been specified.

MWAT Threshold and Criteria for Determining Impairment

Water temperature suitability for anadromous salmonids in the North Coast region can be evaluated using the maximum weekly average temperature (MWAT). MWAT is defined as the highest average of mean daily temperatures over any 7-day period. The MWAT threshold is a measure of the upper temperature recommended for a specific life stage of freshwater fish (Armour 1991). For coho salmon and steelhead, the MWAT threshold is calculated for the late-summer rearing life stage, because water temperatures are generally highest during this stage. Coho salmon are considered to be less tolerant of high water temperatures than steelhead (CDF 1999).

A range of MWAT values has been proposed by different agencies and through independent studies to identify appropriate threshold values (Table 3). For the JDSF EIR, an MWAT value of 16.8°C (62.2°F) was chosen as a threshold of significance to evaluate potential impacts to water temperature that are associated with the proposed project. The National Marine Fisheries Services originally established 16.8°C as an MWAT threshold for coho (NMFS and USFWS 1997). This threshold is supported with recent findings by Welsh et al. (2001), where researchers found juvenile coho present in 18 of 21 tributaries of the Mattole River with MWATs up to 16.7°C (62.1°F). They also found coho in all streams where MWATs were less than 14.5°C (58.1°F). Similarly, Hines and Ambrose (2000) collected water temperature and coho salmon data over a five-year period from 1993 to 1997 at 32 sites in coastal streams of western Mendocino County, including 4 sites in the Noyo and Big River watersheds. Their data showed that the number of days a site exceeded an MWAT of 17.6°C (63.7°F) was one of the most influential variables for predicting coho presence and absence.

Table 3. A range of known MWAT thresholds and standards for salmonids (source: NCRWQCB 2004).

MWAT Thresholds and Standards		
Temperature (C)	**Descriptions**	**Temperature (F)**
26	Upper end of range of acute thresholds (considered lethal to salmonids)	78.8
25		77.0
24	Lower end of range of acute thresholds (considered lethal to salmonids)	75.2
23		73.4
22		71.6
21		69.8
20		68.0
19	Steelhead growth reduced 20% from maximum (Sullivan and others, 2000).MWAT metric USEPA (1977) growth MWAT for rainbow trout	66.2
18	USEPA (1977) growth MWAT for coho	64.4
17	Steelhead growth reduced 10% from maximum. Coho growth reduced 20% from maximum (Sullivan and others, 2000), MWAT metric	62.6
16.8	**NMFS MWAT threshold.**	**62.2**
16.7	Welsh and others (2001) MWAT threshold for coho presence/absence in the Mattole	62.1
16	Oregon Dept. of Environmental Quality Standard for salmonids (equivalent MWAT calculated from 7-day max.)	60.8
15	EPA Region 10 Recommended MWAT. Threshold for Coldwater Salmonid Rearing	59.0
14.8	Coho growth reduced 10% from maximum (Sullivan and others, 2000), MWAT metric	**58.6**
14.6	Upper end of preferred rearing range of coho	58.3
14.3	Washington Dept. of Ecology standard (equivalent MWAT calculated from annual max.)	57.7
14		57.2
13	Upper end of preferred rearing range for steelhead.	55.4

The Recovery Strategy for Coho Salmon (Department of Fish and Game 2004) makes only a generic range-wide recommendation regarding stream temperature. That is, "Identify and implement actions to maintain and restore water temperatures to meet habitat requirements for coho salmon in specific streams," (recommendation RW-X-B-01).

Logging History and Water Temperature

The stream channels and watersheds within and surrounding JDSF have a long and varied history of logging, railroad, and road construction. Beginning in the 1850s, Big River was used as a log transport route to get logs to the sawmill located near the mouth of the river. The Noyo River has a similar history, although railroad transport was dominant in that drainage (Wurm 1986). In the Noyo River, there is evidence that river transport occurred between the 1860s and the very early 1900s (Marc Jameson, CDF, Fort Bragg, personal communication).

Before the development of railroads in and along coastal waterways, trees were felled and moved to the river channels by use of both hand and animal labor (Napolitano and others 1989). In the Big River drainage, animals, primarily oxen, were used for yarding of logs until 1914 (Jackson 1991). The logs were dragged downhill and dumped into the river. In order to facilitate water transport, the channels were often cleared of logs, stumps, debris, and standing trees that were capable of interfering with transport and resulting in logjams. River transport in Big River continued over a period of nearly 70 years, between 1850 and 1930, using 27 splash dams to facilitate the floating of logs downstream to the mill at the town of Mendocino (Jackson 1991) (Figure 2). South Fork Big River is heavily incised from flushing logs. The dams varied in size and construction methods, but ranged to as tall as 40 feet. Many of the dams were designed to operate in a synchronized fashion to maximize the flow of water in downstream reaches.

The actual process of logging removed most, if not all, of the old-growth trees growing along the streams, which probably resulted in large increases in direct solar radiation striking the channel and coincident substantial increases in water temperature. This effect was accentuated with the development of railroad technology. Railroad grades were constructed immediately adjacent to river channels, and often constructed directly within the channels (Wurm 1986). Along with the railroads, steam yarder technology enabled efficient clearcutting of vast tracts upslope and adjacent to the river and stream system, with logs generally pulled downslope within or adjacent to watercourses along their route to the rail line. This activity created large openings along waterways, in addition to massive erosion into the channels, creating wide, unshaded streambeds with aggradation and elevated water temperature.

Railroad logging was replaced by trucks and tractors, beginning in the 1920s, with the railroads being all but eliminated by the mid-1940s (CDF 2003, Wurm 1986). Early road construction and tractor yarding provided no stream protection. Roads were constructed immediately adjacent to, or within stream channels. Logs were yarded downslope by tractor, often being moved directly within stream channels to reduce the amount of excavation required during the yarding process. Log landings were commonly constructed within tributary channels during this period. All of these activities tended to reduce shade-producing canopy, resulting in elevated water temperature. There are numerous accounts by the Department of Fish and Game of stream damage and elevated water temperature within the Noyo and Big River watersheds (DFG stream survey files, Yountville).

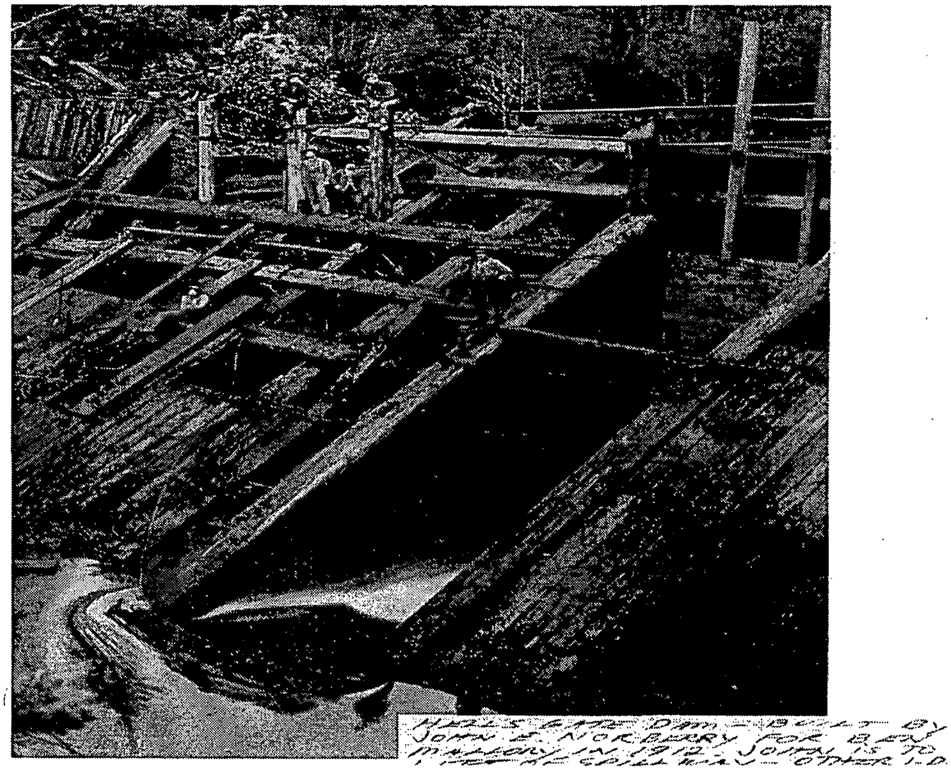


Figure 2. Hells Gate Splash Dam on the South Fork. Photo provided courtesy of the Mendocino Historical Society and the Held Poage Memorial Home and Research Library (from the Collection of Robert Lee).

There were no effective regulations in place to protect stream channels and shade-producing canopy until 1974, with the implementation of the Z'Berg Nejedly Forest Practice Act of 1973. The Forest Practice regulations of the mid-1970s provided for some consideration of stream protection, but it was still possible to substantially reduce shade canopy along fish streams. Streams were defined as natural watercourses--as designated by a solid line or dash and three dots symbol shown on the largest scale USGS maps most recently published, or as corrected in the THP map to reflect conditions on the ground. The Stream Protection Zone (SPZ) was defined as a strip of land along both sides of the watercourse for 100 feet for streams which supported and were used by trout or anadromous fish any time of the year, and 50 feet for any other streams or lakes. Enough trees had to be left so that 50% or more of the shade producing canopy present before timber operations remained after timber operations. Most, if not all of the shade-producing conifers could be removed if the forester could adequately explain how 50% of the shade would be retained.

It was not until 1983 that forest practice rules were enacted that required consideration of key indicator beneficial uses of water (fish, domestic water supplies for Class I watercourses, etc.), and it was not until the mid-1980s that cumulative impacts were expressly considered in the THP process. Protective zones were based on watercourse class and side slopes (0-30%, 30-50%, 50-70%, and >70%). The stream protection rules enacted substantially increased both the consideration of, and protection of, streamside canopy. In 1991, the rules were strengthened again. With the listing of both the Noyo River and Big River as impaired waterbodies, along with the listing of the coho salmon, rules have been substantially strengthened, and streamside canopy considerations have been further elevated. In July 2000, the implementation of the Threatened and Impaired Watersheds Rule Package greatly increased stream protection and post-harvest canopy levels. Proposals to reduce shade-producing canopy adjacent to Class I watercourses within the watercourse protection zone are not often encountered within the assessment area, and the level of shade-producing canopy should be increasing as riparian stands grow.

CDF's Hillslope Monitoring Program report for 1996 through 2001 found that watercourse protection zones retained high levels of post harvest canopy and surface cover (Cafferata and Munn 2002). Mean total canopy exceeded Forest Practice Rule requirements and was approximately 80 percent in the Coast Forest Practice District for both Class I and II watercourses. WLPZ width requirements were generally met, with major Forest Practice Rule departures recorded only about one percent of the time. Modified Completion Report monitoring conducted by CDF Forest Practice Inspectors from 2001 through 2004 similarly revealed that post-harvest total canopy levels were high (281 THPs sampled, 198 with Class I or II WLPZs) (Brandow 2005). Class I and II WLPZ total canopies averaged 83% and 82%, respectively, for the Coast Forest Practice District. These numbers are very similar to those recorded for the earlier Hillslope Monitoring Program. Similar measurement techniques were used by both monitoring efforts. As the streamside forest continues to develop within the assessment area, water temperature should take steady progress toward levels favorable to fish.

Watershed Setting and Regional Context for Stream Temperature

The JDSF ownership covers portions of both the Noyo and Big Rivers (see Map Figure A). The South Fork of the Noyo River (SFNR) and North Fork of the Big River, including Chamberlain and James Creeks, are the primary watersheds that drain the forest. The SFNR is a major tributary to the Noyo River, which drains to the Pacific Ocean at Fort Bragg. The SFNR catchment area at the confluence with the Noyo River drains a 27.32 mi^2 area, which is approximately 35% of the entire Noyo River watershed (113 mi^2). The vast majority of SFNR is owned and managed by JDSF. As such, management activities contribute to the overall water quality conditions in the lower Noyo, below its confluence with SFNR. The SFNR basin is characterized by steep mountainous terrain with confined valleys. The headwaters of the SFNR have more moderate terrain.

The Big River drains a 181 mi^2 watershed, flowing into the Pacific Ocean at the town of Mendocino. The elevation ranges from sea level to 1556 ft and consists of moderate to extremely rugged terrain (Matthews, 2001). Chamberlain and James Creeks are major tributaries to the North Fork of the Big River. The majority of these tributary watersheds are public lands managed by JDSF. The headwaters of the North Fork of Big River are private forest land and reside upstream from the JDSF boundary. Water from the Upper North Fork Big River flows through JDSF, passes through private forest in the Lower North Fork of the Big River, before joining the mainstem of the Big River.

CDF has conducted comprehensive summer water temperature monitoring in streams throughout JDSF since 1993, as well as temperature monitoring in the Caspar Creek watershed since the mid-1960s. Overall, water temperatures in JDSF Class I watercourses are generally in the suitable range for coho salmon and steelhead, with a few exceptions (CDF 1999). The areas of concern that are potentially impacted by JDSF land management are located on the South Fork of the Noyo River and Chamberlain Creek, tributary to the North Fork of Big River.

Stream temperature data are collected widely across the Noyo and Big River watersheds (Figure 3). Stream temperature issues were analyzed using data collected by state agencies (CDF, NCRWCQB, and DFG, and landowners) and supplemented with data from the KRIS Noyo and Big River projects (see http://www.krisweb.com). A summary of the data used in this assessment is provided in Attachment A. While water temperature is of concern for both watersheds, Big River has recorded warmer temperatures, leading to its inclusion on the U.S. EPA's 303(d) list as temperature impaired. The spatial distribution of water temperature was mapped out across the entire assessment area to identify areas of concern that may require more detailed analysis (Figure 3). The thresholds for interpreting water temperature were based on the criteria established by NMFS (1997) and additional criteria that were agreed upon by state agencies under the North Coast Watershed Assessment Program (NCWAP).

Based on these thresholds, Figure 3 identifies several areas that are potentially of concern, including:

- North Fork of the Noyo,
- South Fork of the Noyo (including Parlin Creek),
- North Fork of the Big River (including Chamberlain and James Creek), and
- South Fork of the Big River.

In addition, an emphasis was placed on those watersheds that either deliver water to JDSF (i.e., are up-stream) or are considered receiving waters (i.e., are downstream) from JDSF. Neither the Upper Noyo nor the South Fork of the Big River drain directly to JDSF, and as such, are discussed in less detail. The Mendocino Redwood Company (MRC) watershed analysis reports for the Noyo and Big River watersheds provide a thorough discussion of water temperature for these areas, although limited to that specific ownership. A summary of information from these reports is presented to provide a more comprehensive assessment of water temperature throughout the Noyo and Big River basins.

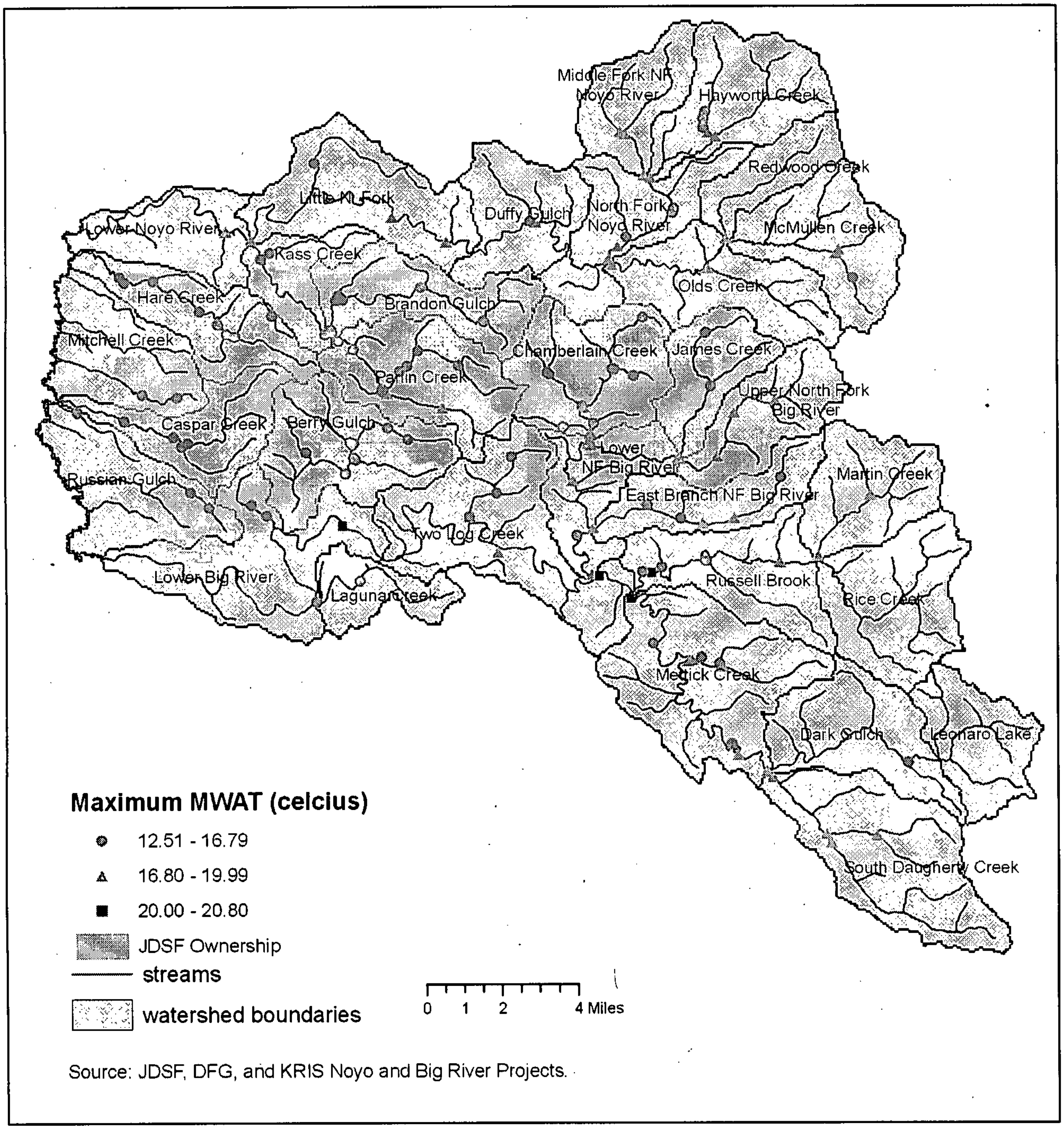


Figure 3. Distribution of Stream Temperatures across the Noyo and Big Rivers Based on the Maximum MWAT Values from 1994-2004.

Noyo River Water Temperature

Water temperatures across the Noyo River are generally desirable and below MWAT thresholds. However, water temperatures increase dramatically in the interior watersheds with the diminishing coastal influence. The warmest stream temperatures are recorded in the headwaters of the North Fork of the Noyo, where summer air temperatures can regularly exceed 100 °F.

A. Upper and Middle Noyo (outside JDSF)

The Upper Noyo consists of the headwaters of the Noyo (27 mi^2) and the North Fork of the Noyo River (25 mi^2). The upper end of the basin is directly west of the city of Willits. The upper mainstem of the Noyo drains a number of tributaries including: Olds Creek, Redwood Creek, McMullen Creek, NF Noyo River, Middle Fork of the NF Noyo River, and Hayworth Creek.

Stream temperature and canopy cover data were collected as part of the Noyo River Watershed Analysis across the MRC ownership in the Upper Noyo. Stream temperature was monitored in the Upper Noyo by Louisiana-Pacific Corp. from 1991 to1997 and MRC in 1999. MRC (2000) reported MWAT values for just 1996 and 1999. Stream temperatures were monitored during the summer months when the water temperatures are highest. Many of the monitoring stations recorded MWAT values that exceed the 16.8°C threshold (Welsh et al. 2001; NMFS and USFWS 1997). In addition, many stations recorded maximum stream temperatures that exceed 20°C. The highest stream temperatures were recorded on Hayworth Creek and along the mainstem of the Upper Noyo. It is presumed that these temperature spikes are associated with extremely warm weather conditions and are not sustained for long periods of time.

Stream temperature in the middle and lower portions of the mainstem Noyo are potentially of concern, although, there is little historic water temperature data available for comparison. Monitoring locations have consistently reported MWAT values that exceed the target threshold of 16.8 °C. Much cooler stream temperatures are reported for tributaries to the Noyo, with MWAT values ranging from 13.2 to 16.3°C (Table 3). Water temperatures for these tributaries have remained below the target threshold despite a history of intensive land management across each of these watersheds.

Table 3. Water Temperature (MWAT) for Tributaries to the Noyo River.

Stream Name	**Percent Harvested** 1986-2004	**Annual Instream Water Temperature (MWAT) (°C) (Target Temperature is ≤ 16.8° C**									
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Little North Fork Noyo	80%	13.7	15.1	14.1	15.6	14.1	14.3	13.8	13.9	14.1	14.6
Duffy Gulch	83%				15.4	15.1	14.9	14.8	14.6		14.8
Kass Creek	63%	13.2	14.5	16.3	13.8	13.8	13.6	13.4	13.6	13.6	14.1

B. Water Temperature Data for the South Fork Noyo River (inside JDSF)

The South Fork of the Noyo River (SFNR) is a major tributary to the Noyo River. The SFNR catchment area at the confluence with the Noyo River drains a 27.32 mi^2 area, which is approximately 35% of the entire Noyo River watershed (113 mi^2). The vast majority of SFNR is owned and managed by JDSF. As such, JDSF management activities contribute to the overall water quality conditions in the lower Noyo, below its confluence with SFNR. The SFNR basin is characterized by steep mountainous terrain with confined valleys. The extreme headwaters of the SFNR have more moderate terrain.

The mainstem of the South Fork Noyo flows for approximately 7 miles through JDSF. Stream temperatures are characterized by fluctuations in maximum MWAT values as the river flows from the upstream boundary to the downstream boundary of JDSF (Figure 4). However, data recorded near the downstream boundary of JDSF has shown a noticeable decline for the last three years of record (site 1, Figure 4). For the most recent date (2000), the MWAT value for site number 1 was 16.2 °C. This is contrasted with much warmer readings on the mainstem of the Noyo above the confluence with the South Fork Noyo. Stream temperature data recorded on the middle Noyo (near Grove) have consistently recorded MWAT values at or near 18.6 °C from 1998 to 2003 (figure 1). Below the confluence with the SF Noyo, the water temperatures decline by about 1 °C (site 13, figure 4). Stream temperature data collected at the USGS gaging station along the mainstem of the lower Noyo has recorded an average MWAT value of 17.5 °C from 1998-2003. As such, the South Fork Noyo appears to have a moderate cooling effect on water temperatures in the lower Noyo depending upon the relative flow of the two streams.

Stream temperatures reported by Valentine (1996) provide a baseline for stream temperature along the South Fork Noyo River. The maximum single measurement (not MWAT) water temperatures identified at two monitoring locations were 19.4° C. All stations were below 18° C more than 85% of the time. Among the tributaries to the South Fork Noyo, Parlin Creek recorded the warmest temperatures. Data loggers along the South Fork Noyo, above and below the confluence (Figure 4, site 6 and 8), showed a modest increase in stream temperatures just below Parlin Creek. The degree to which stream temperatures along the South Fork Noyo are elevated by Parlin Creek were not considered significant by Valentine (1996), but were indicative of warming temperatures in lower reaches of Parlin Creek. Temperatures were shown to increase in the downstream direction along Parlin Creek. Valentine (1996) found that conditions did not represent a serious cause for concern with regard to coho salmon.

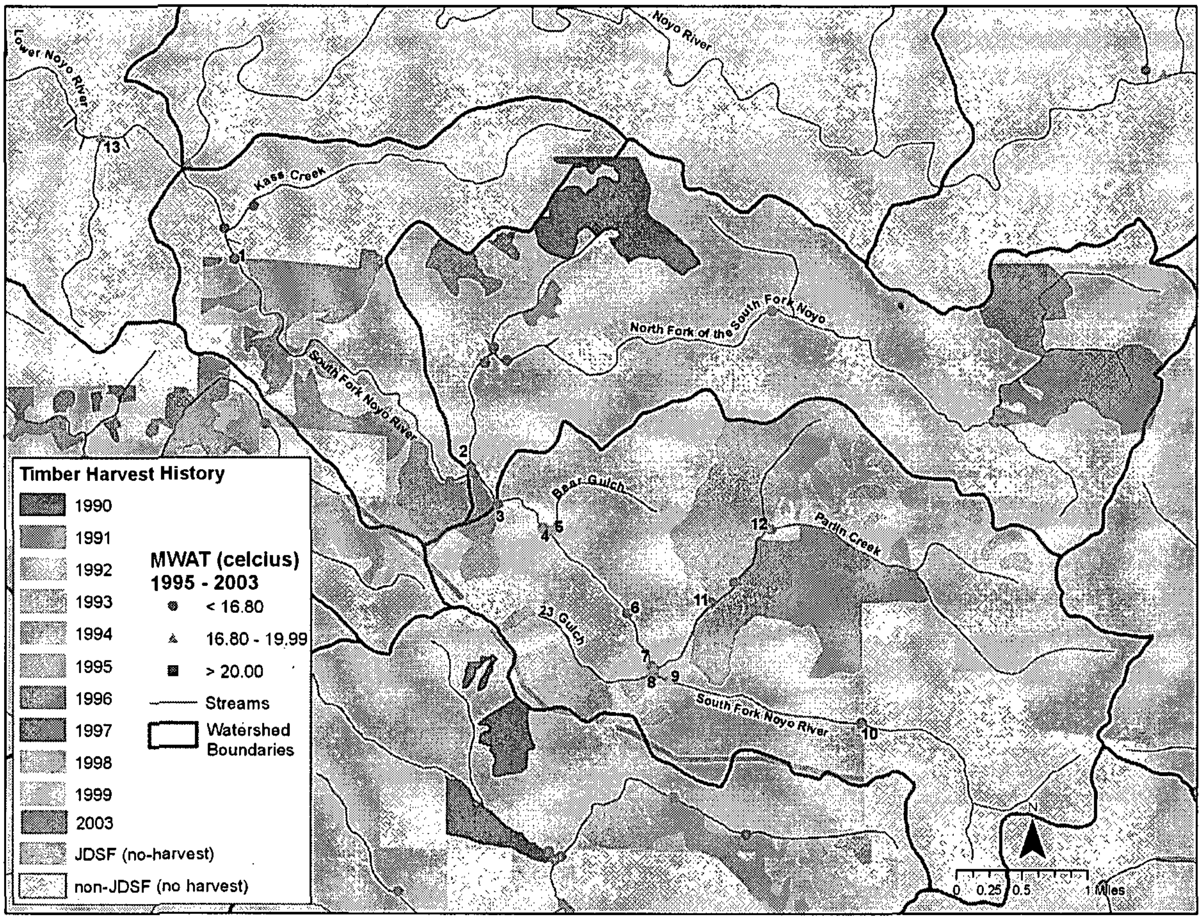
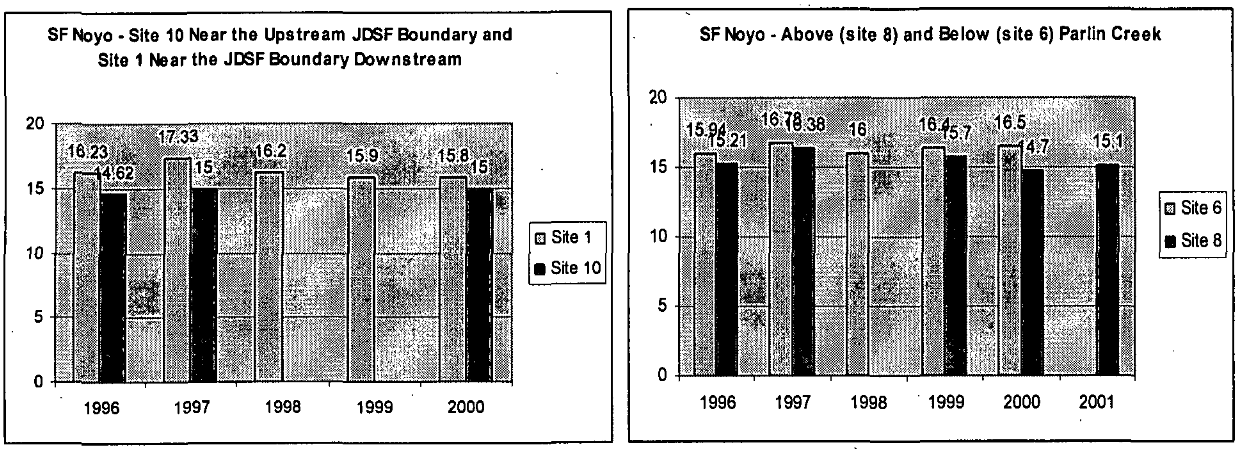


Figure 4. Distribution of Stream Temperatures along the South Fork Noyo River and Parlin Creek. Note: Timber Harvest boundaries ***do not*** reflect harvest restrictions in the WLPZ. There were no timber harvests for 2000–2002.

Stream temperature data following the 1996 study were analyzed to evaluate any changes from previously identified conditions. Treating 1996 as a baseline, data were analyzed post-1996 to determine if there are any trends in water temperature. Stream temperatures remain somewhat higher along the mainstem of the South Fork Noyo, about 0.5° C, as water flows past Parlin Creek, but the trend is flat (Figure 5). This suggests that stream temperatures have been more or less stable since 1996. The area where Parlin Fork meets the South Fork contains a large opening associated with an historic homestead, logging camp, and current conservation camp. The riparian forest zone in this vicinity is relatively narrow. Recent timber harvests in both Parlin Creek and throughout the South Fork of the Noyo since 1996 do not appear to be influencing stream temperature.



A B

Figure 5. Trends in MWAT Stream Temperatures (°C) along the South Fork Noyo River. Figure 5A provides a comparison in stream temperature from the upstream boundary of JDSF and the downstream boundary where water flows out of JDSF. Figure 5B provides a comparison of stream temperatures recorded directly above and below Parlin Creek. The water temperature is moderately warmer below Parlin Creek, but there is no dramatic increase or decrease over time.

Big River Water Temperature

The Big River watershed (181 mi^2) is larger than the Noyo, draining to the Pacific Ocean at the town of Mendocino. Most of basin is remote with few towns or incorporated areas. The topography varies from relatively flat marine terraces and estuaries to extremely rugged mountainous terrain. Land use within the watershed has been dominated by timber harvesting, with a substantial area dedicated to range management in the upper reaches. JDSF predominately influences water temperature along the North Fork of the Big River, and to a lesser extent, along the Little North Fork. Water temperature data along the mainstem of Big River consistently exceeds the 16.8°C MWAT threshold (Figure 3). The Big River is listed as temperature impaired per Section 303(d) of the federal Clean Water Act. Thus, management practices that have the potential to elevate stream temperatures are of concern. Water temperature data were assessed by the NCRWQCB staff under the NCWAP watershed assessment program and a summary of the data is provided in Attachment B. However, a more general discussion of water temperature issues is presented here for completeness of known water temperature issues.

A. South Fork of the Big River

The Mendocino Redwoods Company (MRC) has substantial ownership in the South Fork of the Big River. With ownership concentrated in Daugherty Creek, Mettick Creek and Russell Brook. MRC (2003) conducted a watershed analysis on their lands in the Big River basin, including an assessment of stream temperature and canopy cover. The temperature data for most sites were higher than the 16.8°C MWAT threshold for the North Fork of the Big River, with MWATs ranging from 17.4 to 19.7°C, and streamside canopy cover mostly moderate (40% – 70%). Conditions reported on the South Fork of Big River are similar. MWATs ranged from 18 to 18.4°C on the mainstem, with much cooler water recorded along tributaries (12.9 to 15.1°C).

B. North Fork of the Big River

Some of the warmest stream temperatures on JDSF have been recorded along the lower reaches of Chamberlain and James Creek (Figure 6). Chamberlain and James Creek are the eastern most watersheds that are predominately managed by JDSF. As interior watersheds, they can be influenced by very warm air temperatures throughout the summer months. Both watersheds have a history of intensive land management, but have had very little (none on JDSF lands) timber harvesting over the last 20 years. The maximum value for MWAT ranged from 13.8 to 18.9 °C, based on water temperature data collected from 1996 through 2003.

Stream temperatures are very similar at the mouth of James and Chamberlain Creeks. Chamberlain Creek is a larger watershed (7,868 acres) than James Creek (4,459 acres), but both have a similar north-south orientation. Both creeks exhibit a distinct increase in stream temperatures in the downstream direction. Based upon recorded MWAT values, stream temperatures increased by 2.5 °C in the downstream direction on Chamberlain and 3.5°C on James Creek (Figure 7B). Unlike the South Fork Noyo, there has been no timber harvesting in Chamberlain Creek since 1985, and only two recent harvest units in James Creek off of JDSF land. As such, canopy conditions are likely to have improved as a result of canopy development along both channels, where relatively young forest has re-grown to replace the old forest that existed prior to the 1940s and 1950s.

Stream temperature data have been collected at four locations along the North Fork of Big River (Figure 6). Stream temperature appears to be much higher upstream of the JDSF boundary, cooling as it passes through JDSF, and then increasing below the JDSF boundary (NCWAP, 2004, Attachment B). Stream temperature data loggers have recorded higher temperatures at the station above the confluence of James Creek than at downstream locations within JDSF. Stream temperatures do not appear to increase as water flows past the entrances of James and Chamberlain Creeks. Water temperatures recorded on the mainstem of the North Fork of the Big River are consistently higher than water temperatures recorded along the lower reaches of James and Chamberlain Creeks (Figure 7B). The computed MWAT recorded on the North Fork of the Big River upstream of Chamberlain is a full degree (Celsius) higher than the MWAT recorded from the station on Chamberlain Creek just above its confluence with Big River. As such, the conditions within JDSF appear to have a moderating temperature effect upon water flowing into the state forest. As canopy continues to develop adjacent to these stream reaches in the future, the cooling trend is likely to continue and to improve.

The lower portions of the East Branch of the North Fork of the Big River were included in a recent watershed assessment conducted by Mendocino Redwoods Company (MRC, 2003). Streamside canopy cover was mostly high (> 90%) and MWAT values range from 16.3 to 18.4°C along the mainstem. Temperature data on tributaries (Class II watercourses) were limited to one year of data, but all sites recorded MWAT values below 15°C.

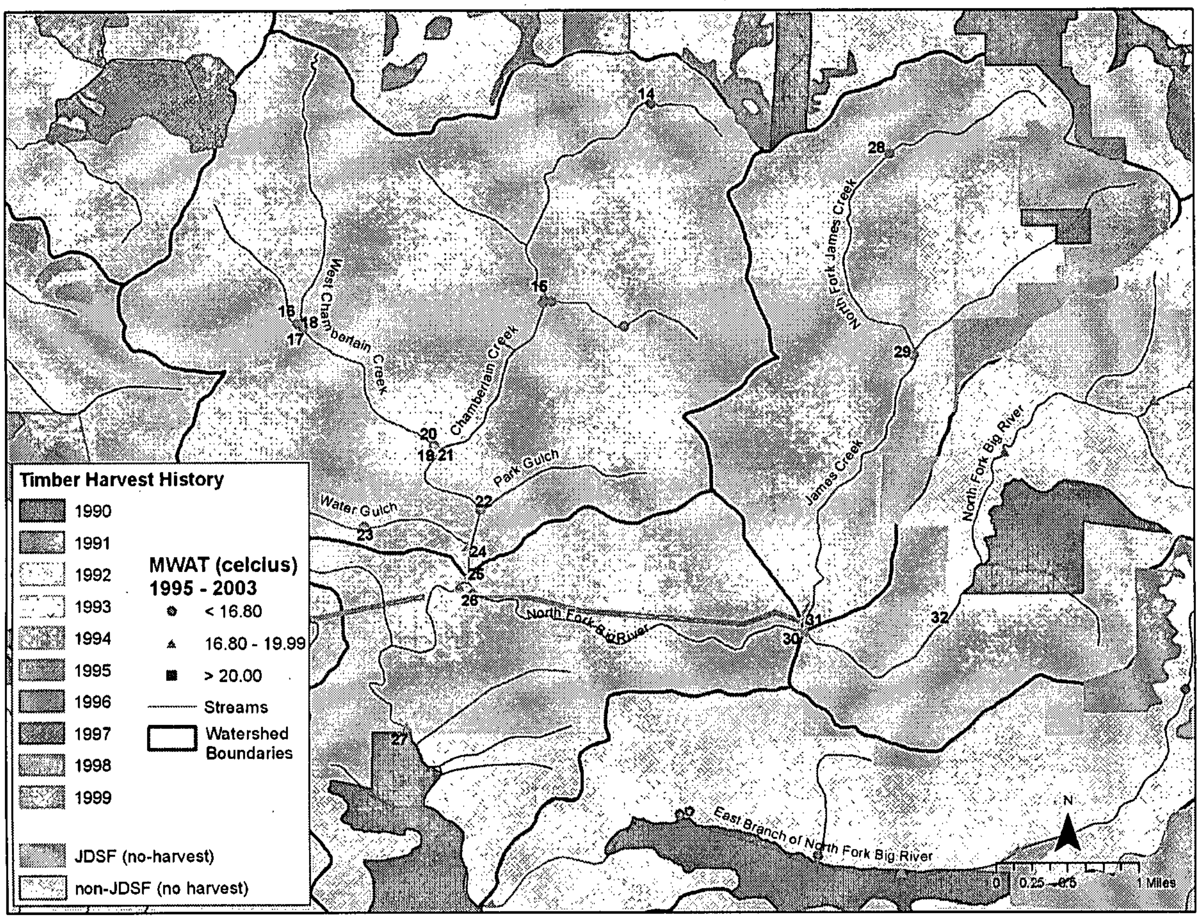
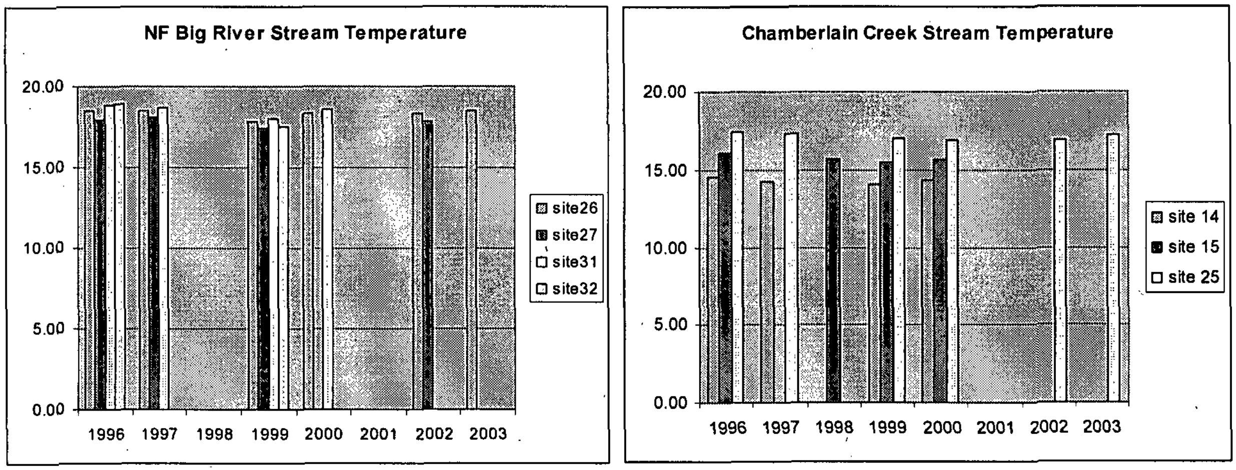


Figure 6. Distribution of Stream Temperatures along the North Fork Big River, Chamberlain and James Creeks. Note: Timber Harvest boundaries ***do not*** reflect harvest restrictions in the WLPZ.



A B

Figure 7. Stream Temperature (MWAT °C) for North Fork Big River and Chamberlain Creek. Figure 7A. MWAT stream temperatures along the North Fork of the Big River are consistently above the target threshold of 16.8 °C. However, there is not a noticeable increase of stream temperature from the upstream boundary of JDSF (site 32) to the downstream boundary of JDSF (site 27). Figure 7B. From the headwaters to the confluence, MWAT stream temperatures increase in the downstream direction along Chamberlain Creek by as much as 3 °C. This trend is fairly consistent over time, with some indication of a decrease in stream temperature at the furthest downstream station (site 25) recorded in the last 4 years of data collection.

Coastal Watersheds

Management practices on JDSF lands also influence a number of small coastal watersheds that drain directly to the Pacific Ocean. These watersheds include Russian Gulch, Caspar Creek, Jughandle Creek, Mitchell Creek, and Hare Creek. In general, the stream temperatures appear to be in a range that is supportive for salmonids. None of the temperature data for these watersheds has exceeded the 16.8 °C MWAT threshold.

Nearly all of the early temperatures monitoring efforts were in the Caspar Creek watershed. Cafferata (1990) reported pre-management water temperatures in the North Fork and South Fork Caspar Creeks. Most observed summer maximum stream temperatures in 1965 were slightly below 16°C (60°F) with absolute maximums reaching 17°C (62.6°F) at the weirs. In 1988, small uncut tributary basins had maximum temperatures of about 13°C (56°F) with average daily highs about 12°C (54°F). Cafferata (1990) reported approximately a 13% reduction in shading resulting from timber harvesting along a Class II watercourse channel in the North Fork Caspar Creek (note that shading and canopy, while related, are two different measurements; see Berbach et al. 1999). Following clearcut logging of approximately 50% of the North Fork of the Caspar Creek watershed with buffer strips prescribed by the modern Forest

Practice Rules, Nakamoto (1998) concluded that the increase in water temperature was small and the range of temperatures observed within the North Fork was within the tolerable range for coho salmon and steelhead.

Stream Canopy Cover

Streamside canopy densities are relatively high throughout JDSF. Stillwater Sciences estimated canopy cover for streams in or adjacent to JDSF in 1996 (Table 4). This survey emphasized fish bearing streams (Class I). In addition, stream surveys have been conducted by CDFG. Of the 35 stream surveys conducted by CDFG between 1995 and 1997, 25 streams had canopy densities exceeding 90%, 6 streams exceeded 80% and 4 streams were between 60 and 79% (see Map Figure F in Map Figures section).

Table 4. Summary of Streamside Canopy Cover Data for Streams in or adjacent to JDSF. Based on 1996 vegetation conditions, the data are summarized by Planning Watersheds.

	SHADE CATAGORIES (UNITS = MILES)						
PWSNAME	**< 40%**		**40 - 70%**		**70 - 100%**		**Total**
	miles	**percent**	**miles**	**percent**	**miles**	**percent**	**miles**
Berry Gulch	0.87	3.0		0.0	27.73	97.0	28.60
Brandon Gulch		0.0		0.0	24.74	100.0	24.74
Caspar Creek	0.33	1.8		0.0	17.86	98.2	18.20
Chamberlain Creek	0.34	1.1	1.17	3.7	30.22	95.2	31.73
East Branch North Fork Big River	2.17	12.4	0.33	1.9	15.02	85.7	17.52
Hare Creek		0.0		0.0	23.75	100.0	23.75
James Creek		0.0	1.22	7.7	14.55	92.3	15.77
Kass Creek		0.0	0.45	3.2	13.36	96.8	13.81
Laguna Creek		0.0		0.0	0.00	100.0	0.00
Lower North Fork Big River	3.43	17.3	1.25	6.3	15.10	76.3	19.78
Mitchell Creek		0.0		0.0	15.62	100.0	15.62
Mouth of Big River	5.44	15.1	6.04	16.8	24.53	68.1	36.01
Mouth of Noyo River		0.0		0.0	0.01	100.0	0.01
Parlin Creek	1.60	5.3	0.60	2.0	28.06	92.7	30.26
Russian Gulch		0.0		0.0	14.19	100.0	14.19
Two Log Creek	12.67	29.0		0.0	31.01	71.0	43.67
Upper North Fork Big River		0.0		0.0	17.93	100.0	17.93
Grand Total	26.84		11.06		313.70		351.60

Outside JDSF, canopy cover data has been collected as part of the Department of Fish and Game (DFG) stream surveys that were conducted between 1995 and 2003. The information relating streamside canopy cover and forest composition is presented in Attachment C. In summary, the data show that most of the streams that were surveyed meet or exceed the 85% canopy cover target. Stream reaches that do not can be found along the mainstem of the Big River, the mainstem of the Noyo, North Fork of the Big

River, South Fork of the Big River, and some of the major tributaries (i.e., Daughtery Cr., Mettick Cr., and James Cr).

Additional information on canopy cover is contained in watershed assessments that have been conducted by private landowners. Streamside canopy cover data were collected by MRC for their lands in the Noyo River watershed in 1998. Canopy cover were grouped into three classes: high (>70%), moderate (40–70%) and low (0–40%). The canopy closure assessment showed a majority of Class I streams with a high streamside shade classification (58% of total Class I watercourses). However, a significant percentage of the Noyo watershed assessment unit Class I streams have a moderate streamside shade classification (28% of Class I watercourses) and low streamside shade classification (14% of Class I watercourses). Streamside canopy cover data also were collected by MRC for their lands on the Big River to support a watershed assessment conducted in 2000. Canopy cover ranged from 40%-100% across MRC lands in the Big River. In general, canopy cover appears lowest among the mainstem of the larger river channels and is summarized as (MRC 2003):

> Canopy closure over watercourses in the Big River WAU [watershed assessment unit] ranges from poor to good. Big River, North Fork Big River and South Fork Big River have less than ideal canopy cover values but this is to be expected from larger river channels. East Branch North Fork Big River and Two Log Creek are two areas that have good canopy cover. Daugherty Creek is an area which has low canopy cover.

Discussion

In addition to a number of other factors, stream temperatures are affected by varying amounts of canopy cover that are the result of differing intensities of harvest and the natural conditions encountered throughout a watershed. The potential impact of timber harvesting on water temperatures can result from a single action, or the cumulative impact of multiple harvests. The recovery from this impact (i.e., return to a temperature regime associated with pre-harvest conditions) should consider both the upstream and downstream canopy conditions and the time required for full canopy cover to be re-established. Studies have shown that stream temperatures will return to equilibrium conditions within 10 km downstream of the harvest area (Bartholow 2000). Studies in Oregon have shown that canopy cover and water temperatures had fully recovered within 15 years following intensive harvesting within three experimental watersheds, but this is dependent upon the localized canopy and channel conditions, and the type of harvesting conducted. The North Fork Caspar Creek study (Nakamoto 1998) discussed above showed that clearcutting 50 percent of the watershed using buffer strips prescribed by contemporary Forest Practice Rules led to a small increase in water temperature; temperatures remained within the range considered suitable for coho and steelhead.

The previous discussion on the effects of timber harvesting on stream temperatures provides an assessment of current conditions and direct impacts associated with canopy cover. While not as well understood, there are other physical changes besides canopy cover that can have a cumulative influence on stream temperatures. The development of a stream temperature model by Bartholow (2000) provides insight into a range of secondary impacts that may result from timber harvesting and the degree to which they influence stream temperatures. While stream shade was an important factor, explaining 40% of the increase in stream temperature, it was not the only factor. Stream width was an important secondary factor

The model identified effects directly related to stream temperatures that are associated with: meteorology, hydrology, and stream geometry (Figure 8). Changes in meteorology refer to the micro-climate dynamics within a riparian zone. On JDSF, recent studies by Hughes et al (2004) focused on changes in riparian micro-climate as a result of timber harvest. Results have shown distinctive temperature gradients that increase with distance from the stream channel. Hydrologic changes are addressed in a separate section of the EIR, but in summary, findings from Caspar Creek suggest a recovery time of approximately 11 years for changes in peak flow. Changes in stream geometry, channel width and depth, are not well documented across the assessment area. However, historic land management practices are very likely to have altered stream geometry across large portions of the assessment area. Recovery of a more natural stream geometry from these substantial historic impacts will take a long time.

Summary

Water temperatures vary both spatially and temporally across the JDSF EIR assessment area. In general, stream temperatures are highest in some of the larger tributaries towards the interior (i.e., eastern) portions, and along portions of the mainstem Noyo River, the Big River and the North and South Forks of the Big River. Achieving targets for canopy cover will require a period of time sufficient to increase both tree height and canopy density. In addition, stream temperatures in a watershed tend to increase in the downstream direction and increase with increasing watershed area (Figure 1). Water temperature data indicate that stream temperatures along the middle and upper mainstem of the Noyo River remain warm and are consistently warmer than water temperatures measured along the lower reaches of the South Fork Noyo downstream of JDSF. This is undoubtedly due to the fact that the channels are wider, have been subjected to substantial canopy reductions in the past, and trees growing along the margins of the stream are incapable of fully shading the full channel width.

To prevent any future impacts to water temperature from the proposed management plan JDSF will meet or exceed all watercourse protection measures as stated in the FPRs. In addition, JDSF is committed to maintaining a network of monitoring stations that can be used to document trends in water temperature and identify potential impacts on water temperature from forest management. Currently, most streams within JDSF consistently record water temperature that is below the MWAT threshold of 16.8 C. However, Parlin Creek, Chamberlain Creek and James Creek have all recorded MWAT values that exceed this threshold and are areas of potential concern. These areas should be priorities for continued monitoring and canopy development.

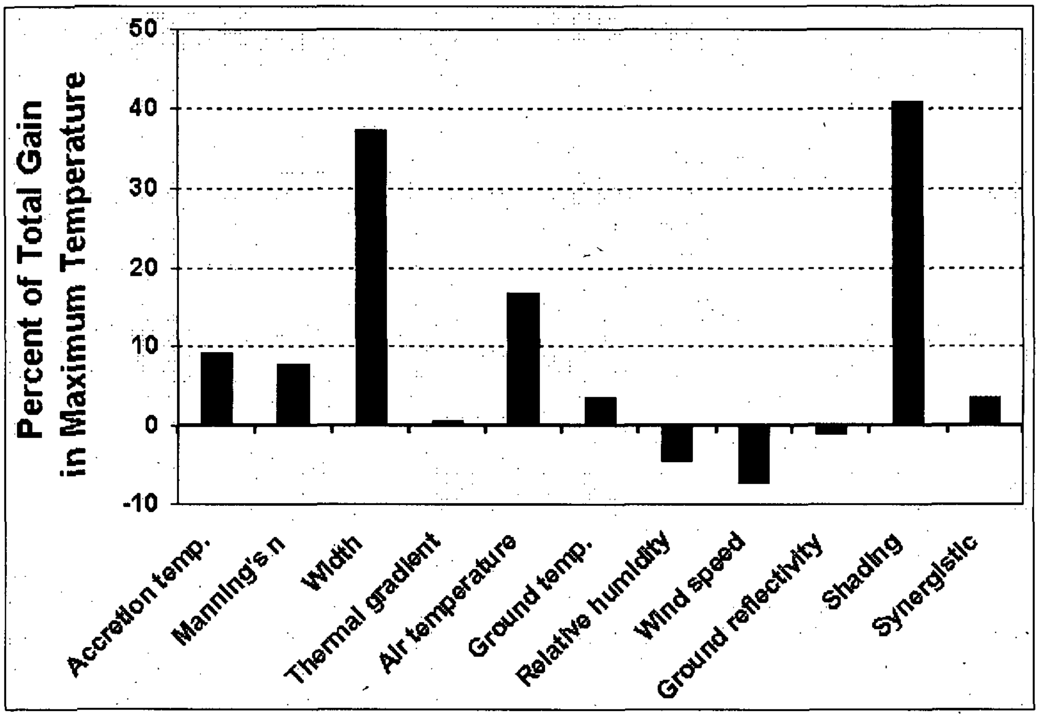


Figure 8. Stream Temperature Model Results. Model shows environmental conditions that are affected by timber harvesting and the relative magnitude of their influence on stream temperatures. Note that values above zero indicate increasing stream temperatures, while values below zero indicate decreasing temperatures (Bartholow, 2000).

References

Armour, C.L. 1991. "Guidance For Evaluating and Recommending Temperature Regimes To Protect Fish: Instream Flow Information Paper 28," Biological Report 90 (22). Fort Collins: U. S. Fish and Wildlife Service, National Ecology Research Center.

Bartholow, J.M. 2000. Estimating cumulative effects of clearcutting on stream temperatures. Rivers 7(4): 284-297. http://smig.usgs.gov/cgi-bin/SMIG/pageprint?page=features_0902/clearcut_inline.html

Bjornn, T. C. and D. W. Reiser. 1991. "Habitat Requirements of Salmonids in Streams." American Fisheries Society Special Publication 19: 83-138.

Berbach, M., P. Cafferata, T. Robards, and B. Valentine. 1999. Forest canopy measurements in watercourse and lake protection zones: a literature review. Final Report dated June, 1999. Calif. Dept. of Forestry and Fire Protection. Sacramento, CA. 22 p.

Beschta, R. L., R. E. Bilby, G. W. Brown, L. B. Holtby, and T. D. Hofstra. 1987. "Stream Temperature and Aquatic Habitat: Fisheries and Forestry Interactions." Streamside Management: Forestry *and Fishery Interactions.* Pages 191-232. Seattle: University of Washington, College of Forest Research.

Brandow, C. 2005. Modified completion report monitoring. PowerPoint presentation for the Board of Forestry and Fire Protection's Monitoring Study Group meeting held on April 7, 2005, Willits, CA. Final report in preparation.

Brosofske, K.D., J. Chen, R.J. Naiman, and J.F. Franklin. 1997. Harvesting effects on microclimatic gradients from small streams to uplands in western Washington. Ecological Applications 7(4): 1188-1200. http://research.eeescience.utoledo.edu/lees/pubs/brosofske1997.pdf

Brungs, W.A. and B.R. Jones. 1977. Temperature criteria for freshwater fish: protocol and procedures. EPA-600-3-77-061. Environmental Research Laboratory-Duluth, Office of Research and Development, US Environmental Protection Agency. 136 p.

Cafferata, P.H. 1990. Temperature Regimes of Small Streams Along The Mendocino Coast. Jackson Demonstration State Forest Newsletter, No. 39, October 1990. P. 1-4.

Cafferata, P.H. and J.R. Munn. 2002. Hillslope Monitoring Program: Monitoring Results from 1996 through 2001. California Department of Forestry and Fire Protection, Sacramento. 114 p. Available at http://www.bof.fire.ca.gov/pdfs/ComboDocument_8_.pdf.

California Department of Forestry and Fire Protection, 1999, Draft Habitat Conservation Plan and Sustained Yield Plan for Jackson Demonstration State Forest dated June 1999. Prepared by Stillwater Sciences, Berkeley, California.

Chamberlin, T.W., R.D. Harr, and F.H. Everest. 1991. "Timber Harvesting, Silviculture, and Watershed Processes." In Influences of Forest and Rangeland Management on Salmonid Fishes *and Their Habitats: American Fisheries Society Special Publication 19*. Pages 181-205 NR: American Fisheries Society.

CH_2M-Hill and Western Watershed Analysts. 1999. FEMAT riparian process effectiveness curves: what is science-based and what is subjective judgment? Final Report prepared for the Oregon Forest Industries Council, Salem Oregon.

Department of Fish and Game. 2004. Recovery Strategy for California Coho Salmon. Species Recovery Strategy 2004-1. February 2004. Report to the California Fish and Game Commission. Sacramento, California. 594p. Available on the Internet at http://www.dfg.ca.gov/nafwb/CohoRecovery/RecoveryStrategy.html

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: an ecological, economic, and social assessment. Report published by the U.S. Department of Agriculture and five other federal agencies, July 1993.

Forest Ecosystem Management Assessment Team Record of Decision (FEMAT ROD). 1994. Record of Decision for amendments to Forest Service and Bureau of Land Management documents within the range of the northern spotted owl. U.S. Government Printing Office for the U.S. Department of Agriculture, Forest Service and Bureau of Land Management. April 1994.

Hetrick, N. J., et al. 1998. "Changes In Solar Input, Water Temperature, Periphyton Accumulation, and Allochthonous Input and Storage After Canopy Removal Along Two Small Salmon Streams In Southeast Alaska" *Transactions of American Fisheries Society 127(6): 859-875*. NR: American Fisheries Society.

Hines, D. and J. Ambrose. 2000. Evaluation of stream temperatures based on observations of juvenile coho salmon in northern California streams. Georgia-Pacific West, Inc., Fort Bragg, California. Unpublished Report. 30 p. http://www.krisweb.com/biblio/gen_afs_hinesetal_xxxx.pdf

Hughes, T., Macedo, R. and B. Valentine, 2004. Air temperature of stream-sides in the North Coast Redwood Region 2001-2003. Redwood Region Forest Science Symposium, Rohnert Park, CA.

Johnson, S.L. and J.A. Jones. 2000. Stream temperature responses to forest harvest and debris flows in western Cascades, Oregon. Can. J. Fish. Aquat. Sci. 57(Suppl. 2): 30–39.

Mendocino Redwood Company Co., LLC, 2003. Watershed Analysis for Mendocino Redwood Company's Ownership in the Big River Watershed.

Mendocino Redwood Company Co., LLC, 2000. Noyo River Watershed Analysis.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska—requirements of protection and restoration. NOAA Coastal Ocean Program Decision Analysis Series No. 7. NOAA Coastal Ocean Office, Silver Spring, MD. 156 p.

Murphy, M. L., and W. R. Meehan. 1991. "Stream Ecosystems," Influences of Forest and Rangeland Management On Salmonid Fishes and Their Habitats: .American Fisheries Society Special Publication 19: 17-46.NR: American Fisheries Society.
Nakamoto, R.. 1998. Effects of timber harvest on aquatic vertebrates and habitat in the North Fork Caspar Creek. *In:* Ziemer, R.R., technical coordinator. Proceedings of the conference on coastal watersheds: the Caspar Creek story, 1998 May 6; Ukiah, CA. General Tech. Rep. PSW GTR-168. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; p. 87-95.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 1997. Aquatic properly functioning condition matrix. NMFS, Southwest Region, Northern California Area Office, Santa Rosa, and USFWS, Arcata, California.

North Coast Regional Quality Control Board. 2004 (preliminary draft). Big River Water Quality Assessment. Report compiled for the North Coast Watershed Assessment Program. North Coast Regional Quality Control Board, Santa Rosa. Draft utilized with permission of R. Klamt, Chief of Timber Harvest Division, North Coast Regional Water Quality Control Board.

Poole, G. C. and C. H. Berman. 2000. Pathways of human influence on water temperature dynamics in stream channels. Environmental Management.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An Ecosystem Approach To Salmonid Conservation. TR-4501-96-6057. Corvallis: Mantech Environmental Research Services Corp.

Steinblums, I.J., H.A. Froehlich, and J.K. Lyons. 1984. Designing stable buffer strips for stream protection. Journal of Forestry 82 (1):49-52.

Sullivan, K., et al. 1990. Evaluation of Prediction Models and Characterization of Stream Temperature Regimes In Washington. Timber/Fish/Wildlife Rep. No. TFW-WQ3-90-006. Olympia: Washington Dept. Nat. Resources.

Valentine, B.E. 1996. Stream Temperatures on Jackson Demonstration State Forest, Mendocino County, California During Summer of 1995. Draft Report. Santa Rosa: CDF, Coast-Cascade Region.

Welsh, H. H., G. R. Hodgson, B. K. Harvey, and M. E. Roche. 2001. "Distribution of Juvenile Coho Salmon In Relation To Water Temperatures In Tributaries of The Mattole River, California," North American Journal of Fisheries Management. 21:464-470.

CDF. 2003. Assessment of Land Use in the Big River Watershed. Draft Report, North Coast Watershed Assessment Program, Sacramento, CA.

Jackson, W.F. 1991. Big River Was Dammed. FMMC Books, Mendocino, CA.

Napolitano, M., F. Jackson, and P. Cafferata. 1989. A history of logging in the Caspar Creek basin. Jackson Demonstration State Forest Newsletter, No. 33, April 1989. p. 4-7. http://www.fs.fed.us/psw/publications/4351/JDSF89.pdf

Wurm, T. 1986. Mallets on the Mendocino Coast: Caspar Lumber Company railroads and steamships. Glendale: Trans-Anglo Books. 34 p.

Attachment A

Stream Temperature Data Summary

PLANNING WATERSHEDS	Site	Avg	Max	Min	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
BIG RIVER HEADWATERS																	
Martin Creek	FSP_5219	18.4	18.6	18.3	0.0	0.0	0.0	0.0	0.0	0.0	18.6	18.3	0.0	0.0	0.0	0.0	0.0
	FSP_5235	16.0	17.3	14.7	0.0	0.0	0.0	0.0	0.0	0.0	17.3	14.7	0.0	0.0	0.0	0.0	0.0
	FSP_5240	17.4	17.8	17.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0	17.8	0.0	0.0	0.0	0.0	0.0
Russel Brook	MRC_T74-01	19.5	20.1	19.0	0.0	20.1	19.0	19.0	0.0	0.0	0.0	0.0	0.0	19.3	19.9	19.4	0.0
	MRC_T74-02	15.8	16.6	14.9	0.0	0.0	0.0	15.2	16.6	0.0	0.0	0.0	0.0	16.0	14.9	15.7	16.6
	MRC_T74-03	18.4	19.0	16.0	0.0	0.0	0.0	18.8	16.0	0.0	0.0	0.0	18.8	0.0	18.8	19.0	18.9
	MRC_T74-20	14.2	14.2	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.2	0.0	0.0
	MRC_T74-21	14.7	14.7	14.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.7	0.0	0.0
NORTH FORK BIG RIVER																	
Upper North Fork Big River	JDSF_3201	18.2	18.9	17.5	0.0	0.0	0.0	0.0	0.0	18.9	0.0	0.0	17.5	0.0	0.0	0.0	0.0
	JDSF_3202	18.5	18.9	18.0	0.0	0.0	0.0	0.0	0.0	18.9	18.7	0.0	18.0	18.6	0.0	0.0	0.0
	JDSF_3213	17.1	17.5	16.8	0.0	0.0	0.0	0.0	0.0	16.8	0.0	0.0	17.0	0.0	0.0	17.0	17.5
	FSP_5220	18.1	18.6	17.5	0.0	0.0	0.0	0.0	0.0	0.0	18.6	17.5	0.0	0.0	0.0	0.0	0.0
	FSP_5238	17.7	18.1	17.3	0.0	0.0	0.0	0.0	0.0	0.0	18.1	17.3	0.0	0.0	0.0	0.0	0.0
James Creek	JDSF_3211	15.1	15.8	14.8	0.0	0.0	0.0	0.0	0.0	15.1	15.8	0.0	14.8	14.8	0.0	0.0	0.0
	JDSF_3212	16.3	16.8	15.9	0.0	0.0	0.0	0.0	0.0	16.8	0.0	0.0	15.9	16.2	0.0	0.0	0.0

PLANNING WATERSHEDS	Site	Avg	Max	Min	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Chamberlain Creek	JDSF_3221	14.3	14.5	14.1	0.0	0.0	0.0	0.0	0.0	14.5	14.2	0.0	14.1	14.4	0.0	0.0	0.0
	JDSF_3222	15.8	16.1	15.5	0.0	0.0	0.0	0.0	0.0	16.1	0.0	0.0	15.5	15.7	0.0	0.0	0.0
	JDSF_3223	16.3	16.3	16.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3	16.2	0.0	0.0	0.0
	JDSF_3224	17.1	17.5	16.9	0.0	0.0	0.0	0.0	0.0	17.5	17.3	0.0	17.0	16.9	0.0	16.9	17.3
	JDSF_3231	15.0	15.2	14.7	0.0	0.0	0.0	0.0	0.0	15.2	15.0	0.0	15.0	14.7	0.0	0.0	0.0
	JDSF_X14	14.1	14.6	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.8	13.8	14.6
	JDSF_X15	15.2	15.7	14.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	14.9	15.7
	JDSF_X16	14.5	14.9	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9	14.7	14.0	0.0	0.0
	JDSF_X17	15.6	16.2	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.3	15.4	16.2
	JDSF_X18	16.9	16.9	16.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9
	JDSF_X19	17.6	17.6	17.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6
	JDSF_X20	15.3	15.3	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.3
	JDSF_X21	15.7	15.7	15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.7	0.0	0.0	0.0	0.0	0.0
	JDSF_X22	15.7	15.9	15.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9	15.4	0.0	0.0	0.0	0.0
	FSP_556	16.0	16.0	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	0.0	0.0	0.0	0.0	0.0
East Branch North Fork Big	MRC_T75-01	17.4	18.4	16.4	0.0	0.0	18.4	0.0	18.1	0.0	17.9	0.0	17.1	17.1	16.4	16.6	17.4
	MRC_T75-03	17.2	17.9	16.3	0.0	0.0	0.0	0.0	0.0	0.0	17.9	0.0	0.0	0.0	16.3	17.0	17.7
	MRC_T75-20	12.1	12.1	12.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.1	0.0	0.0
	MRC_T75-22	13.6	13.6	13.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6	0.0	0.0
	MRC_T75-05	14.4	15.3	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5	15.3
	FSP_5213	17.5	18.1	16.9	0.0	0.0	0.0	0.0	0.0	0.0	18.1	16.9	0.0	0.0	0.0	0.0	0.0
	FSP_5234	15.7	15.8	15.6	0.0	0.0	0.0	0.0	0.0	0.0	15.6	15.8	0.0	0.0	0.0	0.0	0.0

PLANNING WATERSHEDS	Site	Avg	Max	Min	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Lower North Fork Big River	MRC_T75-04	18.5	19.2	17.4	0.0	0.0	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.4	19.0
	MRC_T75-23	13.2	13.2	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	0.0	0.0
	JDSF_3203	18.5	18.5	18.5	0.0	0.0	0.0	0.0	0.0	18.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	JDSF_3204	18.3	18.5	17.8	0.0	0.0	0.0	0.0	0.0	18.5	18.5	0.0	17.8	18.3	0.0	18.4	18.5
	JDSF_3205	17.9	17.9	17.9	0.0	0.0	0.0	0.0	0.0	17.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	JDSF_3206	17.8	18.1	17.4	0.0	0.0	0.0	0.0	0.0	18.0	18.1	0.0	17.4	17.8	0.0	0.0	0.0
SOUTH FORK BIG RIVER																	
Dark Gulch	FSP_552	15.5	15.7	15.3	0.0	0.0	0.0	0.0	0.0	15.5	15.3	15.7	0.0	0.0	0.0	0.0	0.0
South Daugherty Creek	MCWA_154	17.8	18.1	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.1	0.0	17.4	18.0	0.0
	MRC_T79-04	18.7	19.3	18.2	0.0	0.0	0.0	18.7	19.3	0.0	18.4	0.0	18.2	19.0	18.4	18.5	19.1
	MRC_T79-05	18.3	18.7	17.8	0.0	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.0	0.0	0.0	17.8	18.3
	MRC_T79-09	17.8	18.8	16.5	0.0	0.0	0.0	0.0	0.0	0.0	18.2	0.0	0.0	0.0	16.5	17.7	18.8
	MRC_T79-13	17.1	17.4	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	17.4
Mettick Creek	MCWA_155	18.1	18.3	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.3	0.0	18.0	0.0	0.0
	MRC_T79-01	20.1	20.6	19.5	0.0	0.0	0.0	0.0	0.0	20.6	20.5	0.0	20.0	20.4	19.5	19.7	20.3
	MRC_T79-02	18.5	18.7	18.2	0.0	0.0	0.0	0.0	0.0	18.7	18.4	0.0	18.7	0.0	0.0	18.2	18.5
	MRC_T79-08	15.4	16.6	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.1	0.0	14.5	16.6
	MRC_T79-10	18.2	18.3	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	18.3

PLANNING WATERSHEDS	Site	Avg	Max	Min	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	MRC_T79-11	19.4	19.7	19.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	19.7
	MRC_T79-12	19.2	19.9	18.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.4	19.9
	MRC_T79-20	14.0	14.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	0.0	0.0
	MRC_T79-21	13.8	13.8	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.8	0.0	0.0
	MRC_T79-22	12.9	12.9	12.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.9	0.0	0.0
LOWER BIG RIVER																	
Laguna Creek	CTM_BIG12	16.1	16.1	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.1	0.0	0.0	0.0	0.0	0.0
	CTM_BIG14	16.1	16.1	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.1	0.0	0.0	0.0	0.0	0.0
Berry Gulch	CTM_BIG10	14.9	15.6	14.4	0.0	0.0	0.0	14.6	15.6	15.0	0.0	14.9	15.0	14.8	14.4	0.0	15.0
	CTM_BIG8	15.5	16.2	14.6	0.0	0.0	0.0	15.2	16.2	15.8	0.0	15.6	15.6	15.5	14.6	15.4	15.5
	CTM_BIG9	14.7	15.6	13.9	0.0	0.0	0.0	0.0	15.6	0.0	0.0	15.0	14.9	14.4	13.9	0.0	14.7
	JDSF_3301	14.1	14.6	13.6	0.0	0.0	0.0	0.0	0.0	13.6	14.6	0.0	14.3	14.0	0.0	0.0	0.0
	JDSF_3302	15.2	15.8	15.0	0.0	0.0	0.0	0.0	0.0	15.3	15.8	0.0	15.0	15.0	0.0	15.2	15.1
	JDSF_3311	14.9	15.0	14.8	0.0	0.0	0.0	0.0	0.0	14.9	0.0	14.8	15.0	0.0	0.0	0.0	0.0
	JDSF_3321	13.9	14.1	13.8	0.0	0.0	0.0	0.0	0.0	13.8	0.0	0.0	0.0	0.0	14.1	0.0	0.0
	JDSF_X08	14.0	14.9	13.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5	13.4	14.9	14.2	0.0
	JDSF_X10	14.2	14.2	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.2	0.0	0.0
Mouth of Big River	CTM_BIG11	19.3	20.8	15.6	0.0	0.0	0.0	0.0	0.0	15.6	0.0	20.8	20.4	20.2	0.0	0.0	0.0
	CTM_BIG15	20.4	20.4	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.4	20.4
	JDSF_3331	14.8	15.9	14.0	0.0	0.0	0.0	0.0	0.0	14.0	15.9	14.4	14.9	14.8	0.0	0.0	0.0
	JDSF_X05	14.2	14.5	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.2	13.8	14.5
Two Log Creek	CTM_BIG3	16.3	17.1	15.5	0.0	0.0	0.0	15.5	17.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

none exceed annual max 17.5 + 2.0

PLANNING WATERSHEDS	Site	Avg	Max	Min	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CTM_BIG1	20.5	20.9	19.9	0.0	0.0	0.0	20.8	20.9	20.7	0.0	20.6	20.3	20.7	19.9	20.1	20.5
	CTM_BIG13	20.6	20.9	20.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.9	20.7	0.0	20.2	20.6	20.6
	CTM_BIG4	15.7	17.1	14.2	0.0	0.0	0.0	15.5	17.1	0.0	0.0	16.4	15.3	15.6	14.2	15.3	16.0
	CTM_BIG5	14.3	14.9	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.7	14.9
	MRC_T76-01	19.8	20.6	19.3	0.0	0.0	19.7	19.3	0.0	0.0	0.0	0.0	19.4	0.0	0.0	0.0	20.6
	MRC_T76-02	15.4	15.8	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.8	14.8	15.3	15.5
	MRC_T76-20	13.4	13.4	13.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.4	0.0	0.0
NOYO HEADWATERS																	
Hayworth Creek	MRC_T70-03	18.2	19.8	16.8	19.1	19.8	18.9	18.3	18.1	18.2	0.0	0.0	16.8	17.8	17.2	17.1	18.6
	MRC_T70-05	17.3	17.9	16.7	0.0	0.0	0.0	17.5	17.6	17.9	0.0	0.0	16.8	17.2	17.2	16.7	17.8
	MRC_T70-06	17.9	18.9	17.1	0.0	0.0	0.0	0.0	0.0	18.9	18.2	0.0	17.1	17.5	17.4	17.9	18.4
	MRC_T70-23	13.5	13.5	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5	0.0	0.0
	MRC_T70-24	13.8	13.8	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.8	0.0	0.0
	MRC_T70-25	13.5	13.5	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5	0.0	0.0
McMullen Creek	CTM_NOY10	16.2	16.3	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3	16.1	16.1	0.0	0.0	0.0
	MRC_T70-13	16.7	17.5	16.2	0.0	0.0	0.0	0.0	0.0	17.5	16.6	0.0	16.5	0.0	16.2	16.2	17.0
	MRC_T70-14	17.2	17.2	17.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.2	0.0	0.0	0.0
Middle Fork N. Fork Noyo	MRC_T70-07	17.3	18.4	16.3	17.9	18.0	17.3	18.4	0.0	17.4	0.0	0.0	16.5	16.8	16.3	0.0	0.0
	MRC_T70-08	15.9	17.1	13.9	0.0	0.0	0.0	15.6	16.3	16.7	0.0	0.0	13.9	15.9	15.9	15.6	17.1
	MRC_T70-10	15.8	16.8	15.2	0.0	0.0	0.0	0.0	16.1	0.0	0.0	0.0	15.7	16.0	15.2	15.2	16.8
North Fork Noyo	MRC_T70-01	17.8	18.5	17.1	0.0	18.5	17.8	17.1	17.7	18.0	0.0	0.0	17.3	17.3	17.5	18.1	18.4

PLANNING WATERSHEDS	Site	Avg	Max	Min	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	MRC_T70-02	15.2	16.1	13.2	0.0	0.0	0.0	15.0	15.7	15.6	0.0	0.0	13.2	15.3	15.3	15.2	16.1
	MRC_T70-20	19.7	19.7	19.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.7	0.0	0.0
	MRC_T70-21	14.0	14.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	0.0	0.0
	MRC_T70-22	13.3	13.3	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	0.0	0.0
Olds Creek	MRC_T70-11	17.7	18.8	15.6	0.0	18.3	17.9	17.1	17.9	18.1	15.6	0.0	17.9	17.6	17.9	17.7	18.8
	MRC_T70-15	17.4	17.4	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.4
Redwood Creek	MRC_T70-12	17.0	18.1	15.8	0.0	0.0	0.0	16.4	17.4	17.7	0.0	0.0	16.6	17.3	15.8	16.7	18.1
MIDDLE NOYO																	
Duffy Gulch	CTM_NOY11	18.4	19.0	17.9	0.0	0.0	0.0	0.0	0.0	0.0	17.9	18.5	18.3	18.5	18.2	18.8	19.0
	CTM_NOY2	14.9	15.4	14.6	0.0	0.0	0.0	0.0	0.0	0.0	15.4	15.1	14.9	14.6	14.6	0.0	14.8
Little North Fork	CTM_NOY12	17.9	18.1	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	18.1
	CTM_NOY13	18.5	18.7	18.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.7	18.5	18.6	18.1	18.6	18.6
	CTM_NOY14	18.6	18.6	18.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.6	18.5	18.6	18.4	0.0	18.6
	CTM_NOY4	18.1	18.3	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.3	18.2	17.8	18.1	18.1
	CTM_NOY5	14.3	15.6	13.7	0.0	0.0	0.0	13.7	15.1	14.1	15.6	14.1	14.3	13.8	13.9	14.1	14.6
SOUTH FORK NOYO RIVER																	
Brandon Gulch	JDSF_2508	15.6	15.6	15.6	0.0	0.0	0.0	0.0	0.0	15.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	JDSF_2571	14.9	15.2	14.7	0.0	0.0	0.0	0.0	0.0	14.9	15.2	14.9	14.7	0.0	0.0	0.0	0.0
	JDSF_2572	15.4	15.7	15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.3	15.4	15.2	15.3	15.2	15.7
	JDSF_2573	16.0	16.7	15.6	0.0	0.0	0.0	0.0	0.0	16.1	16.7	15.6	15.9	15.6	0.0	0.0	0.0
	JDSF_X06	14.6	15.1	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.8	14.5	14.3	14.4	15.1
	JDSF_X07	15.6	16.0	15.3	0.0	0.0	0.0	0.0	0.0	15.3	16.0	0.0	0.0	0.0	0.0	0.0	0.0

✓ = stations that could be included or already are in Fact sheet = 17 stations/samples
Don't include all stations B/c some R For creeks not in the Factsheet already.

N= 43 TOTAL
15 exceed

PLANNING WATERSHEDS	Site	Avg	Max	Min	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	JDSF_X12	14.0	14.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	14.0	0.0
	JDSF_X13	13.8	14.5	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	13.5	14.5
Kass Creek	CTM_NOY6	15.8	15.9	15.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.9	15.7	15.8	0.0	0.0
	CTM_NOY7	14.0	16.3	13.2	0.0	0.0	0.0	13.2	14.5	0.0	16.3	13.8	13.6	13.5	13.6	13.6	14.1
	JDSF_2509	15.9	15.9	15.9	0.0	0.0	0.0	0.0	0.0	15.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parlin Creek	JDSF_2501	15.8	17.3	14.6	0.0	0.0	0.0	0.0	0.0	16.2	17.3	16.2	15.9	15.8	0.0	0.0	0.0
	JDSF_2502	16.9	17.4	16.7	0.0	0.0	0.0	0.0	0.0	16.9	0.0	17.0	17.4	16.8	16.8	16.7	16.9
	JDSF_2503	15.4	16.4	14.7	0.0	0.0	0.0	0.0	0.0	15.2	16.4	0.0	15.7	14.7	15.1	0.0	0.0
	JDSF_2504	16.3	16.8	15.9	0.0	0.0	0.0	0.0	0.0	15.9	16.8	16.0	16.4	16.5	0.0	0.0	0.0
	JDSF_2506	16.3	17.3	16.0	0.0	0.0	0.0	0.0	0.0	16.0	17.3	16.1	16.5	16.3	16.1	16.1	16.3
	JDSF_2531	14.6	15.0	14.3	0.0	0.0	0.0	0.0	0.0	14.7	14.5	14.5	15.0	14.7	14.4	14.3	14.9
	JDSF_2532	15.4	16.0	15.1	0.0	0.0	0.0	0.0	0.0	15.1	15.6	15.2	15.5	15.1	15.1	15.7	16.0
	JDSF_2533	15.5	15.5	15.5	0.0	0.0	0.0	0.0	0.0	15.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	JDSF_2534	16.5	17.1	16.1	0.0	0.0	0.0	0.0	0.0	16.3	17.1	16.1	0.0	0.0	0.0	0.0	0.0
	JDSF_2551	14.6	15.4	14.0	0.0	0.0	0.0	0.0	0.0	14.0	15.4	14.2	0.0	15.0	0.0	14.2	14.7
	JDSF_2561	13.9	15.1	13.0	0.0	0.0	0.0	0.0	0.0	13.0	15.1	14.0	14.2	13.7	13.6	0.0	0.0
	JDSF_X09	14.7	15.5	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.7	15.5	14.0	0.0	0.0
	JDSF_X11	15.7	16.1	15.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.1	15.8	15.5	15.5	15.8
LOWER NOYO RIVER																	
Lower Noyo River	CTM_NOY9	17.4	18.1	16.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.1	17.6	16.6	17.4	17.2	17.8

circled ones already in Factsheet → we have 9 stations 29 samples – 16 exceed the annual max. guideline of 17.5° for coho

PLANNING WATERSHEDS	Site	Avg	Max	Min	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
COASTAL																	
Caspar Creek	JDSF_3401	14.6	15.5	14.1	0.0	0.0	0.0	0.0	0.0	14.1	15.5	14.5	0.0	14.3	0.0	0.0	0.0
	JDSF_3402	15.0	15.0	15.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	JDSF_3411	14.6	15.8	13.9	0.0	0.0	0.0	0.0	0.0	13.9	15.8	14.2	0.0	0.0	0.0	0.0	0.0
	FSP_5801	14.2	14.2	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.2	0.0	0.0	0.0	0.0	0.0
Hare Creek	JDSF_2402	14.2	14.3	14.0	0.0	0.0	0.0	0.0	0.0	14.0	0.0	14.2	14.3	14.1	0.0	0.0	0.0
	JDSF_2403	14.8	15.7	13.9	0.0	0.0	0.0	0.0	0.0	13.9	15.7	0.0	0.0	0.0	0.0	0.0	0.0
	JDSF_2404	13.8	13.8	13.8	0.0	0.0	0.0	0.0	0.0	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	JDSF_2405	14.3	15.0	13.8	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	13.8	14.1	0.0	0.0	0.0
	JDSF_2411	13.7	14.4	13.1	0.0	0.0	0.0	0.0	0.0	13.1	14.4	13.4	13.6	13.8	0.0	0.0	0.0
	JDSF_2412	14.7	15.8	14.3	0.0	0.0	0.0	0.0	0.0	14.6	15.8	14.5	0.0	14.5	14.5	14.3	15.0
	JDSF_X01	14.5	14.9	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	14.9
	JDSF_X03	14.9	15.1	14.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9	14.7	15.1	14.8	0.0
	JDSF_X04	14.3	14.6	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	14.0	14.6
Mitchell Creek	JDSF_3490	13.4	14.1	12.6	0.0	0.0	0.0	0.0	0.0	12.6	14.1	0.0	13.5	13.7	13.2	0.0	0.0
	JDSF_X02	13.7	14.2	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	14.2
Russian Gulch	MRC_T72	13.6	14.0	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	14.0
	JDSF_3501	13.1	13.1	13.1	0.0	0.0	0.0	0.0	0.0	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	JDSF_3502	13.2	14.1	12.6	0.0	0.0	0.0	0.0	0.0	12.6	14.1	13.0	13.1	0.0	0.0	0.0	0.0

Attachment B

DRAFT North Coast Watershed Assessment Big River Report[1]

Lower Big River

Water Temperature

1. Continuous water temperature data logging devices were deployed by HTC and JSF at a total of twelve (12) locations in the lower Big River sub-watershed. In general, water temperature was monitored in one or more locations in the lower Big River watershed during the years 1993 to 2001.
2. With the exception of the temperature monitoring sites on the mainstem of the Big River (HTC BIG2, HTC BIG11), water temperatures in the Lower Big River subbasin were fully or moderately suitable. The mainstem Big River sites were fully unsuitable in all years monitored with high diurnal fluctuations (7.9-9.9°F) and high maximum temperatures (75-76°F).
3. Most of the Little North Fork and tributary monitoring sites exhibited low diurnal fluctuations suggesting good shading, and/or good flow conditions and/or a tempering marine influence.
4. It is probable that the Little North Fork has a cooling effect on the mainstem Big River. However, the magnitude of that effect is unknown as it is dependant on the temperature differentials and flows.

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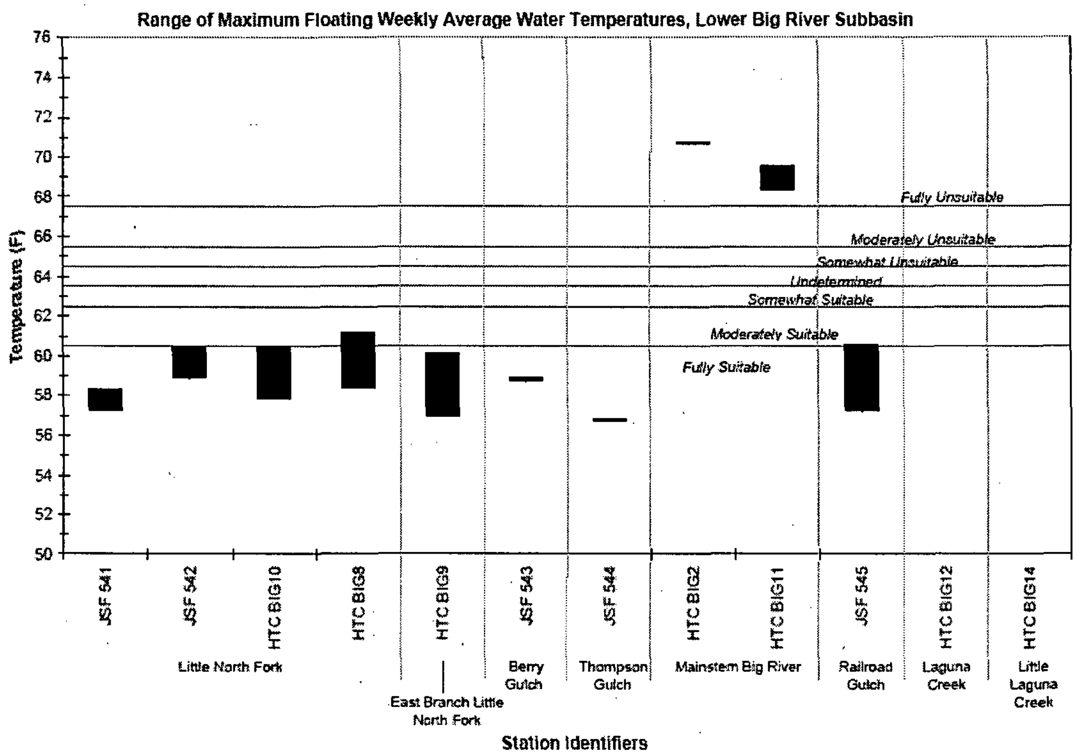
[1] North Coast Regional Quality Control Board. 2004 (preliminary draft). Big River Water Quality Assessment. Report compiled for the North Coast Watershed Assessment Program. North Coast Regional Quality Control Board, Santa Rosa. Draft utilized with permission of R. Klamt, Chief of Timber Harvest Division, North Coast Regional Water Quality Control Board.

FIGURE 4: RANGE OF MWATS, LOWER BIG RIVER SUBBASIN



Middle Big River

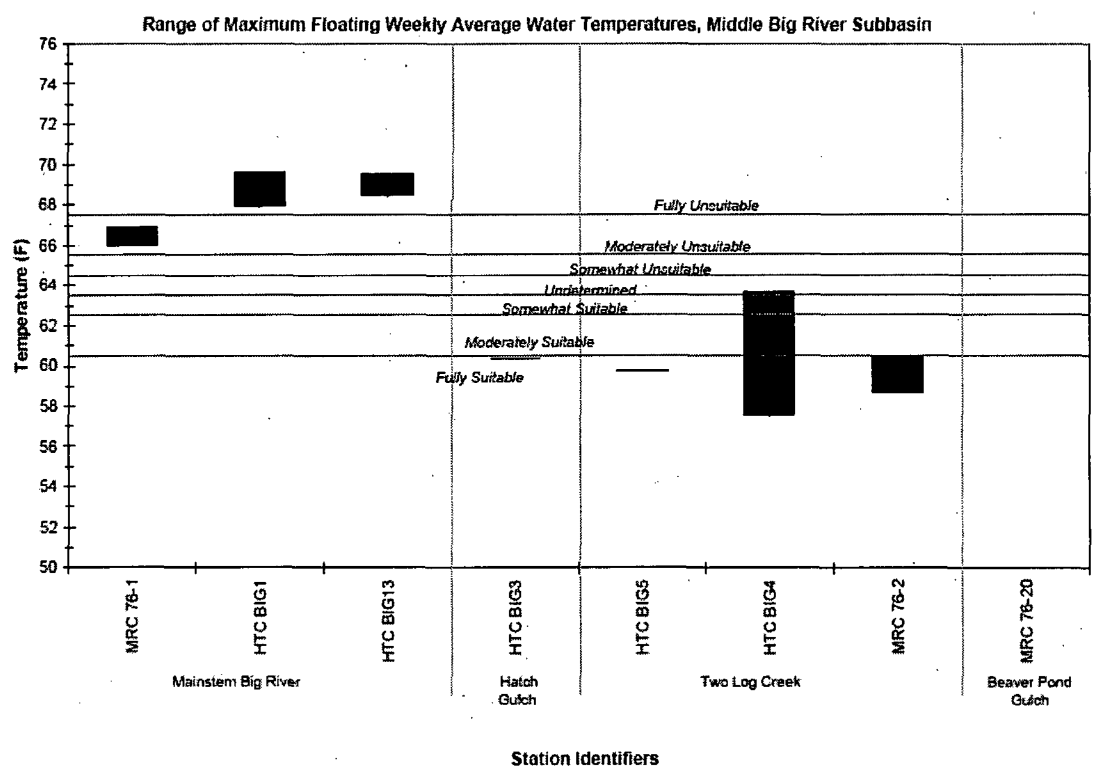
Water Temperature

1. Continuous water temperature data logging devices were deployed by HTC and MRC at a total of nine (9) locations in the middle Big River sub-watershed. With the exception of 1997, water temperature was monitored in one or more locations in the middle Big River sub-watershed during the years 1993 to 2001.
2. Data collected at the two lower Two Log Creek Sites (HTC BIG4 and MRC 76-2), indicated water temperatures between fully suitable with a minimum observed MWAT of 58° F and undetermined with a maximum observed MWAT of 64° F. Large diurnal temperature fluctuations (6.7-12.0°F) were recorded at both lower Two Log Creek sites, which may indicate poor canopy and/or low flows.
3. The only tributary to Two Log Creek that was monitored was Beaver Pond Gulch (MRC 76-20), which was monitored for one year. Based on this data, the water temperatures at this site was fully suitable with a maximum MWAT of 56°F, but based on the thermograph, it may be more representative of a thermally stratified pool or a site with a significant groundwater component.
4. A site on Hatch Gulch (HTC BIG3), a tributary to the mainstem Big River between the North Fork and Two Log Creek (but below HTC BIG1), was monitored for one year. Monitoring at this site recorded water temperatures that

were fully suitable with a maximum observed MWAT of 60°F. The diurnal fluctuations at this site were minimal. It is likely that Hatch Gulch provides some cooling effect to the mainstem Big River.

5. All of the water temperature monitoring sites on the mainstem Big River (MRC 76-1, HTC BIG1, and HTC BIG13) had MWATs that varied from moderately to fully unsuitable (67-70° F) with maximum daily temperatures (73-77° F) in excess of the lethal limit for salmonids. High diurnal fluctuations were also recorded (7.5-12.8° F), suggesting poor canopy and/or low flows.
6. It is probable that Two Log Creek has a cooling effect on the mainstem Big River. However, the magnitude of that effect is unknown as it is dependant on the temperature differentials and flows.
7. In lower Two Log Creek, both MRC and HTC have temperature monitoring sites in nearly the same location. It may be more effective if one company monitored the site and shared the information with the other.

FIGURE 8: RANGE OF MWATS, MIDDLE BIG RIVER SUBBASIN

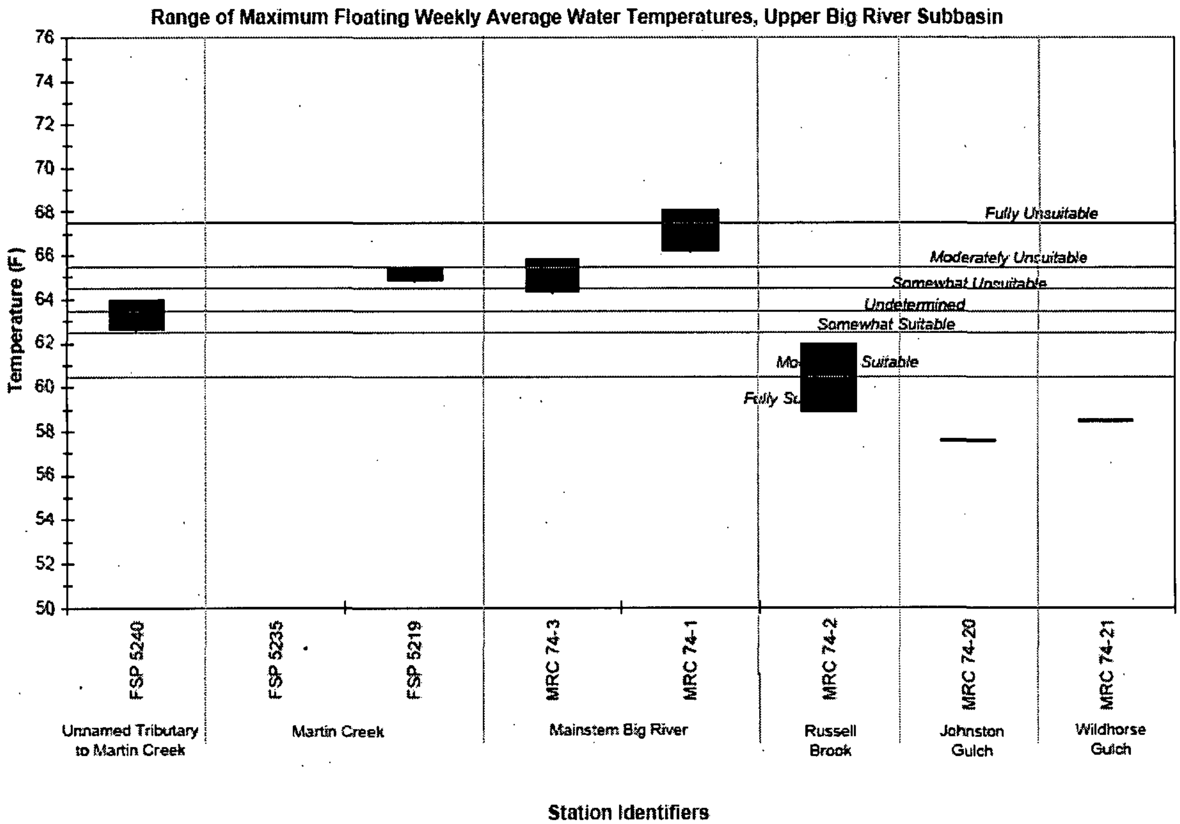


Upper Big River

Water Temperature

1. Continuous water temperature data logging devices were deployed by MRC and JSF at a total of eight (8) locations in the upper Big River sub-watershed. With the exception of 1996, water temperature was monitored in one or more locations in the upper Big River sub-watershed during the years 1990 to 2001.
2. Based on limited data from two sites in the Martin Creek watershed, the water temperatures were somewhat suitable to somewhat unsuitable with a maximum MWAT of 65°F.
3. There are two monitoring sites on the mainstem Big River, both of which were recorded for four years. Both sites had MWATs that were undetermined to fully unsuitable with a maximum MWAT of 68° F. In addition, the site between Russell Brook and the South Fork Big River (MRC 74-1) had a maximum daily temperature of 75° F and large diurnal fluctuations of between 10.8-12.9° F. Several tributaries to the mainstem Big River were monitored for one to four years.
4. Russell Brook (MRC 74-2) had a maximum MWAT of 62° F and moderate diurnal fluctuations of between 6.7-8.4° F. This suggests moderate to poor cover and/or low flows and probably contributes cooler water to the mainstem Big River. The other two sites at Johnston Gulch (MRC 74-20) and Wildhorse Gulch (MRC 74-21) have MWATs that are fully suitable (58° F), with low diurnal fluctuations. It is likely that the temperature probes at these sites are heavily influenced by subsurface flows (groundwater).

FIGURE 12: RANGE OF MWATS, UPPER BIG RIVER SUBBASIN



North Fork Big River

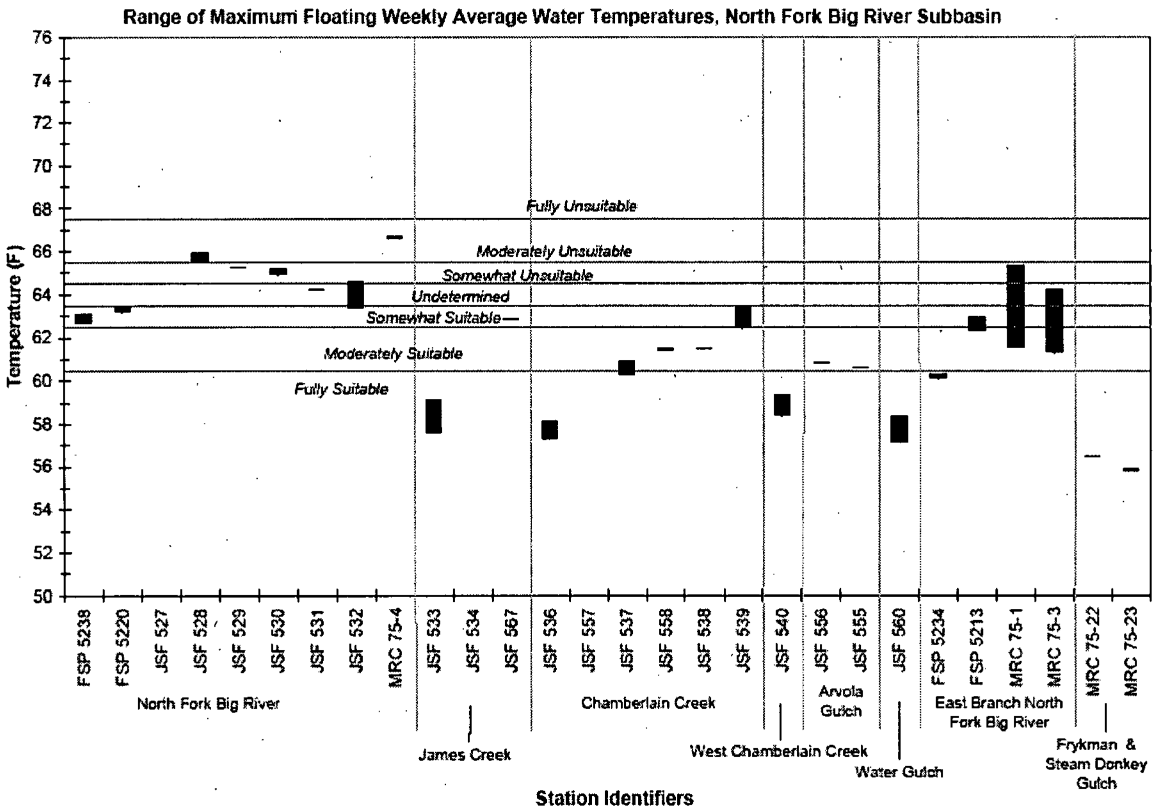
Water Temperature

1. The North Fork Big appears to heat relatively quickly upstream of, and at, the boundary of the JSF. The observed MWATs go from 63° F in the headwater area to 66°F at the JSF boundary. This is likely due to poor canopy, low flows, and possibly different temperature probe placement protocols between FSP and JSF.
2. Once in JSF, water temperatures begin a steady decline. Based on temperature monitors in the North Fork on either side of the James Creek confluence and monitors in James Creek, it appears as though James Creek has a slight cooling effect on the North Fork. Recorded MWATs in the North Fork around James Creek were 65-66° F.
3. James Creek appears to be fully suitable at the headwaters and progressively becomes warmer until the confluence with the North Fork. The one year of monitoring near the confluence of the North Fork indicated an MWAT of 63°F.
4. Based on temperature monitors in the North Fork on either side of the Chamberlain Creek confluence and monitors in Chamberlain Creek, it appears as though James

Creek has a cooling effect on the North Fork. Recorded MWATs in the North Fork around Chamberlain Creek were 64-65°F.

5. Chamberlain Creek appears to be fully suitable at the headwaters and progressively becomes warmer until the confluence with the North Fork. Monitoring near the confluence of the North Fork indicated MWATs of 62-63°F.
6. Other monitoring was conducted on several tributaries to Chamberlain Creek, including West Chamberlain Creek, Arvola Gulch, and Water Gulch. Each of these tributaries were fully to moderately suitable in the years monitored with MWATs of 57-61°F. The thermograph from the Water Gulch site suggests that that the monitoring location may have a significant groundwater component and/or possibly a thermally stratified pool, especially in August and September. To the extent that Water Gulch and West Chamberlain Creek contribute flow to Chamberlain Creek, it is likely that they contribute some amount of cooling to Chamberlain Creek.
7. The final site in lower Chamberlain Creek (JSF 539) appears to have substantially higher water temperatures than JSF 538. Based on a 1994 Landsat vegetation map (KRIS Big River), it may be that the elevated temperatures seen at this site are due to a large clearing in this portion of Chamberlain Creek.
8. Water temperatures downstream of Chamberlain Creek and upstream of the East Branch North Fork appear to remain relatively constant, if the data from JSF 532 can be extrapolated. In any case, the MWAT at this site, it does not appear to be substantially different from JSF 531 (the site upstream of it). The MWAT in this area, with three years of monitoring, is approximately 64°F.
9. The East Branch of the North Fork has some indication of headwaters with an MWAT of approximately 60° F, but with increasing water temperatures between the headwater monitoring site (FSP 5234) and the next site (FSP 5213), which had recorded MWATs of approximately 62-63° F in the two years of monitoring. Water temperatures appear to remain relatively constant to the mouth of the East Branch North Fork, with MWATs between 61-65° F.
10. Frykman and Steam Donkey Gulch, two small tributaries of the East Branch North Fork were monitored. However, while the water temperatures in both tributaries were fully suitable in the years monitored, it appears as though these temperature probes were placed in a deep stratified pool or are dominated by groundwater influences. In any case, it is unlikely that they contribute significantly to the mainstem of the East Branch North Fork.
11. Water temperatures in the North Fork below the confluence with the East Branch North Fork appears to increase significantly from what was recorded in JSF 532 (upstream of the East Branch North Fork). The maximum MWAT increases between JSF 532 and MRC 75-4 approximately 65 to 67°F. While it does not appear the confluence of the East Branch North Fork would significantly affect water temperatures, it may be due to local conditions upstream of MRC 75-4 such as poor canopy, or just could be an artifact of the fact that MRC 75-4 was only monitored during one year, which did not coincide with the years monitored at JSF 532.

FIGURE 16: RANGE OF MWATS, NORTH FORK BIG RIVER SUBBASIN



South Fork Big River

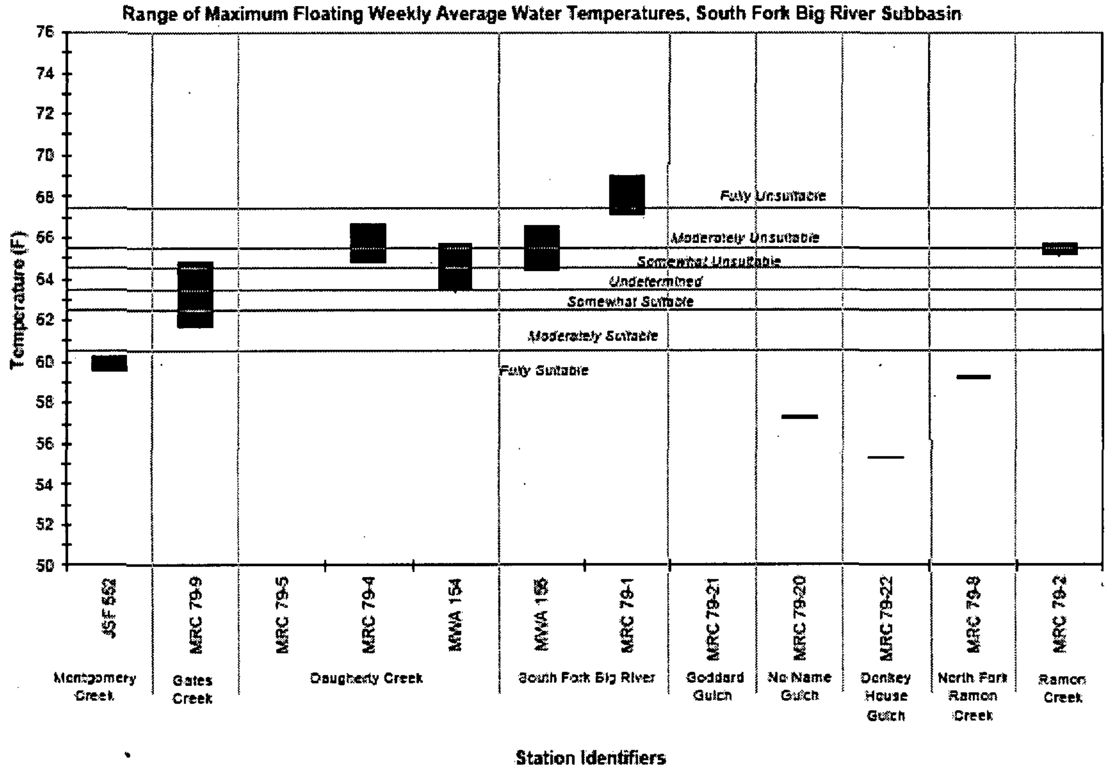
Water Temperature

1. Although upper Daugherty Creek (MRC 79-5) has only one year of data, it appears as though upper and lower Daugherty Creek (MRC 79-4) were similar in temperature with MWATs between 65-67° F. The other downstream site (MWA 154) appears to be generally lower than MRC 79-4, but that is to be expected as MWA places its monitoring devices in areas of thermal refugia.
2. During two years of monitoring on Gates Creek, a tributary to Daugherty Creek, MWATs of between 62-65° F were recorded. Based on this, it would appear that Gates Creek provides some cooling effect to Daugherty Creek.
3. Montgomery Creek (JSF 552) was within the fully suitable range at approximately 60°F during all three years monitored. The maximum diurnal fluctuations varied between 4-5° F. This site is in an undisturbed location in the Montgomery Woods Reserve and is probably a good example of what can be achieved with adequate canopy in the warmer interior portion of the Big River watershed. It should be noted

that much of the interior watershed is naturally grasslands, and could not reasonably be expected to achieve these water temperatures.

4. As would be expected, the mainstem of the South Fork Big River appears to get progressively warmer as it moves towards the bottom of the watershed. However, by the time it reaches the bottom of the watershed (MRC 79-1), MWATs are generally in the fully unsuitable range as high as 69° F with maximum daily temperatures as high as 74°F.
5. During the one year of monitoring water temperatures in the North Fork Ramon Creek (MRC 79-8), it appeared that it was much cooler than Ramon Creek itself (MRC 79-2), which was monitored for three years. The North Fork Ramon Creek site had a fully suitable MWAT of 59° F, whereas Ramon Creek downstream of the North Fork confluence had MWATs from 65-66°F. However, it is not clear if Ramon Creek is much warmer from the headwaters and the North Fork provides only minimal cooling, or if the combined flow of the North Fork and Ramon Creek become warmer in the segment of stream below the confluence.
6. Donkey House Gulch (MRC 79-22) is a tributary to Ramon Creek, but in the one year of monitoring, it exhibited fully suitable water temperatures with an MWAT of 55°F. Nevertheless, diurnal fluctuations in this stream appeared to indicate that the monitoring site is either in a thermally stratified pool or is dominated by groundwater. Therefore, it is expected that this would be associated with low flows and probably have little cooling effect on Ramon Creek.
7. Goddard Gulch (MRC 79-21) and No Name Gulch (MRC 79-20), both tributaries to the mainstem South Fork Big River, were each monitored for one year and had fully suitable MWATs of 57°F. In Lower No Name Gulch, it appears though the stream was flowing until early August, at which time it may have become isolated and dominated by groundwater. This is evident by diurnal temperature fluctuations that gradually become essentially flat. Diurnal fluctuations in Goddard Gulch appeared to indicate that this monitoring site is either in a thermally stratified pool or is dominated by groundwater. Therefore, it is expected Goddard Gulch, and to a lesser degree Lower No Name Gulch would be have low flows making it unlikely that either site would have a significant cooling effect on the mainstem South Fork Big River.
8. Relatively large diurnal fluctuations in virtually all of the monitored sites indicate that throughout the South Fork subbasin there is poor canopy and/or low flows. The only exceptions to this are the monitoring sites at Montgomery Woods Reserve (JSF 552), and the sites located in gulches that are apparently dominated by groundwater. These sites were Goddard Gulch, Donkey House Gulch, and No Name Gulch.

FIGURE 20: RANGE OF MWATS, SOUTH FORK BIG RIVER SUBBASIN



Overall Summary

Water Temperature

With the exception of the Big River Estuary, continuous water temperature data loggers were available in every subbasin. Water temperatures in the mainstem Big River were high in virtually every location tested, and the daily maximum temperatures sometimes exceeded the lethal threshold for salmonids.

Tributaries in the Lower Big River subbasin had fully suitable to moderately suitable water temperatures. It is likely that this is due, in large part, to the cooling marine influence in this subbasin. Although not supported by any data, it is probable that higher precipitation in this subbasin also assists in the rapid re-growth of the forest and understory vegetation that offers stream shading. Overall, the water temperature in the Lower Big River tributaries appears to be in the best condition of any subbasin in the Big River watershed. Also, it is likely that the Little North Fork has some cooling effect as it enters the mainstem Big River.

Tributaries in the Middle Big River subbasin had fully suitable to undetermined water temperatures. While the data in this subbasin is relatively spare, it is likely that the marine influence in this subbasin and rapid re-growth of vegetation also helps keeps water temperatures relatively low. The tributaries that were monitored in this subbasin appear to be in good condition with respect to water temperature for salmonids. Also, it is likely that the Two Log Creek has some cooling effect as it enters the mainstem Big River.

Tributaries in the Upper Big River subbasin had fully suitable to somewhat unsuitable water temperatures. However, except for the site on Russell Brook and two other sites that appear to be dominated by groundwater, the tributaries that were monitored in this subbasin appear to be in poor condition with respect to water temperature for salmonids. It also appears as that the upper mainstem Big River is one of the origins of the warm water seen downstream. Water leaves this subbasin with an MWAT of roughly 66-68° F.

Tributaries in the North Fork subbasin, including the North Fork itself, had fully suitable to moderately unsuitable water temperatures. Generally, the tributaries that were monitored in this subbasin appear to be in good condition with respect to water temperature for salmonids. The notable exceptions to this are Lower Chamberlain Creek, most of the East Branch of the North Fork, and the mainstem of the North Fork. The mainstem North Fork is unusual in that it exhibits a rapid increase in water temperature upstream of the JSF boundary, and then slowly declines until it leaves JSF, and again shows a rapid increase near the confluence with the mainstem Big River. The obvious hypothesis is that it may be due to naturally poor canopy or to commercial timber harvesting on either end of the North Fork. In any case, this should be investigated further. It also appears as that the North Fork is one of the origins of the warm water seen downstream in the mainstem Big River. Water leaves this subbasin with an MWAT of roughly 67° F.

Tributaries in the South Fork subbasin, including the South Fork Big River, had fully suitable to fully unsuitable water temperatures. Except for the tributaries that appear to be dominated by groundwater and the one site in the Montgomery Reserve, the sites in this subbasin were poor with respect to water temperature. In fact, the lower mainstem South Fork had the highest daily water temperature (74° F) of any stream other than the mainstem Big River. Conversely, the site in the Montgomery Reserve is a good example of what can be achieved with adequate canopy in the warmer interior portion of the Big River watershed. Water leaves the South Fork subbasin with an MWAT of roughly 67-69°F.

6. BIOLOGICAL RESOURCES

6.1 Aquatic Resources

The Aquatic Resources section addresses aquatic species such as coho and Chinook salmon, and steelhead, as well as their instream and riparian habitat. Section VII.6.6 Wildlife and Wildlife Habitat addresses amphibians and reptiles. Anadromous salmonids such as coho, steelhead, and Chinook have complex lifecycles that involve significant time spent in streams that, in many cases, have been slightly to significantly altered as a result of human actions such as land management and water withdrawals. These alterations have contributed to federal or state endangered species act listings of salmonids and concerns about amphibian species.

Historic land management practices, such as dam construction, logging activities in or next to streams, agricultural development, urban and rural development, building roads and railroads in or along watercourses, blocking fish passage, ignoring erosion potential of upslope management activities, forestland conversion, inappropriate habitat rehabilitation efforts, and a host of other practices have led to a legacy of significant aquatic habitat impairments that persist today and may be in various stages of recovery. Proposed land management activities, such as those proposed in the DFMP, need to be considered in the context of existing impacts, recovery processes, and potential new impacts.

6.1.1 Regional and Local Setting

The north coast region of California can be described as being generally forested, with relatively short-run watersheds draining directly into the Pacific Ocean. The streams that form these watersheds have been subjected to a long history of land management. Timber management has been the predominant land use in the region, but conversion to cattle range and other agricultural uses has also been extensive in some areas. Extensive logging has been conducted in most areas of the region, and this logging was conducted essentially in the absence of environmental regulation for the first 100 years or so. It was not until 1973 that significant regulation was enacted to protect against erosion and other management-related impacts. A significant level of development has occurred at or near the mouths of the major rivers of the region, including the Smith River, the Klamath River, the Eel River, the Noyo River, Big River, the Gualala River, and the Russian River. This development has had a substantial effect upon the estuary areas of these systems.

The watershed cumulative effects assessment area (see Figure V.3) is similar in many respects to the greater region. Timber management, commercial fishing, rural development, and limited agriculture have been on-going since the mid-1800s. Much like the streams and watersheds throughout the region, the freshwater habitat for salmonids and other aquatic species has been heavily impacted by land management and development practices. In many respects, the condition of stream systems within the region contributes to the pattern and distribution of salmonid species listings intended to provide greater protection and eventual recovery of the populations.

This section examines coho, Chinook and steelhead populations, and aquatic habitat conditions and trends, at three spatial scales: the meta population-based Evolutionarily significant unit (Regional Status), Jackson Demonstration State Forest (JDSF) as defined by planning watershed boundaries (JDSF Proper), and individual watersheds composed largely of private ownership that contribute to aquatic conditions on JDSF (Contributing Watersheds) (Figure V.3).

The current condition of aquatic resources was assessed as part of the watershed analysis conducted for JDSF as part of a draft Habitat Conservation Plan (CDF 1999). In particular, the watershed analysis focused on identification of sensitive biological resources and potential hazards affecting those resources. The two anadromous salmonid species that occur regularly in the JDSF assessment area, coho salmon and steelhead, are sensitive to freshwater aquatic and riparian habitat conditions that are required for reproduction and rearing.

Both coho salmon and steelhead are of particular ecological and economic importance in coastal California, and both have undergone well-documented declines in overall abundance. The coho salmon population within the Central California Coast coho salmon Evolutionarily Significant Unit (ESU), which includes populations within the JDSF assessment area, was listed as a threatened species by the National Marine Fisheries Service (NMFS) in 1996 (NMFS 1996a). On March 30, 2005, the California Fish and Game Commission listed coho salmon as threatened from Punta Gorda in Humboldt County to the Oregon border, and endangered south of Punta Gorda. In 2000, NMFS listed Northern California steelhead as threatened, which also includes populations in the assessment area (65 FR 110).

Overview of Spawning and Rearing Habitat Requirements of Coho Salmon and Steelhead

Spawning of adult salmonids and freshwater rearing of juvenile salmonids are important stages in the freshwater life history of anadromous salmonids; and specific physical habitat conditions are required for each stage. Habitat requirements of coho and steelhead at each of these life history stages are discussed below.

Spawning-Coho salmon and steelhead return to spawn in their natal streams in response to seasonal changes in stream flows or temperatures. Spawning sites (redds) are usually located near the heads of riffles (pool tailouts) where the water changes from smooth to turbulent flow, and where there are well oxygenated and relatively silt-free coarse gravels, and nearby cover for adults (Smith 1941; Briggs 1953; Stuart 1953; Platts et al. 1979; Moyle et al. 1995). Gravel sizes used for construction of redds range from 1.3–10.2 centimeters (0.5-4 in) in diameter for coho (Bjornn and Reiser 1991), and from 0.64–13 centimeters (0.25-5 in) for steelhead (Barnhart 1991). Water temperatures between 3°and 14°C (37°and 56°F) are within the range reported as suitable for spawning coho (Burner 1951; Briggs 1953; Bell 1986), and water temperatures between 10° and 15° (50° and 59°F) are preferred by adult steelhead (Moyle et al. 1995).

Spawning also requires the presence of suitable water depth and velocity conditions, and adequate space and gravel availability for redd construction. Water depths of at least 24 cm (9.4 in) and velocities of 40–91 cm per second (1.3–3 ft/s) are typically preferred by steelhead (Smith 1973, cited in Bjornn and Reiser 1991), while spawning coho salmon reportedly prefer water depths greater than 18 cm (7 in) and velocities of 30–91 cm per second (1-3 ft/s) (Thompson 1972; fide Bjornn and Reiser 1991). Coho salmon redds observed by Burner (1951) averaged 2.8 m^2 (30 ft^2) in area, and Reiser and White (1981) reported an average steelhead redd area of 4.4 m^2 (47 ft^2). Survival from egg to emergence is closely related to the permeability of the spawning gravels and the dissolved oxygen supply available to them (Cloern 1976; Mason 1976a). The proportion of fine sediment in the redd may greatly reduce the amount of dissolved oxygen reaching the eggs (Wickett 1954; Coble 1961; McNeil 1962, 1966; Ringler and Hall 1975; Woods 1980).

The quantity, quality, and spatial distribution of spawning gravels, as well as water depth and velocity in spawning areas, can suffer substantial negative impacts from improperly-conducted or unmitigated land use activities, resulting in decreased survival. Sedimentation resulting from either natural or anthropogenic disturbances is typically considered to be the principal cause of salmonid egg and alevin mortality (Shapovalov and Taft 1954; Chapman 1988). Removal of large wood from stream channels also reduces pool quantity and quality (Bryant 1980; Everest and Meehan 1981; Bisson and Sedell 1984; Bisson et al. 1987) and affects the storage and distribution of spawning gravel (Everest and Meehan 1981).

Rearing-After emerging from the gravel, juvenile coho and steelhead spend at least one summer rearing in fresh water before migrating to the ocean. Food and cover are two of the most important factors influencing juvenile rearing success (Chapman and Bjornn 1969). Production of aquatic macroinvertebrates used as the primary food resource of salmonids during their freshwater residence depends on the availability of relatively silt-free, heterogeneous substrate; cold, well-oxygenated water; and a supply of organic matter and nutrients to the stream (Minshall 1984; Bjornn and Reiser 1991). Relatively cold water temperatures are also required for growth and survival of juvenile coho and steelhead. In late summer or fall, when stream temperatures are generally the highest and flows the lowest, area for rearing is reduced and vulnerability to predation and thermal stress is increased. Burns (1971) found that the highest mortality of juvenile coho during summer occurred in the periods of lowest flow.

Juvenile coho appear to prefer temperatures of 10° to 15°C (50° to 59°F) (Hassler 1987), and Brett (1952) found that exposure to temperatures in excess of 25°C (77°F) resulted in high mortality rates. Preferred rearing temperatures reported for steelhead range from 7° to 15°C (44.5° to 59°F), with optimum water temperatures for juveniles occurring around 10°C (50°F), and lethal temperatures occurring at approximately 23.6°C (75°F) (Barnhart 1991).

Timber harvesting activities in the riparian zone have the potential to reduce stream shading, which may result in increased water temperature and pose a significant threat to the survival of juvenile salmonids. The potential for increases in water temperatureare generally greatest during summer low flow periods because of increased solar radiation, reduced inflow from cold groundwater sources, and the more limited availability of thermal refugia (e.g., reduced pool depth) compared with periods of higher stream flow (Beschta et al. 1995; Spence et al. 1996).

During the juvenile rearing period, steelhead appear to use habitats with higher water velocity and shallower depth than do coho salmon (Sullivan 1986; Bisson et al. 1988; Fausch 1993). In comparison to juvenile coho, steelhead have a body shape that is better adapted to holding and feeding in swifter currents (Bisson et al. 1988). Where the two species coexist, as they do in most JDSF streams, their preferred rearing habitats are generally spatially segregated, especially during the summer months. Although juvenile coho salmon are strongly associated with low velocity habitats such as pools throughout the rearing period (Shirvell 1990), steelhead will use riffles (age 0+ fish) and higher velocity pool habitats (age 1+ fish) in the summer (Bisson et al. 1982; Sullivan 1986). Other stream habitats such as riffles and glides may be occupied during the summer, but the density of juvenile coho found in these habitats is usually much lower than in pool or off-channel habitats (Edie 1975; Everest et al. 1986).

After emergence, steelhead fry move to shallow, low-velocity habitats such as stream margins and low-gradient riffles and will forage in open areas lacking instream cover (Hartman 1965; Everest et al. 1986; Fontaine 1988). As fry increase in size in late summer and fall and their swimming abilities improve, they increasingly use areas with cover and show a preference for higher-velocity, deeper mid-channel areas near the line down the center of the main stream channel (thalweg) (Hartman 1965; Everest and Chapman 1972; Fontaine 1988). In general, age 0+ steelhead are found in a wide range of hydraulic conditions, although their spatial distribution may be affected by the presence of juvenile coho salmon, which tend to displace juvenile steelhead from pools. Age 0+ steelhead have been found to be relatively abundant in backwater pools and in the downstream ends of pools (Bisson et al. 1988; Fontaine 1988). Older age classes of juvenile steelhead are found in a variety of habitats, but tend to prefer deeper water during the summer and have been observed to use deep pools near the thalweg that have ample cover as well as higher velocity rapid and cascade habitats (Bisson et al. 1982; Bisson et al. 1988). Interstitial spaces within the substrate are often used as cover by juvenile steelhead, especially during high flows or periods of low temperature (Fontaine 1988; Bisson et al. 1988). During the summer, steelhead parr appear to prefer habitats with rocky substrates, overhead cover, and low light intensities (Hartman 1965; Facchin and Slaney 1977; Ward and Slaney 1979; Fausch 1993).

During the winter, spatial segregation of stream habitat by juvenile coho salmon and steelhead is less pronounced than in summer because of reduced territorial aggression and reduced feeding activity. Both species tend to prefer pool habitats in the winter, especially deeper pools with cover (Swales et al. 1986; Hartman 1965). While juvenile coho salmon tend to be found in pools associated with large wood (Bustard and Narver 1975; Bugert 1985), steelhead are often found in closer proximity to rocky substrates (Hartman 1965; Facchin and Slaney 1977; Ward and Slaney 1979), especially during periods of low water temperatures and high flows.

During winter high flow events, floodplains, alcoves, side channels, large wood accumulations, deep pools (>3.3 ft or 1 m), and substrate interstices are important in providing velocity refugia for rearing salmonids (Chapman and Bjornn 1969; Bjornn and Reiser 1991). Coho salmon in particular have been observed to seek areas with low velocity and cover during the winter, including deep pools, side channels, debris jams, undercuts, and side-channel pools (Peterson 1982a, 1982b; Tschaplinski and Hartman 1983). Streams in JDSF are primarily confined and therefore generally lack off-channel habitats such as side channels and floodplains that would otherwise provide high-quality overwintering habitat for juvenile coho salmon. In confined channels such as these, deep pools with large wood are preferred as winter habitat, and may be critical for preventing downstream displacement and mortality during high flow events. Because juvenile coho salmon show narrower preferences for pool habitat types in the winter than in the summer, and because of the lack of off-channel habitat in these confined channels, habitat limitations in the assessment area are likely to occur in the winter.

Lack of suitable winter habitat may result in poor survival, and several studies indicate that availability of winter habitat may be the major factor limiting coho salmon production in many areas (Chapman 1966; Mason 1976a; Chapman and Knudsen 1980; McMahon 1983; Nickelson et al. 1992). Tschaplinski and Hartman (1983) documented substantial decreases in juvenile coho salmon numbers in fall and winter, particularly in response to seasonal freshets. They found that habitats such as deep pools, logjams, and undercut banks with woody debris lost fewer fish during high flow events and maintained higher juvenile populations over the winter.

6.1.2 Aquatic Habitat Conditions: Overview

Riparian Function

Riparian lands include instream habitat and stream channels, adjacent floodplains, and wetlands. These lands form a critical link between stream channels and the hillslope processes that deliver material to the channels (Murphy and Meehan 1991). Raedeke (1988) describes riparian systems as having long, linear shapes with high edge-to-area ratios and microclimates distinct from those of adjacent upland areas. Water is present at or near the soil surface during all or part of the year, resulting in variable soil moisture conditions and distinct plant communities. Periodic flooding causes habitat disturbances that produce greater natural plant diversity than is present in the surrounding upland areas. The area adjacent to streams also contributes substantially to the quality of aquatic habitat, as discussed below.

Riparian vegetation provides shade, contributes organic matter and nutrients to streams, helps stabilize stream banks, and provides habitat for a variety of plants and animals (Gregory et al. 1991). Riparian floodplain vegetation buffers the effects of flooding on downstream areas by decreasing stream velocity over floodplain areas and increasing storage time for flood waters, which may also result in sediment deposition on the floodplain (Bisson et al. 1987; Spence et al. 1996). Subsequent growth of riparian vegetation can help stabilize these floodplain deposits, while the deposited sediments can provide valuable nutrients for the vegetation. Lateral channel migration frequently undermines riparian vegetation, resulting in the introduction (recruitment) of large wood (and sediment) to the stream channel. Large wood may also be recruited into the channel directly by treefall from adjacent riparian zones or from hillslopes by means of episodic mass soil movement or windthrow (Bisson et al. 1987; Spence et al. 1996).

Riparian vegetation can also be important in regulating stream water temperature. The temperature of water entering headwater streams in forested ecosystems is typically close to that of the subsoil environment. As this water flows through the stream system, water temperature becomes increasingly influenced by solar radiation and ambient air temperature (Burns 1972; Beschta et al. 1987). Warm water temperatures that occur during the summer low-flow period because of increased solar radiation are of particular concern. Above specific thresholds, higher stream temperatures may limit the survival and growth of salmonids (Bjornn and Reiser 1991), some amphibians (Claussen 1973; Nussbaum et al. 1983; Leonard et al. 1993; Hayes 1996), and other aquatic species. The amount of streamside canopy provided by riparian vegetation is a major factor affecting the amount of solar radiation reaching the stream surface. The degree of stream shading provided by riparian vegetation affects daily water temperature, as well as the magnitude of daily or seasonal fluctuation in water temperature.

Headwater Stream Ecosystems-Headwater streams and drainages (Forest Practice Rule Class II and III) are areas that contribute to stream ecosystem function. These areas can represent 60-80% of total channel length in mountainous terrain (May and Gresswell, 2003a). These small streams contribute structural components such as large woody debris, spawning gravels and stream substrate, and invertebrate and detritus inputs. These sites also contribute to water quality and provide for storage of potentially deleterious fine sediment. Similarly, they can have a strong influence on the rates of sediment and wood delivery to larger watercourses, and consequently, habitat value for a variety of aquatic and semi-aquatic vertebrates and other biota (Welsh et al. 1998). Efforts aimed at restoring structural and biotic elements of stream ecosystems must first increase normative conditions in the river system before sustainable species recovery is possible (Williams et al 1999). Management approaches aimed at restoration and management of watershed processes, rather than individual habitat characteristics, may be more effective in developing complex stream channel structure (May and Gresswell 2003b). The underlying assumption is that movement toward restoration of natural processes and levels of sediment production, large woody debris recruitment, and other stream function processes, will be positive for stream biota.

<u>Disturbance as an Influence on Headwater Stream Ecosystem Structure and Function</u>
Disturbance as an influence on the structure and function of stream ecosystems has been extensively studied and reinforces the concept of the "river continuum" (Vannote et al. 1980). That being that energy and organic material inputs to stream processes change in a predictable way along the stream course from headwaters to downstream reaches. A variety of land uses, including timber harvest and forest management, can influence background erosion and sedimentation regimes, recruitment of large woody debris and other ecological processes. The delivery, time in residence, and transport of these additional sediments and woody debris influence stream channel conditions and associated biota. Change in vegetation in the vicinity of headwater streams can markedly

alter the function of these stream types and those larger stream systems supported. Change in the efficiency of the channel to recharge groundwater, meter trapped sediments and water flow, and process organic material and other nutrients for use by aquatic biota downstream can be expected. Past management practices that reduce local sources of wood and rate of wood recruitment increase the relative importance of wood contributed by debris flows in colluvial tributaries where this means of recruitment occurs.

Most debris flows in the northern California Coast Ranges originate from zero-order colluvial-filled hollows. Increases in pore water pressures in convergent bedrock topography where soil and colluvium is relatively thick can exceed resisting forces to failure, resulting in debris flow initiation. These features can mobilize down steep channels and pick up additional debris as they travel, forming the characteristic U-shaped, relatively straight channel. The principle influence of vegetation along Class III channels on the mobilization of debris is the presence of in-channel large trees that could slow or stop mobilized sediment and debris under some circumstances or contribute large wood at other times. Because debris flow potential is not universal, WLPZ boundaries cannot be used as a surrogate to actual site inspection for potential zones of failure (T. Spittler pers. comm. 10/28/04).

The type of disturbance also can have markedly different results on the structure and function of stream and associated riparian ecosystem processes. For example, floods, fire, mass wasting events are generally less frequent and result in large localized changes to stream system, whereas, timber harvest, land conversion, agricultural and urban development are more frequent and regional in effects. Regionally, the “natural” (fire, flood) and man induced (timber harvest, land conversion) disturbance regime within the redwood zone likely exceeds that under which the plant community and associated biota evolved (Reeves et al. 1995; Sawyer et al., 2000). Stream communities, as shaped by past and present disturbance events have led to widespread and long-lasting alteration of stream conditions. Principle among these is alteration of the amount, size, and recruitment of large woody debris and coincident metering of sediments through the stream system. Large woody debris increases the sediment storage capacity of headwater streams. With sufficient wood inputs, low-order channels have the potential of storing large volumes of sediment and are one of the dominant sediment storage reservoirs.

<u>Headwater Habitat Relationships</u> Because of the small size of headwaters and close connection with uplands, these areas are readily influenced by adjacent land uses. Species that inhabit headwater environments can be especially vulnerable to habitat alteration. These species, amphibians and other taxa, generally achieve higher population densities in headwater habitats. In addition, individual species inhabiting headwater habitats generally exhibit low levels of vagility (mobility) sometimes spending their entire life cycle in a few square meters of habitat. Recolonization of suitable vacant habitat may require extensive periods of time or, lacking movement into vacant habitat, result in local population extirpation.

Headwater stream reaches, lacking fish populations, provide areas with little or no fish predation pressure to the benefit of several aquatic and semi-aquatic amphibians. Amphibians that breed primarily in stream habitats represent a large component of stream biomass and in the Pacific Northwest may exceed fish in both numbers and biomass (Hawkins et al. 1983). Welsh and Ollivier (1998) examined the impact of sediments on aquatic amphibian densities in coast redwood. Three species were sampled in numbers sufficient to be informative: tailed frog (*Ascaphus truei,* larvae), Pacific giant salamander (*Dicamptodon tenebrosus,* paedomorphs and larvae), and southern torrent salamander (*Rhyacotriton variegatus,* adults and larvae). Densities of amphibians were significantly lower in the streams impacted by sediment. While sediment effects were species-specific, reflecting differential use of stream microhabitats, the shared vulnerability of these species to infusions of fine sediments was probably the result of their common reliance on interstitial spaces in the streambed matrix for critical life requisites, such as cover and foraging.

Sources of Large Wood Recruitment and Delivery Mechanisms--Relatively little is known about the contribution of wood delivered by processes occurring in adjacent riparian areas and upstream or upslope areas and differences in recruitment process for channels of different sizes and landscape position (May and Gresswell, 2003; Lassettre and Harris, 2001). May and Gresswell (2003b) examined the relative contribution of processes that recruit and redistribute large wood in headwater streams in the southern Oregon Coast Range. Stream size and topographic setting strongly influenced processes that delivered wood to the channel network. In small colluvial channels draining steep hillslopes, processes associated with slope instability and windthrow were the dominant means of large wood recruitment. Wood delivered from local hillslopes and riparian areas accounted for 63% of the wood pieces and 89% of the wood volume in small colluvial channels. Debris flows were a unique mechanism for creating large accumulations of wood in small streams that lacked the capacity for water influenced large wood movement. May and Gresswell (2003b) note that processes of slope instability, which included landslides on planar hillslopes and in convergent hollows, streamside landslides, and small inner gorges that had evidence of accelerated toe slope creep were important means of wood conveyance to small colluvial channels.

Reid and Hilton (1998) documented wood recruitment source distances for a steep headwater second growth redwood watershed. They reported that about 90% of the instances of large wood input occurred from tree falls within 115 feet (35 m) of the channel in un-reentered second growth redwood/Douglas-fir forests in the North Fork of Caspar Creek, located in western Mendocino County. Slope steepness is high in this second order watershed. They reported that portions of the stream have locally developed inner gorges and slope gradients of 58 to 84 percent. Blow down from wind storms and mass failures were important input mechanisms in this headwater stream in the Caspar Creek watershed.

Numerous studies have shown that large wood is an important component of fish habitat (Swanson et al. 1976; Bisson et al. 1987). Trees entering stream channels are critical for sediment retention (Keller and Swanson 1979; Sedell et al. 1988), gradient modification

(Bilby 1979), structural diversity (Ralph et al. 1994), nutrient production (Cummins 1974), and protective cover from predators.

The potential for trees to enter a stream channel from tree mortality, windthrow, and bank undercutting in the riparian zone is mainly a function of slope distance from the stream channel in relationship to tree height. As a result, the zone of influence for large wood recruitment is determined by specific stand characteristics rather than an absolute distance from the stream channel or floodplain. Slope and prevailing wind direction are other factors that can affect the amount of large wood recruited to a stream (Spence et al. 1996).

The Forest Ecosystem Management Assessment Team (FEMAT 1993) concluded that the probability of wood entering the active stream channel from greater than one tree height is generally low. Two widely used models of large wood recruitment also assume that large wood from areas outside one tree height seldom reaches the stream channel (Van Sickle and Gregory 1990; Robison and Beschta 1990). Cederholm (1994) reviewed the literature regarding recommendations of buffer widths for maintaining recruitment of large wood to streams and found that most authors recommended buffers of 100 to 200 feet to maintain this function. A number of studies suggest buffers approaching one site-potential tree height are sufficient to maintain 100 percent natural levels of recruitment of instream large wood (Spence et al. 1996).

The potential size distribution of large wood is also an important factor when considering the appropriate activities in buffer strips relative to large wood potential recruitment. Larger pieces of wood form key structural elements in streams, which serve to retain smaller debris that would otherwise be transported downstream during high flows (Murphy 1995). The size of these key pieces is approximately 12 inches or more in diameter and 16 feet in length for streams less than 16 feet wide and 24 inches or more in diameter and 39 feet in length for streams greater than 66 feet wide (Bisson et al. 1987). As a result, riparian management zones must ensure not only an appropriate amount or volume of wood, but wood of sufficient size to serve as "key pieces" (Spence et al. 1996).

In addition to the amount and size of large wood input, the species of large wood contributed is also important. Coniferous large wood significantly outlasts deciduous large wood in the stream system (Harmon et al. 1986; Grette 1985). Simply setting aside buffers of second-growth hardwoods does not provide optimal large wood input over the short term, because unassisted recovery of these areas to pre-logging coniferous large wood recruitment levels may take 100 to 200 years.

Although the specific role of lower-order streams in large wood input to downstream areas is not completely understood, these streams are known to supply some large wood to higher-order streams (Potts and Anderson 1990). Large wood input in these streams also plays a role in stabilizing existing debris and sediment to prevent debris flows that affect downstream aquatic habitat.

The relative level of potential large wood recruitment can be estimated based on buffer width and prescriptions for leave trees within the buffer. Buffer width determines the area from which potential source trees can contribute large wood, and prescriptions determine how much of this potential material remains after timber harvesting (Murphy 1995). Full recruitment of large wood by toppling, windthrow, or stream undercutting will generally occur if no-harvest riparian buffers equivalent to one site-potential tree height are retained (FEMAT 1993). However, McDade et al. (1990) estimated that for mature conifer forests in Oregon, 50 percent of debris originates within 33 feet of the stream, 85 percent within 75 feet, and 100 percent within 154 feet. They also showed that 90 percent of large wood in mature forests originated within 89 feet of the stream channel. These values are substantially less than one site-potential tree height and indicate that most large wood is recruited within a short distance of the stream channel.

Additional studies support the contention that most large wood is recruited from within 20 m (66 ft) to 40m (130 ft) of the channel bank. For example, Benda et al. (2002) reported that in the absence of landsliding, wood recruitment in both old-growth and second-growth Humboldt County study sites originated from within 20 to 40 m of the stream. The four main input mechanisms for their second-growth forest sites in the Van Duzen River watershed included bank erosion, mortality, landsliding, and anthropogenic (or logging related), and averaged 18%, 21%, 13%, and 50%, respectively. On average in second-growth forests, recruitment of wood from mortality was approximately equal to the recruitment attributable to bank erosion or landsliding, but wood storage was dominated by logging related debris. Conifer trees accounted for approximately 50% of recruited wood by volume. The field sites that had significant recruitment from bank erosion had approximately 90% of wood originating from within 10 m (~33 ft) of the bank. The theoretical prediction curve from mortality alone predicts 90% of wood originating from about 15 m (~50 ft). For those sites that had significant recruitment from streamside landsliding, source distances were greater than that predicted by the theoretical prediction curve from mortality. Landsliding caused recruitment distances to extend to over 60 m (~200 ft). Landslide recruitment tends to be highest in small channels. Mortality was found to be much more important in second-growth forests compared to old-growth forests.

On JDSF, windthrow and toppling at the streambank are likely the principal means for recruitment of large woody debris with only a minor amount contributed by debris moving down small ephemeral streams (Class III's). Debris slides on JDSF that generate enough speed and force to move LWD downslope generally originate along the edges of old road and landing fills. J. Bawcomb, certified engineering geologist (pers. comm. 11/1/04) notes only a single recent large debris slide from a Class III to II on the North Fk.South Fk Noyo River. This slide occurred in 1974 about 50 years after clearcut logging, with no apparent perched fill present, and again in 1998, at which time the slide delivered LWD into the lower reaches of the Class II. The Class I portion of the streamcourse was not reached with the exception of fine grained sediments. Volume of LWD recruitment is largest along Class I channels as a result of windthrow.

Detritus Production (Leaf and Litterfall)--Forest practices can lead to changes in leaf litter distribution and dynamics in upland and riparian areas, which in turn affect availability in streams. Harvest intensity (i.e., the proportion of forest canopy removed) and cutting frequency affect the rate of nutrient removal from the system (Beschta et al. 1995).

Detritus enters a stream primarily by direct leaf or debris fall, although organic material may also enter the stream channel by overland flow of water, mass soil movements, or shifting of stream channels. Few studies have been done relating litter contributions to streams as a function of distance from the stream channel; however, it is assumed that most fine organic litter originates within 98.4 feet or approximately 0.5 tree height from the channel (FEMAT 1993). In most cases, however, buffers designed to protect most large wood recruitment would likely ensure nearly 100 percent of detrital input (Spence et al. 1996). Spence et al. (1996) concluded that a buffer width of 0.75 of a site-potential tree height is needed to provide full protection for litter inputs.

Stand age significantly influences detrital input to a stream system. Detrital input from outside the stream channel was estimated to be two times as high in old-growth forests as in either 30- or 60-year-old forests (Richardson 1992) and could be as much as five times as high in old-growth forests as in recently clearcut forests (Bilby and Bisson 1992). However, reduced levels of detrital input into streams attributable to streamside timber harvesting is somewhat offset by concomitant increases in detritus production within stream channels (primarily dead algae and other aquatic plant debris). Reduced riparian forest canopy increases light levels and, therefore, the production of algae. The abundance and composition of detritivore (macroinvertebrates that process detritus) assemblages in streams are determined largely by the plant composition of riparian zones (Gregory et al. 1991). Therefore, changing the stand composition may alter the macroinvertebrate composition.

In the North Fork of Caspar Creek, most macroinvertebrate and algal variables increased significantly after logging. Macroinvertebrates increased because of increased stream algae. Algae increased because of increased light, water temperature, and nutrients. Logging impacts on the North Fork of Caspar Creek biota were often not dramatic because forest practices minimized the impacts. The three most important practices that ameliorated the impacts were the presence of the riparian buffer zones, the absence of roads near the stream, and the use of cable yarding which minimized soil disturbance (Bottroff and Knight 1996).

An important long-term effect of clearcut logging is potential overshading from second-growth canopy. Second-growth vegetation produces a denser shade and lacks the canopy gaps that are common in old-growth forest. Thus, increased stream production in the first 20 years after timber harvesting may be followed by a much longer period of depressed production (Murphy 1995).

Streambank Stability--Streambank erosion is a natural process that occurs sporadically in forested and nonforested watersheds (Richards 1982). Under natural conditions, this process is part of the normal equilibrium of streams. The forces of erosion (water), resistance (root strength and bank material), and sediment transport maintain an important balance. Human activity can accelerate streambank erosion. Important alterations of the system components that may result from timber harvesting activities include: (1) removing trees from or near the streambank; (2) changing the hydrology of the watershed; and (3) increasing the sediment load, which fills pools and contributes to lateral scour by forcing erosive stream flow against the streambank (Pfankuch 1975; Cederholm et al. 1978; Chamberlin et al. 1991).

The roots of riparian vegetation help bind soil together, which makes streambanks less susceptible to erosion. Riparian vegetation can also provide hydraulic roughness elements that dissipate stream energy during high or overbank flows, which further reduces bank erosion. In most cases, vegetation immediately adjacent to the stream channel is most important in maintaining bank integrity (FEMAT 1993); however, in wide valleys with shifting unconfined stream channels, vegetation throughout the floodplain may be important over longer periods.

Riparian vegetation also can provide hydraulic elements that dissipate stream energy during high or overbank flows, which further reduces bank erosion. Although there are limited data quantifying the effective zone of influence relative to root strength, FEMAT (1993) concluded that most of the stabilizing influence of riparian root structure is probably provided by trees within 0.5 potential tree height of the stream channel. Overall, buffer widths for protecting other riparian functions (e.g., large wood recruitment and shading) are likely adequate to maintain bank stability if they are performing most of those functions.

Harvesting of trees adjacent to streams can lead to a loss of root strength, thus making streambanks more susceptible to erosion. With respect to the northern California coast, however, it is important to note that redwoods, the dominant conifer along many streams, resprout following harvesting. As a result, decreases in redwood root strength are typically lower than in other forest types.

Relatively little work has been completed on second-growth redwood root decay following harvest. Ziemer and Lewis (1984) completed a brief unpublished retrospective study of root dieback in coast redwood. Root biomass in several different ages of cutblocks and second-growth stands were plotted along with that found in old-growth forests. Live, less-than-25-mm (approx. 1 inch) redwood root biomass reached a minimum 11 years after logging. Thereafter, it gradually increased to pre-logging levels by age 65, except in the layer below a meter in depth. They reported that for redwood, root biomass dropped 42% in 11 years and thereafter began to increase again. Live root biomass declines, but does not drop to zero after logging, as coast redwood roots come into equilibrium with the drastically reduced above ground biomass.

Sediment Control and Transport -Timber harvesting activities often alter watershed conditions by changing the quantity and size distribution of sediment. These alterations can lead to stream channel instability, pool filling by coarse or fine sediment, or introduction of fine sediment to spawning gravels. Stream sedimentation has resulted in significant impacts on aquatic habitat and in turn on fish populations.

The delivery to streams of fine sediment that has been transported overland can be reduced significantly by streamside buffer strips. The ability of riparian buffer strips to control sediment inputs from surface erosion depends on several site characteristics, including the presence of vegetation or organic litter, slope, soil type, and drainage characteristics. These factors influence the ability of buffer strips to trap sediments by determining the infiltration rate of water and the velocity of overland flow. In addition, activities within the riparian zone that disturb or compact soils, destroy organic litter, or remove large down wood can reduce the effectiveness of riparian buffers as sediment filters (Spence et al. 1996). Burning within the riparian zone is one such action that can reduce or diminish buffer effectiveness in the short term until a new duff and vegetation layer redevelops. Although fires are not currently prescribed in riparian buffers, incidental burning could occur within them when adjacent prescribed burns escape into the riparian zone.

The ability of streamside buffer strips to capture fine sediment depends largely on their width and slope. Recommended buffer widths for sediment removal vary widely. Studies of forested watersheds recommend buffers of approximately 100 feet for this purpose (Johnson and Ryba 1992). Considering only fine sediments generated by surface erosion within the riparian zone, buffers of approximately one site-potential tree are recommended by Spence et al. (1996) as being effective in trapping most sediment, provided that slopes are not too steep. Spence et al. (1996) states that on gentle slopes, buffers narrower than one site-potential tree are probably sufficient to remove most sediments. Additionally, other management practices both within and beyond the riparian buffer can prevent or reduce sediment transport to streams.

Sections VII.7, Geology and Soils, and Appendix 11, Overview of Existing Sediment Studies Relevant to the JDSF EIR provide a detailed discussion of sediment processes, sources, and rates. Both natural (e.g., landsliding, soil creep) and anthropogenic sediment sources (e.g., roads, hillslope erosion) are discussed. Roads are recognized as the largest source of anthropogenic sediment in North Coast forests.

Stream Shading -Clearing streamside riparian vegetation during timber harvesting can increase solar exposure to the stream, raising stream temperatures above water quality standards. High stream temperature significantly affects the aquatic environment and associated species, including fish (Beschta et al. 1987). Belt et al. (1992) reviewed numerous studies that indicate removal of forest canopy within a buffer strip can reduce its effectiveness by diminishing shade and thereby increasing stream temperatures.

In areas where partial or complete exposure of the stream causes increased stream temperature, the rate of shade recovery depends on streamside conditions, vegetation, and stream size (Beschta et al. 1987). Small streams may be quickly overtopped by brush and effectively shaded from solar radiation, while larger streams, which require tall conifers for shade, require longer time periods. Reestablishment of canopy cover over streams ranges from 5 to 40 years or more (Gregory and Bisson 1997).

Brazier and Brown (1973) found that angular canopy densities (ACD) comparable to old-growth stands (i.e., 80 to 90 percent ACD) could be attained with buffers of approximately

72 to 100 feet for coniferous forests in the southern Cascades and Oregon Coast Range. Steinblums et al. (1984) determined that an ACD of approximately 100 percent could be achieved by buffer strips greater than 125 feet. Based primarily on the literature above, several authors have concluded that buffers of 100 feet provide adequate shade to stream systems (Murphy 1995; Johnson and Ryba 1992). If the buffer is less than 100 feet, or if the buffer is selectively logged, considerations such as species composition, stand age, and vegetation density become important factors (Beschta et al. 1987). Beschta et al. (1987) concluded that 100 feet of buffer provides 100 percent of ACD in old growth. The generalized curves presented by FEMAT (1993) suggest that cumulative effectiveness for shading approaches 100 percent at a distance of approximately 1.0 tree heights from the stream channel. In a comprehensive review of the FEMAT (1993) standards, CH_2M-Hill and Western Watershed Analysts (1999) reported that nearly 80 percent of the cumulative riparian shade effectiveness is reached within approximately 0.5 site-potential tree heights (Steinblums and others 1984, Broesfske and others 1997—as displayed in CH_2M-Hill and Western Watershed Analysts 1999). The relationships found by Brosofske and others (1997) and Steinblums and others (1984) were recommended over other data in the literature because they are mutually supportive, and probably represent the general relationship for western Oregon more accurately. CH_2M-Hill and Western Watershed Analysts (1999) reported that no studies or data were located that verify the FEMAT report's shading curve. FEMAT only references Steinblums and others (1984) and Beschta and others (1987), who rely on Brazier and Brown (1973). The data and curves from the referenced studies were not found to fit the FEMAT shade relationship.

Shade also is provided by unmerchantable hardwoods and conifers (Murphy 1995). The "Coho Salmon Considerations" (CDF 1997b) recommend increased protection of shade canopy in areas where water temperatures exceed preferred temperatures.

Microclimate -Important components of the microclimate in a forested area include solar radiation, soil temperature, soil moisture, air temperature, wind velocity, and air moisture or humidity (Chen 1991; Chen et al. 1992). Changes in microclimatic conditions within the riparian zone resulting from removal of adjacent vegetation can influence a variety of ecological processes that may affect the long-term integrity of riparian ecosystems (Spence et al. 1996). Harvesting may interrupt natural microclimatic gradients.

Riparian microclimatic conditions are essential for some wildlife species. To avoid significantly altering the microclimate of a riparian zone, Ledwith (1996) recommends leaving buffer strips over 100 feet wide. Buffers wider than 100 feet would still affect the microclimate, but at a lower rate of change (Ledwith 1996). Of all the components that make up the microclimate, humidity has the greatest influence. Studies by Chen (1991) and Chen et al. (1993) suggested that humidity achieved conditions found in interior old-growth at a distance of 575 feet from the edge of a clearcut. FEMAT (1993), based on studies from Chen (1991), suggests that as many as three site-potential trees are needed to provide complete protection of riparian microclimate. However, riparian buffer effects for soil moisture, radiation, and soil temperature reach maximum effectiveness near one site-potential tree height.

James (2003) has collected detailed information on microclimate and water temperature changes associated with different levels of harvest in buffer strips and differing buffer strip widths at the Southern Exposure research site in the northern Sierra Nevada. Microclimate results revealed that edge effects from adjacent upslope clearcut harvest units had no discernible impact within 40 ft. (12.2 m) of the stream bank. Timber operations conducted in the summers of 2000 and 2001 resulted in ± 1.5°C changes in daily maximum water temperature pattern along the experimental reach. The average and maximum daily air temperature patterns within the riparian zone harvest units (stream bank out to 40 ft.) were increased at most up to 0.5°C due to the adjacent upland experimental harvest treatments. Average and maximum daily air temperatures were increased up to 5°C beyond 40 ft. from the stream bank within the harvested blocks. When the buffer was reduced from 150 ft. to 100 ft., the average daily soil temperature increased up to 2°C for the microclimate station located between 80 ft. to 175 ft. from the stream bank. No change in the average daily soil temperature pattern was found in the riparian zone adjacent to the harvest units (stream bank out to 40 ft.) after the two experimental harvest treatments during the three-year study.

Water Temperature (See *Appendix 12, Water Temperature, for a more comprehensive discussion.*)

The North Coast Regional Water Quality Control Board (NCRWQCB) is responsible for implementing and regulating water quality control plans for the North Coast Hydrologic Unit Basin Planning Area. The Basin Plan provides a definitive program of actions designed to preserve and enhance water quality and to protect beneficial uses of water. The US EPA and NCRWQCB have identified 22 North Coast water bodies as having beneficial uses impaired by elevated water temperatures (Table VII.6.1.1). These water bodies, with a total watershed area of 8.7 million acres, are listed as temperature impaired under section 303(d) of the federal Clean Water Act.

Table VII.6.1.1 Temperature Impaired Water Bodies and Watershed Area in the North Coast Hydrologic Unit.

Water Body	Watershed Area (acres)	Water Body	Watershed Area (acres)
Big River	115,840	Shasta River	505,542
Eel River (6 units)	2,356,802	Russian River	949,986
Garcia River	73,223	Klamath River (including)	
Gualala River	191,145	*Salmon River*	480,805
Redwood Creek	180,700	*Scott River*	521,086
Ten Mile River	76,800	*South Fork Trinity River*	596,480
Mattole River	189,440	*Upper & Lower Lost River*	1,917,782
Navarro River	201,600		
Mad River	322,200	TOTAL AREA	8,679,431

The NCRWQCB has listed Big River as impaired for temperature and sediment. The Noyo is listed for sediment, but not temperature, although reaches of the Noyo are subject to relatively high water temperature, especially in the main channel. This designation is assigned to streams where established water quality objectives as specified in the Basin Plan are not being met or where beneficial uses are not sufficiently protected. Total Maximum Daily Loads (TMDLs) must be developed for water quality listed streams, as required in Section 303d of the Clean Water Act (CWA). A TMDL is a planning document designed to identify the causes of impairment and establish a framework for restoring watershed impairments. Sediment TMDLs have been developed for both the Noyo and Big River, but a temperature TMDL has not yet been developed for the Big River watershed (nor has a completion date been specified).

MWAT Threshold and Criteria for Determining Impairment -Water temperature suitability for anadromous salmonids in the North Coast region can be evaluated using the maximum weekly average temperature (MWAT). MWAT is defined as the highest average of mean daily temperatures over any 7-day period. The MWAT threshold is a measure of the upper temperature recommended for a specific life stage of freshwater fish (Armour 1991). For coho salmon and steelhead, the MWAT threshold is calculated for the late-summer rearing life stage, because water temperatures are generally highest during this stage. Coho salmon are considered to be less tolerant of high water temperatures than steelhead (CDF 1999).

A range of MWAT values has been proposed by different agencies and through independent studies to identify appropriate threshold values (Table VII.6.1.2). For the JDSF EIR, an MWAT value of 16.8°C (62.2°F) was chosen as a threshold of significance to evaluate potential impacts to water temperature that are associated with the proposed project. The National Marine Fisheries Services originally established 16.8°C as an MWAT threshold for coho (NMFS and USFWS 1997). This threshold is supported with recent findings by Welsh et al. (2001), where researchers found juvenile coho present in 18 of 21 tributaries of the Mattole River with MWATs up to 16.7°C (62.1°F). They also found coho in all streams where MWATs were less than 14.5°C (58.1°F). Similarly, Hines and Ambrose (2000) collected water temperature and coho salmon data over a five-year period from 1993 to 1997 at 32 sites in coastal streams of western Mendocino County, including four sites in the Noyo and Big River watersheds. Their data showed that the number of days a site exceeded an MWAT of 17.6°C (63.7°F) was one of the most influential variables for predicting coho presence and absence.

Under the current Forest Practice Rules (FPRs) (i.e., Threatened and Impaired Watersheds Rule Package), the riparian system is managed through establishment of the WLPZ. The width requirements of the Class II WLPZ depends upon stream class, sideslope, and yarding method, while it is fixed for Class I watercourses. For Class I (fish-bearing) streams, the WLPZ width is 150 feet on each side of the watercourse. For Class II (non-fish) streams, the WLPZ width ranges from 50 feet where sideslopes are less than 30 percent to 100 feet where sideslopes exceed 50 percent. The need for, and width, of the WLPZ along a Class III (no aquatic life) watercourse is determined by on-site inspection. The Forest Practice Rules allow modification of WLPZ requirements, including width, on a site-specific basis where needed for the protection of beneficial uses. Land managers may specify a wider WLPZ, as needed for protection of identified floodprone areas, distinct microclimates, soil moisture conditions, or plant communities. Protection typically afforded a Class III watercourse includes an equipment exclusion zone of at least 25 feet where sideslope steepness is less than 30% (unless erosion hazard rating is low) and at least 50 feet where sideslope steepness exceeds 30%. These and other measures are intended to prevent degradation of the downstream beneficial uses of water.

Table VII.6.1.2. A range of known MWAT thresholds and standards for salmonids (Source: NCRWQCB 2004).

MWAT Thresholds and Standards		
Temperature (C)	**Descriptions**	**Temperature (F)**
26	Upper end of range of acute thresholds (considered lethal to salmonids)	78.8
25		77.0
24	Lower end of range of acute thresholds (considered lethal to salmonids)	75.2
23		73.4
22		71.6
21		69.8
20		68.0
19	Steelhead growth reduced 20% from maximum (Sullivan and others, 2000).MWAT metric USEPA (1977) growth MWAT for rainbow trout	66.2
18	USEPA (1977) growth MWAT for coho	64.4
17	Steelhead growth reduced 10% from maximum. Coho growth reduced 20% from maximum (Sullivan and others, 2000), MWAT metric	62.6
16.8	NMFS MWAT threshold.	62.2
16.7	Welsh and others (2001) MWAT threshold for coho presence/absence in the Mattole	62.1
16	Oregon Dept. of Environmental Quality Standard for salmonids (equivalent MWAT calculated from 7-day max.)	60.8
15	EPA Region 10 Recommended MWAT. Threshold for Coldwater Salmonid Rearing	59.0
14.8	Coho growth reduced 10% from maximum (Sullivan and others, 2000), MWAT metric	58.6
14.6	Upper end of preferred rearing range of coho	58.3
14.3	Washington Dept. of Ecology standard (equivalent MWAT calculated from annual max.)	57.7
14		57.2
13	Upper end of preferred rearing range for steelhead.	55.4

6.1.3 Aquatic Habitat Conditions within JDSF

The JDSF ownership includes area within the Noyo and Big River watersheds. The South Fork of the Noyo River (SFNR) and North Fork of Big River, including Chamberlain and James Creeks, are the primary watersheds that drain the forest. The SFNR is a major tributary to the Noyo River, which drains to the Pacific Ocean near Fort Bragg. The SFNR catchment area at the confluence with the Noyo River drains a 27.32 mi^2 area, which is approximately 35% of the entire Noyo River watershed (113mi^2). The vast majority of the SFNR watershed is within the state forest. Management activities conducted within the state forest contribute to the overall water quality conditions in the lower Noyo, below its confluence with SFNR. The SFNR basin is characterized by steep mountainous terrain with confined valleys. The headwaters of the SFNR have more moderate terrain.

The Big River watershed is 181 mi^2 in size, flowing into the Pacific Ocean near the town of Mendocino. The elevation ranges from sea level to 1556 ft and consists of moderate to extremely rugged terrain (Matthews, 2001). Chamberlain and James Creek are major tributaries to the North Fork of the Big River. The majority of these tributary watersheds are public lands managed by JDSF. The headwaters of the North Fork of Big River are private forest land and reside upstream from the JDSF boundary. Water from the Upper North Fork Big River flows through JDSF, passes through private forest in the Lower North Fork of the Big River, before joining the mainstem of the Big River.

Lower Caspar, Hare, Jughandle, and Mitchell creeks also receive waer from JDSF. These areas are owned by various private landowners. While relatively little of these creeks or their watersheds lie downstream from JDSF, landowners in these areas are very concerned about the condition of their watersheds.

Within the JDSF watershed cumulative effects assessment area, local information combined with modeling produce an estimate of 206 miles (331 km) of Class I (fish-bearing) stream, 362 miles (583 km) of Class II stream, and 339 miles (546 km) of Class III stream. The estimated extent of Class II and III streams is likely to increase over time, as better local information becomes available. Within JDSF, the estimated stream miles for Class I, II, and III streams are 97 miles (157 km) 186 miles (299 km), and 174 miles (280 km), respectively.

Data describing current aquatic and riparian habitat conditions for streams in JDSF were gathered from several sources. The information presented in this section reflects the analysis and incorporation of data from:

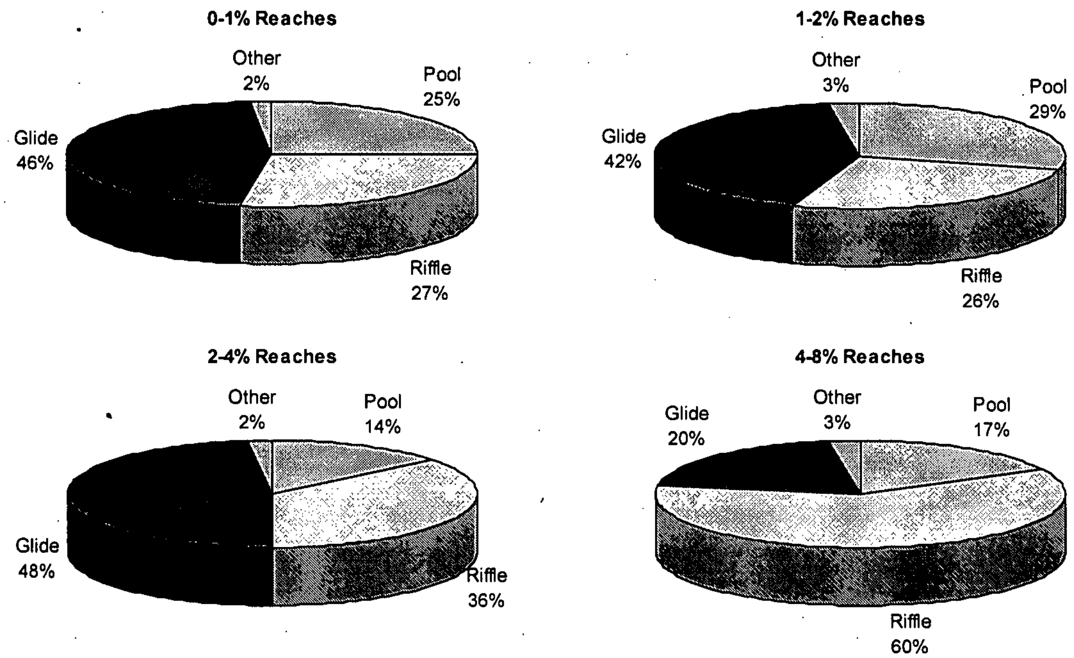
- Stream inventories conducted by the CDFG (1995b, 1996b),1997 stream channel surveys conducted by Stillwater Sciences,
- Data from CDF's biological and hydrological assessments of THPs (Valentine et al. 1995a, 1995b, 1995c), and
- Various other published and unpublished reports of studies conducted in JDSF assessment area streams (e.g., Knopp 1993; Botorff and Knight 1996; Georgia-Pacific 1997).

Current habitat conditions in JDSF streams are summarized in Table VII.6.1.3 and Figure VII.6.1.1. Values reported represent the means of measurements taken in survey reaches located in each of four steam gradient categories established by Montgomery and Buffington (1993).

Table VII.6.1.3 Aquatic Habitat Conditions in JDSF Streams, Measured During Summer 1997 by Stillwater Sciences (Except V* from Knopp 1993).

Channel Gradient	Habitat Parameter (mean values)							
	Pool Spacing[a]	Pool Area (percent)	Average Maximum Pool Depth (m)	V* [b]	Key large wood Spacing[a]	Reach-level d50[c] (mm)	Spawning Gravel d50 (mm)	Alcove/ Backwater Habitat (percent)
0–1 percent	6.1	25.4	0.76	no data	8.9	48	24	1.1
1–2 percent	5.2	29.3	0.84	0.28	7.6	55	27	2.2
2–4 percent	10.5	14.3	0.62	0.39	4.2	49	20	2.0
4–8 percent	9.1	17.2	0.69	no data	4.5	50	19	2.0

[a] Bankfull channel widths between pools or key pieces
[b] From Knopp (1993)
[c] Total (non-structure) bed substrate grain size



Source: Stillwater Sciences, 1997

Figure VII.6.1.1. Habitat Type Frequency, by Gradient Category for JDSF Streams Surveyed.

Channel Confinement and Refuge Habitat

Confinement classifications were made for all Class I stream channels for which aerial photographic coverage was available. Confined channels make up 97 percent (184 mi or 296 km) of the classified Class I stream length in the JDSF Proper assessment area.

Field verification of channel confinement estimates taken from aerial photographs confirmed the similarity between remotely measured values and field delineation in 16 of the 17 survey reaches. In nine of the 15 planning watersheds (PW) in the assessment area examined by Stillwater Sciences (1997), confined channels account for 100 percent of the classified Class I stream length (JDSF Map Atlas). The Two Log Creek Planning Watershed contains the most unconfined stream mileage (2.8 mi or 1.7 km).

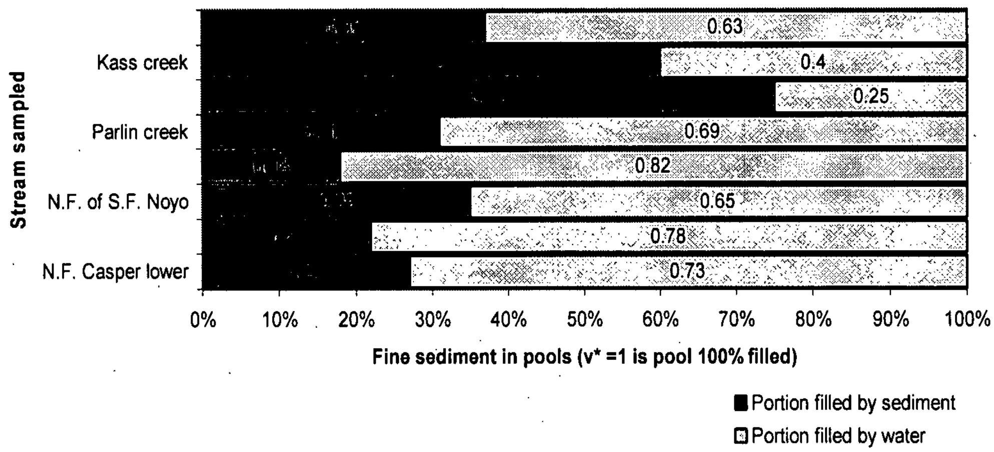
Incised channels, even where the stream is not confined within the valley bottom, have little or no connectivity between channels and floodplains, and typically provide very little off-channel or side-channel habitat capable of providing low-velocity refuge during high flow events. Although valley confinement is not usually subject to the influences of land management and watershed disturbances, the degree of channel incision is highly dependent on changes in sediment supply that potentially result from such activities.

Refuge habitat is the portion of the active channel that potentially provides areas of low water velocity during high flows, thereby serving as valuable overwintering habitat. In streams in the assessment area, refuge habitat consists primarily of alcoves along the channel margin and backwater areas. Reaches in the 0–1 percent gradient range have the lowest overall percentage of this habitat, with just over 1 percent of the total area classified as alcoves or backwaters (Table VII.6.1.3). This type of refuge habitat did not differ appreciably among the remaining three gradient categories. Substantial amounts of off-channel or side-channel habitat were not observed during the 1997 stream survey work (Figure VII.6.1.1).

<u>Pool Habitat and Sediment</u>-Channels with the lowest gradients were found to have the lowest pool spacing and the highest percentage of pool surface area (Figure VII.6.1.1 and Table VII.6.1.3). Pool spacing, reported as the average distance between pools (measured in bankfull channel widths) was lowest in the 1–2 percent gradient reaches (5.2 bankfull channel widths between pools) and highest in 2–4 percent gradient reaches (10.5 bankfull channel widths between pools). Average pool spacing observed in 0–1 percent and 1–2 percent channels falls within the range of properly functioning conditions for pool habitat (NMFS and USFWS 1997) for channels of similar width and gradient. In steeper channels surveyed in JDSF, however, average pool spacing is below the NMFS (NMFS and USFWS 1997) criteria for properly functioning conditions in these channel types.

In addition to having lower pool spacing than any of the other four gradient categories, 1-2 percent gradient reaches also have the highest average percentage of pool surface area—29.3 percent (Table VII.6.1.3). The lowest average percentage of pool area (14.3 percent) occurred in 2–4 percent gradient reaches, which is consistent with the pattern seen for pool spacing. Average JDSF pool surface area in the two lowest gradient channel types (0–1 percent and 1–2 percent) meets the NMFS (NMFS and USFWS 1997) criteria for properly functioning condition, but in the steeper channel types is below the NMFS criterion. The proportion of pool, riffle, and glide habitats was found to be similar in reaches of less than 2 percent gradient (Figure VII.6.1.1). In 2–4 percent gradient reaches, pool area occupied only 14 percent, with both riffle and glide areas increasing relative to the lower gradient reaches.

Knopp (1993) measured the degree to which pools in channels with gradients less than 3 percent (in the 1–2 percent and 2–4 percent Montgomery-Buffington gradient ranges) were filled with fine sediments in several survey reaches within the JDSF assessment area. Values of the V* index, which is an expression of the average ratio of the volume of fine sediment to the residual pool volume (Lisle and Hilton 1991, 1992), averaged 0.28 for 1–2 percent channels, and 0.39 for 2–4 percent channels (Knopp 1993; Table VII.6.1.3). V* values in this range appear to be characteristic of watersheds in northern coastal California with similar management histories (Figure VII.6.1.2) (Knopp 1993).



Note this figure does not report Knopp's data for Brandon Gulch (18%), Hare Creek (37%), Bunker Gulch (41%), Berry Gulch (38%), SF Casper (AW) (55%), SF Caspar (BW) (22%), NF Caspar (AW) (40%).

Figure VII.6.1.2. Sediment in Pools (V*) at Noyo River and Nearby Stream Sites (1992).

Values of V* greater than 0.2 (20 percent pool filling) reflect high sediment supply, whereas V* values less than 0.1 (10 percent pool filling) indicate a relatively low sediment supply (Lisle and Hilton 1992). V* values can be temporarily high in pools downstream of substantial sources of sediment, such as landslides or stream crossing failures. Conversely, low V* values may be the result of recent bed scour and sediment transport, possibly caused by high flow events. Because Knopp's (1993) data were collected in 1992, following 5 to 7 years of winters with few large peak discharge events, the results may represent habitat conditions resulting from below-normal flows. Estimated V* values ranged from 0.01 to 0.1 for pools in reaches in the 0–2 percent gradient range surveyed by Stillwater Sciences in 1997. The large difference between V* values reported by Knopp (1993) and Stillwater Sciences may be due to local variations in sediment supply, differences in sampling techniques, or differences in flow conditions over the several years prior to each of the surveys. Streams on JDSF lands may also be more advanced relative to their recovery and flushing of sediment than pool habitats in other streams that were studied.

It may be hypothesized that fine sediment measurements in 1992 were not representative because they were elevated by drought (Valentine and Jameson 1994). Additional trend monitoring of pool volume and frequency, juvenile salmonid production, and fine sediment extents would help validate assumptions and test hypotheses.

Brown et al. (1994) found that coho favored pools over a meter (39") in depth. In smaller tributaries of the Noyo and Big Rivers, pools greater than three feet in depth are infrequent (CDFG 1995-1999; GP 1994-1996).

A number of streams outside of JDSF within the Noyo Basin have pool frequencies below 20% (Figures VII.6.1.3 and VII.6.1.4), which may indicate a higher level of recovery in the streams of JDSF (Figure VII.6.1.2).

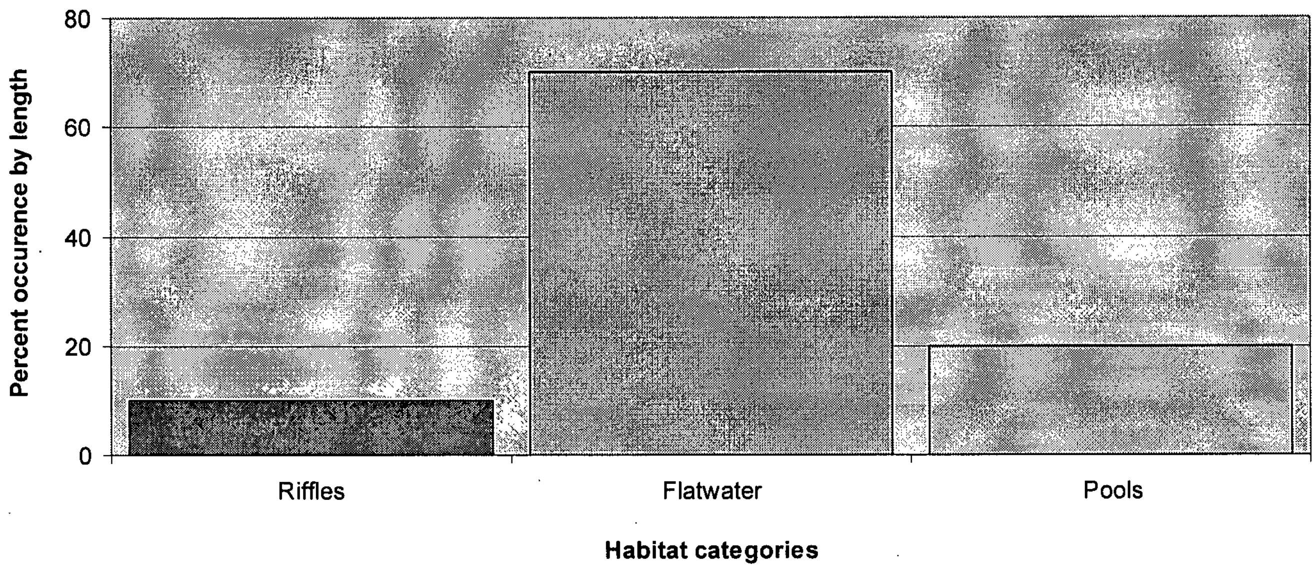


Figure VII 6.1.3. Habitat categories by length of the Little NF Noyo River (1996)

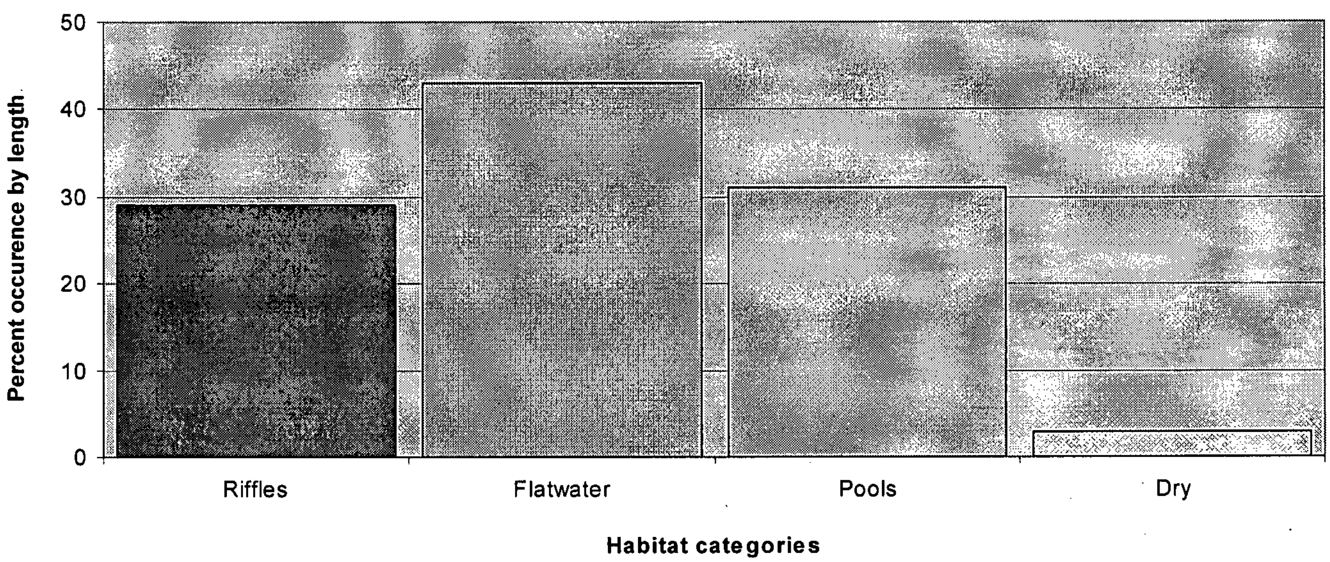


Figure VII 6.1.4. Habitat categories by length of the NF South Fork Noyo River (1996)

The habitat frequency chart from the North Fork of the South Fork Noyo within JDSF depicts some degree of recovery from past activities but pool frequency is still below the optimal range cited in the literature. A dry stream segment may suggest some remaining aggradation. Field measurements by Koehler and others (2001, 2002, 2004) showed that large amounts of historic logging-related sediment trapped in long-term storage along the South Fork channel are transported downstream during high discharge events. This sediment increases the overall suspended sediment load and was not accounted for in the previous TMDL calculations, indicating that the TMDL overestimated sediment generated by upslope management practices (Koehler and others 2002, 2004). This study concluded that accurately quantifying channel sediment storage is a critical step for assessing sediment budgets, especially in TMDL documents attempting to relate upslope management to suspended sediment production.

Research at Caspar Creek in JDSF has shown that the modern FPRs can reduce water quality impacts. Selective tractor logging and streamside road construction in the South Fork completed prior to implementation of contemporary forest practices was shown to produce 2.4 to 3.7 times more suspended sediment than was measured in the North Fork with clearcutting and cable logging operations conducted under the modern FPRs (Lewis 1998, Lewis and others 2001). Numerous landslides were documented after road construction and logging in the South Fork, while the size and number of landslides through 1998 were similar in logged and unlogged units in the North Fork (Cafferata and Spittler 1998).

Spawning Gravel Quality

Spawning gravel quality is influenced by several factors, all of which affect the success of spawning salmonids and the survival of incubating eggs and emerging fry. These factors include gravel size, size and location of available spawning areas, proportion of fine sediment in the gravel at the time of spawning, and subsequent deposition of fine sediment in the redd during incubation and development (Beschta and Jackson, 1979; Grost et al., 1991; Peterson et al., 1992).

Class I stream channels within the JDSF assessment area are generally gravel-bedded (CDFG, 1995b, 1996b). Cobble is the second most frequent dominant bed surface substrate. Sand and smaller sediments are generally the dominant surface bed substrates only in the low-gradient lower reaches of the Big River, Caspar Creek, and Hare Creek (CDFG, 1995b and 1996b; G-P, 1997). Coarse bed substrates can provide valuable cover and thereby contribute to the rearing success of juvenile salmonids. Particle sizes between 65 and 95 mm (2.6 and 3.7 in) provide optimal conditions for rearing juvenile salmonids (NMFS and USFWS, 1997). The estimated reach-level geometric mean diameter (D_{50}) of bed substrates in JDSF streams was lowest in 0–1 percent gradient channels (48 mm), and highest in 1–2 percent gradient channels (55 mm), although substantial differences between the four gradient categories were not observed. These D_{50} estimates relate to the mobile fraction of the bed substrate, and do not take into account the fluvially immobile framework particles that are present (but not dominant) in some of the higher gradient channels Knopp (1993) measured D_{50} as well and had 30.9 mm for reaches 2-4% and 36.7 mm for 1-2% reaches.

The geometric mean particle size (D_{50}) of spawning gravels measured at pool tailouts in JDSF streams during the summer of 1997 ranged from an average of 19 mm (3/4 inch) in 4-8 percent gradient channels, to an average of 27 mm (1 inch) for channels in the 1–2 percent gradient range. These values are well within the range of suitable gravel size for both coho and steelhead spawning (Bjornn and Reiser, 1991), but in the higher gradient channels are at the low end of the suitability range for properly functioning conditions (> 20 mm) as recommended by NMFS (NMFS and USFWS, 1997, after Shirazi and Seim, 1979).

The embeddedness of spawning gravels has often been used as a general indicator of interstitial conditions (space and flow) and the amount of fine sediment present in the gravel (Burns and Edwards, 1985; Torquemada and Platts, 1988). Valentine et al. (1995a, 1995b) measured cobble/gravel embeddedness at pool tailouts in several JDSF streams as part of the biological and hydrological assessments of proposed THPs. All of the reaches surveyed had gradients of less than three percent. Embeddedness in the Little North Fork Big River and the South Fork Noyo River averaged about 50 percent, which was considered moderate. Slight to moderate embeddedness was also reported for survey reaches in Hare Creek and Bunker Gulch, although percent embeddedness values were not reported for these streams (Valentine et al., 1995c).

The average percentage embeddedness of spawning gravels at pool tailouts in JDSF stream reaches surveyed by Stillwater Sciences in 1997 was lowest in the 4–8 percent gradient channels (18 percent embeddedness) and highest in the 2–4 percent gradient channels (32 percent embeddedness). Average spawning gravel embeddedness in the 0–1 percent and 1-2 percent gradient survey reaches was 20 percent and 27 percent, respectively. Possible reasons for the discrepancy between these values and those reported by Valentine et al. (1995a, 1995b) may include differences in sampling methodology and local differences in sediment supply, storage, and transport processes. Further research is required to establish the biological significance of embeddedness to salmonids (Peterson et al., 1992). Also, note that the embeddedness measurements at JDSF were no taken from actuall redds but from pool tailouts.

Aquatic Macroinvertebrates

Aquatic invertebrates are an important food source for juvenile salmonids, and their abundance is therefore indicative of food availability. Many amphibian species, such as the northern red-legged frog, foothill yellow-legged frog, rough-skinned newt, and aquatic reptiles (e.g., northwestern pond turtle), also depend on aquatic invertebrates as food. Aquatic macroinvertebrates can be also be used as indicators of general water quality and impacts to stream ecosystems (Plafkin et al., 1989; Rosenberg and Resh, 1993; Harrington, 1994). Valentine et al. (1995a) reported that the aquatic macroinvertebrate community in a portion of the Little North Fork Big River was rapidly examined in May 1995 during a watershed workshop by Resh using a variation of the California Stream Bioassessment Procedure (Harrington, 1995). Resh stated that the assessment parameters indicated that good habitat conditions were present.

A considerably more detailed study of aquatic macroinvertebrate populations was conducted by Botorff and Knight (1996) in North Fork of Caspar Creek above the weir. Their results showed that changes to the overall benthic community structure occurred following logging of the watershed, but expected decreases in abundance and taxa richness were not observed. Increases in macroinvertebrate density and taxa richness, as well as increased leaf decay rates and algal biomass, were reported. They speculate that few negative effects on macroinvertebrates occurred following increased deposition of fine sediment related to logging because the macroinvertebrate fauna of North Fork Caspar Creek had already changed to reflect higher fine sediment levels in the substrate from old growth logging approximately 100 years earlier (Botorff and Knight, 1996). The authors also noted:

> Logging impacts on the North Fork of Caspar Creek biota were often not dramatic because forest practices minimized the impacts. The three most important practices which ameliorated the impacts were the presence of the riparian buffer zones, the absence of roads near the stream, and the use of cable yarding which minimized soil disturbance.

Canopy Cover, Streamside Shade, and Temperature

Overall levels of streamside shade were assessed for streams within the JDSF assessment area, and streamside canopy densities were found to be relatively high throughout JDSF. Based on analysis of 1996 aerial photographs by Stillwater Sciences (1997;), the Class I and II stream channels that were discernible in the photographs were classified as having low, moderate, or high levels of streamside shading. Streamside shade levels assessed using aerial photographs were verified in the field at each of the stream channel survey locations using a handheld spherical densiometer. Field measurements of shade levels were similar to remotely assessed values, with minor discrepancies attributable to local variations in the riparian canopy that were not visible in aerial photographs. In addition, stream surveys have been conducted by CDFG. Of the 35 stream surveys conducted by CDFG between 1995 and 1997, 25 streams had canopy densities exceeding 90%, 6 streams exceeded 80% and 4 streams were between 60 and 79% (see Map Figure F [Canopy Cover Map] in Map Figures Section).

The Two Log Creek planning watershed (Table VII.6.1.4) had the largest percentage of stream length in the low shade category (29 percent). In general, streamside shade levels in the northern and western parts of the assessment area were highest, with nearly all of the classified stream length in each of the planning watersheds falls into the high shade category. The total stream length in the low shade class was greatest in the southern part of the assessment area, where 20 percent was classified as having a low streamside shade level. The majority of the stream length in the assessment area in the low and moderate shade classes occurred on the Big River and its tributaries, outside of JDSF.

Temperature

CDF has conducted comprehensive summer water temperature monitoring in streams throughout JDSF since 1993, as well as temperature monitoring in the Caspar Creek watershed since the mid-1960s. Overall, water temperatures in JDSF Class I watercourses are generally in the suitable range for coho salmon and steelhead, with a few exceptions (CDF, 1999). The areas of concern are located on the South Fork of the Noyo River and Chamberlain Creek, tributary to the North Fork of Big River.

Stream temperature data are collected widely across the Noyo and Big River watersheds (Figure VII.6.1.5). Stream temperature was evaluated using data collected by land owners and state agencies (CDF, NCRWCQB, and DFG), and supplemented with data from the KRIS Noyo and Big River projects. A summary of the data used in this assessment is provided in Appendix A. While water temperature is of concern for both watersheds, higher temperatures have been recorded in Big River, leading to its inclusion on the U.S. EPA's 303(d) list as temperature impaired. The spatial distribution of water temperature was mapped across the entire assessment area to identify areas of concern that may require more detailed analysis. The thresholds for interpreting water temperature were based on the criteria established by NMFS (1997) and additional criteria that were established by state agencies participating in the North Coast Watershed Assessment Program (NCWAP).

Table VII.6.1.4. A summary of streamside canopy cover data for streams in or adjacent to the JDSF ownership. Based on 1996 vegetation conditions the data are summarized by Planning Watersheds.

	Shade Categories (units=miles)						
Planning Watershed	**<40%**		**40-70%**		**70-100%**		**Total**
	Miles	**Percent**	**Miles**	**Percent**	**Miles**	**Percent**	**Miles**
Berry Gulch	0.87	3.0			27.73	97.0	28.60
Brandon Gulch					27.74	100.0	24.74
Caspar Creek	0.33	1.8			17.86	98.2	18.20
Chamberlain Creek	0.34	1.1	1.17	3.7	3.22	95.2	31.73
East Branch North Fork Big River	2.17	12.4	0.33	1.9	15.02	85.7	17.52
Hare Creek					23.75	100.0	23.75
James Creek			1.22	7.7	14.55	92.3	15.77
Kass Creek			0.45	3.2	13.36	96.8	13.81
Laguna Creek						100.0	
Lower North Fork Big River	3.43	17.3	1.25	6.3	15.10	76.3	19.78
Mitchell Creek					15.62	100.0	15.62
Mouth of Big River	5.44	15.1	6.04	16.8	24.53	68.1	36.01
Mouth of Noyo River					0.01	100.0	0.01
Parlin Creek	1.60	5.3	0.60	2.0	28.06	92.7	30.26
Russian Gulch					14.19	100.0	14.19
Two Log Creek	12.67	29.0			31.01	71.0	43.67
Upper North Fork Big River					17.93	100.0	17.93
Grand Total	26.84		11.06		313.70		

Based on these thresholds, the map identifies several areas that are of potential concern, including: The North Fork of the Noyo, the South Fork of the Noyo (including Parlin Creek), the North Fork of the Big River (including Chamberlain and James Creek), and the South Fork of the Big River. In addition, an emphasis was placed on those watersheds that either deliver water to JDSF (i.e., up-stream) or are considered receiving waters (i.e., downstream) from JDSF. Neither the Upper Noyo nor the South Fork of the Big River flow into JDSF, and as such, are discussed in less detail. The Mendocino Redwood Company (MRC) watershed analysis reports available for the Noyo and Big

River watersheds provide a detailed discussion of water temperature for those areas, although limited to that specific ownership. A summary of information from these reports is presented here, to provide a more comprehensive assessment of water temperature throughout the Noyo and Big River basins.

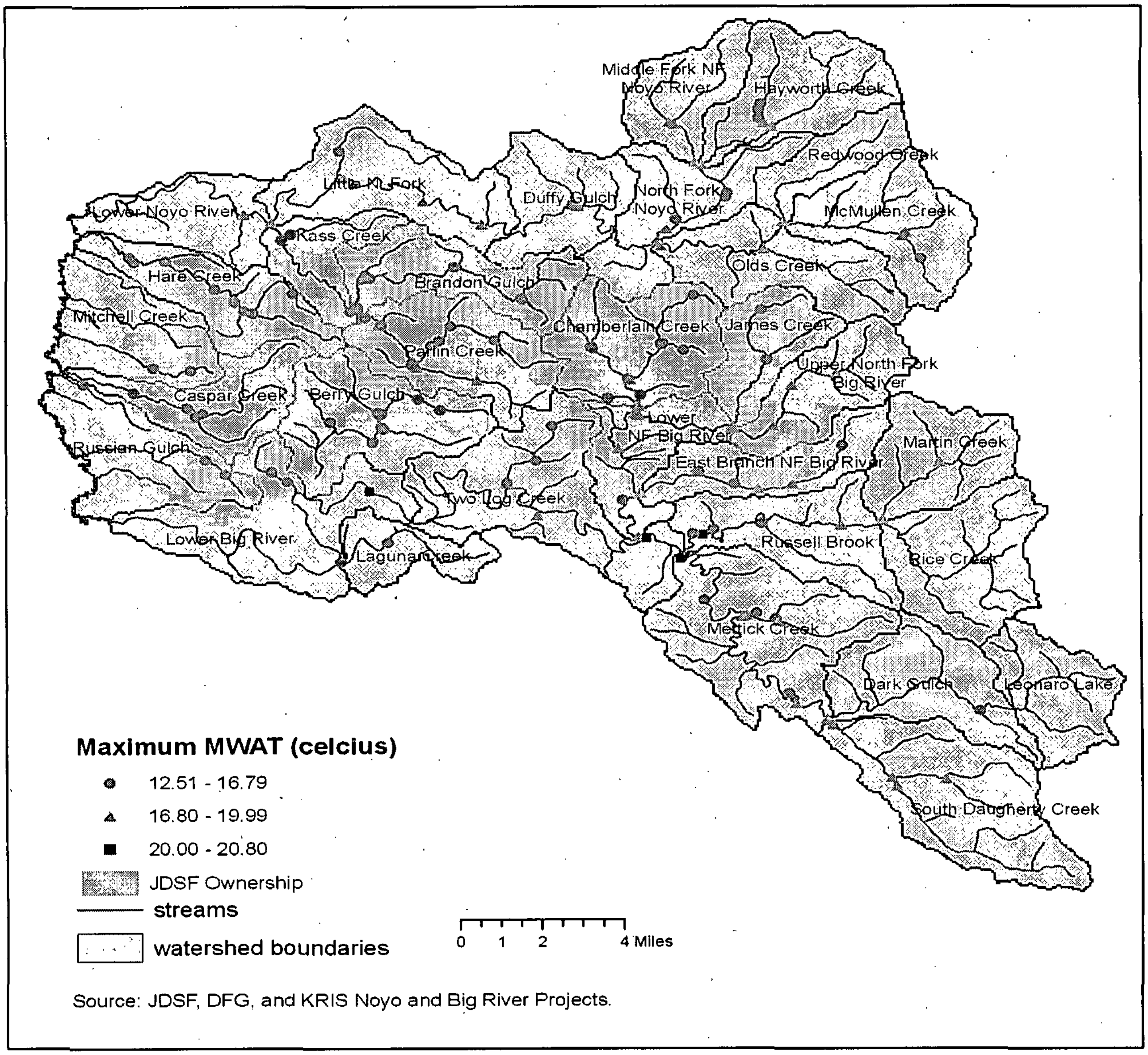
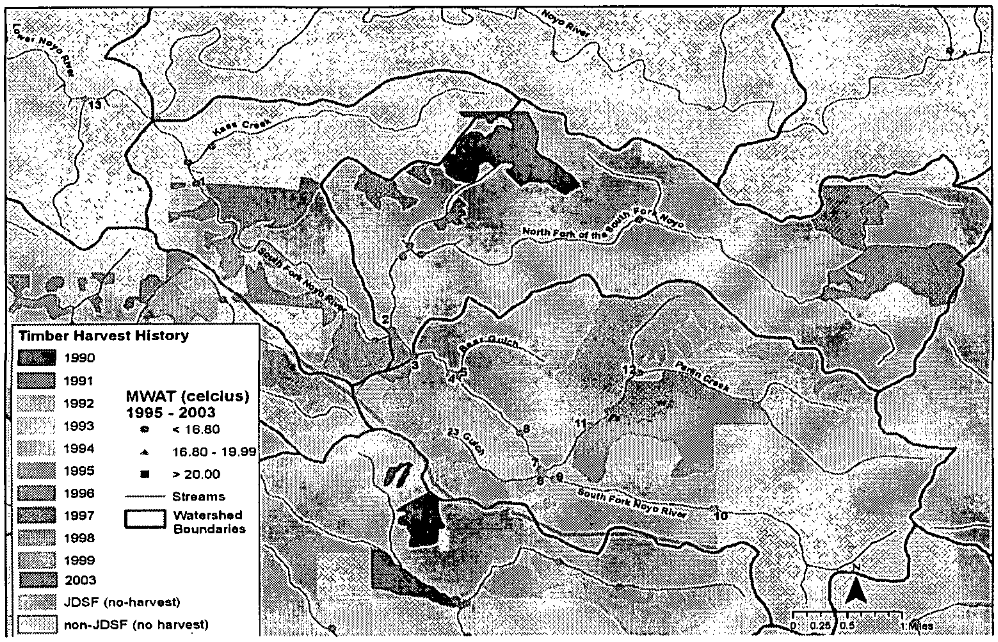


Figure VII.6.1.5. The distribution of stream temperatures across the Noyo and Big Rivers based on the maximum MWAT values from 1994 - 2004.

Water Temperature for the South Fork Noyo River (within JDSF) -The South Fork of the Noyo River (SFNR) is a major tributary to the Noyo River. The SFNR catchment area at the confluence with the Noyo River drains a 27.32 mi^2 area, which is approximately 35% of the entire Noyo River watershed (113 mi^2). The vast majority of SFNR is owned and managed by JDSF. As such, JDSF management activities contribute to the overall water quality conditions in the lower Noyo, below its confluence with SFNR. The SFNR basin is characterized by steep mountainous terrain with confined valleys. The extreme headwaters of the SFNR have more moderate terrain.

The mainstem of the South Fork Noyo flows for approximately 7 miles through JDSF. Stream temperature is characterized by fluctuation in maximum MWAT value as the river flows from the upstream boundary to the downstream boundary of JDSF (Figure VII.6.1.6). However, data recorded near the downstream boundary of JDSF has shown a noticeable decline for the last three years of record (site 1, Figure VII.6.1.6). For the most recent date (2000), the MWAT value for site number 1 was 16.2 °C. This is contrasted with much warmer readings on the mainstem of the Noyo River, above the confluence with the South Fork Noyo and beyond the boundary of JDSF. Stream temperature records from the middle Noyo (near Grove) have consistently produced MWAT values at or near 18.6 °C from 1998 to 2003 (figure 1). Below the confluence with the SF Noyo, the water temperatures decline by about 1 °C (site 13, Figure VII.6.1.6). Stream temperature data collected at the USGS gauging station along the mainstem of the lower Noyo has recorded an average MWAT value of 17.5 °C from 1998-2003. As such, the South Fork Noyo appears to have a cooling effect upon water temperature in the lower Noyo, depending upon the relative flow of the two streams.

Stream temperature reported by Valentine (1996) provides a baseline for stream temperature along the South Fork Noyo River. The maximum high water temperature measurement (not MWAT), identified at two monitoring locations, was 19.4 C. All stations were below 18° C more than 85% of the time. Among the tributaries to the South Fork Noyo, Parlin Creek had the highest recorded temperature. Data loggers along the South Fork Noyo, above and below the confluence (Figure VII.6.1.6, site 6 and 8), showed a modest increase in stream temperature just below Parlin Creek. The degree to which stream temperature along the South Fork Noyo are elevated by Parlin Creek were not considered significant by Valentine (1996), but were indicative of warming temperatures in lower reaches of Parlin Creek. Temperatures were shown to increase in the downstream direction along Parlin Creek. Valentine (1996) found that conditions did not represent a serious cause for concern with regard to coho salmon, due to the degree of variance from MWAT threshold values.



Timber Harvest boundaries **do not** reflect harvest restrictions in the WLPZ. Note there were no timber

Figure VII.6.1.6 Distribution of stream temperatures along the South Fork Noyo River and Parlin Creek.

Stream temperature data following the 1996 study were analyzed to evaluate any changes from previously identified conditions. Treating 1996 as a baseline, data were analyzed post-1996 to determine if there are any trends in water temperature. Stream temperature remained somewhat higher along the mainstem of the South Fork Noyo, about 0.5° C, as water flows past Parlin Creek, but the trend is flat (Figure VII.6.1.7). This suggests that stream temperature has been more or less stable since 1996. The area where Parlin Fork meets the South Fork contains a large opening associated with an historic homestead, logging camp, and current conservation camp. The riparian forest zone in this vicinity is relatively narrow. Recent timber harvest in both Parlin Creek and throughout the South Fork Noyo since 1996 do not appear to be influencing stream temperature.

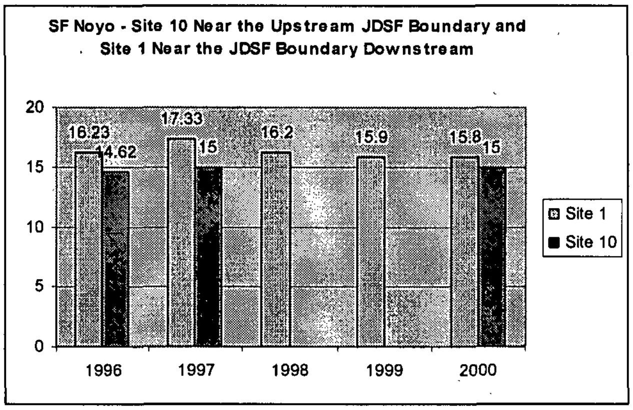


Chart A

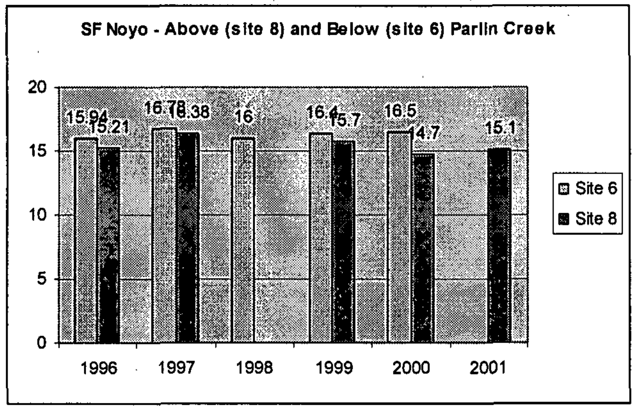


Chart B

VII.6.1.7. Trends in MWAT Stream Temperatures (°C) along the South Fork Noyo River.

Chart A provides a comparison in stream temperature from the upstream boundary of JDSF and the downstream boundary where water flows out of JDSF. Chart B provides a comparison of stream temperatures recorded directly above and below Parlin Creek. The water temperature is moderately warmer below Parlin Creek, but there is no dramatic increase or decrease over time.

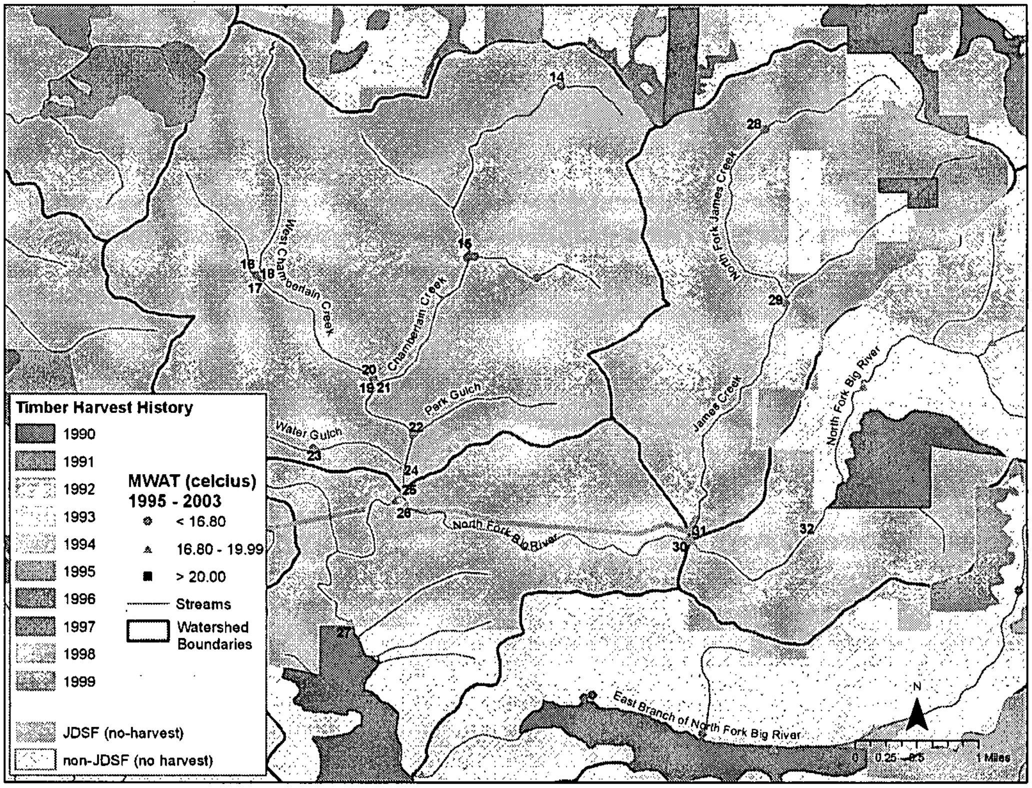
Water Temperature for the Big River -The Big River watershed (181 mi^2) is larger than the Noyo, flowing into the Pacific Ocean near the town of Mendocino. Most of basin is remote, with few towns or incorporated areas. The topography varies from relatively flat marine terraces and estuaries to extremely rugged mountainous terrain. Land use within the watershed has been dominated by timber harvesting, with a substantial area dedicated to range management in the upper reaches. JDSF management has potentil to influence water temperature along the North Fork of the Big River, and to a lesser extent, along the Little North Fork. Water temperature data taken from the mainstem of Big River consistently exceeds the 16.8°C MWAT threshold (Figure VII.6.1.8). The Big River is listed as temperature impaired per Section 303(d) of the federal Clean Water Act. Thus, management practices that have the potential to elevate stream temperature are of concern. Water temperature data were assessed by the NCRWQCB staff under the NCWAP watershed assessment program and a summary of the data is provided in Appendix B. However, a more general discussion of water temperature is presented here.

<u>Water Temperature for North Fork of the Big River</u> -Some of the warmest stream temperature measurements on JDSF have been recorded along the lower reaches of Chamberlain and James Creeks (Figure VII.6.1.8). Chamberlain and James Creeks are the eastern-most watersheds that are predominately managed by JDSF. Being relatively distant from the coast, these two watersheds are more heavily influenced by very warm ambient air temperature throughout the summer months. Both watersheds have a history of intensive land management, but have had very little (none on JDSF lands) timber harvesting over the last 20 years. The maximum MWAT value obtained from these

streams ranged from 13.8 to 18.9 °C, based on water temperature data collected from 1996 through 2003.

Stream temperatures are very similar at the mouths of James and Chamberlain Creeks. Chamberlain Creek is a larger watershed (7,868 acres) than James Creek (4,459 acres), but both have a similar north-south orientation. Both creeks exhibit a distinct increase in stream temperature in the downstream direction. Based upon recorded MWAT values, stream temperature increased by 2.5 °C in the downstream direction on Chamberlain and 3.5°C on James Creek (Figure VII.6.1.9, Chart A). Unlike the South Fork Noyo, there has been no timber harvesting in Chamberlain Creek since 1985, and only two recent harvest units in James Creek off of JDSF land. As such, canopy conditions are likely to have improved over the past 20 years, as a result of canopy development along both channels, where relatively young forest has re-grown following the removal of the old growth between 1940 and 1985.

Stream temperature data has been collected at four locations along the North Fork of Big River. Stream temperature appears to be much higher upstream of the JDSF boundary, cooling as it passes through JDSF, and then increasing below the JDSF boundary (NCWAP, 2004, Appendix B). Stream temperature data loggers have recorded higher temperatures at the station above the confluence of James Creek than at downstream locations within JDSF. Stream temperature does not appear to increase as water flows past the mouths of James and Chamberlain Creeks. Water temperature recorded on the mainstem of the North Fork of the Big River are consistently higher than water temperature recorded along the lower reaches of James and Chamberlain Creeks (Figure VII.6.1.9, Chart A). The computed MWAT recorded on the North Fork of the Big River upstream of Chamberlain is a full degree (Celsius) higher than the MWAT recorded from the station on Chamberlain Creek just above its confluence with Big River. As such, the conditions within JDSF appear to have a moderating temperature effect upon water flowing into and through the state forest. As canopy continues to develop adjacent to these stream reaches in the future, the cooling trend is likely to continue.



Timber harvest boundaries **do not** reflect harvest restrictions in the WLPZ.

Figure VII.6.1.8. Distribution of stream temperatures along the North Fork Big River, Chamberlain and James Creeks.

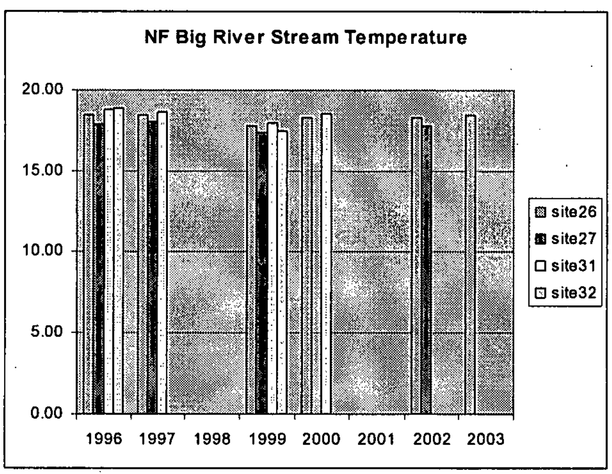


Chart A

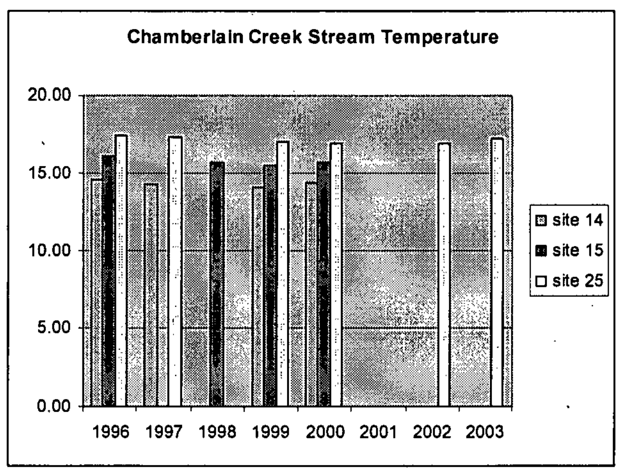


Chart B

Figure VII.6.1.9. MWAT stream temperatures along the Big River.

Water Temperature for Coastal Watersheds-Management practices on JDSF lands also influence a number of small coastal watersheds that drain directly to the Pacific Ocean.

These watersheds include Russian Gulch, Caspar Creek, Jughandle Creek, Mitchell Creek, and Hare Creek. In general, the stream temperatures appear to be in a range that is supportive for salmonids. None of the temperature data for these watersheds has exceeded the 16.8 °C MWAT threshold.

Nearly all of the early temperature monitoring efforts were in the Caspar Creek watershed. Cafferata (1990) reported pre-management water temperature in the North Fork and South Fork Caspar Creeks. Most observed summer maximum stream temperature in 1965 were slightly below 16°C (60°F) with absolute maximums reaching 17°C (62.6°F) at the weirs. In 1988, small uncut tributary basins had maximum temperatures of about 13°C (56°F) with average daily highs about 12°C (54°F). Cafferata (1990) reported approximately a 13% reduction in shading resulting from timber harvesting along a Class II watercourse channel in the North Fork Caspar Creek (note that shading and canopy, while related, are two different measurements; see Berbach et. al. 1999). Following clearcut logging of approximately 50% of the North Fork of the Caspar Creek watershed, with buffer strips established as prescribed by the modern Forest Practice Rules, Nakamoto (1998) concluded that the increase in water temperature was small and the range of temperatures observed within the North Fork was within the tolerable range for coho salmon and steelhead.

Figure VII 6.1.9 Chart A shows that MWAT stream temperature along the North Fork of the Big River are consistently above the target threshold of 16.8 °C. However, there is not a noticeable increase of stream temperature from the upstream boundary of JDSF (site 32) to the downstream boundary of JDSF (site 27). Figure 17, Chart B from the headwaters to the confluence, MWAT stream temperatures increase in the downstream direction along Chamberlain Creek by as much as 3 °C. This trend is fairly consistent over time, with some indication of a decrease in stream temperature at the furthest downstream station (site 25) recorded in the last four years of data collection.

Large Wood Loading and Recruitment

Keller et al. (1982) reported the equivalent of one key piece of large wood per 1.8 to 2.5 channel widths in confined, low- to mid-order streams draining old-growth redwood forests in Redwood National Park, in coastal Humboldt County, California. In JDSF streams with the same general physical characteristics, large wood frequency in 1997 averaged one key piece per 6.9 channel widths (range: one key piece per 2.1 to 23.1 channel widths). The average density of all large wood in the Redwood National Park streams was 0.136 cubic meters of large wood per square meter of active channel at sites with drainage areas of the same order of magnitude as the North Fork Caspar Creek watershed (Keller and MacDonald, 1983). In the same study the authors reported large wood densities of 0.042 and 0.048 cubic meters per square meter at sites on upper and lower North Fork Caspar Creek, respectively. O'Connor and Ziemer (1989) found a large wood density of 0.017 cubic meters per square meter in an area they define as the "effective zone" (roughly equivalent to the active channel) in their study reaches on North Fork Caspar Creek. This apparent discrepancy may be the result of local variability in large wood densities. The value reported by O'Connor and Ziemer (1989) may better represent the average for North Fork Caspar Creek, because their contiguous survey reaches encompassed a larger area of the channel than did the area surveyed by Keller and MacDonald (1983).

Napolitano (1998) reported a large wood density in North Fork Caspar Creek of 24 kilograms per square meter and densities in physically similar streams in old-growth redwood basins of 49-268 kilograms per square meter. Napolitano (1998) suggests that large wood loading in North Fork Caspar Creek was greatly diminished by historical logging activities and changes to second-growth cover. As these comparisons demonstrate, it is apparent that large wood loading in North Fork Caspar Creek is considerably lower than in streams bordered by old-growth redwood forest in coastal northern California. It should be recognized, however, that local variability in large wood loading can also be influenced by differences in geomorphology, climate, past management (including channel clearance), and stochastic natural events (such as episodic windthrow of trees in the riparian zone).

The apparent absence of large wood removal activities in the North Fork Caspar Creek (post-1940s) contrasts with the extensive large wood removal that has occurred in many other JDSF streams. The most recent documented removal of large wood and other obstructions from the channel of North Fork Caspar Creek took place during old-growth logging between 1864 and 1904, when splash dams were used to transport logs downstream to the mill (Napolitano, 1998). By contrast, the South Fork Caspar Creek was cleared of large wood when the main road was built in 1967, at the request of the Department of Fish and Game. There was extensive debris removal after logging, with a tractor used directly in the stream expressly for the purpose of bulldozing woody debris from the channel(Burns, 1972). The role of woody debris in stream ecology was not well understood at that time, and the log jams were often seen as potential obstructions to spawning salmonids.

Large woody debris loading in several other JDSF stream reaches was also reported in biological and hydrological assessments conducted for individual THPs (Valentine et al., 1995a, 1995b, 1995c), and watershed cumulative impacts assessments of THPs (CDF, 1996). The density of large wood in Hare Creek was approximately 0.029 cubic meters per square meter of high flow channel, and was twice that amount (0.058 m^3/m^2 of high flow channel) in Bunker Gulch, a tributary to Hare Creek (Valentine et al., 1995c). Removal of large wood is known to have occurred in Bunker Gulch and portions of Hare Creek in the 1980s. The Hare Creek drainage may have also been subject to undocumented large wood removal as part of stream clearance efforts in the 1970s and old-growth logging around 1900 (Valentine et al., 1995c).

Valentine et al. (1995a, 1995b) and CDF (1996) collected additional large wood loading data in the Little North Fork Big River, the South Fork Noyo River, and several South Fork Noyo tributaries. Although these data were recorded as volume (m^3) of large wood per 1,000 ft of channel length, and are therefore not directly comparable to the large wood loading values reported above, they do allow comparison among several JDSF watersheds. Loading was highest in the Little North Fork Big River (7,675 m^3/1000 ft) in which only scattered large wood removal in the 1980s and early 1990s has been documented. Past large wood removal activity in the Little North Fork Big River is also noted by Valentine et al. (1995a), but additional details of the extent or how long ago large wood was removed from this stream that would supplement the information presented are not available. In the South Fork Noyo River drainage, large wood loading ranged from a high of 2,394 cubic meters per 1,000 feet in Peterson Gulch (a small tributary to the South Fork Noyo River, near the CDFG egg-taking station) to a low of 124 cubic meters per 1,000 ft in mainstem South Fork Noyo River (Valentine et al., 1995b). Removal of large wood along most of mainstem South Fork Noyo River is documented to have occurred in the 1950s, 1980s, and 1990s as part of stream clearance projects, but no removal activity from Peterson Gulch is known. High large wood loading in Peterson Gulch is thought to be related to construction of a rail line there during old-growth logging activity (Valentine et al., 1995b). Although old-growth logging has potentially influenced long-term large wood recruitment rates to these channels, the absence of splash dams in this area leads to the supposition that the channel was not cleared of large wood during historical logging operations. However, channel bottoms were commonly utilized as log skidding routes during early logging. Woody debris was often utilized to provide a hard, stable skidding surface.

Munn (1997) reported that large wood input rates can be substantially influenced by the effects of timber harvesting adjacent to the WLPZ, which in North Fork Caspar Creek is thought to have increased the susceptibility of riparian trees to windthrow. Reid and Hilton (1998) found that the presence of North Fork Caspar Creek clearcuts at least doubled tree fall rates for a distance of more than 150 meters (492 ft) into a stand composed of 50-60 meters (164-199 ft) tall second-growth trees. Reid and Hilton (1998) reported that about 90% of the instances of large wood input occurred from tree falls within 115 feet (35 m) of the channel in un-reentered second growth redwood/Douglas-fir forests in the North Fork of Caspar Creek. Slope steepness is high in this second order watershed. They reported that portions of the stream have locally developed inner gorges, with slope-lengths of 40 to 100 m and gradients of 30 to 40 degrees (or 58 to 84 percent).

The large wood recruitment rate from the developing second-growth forest in the North Fork Caspar Creek watershed during the approximately 95 years following the initial harvesting of old-growth in the 1860s was estimated by O'Connor and Ziemer (1989) to be 5.3 cubic meters per hectare per year. Recent information on the variable rate of large wood recruitment over time suggests that this value may be as high as 12.5 m^3/ha per year (O'Connor, pers. comm., 1997). Munn (1997) summarized large wood recruitment data from North Fork Caspar Creek and concluded that recruitment of large wood is most likely episodic. Recruitment rates in old-growth redwood forests are expected to be higher than those observed at Caspar Creek, but a quantitative comparison is not possible owing to a lack of baseline data.

In the Noyo and Ten Mile River watersheds, Benda (2004) reported that wood recruitment to streams is dominated by non-forest mortality sources (i.e., bank erosion and streamside landsliding): 64% in Ten Mile and 85% in the Noyo River basins). Ninety percent of wood recruitment (by volume) was found to occur within 14 m (46 ft) and 8 m (26 ft) of stream edges respectively in Ten Mile and Noyo watersheds.

In a comprehensive review of the literature, Lassettre and Harris (2001) state: "To ensure future supplies of large wood to stream channels, buffer strips serving as reservoirs of wood supply should be wide enough to encompass the zone of large wood input, typically within 20 m to 30 m of the stream channel (Lienkaemper and Swanson, 1987; McDade et al., 1990; Van Sickle and Gregory, 1990) "... "The use of a selectively logged fringe buffer adjacent to the streamside buffer may serve to reduce abnormally high rates of windthrow and preserve natural input rates. Any selective cutting within buffer strips should leave an abundant supply of the largest trees for recruitment (Murphy and Koski, 1989; Abbe and Montgomery, 1996)."

Much of the riparian landscape on JDSF is not yet providing full riparian function. Seral stage classification provides a general indication of riparian conditions and quality. Two percent of the riparian vegetation found in JDSF is made up of young open forest and 34 percent is mid-seral forest. Where some level of disturbance has occurred in riparian areas, there would be an extended period required to attain fully functioning conditions. For example, in early-seral stages, the immature riparian vegetation (both hardwood and coniferous species) is a low-to-moderate shade source and a poor contributor of large wood. In mid-seral stages, the riparian vegetation is a good shade source and a low-to-moderate contributor of large wood. Most riparian vegetation does not become a good source of large wood until the late-seral stages. Although much of the land is currently in early- to mid-seral stages, riparian habitat should improve over time (20 to 90 years).

6.1.4 Aquatic Habitat Conditions: Contributing and Receiving Watersheds in the JDSF Assessment Area

Habitat Suitability Overview

Historic management practices and more recent (mid-1980s to mid-1990s) harvest levels in assessment watershed areas (Noyo and Big River) and other adjacent watersheds (Pudding Creek, Ten Mile) at the regional scale may have contributed to the decline of salmonid habitat quality and populations.

Unstable but improving watershed conditions on lands adjacent to JDSF make the rate of coho salmon habitat recovery and population sustainability uncertain. As such, JDSF makes a significant regional contribution to the maintenance and/or reestablishment of coho stocks along the Mendocino coast.

Outside JDSF, canopy cover data has been collected as part of the Department of Fish and Game (DFG) stream surveys that were conduct between 1995 and 2003. The information relating streamside canopy cover and forest composition is presented in Appendix 12. In summary, the data shows that most of the streams that were surveyed meet or exceed the 85% canopy cover target. Stream reaches that do not can be found along the mainstem of the Big River, the mainstem of the Noyo, North Fork of the Big River, South Fork of the Big River, and some of the major tributaries (i.e., Daughtery Cr., Mettick Cr., and James Cr).

Additional information on canopy cover is contained in watershed assessments that have been conducted by private landowners. Streamside canopy cover data was collected by MRC for their lands in the Noyo River watershed in 1998. Canopy cover was grouped into three classes: high (>70%), moderate (40 – 70%) and low (0 – 40%). The canopy closure assessment showed a majority of Class I streams with a high streamside shade classification (58% of total Class I watercourses). However, a significant percentage of the Noyo WAU Class I streams have a moderate streamside shade classification (28% of Class I watercourses) and low streamside shade classification (14% of Class I watercourses). Streamside canopy cover data was also collected by MRC for their lands on the Big River to support a watershed assessment conducted in 2000. Canopy cover ranged from 40% - 100% across MRC lands in the Big River. In general, canopy cover appears lowest among the mainstem of the larger river channels and is summarized as (MRC, 2003):

> *Canopy closure over watercourses in the Big River WAU ranges from poor to good. Big River, North Fork Big River and South Fork Big River have less than ideal canopy cover values but this is to be expected from larger river channels. East Branch North Fork Big River and Two Log Creek are two areas that have good canopy cover. Daugherty Creek is an area which has low canopy cover.*

BIG RIVER WATERSHED—MENDOCINO REDWOOD COMPANY—STREAM HABITAT ASSESSMENT-The Big River WAU is comprised of eight planning watersheds, seven of which were surveyed for fish habitat. The discussion of results is separated into the seven surveyed planning watersheds of the Big River WAU. Each planning watershed contained 1 to 13 survey segments. Source: Big River Watershed Analysis--Mendocino Redwood Company

South Fork of the Big River-The Mendocino Redwoods Company (MRC) has substantial ownership in the South Fork of the Big River. With ownership concentrated in Daugherty Creek, Mettick Creek and Russel Brook. MRC (2003) conducted a watershed analysis on their lands in the Big River basin, including an assessment of stream temperature and canopy cover. The temperature data for most sites were higher than the 16.8°C MWAT threshold for the North Fork of the Big River, with MWATs ranging from 17.4 to 19.7°C, and streamside canopy cover mostly moderate (40% – 70%). Conditions reported on the South Fork of Big River are similar. MWATs ranged from 18 to 18.4°C on the mainstem, with much cooler water recorded along tributaries (12.9 to 15.1°C).

East Branch North Fork Big River-The segments surveyed (BE1, BE2, BE8 and BE14) in the East Branch North Fork of Big River planning watershed had slope gradients of 0-7%. Steelhead and coho were present throughout segments BE1 and BE2. Segments BE8 and BE14 did not have salmonids present. Spawning habitat was rated ‘Fair’ for all segments due to fair to good quantities of spawning gravel but moderate to highly embedded substrates. Summer rearing habitat was rated ‘Fair’ for segments BE1 and BE2; pool habitat was abundant but there were low amounts of instream cover available to fish. Segments BE8 and BE14 were rated 'Poor' for rearing habitat due to low amounts of instream cover, poor pool depths and low levels of large woody debris. Overwintering habitat was rated 'Fair' for segments BE1 and BE14 due to fair to good quantities of overwintering substrate, which provides shelter to young fish during higher wintertime flows. Segments BE2 and BE8 received 'Poor' overwintering ratings due to low levels of overwintering substrate and poor pool depths. All segments surveyed within the planning watershed had shallow pools, which may be related to the low levels of large woody debris present. Large woody debris was removed from streams within this planning watershed during the 1980's and 1990's.

The lower portions of the East Branch of the North Fork of the Big River were included in a recent watershed assessment conducted by Mendocino Redwoods Company (MRC, 2003). Streamside canopy cover was mostly high (> 90%) and MWAT values range from 16.3 to 18.4°C along the mainstem. Temperature data on tributaries (Class II watercourses) were limited to one year of data, but all sites recorded MWAT values below 15°C.

Lower North Fork Big River-The segments surveyed (BL1, BL3, BL7 and BL12) in the Lower North Fork of Big River planning watershed had slope gradients of 0-7%. Steelhead and coho were present throughout segments BL1 and BL3. Segments BL7 and BL12 did not have salmonids present. Spawning habitat was rated 'Good' for segments BL1 and BL3 due to abundant high quality spawning gravels and moderately embedded substrate. Spawning habitat was rated 'Poor' for segments BL7 and BL12 due to moderate quantities of spawning gravel, highly embedded substrate and high levels of fine sediment. Summer rearing habitat was rated 'Fair' for segments BL1, BL3 and BL12 due to abundant pool habitat, fair to good levels of instream cover and fair to good pool depths. Segment BL7 was rated 'Poor' for rearing habitat since it has poor levels of instream cover, shallow pools and highly embedded substrates. Overwintering habitat ratings were 'Fair' for segments BL7 and BL12 due to good quantities of overwintering substrate. BL3 earned a 'Fair' overwintering rating for having abundant pool habitat with good pool depths. Segment BL1 received 'Poor' ratings for overwintering habitat due to low levels of large woody debris as well as poor quantities of overwintering substrate. The segments surveyed in the smaller tributaries in this planning watershed (BL7 and BL12) had high levels of fine sediment and shallow pools, which may indicate high sediment loads.

Rice Creek-The only segment surveyed (BI1) in the Rice Creek planning watershed had slope gradients of 0-3%. Coho and steelhead were present throughout the segment (Mainstem Big River). Spawning habitat was rated 'Fair' due to low quantities of spawning gravels, moderately embedded substrate and moderate levels of fine sediment. Summer rearing habitat was rated 'Poor' due to low levels of instream cover, poor pool depths and low levels of large woody debris.

Overwintering habitat was rated 'Poor' due to low quantities of overwintering substrate as well as the low levels of instream cover, shallow pools and low levels of large woody debris that led to 'Poor' rearing habitat ratings. Shallow pool depths and the poor instream cover suggest a need for large woody debris.

Mettick Creek-There were 13 segments surveyed (BM1, BM3, BM5, BM25, BM26, BM27, BM31, BM32, BM54, BM55, BM59, BM65 and BM76) in the Mettick Creek planning watershed with slope gradients of 0-7%. Coho and steelhead were present throughout segments BM1, BM3, BM5, BM25, BM26, BM27, BM31 and BM32. Steelhead were present throughout segments BM54, BM55, BM59, BM65 and BM76. Spawning habitat was rated 'Fair' for all segments (except BM3) due to fair quantities of spawning gravel, moderate to high embeddedness and fair levels of fine sediment. Segment BM3 received 'Good' ratings for spawning habitat due to abundant spawning gravels, low embeddedness and good gravel quality. Summer rearing habitat was rated 'Fair' for segments BM1, BM3, BM5, BM25, BM54, BM65 and BM76 due to fair to good percentages of pool habitat, moderate amounts of instream cover and moderately embedded substrates. 'Poor' overwintering ratings were received by segments BM26, BM27, BM31, BM32, BM55 and BM59 because these segments were highly embedded, had poor to fair levels of instream cover and low levels of large woody debris. Overwintering habitat was rated 'Fair' for the same segments which rated 'Fair' for rearing habitat due to the low quantities of overwintering substrate, fair amounts of instream cover and fair to good percentages of pool habitat. 'Poor' overwintering ratings were given to the same segments which rated 'Poor' for rearing conditions, because these segments had no overwintering substrate available to fish, poor instream cover and low levels of large woody debris.

This planning watershed had low levels of large woody debris present, which may be the cause of the shallow pool depths. Large woody debris was removed from streams within this planning watershed during the 1980's and 1990's.

Russell Brook-The segments surveyed (BR1, BR2, BR4, BR5, BR6, BR7 and BR29) within the Russell Brook planning watershed had slope gradients of 0-7%. Coho and steelhead were present in the mainstem Big River (segments BR1, BR2 and BR4). Steelhead are present throughout segments BR5, BR6, BR7 and BR29. Spawning habitat was rated 'Fair' for all segments (except BR2) due to fair to good quantities of spawning gravels and fair levels of fine sediment. BR2 received a 'Good' spawning habitat rating due to abundant spawning gravels, moderately embedded substrate and good gravel quality. Summer rearing habitat was rated 'Poor' for segment BR29 due to low levels of large woody debris, highly embedded substrates and poor pool depths. Summer rearing habitat was rated 'Fair' for all other segments due to abundant pool habitat, moderate to high embeddedness and low levels of large woody debris. Overwintering habitat was rated 'Fair' for all segments except BR1 and BR29, which rated 'Poor' due to low quantities of overwintering substrate and low levels of large woody debris. The segments which rated 'Fair' for overwintering habitat had abundant pool habitat but also had low levels of both large woody debris and overwintering substrate. All segments surveyed within the Russell Brook planning watershed (except BR7) had poor levels of large woody debris and poor instream cover available to fish. Large woody debris was removed from streams within this planning watershed during the 1980's and1990's.

South Daugherty Creek -The segments surveyed (BS1, BS3, BS5, BS15, BS23, BS24 and BS49) within the South Daugherty planning watershed had slope gradients of 0-7%.

Coho and steelhead were present throughout segments BS1, BS3 and BS5. Steelhead were present throughout all other segments. Spawning habitat was rated 'Fair' for all segments except BS49, which received a 'Poor' rating due to the highly embedded substrates and high levels of fine sediment. All of the other segments were rated 'Fair' for spawning habitat due to abundant quantities of spawning gravels. Summer rearing habitat was rated 'Poor' for segment BS23 due to poor pool depths and low levels of large woody debris. All other segments were rated 'Fair' for rearing habitat due to fair percentages of pool habitat and poor to fair levels of large woody debris. Overwintering habitat was rated 'Fair' for all segments except BS15, which rated 'Good' due to good quantities of overwintering substrate, fair levels of large woody debris and abundant pool habitat. The other segments, which were rated 'Fair', had shallow pools and less pool habitat. All of the segments surveyed within this planning watershed had poor pool depths, which may be related to the low levels of large woody debris present. Large woody debris was removed from streams within this planning watershed during the 1980's and 1990's.

Two Log Creek-The segments surveyed (BT1, BT2, BT4, BT4(2), BT5, BT12 and BT26) in the Two Log Creek planning watershed had slope gradients of 0-7%. Coho and steelhead were present throughout segments BT1, BT2, BT4 and BT4(2). Steelhead were present throughout segment BT12. Segments BT5 and BT26 had no fish present. Spawning habitat was rated 'Fair' for all segments except BT5 and BT26, which rated 'Poor' due to highly embedded substrates and high levels of fine sediment. The remaining segments (which rated 'Fair') had fair to good quantities of spawning gravel and fair levels of fine sediment. Summer rearing habitat was rated 'Fair' for segments BT2 and BT4 due to moderately embedded substrates and fair to good percentages of pool habitat. Rearing habitat rated 'Poor' for the other segments due to shallow pool depth, highly embedded substrates and poor levels of large woody debris. Overwintering habitat rated 'Fair' for segments BT4 and BT5 due to abundant pool habitat and fair to good instream cover available to fish. All other segments received 'Poor' overwintering habitat ratings due to low quantities of overwintering substrate, low levels of large woody debris and shallow pools. All of the segments surveyed within this planning watershed had poor pool depths, which may be related to the low levels of large woody debris present. Large woody debris was removed from streams within this planning watershed during the 1980's and 1990's.

Noyo River Watershed—Mendocino Redwood Company-Stream Habitat Assessment- Water temperatures across the Noyo are generally desirable and below MWAT thresholds. However, water temperatures increase dramatically in the interior watersheds with the diminishing coastal influence. The warmest stream temperatures are recorded in the headwaters of the North Fork of the Noyo, where summer air temperatures can regularly exceed 100 °F. Source: Noyo River Watershed Analysis-Mendocino Redwood Company

Upper and Middle Noyo (outside JDSF) -The Upper Noyo consists of the headwaters of the Noyo (27 mi^2) and the North Fork of the Noyo River (25 mi^2). The upper end of the basin is directly west of the city of Willits. The upper mainstem of the Noyo drains a number of tributaries including: Olds Creek, Redwood Creek, McMullen Creek, NF Noyo River, Middle Fork of the NF Noyo River, and Hayworth Creek.

Stream temperature and canopy cover data were collected as part of the Noyo River Watershed Analysis across the MRC ownership in the Upper Noyo. Stream temperature was monitored in the Upper Noyo by Louisiana-Pacific Corp. from 1991 to1997 and MRC in 1999. MRC (2000) reported MWAT values for just 1996 and 1999. Stream temperatures were monitored during the summer months when the water temperatures are highest. Many of the monitoring stations recorded MWAT values that exceed the 16.8°C threshold (Welsh et al. 2001; NMFS and USFWS 1997). In addition, many stations recorded maximum stream temperatures that exceed 20°C. The highest stream temperatures were recorded on Hayworth Creek and along the mainstem of the Upper Noyo. It is presumed that these temperature spikes are associated with extremely warm weather conditions and are not sustained for long periods of time.

Stream temperature in the middle and lower portions of the mainstem Noyo are potentially of concern, although, there is little historic water temperature data available for comparison. Monitoring locations have consistently reported MWAT values that exceed the target threshold of 16.8 °C. Much cooler stream temperatures are reported for tributaries to the Noyo, with MWAT values ranging from 13.2 to 16.3°C (Table VII.6.1.5). Water temperatures for these tributaries have remained below the target threshold despite a history of intensive land management across each of these watersheds.

Table VII.6.1.5. Water Temperature (MWAT) for tributaries to the Noyo River.

Stream Name	Percent Harvested 1986-2004	Annual Instream Water Temperature (MWAT) (°C) (Target Temperature is ≤ 16.8° C									
		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Little North Fork Noyo	80%	13.7	15.1	14.1	15.6	14.1	14.3	13.8	13.9	14.1	14.6
Duffy Gulch	83%				15.4	15.1	14.9	14.8	14.6		14.8
Kass Creek	63%	13.2	14.5	16.3	13.8	13.8	13.6	13.4	13.6	13.6	14.1

The following discussion of results is separated into the six planning watersheds of the Noyo Watershed Analysis Unit (WAU). Each planning watershed contained one to eight survey segments.

<u>North Fork Noyo-</u>The segments surveyed (1, 3, 23, and 48) in the North Fork Noyo planning watershed range between 0% and 4% slope. Geomorphic Units 1-3 are associated with these segments. These Geomorphic Units are depositional with varying confinement associated with strath terraces. Coho and steelhead were found in all segments except 48 which had only steelhead. Spawning habitat rated 'Fair' in all segments except segment 1, which rated 'Good'. All of the segments exhibited an abundance of spawning gravel with low levels of embeddedness, and a high amount of fine sediment. Segment 1 had a low amount of fine sediment present, raising the overall rating for measured parameters to 'Good.' Rearing habitat in segments 1 and 3 rated 'Poor', while 23 and 48 rated 'Fair'.

Fewer pools, a lower amount of wood, and a higher percentage of embeddedness contributed to the 'Poor' rating Segments 23 and 48 had a higher frequency of pools which increased their rating to 'Fair', however all segments lacked instream cover and pool depth which prevented ratings from being 'Good'. The overwintering habitats in these segments all rated 'Poor' except for segment 48 which received a 'Fair' rating. Overall these units had a fair amount of pools per stream length, yet lacked large wood, substrate roughness, and other elements of shelter complexity. Segment 48 had adequate large wood and received a 'Good' rating in that category.

Olds Creek -The segments surveyed (56, 57, 63, and 64) in the Olds Creek planning watershed ranged from 0% to 4% slope. These segments are in Geomorphic Units 1-3. These Geomorphic Units are depositional with varying confinement associated with strath terraces. Steelhead were present in all segments, and coho were found in segments 63 and 64. Spawning habitat rated 'Good' in segments 56 and 57, and 'Fair' in segments 63 and 64. There were low levels of embeddedness and fine sediment in all of the segments. Gravel quantity decreased in segments 63 and 64, lowering the overall quality. Segments 57 and 64 were assigned 'Poor' ratings for both rearing and overwintering habitat due to the lack of pools, low pool frequency and poor pool depth. In addition, little large wood was present. All segments had sufficient amounts of overwintering substrate which provides an element of roughness, but this alone does not warrant 'Good' overwintering habitat ratings for these units.

McMullen Creek -Only segment 80 was surveyed in this planning watershed. This segment is within Geomorphic Unit 3. Geomorphic Unit 3 is characterized by slightly entrenched depositional channels within strath terraces and 'U'-shaped canyons. Segment 80 has a slope of 1% to 2%, and both coho and steelhead were present. Spawning habitat consisted of low amounts of gravel, low embeddedness, and low levels of fines. The overall rating was 'Fair'. Rearing habitat was 'Poor' due to the lack of pools and large wood. Overwintering habitat was characterized by low amounts of pools, but high levels of substrate roughness, shelter, and small woody debris, which creates refuges for young fish. The overall rating was 'Fair'.

Redwood Creek -The two segments surveyed (92(lower) and 92(upper)) in this planning watershed had slope gradients of 1% to 2%. These segments are within Geomorphic Unit 3. Geomorphic Unit 3 is characterized as a slightly entrenched depositional channel within strath terraces and 'U'-shaped canyons. Both coho and steelhead are found throughout these segments. These segments rated 'Good' for spawning habitat. Gravel quantity was abundant in these sections with low levels of fine sediment associated with them. Embeddedness was slightly higher in segment 92 (lower). Rearing rated 'Good' for the upstream segment, 92 (upper), and 'Fair' for the lower segment of 92. Overwintering habitat was rated 'Good' for both of these segments. The lower segment had 50% less large wood and fewer pools than the upstream segment. Of the pools that were present in segment 92 (lower), only 13% were greater than 3 ft. in depth. Eighty-nine percent of the pools in Segment 92 (upper) were greater than 3 ft. deep. Redwood Creek had the highest densities of juvenile coho salmon than any other planning watershed in the Noyo River WAU.

Hayworth Creek -The five segments surveyed (104, 106, 112, 118, and 119) in the Hayworth Creek planning watershed had slopes ranging from 0% to 8%. Segment 104 is in Geomorphic Unit 1 and segments 106 and 118 are in Geomorphic Unit 2. These geomorphic units are depositional with varying confinement associated with strath terraces. Segments 112 and 119 are in Geomorphic Unit 4. This Unit is characterized as a moderate gradient transport segment of 'V'-shaped canyons. Steelhead were found in all segments and coho were found in segments 104 and 106. Spawning habitat was assigned a rating of 'Fair' in segments 104, 106, and 118. The other two segments, 112 and 119, had the highest amount of subsurface fines and the least amount of spawning gravel. Segment 112 was entirely boulder dominated. These factors lead to a rating of 'Poor' for spawning habitat quality for segments 112 and 119. Rearing habitat for segments 106, 112, 118, and 119 was 'Fair'. Segment 104 was 'Good' for rearing habitat. Segment 119 had the fewest amount of pools, the lowest value of shelter complexity, and no pools greater than 3 ft. deep. Overwintering habitat was rated 'Fair' in all segments except 104, which was 'Good'. Of the four 'Fair' segments, only one, segment 106, had pools with a residual depth greater than 3 ft. Segment 104 had the highest shelter value, highest amount of pools by stream length, and 59% of the pools were greater than 3 ft. in residual depth.

<u>Middle Fork North Fork Noyo</u>-The eight segments surveyed (152(lower), 152(upper), 153(lower), 153(upper), 156, 159(lower), 159(upper), and 161) in the Middle Fork Noyo Planning Watershed had slope gradients ranging from 1% to 8%. Segments 152, 153, and 159 are within Geomorphic Units 1-3. These geomorphic units are depositional with varying confinement associated with strath terraces. Segments 156 and 161 are in Geomorphic Unit 4. This Unit is characterized as a moderate gradient transport segment of 'V'-shaped canyons. Segments 156, 159(lower), 159(upper) and 161 had only steelhead present while steelhead and coho were found in all other segments. The spawning habitat was rated as 'Fair' for all but two segments, 159(lower) and 161. Segment 159(lower) was rated as 'Good' and segment 161 was rated as 'Poor'. The 'Poor' rating was attributed to higher amounts of subsurface fines that lead to an increased amount of embeddedness.

Segments 153 (upper) and 159 (lower) rated 'Poor' for rearing habitat. These two units had the least amount of pools per stream length, no pools greater than 3 ft. deep, and a decreased pool frequency. Segments 153(lower) and 159(upper) rated 'Fair' for rearing habitat. For overwintering habitat, six of the eight segments were rated as 'Fair'.

Segment 156, which had the greatest number of pools and the highest frequency of pool spacing, was the only 'Good' rating for overwintering habitat. Segment 159(lower) received the only 'Poor' overwintering rating due to a lack of pool frequency, pool shelter complexity, and lack of large substrate.

6.1.5 Timber Harvest History

The rate of timber harvest increased substantially from the mid-1980s to the mid-1990s in the Noyo River watershed, when compared with periods for the last 70 years (Figure VII 6.1.10). In some sub-basins approximately 80% of the land area has been included in a THP applying a range of harvest prescriptions. Extensive harvests in portions of the Big River watershed to the south of JDSF also occurred from the mid-1980s through the decade of the 1990s. Detailed harvest history information may be found in section VIII.2.1 and Appendix 14.

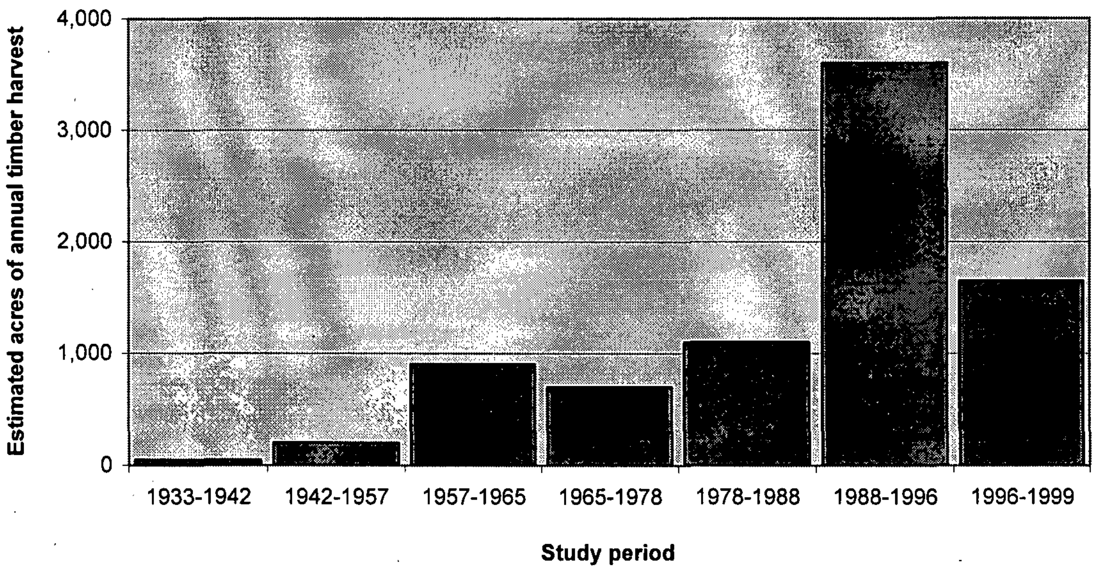


Figure VII 6.1.10. Average Acres of Timber Harvest per Year in the Noyo River Watershed.

Big River and Noyo River

Big River-Large woody debris recruitment potential and in-stream large wood demand provides baseline information on the structure and composition of the riparian stand and the level of concern about current large wood conditions in the stream (Mendocino Redwood Company, 2002).

Only six of forty-four segments surveyed in the Big River WAU met the target for key large wood. However, many of the streams in the WAU have reasonably good levels of functional large wood. Generally, large wood loading in streams in the Big River WAU needs improvement.

Debris jams, though very scarce in the Big River WAU, were shown to contain a significant portion of the total piece count and volume when they occurred. In the Big River WAU, debris jams occurred in seven segments and contained approximately 40-50% of the total pieces and at times a considerable amount of the total volume. In a few streams, debris jams actually affected whether or not the segment met the key large wood target. Although there obviously can be a significant amount of large wood trapped in debris jams, the ecological function may not be accurately represented by numbers alone. All of the pieces in a debris jam may actually have more habitat value if they were spread out in the stream as opposed to being piled up in one spot. The percent of volume contained in debris accumulations (>3 pieces) varied widely in segments in the Big River WAU. A considerable amount of large wood in any given segment was at least partially buried. A significant portion of the large wood volume may therefore, eventually be useful to the stream (Mendocino Redwood Company, 2002).

Large wood species composition was largely redwood dominated. This Mendocino Redwood Company analysis was limited to pieces not contained within debris jams. Redwood comprised 77% of the large wood volume in all surveys in the Big River WAU and in a few streams all pieces were redwood. This may not be surprising, as these streams flow through a redwood forest, but it does show that the large wood currently found in streams within the Big River WAU is more stable, as redwood breaks down more slowly in streams than hardwood species (Mendocino Redwood Company, 2002).

Nearly all segments in the Big River WAU contained large wood that was not recently contributed to the stream. All but two of the segments fell into the 0-25% category for large wood recently recruited (<10 yrs). It did not appear that many of the large wood pieces had been contributed within the last 10 years.

Riparian recruitment potential is, in general, quite poor in the Big River WAU. Exceptions are the East Branch North Fork of Big River and Two Log Creek, where the majority of riparian stands fall into the high and moderate recruitment potential rating. Provided this is maintained, good future large wood recruitment potential from the riparian stands will be present in these streams. Here, as in most of the Big River WAU, Class II and III channels have especially poor riparian stands. Russell Brook, South Fork Big River, upper Daughtery Creek and especially Ramon Creek are noteworthy for their exceptionally low riparian recruitment potential. Past harvesting activities in riparian areas have resulted in small-sized, open stands, which are composed of mixed conifer and hardwood species. Due primarily to the low large wood recruitment potential of riparian stands, nearly every major channel in the Big River WAU falls into the high instream large wood demand category. The mainstem Big River, South Fork Big River, North Fork Big River, and East Branch North Fork Big River are large wood deficient (Mendocino Redwood Company, 2002).

Table VII.6.1.6 shows the instream large wood quality rating for major streams and sections of stream or river in individual Calwater planning watersheds. Currently the major streams within the Big River WAU have a mix of marginal and deficient large wood quality ratings. None of the major streams in the Big River WAU received an on- target rating.

Noyo River- Fifty percent of the units surveyed within these planning watersheds were deficient in large wood and twenty-five percent had optimal large wood. Between 1959 and 1964 CDFG removed large wood accumulations by burning in channel and cutting material and placing it above the floodplain. Approximately 4,661,668 board feet were removed from the Noyo River during this time period (Mendocino Redwood Company, 2002).

Table VII.6.1.6. Instream large wood Quality Ratings for Major Streams and Sections of Streams or Rivers in Calwater Planning Watersheds for the Gualala WAU. (Source: Mendocino Redwood Company 2002)

Stream	Calwater Planning Watershed	Instream Large Wood Quality Rating
Big River (Two Log PWS)	Two Log Creek	Deficient
Big River (Russell Brook PWS)	Russell Brook	Deficient
Big River (Rice Creek PWS)	Rice Creek	Deficient
Russell Brook	Russell Brook	Marginal
North Fork Big River	Lower North Fork Big River	Deficient
East Branch North Fork Big River	East Branch North Fork Big River	Marginal
Two Log Creek	Two Log Creek	Deficient
Tramway Gulch	Two Log Creek	Marginal
South Fork Big River	Mettick Creek	Deficient
Ramon Creek	Mettick Creek	Marginal
Mettick Creek	Mettick Creek	Deficient
Anderson Gulch	Mettick Creek	Deficient
Boardman Gulch	Mettick Creek	Deficient
Halfway House Gulch	Mettick Creek	Marginal
Daugherty Creek	South Daugherty	Marginal
Soda Creek	South Daugherty	Marginal
Gates Creek	South Daugherty	Marginal
Snuffins Creek	South Daugherty	Marginal

The quantities of material (in board feet (bf)) removed from the tributaries is listed below:

Tributary	Large Wood Removed
Little North Fork Noyo	201,420 bf.
North Fork Noyo	18,000 bf.
Hayworth Creek	2,232,480 bf.
Duffy Gulch	362,040 bf.
Burbeck Creek	67,800 bf.
Kass Creek (S.F. Noyo)	132,024 bf.
Marble Gulch	604,440 bf.
Olds Creek	153,900 bf.
Redwood Creek	590,244 bf.
McMullen Creek	299,340 bf.

Large wood was determined to be sparse in the mainstem channel segments of the Noyo WAU; the Noyo River, North Fork Noyo River, and Hayworth Creek. Most sections of these mainstem rivers are large channels with high stream power. In the mainstem rivers of the Noyo River WAU, very large large wood pieces or large debris jams are required to keep the large wood in the channel during high flow events.

Large wood is generally sparse, with some areas of abundant large wood in the channel segments of Redwood Creek, Olds Creek, Middle Fork of the North Fork Noyo River, Burbeck Creek, and Marble Gulch. The smaller tributaries of the Noyo WAU vary from having sparse to abundant large wood in their channel segments.

In many of the channel segments of the Noyo River tributaries, large wood is limited (Table VII.6.1.7).

Water Temperature-Water temperatures vary both spatially and temporally across the JDSF EIR assessment area. In general, stream temperatures are highest in some of the larger tributaries towards the interior (i.e., eastern) portions, and along portions of the mainstem Noyo River, the Big River and the North and South Forks of the Big River. Achieving targets for canopy cover will require a period of time sufficient to increase both tree height and canopy density. In addition, stream temperatures in a watershed tend to increase in the downstream direction and increase with increasing watershed area (Figure 1). Water temperature data indicate that stream temperatures along the middle and upper mainstem of the Noyo River remains warm and are consistently warmer than water temperatures measured along the lower reaches of the South Fork Noyo downstream of JDSF. This is undoubtedly due to the fact that the channels are wider, have been subjected to substantial canopy reductions in the past, and trees growing along the margins of the stream are incapable of fully shading the full channel width.

To prevent any future impacts to water temperature from the proposed management plan JDSF will meet or exceed all watercourse protection measures as stated in the FPRs. In addition, JDSF is committed to maintaining a network of monitoring stations that can be used to document trends in water temperature and identify potential impacts on water temperature from forest management. Currently, most streams within JDSF consistently record water temperature that is below the MWAT threshold of 16.8° C. However, Parlin Creek, Chamberlain Creek and James Creek have all recorded MWAT values that exceed this threshold and are areas of potential concern. These areas should be priorities for continued monitoring and canopy development.

Table VII.6.1.7. Large woody Debris in Selected Stream Segments of the Noyo WAU. Source: Mendocino Redwood Company, 2002

	Active Channel			Bankfull Channel				Overall
Stream Segment Name	Functional large wood (# 100 m)	Key large wood (# pieces)	Key large wood (#100m)	Functional large wood (# pieces)	Functional large wood (bf #/100m)	Key large wood (# in bfull)	Key large wood (bf#/100m)	Percent Current/ Relic Recruitment
Noyo River	0.8	1	0.3	5	1.3	2	0.5	n/a
Noyo River	2.1	2	0.4	11	2.3	2	0.4	90/10
North Fork Noyo	0.2	4	0.9	8	1.8	4	0.9	n/a
Hayworth	0.0	0	0.0	2	0.8	0	0.0	n/a
North Fork Noyo	2.0	0	0.0	4	2.0	1	0.5	n/a
Olds Creek	1.1	0	0.0	0	0.0	0	0.0	n/a
Marble Gulch	2.7	3	1.6	6	3.2	6	3.2	65/35
Hayworth Creek	0.9	0	0.0	5	1.5	1	0.3	60/40
Hayworth Creek	4.4	1	0.4	80	32.2	14	5.6	70/30
North Fork Noyo	3.5	3	1.2	16	6.2	3	1.2	70/30
Redwood Creek	5.4	2	0.9	13	5.9	0	0.0	100/0
Redwood Creek	10.8	5	1.5	38	11.7	6	1.8	n/a
Burbeck trib.	3.3	0	0.0	1	0.7	2	1.3	80/20
Upper trib. Of Noyo	7.7	0	0.0	2	2.2	0	0.0	100/0
Unnamed trib.of Noyo	11.0	4	2.0	5	2.5	2	1.0	80/20
Gulch#7	14.5	3	2.9	15	14.5	3	2.9	80/20
MiddleForkNorthFork	8.7	0	0.0	22	10.1	1	0.5	90/10
MiddleForkNorthFork	9.3	1	0.7	15	10.7	3	2.1	90/10
North Fork Noyo	3.6	4	1.4	27	9.8	4	1.4	90/10
North Fork Noyo	14.7	0	0.0	26	15.9	0	0.0	95/5
Middle Fork North Fork	7.3	6	2.9	25	12.2	7	3.4	n/a
DeWarren Creek	33.5	11	7.2	51	33.5	15	9.8	80/20
North Fork Hayworth	0.5	2	1.1	31	16.9	26	14.2	10/90
Soda Creek	36.1	11	7.2	66	43.3	16	10.5	15/85

North Fork Big River (excerpted from NCWAP Big River)--

The North Fork Big appears to heat relatively quickly upstream of, and at, the boundary of the JDSF. The observed MWATs go from 63° F in the headwater area to 66° F at the JDSF boundary. This is likely due to poor canopy, low flows, and possibly different temperature probe placement protocols between ownerships.

Once in JDSF, water temperatures begin a steady decline. Based on temperature monitors in the North Fork on either side of the James Creek confluence and monitors in James Creek, it appears as though James Creek has a slight cooling effect on the North Fork. Recorded MWATs in the North Fork around James Creek were 65-66° F. James Creek appears to be fully suitable at the headwaters and progressively becomes warmer until the confluence with the North Fork. The one year of monitoring near the confluence of the North Fork indicated an MWAT of 63° F.

Similarly, temperature monitors in the North Fork on either side of the Chamberlain Creek confluence and monitors in Chamberlain Creek, it appears as though Chamberlain Creek has a cooling effect on the North Fork. Recorded MWATs in the North Fork around Chamberlain Creek were 64-65° F. Chamberlain Creek appears to be fully suitable at the headwaters and progressively becomes warmer until the confluence with the North Fork. Monitoring near the confluence of the North Fork indicated MWATs of 62-63° F.

Other monitoring was conducted on several tributaries to Chamberlain Creek, including West Chamberlain Creek, Arvola Gulch, and Water Gulch. Each of these tributaries were fully to moderately suitable in the years monitored with MWATs of 57-61° F. The thermograph from the Water Gulch site suggests that that the monitoring location may have a significant groundwater component and/or possibly a thermally stratified pool, especially in August and September. To the extent that Water Gulch and West Chamberlain Creek contribute flow to Chamberlain Creek, it is likely that they contribute some amount of cooling to Chamberlain Creek.

The final site in lower Chamberlain Creek (JDSF 539) appears to have substantially higher water temperatures than JDSF 538. Based on a 1994 Landsat vegetation map (KRIS Big River), it may be that the elevated temperatures seen at this site are due to a large clearing in this portion of Chamberlain Creek.

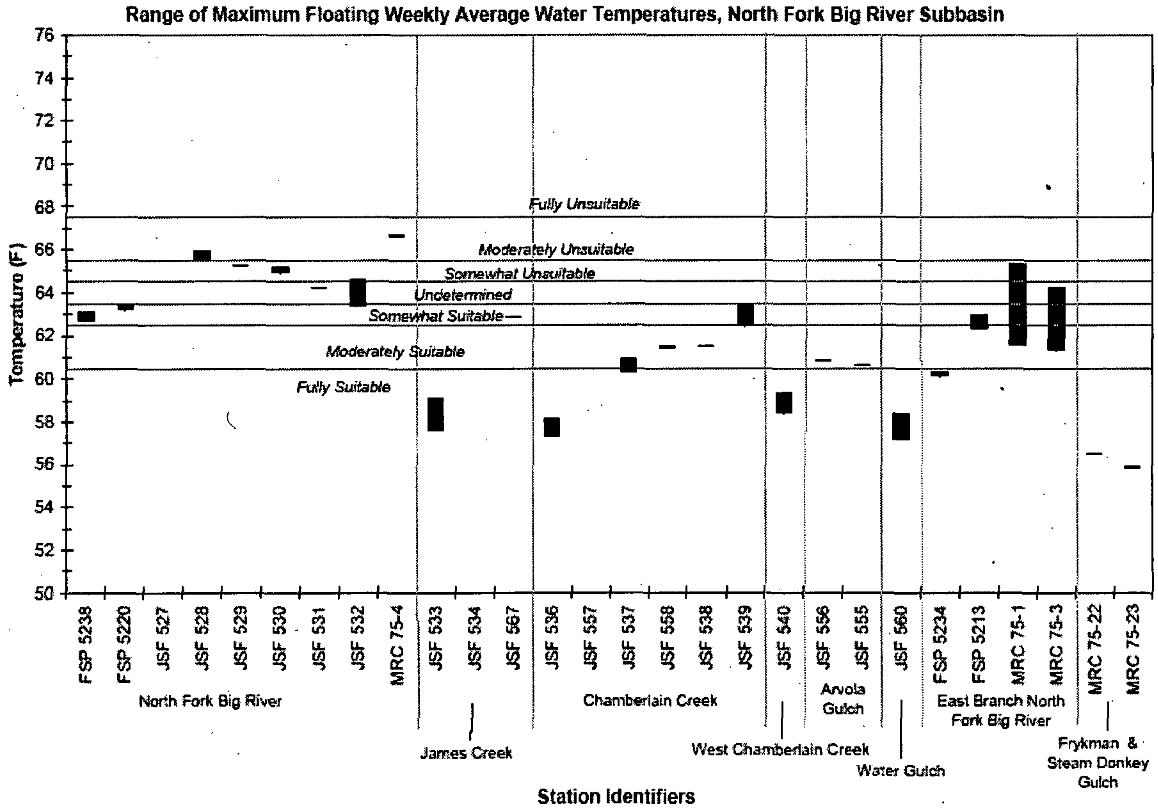
Water temperatures downstream of Chamberlain Creek and upstream of the East Branch North Fork appear to remain relatively constant, if the data from JDSF 532 can be extrapolated. In any case, the MWAT at this site does not appear to be substantially different from JDSF 531 (the site upstream of it). The MWAT in this area, with three years of monitoring, is approximately 64° F.

The East Branch of the North Fork has some indication of headwaters with an MWAT of approximately 60° F, but with increasing water temperatures between the headwater monitoring site (FSP 5234) and the next site (FSP 5213), which had recorded MWATs of approximately 62-63° F in the two years of monitoring. Water temperatures appear to remain relatively constant to the mouth of the East Branch North Fork, with MWATs between 61-65° F.

Frykman and Steam Donkey Gulch, two small tributaries of the East Branch North Fork, were monitored. However, while the water temperatures in both tributaries were fully suitable in the years monitored, it appears as though these temperature probes were placed in a deep stratified pool or are dominated by groundwater influences. In any case, it is unlikely that they contribute significantly to the mainstem of the East Branch North Fork.

Water temperatures in the North Fork below the confluence with the East Branch North Fork appear to increase significantly from what was recorded in JDSF 532 (upstream of the East Branch North Fork). The maximum MWAT increases between JDSF 532 and MRC 75-4 from approximately 65 to 67° F. While it does not appear the confluence of the East Branch North Fork would significantly affect water temperatures, the difference may be due to local conditions upstream of MRC 75-4 such as poor canopy, or just could be an artifact of the fact that MRC 75-4 was only monitored during one year, which did not coincide with the years monitored at JDSF 532.

FIGURE 16: RANGE OF MWATS, NORTH FORK BIG RIVER SUBBASIN



Overall Summary (excerpted from NCWAP Big River)--

With the exception of the Big River Estuary, continuous water temperature data loggers were available in every subbasin. Water temperatures in the mainstem Big River were high in virtually every location tested, and the daily maximum temperatures sometimes exceeded the lethal threshold for salmonids.

Tributaries in the Lower Big River subbasin had fully suitable to moderately suitable water temperatures. It is likely that this is due, in large part, to the cooling marine influence in this subbasin. Although not supported by any data, it is probable that higher precipitation in this subbasin also assists in the rapid re-growth of the forest and understory vegetation that offers stream shading. Overall, the water temperature in the Lower Big River tributaries appears to be in the best condition of any subbasin in the Big River watershed. Also, it is likely that the Little North Fork has some cooling effect as it enters the mainstem Big River.

Tributaries in the Middle Big River subbasin had fully suitable to undetermined water temperatures. While the data in this subbasin is relatively spare, it is likely *that the marine influence in this subbasin and rapid re-growth of vegetation also helps keeps water temperatures relatively low. The tributaries that were monitored in this subbasin appear to be in good condition with respect to water temperature for salmonids. Also, it is likely that the Two Log Creek has some cooling effect as it enters the mainstem Big River. Tributaries in the Upper Big River subbasin had fully suitable to somewhat unsuitable water temperatures. However, except for the site on Russell Brook and two other sites that appear to be dominated by groundwater, the tributaries that were monitored in this subbasin appear to be in poor condition with respect to water temperature for salmonids. It also appears as that the upper mainstem Big River is one of the origins of the warm water seen downstream. Water leaves this subbasin with an MWAT of roughly 66-68° F.*

Tributaries in the North Fork subbasin, including the North Fork itself, had fully suitable to moderately unsuitable water temperatures. Generally, the tributaries that were monitored in this subbasin appear to be in good condition with respect to water temperature for salmonids. The notable exception to this is Lower Chamberlain Creek, most of the East Branch of the North Fork, and the mainstem of the North Fork. The mainstem North Fork is unusual in that it exhibits a rapid increase in water temperature upstream of the JDSF boundary, and then slowly declines until it leaves JDSF, and again shows a rapid increase near the confluence with the mainstem Big River. The obvious hypothesis is that it may be due to naturally poor canopy or to commercial timber harvesting on either end of the North Fork. In any case, this should be investigated further. It also appears as that the North Fork is one of the origins of the warm water seen downstream in the mainstem Big River. Water leaves this subbasin with an MWAT of roughly 67° F.

Tributaries in the South Fork subbasin, including the South Fork Big River, had fully suitable to fully unsuitable water temperatures. Except for the tributaries that appear to be dominated by groundwater and the one site in the Montgomery Reserve, the sites in this subbasin were poor with respect to water temperature. In fact, the lower mainstem South Fork had the highest daily water temperature (74° F) of any stream other than the mainstem Big River. Conversely, the site in the Montgomery Reserve is a good example of what can be achieved with adequate canopy in the warmer interior portion of the Big River watershed. Water leaves the South Fork subbasin with an MWAT of roughly 67-69° F.

6.1.6 Regional Salmonid Population Status

Coho Salmon

A comprehensive review of estimates of historic abundance, decline and present status of coho salmon in California is provided by Brown et al. (1994). They estimated that the coho salmon annual spawning population in California ranged between 200,000 and 500,000 fish in the 1940s, which declined to about 100,000 fish by the 1960s, followed by a further decline to about 31,000 fish by 1991, of which 57 percent were artificially propagated. The other 43 percent (13,240) were natural spawners, which included naturally-produced, wild fish and naturalized (hatchery-influenced) fish. Brown et al. (1994) cautioned that this estimate could be overstated by 50 percent or more. Of the 13,240, only about 5,000 were naturally-produced, wild coho salmon without hatchery influence, and many of these were in individual stream populations of less than 100 fish each. In summary, Brown et al. (1994) concluded that the California coho salmon population had declined more than 94 percent since the 1940s, with the greatest decline occurring since the 1960s (Table VII.6.1.8). Brown et al. (1994) in *Historical Decline and Current Status of Coho Salmon in California* indicated that California coho salmon were in need of protection under the Endangered Species Act. They noted that one of the last of seven adult coho populations in the hundreds occurred in the Noyo River. The remaining coho salmon populations that number in the hundreds are important to conservation and restoration of the species because they provide a source of colonists for other streams. The current population centers, according to Brown et al. (1994), are several hundred miles from one another.

Nehlsen et al. (1991) provided no specific information on individual coho salmon populations in their 1991 status review, but concluded that salmon stocks in small coastal streams north of San Francisco Bay were at moderate risk of extinction and those in coastal streams south of San Francisco Bay were at high risk of extinction. A subsequent status review by the Humboldt Chapter of the American Fisheries Society (Higgins et al., 1992) found four populations (Pudding Creek, Garcia River, Gualala rivers, and Russian River) as high risk of extinction and five (Ten Mile, Noyo, Big, Navarro, and Albion rivers) as stocks of concern.

Risk factors identified by a National Marine Fisheries Service Biological Review Team (BRT) included extremely low contemporary abundance compared to historical abundance, widespread local extinction, clear downward trends in abundance, extensive habitat degradation, and associated decreases in carrying capacity. Additionally, the BRT concluded that the main stocks of coho salmon in the CCC ESU have been heavily influenced by hatcheries and that there were relatively few native coho salmon left in the ESU (Weitkamp et al., 1995). Most existing stocks have a history of hatchery planting, with many out-of-ESU stock transfers. A subsequent status review (Schiewe, 1996a fide NOAA, 2003), which focused on existing hatcheries, concluded that, despite the historical introduction of non-native fish, the Scott Creek (Kingfisher Flat) and Noyo River brood stocks have regularly incorporated wild broodstock and, thus, were unlikely to differ from naturally spawning fish within the ESU. Recent droughts and unfavorable ocean conditions were identified as natural factors contributing to reduced run size.

Based on the data presented above, the BRT concluded that all coho salmon stocks in the CCC ESU were depressed relative to historical abundance and that most extant populations have been heavily influenced by hatchery operations. They unanimously concluded that natural populations of coho salmon in this ESU were in danger of extinction (Weitkamp et al., 1995). After considering new information on coho salmon presence within the ESU, the majority of the BRT concluded that the ESU was in danger of extinction; while a minority concluded the ESU was not presently in danger of extinction but was likely to become so in the foreseeable future (Schiewe, 1996b fide NOAA, 2003).

Table VII.6.1.8. Historical Estimates of Coho Salmon Spawner Abundance for Various Rivers and Regions within the Central California Coast Evolutionarily Significant Unit.

	Estimated Escapement		
	CDFG (1965)[a]	Wable & Pearson (1987)[b]	Brown et al. (1994)[c]
River/Region	1963	1984-1985	1987-1991
Ten Mile River	6,000	2,000	160[d]
Noyo River	6,000	2,000	3,740
Big River	6,000	2,000	280
Navarro River	7,000	2,000	300
Garcia river	2,000	500	
Other Mendocino County	10,000	7,000[e]	470[f]
Gualala River	4,000	1,000	200
Russian River	5,000	1,000	255
Other Sonoma County	1,000		180
Marin County	5,000		435
San Mateo & Santa Cruz Counties	4,100	550	140
San Mateo County	1,000		
Santa Cruz County (excl. San Lor. Riv.)	1,500	50	
San Lorenzo River	1,600	500	
ESU Total	56,100	18,050	6,160
Statewide Total	99,400	30,480	13,240

[a] Values excludes ocean catch.

[b] Estimates are for wild or naturalized fish; hatchery returns excluded.

[c] Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.

[d] Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.

[e] Value may include Marin and Sonoma County fish.

[f] Appears to include Garcia River fish.

Source: http://swr.nmfs.noaa.gov/sac/NOAARPTBOARDFORESTRY.pdf

Table VII.6.1.9. Historical Presence of Coho salmon in the CCC ESU as Determined by Brown and Moyle (1981) and the California Department of Fish and Game's Analysis of Recent Presence (1995-2001).

Brown et al. (1994) calendar yrs 1987-1990					CDFG (2002) Years 1995-2001				
County/River Basin	# of streams	# of streams w/info	Coho present	%	# of streams surveyed in 2001	# of streams w/coho present	# of streams w/coho assumed present	# of streams w/coho not detected in 2001	% present (1995-2001)
Mendocino									
Coastal	44	35	13	37	30	11	10	19	52
Ten Mile River	11	10	7	79	11	9	0	2	82
Noyo River	13	12	11	92	8	7	5	1	92
Big River	16	13	11	85	8	3	6	5	64
Navarro River	19	8	4	50	14	6	1	8	47
Subtotal	103	78	46	59	71	36	22	35	62
Sonoma									
Coastal	10	2	1	50	4	0	0	4	0
Gualala River	11	2	1	50	10	0	0	10	0
Russian River	32	24	2	8	29	1	1	28	0
Subtotal	53	28	4	14	43	1	1	42	4
Marin									
Coastal	10	7	7	100	15	6	0	9	40
Subtotal	10	7	7	100	15	6	0	9	40
Tribs. To S. F. Bay									
Coastal	7	7	0	0	6	0	0	6	0
Subtotal	7	7	0	0	6	0	0	6	0
South of S. F. Bay									
Coastal	13	13	5	38					
Subtotal	13	13	5	38					
ESU Total	186	133	62	47	135	43	23	92	42

County classifications are based on the location of the mouth of the river system. Data from CDFG (2002)

In mid-2003, the Board of Forestry and Fire Protection requested information from the National Oceanic and Atmospheric Administration (NOAA) on salmonid enumeration. NOAA responded to that request with transmittal of a report summarizing preliminary scientific conclusions of the NMFS Biological Review Team (BRT) on the updated status of 26 ESA-listed Evolutionarily Significant Units (ESUs) of salmon and steelhead from Washington, Oregon, Idaho, and California. This report represented the best available data as of April 2003. Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead, by the West Coast Salmon Biological Review Team is the basis for the regional status of listed ESUs. Pertinent regional population and trend data and associated text are reproduced below.

Populations Central California Coho-Within California, coho salmon historically ranged from the Oregon-California border (including the Winchuck and Illinois River drainages) south to the streams of northern Monterey Bay (Snyder, 1931; Fry, 1973), including small tributaries to San Francisco Bay (Brown and Moyle, 1991; Leidy and Becker, 2001). However, there is some evidence that they historically ranged as far south as the Pajaro River (Anderson, 1995), the Big Sur River (Hassler et al., 1991), or even the Santa Ynez River (Lucoff, 1980, fide National Council on Gene Resources 1982), although evidence of spawning populations south of the Pajaro River is anecdotal (Anderson, 1995). Currently, the southernmost stream that contains coho salmon is Aptos Creek in Santa Cruz County (NMFS, 2001) (FigureVII.6.1.11).

Two coho salmon Evolutionarily Significant Units (ESUs) are found in California; the Southern Oregon /Northern California Coast Coho ESU (from Punta Gorda, California, north across the state border to Cape Blanco, Oregon); and the Central California Coast Coho ESU (from Punta Gorda, California, south to the San Lorenzo River) (Figure VII.6.1.12).

The National Marine Fisheries Service (NMFS, 2001) *Status Review Update for Coho Salmon (Oncorhynchus kisutch) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Unit* found that: "The Central California Coast ESU is presently in danger of extinction.

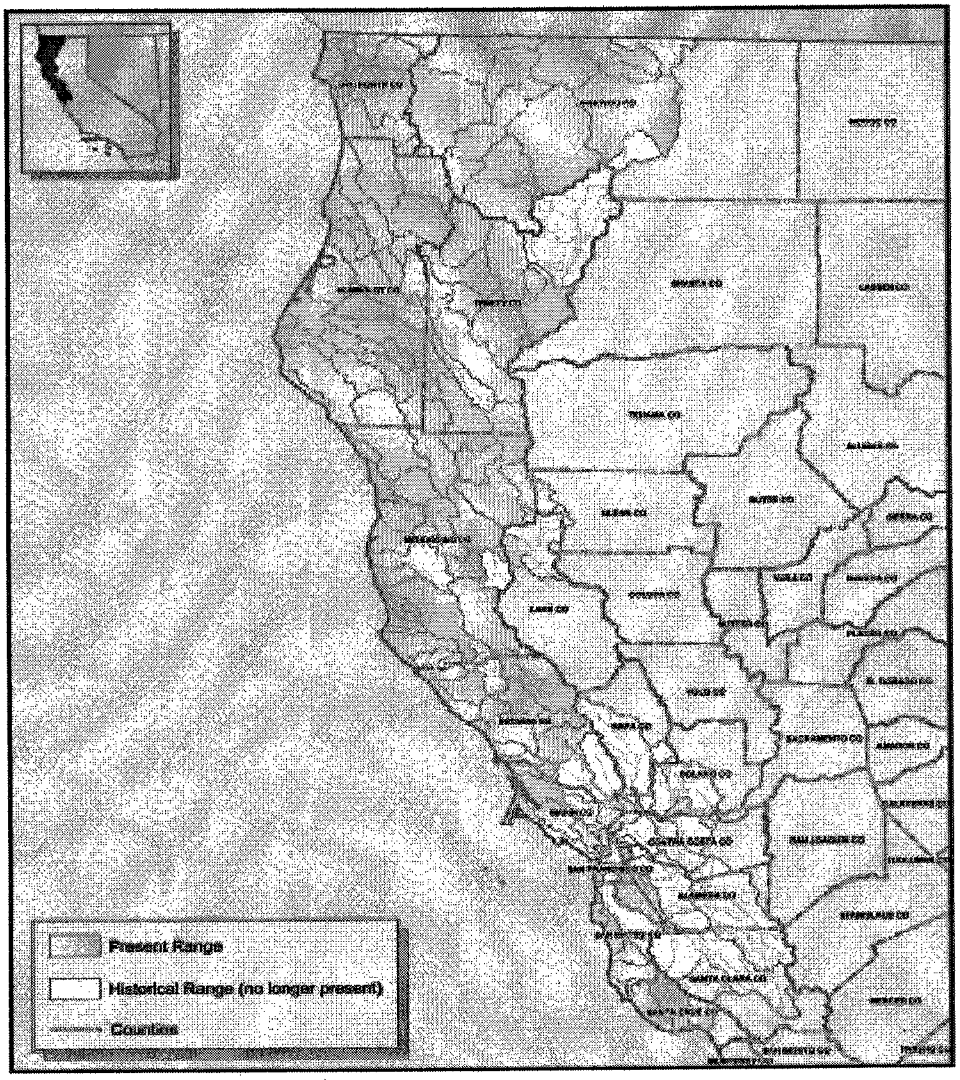
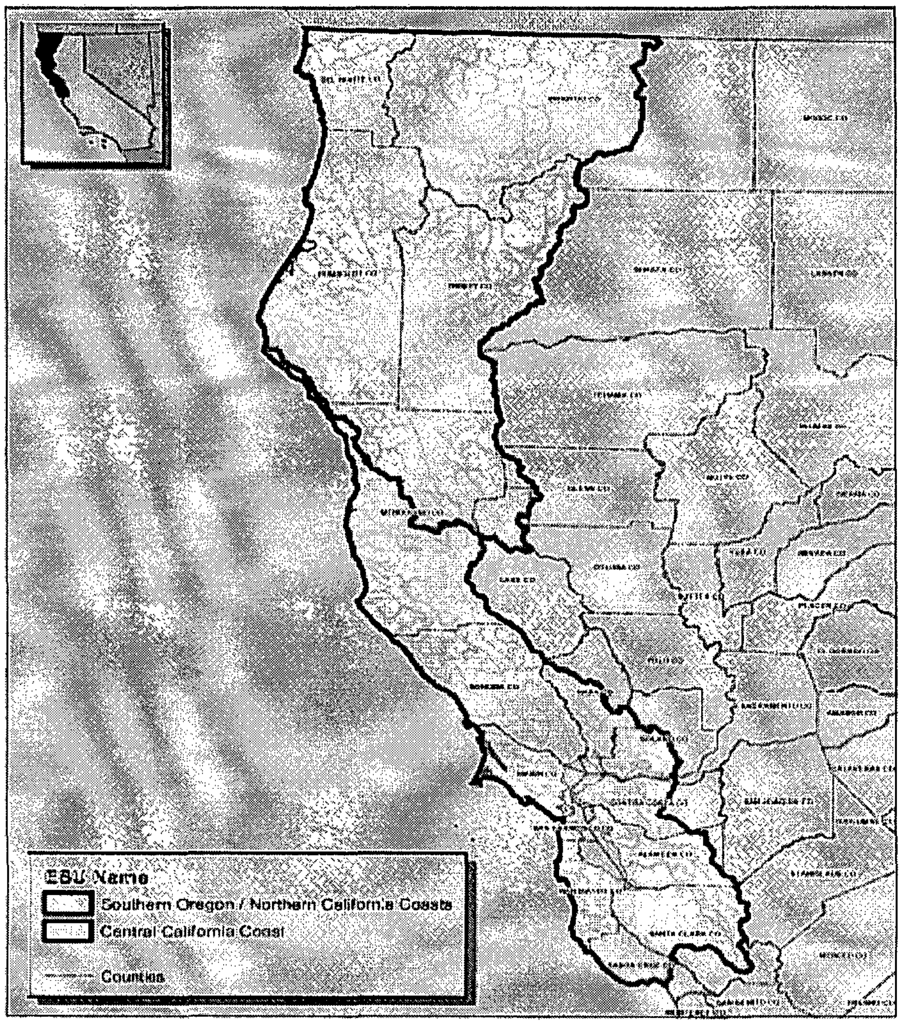


Figure VII 6.1.11. Historical and Present Range of Coho Salmon in California
Source: *Recovery Strategy for California Coho Salmon* (*Oncorhynchus kisutch*) Report to the California Fish and Game Commission Public Review Draft November 2003



Source: CDFG 2002

Figure VII 6.1.12. Coho Evolutionarily Significant Units in California
Source: *Recovery Strategy For California Coho Salmon* (*Oncorhynchus kisutch*): Report to the California Fish and Game Commission Public Review Draft November 2003

The condition of coho salmon populations in this ESU is worse than indicated by previous reviews." The recently released California Department of Fish and Game (CDFG, 2002) *Status Review of Coho Salmon North of San Francisco* characterized the coho meta population including the JDSF area as follows: "Extant populations in this region appear to be small. Small population size along with large-scale fragmentation and collapse of range observed in data for this area indicate that metapopulation structure may be severely compromised and remaining populations may face greatly increased threats of extinction because of it. For this reason, the Department of Fish and Game conclude that coho salmon in the Central Coast Coho ESU are in serious danger of extinction throughout all or a significant portion of their range."

Within the Central California Coast ESU, coho populations in streams in the northern portion of the ESU appear relatively stable or are not declining as rapidly as those to the south. However, a significant part of the ESU (southern portion) has experienced widespread extirpation or significant reduction in numbers within some larger stream systems (e.g., Gualala and Russian rivers) or over broad geographical areas (e.g., Sonoma County coast, San Francisco Bay tributaries, and streams south of San Francisco). Most abundance trend indicators for streams in the CCC Coho ESU suggest a decline since the late 1980s. However, some streams of the Mendocino County coast showed an upward trend in 2000 and 2001. Time-series analyses for these streams show a declining trend and predict that this trend will continue, despite the recent increases (CDFG 2002).

Listing status

Central California Coast coho salmon ESU

On August 29, 2005, NOAA Fisheries issued a final determination that the CCC coho salmon would be listed as a endangered species. In a technical correction (62 FR 1296), NOAA Fisheries defined the CCC coho salmon ESU to include all coho salmon naturally-reproduced in streams between Punta Gorda in Humboldt County, California, and the San Lorenzo River in Santa Cruz County, California (inclusive), and included tributaries to San Francisco Bay. The taking of this species was prohibited, pursuant to section 4(d) and section 9 of the ESA in the final determination (61 FR 56138). Certain limitations to this taking prohibition were provided, including research and enhancement permits pursuant to section 10 of the ESA (NOAA, 2003).

Coho occurring south of Punta Gorda in Humboldt County were listed as endangered under the California Endangered Species Act on March 30, 2005.

Status of stocks

NOAA Fisheries' status review (Weitkamp et al. 1995) concluded that abundance data for the CCC coho salmon ESU were very limited. It has been conservatively estimated that the population in this ESU has declined from 50,000 to 6,000 naturally reproducing coho; a population decline of approximately 88 percent (61 FR 56138). Indigenous, naturally reproducing populations of coho are believed to be in severe decline throughout this ESU (Table VII.6.1.9).

Recent Information

NOAA Fisheries' Southwest Fisheries Science Center updated the status review for the CCC coho salmon ESU on April 12, 2001 (NOAA Fisheries 2001). The review found that the limited data available strongly suggest that the ESU's population continues to decline. Declines are now also observed in several stream sub-populations previously considered stable. The review concludes that the CCC coho salmon ESU is presently in danger of extinction and the condition of CCC coho salmon populations in this ESU is worse than indicated by previous reviews.

Significant new information on recent abundance and distribution of coho salmon within the CCC ESU has become available, much of which has been summarized in two recent status reviews (NMFS, 2001; CDFG, 2002). Most of these data are of two types: 1) compilations of presence-absence information for coho salmon throughout the CCC during the period 1987 to the present, and 2) new data on densities of juvenile coho salmon collected at a number of index reaches surveyed by private timber companies, CDFG, and other researchers. Excepting adult counts made at the Noyo Egg Collecting Station, which are both incomplete counts and strongly influenced by hatchery returns, there are no current time series of adult abundance within this ESU that span eight or more years. Outmigrating smolts have been trapped at two trapping facilities in Caspar Creek and Little River since the mid-1980s; however, these are partial counts and only recently have mark-recapture studies been performed that allow correction for capture efficiency at these two sites. Thus, these smolt counts can only be considered indices of abundance.

Two analyses of presence-abundance data have recently been published. CDFG (2002) performed an analysis that focused on recent (1995-2001) presence of coho salmon in streams identified as historical producers of coho salmon by Brown and Moyle (1991). NMFS (2001) published an updated status review that analyzed coho salmon presence in streams throughout the CCC during the period 1989-2000. Scientists at NMFS' Southwest Fisheries Science Center have continued to compile information of coho salmon presence-abundance and have incorporated data into a database that is now summarized by brood year (rather than year of sampling) and covers brood years 1986-2001. Data from CDFG's 2001 field survey of the Brown and Moyle (1991) streams has been incorporated into this database.

Results

For the CCC ESU as a whole, CDFG (2002) estimated that coho salmon were present in 42% of streams historically known to contain coho salmon. Estimated occupancy was highest in Mendocino County (62%), followed by Marin County (40%), Sonoma County (4%), and San Francisco Bay tributaries (0%) (Table VII.6.1.9). Although the numbers are not directly comparable with those derived by Brown et al. (I994), because the specific streams and methods used differ between the two studies, the general regional and overall ESU patterns are similar (Table VII.6.1.9). The apparent decrease in percent presence in Marin County is likely a function of the increase in number of streams surveyed by CDFG rather than actual extirpations of populations. The estimated percentage of streams in which coho salmon were detected shows a general downward trend from 1987 to 2000, followed by a substantial increase in 2001 (Figure VII.6.1.13).

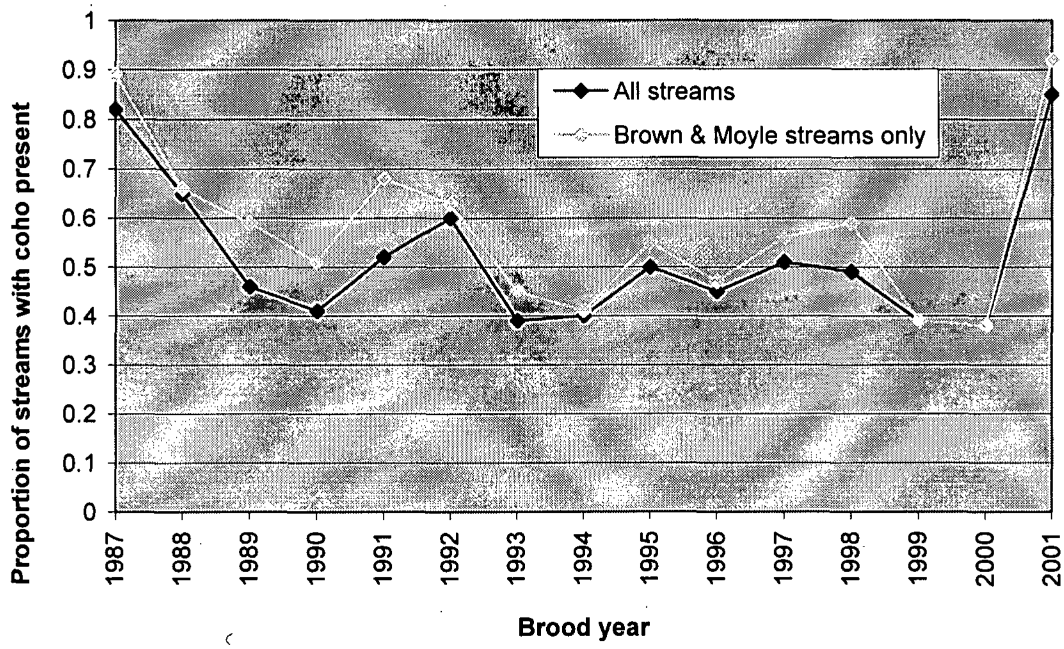


Figure VII 6.1.13. Percent of streams surveyed for which coho salmon presence was detected for all historic coho streams and streams identified in Moyle and Brown's historical list with the CCC ESU

Several caveats, however, warrant discussion. First the streams surveyed per year also shows a general increase from 1981 to 2003; thus, there may be a confounding influence of sampling if sites surveyed in the first half of the time period are skewed disproportionately toward observation in streams where presence was more likely. Second, sample size from brood year 2001 was relatively small and the data were weighted heavily toward certain geographic areas (Mendocino County and systems south of the Russian River). The data for brood year 2001 included almost no observations from watersheds from the Navarro River to the Russian River, or tributaries to San Francisco Bay, areas where coho salmon have been scarce or absent in recent years. Thus, while 2001 appears to have been a relatively strong year for coho salmon in the CCC as a whole, the high proportion of streams where presence was detected shown in Figure VII.6.1.13 is likely inflated.

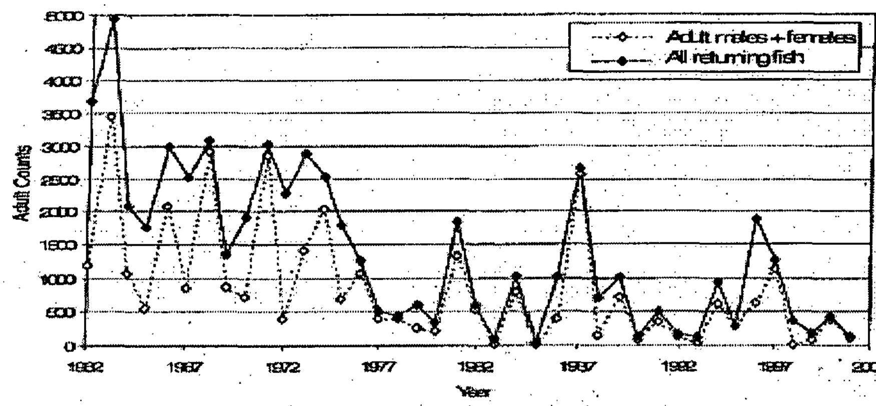
Two other patterns were noteworthy. First, compared with percent presence values for the Southern Oregon Northern California Coast (SONCC) ESU, values in the CCC were more highly variable and showed a somewhat more cyclical pattern. In general percent occupancy was relatively low in brood years 1990, 1993, 1996, and 1999 suggesting that this brood lineage is in the poorest condition. In contrast, during the 1990s, percent occupancy tended to be high in brood years 1992, 1995, 1998, and 2001, suggesting that this is the strongest brood lineage of the three. Second, there is a general tendency for percent occupancy to be slightly higher (2 to15%) for the Brown and Moyle streams compared with the ESU as a whole, indicating that the Brown and Moyle streams do not constitute a random subset of CCC streams.

When data are aggregated over brood cycles (3-year periods), the percentage of streams with coho salmon detected shows a similar downward trend, from 73% in 1987-1989, to 63% in 1990-1992, to less than 50% in the last three brood cycles. Again there are confounding influences of increased sampling fraction through time and incomplete reporting for the 2001 brood year. Nevertheless, it appears that the percent of historical streams occupied continued to decline from the late- 1980s to the mid-1990s, and remains below 50% for the ESU as a whole. Additionally, coho salmon appear to be extinct or nearing extinction in several geographic areas, including the Garcia River, the Gualala River, the Russian River, and San Francisco Bay tributaries. There is also evidence that some populations that still persist in the southern portion of the range, including Waddell and Gazos Creeks, have lost one or more brood lineages (Smith, 2001).

Results from this presence-absence analysis are generally concordant with CDFG's analysis. The two studies show consistent regional patterns suggesting that within the CCC the proportion of streams occupied is highest in Mendocino County, but the population in streams in the southern portion of the range (excluding portions of Marin County) have suffered substantial reductions in range. The NMFS analysis is more suggestive of a continued decline in percent occupancy from the late 1980s to the present; however, increased sampling in recent years may be confounding any apparent trends.

Adult time series

No time series of adult abundance free of hatchery influence and spanning eight or more years are available for the CCC ESU. Adult counts from the Noyo Egg Collecting Station (ECS) dating back to 1962 represent a mixture of naturally produced and hatchery fish, and counts are incomplete most years since trap operation typically ceased after brood stock needs were met. Thus, at best they represent an index of abundance and reflect population trends. There appears to have been a significant decline in abundance of coho salmon in the South Fork Noyo River beginning in 1977 (Figure VII.3.1.4). No formal analysis of trends has been conducted because of the uncertainty of the relationship between catch statistics and population size, as well as the relative contribution of hatchery fish to total numbers during the entire period of record.



Solid line with closed symbol indicates total fish captured (including grilse); dashed line with open symbols indicates adult males and females only. Counts are partial and thus are only a crude index of adult abundance. Source: Grass, 2002.

Figure VII 6.1.14. Counts of adult coho salmon at Noyo Egg Collecting Station from 1962 to 2002.

There are no basin-wide estimates of natural and artificial production for the Noyo Basin as a whole; however, marking of coho salmon juveniles released from the Noyo ECS on the South Fork began in 1997, and returns have been monitored since the 1998-1999 spawning season. In the 1998, 1999, and 200 brood years, marked hatchery fish constituted 85%, 70%, and 80%, respectively, of returning adults captured at the ECS.

The BRT (Schiewe, 1996a fide NOAA, 2003) concluded that, although exotic stocks have occasionally been introduced into the Noyo system, the regular incorporation of local natural fish into the hatchery population made the likelihood that this population differs substantially from naturally spawning fish in the ESU low and, therefore, included them in the ESU. Since CCC coho salmon were listed, no significant changes in hatchery practices have occurred.

Northern California Steelhead

West coast steelhead are presently distributed across 15 degrees of latitude, from approximately 49°N at the U.S.-Canada border, south to 34°N at the mouth of Malibu Creek, California. In some years steelhead may be found as far south as the Santa Margarita River in San Diego County (Busby et al., 1996). Historically, steelhead likely inhabited most coastal and many inland streams along the west coast of the United States. During this century, however, over 23 indigenous, naturally reproducing stocks have been extirpated, and many more are at risk for extinction.

In California, known spawning populations of steelhead (*Oncorhynchus mykiss*) are found in coastal rivers and streams from Malibu Creek in Los Angeles County to the Smith River near the Oregon border, and in the Sacramento River system (Figure 5).

Northern California Steelhead include all naturally spawned populations of steelhead (and their progeny) in coastal river basins ranging from Redwood Creek in Humboldt County, California to the Gualala River, inclusive, in Mendocino County, California (65 FR 14196).

Listing Status

In February 1998, DFG completed its strategic management plan for steelhead stocks in the northern California ESU (DFG 1998). In March 1998, the State and DFG formally committed to implement this plan as part of the NMFS/California MOA. The plan describes existing and new management measures for recreational steelhead angling, steelhead hatchery programs, and steelhead monitoring, and assessment and adaptive management efforts in this ESU. In addition, the plan describes DFG's ongoing efforts to protect and enhance steelhead habitat. These management measures are intended to provide immediate protection for steelhead populations while longer-term measures are implemented to protect anadromous fish habitat on non-federal lands through the Watershed Protection Program and the SB 271 habitat restoration program.

Because Federal land ownership is both fragmented and limited in this ESU (approximately 19 percent), the key to achieving habitat protection and properly functioning habitat conditions is the improvement of land management activities on non-Federal lands (approximately 81 percent). To ensure improved protection of habitat on non-Federal lands, the NMFS/California MOA contains several provisions for the review and modification of the State's FPRs. Full implementation of these provisions, including implementation of changes in the FPRs on July 1, 2000, was a critical factor in NMFS's previous decision not to list this ESU.

The State has not yet implemented all the changes in the FPRs that NMFS feels are necessary to protect steelhead. Consequently, NMFS concluded that existing State and Federal conservation measures collectively fail to provide for attainment of properly functioning habitat conditions necessary to provide for long-term protection and conservation, and the Northern California steelhead ESU warrant listing as a threatened species.

Therefore this ESU was federally listed as threatened on August 7, 2000 (65 FR 36074). On January 9, 2002 NOAA Fisheries promulgated take prohibitions for Northern California steelhead (67 FR 1116).

Status of Stocks

The Northern California steelhead ESU includes coastal basins from Redwood Creek (Humboldt County) southward to the Gualala River (Mendocino County), inclusive

(Busby et al., 1996). Within this ESU summer run, winter run, and half-pounders are found. Summer steelhead are found in the Mad and Eel Rivers, and Redwood Creek; the Middle Fork Eel River population is their southern-most occurrence. Half-pounders are found in the Mad and Eel Rivers. Busby et al. (1996) argued that when summer and winter steelhead co-occur within a basin, they were more similar to each other than either is to the corresponding run-type in other basins. Thus Busby et al. (1996) considered summer and winter steelhead to jointly comprise a single ESU.

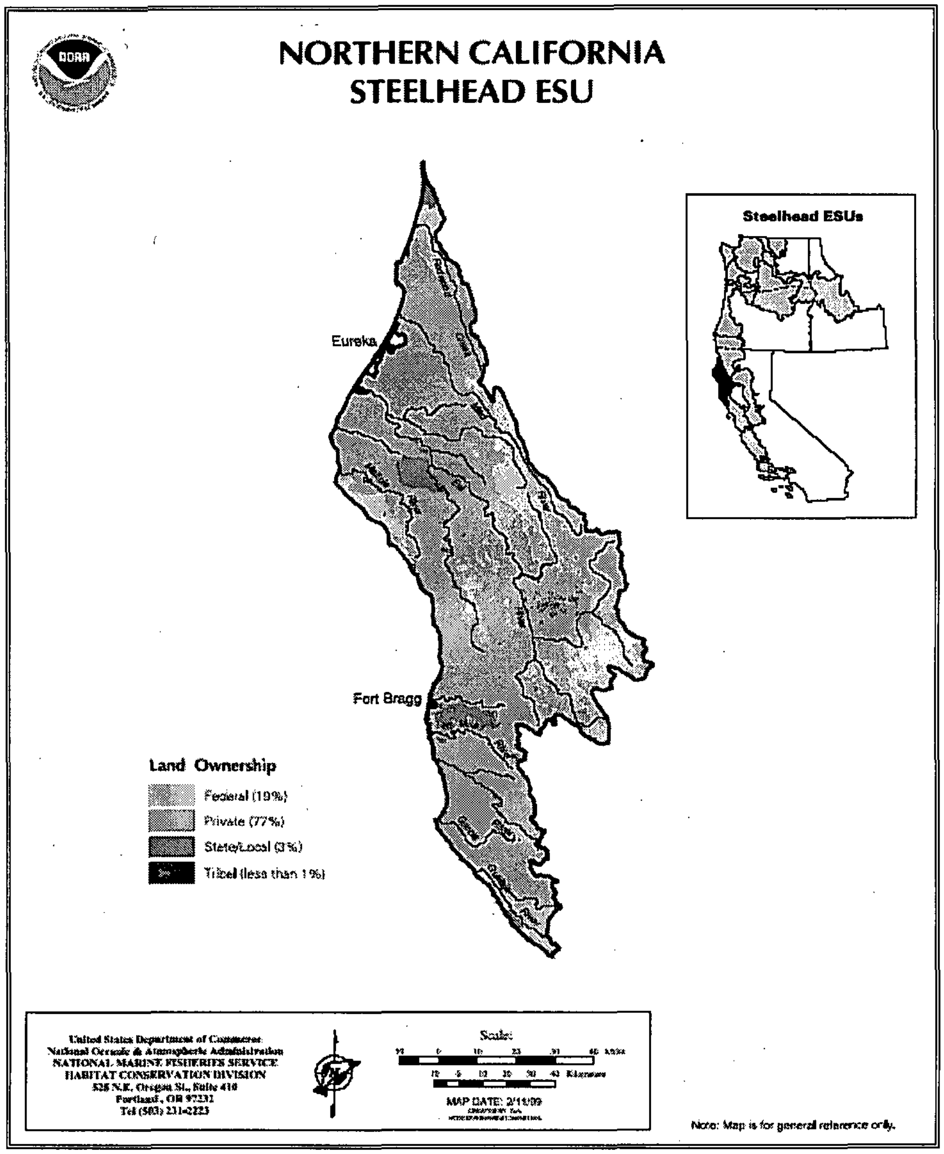
Summary of Major Risks and Status Indicators

Risks and limiting factors: The previous status review (Busby et al., 1996) identified two major barriers to fish passage: Mathews Dam on the Mad River and Scott Dam on the Eel River. Numerous other blockages on tributaries were also thought to occur. Poor forest practices and poor land use practices, combined with catastrophic flooding in 1964, were thought to have caused significant declines in habitat quality that then persisted up to the date of the status review. These effects include sedimentation and loss of spawning gravels. Non-native Sacramento pike minnow (*Ptychocheilus grandis*) have been observed in the Eel River Basin and could potentially be acting as predators on juvenile steelhead.

Although the data were relatively few, the data that did exist suggested the following to the BRT: 1) Population abundances were low relative to historical estimates (1930s dam counts; see Table Table VII.6.1.10 and Figure VII.3.1.5). 2) Recent trends were downward (except for a few small summer stocks; see Figure 6 and 7). 3) Summer steelhead abundance was "very low." The BRT was also concerned about negative influences of hatchery stocks, especially in the Mad River (Busby et al., 1996). Finally, the BRT noted that the status review included two major sources of uncertainty: lack of data on run sizes throughout the ESU, and uncertainty about the genetic heritage of winter steelhead in the Mad River.

Table VII.6.1.10. Summary of Historical Abundance (average counts) for Steelhead in the Northern California Evolutionarily Significant Unit.

		Average Count						
Basin	Site	1930s	1940s	1950s	1960s	1970s	1980s	Reference
Eel River	Cape Horn Dam	3,390	4,320	3,597	917	721	1,287	Grass 1995
Eel River	Benbow Dam	13,736	18,285	12,802	6,676	3,355	--	
Mad River	Sweasey Dam	3,167	4,720	2,894	1,985	--	--	

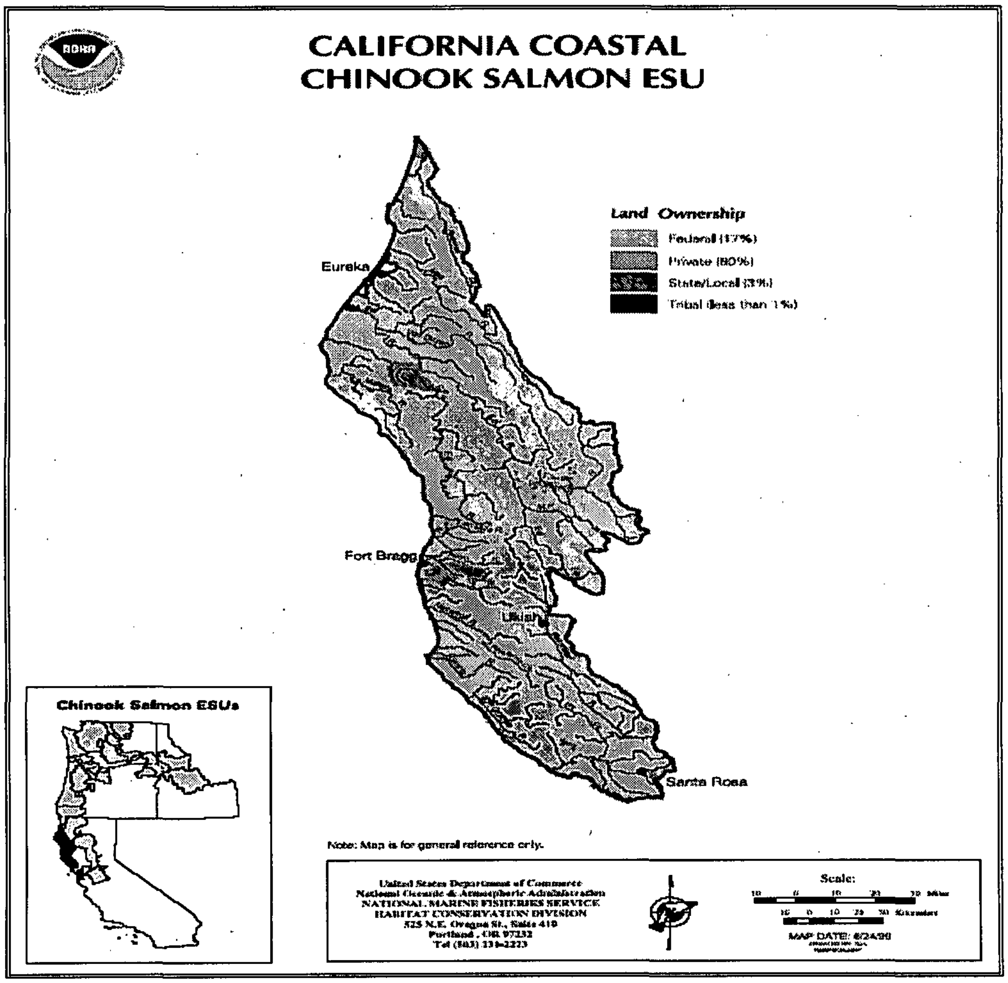


Source: NMFS, 1999

Figure VII 6.1.15. Northern California Steelhead ESU.

California Coastal Chinook Salmon

This species was listed as threatened on November 15, 1999. The ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River, California (Figure VII.3.1.6).



Source: NMFS, 1999

Figure VII 6.1.16. California Coastal Chinook Salmon ESU.

The coastal drainages south of Cape Blanco are dominated by the Rogue, Klamath, and Eel Rivers. The Chetco, Smith, Mad, Mattole, and Russian Rivers and Redwood Creek are smaller systems that contain sizable populations of fall-run Chinook salmon (Campbell and Moyle, 1990, ODFW,1995). Presently, spring runs are found in the Rogue, Klamath, and Trinity Rivers; additionally, a vestigial spring run may still exist on the Smith River (Campbell and Moyle, 1990; USFS, 1995). Historically, fall-run Chinook salmon were predominant in most coastal river systems south to the Ventura River; however, their current distribution only extends to the Russian River (Healey, 1991). There have also been spawning fall-run Chinook salmon reported in small rivers draining into San Francisco Bay (Nielsen et al. 1994).

Chinook salmon populations south of Cape Blanco all exhibit an ocean-type life history. The majority of fish emigrate to the ocean as subyearlings, although yearling smolts can constitute up to approximately a fifth of outmigrants from the Klamath River Basin, and to a lesser proportion in the Rogue River Basin; however, the proportion of fish which smolted as subyearling vs. yearling varies from year to year (Snyder, 1931; Schluchter and Lichatowich, 1977; Nicholas and Hankin, 1988; Barnhart, 1995).

Run timing for spring-run Chinook salmon in this area typically begins in March and continues through July, with peak migration occurring in May and June. Spawning begins in late August and can continue through October, with a peak in September. Historically, spring-run spawning areas were located in the river headwaters (generally above 400 m). Run timing for fall-run Chinook salmon varies depending on the size of the river.

Agricultural, logging, and mining activities, in combination with periodic flood events (e.g. 1955, 1964), have affected all of the coastal river systems to some degree. Mining activities have also caused severe habitat degradation. The construction of dams in the Rogue, Klamath, and Eel River Basins has restricted the distribution and potentially altered the life history of Chinook salmon, especially spring-run fish that historically utilized upstream habitat. Similarly, dam construction on the Klamath River Basin has eliminated much of the spawning habitat for spring-run fish and increased the potential for interbreeding between spring and fall runs.

Several dams have subsequently been constructed on the mainstem Klamath River. Historically, the largest spring-run population in the Klamath River Basin was in the Shasta River; however, this population was extirpated in the early 1930s as a result of land use practices and water diversion dams. Since 1962, the upper limit to anadromous migration has been the Iron Gate Dam. Additionally, the Lewiston water diversion dam on the Trinity River has prevented access of spring-run Chinook salmon to their historical spawning grounds on the East Fork, Stuart Fork, Upper Trinity River, and Coffee Creek (Campbell and Moyle, 1990).

Habitat loss and/or degradation is widespread throughout the range of the ESU. The California Advisory Committee on Salmon and Steelhead Trout (CACSST, 1988) reported habitat blockages and fragmentation, logging and agricultural activities, urbanization, and water withdrawals as the most predominant problems for anadromous salmonids in California's coastal basins.

Listing Status

The California Coastal Chinook Salmon ESU is listed as threatened under the federal ESA. Primary causes for concern are low abundance, reduced distribution (particularly in the southern portion of the ESU's range), and generally negative trends in abundance. All of these concerns were especially strong for spring-run Chinook salmon in the ESU (Myers et al., 1998). Data for this ESU are sparse and, in general of limited quality, which contributes to substantial uncertainty in estimates of abundance and distribution. Degradation of the genetic integrity of the ESU was considered to be of minor concern and to present less risk for this ESU than for other ESUs.

Status of Stocks

CDFG (1965) estimated escapement for the California portion of the ESU at about 88,000 fish, predominantly in the Eel River (55,500), with smaller populations in the Smith River (15,000), Redwood Creek, Mad River, Mattole River (5,000 each), Russian River (500), and several smaller streams in Del Norte and Humboldt Counties. Based on the 1968 angler catch records for the Oregon portion of the ESU (which estimated escapements of about 90,000 fish), the average escapement for the entire ESU in the 1960s was estimated to be 178,000 fish.

Within this ESU, recent abundance data vary regionally. Dam counts of upstream migrants are available on the South Fork Eel River at Benbow Dam from 1938 to 1975, and at Gold Ray Dam on the Rogue River from 1944 to the present. Counts at Cape Horn Dam on the upper Eel River are available from the 1940s to the present, but they represent a small, highly variable portion of the run.

Current hatchery contribution to overall abundance is relatively low, *except for the* Rogue River spring run, which also contains almost all of the documented spring-run abundance in this ESU. The lack of population monitoring, particularly in the California portion of the range, led to a high degree of uncertainty regarding the status of these populations.

Population Status

Previous reviews of conservation status for Chinook salmon in this area exist. Nehlsen et al. (2001) identified three reputed populations (Humboldt Bay tributaries, Mattole River, and Russian River) as being at high risk of extinction and three other populations (Redwood Creek, Mad River, and Lower Eel River) as being at moderate risk of extinction. Higgins et al. (1992) identified seven "stocks of concern," of which two populations (tributaries to Humboldt Bay and the Mattole River) were considered to be at high risk of extinction. Chinook salmon native to the Russian River have been extirpated.

Historical estimates of escapement are based on professional opinion and evaluation of habitat conditions, and thus do not represent rigorous estimates based on field sampling (Table VII.6.1.11).

Table VII.6.1.11. Historical Estimates of Abundance of Chinook salmon in the California Coastal Chinook Salmon ESU.

Selected Watersheds	CDFG 1965 fide NOAA 2003	Wahle & Pearson 1987
Redwood Creek	5,000	1,000
Mad River	5,000	1,000
Eel River	55,000	17,000
Mainstem Eel	13,000	
Van Duzen River	2,500	
Middle Fork Eel	13,000	
South Fork Eel	27,000	
Bear River		100
Small Humboldt County River	1,500	
Miscellaneous Rivers North of Mattole		600
Mattole River	5,000	1,000
Noyo River	50	
Russian River	500	50
Total	72,550	20,750

<u>Summary of Major Risk and Status Indicators</u>

Previous status reviews considered the following to pose significant risks to the California Coastal Chinook Salmon ESU: degradation of freshwater habitats due to a variety of agricultural and forestry practices, water diversions, urbanization, mining and severe recent flood events (exacerbated by land use practices). Special concern was noted regarding the more precipitous declines in distribution and abundance in spring-run Chinook salmon. Many of these factors are particularly acute in the southern portion of the ESU range and were compounded by uncertainty stemming from the general lack of population monitoring in California (Myers et al., 1998).

In previous status reviews, the effects of hatcheries and transplants on the genetic integrity of the ESU elicited less concern than other risk factors for this ESU, and were less of a concern for this ESU in comparison to other ESUs.

Chinook salmon in the Coastal California ESU continue to exhibit depressed population sizes relative to historical abundances; this is particularly true for spring-run Chinook, which may no longer be extant anywhere within the range of the ESU. No information exists to suggest new risk factors, or substantial effective amelioration of risk factors noted in the previous status reviews, save for recent changes in ocean conditions. Recent favorable ocean conditions have contributed to apparent increases in abundance and distribution for a number of anadromous salmonids, but the expected persistence of this trend is unclear.

6.1.7 Fish Distribution—JDSF

Historically, coho salmon and steelhead occurred in all of the Planning Watersheds in the JDSF assessment area. The upstream extent of fish can vary annually and seasonally depending on environmental variables such as precipitation, water temperature, and flow. Fish distribution can also be influenced by changes in channel morphology caused by high flows, landslides, or other stochastic events that limit habitat accessibility and suitability.

In summer and fall of 1995, 1996, and 1997, streams in this assessment area were surveyed by CDFG crews under contract with CDF to identify the upstream extent of salmonids and document the species present (CDFG, 1995a, 1996a; S. Harris, pers. comm., 1998). In most of their surveys, CDFG crews identified potential barriers to salmonid migration and ended stream inventories either at barriers or where stream flows were deemed too low to provide suitable salmonid habitat. Distribution data collected using this methodology should be considered to be conservative low flow estimates, since the upstream extent of salmonid distribution can be greater during higher (i.e., winter) flow conditions. No fish abundance data were collected during these surveys. Other stream survey reports documenting fish distribution in the assessment area were used when available to supplement the upstream extent surveys. Occasionally, locations expected to provide salmonid habitat (i.e., Class I streams) were not surveyed because of access restrictions on other ownerships.

Generally, salmonids were the most widely distributed of the fish species occurring in the assessment area. Based on data available in 1997, steelhead occur in all planning watersheds, and coho salmon are found in at least 12 of the 15 planning watersheds in the assessment area. The East Branch North Fork Big River, Russian Gulch, and Mitchell Creek planning watersheds were not found to support coho in 1997. However, comprehensive fish distribution surveys have not been conducted in the East Branch North Fork Big River planning watersheds, and further information is needed to determine the full extent of fish distribution in these three planning watersheds, all of which contain relatively little JSDF ownership.

The other native fish species found during the CDFG stream surveys were Pacific lamprey (*Lampetra tridentata*), threespine stickleback (*Gasterosteus aculeatus*), and sculpin (*Cottus* sp.). Non-native fish species have been documented in the assessment area only in the South Fork Noyo River, where juvenile smallmouth bass (*Micropterus dolomieu*) were observed in the summer of 1995 approximately 9.5 miles (15 km) upstream from the confluence with Kass Creek, and one green sunfish (*Lepomus cyanellus*) was found in November of 1995 just upstream of the confluence with Parlin Creek. It is assumed that the fish of both species escaped from McGuire's Pond near the headwaters of the South Fork Noyo River.

Based primarily on channel gradient, steelhead were expected to occur in approximately 192 miles (309 km) of the Class I streams in the JDSF assessment area. Using the same methods, 123 miles (198 km) of Class I streams were identified as likely to support coho salmon. Of the 192 miles (309 km) of Class I stream length in the JDSF assessment area used in this analysis, steelhead were found in 64 percent (123 mi or 198 km). Coho were found in 75 percent (92 mi or 148 km) of their expected distribution (123 mi or 198 km), which equates to 48 percent of the Class I streams included in the analysis. Coho were also found in 2 miles (4 km) of Class I streams where they were not expected, based on channel gradient. Other salmonids (not identified as to species) were found in an additional 3 percent (6 mi [9 km]) of Class I streams. All together, salmonids were found in a total of 67 percent (129 mi or 208 km) of the Class I stream length analyzed in the assessment area (Stillwater Sciences 1997).

These results indicate that coho and steelhead appear to be using a substantial amount of the stream mileage. However, neither species is distributed throughout the full extent of channels, which may be attributable to a lack of available or suitable habitat in these reaches, or it may indicate that populations are not fully seeding the available habitat (Nickelson et al., 1992).

Barriers to Fish Distribution-The CDFG survey crews documented several total or partial barriers to fish migration in anadromous fish-bearing streams within JDSF. Partial barriers are those that may only limit fish access during certain flows, or which are impassable for some species or life stages but not others. For example, the swimming and jumping abilities of steelhead surpass those of coho salmon (Bjornn and Reiser, 1991); therefore, a barrier to coho may be passable by steelhead.

In South Fork Hare Creek, no fish were observed above a debris jam 0.3 miles (0.5 km) from the confluence with the mainstem of Hare Creek. In the headwaters of North Fork of Caspar Creek, fish access ended at a debris jam associated with an old splash dam, 3.8 miles (6.1 km) from the confluence with South Fork Caspar Creek. Bedrock falls in the middle fork of Caspar Creek are reported to be a barrier to coho salmon. In upper South Fork Caspar Creek, a culvert was believed to end all upstream fish access until it was removed in 1998. Fish distribution data above this location are not currently available. A bedrock sheet located in an unnamed tributary to Parlin Creek was judged by CDFG to be a barrier to coho, and is reported to be a low flow barrier to steelhead. The dam spillway at McGuire's pond near the headwaters of the South Fork Noyo River is also a barrier to upstream fish migration.

CDFG survey crews also identified several potential barriers, including locations where woody debris was retaining large amounts of sediment. These potential barriers were found in James Creek, Bear Creek, Hare Creek, 23 Gulch, an unnamed tributary to Parlin Creek ("tributary B"), and Petersen Gulch. In Parlin Creek, a debris jam 3 miles (4.9 km) from the confluence with the South Fork Noyo River blocked coho salmon access until it was modified in 1996; however, the entire debris jam was not removed (F. Yee, CDF, Fort Bragg, CA, pers. comm., 1997). At the Road 400 culvert where Walton Gulch enters Hare Creek, CDFG survey crews suggested that the culvert design was preventing fish passage. The culvert was not a complete barrier, however, because an adult steelhead was observed upstream.

In general, the confirmed barriers to fish migration are located near the headwaters of drainages such that they do not restrict access to substantial areas of potentially suitable habitat. Of the total length of Class I streams in the assessment area, only 3 percent (5.7 mi or 9.1 km) is upstream of confirmed barriers. These confirmed barriers therefore are not considered to limit coho or steelhead distribution significantly in JDSF.

Fish Abundance

Fish population data for the pre-logging period are not known to exist for streams in or near the JDSF assessment area. However, salmonid populations in Mendocino County are widely believed to have declined during this century compared to historical conditions (Brown and Moyle, 1991; Nehlson et al., 1991). In the absence of evidence that conditions in assessment area streams differ greatly from other Mendocino County streams, it is reasonable to assume that salmonid populations have likely declined from pre-logging levels in the assessment area. Data indicating regional declines of salmonid populations include counts of adult coho and steelhead at Benbow Dam on the South Fork Eel River (approximately 50 mi or 81 km north of JDSF), conducted by CDFG between 1938 and 1972, which show a marked decline in numbers of both species during that time period (CDWR, 1974).

Adult Spawners-*Since 1979, CDFG has maintained a weir and coho salmon* egg-taking station in JDSF, on the South Fork Noyo River near the confluence with the North Fork of the South Fork Noyo River. The weir consists of a channel-spanning cement dam (approximately five feet high) that directs adult salmon into a bunker where fish are counted, and can be detained or allowed to pass upstream. CDFG attempts to count 100 percent of the returning coho at the weir. However, fish are sometimes missed because of high flows and the fact that the trap is not in operation during the entire season.

CDFG data do not show any obvious trends since 1979 in the number of adult coho salmon returning to the egg-taking station during the three-month egg-taking season (CDFG, 1995c; Figure 4). However, effects of hatchery releases of yearling coho may mask any downward trend in returning adults. From the winter of 1979–1980 through 1994–1995, the number of adult coho salmon returning to the egg-taking station ranged from a low of 46 fish in 1985–1986 to a high of 2,668 in 1987–1988. Reliable counts of steelhead at this station are not available because (1) the timing of steelhead spawning is such that the station is not in operation during most of the steelhead spawning season, and (2) the superior ability of steelhead to negotiate the weir at the station often enables them to avoid capture.

Juveniles-Outmigration of coho smolts typically does not begin in California populations until the fish have reached approximately 15 months of age (age Class I+) (Sandercock, 1991). Young steelhead and coho establish territories and defend them throughout most of their time rearing in freshwater (Hartman et al., 1982, Barnhart, 1991), with coho fry displaying territorial behavior as soon as one week after emergence (Mason, 1966). The age 0+ outmigrating steelhead and coho observed in Caspar Creek are likely being displaced downstream by interspecific and possibly intraspecific competition, and are therefore likely surplus to the available habitat upstream of the trap. In addition, habitat conditions downstream of the trapping location are thought to provide relatively little overwintering habitat for these young outmigrating fish. Coho that enter salt water in their first summer or before are not thought to survive to adulthood (Otto, 1971; Crone and Bond, 1976). Therefore, the majority of age 0+ coho and steelhead outmigrants in Caspar Creek probably contribute little, if any, to the adult population.

In 1998, the California Department of Fish and Game initiated a study of downstream migration of juvenile salmonids in six coastal Mendocino County streams: Caspar Creek (JDSF), Little River (Van Damme State Park), Hare Creek (JDSF), Wages Creek (Private), South Fork Noyo River (JDSF) and the North Fork of the South Fork Noyo River (JDSF). Downstream migrant traps were installed and monitored to assess the timing, population composition, and amplitude of downstream migrating juvenile salmonid populations (Harris 1999).

In addition, a downstream migrant fish trap has been operated annually in the Caspar Creek basin since 1987 by the CDFG (CDFG, 1996c). This trap is located on the mainstem of Caspar Creek, approximately 1 mile (1.6 km) downstream from the confluence with South Fork Caspar Creek.

Habitat conditions and fish abundance in Caspar and Hare Creeks are thought to be fairly representative of other streams in the assessment area. Downstream migrant trapping data and estimated usable habitat area provide a representative measure of the approximate production potential of other assessment area streams with similar habitat characteristics and physical parameters (e.g., drainage area, channel gradient). Actual or raw numbers of coho or steelhead captured do not provide a population estimate but give an indication of salmonid brood year production (particularly for coho salmon).

It is apparent from the early Caspar Creek data that in some years substantial numbers of age 0+ salmonids (fish up to 1 year of age) and age 1+ and older salmonids (fish greater than 1 year of age) were outmigrating prior to the start of the annual trapping effort. For this reason, the raw outmigrant capture numbers reported here do not reflect the total number of salmonid outmigrants in some years. In addition, variation in water flow across trapping seasons influences the efficiency of downstream migrant trap operation. The numbers of age 0+ coho salmon were likely substantially higher than reported in 1989, 1993, 1995, and 1996. Numbers of age 1+ coho outmigrants were likely higher than reported in 1987, 1990, and 1993; and numbers of age 1+ and older steelhead were likely higher than reported in 1987.

The annual number of age 1+ coho and age 1+ and older steelhead outmigrants is a better indication of habitat-related factors and population trends than is the number of 0+ outmigrants. These older fish have spent at least one summer and winter rearing in freshwater habitats. Summer and winter rearing habitat conditions are considered important factors limiting coho salmon production (Chapman, 1966; Chapman and

Knudsen, 1980; Tschaplinski and Hartman, 1983; Nickelson et al., 1992), and also may be important factors governing steelhead populations. Populations of age 0+ coho salmon and steelhead outmigrants exhibit significant year-to-year variability. It is likely that the annual fluctuation in the number of age 0+ coho and steelhead outmigrants reflects annual variability in spawning escapement and egg-to-emergence survival.

Steelhead Outmigrants-The number of age 0+ steelhead captured in Caspar Creek over a 10-year period (1987–1996) ranged from 11 in 1987 to 19,139 in 1996 (Figure VII 6.1.17), with an average of 5,661 for the period of record. Numbers of age 1+ and older steelhead ranged from 162 in 1991 to 1,193 in 1993 (Figure VII 6.1.18), with an average of 438 for the 1987-1996 period. In 1999, 694 1+ steelhead were captured, 622 in 2000, 1129 in 2001, 503 in 2002, 449 in 2003. In 2001, the running 15 year average of age1+ steelhead in Caspar Creek was 504 fish. The 2003 steelhead yearling count at Caspar Creek was 62% less than the maximum count of 1,193 in 1993, and 10% less than the 16 year average of 501 (Harris 2003). In 2004, a total of 401 yearling steelhead were captured in Caspar Creek (Harris 2004).

A total of 3,163 yearling steelhead were captured during the 2002 season at all 6 of the CDFG coastal Mendocino County sites with 1,207 of those at Hare Creek (an increase of 144% from the previous high of 494 in 2001 and 148% higher than the five-year average of 485)(Harris 2002). In 2003, the steelhead yearling count at Hare Creek was 110, which was a 91% decrease from the 2002 count and record high of 1,207. The 2003 count was 74% lower than the six-year average of 423 at Hare Creek. The total number of yearling steelhead trapped at all Mendocino County sites in 2002 was 10% higher from the 2001 total count of 2,872. For the 2003 season, The total number of steelhead yearlings trapped at all sites (1,788) was down 43% from the 2002 season with the lowest number of captures at Hare Creek (110) (Harris 2003). Downstream migrant steelhead data were not reported for Hare or Wages Creek for the July 1, 2003 through June 30, 2004 period. However, a total of 1,603 yearling steelhead were captured in the remaining 4 sites up a relative 3% from the prior years count (Harris 2004).

Coho Outmigrants-Numbers of age 0+ coho captured over a 10-year period (1987-1996) in Caspar Creek ranged from 43 in 1987 to 34,955 in 1989, with an average of 10,942. Numbers of age 0+ coho were unusually high in both 1988 and 1989. The number of age 1+ and older coho captured ranged from 662 in 1992 to 2,121 in 1990 and averaged 1,178 over this same time period.

The raw number of coho yearlings trapped decreased at the Caspar Creek site by 23% from 1078 in 1999 to 829 in 2002, 61% below the 1990 high of 2,121 and 35% below the 6 year average of 1276. ANOVA analysis indicated no statistical difference in probability of capture at the Caspar Creek site (f=1.58, p=.22) during the 2000, 2001 and 2002 trapping seasons (Harris 2002). The Caspar Creek count increased 30% from 1,346 in 2000 to 1,750 in 2003 (46% higher than than the 6 year average of 1,196 coho yearlings (Harris 2003). In 2001 1,871 juvenile coho were captured in Caspar

Creek (Harris 2001). In 2004 a total of 1,837 juvenile coho were captured in Caspar Creek.

The Hare Creek count for coho yearlings decreased 75% from 1,165 in 1999 to 296 in 2002. The Hare Creek count increased 85% from 314 in 2000 to 584 in 2003 (Harris 2003) Coho yearling numbers in Hare Creek were not reported for 2004 (Harris 2004).

For the 2002 trapping season, of the CDFG Mendocino County coastal stream study, the raw number of yearling coho captured at all 6 trapping sites was down 31% from 6,549 in 1999. During the 2003 trapping season, at all of the Mendocino County coastal trap sites, 6,494 coho yearlings were captured, up 116% from 2,999 in 2000. The raw number of coho yearlings captured at 4 sites in 2004 (Hare and Wages Creeks were not reported) totaled 7,751, up 181% from 2,742 captured at the four sites in 2001 (Harris 2004).

Population Estimates-As part of the CDFG Coastal Mendocino County Streams project, a mark/recapture study for 1+ (Y+) coho and steelhead was conducted to obtain population estimates.

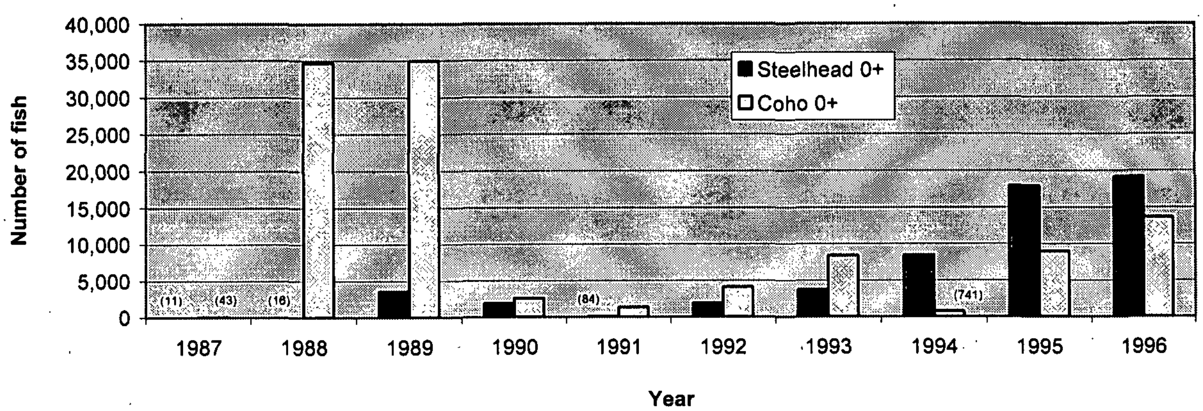
Coho Salmon-Juvenile coho populations at each of the six trap sites for 2001, 2002, 2003, and 2004 were as follows respectively: Caspar Creek 3,799 (+/- 222); 2,224(+/- 151); 4,976 (+/- 359); 5753 (+/- 691) Hare Creek 2,193 (+/- 215); 368 (+/- 9); 4,111 (+/- 856); (no data reported) Little River 264 (+/- 13); 1,575 (+/- 67); 2,115 (+/- 115); 2,202 (+/- 82) NFSF Noyo 312 (+/- 211); 3,376 (+/- 547); 1,493 (+/- 60); 2,732 (+/- 173); SF Noyo 3,840 (+/- 1,067); 4,186 (+/- 237) 3,864 (+/- 224); 5,243 (+/- 261) and Wages Creek 1,952 (+/-577); (insufficient data in 2002) 1,237 (+/- 551)(no data reported)(Harris 2002, 2003, 2004). At all 6 monitored streams, the trapping effort showed a significant increase in brood year production of down stream migrating coho in 2003 in spite of record high stream flows and inoperable traps during a portion of the out-migration.

Steelhead-Juvenile steelhead population estimates were as follows: Caspar Creek 1,708 (+/- 131) in 2002 below 2001's estimate of 3,146 (+/- 383) but similar to the 2000 estimate of 1,558 (+/- 103). The Caspar Creek population was estimated at 1,544 (+/- 173) in 2003 and 2,026 (+/- 440) in 2004. Hare Creek 2,703 (+/- 131) for 2002, 1,651 (+/- 204) in 2001 and similar to the 2000 estimate of 2,798 (+/- 708). The Hare Creek population was estimated at 615 (+/- 133) in 2003. Hare Creek trap data were not reported for 2004. Little River 976 (+/- 167) in 2002, below the 2001 estimate of 1,882 (+/- 110) but similar to the 2000 estimate of 1,043 (+/- 59). The Little River population was estimated at 1,689 (+/- 198) in 2003 and 1,406 (+/- 218) in 2004. The population estimate for the NFSF Noyo was 2,348 (+/- 722) in 2002 similar to the 2001 estimate of 3,825 (+/- 2,672) or the 2000 estimate of 3,176 (+/- 338). The NFSF Noyo population was estimated at 1,689 (+/- 198) in 2003 and 2,232 (+/- 437) in 2004. SF Noyo juvenile steelhead were estimated at 2,214 (+/- 232) in 2002, 9,842 (+/- 8,057) in 2001 and 2,252 (+/- 310) in 2000. In 2003 the SF Noyo population was estimated at 1,039 (+/- 122) and 1,814 (+/- 174) in 2004. Wages Creek juvenile steelhead in 2002 were 6,587 (+/- 1980), similar to the 9,984 (+/- 5,094) estimate in 2001 or the 2000 estimate of

10,192 (+/- 7,440) (Harris 2002). The Wages Creek population was estimated at 6,843 (+/- 6,672) in 2003. Wages Creek trap data were not reported for 2004 (Harris 2004).

Chinook Salmon-In 2003, 85 yearling Chinook salmon (likely a product of more than one successful Chinook redd) were captured at the Wages Creek site and 5 at the SF Noyo site (Harris 2003).

"The most interesting trend information reflected by the 17 years of data from Caspar Creek and Little River is the similarity in coho salmon trends and the recent similarity of steelhead trends. These watersheds were chosen for this project due to their differing management: Caspar Creek is managed by Jackson Demonstration State Forest as an experimental silviculture watershed and Little River is managed by the state park system and individual private landowners. Although salmonid limiting factors are present in both watersheds to some degree, the data suggests recent trends may be controlled by factors outside the watersheds: ocean conditions" (Harris 2004 p. 1).



Data are from CDFG downstream migrant trapping program. Numbers may be underestimates owing to intermittent trap operation during high flows.

Figure VII 6.1.17. Age 0+ downstream migrant salmonids in Caspar Creek, CA (1987-1996; values less than 1,000 are showing in parentheses*)

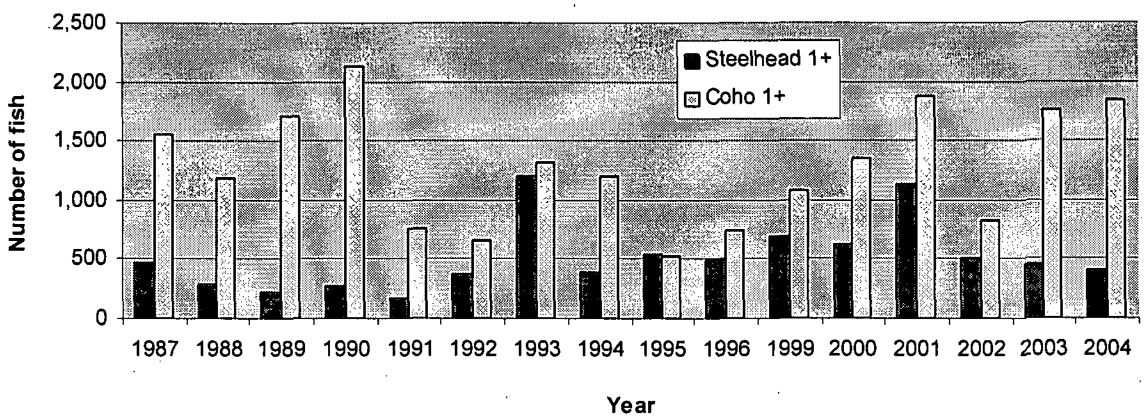


Figure VII 6.1.18. Age 1+ downstream migrant salmonids in Caspar Creek, CA (1987–2004; note scale difference compared to Figure VII.6.1.17)

Habitat Relationships-

The USFS-PSW's Redwood Sciences Laboratory conducted electrofishing surveys in North Fork and South Fork Caspar Creek from 1990 through 1995 (Nakamoto, 1996). The surveys were made during summer months, and data were collected on densities of fish (coho salmon, steelhead, and three-spine stickleback) and of amphibians (Pacific giant salamander and tailed frog) in selected habitat types. The extensive data set provides detailed information on age 0+ and age 1+ and older salmonids (particularly steelhead). However, the number of adult coho returning to the areas sampled is thought to be low because they may have difficulty negotiating the North Fork and South Fork weirs (R. Nakamoto, pers. comm., 1998). Weirs apparently do not substantially affect the number of steelhead returning to the areas sampled (R. Nakamoto, pers. comm., 1998). Other data on fish presence and relative abundance in selected watersheds include qualitative values recorded in biological assessment reports prepared by CDF staff for THPs on JDSF (Valentine et al., 1995a, 1995b, 1995c). Given the potentially low numbers of returning coho in Caspar Creek from 1990 through 1995, only comparisons of steelhead densities between habitat types are reported here.

Electrofishing survey data for Caspar Creek describe summer rearing densities of steelhead in various habitat types defined by McCain et al. (1990). Fish densities from USFS electrofishing data (USFS, 1996) were compared for those habitat units comprising the largest percentage of habitat area from 6 years of surveys (1990–1995) in Caspar Creek (Figures VII 6.1.19 and VII 6.1.20). The six habitat types compared are low-gradient riffles (LGR), lateral scour pools associated with large organic debris (LSP-LOD), glides (GLD), runs (RUN), step-runs (SR), and lateral scour pools associated with boulders (LSP-BO).

Note: 1992 data reflect North Fork only

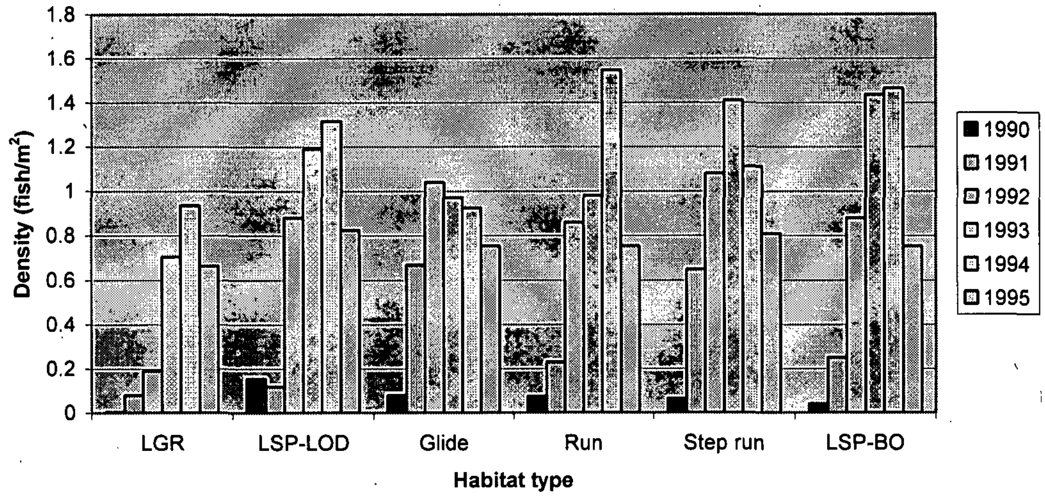


Figure VII 6.1.19. Mean density of age 0+ steelhead in various habitats of North and South Forks Caspar Creek.

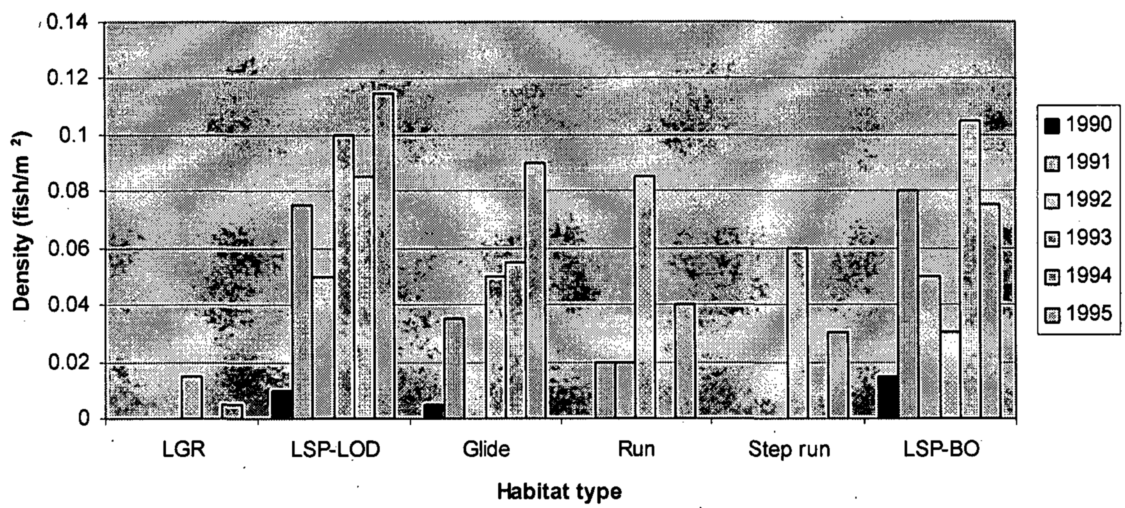


Figure VII 6.1.20. Mean density of age 1+ steelhead in various habitats of North and South Forks Caspar Creek.

Overall, densities of age 0+ steelhead varied more between years than between habitat types. Low-gradient riffles generally had the lowest densities of age 0+ steelhead among the habitat types compared. Densities of age 1+ steelhead were slightly more variable between habitat types than densities of age 0+ steelhead. Generally, age 1+

steelhead densities were higher in LSP-LOD, LSP-BO and GLD habitat types than in LGR, RUN, and SR habitat types. Comparison of steelhead densities between the North and South Forks of Caspar Creek revealed higher densities of steelhead in all North Fork habitat types except riffles.

Mean densities of age 1+ steelhead in Caspar Creek for the period 1990–1995 ranged from < 0.01fish/m^2 in LGR habitats to 0.07 fish/m^2 in LSP-LOD habitat types. These values are within the range of those reported in the published literature for other streams in northern California, Oregon, and Idaho. Depending on the habitat type and stream location, age 1+ steelhead density in pools, riffles, and glides ranged from about 0.01 fish/m^2 to about 0.08 fish/m^2 in other Pacific Northwest streams (Everest, 1987; Bjornn and Reiser, 1991; Dambacher, 1991).

Burns (1971, 1972) measured similar steelhead densities in Caspar Creek before and after logging and roadbuilding in the late 1960s. Between 1967 and 1969 densities of late summer age 1+ steelhead in South Fork Caspar Creek ranged from 0.01 fish/m^2 in 1968 to 0.04 fish/m^2 in 1969 (Burns, 1972). The Burns (1972) densities were derived from all stream conditions in a 3,093 meter study section. In 1967, a bulldozer operated through 41% of the study section stream channel to yard logs and remove debris. In North Fork Caspar Creek late summer densities of age 1+ steelhead were 0.02 fish/m^2 in 1967 and 0.03 fish/m^2 in both 1968 and 1969 (Burns, 1971). Burns (1971, 1972) also made comparisons with steelhead densities in other northern California streams from the same time period. From 1967 to 1969, late summer densities of age 1+ steelhead in South Fork Yager Creek (in the Van Duzen River drainage) were similar to Caspar Creek densities, ranging from 0.02 fish/m^2 to 0.04 fish/m^2 (Burns, 1972). However, Burns (1972) reported substantially higher densities in Bummer Lake Creek, a tributary to the Smith River. Late summer densities of age 1+ steelhead in Bummer Lake Creek ranged from 0.08 fish/m^2 in 1969 to 0.14 fish/m^2 in 1967 (Burns, 1972).

Nakamoto (1998) examined the impacts of logging the North Fork of Caspar Creek on fish populations. He found that variability was high, but no dramatic changes in the abundance of coho salmon or steelhead trout were recorded after logging activity in the North Fork of Caspar Creek.

6.1.8 Changes in Species Composition—water flow pattern and large woody debris as an influence on salmonid species composition

The factors influencing the size of salmon runs have been studied extensively. Sobel and Botkin (1993) developed models to forecast spring Chinook salmon runs in Oregon's Rogue River. They noted that an explanation of run size might include factors such as ocean conditions, spawning gravel availability and quality, availability of large woody debris, and other important variables. However, it is also possible that, at any one time, a single environmental variable can influence a cohort to a much greater degree than others. Water flow, as an influence on a variety of salmon life history elements, is a likely overarching controlling factor. Sobel and Botkin (1993) found support for this hypothesis and developed regression models as a salmon run forecasting tool. Water flow data from three and four years prior to the run year in question showed a significant correlation to escapement and possible salmon harvest. In their study, November low water flows were considered critical to spawning success (an influence on both spawning and egg incubation). Too great a stream flow results in loss of redds and juvenile fish from the prior year being washed downstream prematurely. They concluded that water flow timing and amount was critical to the upstream migration of adults, rearing of young and subsequent timely migration of those young downstream. The presence of large wood, both within and outside of the stream channel also plays an important role in juvenile salmonid survival. Pool and backwater environments that are fostered by this type of instream structure provide cover from high flows and protect young from being prematurely displaced to larger river or ocean environments.

Annual precipitation patterns and effects on streamflow may also help explain perceived shifts in dominance between steelhead and coho salmon over time in the assessment area. Data on juvenile steelhead and coho densities collected intermittently over a span of 37 years in the Little North Fork of the Noyo provides a starting point to examine water flow conditions and juvenile salmonid species composition over time (Figure 23). Burns (1972) examined stream habitat conditions and salmonid numbers in the late 1960's in an effort to determine the impacts of logging on salmonids. The Little North Fork of the Noyo, one of the streams in his study, was evaluated before, during, and after logging activities in a second-growth redwood/Douglas-fir forest and with harvest practices common to that time period. Data on a variety of stream physical conditions was collected, as was information on the density of juvenile steelhead and coho.

Valentine and Jameson (1994) revisited the Burns study to assess changes in habitat and salmonid population measures (although with slightly different methods). Their data indicated that by 1992, stream depth had recovered, if not increased, and stream width was intermediate between the pre and post logging conditions described by Burns. Canopy, as protection from solar radiation, had recovered and was near maximum. Although large woody debris data was not collected in the late 1960s work of Burns, Valentine and Jameson (1994) noted that large wood was limited and showed evidence of removal. The large wood that was present in 1992 was often oriented parallel to channel flow and had limited influence on stream structure. Sediment quality, when measured as percent fines less than 0.85 mm, was also intermediate to Burns pre and post logging data. In addition, and in spite of some apparent improvements in stream conditions, Valentine and Jameson noted an apparent inversion in salmonid species composition (1992-year data of Figure 23). Although Valentine and Jameson did not identify reasons for a shift in species composition, they hypothesized that large woody debris dynamics from the Burns time period and the extended drought of the early 1990s were likely important contributors to species composition.

Juvenile salmonid species composition data in the Little North Fork Noyo continues to be collected by private timberland owners (Campbell Timberland Management, pers. comm. 16 February 2004) reported juvenile salmonid densities and composition from

1994 through 2003. Their data show a clear increase in coho presence in five of the eight years for the period of data collection (Figure 24). Although it would appear that there has been a measurable decrease in salmonid habitat capability and biomass when measured against the pre logging (Figure 24, 1966 data year) data of Burns, and a likely increase in representation of steelhead, the hypothesis that a long lasting inversion in species composition as a result of change in stream habitat conditions that would result in the competitive exclusion of coho by steelhead is not strongly supported. The magnitude of variation between "good" coho and "good" steelhead years is more likely due to the combined effects of natural variation in numbers of juvenile salmonids produced, water flow influence, and the dampening effects of large woody debris as cover against high flows (B. Valentine, DFG, Santa Rosa, pers. comm.).

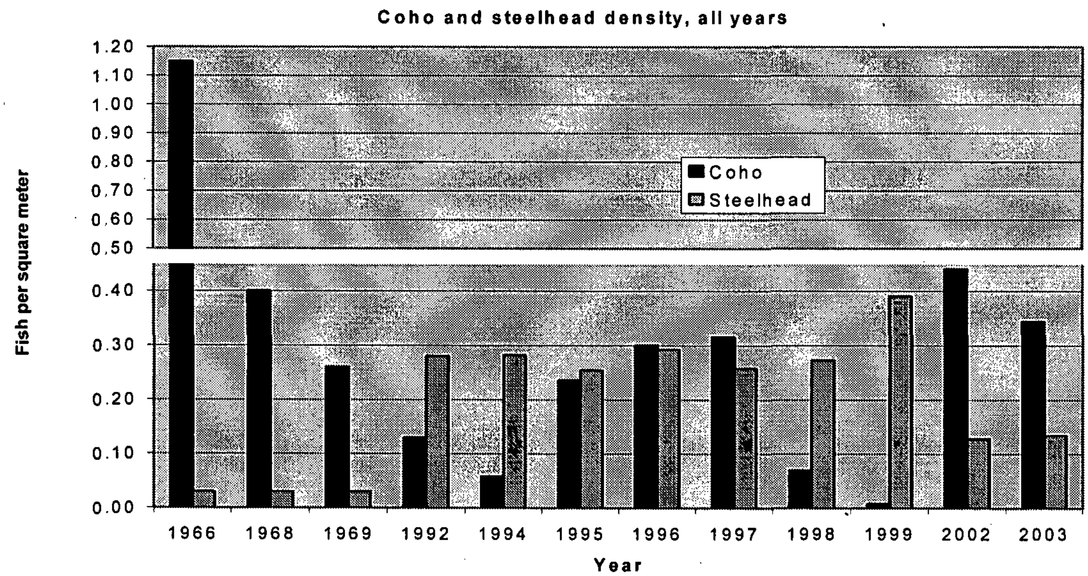


Figure VII 6.1.20. Coho and Steelhead Density.

Watersheds where short-term species composition data suggest steelhead dominance over coho may still provide a useful indicator of salmonid habitat variables at less than desirable levels.

Reeves et al (1993) examined the relationship of timber harvest, stream habitat complexity, and diversity of juvenile anadromous salmonids on the Oregon coast. Juvenile salmonid diversity was higher in streams in basins that had less than 25% of the basin area harvested. A primary factor influencing diversity values of stream fish communities was habitat complexity. Higher levels of stream habitat diversity (pool frequency, large woody debris presence) occurred in streams where basins showed less than 25% of area experiencing harvest. Reeves et al (1993) also noted that salmonid assemblages in basins with high harvest levels (>25%) were dominated by a single species more often than low harvest basins (<25%). In terms of *total fish* supported there were no differences in average densities between basins with different harvest levels.

Although Reeves et al (1993) do not define "harvested" or time frames within which harvest, road building and site preparation occurred and streams were only sampled on one occasion, some parallels to salmonid diversity in the JDSF Assessment area are evident. Virtually all basins in the JDSF Assessment area have had more than 25% of their area harvested over the past 30-40 years. This activity, associated road building, and active removal of LWD have likely simplified (reduction in the range and variety of hydraulic conditions and structural elements) instream habitat conditions. Reduced stream habitat diversity may explain, in part, the large differences generally described as "good steelhead" versus "good coho" years. Although currently an unknown, as stream LWD loading and channel geomorphology and structural complexity increase over time, it can be reasonably expected that the amplitude of fluctuation between "good coho" and "good steelhead" years, (as influenced by timing and velocity of water flow) will decrease. Stream fish community diversity may subsequently increase. Clearly, the examination of population response by one species or annual variation in total fish present may not adequately capture fish community level effects.

Large Woody Debris in the Little North Fork Noyo as an Influence on Species Composition

Valentine and Jameson (1994) summarized the extent of logging in the Little North Fork Noyo watershed. Early logging, (prior to 1920) was complete and approximated clear-cutting in prescription. Scattered residual old-growth trees were retained. Second-growth harvest was initiated within the watershed in 1964. This harvest and all which occurred prior to 1981 employed selection harvest and tractor yarding. Approximately 85 percent of the drainage was logged between 1964 and 1972 (2069 acres). During this logging period the road system was located primarily adjacent to the stream system. Many of the selectively cut stands within the drainage were logged again, beginning in 1980. Between 1980 and 1992, 1809 acres of sapling-sized stands in the Little North Fork drainage were created and 3514 acres harvested (1349 acres of clear-cut prescription). Between 1959 and 1964, CDFG removed 201,420 board feet of large wood (Mendocino Redwood Company, LLC 2000 Fish Habitat Assessment Noyo WAU). Similarly, CDFG records (Anonymous 1984, Valentine and Jameson 1994) indicate that large wood was removed from 50 log jams between 1983 and 1986. Gallagher at al. (2000) have noted that steelhead carrying capacity in the Noyo River basin has been reduced, with the adult population estimated at 300-400 fish. This is down an order of magnitude from former estimates (Taylor, 1978), when approximately 6000 adult steelhead returned to the Noyo River. Freshwater habitat conditions in the Noyo River watershed have likely restricted survival of older age steelhead juveniles and thus influences adult population levels.

6.1.9 Restoration Efforts and Opportunities

Keithley (1999) used riparian condition, gradient and watershed disturbance to gauge restoration potential of sub-basins in the Noyo and Big river basins as well as adjacent coastal tributaries (Figure VII.6.1.21).

The California Department of Fish and Game maintains a database of fishery restoration projects. Within the EIR assessment area there are a total of 71 projects and 213 sites (as of September 2004) beginning in 1984. These projects span a variety of instream habitat improvements, survey and research efforts, site purchase, road decommission and riparian habitat improvement efforts.

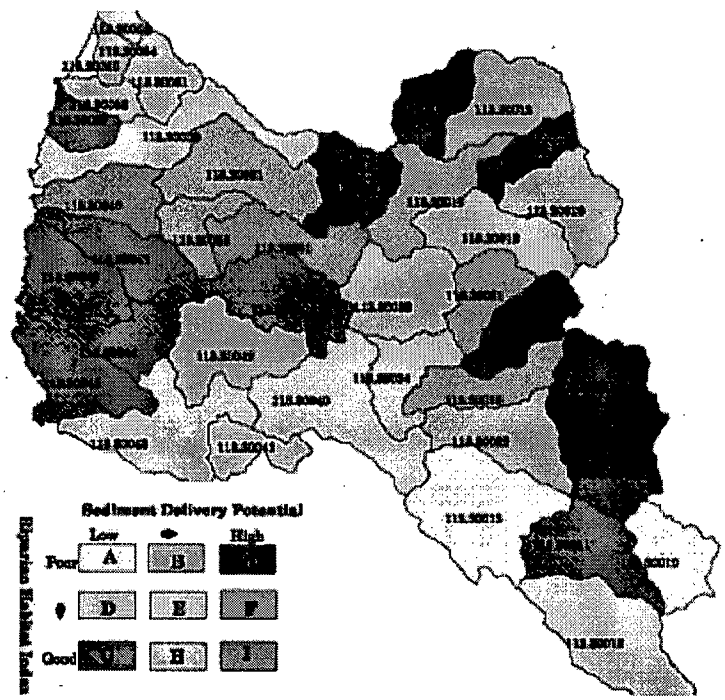


Figure VII 6.1.21. Map shows Noyo, Big River and coastal drainage riparian conditions and potential sediment yield. The dark green polygons represent the best prospects for restoration.

6.1.10 Critical Habitat

Section 4(a)(3)(A) of the ESA requires that, to the extent prudent and determinable, critical habitat be designated concurrently with the listing of a species. Critical habitat is defined in section 3(5)(A) of the ESA as "(I) the specific areas within the geographical area occupied by the species . . . on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species . . . upon a determination by the Secretary of Commerce (Secretary) that such areas are essential for the conservation of the species" (see 16 U.S.C. 1532(5)(A)). The term 'conservation', as defined in section 3(3) of the ESA, means ". . . to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary" (see 16 U.S.C. 1532(3)). Therefore, critical habitat is the geographic area and habitat functions necessary for the recovery of the species.

In designating critical habitat, NOAA Fisheries considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (50 CFR 424.12(b)). In addition to these factors, NOAA Fisheries also focuses on known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

Coho Salmon

On May 5, 1999 NOAA Fisheries designated critical habitat for the Central California Coast (CCC) coho salmon Evolutionarily Significant Unit (ESU) (64 FR 24049). The designations include all accessible reaches of rivers between Punta Gorda and the San Lorenzo River in Santa Cruz County, California; this designation also includes two rivers entering the San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. Critical habitat includes the water, substrate, and adjacent riverine and estuarine riparian zones. Adjacent riparian areas are defined as the area adjacent to a stream that functions to provide shade, sediment, nutrient or chemical regulation, streambank stability, and input of large woody debris and other organic matter.

Areas that are excluded from critical habitat designation include tribal lands in northern California and areas that NOAA Fisheries has identified as inaccessible reaches of rivers that are above longstanding, naturally impassable areas, or above dams which block anadromy. Dams identified by NOAA Fisheries as barriers to CCC coho salmon are: Warm Springs Dam on Dry Creek and Coyote Dam on the Russian River.

Logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals and unscreened diversions for irrigation have been identified as causes contributing to the modification and curtailment of coho salmon habitat within the CCC coho salmon ESU (64 FR 24049). Essential features of the designated critical habitat include adequate (1) substrate; (2) water quality; (3) water quantity; (4) water temperature; (5) water velocity; (6) cover/shelter; (7) food; (8) riparian vegetation; (9) space; and (10) safe passage conditions. All these human induced factors have exacerbated the adverse effects of natural environmental variability from such factors as drought, poor ocean conditions and predation (64 FR 24049).

The condition of the CCC coho salmon critical habitat, specifically its ability to provide for the species long-term survival and recovery, has been degraded from conditions known to support a viable population. The relative significance of each contributing factor will vary based on the frequency and magnitude of its occurrence in the ESU, and the ecological conditions of the ESU.

NOAA Fisheries determined that present depressed population conditions were the result of human induced factors including, logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals and unscreened diversions for irrigation. Other factors, such as over fishing and artificial propagation have also contributed to the current population status of coho salmon.

A federal agency that authorizes, funds or implements an action with the potential to affect critical habitat must consult with the USFWS to ensure that the action does not result in the destruction or adverse modification of critical habitat.

Steelhead

On September 2, 2005 NOAA Fisheries designated critical habitat for the Northern California Steelhead Evolutionarily Significant Unit (ESU) which will become effective January 2, 2006 (Federal Register 9/2/05 p52488-52536). The designation encompasses 50 occupied HSA watersheds (CalWater Hydrologic Subareas) within the freshwater and estuarine range of the Northern California Steelhead ESU. Nine watersheds received a low rating, 14 received a medium rating, and 27 received a high rating of conservation value to the ESU. Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating.

HSA watershed habitat areas for this ESU include approximately 3,148 mi (5,037 km) of stream habitat and approximately 25 square miles (65 square kilometers of estuarine habitat (principally Humboldt Bay). Of these, approximately 21 stream miles (33.5 km) are being excluded because they overlap with Indian lands. Approximately 120 stream miles (192 km) are being excluded because the economic benefits of exclusion outweigh the benefits of designation and are as follows:

Ruth	Entire watershed
Spy Rock	Tribal land
North Fork Eel	Entire watershed; Indian lands
Lake Pillsbury	Entire watershed
Eden Valley	Indian lands
Round Valley	Indian lands

California Coastal Chinook Salmon

On September 2, 2005 NOAA Fisheries designated critical habitat for the California Coastal Chinook Salmon Evolutionarily Significant Unit (ESU) which will become effective January 2, 2006 (Federal Register 9/2/05 p52488-52536). The designations encompass 45 occupied HSA watersheds within the freshwater and estuarine range of this ESU. Eight watersheds received a low rating, 10 received a medium rating, and 27 received a high rating of conservation value to the ESU. Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating.

HSA watershed habitat areas for this ESU include approximately 1,634 mi (2,614 km) of stream habitat and approximately 25 square miles (65 square kilometers) of estuarine habitat (principally Humboldt Bay). Of these, 10.3 stream miles (16.5 km) are being excluded because they overlap with Indian lands. Of the habitat areas eligible for designation, approximately 158 stream miles (253 km) are being excluded because the economic benefits of exclusion outweigh the benefits of designation and are as follows:

Bridgeville	Entire watershed
Spy Rock	Indian lands
North Fork Eel River	Indian lands
Eden Valley	Tributaries only; Indian lands
Round Valley	Indian lands
Black Butte River	Entire watershed
Wilderness	Entire watershed
Navarro River	Entire watershed
Santa Rosa	Entire watershed
Mark West	Entire watershed

For the Northern California steelhead and California coastal Chinook salmon, critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line (33 CFR 329.11). In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge which generally has a recurrence interval of 1 to 2 years on the annual flood series. Critical habitat in estuaries (e.g. San Francisco-San Pablo-Suisun Bay, Humboldt Bay, and Morro Bay) is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

Within these areas, the primary constituent elements essential for the conservation of these ESUs are those sites and habitat components that support one or more life stages, including:

(1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
(2) Freshwater rearing sites with:
(i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
(ii) Water quality and forage supporting juvenile development; and
(iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
(3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
(4) Estuarine areas free of obstruction and excessive predation with:
(i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
(ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and
(iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

(d) Exclusion of Indian lands. Critical habitat does not include occupied habitat areas on Indian lands. The Indian lands specifically excluded from critical habitat are those defined in the Secretarial Order, including:
(1) Lands held in trust by the United States for the benefit of any Indian tribe;
(2) Land held in trust by the United States for any Indian Tribe or individual subject to restrictions by the United States against alienation;
(3) Fee lands, either within or outside the reservation boundaries, owned by the tribal government; and
(4) Fee lands within the reservation boundaries owned by individual Indians.
(e) Land owned or controlled by the Department of Defense. Additionally, critical habitat does not include the following areas owned or controlled by the Department of Defense, or designated for its use, that are subject to an integrated natural resources management plan prepared under section 101 of the Sikes Act (16 U.S.C. 670a):
(1) Camp Pendleton Marine Corps Base;
(2) Vandenberg Air Force Base;

(3) Camp San Luis Obispo;
(4) Camp Roberts; and
(5) Mare Island Army Reserve Center.

6.1.11 Applicable Standards for Protection of Resources

State agencies, including CDF, are directed through a variety of programs and policies to protect and manage California's aquatic resources. These include:

- California Forest Practice Rules (e.g., see above discussion re WLPZs)
- Basin Plan (see Section VII.7, Geology and Soils, and Section VII.10, Hydrology and Water Quality)
- Fish and Game Code
- State and Federal Endangered Species Acts (see above discussion re state and federal listings of salmonids)
- Clean Water Act (see Section VII.7, Geology and Soils, and Section VII.10, Hydrology and Water Quality)
- Draft Jackson Demonstration State Forest Management Plan (DFMP) (see below)

The DFMP has been developed to achieve desired future conditions that will provide site- and species-specific protection measures that contribute to maintenance or improvement of the long-term conservation of population viability of aquatic and riparian dependent species of concern and enhance habitat values over existing conditions.

The goal of the JDSF riparian and stream management program is to maintain "properly functioning" riparian and stream ecosystems, i.e., systems that provide essential ecological function. JDSF's management strategy will go beyond simply preventing significant detrimental effects to aquatic and riparian habitats. The goal is to ensure that the aquatic and terrestrial resources and the ecological functions of riparian areas are protected and improved or restored. JDSF will manage forested stands in WLPZs to promote their ecological succession to late-successional forest conditions. JDSF will retain and enhance the vertical structural diversity of these stands, and protect riparian zone special habitat elements such as snags and LWD to improve habitat values.

Individual project stream and riparian protection and management measures will be determined on a site-specific basis and be designed to attain or maintain properly functioning condition as described above. A variety of conservation measures are available to avoid degradation and improve aquatic and riparian habitat. For example, large woody debris may be recruited to the stream through undisturbed buffer strips, retaining a predetermined number of trees, rotation age adjustment, or silvicultural control of recruitment rate and the species mix of trees. In order to develop an integrated conservation approach it is necessary to identify stream and riparian conditions that may already be degraded and could be affected by planned operations. As these areas are identified, measures will be developed that are intended to improve conditions, especially in regard to LWD loading.

6.1.12 Habitat Protections in DFMP

JDSF will manage forested stands in WLPZs to promote their ecological succession to late-successional forest conditions. Except as modified to support research conducted under appropriate authorities, watercourse protection measures will include all applicable FPRs and will at all times meet or exceed the following levels:

- Class I–150 foot WLPZ; class II–50 to 100 foot WLPZ. Zone widths are to be expanded where appropriate (e.g., unstable areas, etc.).
- Timber operations within channel migration zones will not occur (except as allowed in the Forest Practice Rules).
- Class I inner band–0 to 25 feet from the watercourse transition line: No-cut (except for harvest of cable corridor trees where needed) or limited entry to improve salmonid habitat through use of selection or commercial thinning silvicultural methods. At least 85 percent overstory canopy (where it exists prior to harvest) is to be retained within 75 feet of the channel.
- Class I outer band–remainder of WLPZ: High basal area and canopy retention zone. Basal area retention will remain high through the use of the all-age large tree and single tree selection silvicultural systems. Vertical overstory canopy (measured with sighting tube) at least 70 percent (where it exists prior to harvest) is to be retained in the outer band.
- Within Class I and Class II WLPZ, retain a minimum of 240 sq. ft. conifer basal area following completion of timber operations.
- Reentry–No more frequently than every 20 years for Class I WLPZs.
- Class I/II: Ten largest conifers per 330 feet of stream channel retained within 50 feet of the watercourse transition line.
- Class II inner band–0 to 25 feet from the watercourse transition line: No-cut (except for harvest of cable corridor trees where needed) or limited entry to improve salmonid habitat through use of selection or commercial thinning silvicultural methods. At least 85 percent overstory canopy (where it exists prior to harvest) is to be retained within 25 feet of the channel.
- Class II outer band–remainder of WLPZ: High basal area and canopy retention zone. Basal area retention will remain high through the use of all-age large tree and single tree selection silvicultural systems. Overstory canopy will be retained to prevent water temperature increases and allow for adequate canopy recovery where required.
- Class III–ELZs will be at least 25 feet on side slopes less than 30 percent, and 50 feet on slopes greater than 30 percent. These zones will be expanded where site-specific investigations reveal that additional protection is merited for preventing sediment movement into Class III channels.

- Class III–Burning will be conducted so that the majority of large woody debris is left within the ELZ. Fuels are not to be ignited within 50 feet of Class III channels.

The recruitment of LWD to the stream environment over time and consequent influence on the formation of pool habitats is also achieved through a variety of other habitat conservation strategies. The following strategies will be applied where they overlap with stream environments:

- Retain native hardwoods in the WLPZ except where species imbalance has occurred.
- Old-growth groves and residuals are protected per the JDSF old-growth conservation strategy.
- Salvage of dead or dying trees will not occur within the WLPZ, old-growth augmentation area, species-specific management area described in a Habitat Conservation Strategy, or other area specifically identified. Exceptions may exist in response to large-scale occurrence of fire, insect attack, windthrow, or threat to infrastructure..

Other habitat protection measures include:

- Natural springs and seeps that may provide habitat for non-fish aquatic species are provided the same protections as Class II streams
- LWD within the WLPZ will be retained and recruited to the stream system unless it presents an imminent risk to drainage structures.
- Selected roads within the WLPZ will be abandoned and decommissioned as described in the Road Management Plan. Construction and abandonment will be consistent with the standards described in the Road Management Plan.
- Road construction and harvesting proposed in inner gorge areas may be approved only after conferring with a Certified Engineering Geologist.

The DFMP includes a Road Management Plan. The objective of the Road Management Plan is to ensure that the design, construction, use, maintenance, and surfacing of JDSF roads will minimize sediment delivery to aquatic habitats. Improvement of JDSF roads to reduce sediment yield is needed due to the legacy of a road network partially relying on out-dated drainage systems and old segments located along watercourse channels. Numerous studies have shown that forest roads are a major source of management-related stream sediment. The Road Management Plan is a program to inventory the existing roads and crossings, improve the road segments that will remain in the permanent transportation network, and abandon high risk roads where possible. Additionally, the road plan provides guidelines for new road construction. The goal of this program is to enhance stream channel conditions for anadromous fish, amphibians, and other sediment-sensitive aquatic organisms by reducing both fine and coarse sediment loading. The DFMP also will improve water quality by reducing suspended sediment concentrations and turbidity. In addition fish passage at Class I crossings will also be assessed and addressed as needed.

The Road Management Plan includes the following six major components:

1) Inventory. The inventory of roads and stream crossings will provide the basis for upgrading and mitigating the road system at JDSF. It will allow the Forest staff to: a) identify problems that can be corrected through routine maintenance activities; b) assign maintenance and mitigation priorities to planning watersheds, road segments, and crossings; c) identify the most effective designs for roads, landings, and culvert problem sites; and d) identify roads to be properly abandoned. During the first five years, all existing roads will be inventoried (approximately 100 miles per year). Following a reconnaissance level screening for problem sites, staff and other consulted experts will develop site specific mitigation measures for identified significant potential or existing problems.

2) Design and Construction. Road, landing, and crossing design will follow the current state of the practice, such as is currently described in the Handbook for Forest and Ranch Roads (Weaver and Hagans 1994), or as suggested by JDSF RPFs and CEGs where a THP has been submitted. Existing and new roads needed to accommodate cable yarding on slopes steeper than 40 percent will generally be located on or near ridge lines (although mid-slope roads will remain). The goal for the final transportation network is to establish roads in low risk locations that will accommodate appropriate yarding and silvicultural systems. A specific target road density, however, will not be used. Roads in unstable areas will be avoided whenever possible and are only to be built if a CEG finds it unlikely that mass wasting will deliver sediment to a watercourse.

3) Use Restrictions. Wet weather operations on JDSF will be minimized. Specific measures include:
   a) no truck hauling when greater than 0.25 inch of precipitation has fallen during the preceding 24 hour period (applies to the entire year);
   b) no hauling/vehicle access when road rutting is occurring at a rate greater than that found during normal road watering,
   c) resumption of hauling only after rain has ceased for 24 hours and no turbid water produced from road surface runoff is observed in ditches along the roads where hauling may occur, and
   d) seasonal closure or surfacing for roads located in WLPZs if they are subject to moderate to heavy log truck traffic during the winter period.

4) Inspection and Maintenance. Proper maintenance is a key to reducing the long-term contribution of road related sediment. Permanent and seasonal roads will be inspected at least once annually to ensure that drainage facilities and structures are functioning properly. Two types of inspections will be used: 1) formal inspections, and 2) rapid ad hoc inspections. During formal inspections, all crossings and roads will be carefully observed every two years, and problem

sites will be recorded on road/crossing inventory forms. To cover the period between detailed inspections, a rapid ad hoc inspection will be made by JDSF Foresters and other staff during normal activities. "Storm patrol inspections" of known or anticipated problem facilities will be triggered by large winter storm events. Abandoned roads will be inspected at least twice following the completion of the decommissioning process.

5) Abandonment. Information for identifying and prioritizing road segments requiring abandonment will come from the road inventory, which will be completed over the first five years of the Road Management Program. The actual number of miles that will be proactively abandoned will depend on the results of the inventory, but it is estimated to be between 50 and 100 miles. Some of the criteria that will be used to identify candidate roads to proactively abandon include: 1) unstable areas, 2) roads in close proximity to a watercourse (particularly Class I watercourses with anadromous fish habitat), 3) roads not needed for management purposes, and 4) roads with excessive amounts of perched fill on steep slopes or in close proximity to watercourses.

6) Schedule. The locations of critical habitat for coho salmon and steelhead will be used to prioritize the sequence of the road inventory work. Secondary factors will include existing rates of sediment delivery to sensitive watercourse channels, based on gradient and degree of confinement, and likely hazards such as high density of riparian roads or stream crossings.

Additional protection measures relating to mass wasting, surface erosion, road management, and riparian vegetation can be found in the DFMP and are also discussed in other sections of this EIR: VII.6.6 Wildlife and Wildlife Habitat, VII.7 Geology and Soils, VII.10 Hydrology and Water Quality, and VIII Cumulative Effects.

6.1.13 Monitoring and Adaptive Management.

A description of the Monitoring and Adaptive Management goals are presented as Chapter 5 of the DFMP. Monitoring is described as "the process used to evaluate progress toward the stated goals in the management plan for JDSF." Adaptive management describes the "management strategies that will be implemented if analyses of monitoring results indicate that resource conditions begin to deviate from the desired trajectory." Under the heading "Watershed Resources," five goals are presented that are aimed at hillslope management, reduction of sedimentation impacts, channel form and function, water temperatures, and aquatic species populations:

Goal: Hillslope Conditions. Mitigate road and crossing problem sites (high priority).

As described in the Road Management Plan, problem road sites will be inventoried, prioritized, and mitigated. The road network will be monitored on an informal basis by JDSF staff, and every two years as part of a formal monitoring program.

Goal: Hillslope Monitoring. Minimize erosion impacts resulting from forest management operations (high priority).
Completed THPs that have over-wintered for 1 to 4 years will be monitored. The scope of this THP monitoring will include:

- inspection of all watercourse crossings, road segments and landings;
- mapping the location of rilling/gullying on roads, landings, etc. that are contributing sediment to watercourses;
- mapping the location of mass wasting features (including cutbank/fillslope failures) associated with roads, crossings, and landings, or within harvest units;
- mapping the location of road drainage structures (including crossings) that are contributing significant amounts of sediment to watercourses;
- measurement of WLPZ canopy for Class I watercourses; and
- recording information on the causes of erosion features, proposed improvements, and a schedule for mitigation treatments.

Documented erosion problems will be analyzed to determine what management practice or site-specific condition was responsible. Adaptive management solutions will be site specific and based on professional judgment of JDSF staff.

Goal: Stream Channel Conditions. Maintain or improve aquatic and riparian habitat conditions and minimize sediment delivery to watercourses (high priority).

- Surveys of stream channel conditions will be implemented for a limited number of streams on JDSF.
- Monitor long-term trends in channel morphology, habitat quality and woody debris, and evaluate the effectiveness of prescriptions designed to maintain or improve aquatic and riparian habitat conditions and minimize sediment delivery to watercourses.
- Parameters sampled will vary depending on the stream reach evaluated, but may include:
  - LWD frequency by size class, with information on condition and placement
  - Pool dimensions (including pool volume], residual pool depth, and useable rearing/holding/overwintering habitat)
  - Pool frequency
  - Gravel permeability, embeddedness and size distribution (including overall d50 of sampled reaches)
  - Channel dimensions (measured using transects)
  - Longitudinal profiles and cross sections

- Bank conditions and entrenchment
- Benthic macroinvertebrates

The adaptive management solution relative to this goal consists of developing a set of management prescriptions designed to maintain or improve aquatic and riparian habitat conditions and minimize sediment delivery to watercourses.

Goal: Stream Temperature. Maintain or improve current stream temperature regimes (normal priority).

- Annual summer stream temperature monitoring is scheduled to continue.
- Stream temperature data currently reported for each location include: (1) hourly water temperature, (2) maximum 4-week moving average temperature and date of occurrence, and (3) maximum 7-day moving average temperature and date of occurrence.

Analysis will consist mainly of trend analysis. Adaptive management solutions will consist of modifying forest management prescriptions and manipulating vegetation canopy cover as needed.

Goal: Fish and Amphibian Populations. Maintain or improve current fish and amphibian populations on the Forest (high priority).

- maintained a weir and coho salmon egg-taking station in JDSF
- USFS yearly electrofishing surveys in the North and South Forks of Caspar Creek documenting density, biomass, and distribution of fish and amphibians by habitat type during the early summer.
- CDFG trapping and counts of downstream juvenile migrant salmonids in mainstem Caspar Creek.
- Analysis will consist of summarizing available data and projecting fish and amphibian populations.
- Utilize same management strategies as used for stream temperature.

6.1.14 Additional Management Measures to Contribute to Recovery of Aquatic Resources

Since the release of the DFMP, CDF has developed the following additional proposed measures for application to JDSF to facilitate recovery of aquatic resources and habitats. These management measures are proposed for application to alternatives C1 and C2.

Accelerated Road Management Plan

The Road Management Plan provided for in the DFMP proposes to take 5 years to complete a survey and evaluation of all roads on the Forest. At that time, priorities would be set for road upgrade and abandonment projects and the work on these projects would begin. CDF proposes to modify the Road Management Plan in the following way in order to more quickly achieve reductions in road-related sediment inputs into streams. To the extent feasible, accelerate the implementation of the Road Management Plan:

- Complete inventory of roads within 3 years rather than 5.
- Until completion of the road inventory, survey and evaluate all appurtenant roads as a part of each THP; complete the identified needed road upgrades as a part of the THP.
- Feasibility will be determined by availability of JDSF staff and contractors, availability of funding, and by ability to include road upgrade work as a part of timber sale contracts.

Large Woody Debris Survey, Recruitment, and Placement

CDF has developed a large woody debris survey, recruitment, and placement management measures for JDSF to contribute toward a more rapid recovery of aquatic habitat features and functions related to LWD.

I. The following apply to all THPs:

   A. Conduct either programmatic or THP-specific instream LWD surveys of Class I and II streams to determine LWD loading prior to designing final WLPZ prescriptions for a THP.

      1. If the surveys indicate that instream wood loads meet target criteria as described in Bilby and Ward (1989), then no further steps are needed and the standard DFMP measures apply.

      2. If the surveys indicate that instream wood loads do not meet target criteria as described in Bilby and Ward (1989), then implement either a or b:

         a. Class I and Class II WLPZ silviculture will either be no-cut (except for harvest of cable corridor trees where needed) within 100 to 150 feet of the watercourse transition line for Class I or 75-100 feet for Class II, or limited to removal of codominant, intermediate, or suppressed trees to promote growth on the larger diameter dominant trees and improve LWD recruitment potential. Some flexibility should be maintained to allow removal of large trees to adjust species composition and improve the potential permanence of future LWD; however the goal of enhanced LWD recruitment must still be met.

b. Assess the potential for placing large wood into the Class I or Class II channel. Where assessment indicates that instream LWD placement is feasible, would have a clearly beneficial effect upon aquatic habitat, and is deemed appropriate by DFG, place unanchored log and/or rootwads in streams. Most of the placed LWD should exceed one bankfull width in length. Where assessments indicate instream LWD placement is not feasible, then measure A(2)(a) is to be applied.

B. If LWD surveys per A are not conducted, WLPZ prescriptions default to A(2)(a), above.

C. For specific research and demonstration purposes related to ecological questions (e.g., exploring the role of streamside canopy openings in increasing benthic productivity and fish response), A and B may be overridden on a limited basis.

II. Experiment with placement of LWD in Class III streams to improve sediment metering and other hydrologic functions.

6.1.15 Thresholds of Significance

Based on policy and guidance provided by CEQA (PRC Section 21001 and the CEQA Guidelines), an impact of the proposed project would be considered significant if it results in one or more of the following:

1. Have substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive or special status species in local or regional plans, policies, or regulations, or by the CDFG or U.S. Fish and Wildlife Service.
2. Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.
3. Have a substantial adverse effect on any riparian habitat.
4. Conflict with the provisions of an adopted Habitat Conservation Plan, or other approved local, regional, or State habitat conservation plan related to aquatic resources.
5. Have the potential to substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal.

The degree to which timber management would affect aquatic habitat and, hence, fish and wildlife populations, was assessed based on appropriate scientific literature, current condition of existing habitat, general life-history and habitat requirements, and projected effect on specific habitat parameters resulting from the proposed project and the alternatives. Because quantitative relationships between forest management activities and their effects on fish habitat on JDSF lands have not been developed, the assessment of fishery-related impacts for each alternative was generally and necessarily qualitative.

6.1.16 Project Impacts

The DFMP has been developed to minimize the potential for adverse impacts to aquatic habitat, fish migration, riparian habitat, aquatic species populations, and wetlands. Two of the aforementioned thresholds of significance referring to adverse effects on 1) species either directly or through habitat modification and 2) riparian vegetation, contain several individual components that could be affected by management activities. The various elements within each threshold of significance and associated impacts for the proposed action are considered below.

Project Impact 1: ***Potential to have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive or special status species in local or regional plans, policies, or regulations, or by the CDFG or U.S. Fish and Wildlife Service.***

Although juvenile and adult salmonids and certain amphibians can be adversely affected by forest management activities, direct impacts on fish populations under any of the alternatives would be uncommon. Management-related impacts would primarily result from indirect effects on aquatic habitat that result from changes to inputs of water, sediment, and LWD. Indirect effects may include, but are not limited to, changes in water temperature resulting from reductions in stream shading; increased sedimentation resulting from increased erosion; reduced recruitment of LWD; alteration of flow patterns resulting from changes in runoff characteristics; changes in stream channel geomorphology; and blockage of fish migration at stream crossings. Additional discussion regarding peak flows and sedimentation can be found in section VII.10, Hydrology and Water Quality, section V.7, Geology and Soils sections, Appendix 10, Peak Flow Analysis, and Appendix 11, Overview of Existing Sediment Studies Relevant to the JDSF EIR.

Impact 1a: ***Increases in Water Temperature*** **(Beneficial)**

Most of JDSF's watercourses currently have water temperature regimes that meet NMFS (1997) target criteria. Those reaches not meeting target criteria are generally larger order streams such as the mid- to lower South Fork Noyo River or the North Fork Big River in the eastern portion of the Forest. Over-stream canopy densities are generally considered to be high throughout JDSF. Of the 35 stream surveys conducted by CDFG between 1995 and 1997, 25 streams had densities exceeding 90%, 6 streams exceeded 80%, and 4 streams were between 60 and 79%. These high canopy densities have developed over time under the requirements of the FPRs and 1983 management plan. The DFMP (alternative C1) and alternative C2 would require at least

85% overstory canopy within 75 and 25 feet of Class I and II watercourses respectively. Much of the previous timber harvesting on JDSF was conducted using FPRs with lower WLPZ retention standards than those stated above. The additional management measure discussed above, Large Woody Debris Survey, Recruitment, and Placement, also will help to ensure that dense streamside canopy develops over time. In addition, late seral forests would be developed in the WLPZs. For lands outside of JDSF but still within the cumulative watershed effects assessment area, current stream canopy cover is typically less than on JDSF. However, these areas are now subject to FPRs that require higher canopy retention that previously (though lower than proposed under the DFMP). Thus, stream canopy will increase over time in most if not all areas of the cumulative watershed effects assessment area. Therefore, it can be expected that the higher stream canopy retention standards and late successional forest management contained in the DFMP and alternative C2 will result in decreasing water temperatures over time. This effect would be beneficial.

Mitigation: None required.

Under alternative A, the no-harvest management would not remove canopy cover along watercourses, allowing canopy cover to increase over time and temperature regimes to decease proportionately. This alternative does not provide for restoration work in WLPZs where conifers need to be reestablished, resulting in a slower rate of recovery than might otherwise be achieved.

Under alternative B, the FPR Threatened and Impaired Watershed standards would apply, resulting in some increase in canopy cover over time. This alternative would not result in significantly higher water temperatures. There would be a less than significant impact on stream temperatures.

Alternatives D, E, and F all have riparian protection standards at least comparable alternatives C1 and C2. Shading effects of increased canopy and microclimate effects of wider stream buffers will result in a decrease in stream temperatures over time, resulting in a beneficial effect.

Impact 1b*<u>: Increases in Sedimentation</u>* (Less than Significant)

The DFMP (Section 2, Watersheds) acknowledges that the present road network reflects a history of various transportation technologies and forest practices. Many existing roads utilize railroad grades, constructed beginning in the 1870s, that are often located adjacent to streambeds, exacerbating erosional processes (e.g., mass wasting). The present road network was mostly constructed from the 1950s to the 1970s. JDSF contains an estimated 350 miles of actively used roads and 150 miles of potentially improperly abandoned roads. The sediment contribution per unit area from roads is often much greater than that from all other land management activities combined, including log skidding and yarding (Furniss et al. 1991). Sidle et al. (1985) (fide Furniss et al. 1991) summarized the results of 10 landslide inventories and found that mass wasting associated with roads produced 26-346 times the volume of sediment as undisturbed forest with clear-cuts producing 1.9-40.4 times the amount of undisturbed areas. The amount of sediment resulting from road-related shallow landslides from 1979 to 1996 for all the planning watersheds draining JDSF was approximately half that found during 1958 to 1978 (DFMP). Erosion from road related shallow landslides and surface erosion is expected to continue to decrease as the Accelerated Road Management Plan on the State Forest is implemented and use of tractors in and near WLPZs is minimized. Sediment delivery from mass wasting or unstable hillslope locations also should be reduced over the current condition by implementing the hillslope management activities stated in the DFMP, including CEG involvement on on-the-ground projects. The DFMP (alternative C1) and alternative C2 have the same measures to address sediment. Both would result in a less than significant effect.

Mitigation: None required.

Under alternative A, road maintenance would be limited to that necessary to maintain public access. There is no directed road upgrade or abandonment program. Sediment delivery may increase from the unmaintained road system. Potential road sediment problems could be mitigated through application of a Road Management Plan. No timber harvest eliminates potential for sediment from harvesting operations. Potential hillslope sediment sources could be mitigated through application of Hillslope Management Guidelines provided in DFMP. With these mitigations, alternative A would have a less than significant impact.

Under alternative B, timber harvest would be conducted, including higher levels of clearcutting and other evenaged management than under the other five alternatives that include harvest. Standard Forest Practice Rules would be applied to prevent and reduce sedimentation. The FPR-based three-year road maintenance requirement without directed upgrade and abandonment plan may not be sufficient to reduce sediment delivery to less than significant levels. Potential road sediment problems could be mitigated through application of a Road Management Plan. Potential hillslope sediment sources could be mitigated through application of Hillslope Management Guidelines provided in the DFMP. With these mitigations, alternative B would have a less than significant impact on stream sedimentation.

Alternatives D, E, and F have expanded watercourse protections for all watercourse classes with limited or no-harvest restrictions. Class III/headwater protections are provided with Riparian or Aquatic Management Zones. The Road Management Plan will reduce road-related sediment over time. Decreased levels of harvesting activity contribute to a reduction in the potential for sediment generation. Potential hillslope sediment sources are addressed through application of Hillslope Management Guidelines provided in DFMP. These alternatives would have a less-than-significant impact on stream sedimentation.

Impact 1c: *Reduction in LWD Recruitment* (Benefical)

Timber harvesting along streams, depending upon how it is conducted, has potential to alter the quantity and quality of large woody debris (LWD) in streams, which can affect the area and depth of pools (Beechie and Sibley 1997) as well as a variety of other instream and streambank measures. Instream sediment storage, sorting, and transport are partially dependent on LWD. Reductions in instream LWD also have been linked to decreases in salmonid habitat complexity, winter rearing habitat, stream carrying capacity, species diversity and composition (Spence et al. 1996). In this region, historic timber harvesting and focused stream clearing projects have reduced LWD levels by a substantial margin. Therefore, to increase the recovery rate of instream habitats on JDSF, an increase in recruitment and potential for recruitment of LWD from the riparian zone would be beneficial, as would management actions to place LWD in streams. Spence et al. (1996) stated a protected buffer of approximately one site tree height (30-45 m or 98-148 feet) would provide 90-100% of a fully functioning riparian corridor. Reid and Hilton (1998) reported that about 90% of the instances of debris input occurred from tree falls within 115 feet of the channel in un-reentered forests and within 164 feet of the channel in buffer strips. Management decisions made relating to WLPZ management measures will have an effect on the amount, species, and size of LWD available for recruitment to streams.

The DFMP (alternative C1) and alternative C2 propose (1) retention of the 10 largest conifers within 50 feet of Class I and II streams per 330 feet of stream length and (2) 25-foot buffers on Class I and II streams that are no-cut (except for harvest of cable corridor trees where needed) or limited entry to improve salmonid habitat through use of selection or commercial thinning silvicultural methods, these alternatives are more permissive for harvests in the outer bands of the WLPZs. In the outer bands (covering the area from 25 feet to 150 feet from the watercourse transition line for Class I streams and 25 feet to 100 feet from the watercourse transition line for Class II streams), harvest constraints are less restrictive and could result in the removal of recruitable large wood. Modification of stocking, species distribution, and tree size in the WLPZ could have a direct bearing on LWD recruitment potential. Application of the management measure for Large Woody Debris Survey, Recruitment, and Placement would ensure that harvesting in either the inner or outer WLPZ zones would be restricted so as to ensure recruitment of LWD over time. This measure also could include the placement of LWD in streams. Further, the DFMP and alternative C2 WLPZ prescriptions are designed to promote late successional stands. Based on these measures, these two alternatives would have a beneficial effect on LWD recruitment.

Mitigation: None required.

Under alternative A, the no harvest management would allow full development of LWD recruitment potential, over time, except where conifer restoration is needed. This alternative would have a beneficial impact on LWD over time.

Alternative B provides only the protections required under the FPRs. FPR retention standards are designed to protect LWD recruitment potential on a THP-by-THP basis. Additional mitigation is necessary, such as that included in the Large Woody Debris Survey, Recruitment, and Placement management measure. Application of this mitigation will result in increased LWD recruitment over time, resulting in improved instream habitat conditions, which constitutes a beneficial effect.

Under alternatives D through E, FEMAT or NOAA Fisheries style WLPZ retention and late successional management standards under Alternatives D, E, and F should increase potential for LWD recruitment with broader riparian management zones, harvest restrictions, and emphasis on late seral development. These measures will result in beneficial improvements in LWD recruitment and stream habitat conditions over time.

Impact 1d: *Alteration of Flow Patterns* (No Impact)

Timber harvesting activities can alter flow patterns through construction of roads and interception of the drainage network. Roads, inboard ditches, skid trails, and landing surfaces can act as man-made drainages that carry water and sediment into natural streams (Weaver and Hagans 1994). Culverted stream crossings can be obstructed with debris and cause the fill to fail or gullies to form when the diverted water runs down the road surface and spills onto hillslopes. Inboard ditches can intercept one or more ephemeral channels and carry their flow to a receiving watercourse. Interception and delivery of water from these watercourses can result in excessive flow and downcutting of the receiving channel. Diversion potential will be inventoried and corrected as part of the Road Management Plan. See the Section VII-10 (Hydrology) for additional discussion of peak flows.

Under both the DFMP (alternative C1) and alternative C2, the Accelerated Road Management Plan will be implemented and will reduce and eventually eliminate diversion potential at road crossings. Further, the FPRs require THP-based assessment and repair of diversion potentials. These measures will result in no impact on flow patterns.

Mitigation: None required.

Alternative A provides for no directed road maintenance, upgrade, or abandonment program. This hands-off management could result in diverted flow as crossings are obstructed. These potential impacts could be mitigated to less than significant though the adoption of a Road Management Program.

Alternative B has active management that includes basic road maintenance and application of FPRs to roads appurtenant to timber harvesting plans. However, roads that are not a part of THPs are not actively surveyed and upgraded to address potential crossing obstructions and diversions. Mitigation through application of a Road

Management Plan would result in a less than significant impact for alteration of flow patterns.

Alternatives D through F all call for Road Management Plans. The FPRs call for THP-by-THP assessment and upgrade of road crossings where diversion potential exists. These measures should reduce and eventually eliminate diversion potential at road crossings. These alternatives would have no impact on flow patterns.

Impact 1e: *Channel Geomorphology* (Less than Significant)

Channel geomorphology is affected by a number of factors. These include geology, channel gradient and confinement, rainfall patterns and hydrology, LWD and sediment inputs, and anthropogenic activities. The other factors affecting geomorphology are discussed in the section VII.7 Geology and Soils and VII.10 Hydrology and Water Quality.

Class I and Class II channel form and function on JDSF have been affected by management activities. Pools have V* measurements that are twice as high as undisturbed channels in the same geologic type (Knopp 1993). Instream LWD loads, which could help scour and route sediment, are well below those for undisturbed systems. However, Valentine (1994) found stream depth had recovered, if not increased, between the late 1960s and 1993. In addition, the percentage of fine sediment in spawning gravel also decreased during that period. The DFMP (alternative C1) and alternative C2 include Hillslope Management Guidelines, WLPZ retention standards, use of CEGs on projects, and an Accelerated Road Management Plan that will reduce the potential for impacts to channel geomorphology. Further, the Large Woody Debris Survey, Recruitment, and Placement would provide adequate levels of instream LWD to ensure properly functioning channel geomorphology. The resulting impacts on channel geomorphology would be less than significant.

Mitigation: None required.

Under alternative A, there will be no timber harvest and associated potential effects that can alter channel geomorphology. However, there could be increased sediment from non-maintained roads that could fill pools and gravel interstices and reduce channel volume. These potential impacts could be mitigated to less than significant though the adoption of a Road Management Program.

Alternative B provides no special protections for channel geomorphology beyond the FPRs. Increased sediment delivery from roads that are not upgraded or abandoned could fill pools and gravel interstices and reduce channel volume. Potential road sediment impacts could be mitigated though the adoption of a Road Management Program. Potential hillslope sediment impacts could be mitigated through the Hillslope Management Guidelines developed in the DFMP. Mitigation with a measure such as Large Woody Debris Survey, Recruitment, and Placement would ensure adequate instream LWD to address channel geomorphology processes and to reduce overall impacts to less than significant.

For alternatives D through F, enhanced riparian zone protections, Road Management Plan, Hillslope Management Guidelines, and use of CEG on THPs should reduce sediment delivery below current conditions and not result in further degradation of channel geomorphology. Thus, there would be a less than significant impact under these alternatives.

Project Impact 2: *Potential to interfere substantially with movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.* (Beneficial).

Migration barriers affect salmonids by restricting juvenile access to higher quality habitats, downstream movement, and inhibiting or halting adult entry to spawning grounds. Barriers to migration usually involve improper placement of stream crossings or development of thermal barriers during the summer. The CDFG stream surveys reported the presence of 55 definite, probable, or possible barriers to anadromous migration within JDSF. JDSF personnel identified several more. In addition, there are 66 Class I crossings on JDSF. Some of these crossings may inhibit movement of adult or juvenile salmonids to some degree. The Accelerated Road Management Plan includes inventories of crossings to determine risk to fish migration. The road upgrade component of the Accelerated Road Management Plan will correct problem culverts and have a beneficial impact on fish migration and rearing habitat.

Mitigation: None required.

Under alternative A, increased sediment delivery from non-maintained roads could fill pools and gravel interstices and reduce egg incubation and rearing habitat quality. Inadequate existing road crossings and road crossing failures on Class I streams could impede anadromous and resident migration and increase sedimentation-associated impacts. These potential impacts could be mitigated to less that significant through application of a Road Management Plan.

Alternative B applies standard Forest FPRs to timber management activities. Increased sediment delivery from roads that are not upgraded or abandoned could fill pools and gravel interstices and reduce egg incubation and rearing habitat quality. Road crossing failures on Class I streams could impede anadromous and resident migration. Potential impacts could be mitigated to less that significant through application of a Road Management Plan.

For alternatives D through F, there is the inclusion of a Road Management Plan that will upgrade and abandon roads and correct migration barriers along the road system.

These measures will reduce sediment-associated impacts and improve access to spawning areas and downstream migration. Potential impacts will be beneficial.

Project Impact 3: ***Potential to have a substantial effect on any riparian habitat.***

The presence of riparian vegetation adjacent to stream channels and within the flood prone area contributes to streambank stability, allochthonous inputs (leaf litter and terrestrial invertebrates), and instream habitat. Vegetative root structure reinforces streambanks to resist erosional forces. Leaf litter provides the trophic base for aquatic macro-invertebrates, which are an important food source for fish. LWD inputs from the riparian zone provide cover habitat for salmonids, amphibians and other aquatic life, promote streambed scour and pool development, sort and store sediment, and slow water velocities. Shading and microclimate effects of dense and wide riparian forest helps to keep stream temperatures low enough for salmonid health and to maintain beneficial microclimate effects. These riparian functions have a direct bearing on the quality of salmonid spawning and rearing habitat.

Impact 3a: ***Riparian Forest Extent and Quality*** **(Beneficial)**

The extent (width and continuity) and quality (tree size, structure, and species composition) of riparian forest has a number of positive effects on riparian habitat quality. The DFMP (alternative C1) and alternative C2 require a 25-foot no-cut/limited entry for habitat improvement WLPZ for Class I and Class II watercourses, which would protect streambank stability. Further, the Large Woody Debris Survey, Recruitment, and Placement management measure is applied. These alternatives also require management of WLPZs for late seral forest conditions. These measures will protect riparian forest extent; they also will enhance riparian forest condition and ecological function. These alternatives will have a beneficial effect on riparian forest extent and quality.

Mitigation: None required

The no-harvest nature of alternative A will maintain all trees in riparian areas and beyond. However, this is no opportunity to use management to enhance the rate at which late seral forest characteristics are achieved. This alternative will have no impact.

Under alternative B, the FPRs provide for substantial riparian forest retention for Class I and II watercourses, and protection measures and buffer considerations for Class III stream. Harvest activities consistent with FPRs will occur in WLPZs, typically resulting in stands that do not have late seral characteristics. This alternative will have a less than significant impact of riparian forest extent and quality.

Under alternatives D through F, FEMAT-style stream buffers of NOAA Fisheries short-term HCP guidelines will protect and enhance riparian forest condition, extent, and ecological function, resulting in beneficial impacts.

Impact 3b: *<u>Allochthonous Inputs</u>* (Less Than Significant)

Riparian vegetation provides a key source of nutrient input to the stream ecosystem. The degree to which the riparian zone can provide invertebrates, leaf litter, and LWD as a substrate and nutrient source for aquatic macro-invertebrates has a direct relationship on the production of food resources for aquatic species. Timber harvesting can reduce allochthonous inputs through direct removal of timber and vegetative cover and thereby have an effect on nutrient input to stream ecosystem processes. The DFMP (alternative C1) and alternative C2 both establish a no-cut WLPZ on Class I and II watercourses (except for habitat enhancement), promote the development of late successional habitat, and ensures at least an 85% overstory canopy closure within 75 feet and 25 feet of Class I and II watercourses, respectively. These measures will reduce the potential for loss of allochthonous inputs to a less than significant level.

Mitigation: None required.

Under alternative A, there will be no harvesting and no resulting change in allochthonous inputs. This alternative would have no impact.

Alternatives B and alternatives D through F all allow some form of harvesting within the stream buffers. However, the canopy retention and habitat improvement measures should results in the maintenance of allochthonous inputs, resulting in a less than significant impact.

Impact 3c: *<u>Instream Habitat and Streambank Stability</u>* (Beneficial)

As previously discussed and analyzed, riparian vegetation and timber management can affect instream habitat in a number of ways. Riparian root structure can be undercut and provide holding and rearing habitat for adult and juvenile fish while stabilizing streambanks. Timber harvesting activities have the potential to destabilize streambanks by removing trees whose roots provide erosional resistance to flows. As streambanks fail the channel widens and cross-sectional area increases. The increase in cross-sectional area reduces stream velocities during runoff events and decreases the ability of the watercourse to transport sediment. Reduced sediment transport ability could result in channel aggradation and decreases in the quantity and quality of amphibian and salmonid spawning and rearing habitat. The DFMP (alternative C1) and alternative C2 establish a no-cut/limited cut WLPZ inner band on Class I and II watercourses that reduces the potential for loss of streambank stability. Since only inner band harvests that improve salmonid habitat are permitted under these alternatives, harvesting that would reduce streambank stability and thus threaten salmonid habitat would not be permitted.

Riparian canopy closure reduces the amount of solar radiation reaching the watercourse thereby moderating water temperatures. LWD provides roughness elements that cause flow turbulence resulting in pool scour and development. The turbulent flow also helps contribute to fine sediment mobilization and transport. Riparian areas also provide fish with velocity refuge areas during overbank flood flows. Instream LWD provides critical winter cover for flows that do not overtop banks. Soil disturbance in WLPZs could result in delivery of sediment to watercourses that could affect quality and quantity of amphibian habitat and salmonid spawning and rearing habitat.

Overstream canopy densities are generally considered to be high throughout JDSF (see section VII.6.1.4, subsection **Canopy Cover, Streamside Shade, and Temperature** and Appendix 12 regarding water temperatures). Although the riparian zone appears to be healthy, instream LWD loads are considerably below target levels for many JDSF stream reaches. These diminished levels of LWD were reflected in the low pool shelter ratings observed during the CDFG stream surveys. Only one watercourse (Caspar Creek downstream of the South Fork) exceeded the desired level of 100. The majority (74%) of watercourses on JDSF had shelter ratings of less than 39, with 91% of the watercourses having of less than 60. Nearly all the CDFG surveys recommended direct placement of LWD into streams to improve aquatic habitat. The restrictions on WLPZ harvesting contained in the DFMP, alternative C2, and the Large Woody Debris Survey, Recruitment, and Placement management measure will ensure that increasing levels or LWD are available for recruitment to Class I and II streams, or that direct placement of LWD occurs.

Although there have been improvements in fine sediment levels in JDSF streams, V* values indicated a continuing high sediment supply. In addition, Valentine's (1994) mean percentage of fine sediment was higher than the pre-logging amounts reported by Burns (1970). The implementation of the Accelerated Road Management Plan and Hillslope Management Guidelines will reduce the amounts of erosion and sediment delivery to below current levels and below levels that would occur under the 1983 Management Plan.

Taken as a whole, the measures in the alternatives C1 and C2 would result in beneficial improvements to instream habitat and streambank stability.

Mitigation: None required

Alternative A does not permit any harvesting, thus maintaining all the benefits that current riparian vegetation provides to instream habitat quality and streambank stability. Further, without harvest, these vegetation values will increase over time as trees get larger and forest canopy denser. This alternative would benefit instream habitat and streambank stability over time.

Under alternative B, application of the FPRs may not affect instream large wood and habitat in some reaches. However, riparian silviculture may reduce large wood recruitment potential in watercourses where instream wood loads are low thereby affecting instream habitat. Mitigation regarding WLPZ outer zone harvesting is needed, such as the Large Woody Debris Survey, Recruitment, and Placement management measure. With this mitigation, the impact would be less than significant.

Alternatives D, E and F have measures including no-cut zones and wide stream buffers where they promote the development of late successional riparian habitat and will likely lead to beneficial improvements in instream habitat quality and streambank stability.

Project Impact 4: ***Conflicts with provisions of an adopted HCP or other approved local, state, or federal HCP relating to aquatic resources.*** **(No Impact).**

There are no approved or adopted HCPs pertaining to JDSF. There would be no impact for any of the seven alternatives considered.

Mitigation: None required

Project Impact 5: ***Causes a fish or amphibian population to drop below self-sustaining levels or threaten to eliminate an aquatic community.*** **(Beneficial)**

Fish and amphibian populations can be extirpated from watercourses and watersheds if conditions degrade to a point that populations are no longer self-sustainable. Fish and amphibian populations are not expected to drop below self-sustaining levels under the DFMP (alternative C1) or alternative C2. Similarly, no aquatic community will be eliminated. In general, conditions for aquatic species are expected to show continued improvement over time. The Accelerated Road Management Plan should result in decreased sedimentation, protect flow and channel geomorphology, and improve fish movement and access to spawning areas. The Hillslope Management Guidelines also will help to significantly limit sediment inputs. WLPZ management activity, including the Large Woody Debris Survey, Recruitment, and Placement management measure, will ensure adequate LWD recruitment. Promotion of late seral habitat conditions within WLPZs and added protections of Class III/headwater streams will further reduce risk of sedimentation, restriction of fish movement and altered channel geomorphology; as well as increased large wood recruitment to stream systems generally lacking this attribute. Some beneficial effects on fish and amphibian populations will result from the cumulative effects of these measures.

Mitigation: None required.

For alternative A, lack of Road Management Plan under could result in increased sedimentation, alter flow and channel geomorphology, and restrict fish movement and access to spawning areas, potentially resulting in significant adverse impacts. Implementation of Road Management Plan as a mitigation would reduce the potential for these impacts and would likely reduce sedimentation over time, which would be beneficial. This mitigation would result in less than significant impacts.

Alternative B also lacks a Road Management Plan and, because it includes timber harvest, lack of Hillslope Management Guidelines also is of concern regarding potential sedimentation. WLPZ harvest activity and its potential impact on large wood recruitment could be mitigated with the Large Woody Debris Survey, Recruitment, and Placement management measure. Promotion of late seral habitat conditions within WLPZs and added protections of Class III/headwater streams in addition to the Road Management Plan, as well as application of Hillslope Management Guidelines, could further reduce risk of sedimentation, restriction of fish movement and altered channel geomorphology, and increase large wood recruitment to stream systems generally lacking this attribute. With these mitigations, alternative B would have a less than significant impact.

For alternatives D through F, taken as a whole, the various measures to protect fish habitat elements (Road Management Plan, Hillslope Management Guidelines, stream buffer protections, CEG review, harvesting types, levels, and restrictions) would cumulatively result in a beneficial impact to fish and amphibian populations.

Project Impact 6: *Reduce the number or restrict the range of a rare or endangered aquatic plant or animal.* (Beneficial)

There are no known rare or endangered aquatic plants on JDSF. Coho salmon and steelhead trout occurring on JDSF are listed as "endangered" and "threatened" respectively under the federal ESA and coho are listed as "endangered" under the California ESA. Chinook salmon are listed as "threatened" under the federal ESA. The Big River is listed and sediment and temperature impaired, and the Noyo River is listed as sediment impaired by the North Coast Regional Water Quality Control Board. Timber management activities have been identified as a contributing factor in the decline of salmonids and aquatic habitat conditions throughout northwestern California. Changes in aquatic habitat conditions including elevation of water temperatures, increased sedimentation, reduced instream LWD loads, and altered flow patterns have been identified as factors contributing to the decline of certain amphibian and formally listed salmonid populations. The number and range of salmonids were reduced on the JDSF cumulative effects assessment area from the effects of timber operations prior to the introduction of the modern Forest Practice Rules.

Instream sediment and LWD loads and pool shelter in JDSF currently fail to meet target criteria or desired levels in most cases. In addition, State personnel have identified a number of definite or potential migration barriers within the Forest.

Under the DMFP (alternative C1) and alternative C2, the Accelerated Road Management Plan will inventory and correct the road-related sediment problems and migration barriers associated with the road system. The Hillslope Management Guidelines, establishment of EEZs, and use of a CEG on THPs will reduce the amount of sediment generated from upslope harvesting operations. These measures will lead to improvement of instream habitat and may lead to increased numbers of fish. WLPZ protection measures plus the Large Woody Debris Survey, Recruitment, and Placement management measure will ensure adequate recruitment of LWD over time. Therefore, alternatives C1 and C2 would have a beneficial effect on the number or range of threatened or endangered fish.

Mitigation: None needed.

For alternative A, lack of a Road Management Plan under could result in increased sedimentation, alter flow and channel geomorphology, and restrict fish movement and access to spawning areas, potentially resulting in significant adverse impacts on the number or range of salmonids. Implementation of the Road Management Plan as a mitigation would reduce risk of these potential impacts. It would likely reduce sediment levels over time. This mitigation would result in less than significant impacts.

Alternative B also lacks a Road Management Plan and, because it includes timber harvest, lack of Hillslope Management Guidelines also is of concern regarding potential sedimentation and its impacts on salmonid numbers. WLPZ harvest activity and its potential impact on large wood recruitment could be addressed with application of the Large Woody Debris Survey, Recruitment, and Placement management measure. Additional mitigations for promotion of late seral habitat conditions within WLPZs and added protections of Class III/headwater streams in addition to Road Management Plan, as well as application of Hillslope Management Guidelines, would further reduce potential impacts to salmonid numbers and range. With these mitigations, alternative B would have a less than significant impact.

For alternatives D through F, taken as a whole, the various measures to protect fish habitat elements (Road Management Plan, Hillslope Management Guidelines, stream buffer protections, CEG review, harvesting types, levels, and restrictions) would cumulatively result in a beneficial impact.

6.1.17 Alternatives Comparison

A summary comparison regarding the level of aquatic resource impacts among the various alternatives is provided in Table VII.6.1.12.

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.						
Alternatives						**Discussion**
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible**
1. Will the project have substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive or special status species?						
1a. Water Temperature						
Alt. A	■					No-harvest management would result in no canopy cover removal along watercourses, allowing canopy cover to increase over time and temperature regimes to return to background levels. This alternative does not provide for restoration work in WLPZs where conifers need to be reestablished, resulting in a slower rate of recovery than might otherwise be achieved
Alt. B			■			Most watercourses met canopy target criteria under old FPRs. New FPR retention standards for Threatened and Impaired Watersheds increase canopy cover and would not result in significantly higher water temperatures.
Alt. C1 May 2002 DFMP	■					Most watercourses met target criteria under old FPRs. New FPR and DFMP retention standards and late successional development emphasis in WLPZs should increase stream shading over time, resulting in lower water temperatures in some streams segments and at least maintaining current temperature regimes in others.
Alt. C2 Nov. 2002 Plan	■					
Alt. D	■					FEMAT-style stream buffer retention standards will increase stream shading over time, resulting in lower water temperatures in some streams segments and at least maintaining current temperature regimes in others. Protection zones managed for late seral forest. Goal is the rapid return of riparian management zones to historical, natural ecologic functions.
Alt. E	■					Most Class I watercourse zones and adjacent areas managed for late seral conditions. FEMAT-style stream buffer retention standards for Class II and III streams, with management for late seral conditions. Protection standards will increase stream shading over time, resulting in lower water temperatures in some streams segments and at least maintaining current temperature regimes in others.
Alt. F	■					Applies NOAA Fisheries short-term HCP guidelines, resulting in wide watercourse buffers and increasing stream shading over time, leading to lower water temperatures in some streams segments and at least maintaining current temperature regimes in others. Watercourse protection zones managed for late seral forest.

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.

Alternatives						Discussion
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible**
1b. Sedimentation						
Alt. A				■		Road maintenance would be limited to that necessary to maintain public access. No directed road upgrade or abandonment program. Sediment delivery may increase from the unmaintained road system. Potential road sediment problems could be mitigated through application of a Road Management Plan. No timber harvest eliminates potential for sediment from harvesting operations. Potential hillslope sediment sources could be mitigated through application of Hillslope Management Guidelines provided in DFMP.
Alt. B				■		Standard Forest Practice Rules to prevent and reduce sedimentation apply. Three-year road maintenance requirement without directed upgrade and abandonment plan may not be sufficient to reduce sediment delivery to less than significant levels. Potential road sediment problems could be mitigated through application of a Road Management Plan. Potential hillslope sediment sources could be mitigated through application of Hillslope Management Guidelines provided in DFMP.
Alt. C1 May 2002 DFMP			■			Alternatives C1 and C2 have an Accedlerated Road Management Plan element to address road-related sediment over time. These alternatives have EEZs, as well as CEG involvement in THP preparation, which also should contribute to decreased sediment delivery potential. Potential hillslope sediment sources are addressed through application of Hillslope Management Guidelines provided in DFMP.
Alt. C2 Nov. 2002 Plan			■			
Alt. D			■			Alternatives D, E, and F have expanded watercourse protections for all watercourse classes with limited or no-harvest restrictions. Class III/headwater protections with Riparian or Aquatic Management Zones. Road Management Plan will reduce road-related sediment over time. Decreased levels of harvesting activity contribute to a reduction in the potential for sediment generation. Potential hillslope sediment sources are addressed through application of Hillslope Management Guidelines provided in DFMP.
Alt. E			■			
Alt. F			■			

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.

Alternatives						Discussion
Impact*	1	2	3	4	5	*Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible
1c. LWD Recruitment						
Alt. A	■					No harvest would allow full development LWD recruitment potential, except where conifer restoration needed.
Alt. B				■		Recent FPR retention standards are designed to protect LWD recruitment potential on a THP-by-THP basis. Additional mitigation such as the Large Woody Debris Survey, Recruitment, and Placement management measure is necessary to ensure adequate LWD recruitment. This mitigation would result in beneficial effects over time.
Alt. C1 May 2002 DFMP	■					New FPR and DFMP retention standards and late successional development emphasis in WLPZs, combined with the Large Woody Debris Survey, Recruitment, and Placement management measure should have a beneficial effect on LWD supply.
Alt. C2 Nov. 2002 Plan	■					
Alt. D	■					FEMAT or NOAA Fisheries style WLPZ retention and late successional management standards under Alternatives D, E, and F should increase potential for recruitment with broader riparian management zone, harvesting restrictions, and emphasis on late seral development.
Alt. E	■					
Alt. F	■					
1d. Alteration of Flow Patterns						
Alt. A				■		No directed road maintenance, upgrade, or abandonment program could result in diverted flow as crossings are obstructed. Potential impacts could be mitigated though the adoption of a Road Management PLan.
Alt. B				■		Standard Forest Practice Rules apply to timber management and appurtenant roads. No directed road maintenance beyond three years post-THP completion could result in diverted flow as crossings are obstructed. These impacts could be mitigated with a Road Management Plan.
Alt. C1 May 2002 DFMP		■				Alternatives C1 through F all have Road Management Plans that should reduce and eventually eliminate diversion potential at road crossings.
Alt. C2 Nov. 2002 Plan		■				
Alt. D		■				
Alt. E		■				
Alt. F		■				

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.

Alternatives						**Discussion**
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible**
1e. Channel Geomorphology						
Alt. A				■		Increased sediment delivery from non-maintained roads could fill pools and gravel interstices and reduce channel volume. Potential impacts could be mitigated though the adoption of a Road Management Program.
Alt. B				■		Standard Forest Practice Rules apply. Increased sediment delivery from roads that are not upgraded or abandoned could fill pools and gravel interstices and reduce channel volume. Potential road sediment impacts could be mitigated though the adoption of a Road Management Program. Potential hillslope sediment impacts could be mitigated through the Hillslope Management Guidelines developed in the DFMP. Mitigation such as the Large Woody Debris Survey, Recruitment, and Placement management measure is needed to ensure adequate instream LWD to address channel geomorphology processes.
Alt. C1 May 2002 DFMP			■			Enhanced riparian zone protections, Road Management Plan, Hillslope Management Guidelines, and use of CEG on THPs should reduce sediment delivery below current conditions and not result in further degradation of channel geomorphology. The Large Woody Debris Survey, Recruitment, and Placement management measure would ensure adequate instream LWD to address channel geomorphology processes.
Alt. C2 Nov. 2002 Plan			■			
Alt. D			■			Enhanced riparian zone protections, Road Management Plan, Hillslope Management Guidelines, and use of CEG on THPs should recruit adequate LWD and reduce sediment delivery below current conditions and not result in further degradation of channel geomorphology.
Alt. E			■			
Alt. F			■			

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.

Alternatives						Discussion
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible**
2. Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?						
Alt. A				■		Increased sediment delivery from non-maintained roads could fill pools and gravel interstices and reduce egg incubation and rearing habitat quality. Road crossing failures on Class I streams could impede anadromous and resident migration and increase sedimentation-associated impacts. Potential impacts could be mitigated through application of a Road Management Plan.
Alt. B				■		Standard Forest Practice Rules apply to timber management activities. Increased sediment delivery from roads that are not maintained or not upgraded could fill pools and gravel interstices and reduce egg incubation and rearing habitat quality. Road crossing failures on Class I streams could impede anadromous and resident migration. Potential impacts could be mitigated through application of a Road Management Plan.
Alt. C1 May 2002 DFMP	■					Alternatives C1 through F include the Road Management Plan that will inventory and correct migration barriers along the road system. This will improve access to spawning areas and downstream migration and will further reduce sediment-associated impacts.
Alt. C2 Nov. 2002 Plan	■					
Alt. D	■					
Alt. E	■					
Alt. F	■					

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.

Alternatives						Discussion
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible**
3. Have a substantial adverse effect on any riparian habitat? (Alternative impacts on riparian vegetation's role in water temperature and LWD inputs identified above.)						
3a. Riparian Forest Extent and Quality						
Alt. A		X				The no harvest component will maintain all trees along the streambank. Opportunity to enhance rate at which late seral forest conditions are achieved is not available.
Alt. B			X			FPRs currently provide for substantial riparian forest retention for Class I and II watercourses, protection measures and buffer considerations for Class III stream.
Alt. C1 May 2002 DFMP	X					These alternatives require a 25-foot no-cut/limited entry for habitat improvement WLPZ for Class I and Class II watercourses, which would protect streambank stability. Also require management of WLPZs for late seral forest conditions. These measures will protect riparian forest extent; they also will enhance riparian forest condition and ecological function.
Alt. C2 Nov. 2002 Plan	X					
Alt. D	X					FEMAT-style WLPZ retention measures and late-successional management requirements will protect and enhance riparian forest condition, extent and, ecological function.
Alt. E	X					
Alt. F	X					NOAA Fisheries short-term HCP guidelines for streams will protect and enhance riparian forest condition, extent, and ecological function.
3b. Allochthonous Inputs						
Alt. A		X				No harvesting will result in no reduction in allochthonous inputs.
Alt. B			X			Alternatives B, C1, C2, D, E., and F allow some form of harvesting within the WLPZ as management for the development of late successional habitats. WLPZ canopy retention measures should result in maintenance of allochthonous inputs.
Alt. C1 May 2002 DFMP			X			
Alt. C2 Nov. 2002 Plan			X			
Alt. D			X			
Alt. E			X			
Alt. F			X			

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.						
Alternatives						**Discussion**
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible**
3c. Instream habitat and streambank stability (also see discussion above under Sedimentation, LWD Supply, and Channel Geomorphology)						
Alt. A	■					No harvesting would allow development of instream large wood recruitment and associated pool and habitat
Alt. B				■		FPRs may not affect instream large wood and habitat in some reaches. However, riparian silviculture may reduce large wood recruitment potential in watercourses where instream wood loads are low thereby affecting instream habitat. Mitigation regarding WLPZ harvesting is, such as could be provided by the Large Woody Debris Survey, Recruitment, and Placement management measure. With this mitigation, this alternative should have a beneficial effect on instream habitat and streambank stability over time.
Alt. C1 May 2002 DFMP	■					Alternatives C1 and C2 have measures that include a Road Management Plan, no-cut zones in WLPZs, promote the development of late successional riparian habitat, and the Large Woody Debris Survey, Recruitment, and Placement management measure. These alternatives would lead to improvements in instream habitat quality and streambank stability.
Alt. C2 Nov. 2002 Plan	■					
Alt. D	■					Alternatives D, E and F have measures including no-cut zones and wide stream buffers managed to promote the development of late successional riparian habitat and will likely lead to improvements in instream habitat quality and streambank stability.
Alt. E	■					
Alt. F	■					
4. Conflict with the provisions of an adopted Habitat Conservation Plan, or other approved local, regional, or State habitat conservation plan related aquatic resources?						
Alt. A		■				None of these alternatives would be in conflict with the provisions of any HCP or other local, regional, or State HCP relating to aquatic resources.
Alt. B		■				
Alt. C1 May 2002 DFMP		■				
Alt. C2 Nov. 2002 Plan		■				
Alt. D		■				
Alt. E		■				
Alt. F		■				

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.

Alternatives						Discussion
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible**
5. Cause a fish or amphibian population to drop below self-sustaining levels or threaten to eliminate an aquatic community within the assessment area? (see also discussion for individual aquatic habitat impacts, above)						
Alt. A				X		Lack of a Road Management Plan could result in increased sedimentation, alter flow and channel geomorphology, and restrict fish movement and access to spawning areas. Implementation of a Road Management Plan as a mitigation will reduce the potential for sedimentation, altered channel geomorphology or stream flow, and restricted fish movement from road crossing obstruction to a less than significant level. With these mitigations, this alternative could achieve some beneficial effects over time.
Alt. B				X		Lack of a Road Management Plan could result in increased sedimentation, alter flow and channel geomorphology, and restrict fish movement and access to spawning areas. Implementation of a Road Management Plan as a mitigation will reduce risk of sedimentation, altered channel geomorphology or stream flow, and restricted fish movement from road crossing obstruction. WLPZ harvest activity and its impact on large wood recruitment mitigated could be addressed with a mitigation such as the Large Woody Debris Survey, Recruitment, and Placement management measure. Other mitigations for promotion of late seral habitat conditions within WLPZs and added protections of Class III/headwater streams in addition to Road Management Plan, as well as application of Hillslope Management Guidelines, could further reduce risk of sedimentation, restriction of fish movement and altered channel geomorphology, and increase large wood recruitment to stream systems generally lacking this attribute. With these mitigations, this alternative could achieve some beneficial effects over time.
Alt. C1 May 2002 DFMP	X					Taken as a whole, the various measures to protect fish habitat elements (Road Management Plan, Hillslope Management Guidelines, WLPZ protections, Large Woody Debris Survey, Recruitment, and Placement management measure, CEG review, and Special Concern Areas would cumulatively result in a less than significant impact. Some beneficial effects would likely be achieved as well.
Alt. C2 Nov. 2002 Plan	X					
Alt. D	X					Taken as a whole, the various measures to protect fish habitat elements (Road Management Plan, Hillslope Management Guidelines, WLPZ protections, CEG review, harvesting levels and restrictions) would cumulatively result in a beneficial impact.
Alt. E	X					
Alt. F	X					

Table VII.6.1.12. Comparison of Aquatic Resource Impacts among the Various Alternatives.

Alternatives						**Discussion**
Impact*	**1**	**2**	**3**	**4**	**5**	***Impact Levels: (1) Beneficial (2) No Impact (3) Less than Significant (4) Less than Significant after Mitigation (5) Significant -Mitigation Not Feasible**
6. Reduce the number or restrict the range of a rare or endangered aquatic plant or animal?						
Alt. A				■		Lack of Road Management Plan could result in degradation of spawning and rearing habitat and reduce the numbers of salmonids and other sensitive aquatic species for alternatives A and B. Mitigation via a Road Management Plan and Hillslope Management Guidelines would reduce potential impacts to less than significant. For Alternative B, WLPZ harvesting operations may degrade habitat and reduce fish and certain amphibian numbers under specific conditions unless a mitigation such as the Large Woody Debris Survey, Recruitment, and Placement management measure is applied.
Alt. B				■		
Alt. C1 May 2002 DFMP	■					Utilization of WLPZ retention measures, Road Management Plan, Hillslope Management Guidelines, Large Woody Debris Survey, Recruitment, and Placement management measure, etc., would result in improved habitat conditions and access to spawning and improve downstream migration.
Alt. C2 Nov. 2002 Plan	■					
Alt. D	■					Utilization of FEMAT and NOAA Fisheries short-term HCP WLPZ retention measures, Road Management Plan, and Hillslope Management guidelines may result in improved habitat conditions, access to spawning areas, downstream migration, and fish and amphibian numbers.
Alt. E	■					
Alt. F	■					