FINAL REPORT

205(J) Contract # 5-029-250-2

EEL RIVER WATER QUALITY MONITORING PROJECT

Submitted To: The CALIFORNIA STATE WATER QUALITY CONTROL BOARD

Joanne Cox, Contract Manager

Submitted By: The HUMBOLDT COUNTY RESOURCE CONSERVATION DISTRICT

Gary L. Friedrichsen, Project Director

May 15, 1998

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working with
USDA Natural Resources Conservation Service

Draft Final Report
Eel River Water Quality Monitoring Project

Table of Contents:

ABSTRACT
Eel River Water Quality Monitoring Project

Humboldt County Resource Conservation District (HCRCD) has recently completed two field seasons (1996-97) of temperature monitoring and biological inventory (1995-96) in the Eel River watershed. This work was funded by the State Water Resources Control Broad/U.S. Environmental Protection Agency under the non-point source pollution assessment grant (205j # 5-029-250-0). The HCRCD deployed over one-hundred and fifty (150) temperature data loggers in mainstem and tributary reaches of this large system. The basin wide effort was coordinated by the HCRCD and has been completed with the cooperation of twenty-one other individuals, agencies, and/or land owners throughout the four counties that encompass the entire watershed.

With the combined resources of these cooperators four hundred and forty three (443) data sets are reported here for the two year period. Two hundred and sixteen (216) gauges were placed and recovered in 1996 while two hundred and twenty seven (227) gauges were placed and recovered in 1997. In addition to the temperature work, a portion of this grant was focused on aquatic macro-invertebrates in the Eel River. Twenty two streams were sampled in the spring and fall using Environmental Protection Agency's (EPA) RAPID-Bioassessment for stream water quality.

Results of both portions of field work are presented with analysis focused on water quality and the limiting factors affecting anadromous fish in this watershed. The temperature analysis provided here defines temperature trends from the headwaters to river confluence's in all major sub-basins (mainstem, South Fork, North Fork, Middle Fork, and Van Duzen). Data are grouped to define the general progressive heating of the waterbodies as they flow downstream until reaching the cooling effects of coastal influences. Since many of the gauges were placed in the same locations in reaches during both years, temperature information is discussed in terms of annual variation between the two years.

A review of the temperature data in light of limited historical data shows little change in mainstem temperatures over a period of twenty three years (1973-1996). However, some streams indicate cooling trends which could be the result of passive/active habitat restoration in these watersheds.

A conceptual basin restoration plan is presented using the temperature data in terms of the Maximum Weekly Average Temperature (MWAT), an arbitrary standard, as indicators for suitable salmonid habitat. This first step of prioritizing watersheds within the sub-basins will be a useful tool to the HCRCD and other resource managers in the Eel River.

The raw and validated data from this survey will be archived in several locations for future use by interested parties, these locations include:

STORET-SWRCB/EPA data system. Contact Susan Lowell (916) 657-1830
NCRWQCB- Contact Bob Klamt (707) 576-2693
HCRCD- Contact Gary L. Friedrichsen/Curtis Ihle (707) 444-9708
CDF&G, Inland Fisheries Division- Contact Scott Downie (707) 725-0368
Forest Science Project, HSU- Contact Dr. Tim Lewis (707) 826-3258

SUMMARY OF COMPLETED TASKS FOR EEL RIVER BASIN WATER QUALITY PROJECT
HUMBOLDT COUNTY RESOURCE CONSERVATION DISTRICT (HCRCD)

Task 1: Project Management and Administration

Sub-task 1.1 Administration

With the receipt of this Final Report the HCRCD has completed all administration requirements as set forth in the contract. All quarterly reporting, billing, sub-contractor coordination has been carried out within contract deadlines and budget. Sub-contractor work (see Sub-task 1.3) has been monitored, reviewed, and found to be satisfactory with sub-contracts that detailed this effort. For technical oversight, the HCRCD relied on Natural Resource Conservation Service (NRCS) staff, the Quality Control Officer James Komar, NRCS and his replacement, Jim Hoplain of the California Department of Fish and Game (CDF&G).

Sub-task 1.2 Quarterly Progress Reports

In all, a total of ten[1] progress reports were submitted during the course of this study (July 1, 1995- April 30, 1998). These quarterly progress reports detailed sub-contractor activities and project accomplishments on a task by task basis. This information is resubmitted here in summary form.

Sub-task 1.3 Sub-contract Administration

HCRCD procurement policies were adhered to throughout the project period. All sub-contractors were solicited in an open competitive manner consistent with County, State, and Federal procurement regulations including CFR 40 Part 31: Procurement.

One sub-contract was let to Mr. Gary L. Friedrichsen. He, in turn, contracted with three other sub-contractors to assist him in the fulfillment of contractual responsibilities. These individuals were; Diane Higgins, a local curriculum consultant, Darrell Martin, a computer programmer, and John Lee, a professional aquatic entomologist. They assisted Mr. Friedrichsen with field work, classroom activities, construction of a data analysis program, and report writing. (See Tasks 4.2, 4.3, and 7.1). Sub-contract Administration of this grant will conclude with the final payment of the 10% retention funds held by the SWRCB.

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[1] This project was extended beyond the original deadline of December 31, 1996 in order to accomplish two complete temperature field seasons. This was deemed necessary in that State funds had been held up due to budgetary complications and 1995 data would not be able to capture the rise in temperatures from early spring nor the low flow maximum that was of most interest to all cooperators.

Task 2. Public Participation

Sub-Task 2.1 Technical Advisory Committee

One of the most successful aspects of this large undertaking has been the support and involvement of the technical advisory committee (TAC). This group of individuals cooperated on a tremendous undertaking and set the stage for continued work on this basin-wide effort.

COOPERATORS/TAC MEMBERS:

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Laytonville High Bruce Potter P.O. Box 325 Laytonville, Ca. 95454 (707) 459-3528	Leggett High Collin Miller P.O. Box 186 Leggett, Ca. 95585 (707) 468-8220	Leggett Middle Luann Talbot P.O. Box 186 Leggett, Ca. 95585 (707) 468-8220
Round Valley High Rick Martinez P.O. Box 421 Covelo, Ca. 95428 (707) 983-6655	Round Valley Elem. Nancy Scholl P.O. Box 421 Covelo, Ca. 95428 (707) 983-6568	Cuddyback Thomas McMahon P.O. Box 7 Carlotta, Ca. 95528 707) 768-3372
Willits High Don McCallister P.O. Box 775 Willits, Ca. 95490 (707) 459-2583	Willits Elem. Joe Benoit 67 Northbrook Way Willits, Ca. 95490 (707) 459-6758	

The TAC met prior to each field season to discuss and agree upon placement protocols, quality assurance guidelines, field data forms, stream identification for gauge placement, and data management. In addition, contact was maintained with most TAC members throughout the course of the program. This helped to remedy some of the confusion that is unavoidable in under- takings of this nature.

Teachers from 85% of our cooperating schools attended a weekend workshop in the spring of 1996. This event provided the opportunity for sub-contractors and teachers to discuss the project materials, goals, schedule classroom opportunities, and set in motion the networking between schools that continues at this time.

Sub-task 2.2 Public Meetings

The HCRCD holds monthly noticed meetings open to the public. This project has been listed on most agendas since contract inception. Public comment was consistently solicited at these meetings. All schools participating in this program are State/County funded public schools. Parent volunteers and other interested landowners were welcome to join the classes during field work (aquatic invertebrate monitoring and temperature probe placement/retrieval).

Task 3. Data Quality and Submission

Sub-task 3.1 Quality Assurance Plan

The Quality Assurance Plan was approved and in place throughout the course of this contract with James Komar or Jim Hoplain as the Quality Assurance Officers.
This Plan details:

(1) Project Description and Purpose
(2) Problem/Background
(3) Project Organization and Responsibilities
(4) Quality Assurance (QA) Objectives
(5) Sampling Procedures
(6) Calibration of Instruments, Procedures and Frequencies
(7) Retrieval and Storage of Data
(8) Analytical Procedures
(9) Destination and Use of Data
(10) Quality Control
(11) Assessment and Response Actions
(12) QA Reporting

Sub-task product: Quality Assurance Plan, July 6, 1995 revised April 19, 1996 (See **Appendix A**). Review of QA/QC tests will be submitted in the Final Report.

EPA RAPID Bioassessment Protocol: This method of bioassessment (Plafkin et al. 1989) uses aquatic organisms to evaluate the relative condition of an aquatic habitat. It is based on samples of benthic macroinvertebrates that possess the following attributes: 1) They are the most common animal in the habitat. 2) They are relatively immobile as immatures. 3) They have long life cycles so that temporal perturbations should be detectable. 4) Taxonomic keys for generic level determinations are available for all but a few difficult families. 5) The large number of taxa found offer a wide range of responses to disturbance. A multi-metric approach is employed where the metric values based on benthic macroinvertebrate assemblage in a benthic sample are calculated and compared to assess habitat. (See Task 4.3 this report and **Appendix B**).

Sub-task 3.2 Data Submission

All temperature data collected during the past two field seasons have been forwarded to the Storage and Retrieval (STORET) Data Control Unit with copies to the Contract Manager and North Coast Regional Water Quality Control Board (NCRWQCB) Senior Land and Water Use Analyst. In addition to the raw data, the NCRWQCB staff will receive the complete analysis of temperature information which includes a cumulative distribution curve, maximum, minimum, and average temperature profiles of all stream placements. Included in the task product is a Graphic Information System (GIS) map showing site placement throughout the Eel River basin. This map will be hard copied and available on electronic file. The placements, indicated by a colored symbol, represent temperature ranges of the rolling seven day maximum weekly average temperature (MWAT), the highest **average** temperature recorded during that week.

During the course of the monitoring twelve data loggers were lost or stolen. In addition to these twelve, several sets of data from other cooperators have been discarded as being too incomplete or questionably accurate. Air temperatures taken during these two years will be available but are not reported here as placement protocols are just being defined.

The report for the aquatic invertebrate RAPID Bioassessment has been submitted to the Contract Manager and is included here as **Appendix B**.

Task Products: QAP and STORET Data Submission

Task 4. Water Quality Assessment

Sub-task 4.1 Site Selection

Initial site selection took place in summer 1995. Twenty-two streams were selected for aquatic invertebrate monitoring by CDF&G. This list was then discussed and agreed upon by the TAC at their first meeting. The streams selected and monitored are reviewed in Sub-task 4.3 below.

Temperature monitoring sites were originally suggested by representatives from CDF&G (Scott Downie and Weldon Jones). This list of sites was derived from knowledge of historic anadromous fish presence and/or the site's representational quality for the sub-basin. This list formed the basis for discussion at the January 1996 TAC meeting where additional tributaries and main stem locations were added by cooperators. At the May 1997 TAC meeting stream sites were again discussed. Some sites were deleted due to low summer flows that de-watered and others were added as industry and research personnel refocused their survey plans.

In all, 443 (216 in 1996 and 227 in 1997) deployments are reported below. The combined list for 1996 and 1997 placements is found in **Appendix C**. This spread sheet identifies site number used by Forest Science Project (FSP) [2], STORET station ID, MWAT, stream name (by basin) , two letter code used in file name for Eel River Version Bio-index (EVB), Eel River basin, Calwater number, text file name, elevation of site, field technician (Surveyor), Latitude and Longitude, device ID number and USGS quad where site is located.

Sub-task 4.2 Water Temperature Monitoring

For this project, 175 Hobo-Temp.™ temperature gauges were purchased from the Onset Corporation. These gauges were obtained through the cooperation of the Eureka County Schools Purchasing Department. Since the HCRCD was working with students in Humboldt, Mendocino, and Trinity Counties for much of the temperature collection, Onset agreed to sell the data loggers at a substantial discount (50%). This enabled a much broader distribution of gauges in this large basin.

In addition to the HCRCD hardware (Hobo-Temps w/ submersible cases), several cooperators joined in this study and provided the HCRCD with the results of their individual efforts. Additional temperature data were received from the following sources[3] :

Pacific Lumber Company- SCOPAC, Scotia, CA.
Georgia-Pacific Corp., Fort Bragg, CA.
Louisiana-Pacific Corp., Big Lagoon, CA.

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[2] Use of FSP site numbers does not infer their acceptance of the subjective terminology used to denote stream temperature (i.e. **very cold, cold, moderate, etc**. used in Task 5.

[3] See **Appendix C** for the sites covered by these cooperators. It should be noted that some of the data derived from the above sources did not receive the Quality Assurance/Quality Control (QA/QC) process required of the HCRCD probes. However, all cooperators did perform their own QA/QC on their data loggers and all cooperators used similar devices made by Onset Corporation. This information should be viewed as opportunistic in that it vastly improves the baseline information available for the Eel River.

Barnum Timber, Arcata, CA.
Parnum Paving Corp., Ukiah, CA.
Natural Resource Management Corp., Eureka, CA.
Mendocino Water Agency, Ukiah, CA.
USFS-Six Rivers National Forest, Mad River Ranger District, Mad River, CA.
USFS-Mendocino National Forest, Covelo Ranger District, Covelo, CA.
USFS-Mendocino National Forest, Upper Lake District, Upper Lake, CA.
USFS-Redwood Sciences Laboratory, Arcata, CA.
Humboldt State University, Masters work, Arcata, CA.
California Department of Fish and Game, Inland Fisheries Div., Fortuna, CA.
California Department of Fish and Game, Inland Fisheries Div., Yountville, CA.
Salmon Forever, McKinleyville, CA.

A map showing site placement in the Eel River Basin has been constructed by Joe Krieter of the Forest Science Project (FSP). These data are available electronically for ArcInfo™ and ArcView™ software users, displays both 1996 and 1997 station placements. Sites are referenced with Forest Science Project Id codes. These codes are then cross referenced to HCRCD filing codes (e.g. FSP# 1533 = HTDC1433.961= Dutch Charlie Creek, South Fork Eel River at an elevation of 1433 feet in 1996). (See Task 5 below for more information).

Task Product: All usable data recorded during this study will be available in the following locations:

STORET-SWRCB/EPA data system. Contact Susan Lowell (916) 657-1830
NCRWQCB- Contact Bob Klamt (707) 576-2693
HCRCD- Contact Gary L. Friedrichsen (707) 444-9708
CDF&G, Inland Fisheries Division- Contact Scott Downie (707) 725-0368
Forest Science Project, HSU- Contact Dr. Tim Lewis (707) 826-3258

Data, both raw and verified/validated, have been archived and maintained at the HCRCD in Microsoft Excel 6.0. Data analysis has been completed and includes minimum-maximum-mean, cumulative distribution of temperatures with regard to time, and association of selected reference stream temperatures in relation to some historical data for the same streams (see below). Sample copies of each form of analysis is provided (see **Appendix D**) however, the bulk of information available should be referenced electronically.

Background:

The Eel River is the largest basin draining the coastal mountains of northern California. This watershed with a total of 3,684 square miles has four major sub-basins that include the South Fork Eel (689 sq.mi.), the North Fork Eel (283 sq.mi.), the Middle Fork Eel (753 sq.mi.), and the Van Duzen River (428 sq.mi.). The Eel River ranges in elevation from 7,581 feet on Solomon Peak in Trinity County to sea level at the mouth near Ferndale in Humboldt County. The River is approximately 120 miles in length along the main channel (Trush 1992).

"The Eel River typically flows big and small, all in the same year. It's Mediterranean climate and poor aquifer (except in isolated alluvial valleys) produce high runoff in the winter and greatly reduced runoff otherwise. At Scotia, the minimum daily flow was 10 cubic feet per second (cfs) in August, 1924; maximum discharge was 752,000 cfs on December 23, 1964."(ibid.). "Over half of the mainstem and major tributary channels can be considered thermally lethal during some portion of the summer. This was probably true before significant human impact, yet huge salmon populations flourished." (ibid.).

Interpretation of Temperature Findings From This Study:

This 205(j) study's goal was to determine the temperature regime of the Eel River, including many of its tributaries, and to compare results of temperature findings from the 1973 study by Kubicek (1977). The earlier study deployed 30 automated temperature sensing devices throughout the Eel River basin and also included numerous temperature assessments using hand held thermometers. Methods of site selection(see Sub-task 4.1) and protocols (Appendix A, Sec. 5.0) for probe placement are described elsewhere in this report.

As a convention, these figures show the absolute maximum weekly water temperature by location (the highest reading for each week). This convention differs from the MWAT[4] used for the prioritization processes used in Task 5 and is used here to maintain comparability to the information presented by Kubicek (1977). The figures denote 20^0 C as the threshold of stress for salmonids (Bjornn and Reiser, 1991). Although some species such as coho salmon may have a lower threshold for stress (Spence et al. 1997), the 20^0 C value presents a simple but useful reference point. Some comparison of maximum temperature between the field seasons of 1996 and 1997 are made with results from 1973 as measured by Kubicek (1977). These maximum weekly temperatures are not specifically relevant salmonid health in that they are momentary high points, however, they are useful for general discussion. Capturing the duration of exposure to stressful or lethal temperatures on a reach by reach basis is possible with this data set but is not attempted here due to the more limited scope of basin/stream prioritization. Further analysis of these data will produce more qualitative site specific information. For example, an alternate method of interpreting this data, rather than the MWAT or maximum weekly temperature, is seen in the cumulative distribution curve. This "snap-shot" (Figure 1) of stream reach temperature over the course of the low flow period reflects the range of temperatures that would affect summering salmonids.

[4] This maximum weekly average temperature (MWAT) is computed by using a rolling seven day average and selecting the highest or maximum average recorded for the weekly time period.

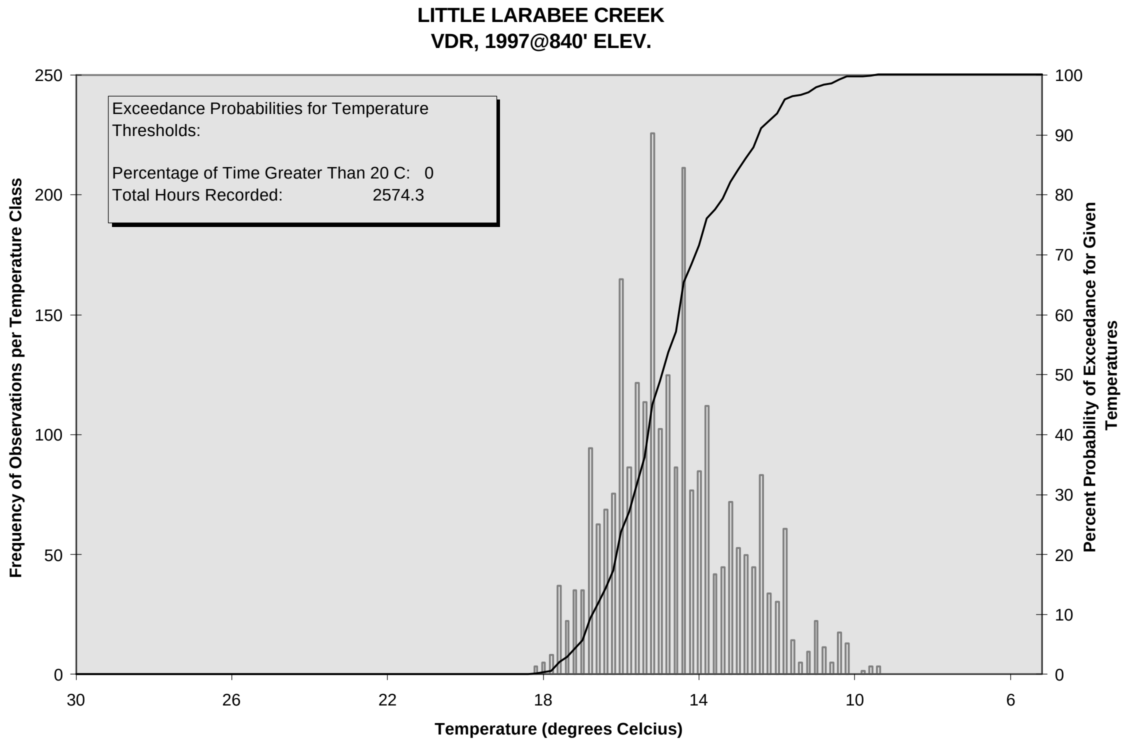


Figure 1. Sample Modified Cumulative Distribution Curve produced by Forest Science Project : (Bill Conroy et al. 1998) shows frequency of temperature class and percent probability of exceedance of a temperature. This graph does not relate to consecutive hours at or above a critical temperature, only **cumulative** exposure. (Little Larabee Creek, in the Van Duzen drainage, was picked at random as an example.)

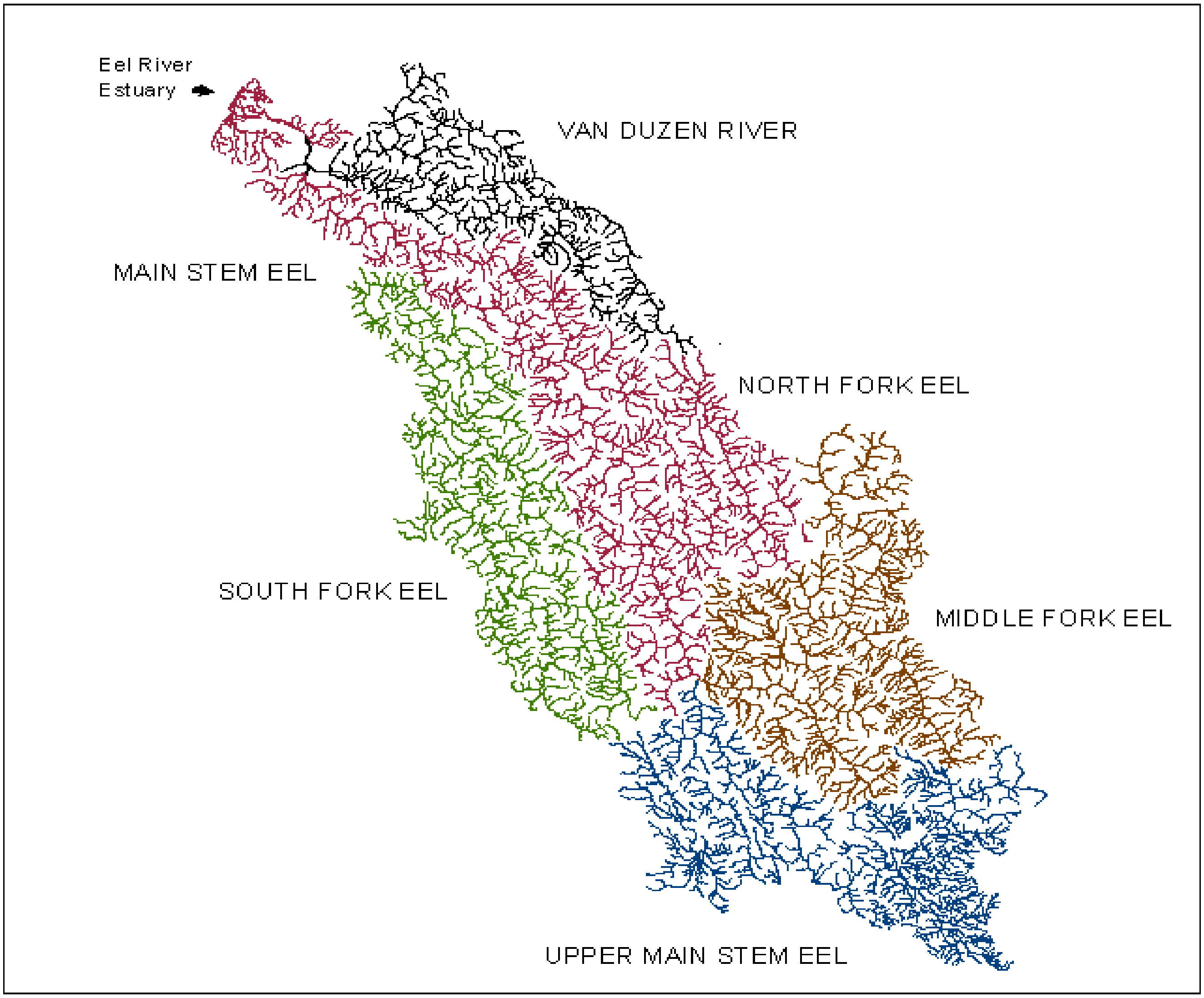


Figure 2. Stream network of Eel River drainage.

The following is a general characterization of the Eel River, by reach, with maps that show general locations discussed in the text and appropriate figures to illustrate apparent temperature trends by sub-basin. Distances are indicated by river mile (RM) from the estuary up stream (e.g. Van Duzen River occurs at RM 13.7) .

Upper Eel River above Lake Pillsbury and Mainstem Eel River from Scott Dam (RM 168.5) to Outlet Creek (RM 126): By the time the headwaters of the Eel River have reached Lake Pillsbury, they have already warmed substantially (Figure 4), reaching a maximum of over 26^0 C. Water releases at Scott Dam come from low in the water column of Lake Pillsbury. Consequently, flows at the dam, through the Monkey Rock area and downstream as far as Van Arsdale Dam remain under the stressful threshold in most years. Warmer releases from Scott Dam do occur in some years when the reservoir is being drawn down. Downstream of Van Arsdale Dam above Tomki Creek, the Eel River warms substantially to 27^0 C which is above the incipient lethal temperature for salmon and steelhead (Brett, 1952; Coutant, 1970).[5]

[5] Graphs of weekly maximum temperature use a convention where locations to the left in the legend are upstream and those to the right are downstream.

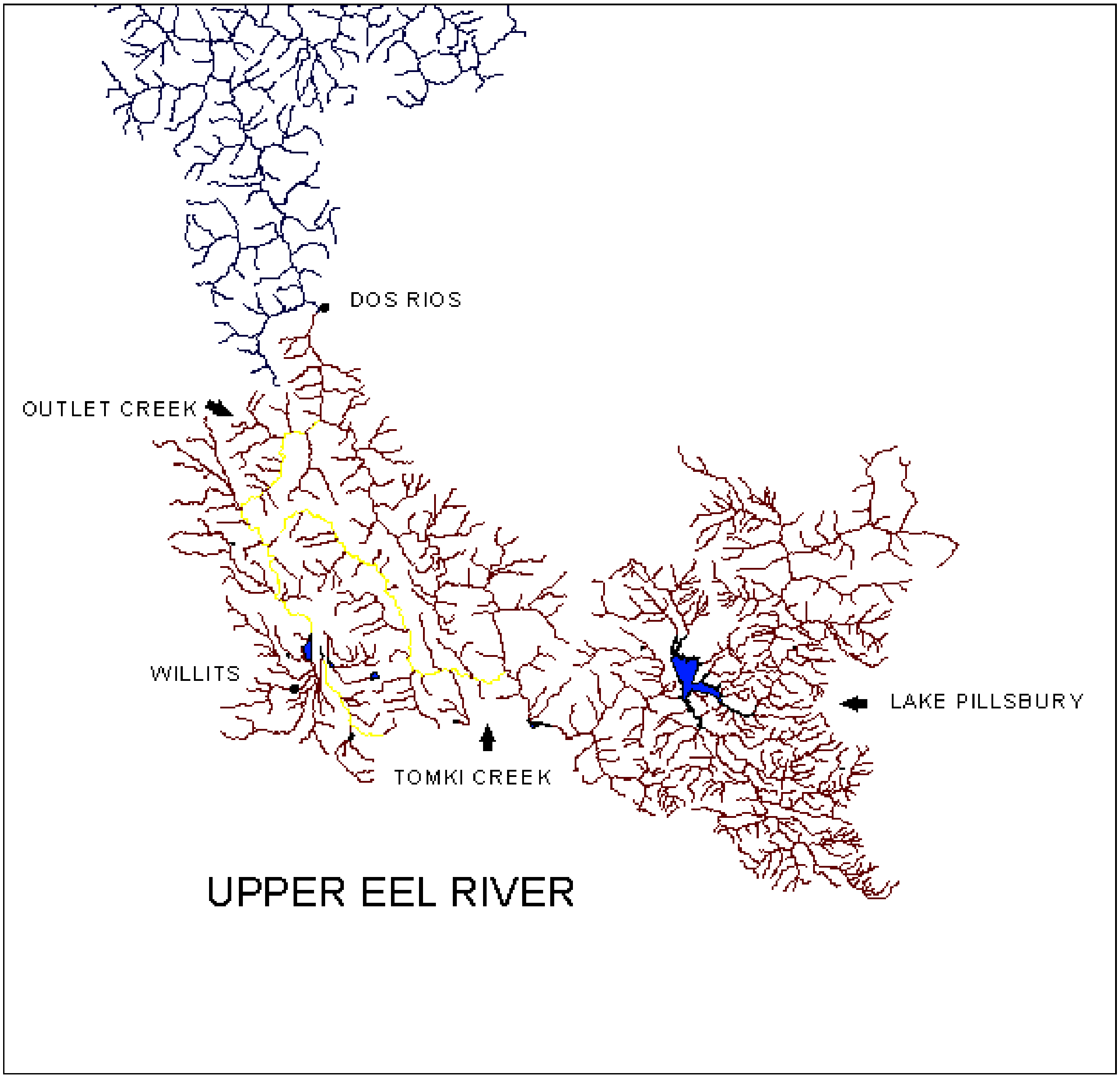


Figure 3. Upper Eel River, Lake Pillsbury to Dos Rios (Lake and Mendocino Counties).

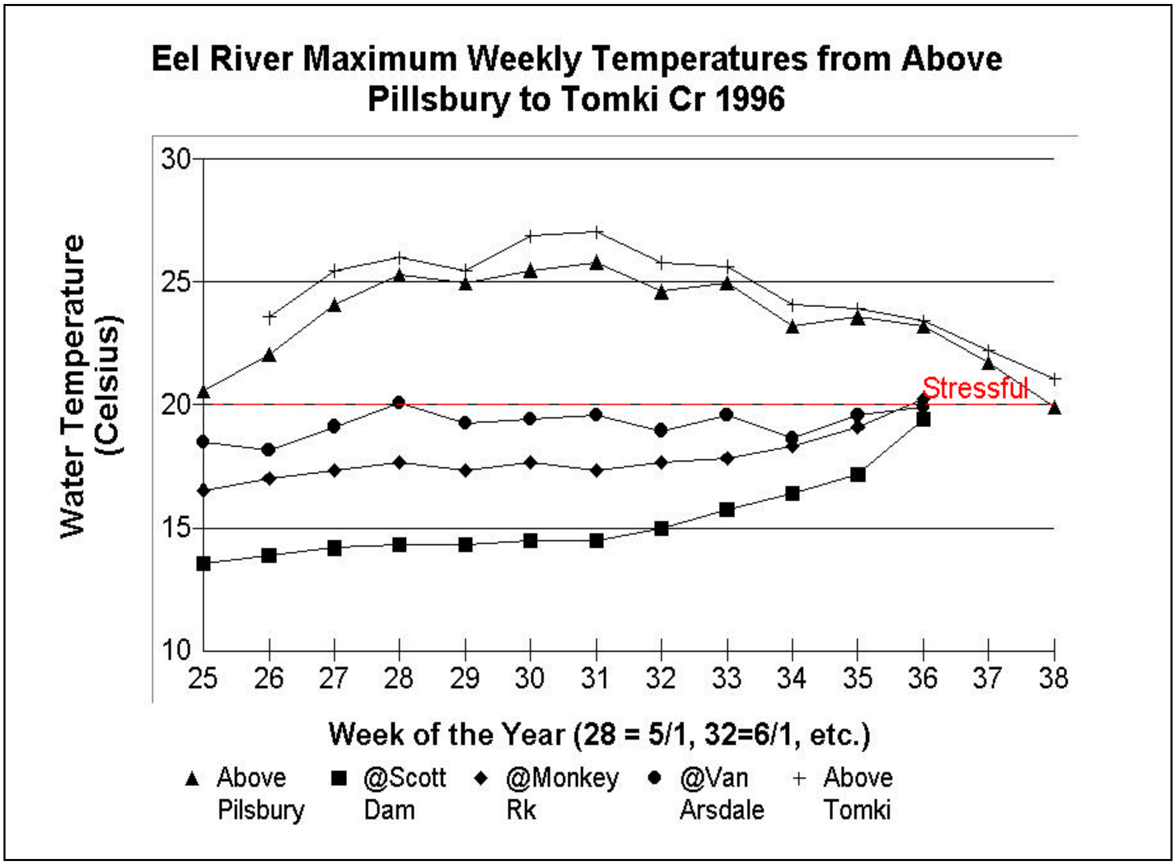


Figure 4. Eel River maximum weekly stream temperatures for 1996 from above Lake Pillsbury to just upstream of Tomki Creek.

Mainstem Eel River from above Outlet Creek to Dyerville (RM 40.6): One of the warmest reaches of the Eel River is just above Outlet Creek (RM 126) at Highway 162 (Figure 7) where temperatures reached 31^0 C in 1996 and 29^0 C in 1997. The Eel River cools somewhat between Outlet Creek and the Middle Fork Eel, although Outlet Creek had little cooling influence as it joined the Eel at 29^0 C in 1996. Kubicek (1977) ascribed the drop in temperature to some addition of ground water in this reach. The water temperature of the mainstem Eel River moderates only slightly at the Middle Fork Eel (RM 119.3) and then warms again as it flows northward. In 1996, the temperature at Nashmead (RM ~94), downstream from the North Fork, was 31^0 C while Eel Rock (RM.52) further downstream was 28.7^0 C. The temperature of the Eel River moderates as it approaches Dyerville (maximum 27^0 C) where cooling influences of summer fog take effect.

Mainstem Eel River from Dyerville to the Estuary: The Eel River comes into equilibrium with cooler coastal temperatures as it flows downstream from Dyerville (Figure 8). The maximum water temperature was 24^0C at the mouth of the Van Duzen River (RM 13.7) in 1996 and a degree less (23^0 C) at Fortuna.(RM 10) These temperatures are still well above the threshold for salmonid stress. The Eel River estuary at Cock Robin Island (RM 0.3) also benefits from heat exchange with the cold Pacific Ocean due to tidal flux and the maximum temperature here was only 17^0 C.

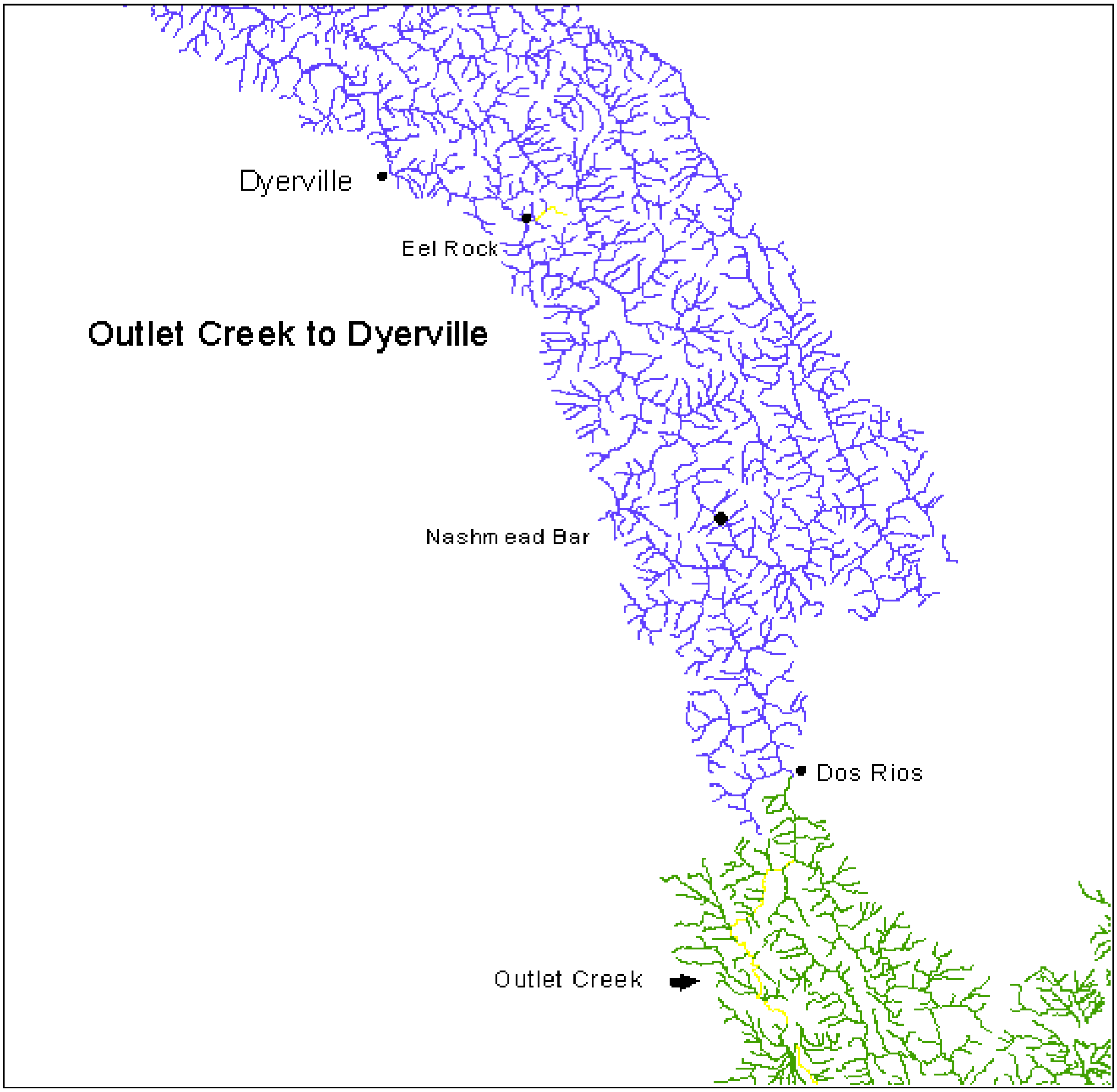


Figure 5. Stream route of Eel River mainstem, Outlet Creek to Dyerville (Mendocino and Humboldt Counties).

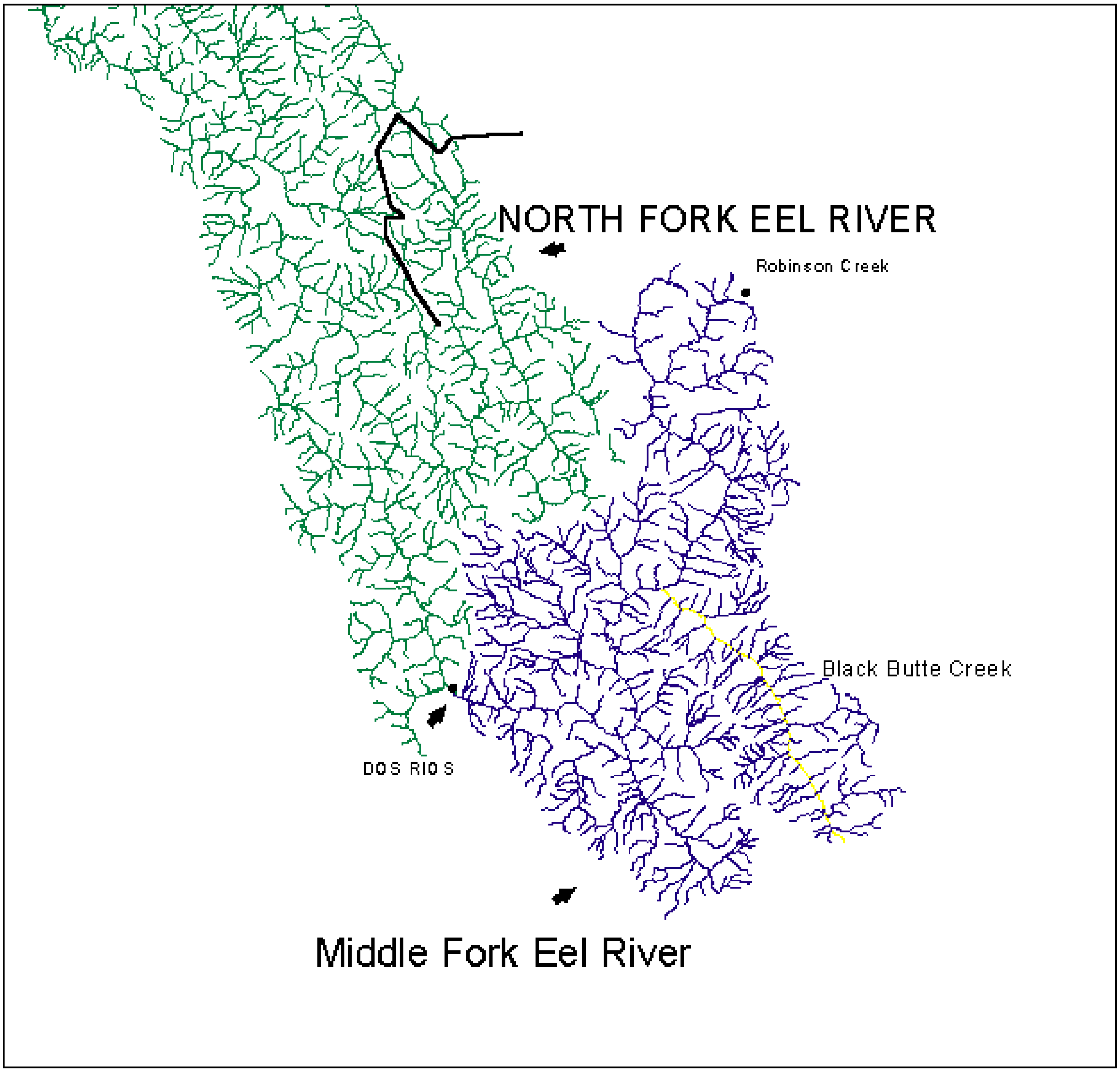


Figure 6. Stream route Middle Fork Eel and mainstem from Dos Rios.

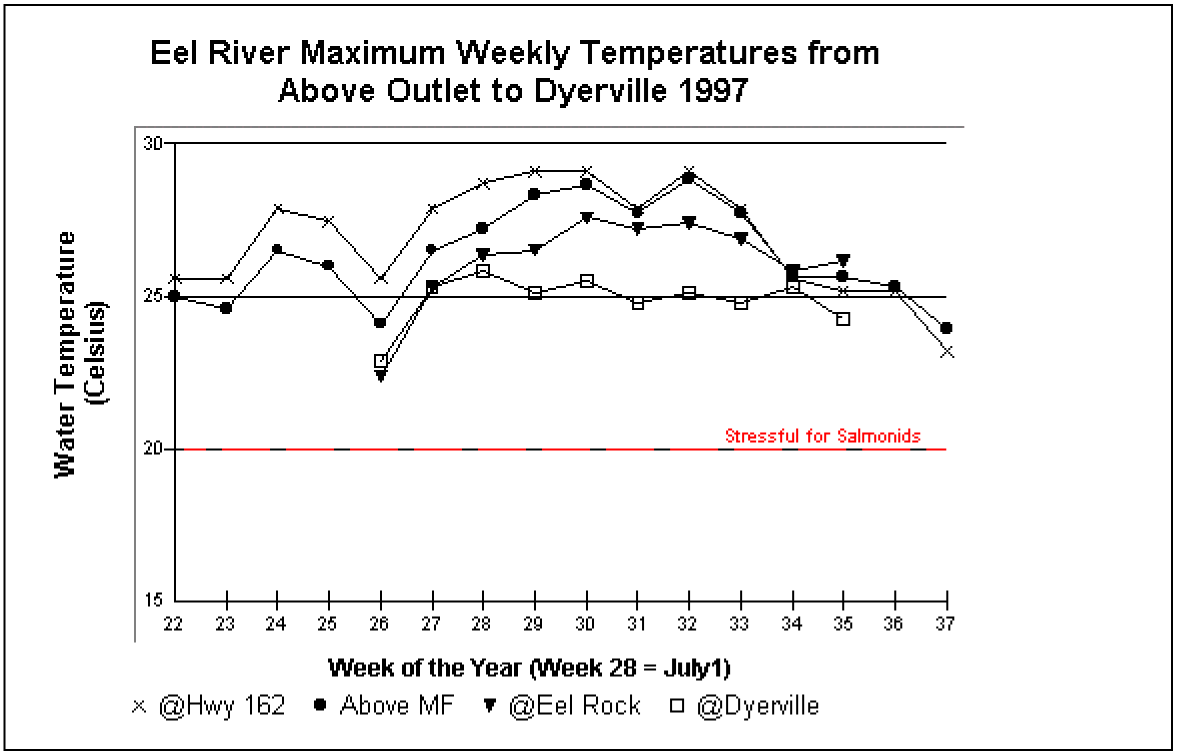


Figure 7. Mainstem Eel River maximum weekly water temperatures from above Outlet Creek at Highway 162 downstream to Dyerville

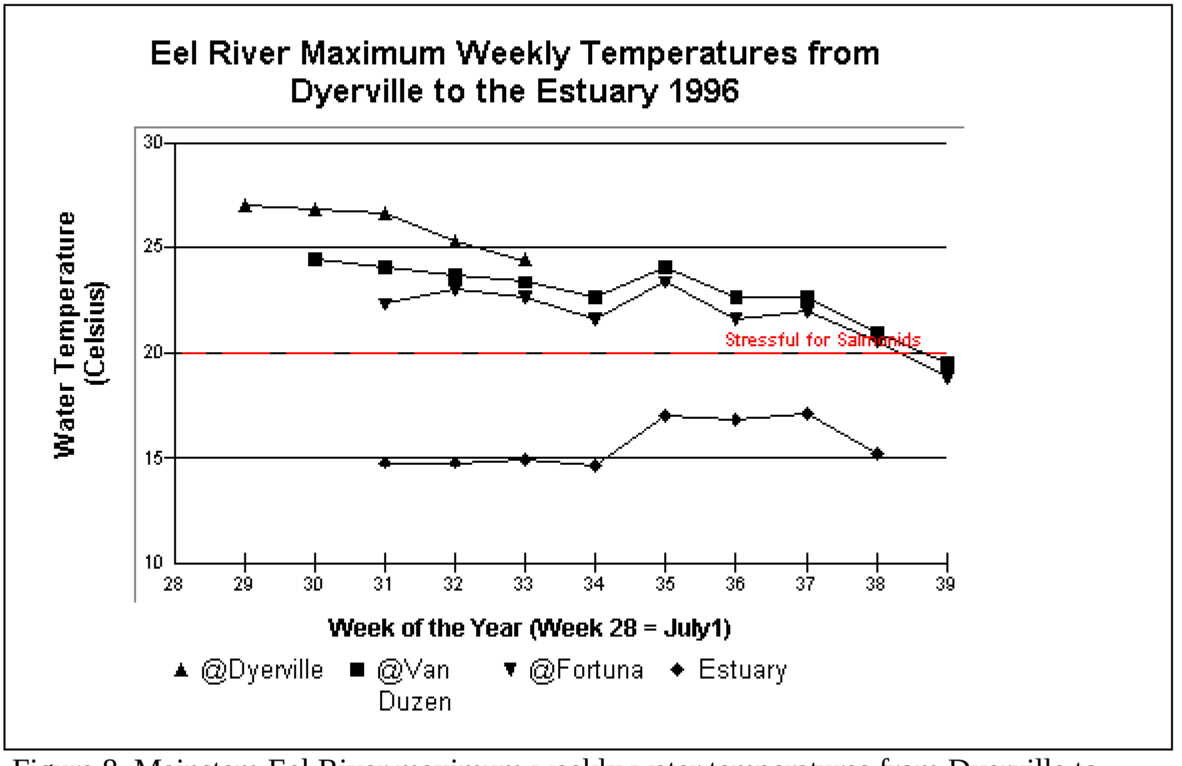


Figure 8. Mainstem Eel River maximum weekly water temperatures from Dyerville to Cock Robin Island in the Eel River estuary 1996.

Van Duzen River: Maximum weekly water temperatures at all locations on the Van Duzen River exceeded stressful levels for salmonids during 1996 (Figure 9). The Little Van Duzen River attained a maximum water temperature of 29^0 C, while the Van Duzen reached 28^0C at Dinsmore and 27^0 C at Root Creek in 1996. These temperatures are all acutely stressful or lethal for salmonids (Brett, 1952; Coutant, 1970). The water temperature of the Van Duzen River shows similar moderating trends as it flows downstream from Root Creek into the influence of the coastal climate. The maximum weekly water temperature immediately above Highway 101 was 25^0 C in 1996.

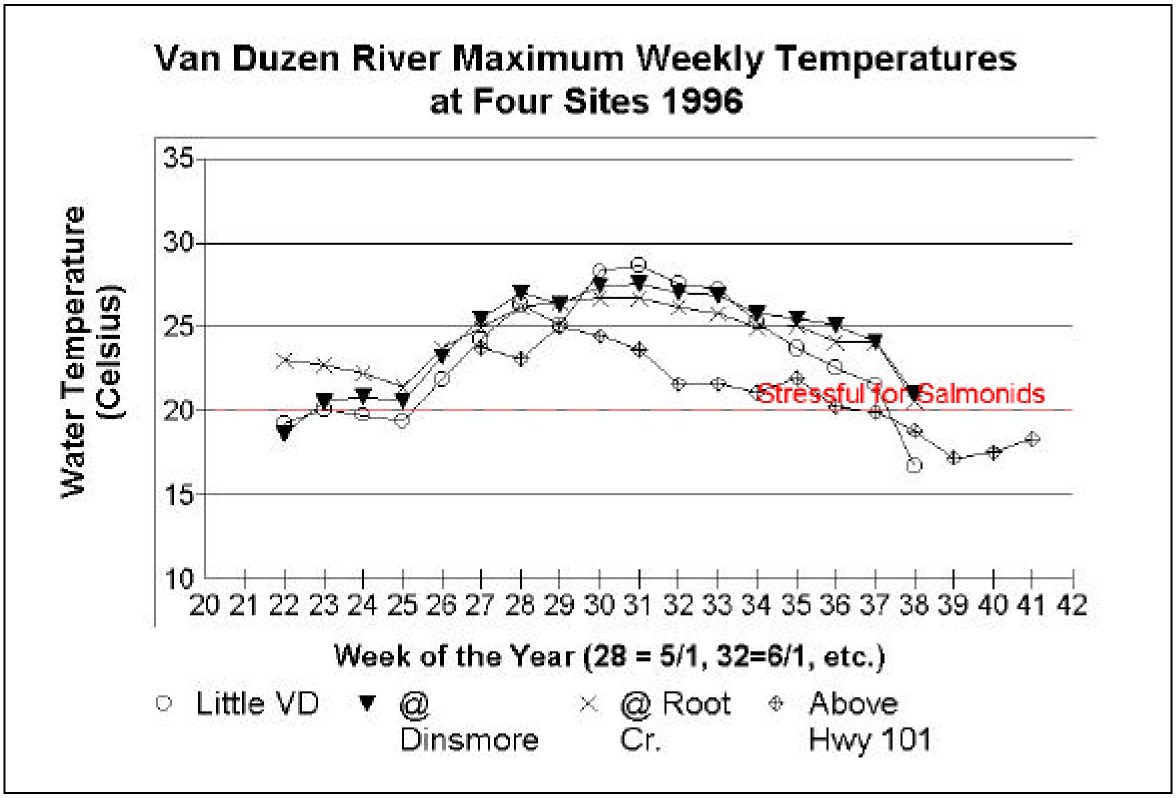


Figure 9. Van Duzen River maximum weekly water temperatures at four locations including the Little Van Duzen in 1996

Middle Fork and North Fork Eel River: Both the Middle Fork Eel River (Figure 10) and the North Fork (Figure 11) show similar temperature patterns, with cooler temperatures at higher elevations near headwaters and lethal temperatures for salmonids just above their confluence with the mainstem Eel River. The Middle Fork at Robinson Creek in the Yolla Bolla Wilderness had a maximum weekly water temperature of 23^0 C during summer 1996. While this temperature exceeds the range of stress for salmonids, apparently, there are pools that stratify which allow refuge for the fish in this reach. All lower Middle Fork reaches were above lethal limits for salmonids with temperatures rising from 28^0C above the Black Butte River to 29^0C at Thatcher Creek and finally to 31^0C at Dos Rios. The West Branch of the NF Eel attained a maximum of 24^0C during 1996, but the North Fork Eel warmed rapidly as it descended. Below Kettenpom Creek the river reached 26^0C, while further downstream at Salt Creek, temperatures rose above lethal levels for salmonids (29^0C). The North Fork Eel at the Mina Road Bridge exceeded 30^0C. for the maximum weekly temperature.

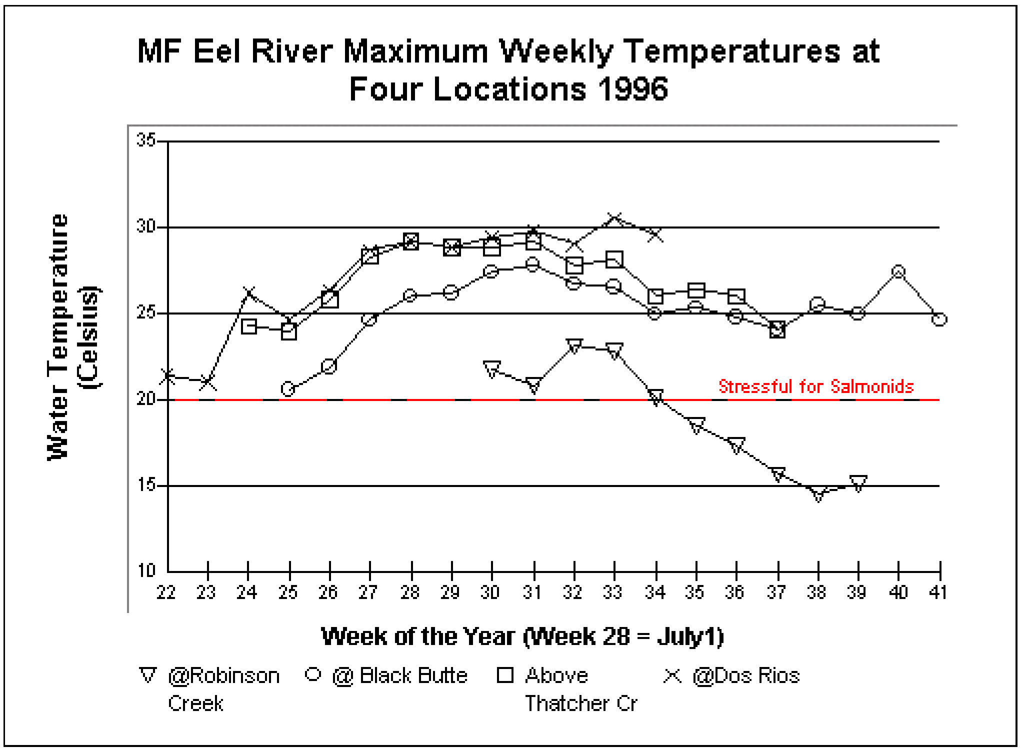


Figure 10. Middle Fork Eel River maximum weekly water temperatures from Robinson Creek to Dos Rios 1996.

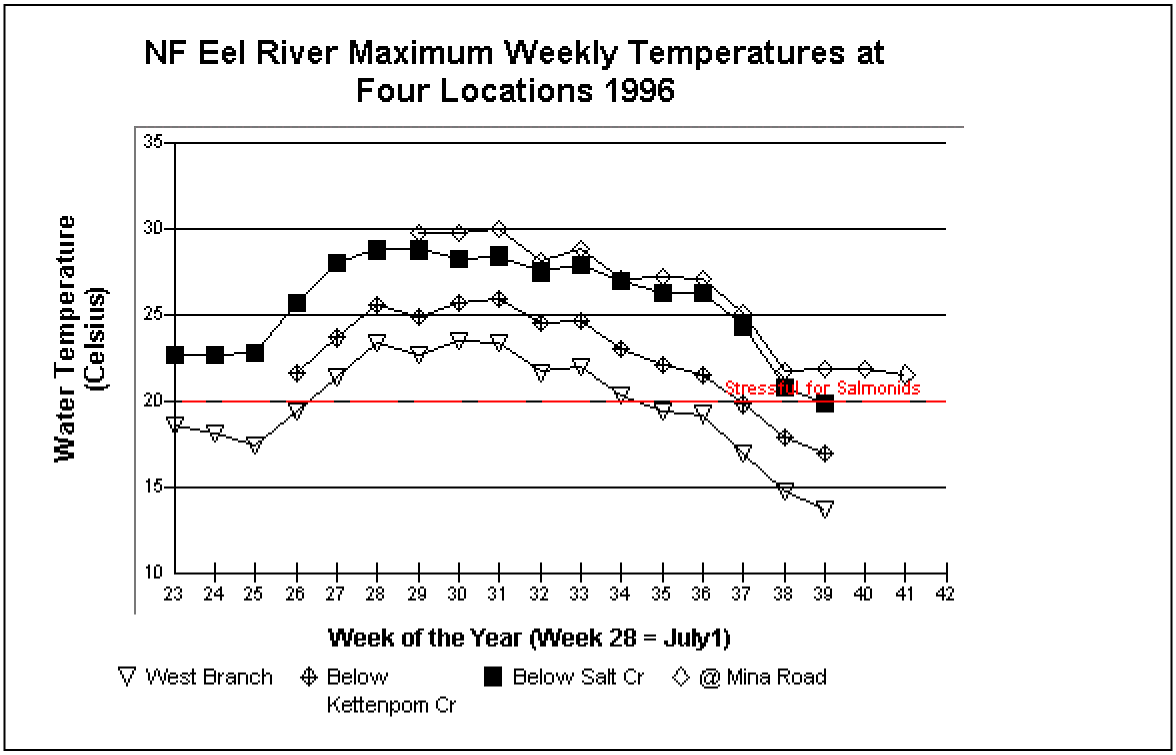


Figure 11. North Fork Eel River maximum weekly water temperatures from the West Branch to Mina Road Bridge in 1996.

South Fork Eel River (Branscomb (RM ~93) to Dyerville): The upper South Fork provides one of the few cold water refuge areas for salmonids in the entire Eel River system. The South Fork at Branscomb (Figure 13) only rose above stressful for salmonids for an extremely brief period in 1997 and temperatures remained highly suitable for salmonids just above Elder Creek (maximum 24^0 C). The South Fork warms substantially by the time it reaches Rattlesnake Creek, and temperatures exceed lethal limits for salmonids for at least some periods with a maximum of 28^0 C attained. The South Fork maintains this extremely warm temperature at Phillipsville and Miranda further downstream (Figure 24). Just as the mainstem Eel moderated in temperature as it approached Dyerville, so does the South Fork Eel which attained a maximum of 26^0 C in 1996.

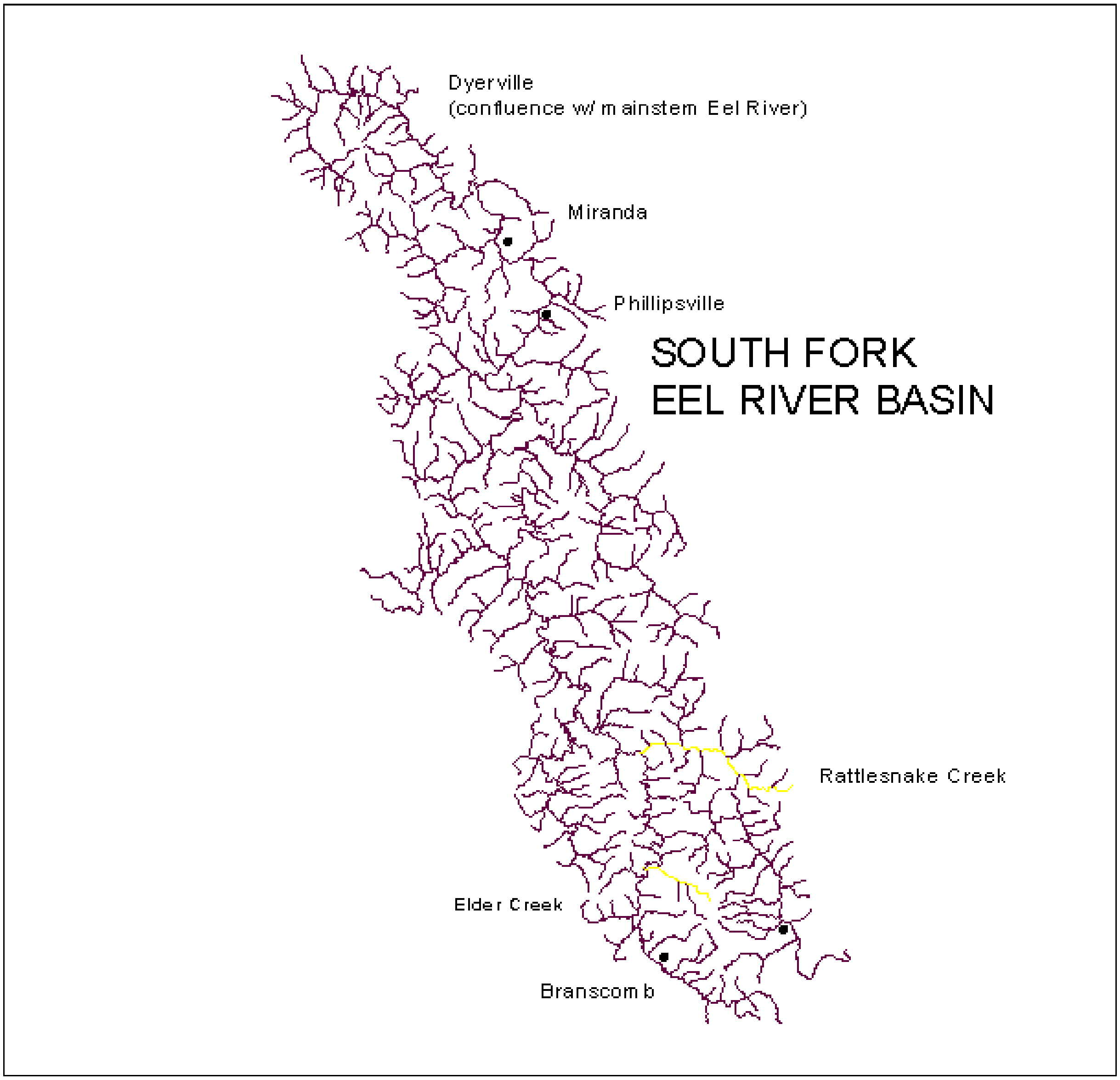


Figure 12. South Fork Eel River stream route, Branscomb to Dyerville.

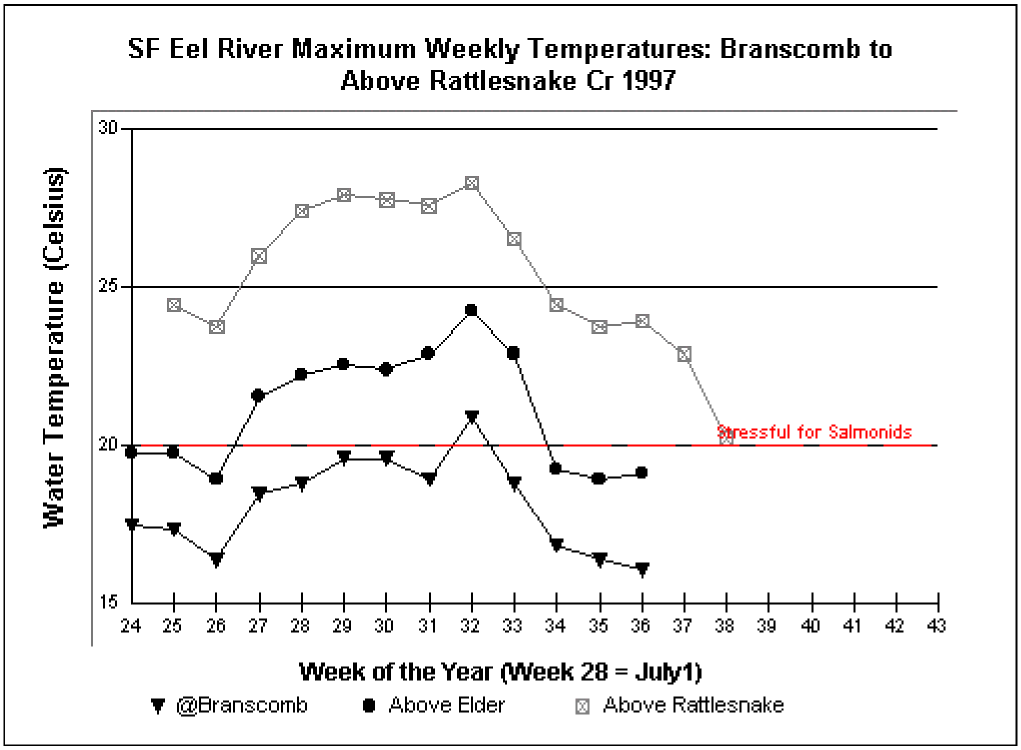


Figure 13. South Fork Eel River maximum weekly water temperature from Branscomb to above Rattlesnake Creek in 1997.

Inter-Annual Variation in Water Temperatures: The temperature regimes at all sites were fairly similar for the 1996 and 1997 placements, however there was some variation between sites. The South Fork Eel River at Branscomb showed a typical pattern of comparison between years (Figure 15) with an identical maxima in both years (21^0 C). The temperature range was almost identical with timing of peaks driven by variability between warm spells in the respective years. The Van Duzen River at Root Creek had a different trend (Figure 16) with the 1997 water temperatures ranking consistently warmer than those in 1996. However, the variation between maxima was not significant between years as a temperature of 27^0 C attained in both years. The maximum weekly water temperatures for 1996 and 1997 for the mainstem Eel River at Eel Rock show exactly the reverse of the Van Duzen. At Eel Rock, temperatures were consistently higher in 1996, with a maximum temperature of 29^0 C and 28^0 C in 1997 (Figure 17).

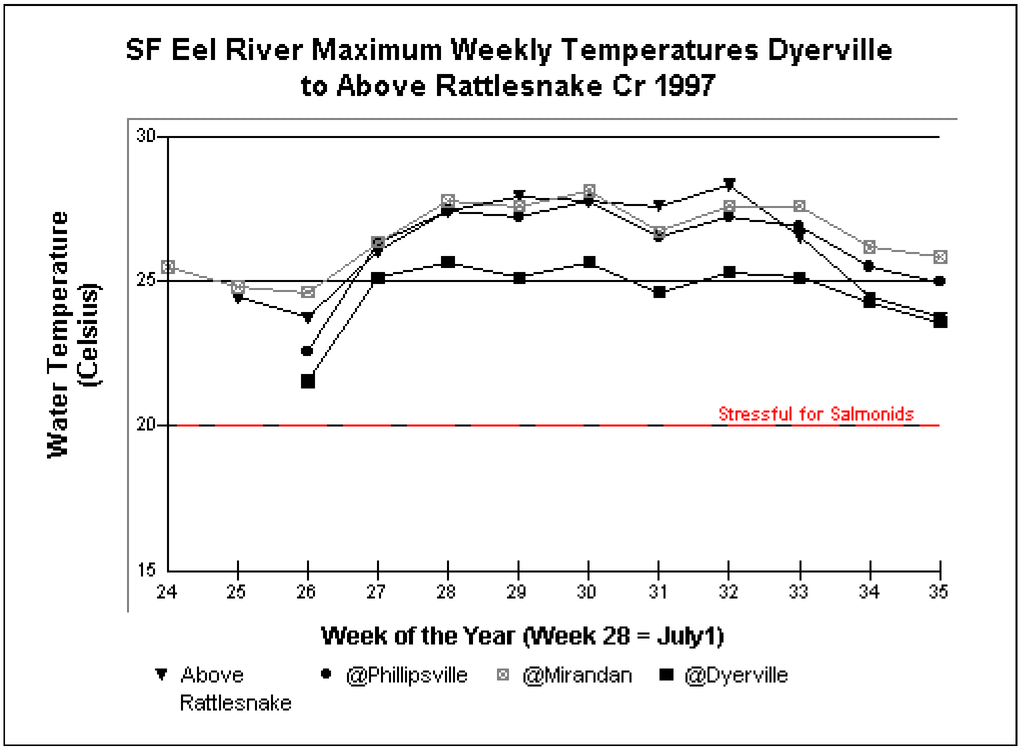


Figure 14. South Fork Eel River maximum weekly water temperatures from above Rattlesnake Creek to Dyerville in 1997.

Comparisons of 1973 and 1996: The data for this report were collected using affordable and easy to use automated temperature recording devices. While Kubicek (1977) did have a number of recording thermographs (30), many of his temperature observations were derived from use of a hand-held thermometer. Maximum temperatures were sometimes estimated or extrapolated from nearby sites. Despite the limited accuracy of these baseline data, it is worthwhile to use Kubicek's (1977) data collected in the 1973 field season to compare with data recently collected to see if there are dramatic changes in the Eel River's temperature regime. (For this comparison, all sites represented were duplicated as close as possible.)

The upper Eel River from above Lake Pillsbury to Tomki Creek (RM 153) did not show significant variation between maximum temperatures recorded by Kubicek (1977) in 1973 and those collected in the 1996 field season (Figure 18). The maximum water temperature for Tomki Creek (27.5 C) was down less than two degrees C. This drop could be ascribed to inter-annual variation. Significant lengths of Tomki Creek have been re-vegetated in an attempt prevent gully and bank erosion in this drainage. Unfortunately, there are not sufficient recent data to gauge whether these projects have helped to decreased temperatures in Tomki Creek.

The maximum water temperatures for all locations on the mainstem Eel River from Highway 162, above Outlet Creek, to Dyerville were almost identical between 1973 and 1996 (Figure 19). The Eel River may have been historically warm in this reach. It is speculated that prior to the 1964 flood and the ensuing deposition of material, the Eel River had much greater depth and provided cooler water for salmonids in stratified pools.

The North Fork Eel River at Mina Road Bridge had a maximum water temperature of 30^0 C in 1973 and 1996 (Figure20). Asbill Creek, a tributary of the North Fork, shows a dramatic drop in temperature between 1973 and 1996. In 1973, Kubicek (1977) measured a maximum water temperature of 26^0 C . The continuing recording device in 1996 measured a maximum of 19^0 C. This major drop in maximum water temperatures may indicate that this tributary has experienced substantial recovery from 1964 flood damage or the data are flawed. It is possible that the sequence of drought years in the late 1980's and early 1990's facilitated regeneration of riparian vegetation.

The South Fork of the Eel above Elder Creek experienced some decrease in temperature between 1973 and 1996 (Figure 21). The maximum temperature recorded by Kubicek (1977) with a hand held thermometer was 26^0 C while the maximum temperature recorded in 1996 was 22^0 C. No significant changes were noted for Ten Mile Creek or the South Fork above Rattlesnake Creek.

While temperatures at Dinsmore on the Van Duzen River and those of the Little Van Duzen did not change between 1973 and 1996, Little Larabee Creek seems to have changed substantially. Kubicek (1977) recorded a maximum water temperature of Little Larabee Creek of 27^0 C while data probes deployed in 1996 found the maximum to be 23^0 C.

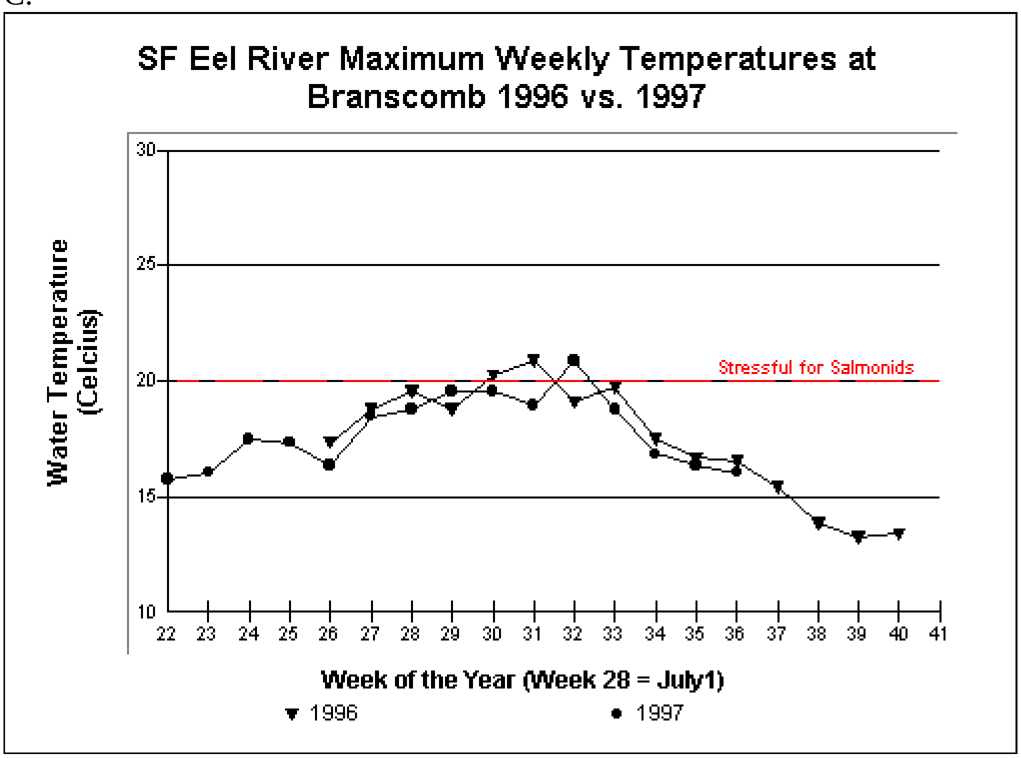


Figure 15. Inter-annual comparison of water temperature of the South Fork Eel at Branscomb for 1996 and 1997.

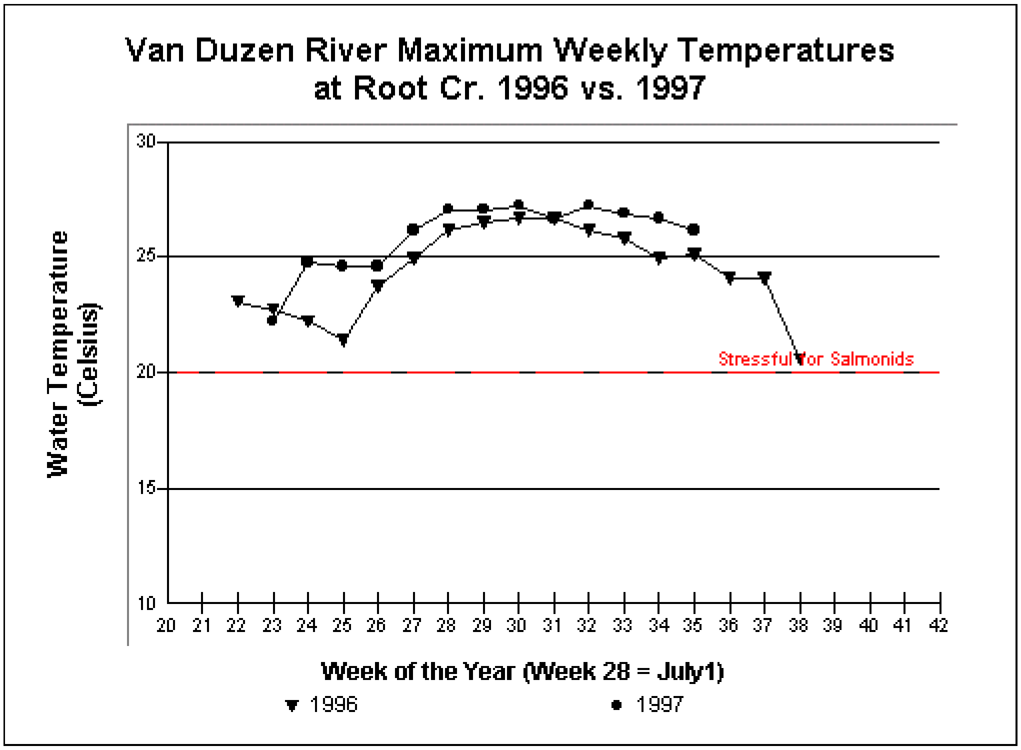


Figure 16. Inter-annual comparison of water temperatures on the Van Duzen River at Root Creek for 1996 and 1997.

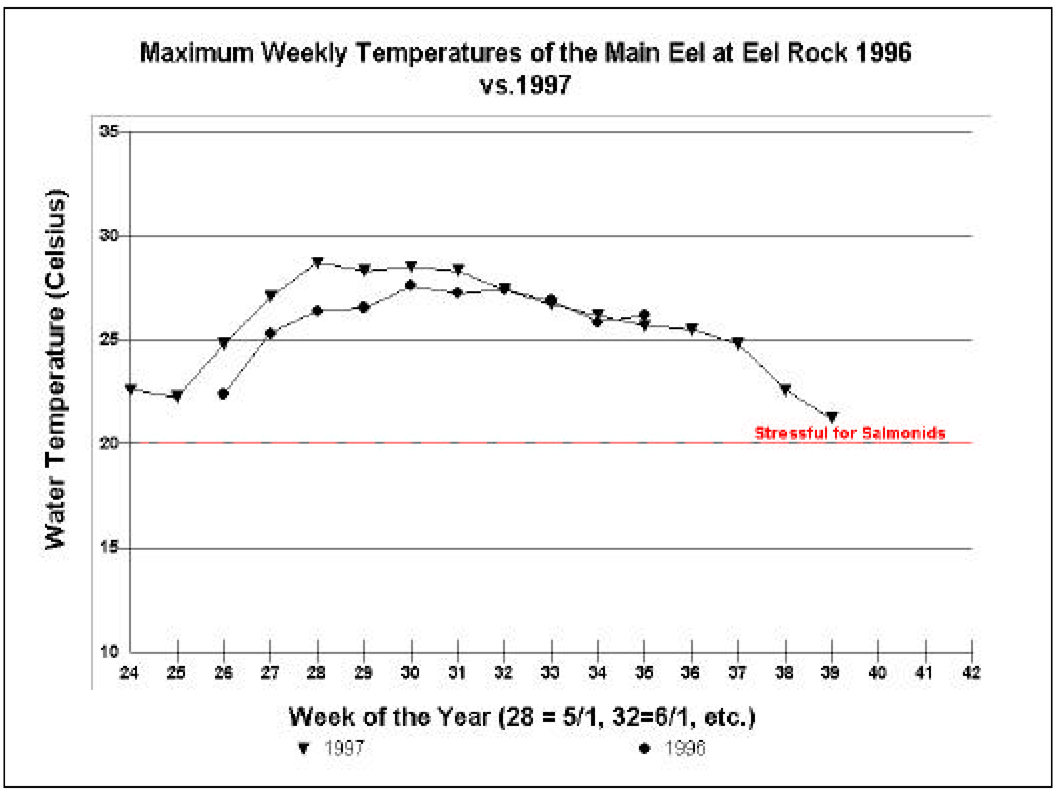


Figure 17. Inter-annual variation in water temperature of the mainstem Eel River at Eel Rock for 1996 and 1997.

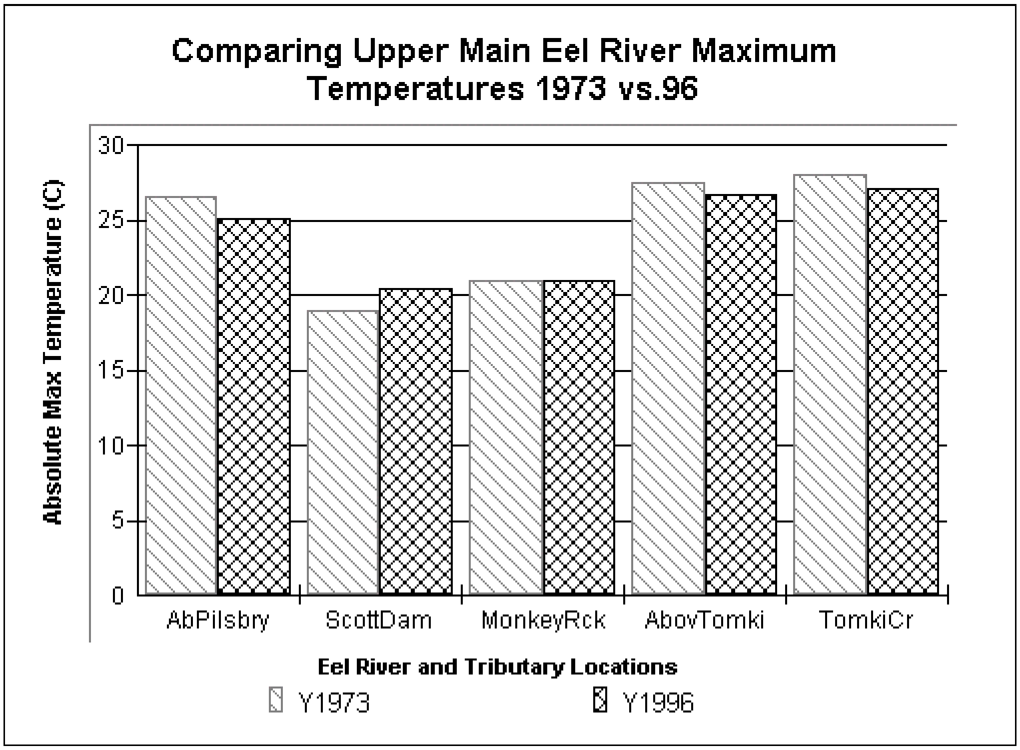


Figure 18. Comparison of maximum water temperatures from 1973, collected by Kubicek (1977), and data collected in 1996 for main Eel River locations from above Lake Pillsbury to Tomki Creek.

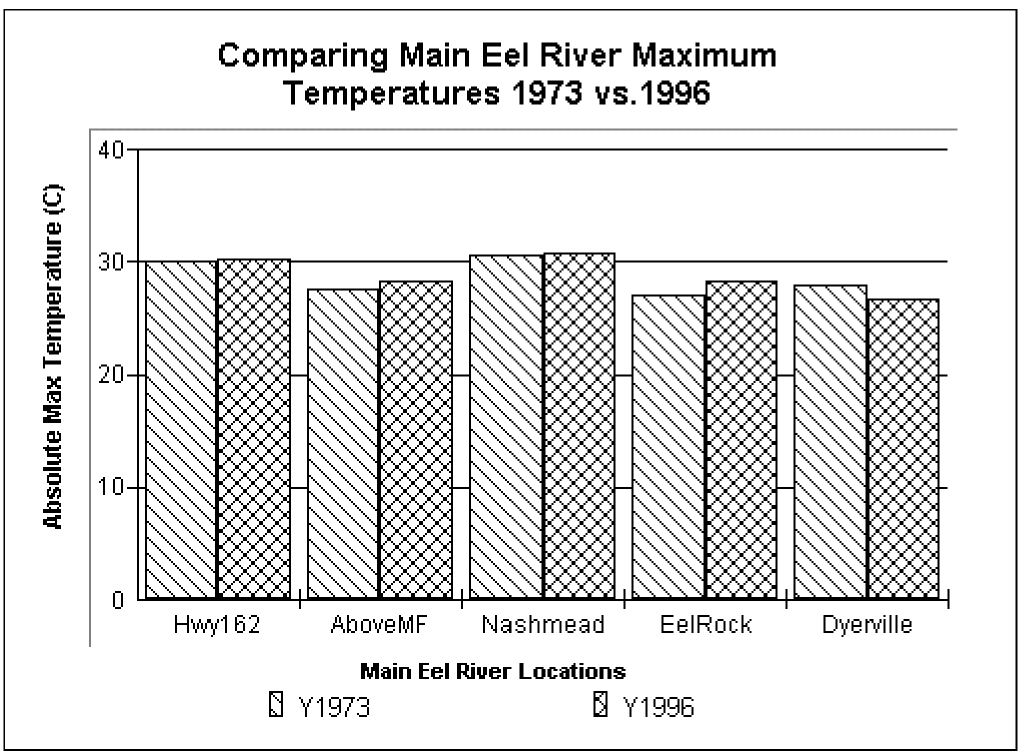


Figure 19. Comparison of maximum temperature data from Kubicek (1977) from 1973 and 1996 at five locations on the mainstem Eel River.

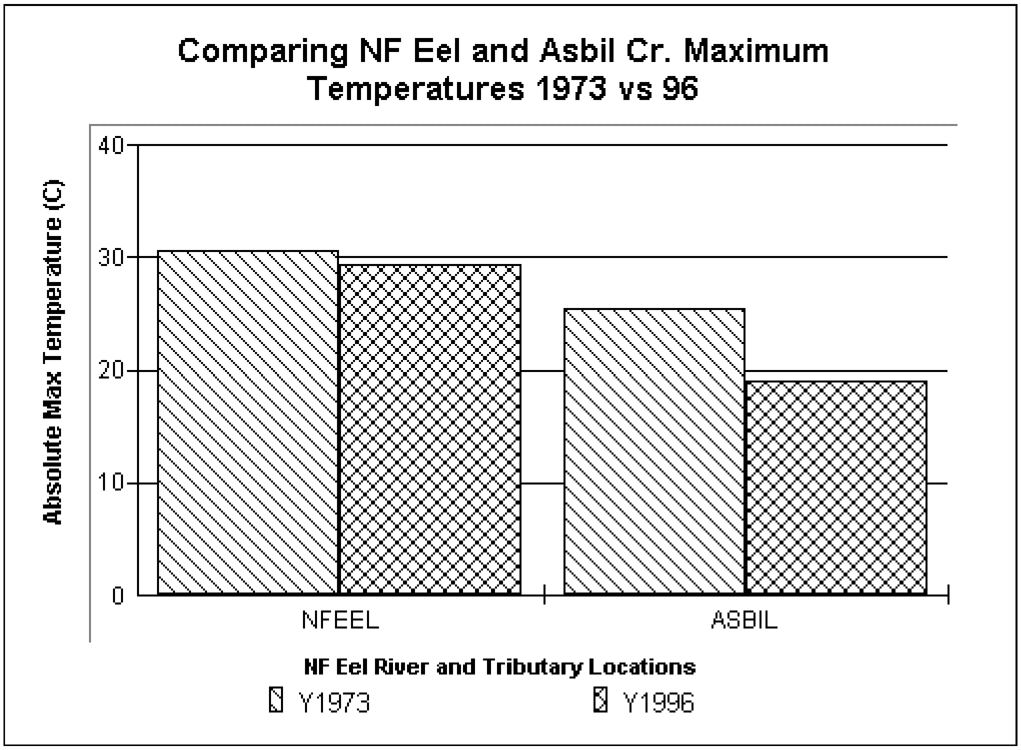


Figure 20. Comparison of maximum temperature data from 1973, collected by Kubicek (1977), and the 1996 field season for the NF Eel at Mina Bridge and Asbil Creek.

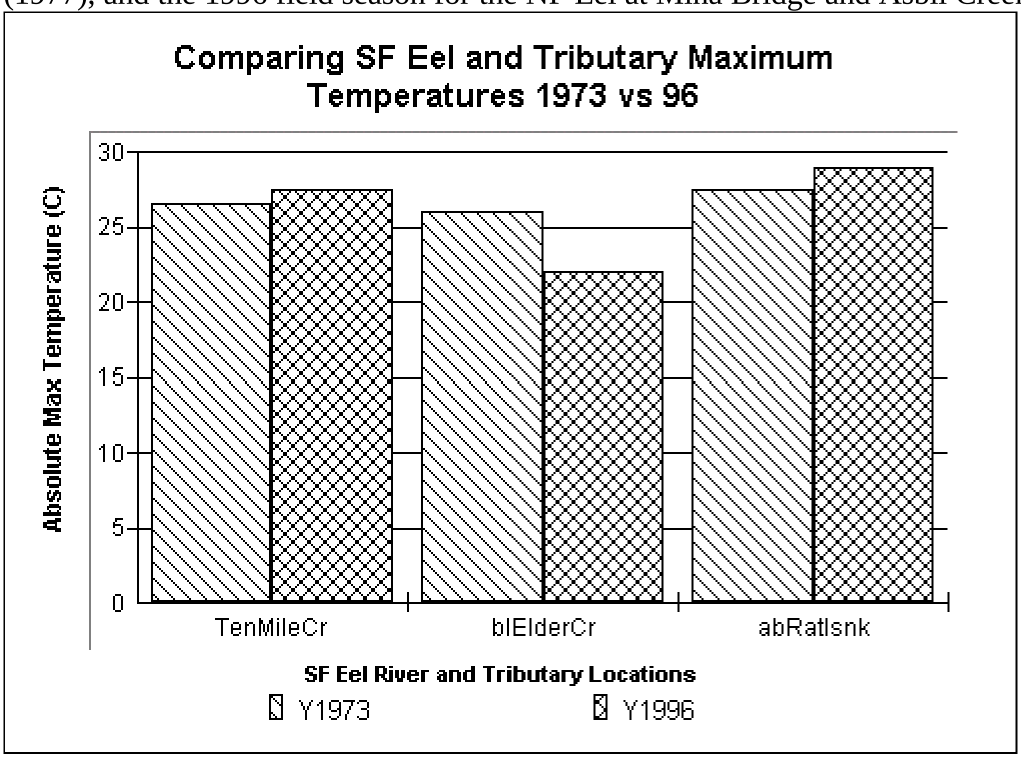


Figure 21. Maximum water temperature comparisons of South Fork Eel River locations between 1973 field data (Kubicek 1977) and 1996 field data.

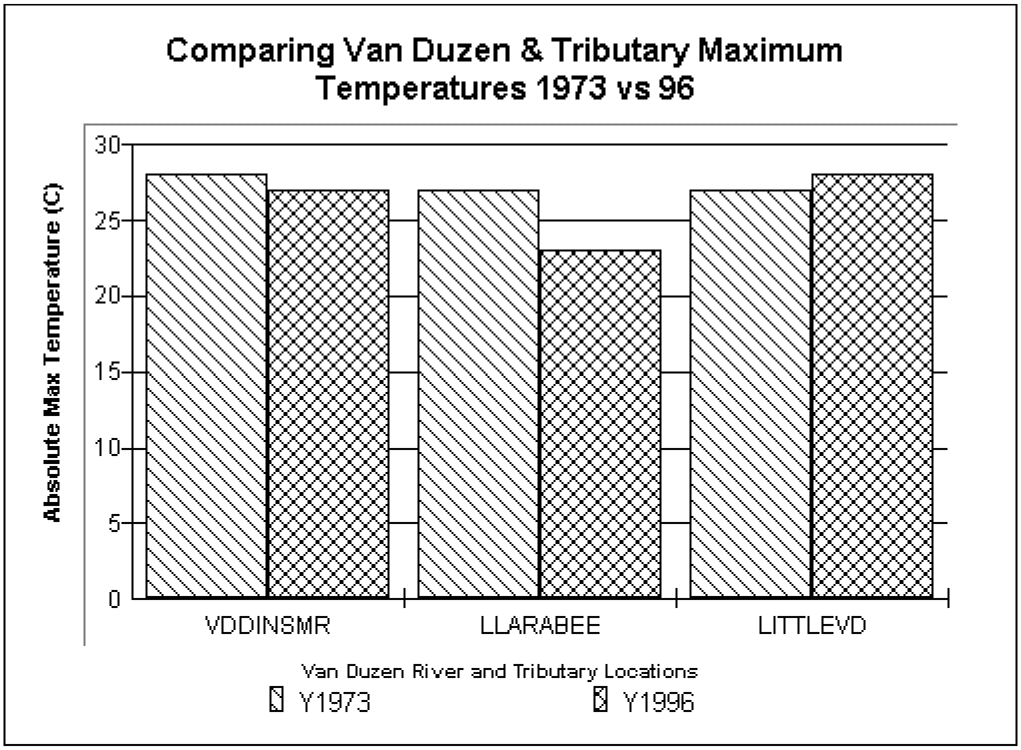


Figure 22. Temperature comparisons of the Van Duzen River at Dinsmore, the Little Van Duzen (S.F.) and Little Larabee Creek between 1973 field data (Kubicek 1977) and 1996 field data.

Sub-task 4.3 Aquatic Invertebrate Monitoring

Twenty-two Eel River tributaries were sampled for aquatic invertebrates in spring and fall 1996 as part of this study. These streams were selected by CDF&G Eel Basin Coordinator Scott Downie. The selection criteria was intended to satisfy two needs; a random cross section of stream health and proximity to a cooperating school. Full analysis of the samples by the principal investigator, John Lee, can be reviewed in **Appendix B**. Five different metrics were used to gauge stream health: the Simpson Index, modified Hilsenhoff Index, EPT Index, Percent Dominant Taxa and the Richness Index. Lee noted that the Hilsenhoff Index may need further modification for use in northern California. Below is a brief summary of what the aquatic macro-invertebrate samples revealed about the health of Eel River tributaries. In addition to analysis done by Lee, the ten most abundant species by site were arrayed in bar graphs and assigned color values associated with tolerance. Community structure can be indicative of whether an aquatic ecosystem is stressed. Metrics, values based on benthic macroinvertebrate assemblage in the sample, explained below are based on Plafkin et al. (1989). Ranges suggested are based on impact compared with “theoretically undisturbed conditions.” Determining whether a metric value indicates an impaired stream habitat is an iterative process (Fore et al. 1996), particularly without a reference stream for comparison. As more work is performed with the Rapid Bioassessment Protocol on Northern California streams and more data are gathered metric values should have greater precision in assessing relative impact.

Richness Index: The Richness at each site per season is simply the total number of taxa. The diversity of aquatic insects decreases as water quality deteriorates due to anthropogenic causes (e.g. warming, point and non-point pollution etc., etc.) . Graphs representing scores for all sites in spring (Figure 1) and fall (Figure 2) 1996 show a wide range of scores that can be interpreted as follows (Plafkin et al. 1989):

>40 = Low Impact
25-39 = Moderate Impact
<25 = High Impacts

EPT Index: The EPT Index is the number of species at a given location of the orders Ephemeroptera, Plectoptera, and Trichoptera. These are commonly known as mayflies, stoneflies and caddisflies. The species of aquatic invertebrates within these orders generally have higher water quality requirements than Diptera (true flies), Coleoptera (beetles) or other orders. Spring 1996 EPT scores for all locations appear in Figure 3 and fall 1996 results in Figure 4. EPT score rankings indicate the following levels of stream impacts:

>25 = Low Impact
15-25 = Moderate Impact
<15 = High Impact

Percent Dominant Taxa: This index is calculated by dividing the number animals in the most abundant taxa by the total number of organisms in the entire sample. Collections dominated by one taxon represent a very disturbed ecosystem (Fore et al. 1996). Scores for this parameter in spring 1996 (Figure 5) and fall 1996 (Figure 6) show that some streams sampled have high impact levels. Scores can be interpreted as follows:

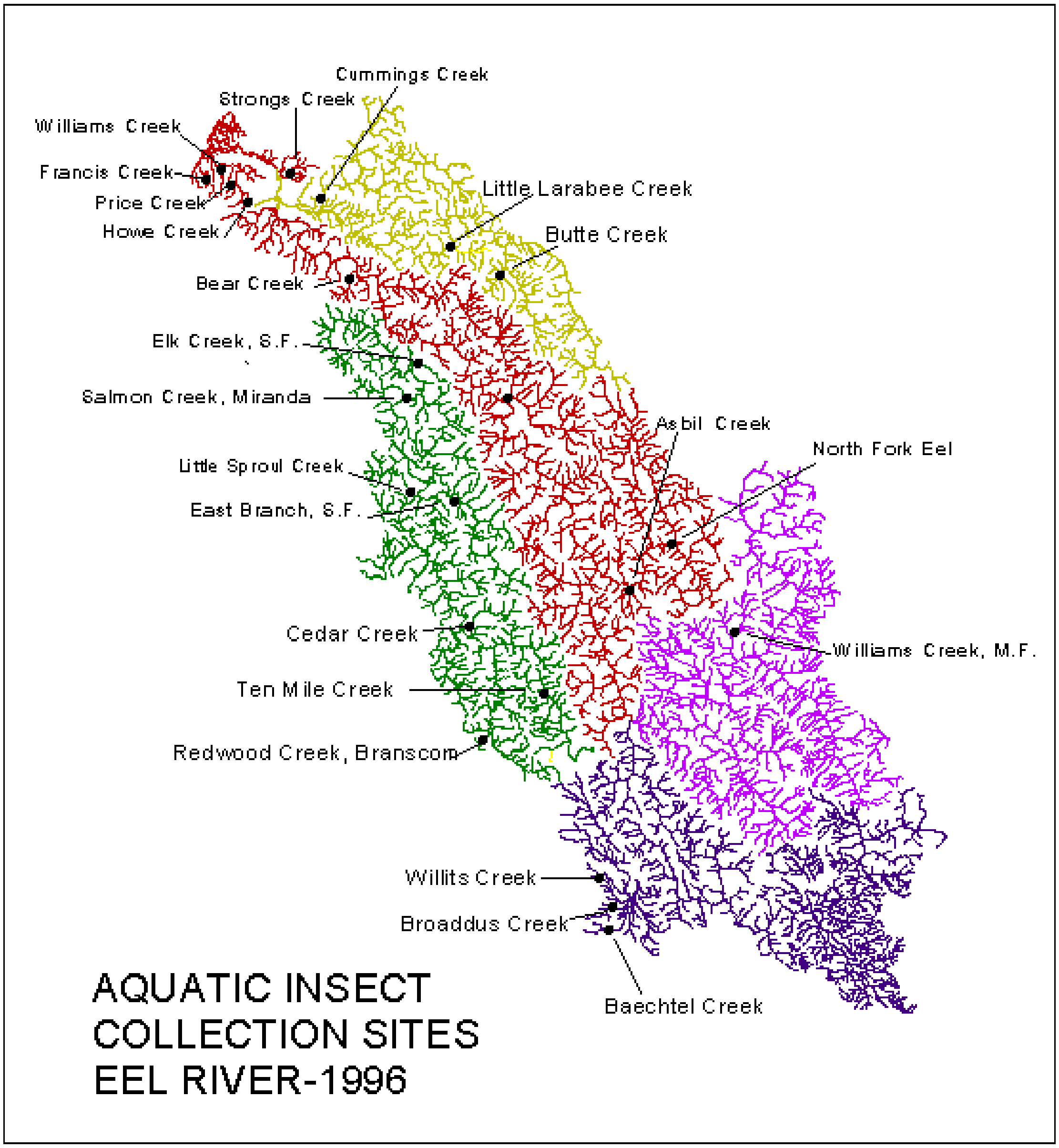
<20% = Low Impact
20-30% = Slight Impact
30-40% = Moderate Impact
>40% = High Impact

Simpson Diversity Index: This metric is calculated using the diversity of taxa present and also the evenness of the community. A community of aquatic invertebrates in a fairly stable and healthy environment will have many species that are fairly even in abundance, which can be said to exhibit evenness. Simpson scores for spring 1996 samples (Figure 7) have a far wider range than those for fall 1996 samples (Figure 8). Simpson Diversity Index scores can be interpreted as follows:

>0.9 = Low Impact
0.8-0.9 = Moderate Impact
<0.8 = High Impact

Modified Hilsenhoff Index: This index is calculated by assigning tolerance values (t-value) for all taxa present, multiplying the number of organisms present in each taxa by the t-value, adding all scores and then dividing by the total number of insects in the sample (EPA, 1997). Tolerance values reflect an insects ability to withstand organic pollution, such as dairy waste on a 0 to 10 ranking system (Hilsenhoff, 1982). Insects that can only survive in high quality water having low tolerance scores (0-5) and higher tolerance having higher scores (6-10). These values assigned to different species may need further refinement for northern California streams to make this metric more useful (see Appendix B). Scores for the modified Hilsenhoff Index (0-3 rating) by site can be found in Figure 9 (spring, 1996) and Figure 10 (fall, 1996). Values can be interpreted as follows:

- <2 = Low Impact
- 2.0-2.5 = Moderate Impacts
- >2.5 = High Impacts


Cummings Creek
Strongs Creek
Williams Creek
Francis Creek
Price Creek
Howe Creek
Little Larabee Creek
Butte Creek
Bear Creek
Elk Creek, S.F.
Salmon Creek, Miranda
Asbil Creek
North Fork Eel
Little Sproul Creek
East Branch, S.F.
Cedar Creek
Williams Creek, M.F.
Ten Mile Creek
Redwood Creek, Branscom
Willits Creek
Broaddus Creek
Baechtel Creek
AQUATIC INSECT
COLLECTION SITES
EEL RIVER-1996

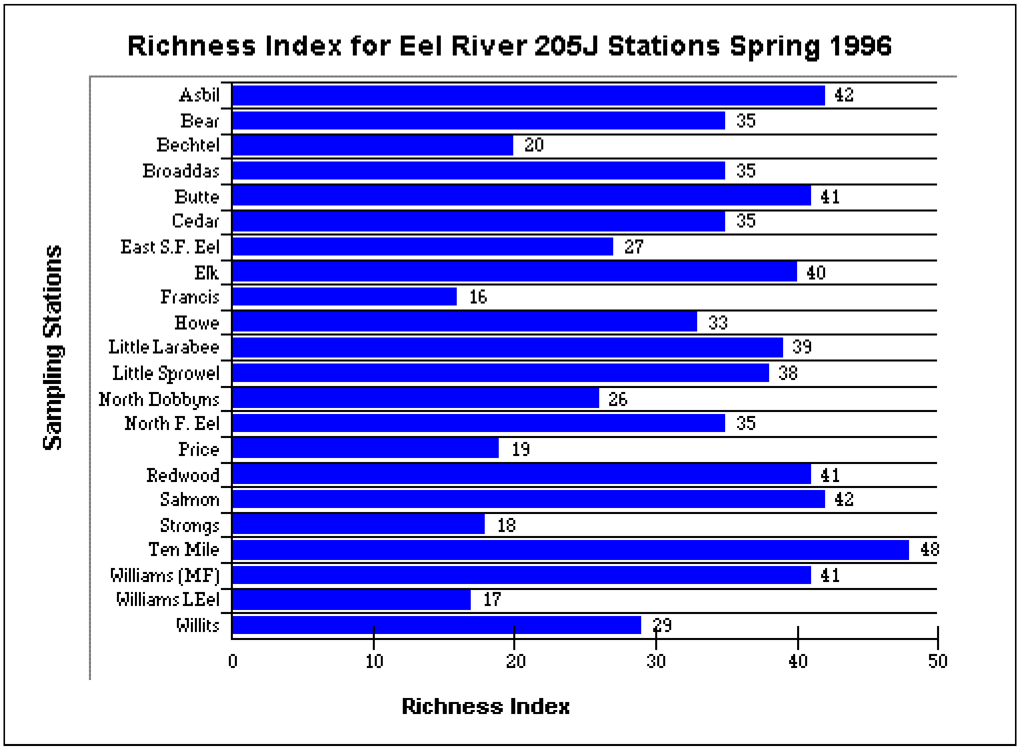


Figure 23.Chart of Richness Index for spring 1996 from all Eel River sampling sites.

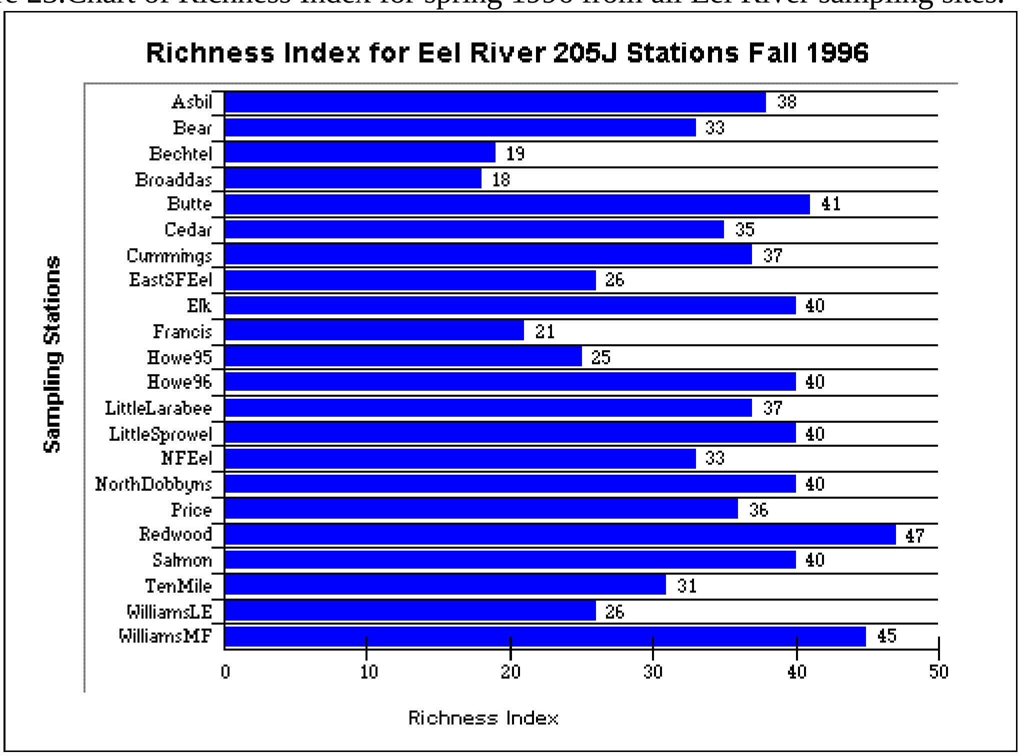


Figure 24. Chart of Richness Index for fall 1996 for all Eel River sampling sites.

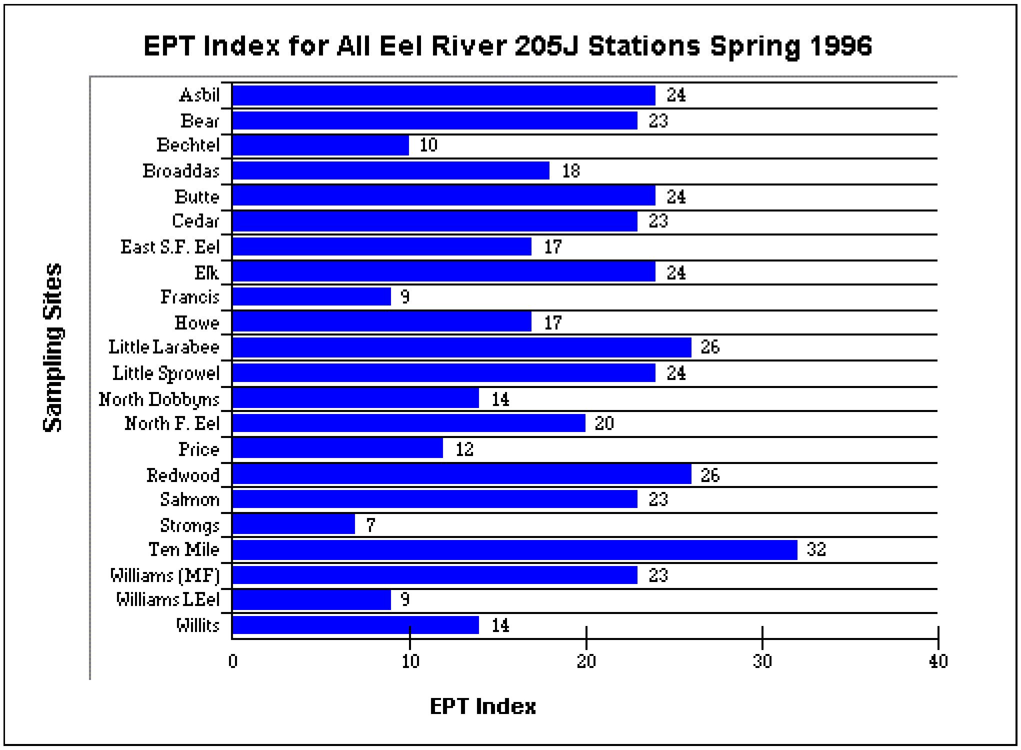


Figure 25. Emphmeroptera/Plecoptera/Trichoptera (EPT) Index for all Eel 205J sampling sites for spring 1996.

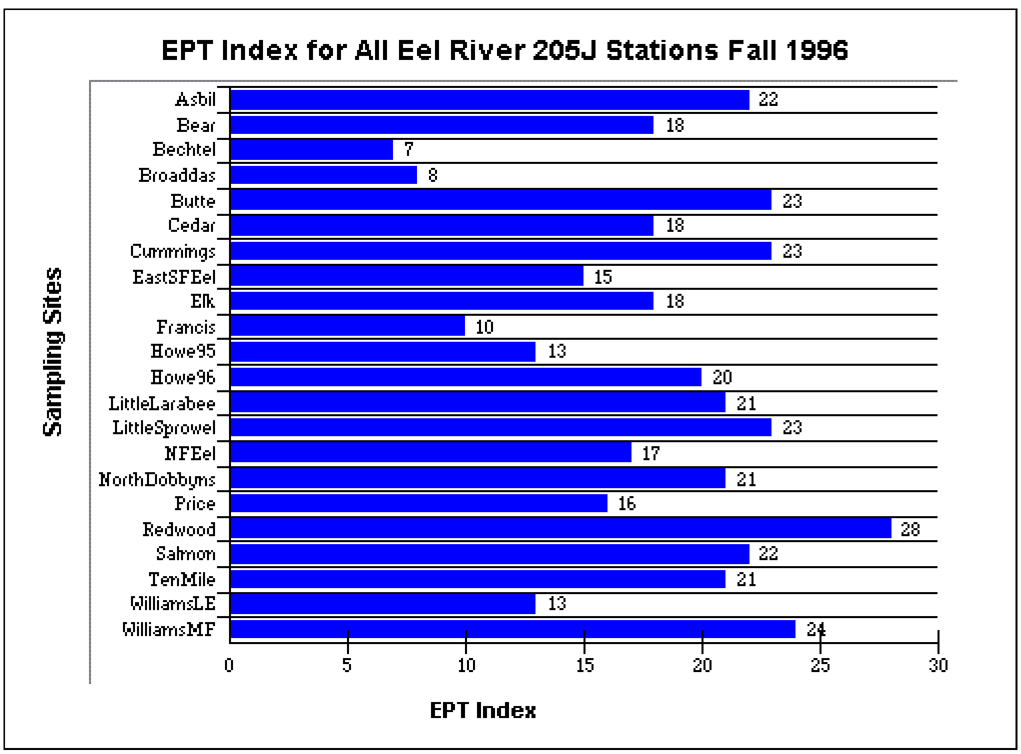


Figure 26. Emphmeroptera/Plecoptera/Trichoptera (EPT) Index for all Eel 205J sampling sites for fall 1996.

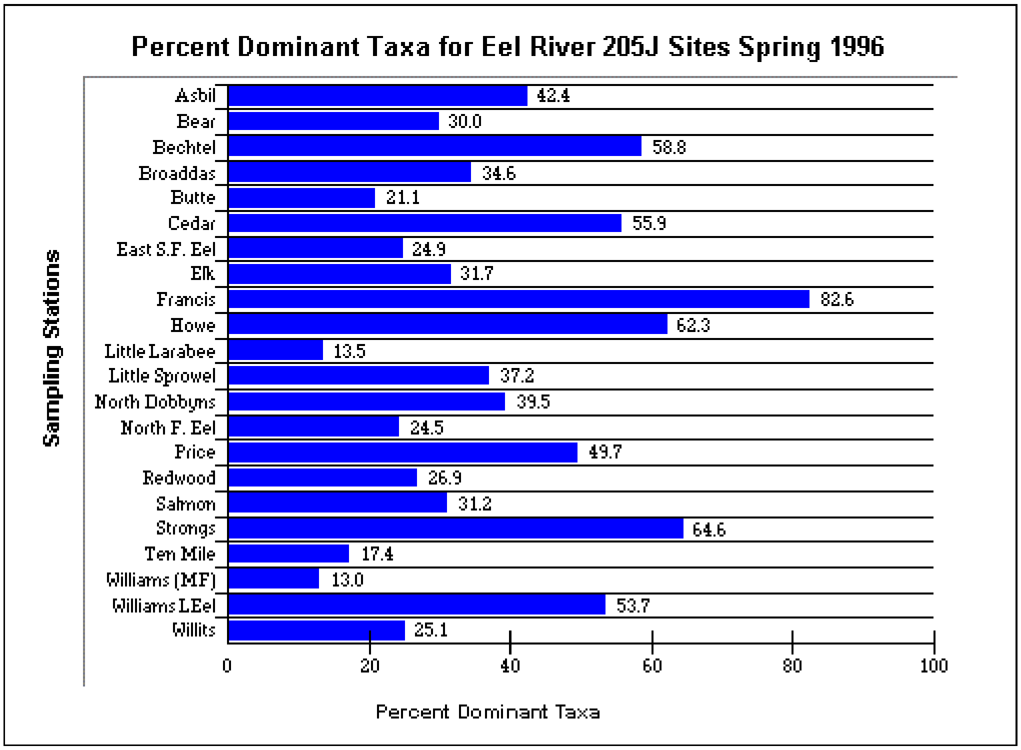


Figure 27. Chart of Percent Dominant Taxa for all Eel River sampling sites, spring 1996.

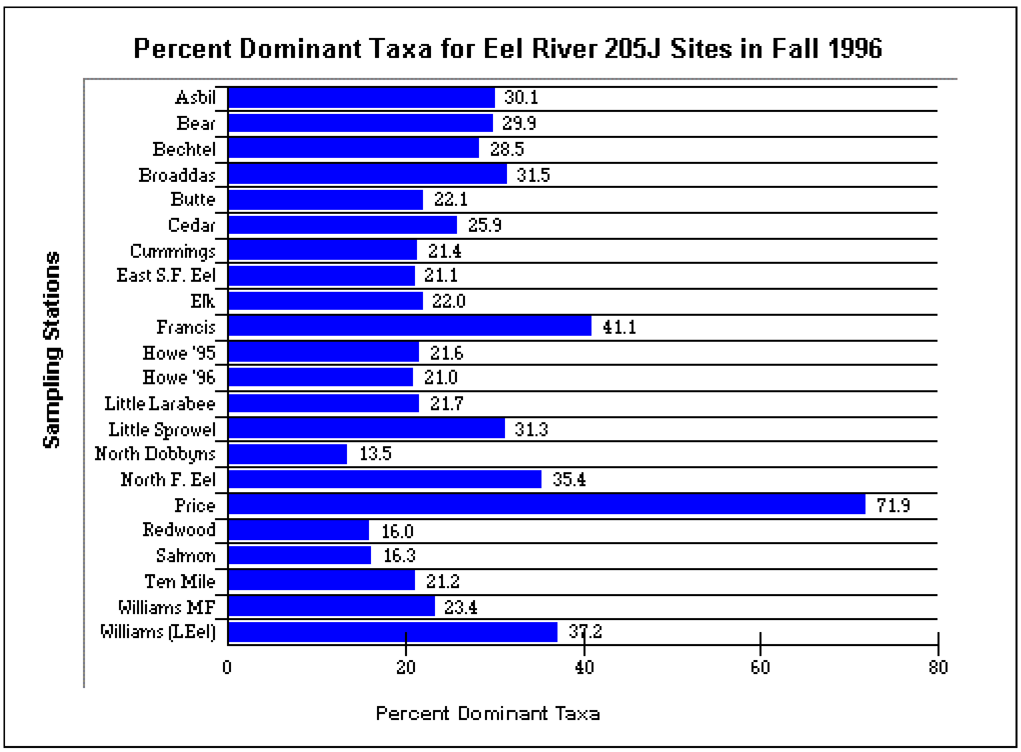


Figure 28. Chart of Percent Dominant Taxa for all Eel River sampling sites, fall 1996.

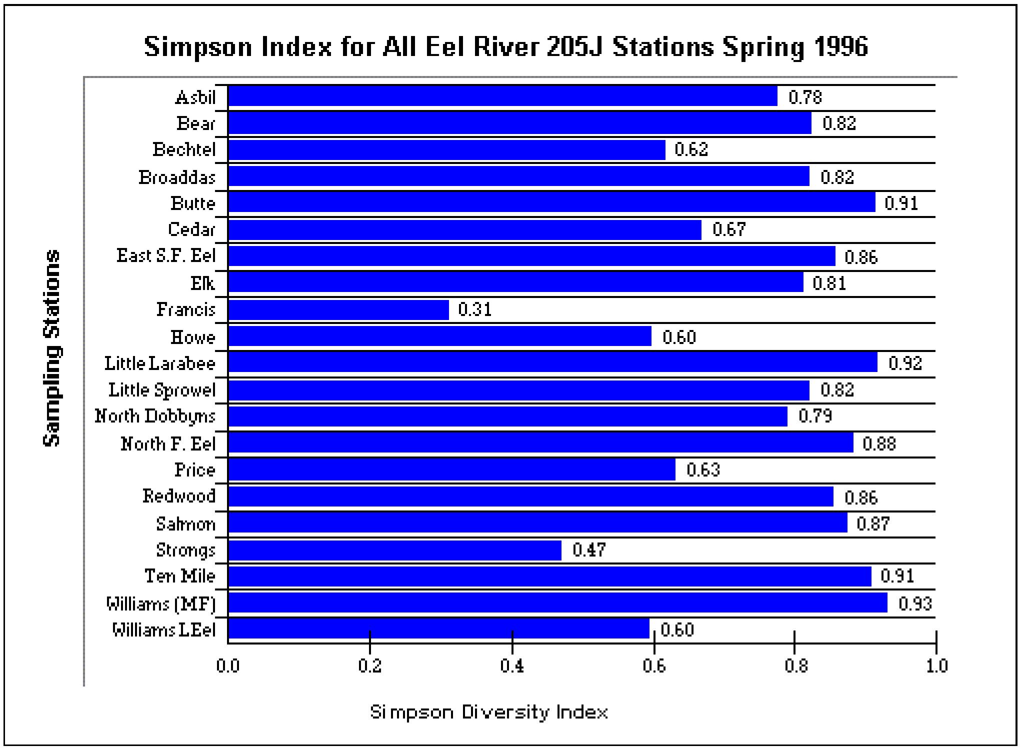


Figure 29. Spring 1996 Simpson Diversity Index scores for all 205J sites.

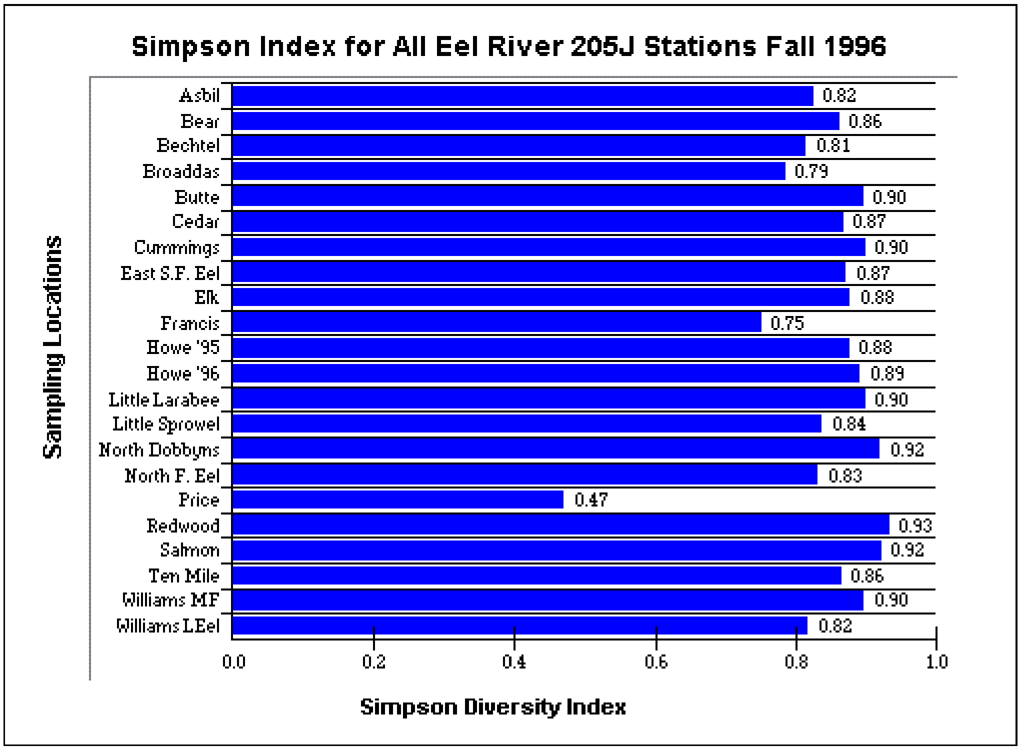


Figure 30. Fall 1996 Simpson Diversity Index scores for all 205J sites.

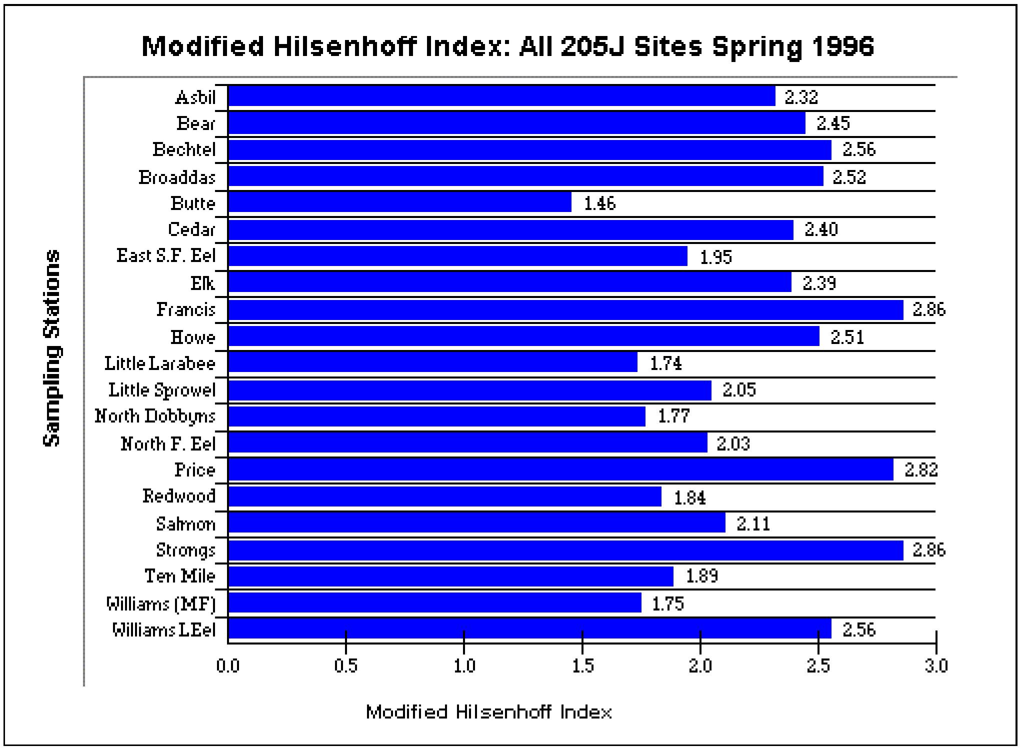


Figure 31. Graph of all 205J Site modified Hilsenhoff Index scores, spring 1996.

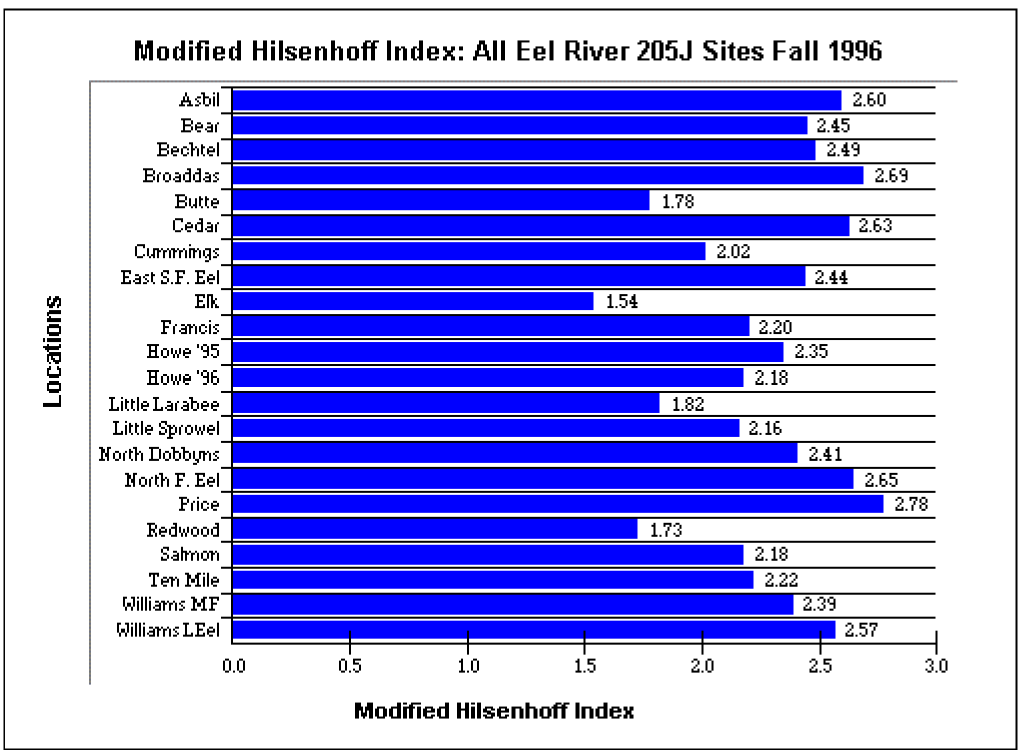


Figure 32. Graph of all 205J site modified Hilsenhoff Index scores, fall 1996.

Community Structure with Tolerance Values: Graphs showing the ten most abundant aquatic invertebrate species by location were generated for all locations. Tolerance values from the California Department of Fish and Game Aquatic Invertebrate Laboratory (CDF&G. 1996) were assigned colors for use in this analysis:

- 0-3 = Light Impacts (Green)
- 4-6 = Moderate Water Quality (Yellow)
- 7-10 = Degraded Water Quality (Red)

The Redwood Creek, S.F., RM 30, chart of the ten most abundant species for fall 1996 (Figure 36) shows a community with fairly good evenness as evidenced by the shape of the bar graph, reflecting a stream with perennial cold water and low sediment transport. This contrasts with both spring and fall samples from Price Creek, RM 14.7, (Figures 37 & 38) and the spring sample from Baechtel Creek, RM 148 (Figure 11), an urban stream in Willits. From this sampling effort, Price Creek appears to have problems related to high sediment supply and transport.

The color codes, above, also give an indication of the number of pollution intolerant species present at each location. Redwood Creek had a majority of pollution intolerant taxa in the spring sample and retained four high water quality indicator species in the fall sample. The lack of more pronounced evenness in the Redwood Creek spring sample may be the result of sampling slightly late, after emergence of some species (Figure 35). While Price Creek reflects extreme disturbance with regard to evenness and species diversity, it still had five intolerant species in spring 1996 in low numbers (Figure37). This might reflect the fact that Price Creek has cold water temperatures due to its proximity to the ocean. Baechtel Creek in fall 1996 had two species, the mayfly *Eurylophella sp.* and dragonfly *Sigara sp.,* which are both very tolerant of poor quality water. Both these species occurred only in this severely impacted urban stream.

Summary of Findings: When all metric analysis methods are taken together, the least impacted streams surveyed were Butte, Redwood, Salmon, Williams (MF Eel) and Little Larabee Creeks. No control stream was available for this study and Lee (Appendix A) noted that several aquatic insect species associated with high water quality from other northern California streams were generally lacking or in low abundance. He asserted that Redwood, Little Larabee and Butte Creeks had a higher level of representation of those taxa associated with cooler water temperatures in summer.

Urban streams clearly had the most consistently low ranking scores among virtually all systems of analysis. Francis Creek (Ferndale), Strongs Creek (Fortuna) and Baechtel, Willits, and Broaddus Creeks (Willits) all scored consistently in impaired ranges. May et al. (1996) studied 22 Puget Sound creeks and found that cumulative watershed effects from urbanization can negatively impact aquatic invertebrates. Problems included increased storm flows, reduced summer flows, loss of channel complexity and loss of aquatic species diversity. Non-point source contributions of pollutants from paved areas and stream-side residences can also contribute to water quality degradation.

Lee (**Attachment B**) noted that Baechtel Creek in fall had some organisms more characteristic of ponds than streams. When extensive areas are paved, runoff occurs quickly during winter storms, leaving little opportunity to re-charge ground water. Extremely low flows in Baechtel Creek in fall probably reflect less water storage in the flood plain due to urbanization. Both Strongs Creek and Willits Creek had so little surface flow in fall 1996 that neither could be sampled. Low species diversity in these urban streams, including Baechtel Creek, (Figure 33) in spring 1996 may have resulted from high run-off in winter, flushing aquatic invertebrates downstream. Francis Creek experienced extensive flood damage in December 1995 that deposited large quantities of sediment in the channel. This is probably linked to very low insect diversity in spring 1996.

Some streams were known to have low water temperatures but also showed substantial components of pollution tolerant taxa and low community diversity. Williams Creek (Salt River, RM 0.8), Price and Howe Creeks were rated in high impact categories, possibly the result of high sediment contributions that disturbed the aquatic community. These tributaries are proximate to Francis Creek in the lower Eel basin and also experienced a flood event in December 1995 with associated high sediment transport. Price Creek still had a low diversity of organisms (evenness) when samples were collected in fall (Figure 34).

Several streams with high summer temperatures, such as the North Fork Eel and East Branch SF Eel and Ten Mile Creek, had declining scores from spring to fall, possibly as a result of high water temperature. Lee (Appendix A) noted that the most abundant taxa in the former two streams were adapted to warm water and were grazers. Grazing aquatic invertebrates thrive in streams that lack canopy and provide abundant algae growth. Tolerance values for aquatic invertebrates were derived on the ability of organisms to survive nutrient enrichment from dairy waste (Hilsenhoff, 1982). The temperature problems in the Eel River may need a re-determination of species tolerance levels as some species that have a low tolerance for organic pollution have a high tolerance for elevated water temperatures. The baseline collection provided by this study will help the California Department of Fish and Game Aquatic Bio-Assessment Laboratory and other experts to ascribe more accurate thermal tolerance ratings in future studies.

The graphs below use the following color code:

0-3 = Light Impacts (green)
4-6 = Moderate Water Quality (yellow)
7-10 = Degraded Water Quality (red)

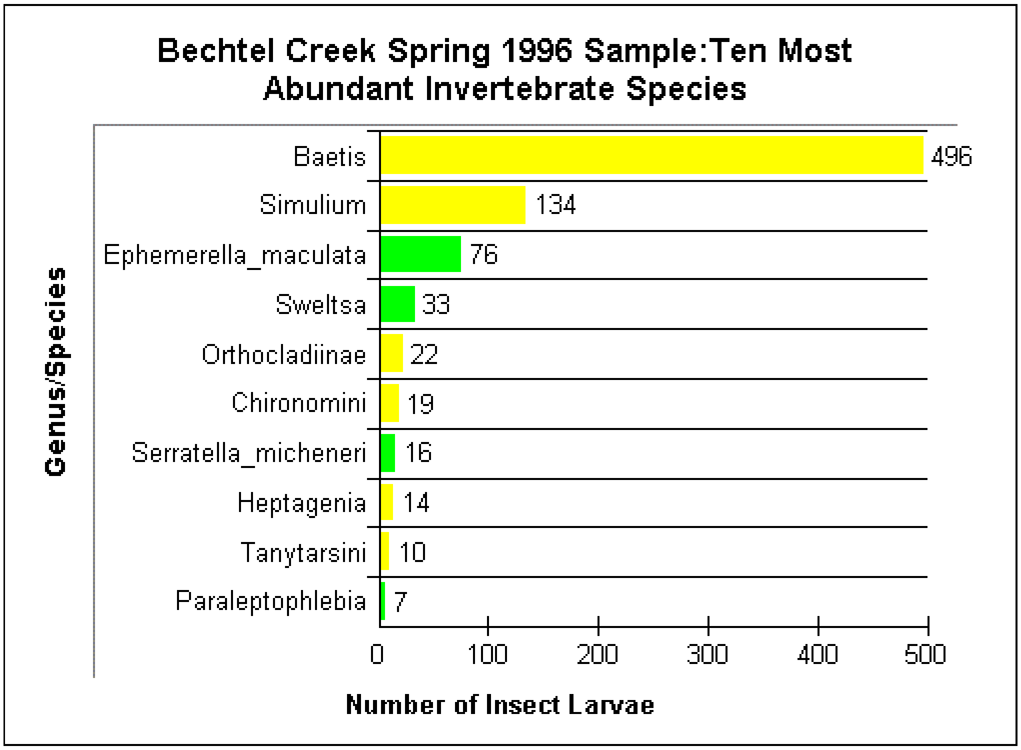


Figure 33. The ten most abundant species in Baechtel Creek, an urban stream in Willits, from the spring 1996 sample, with tolerance values assigned by color.

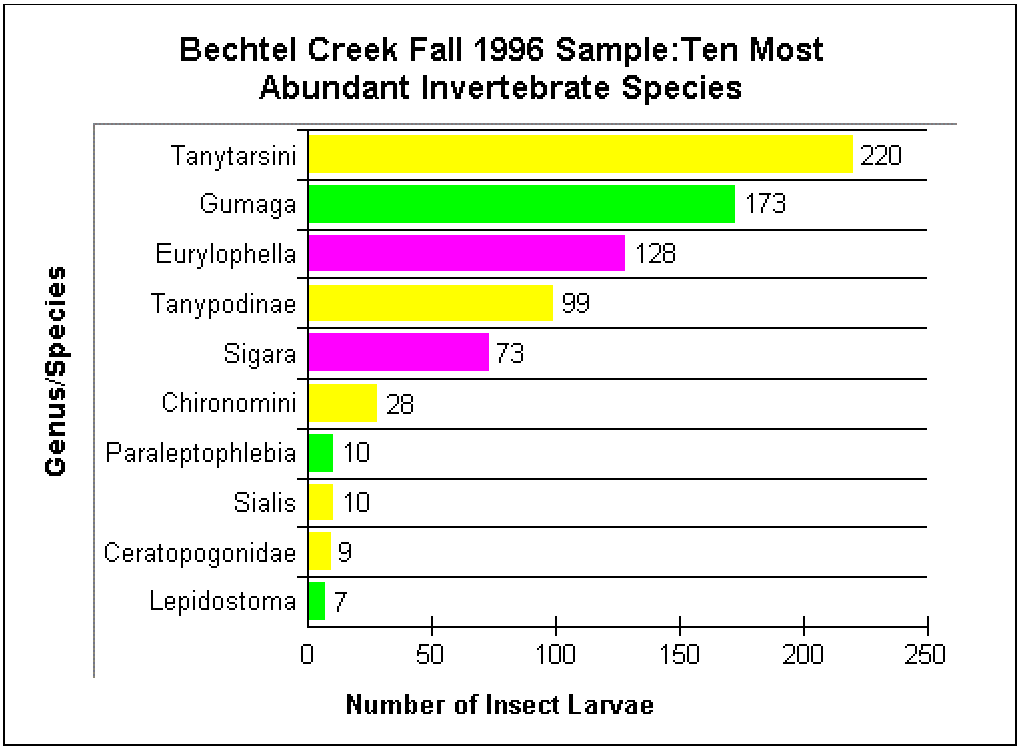


Figure 34. Ten most abundant species from Baechtel Creek fall 1996 with tolerance values assigned by color.

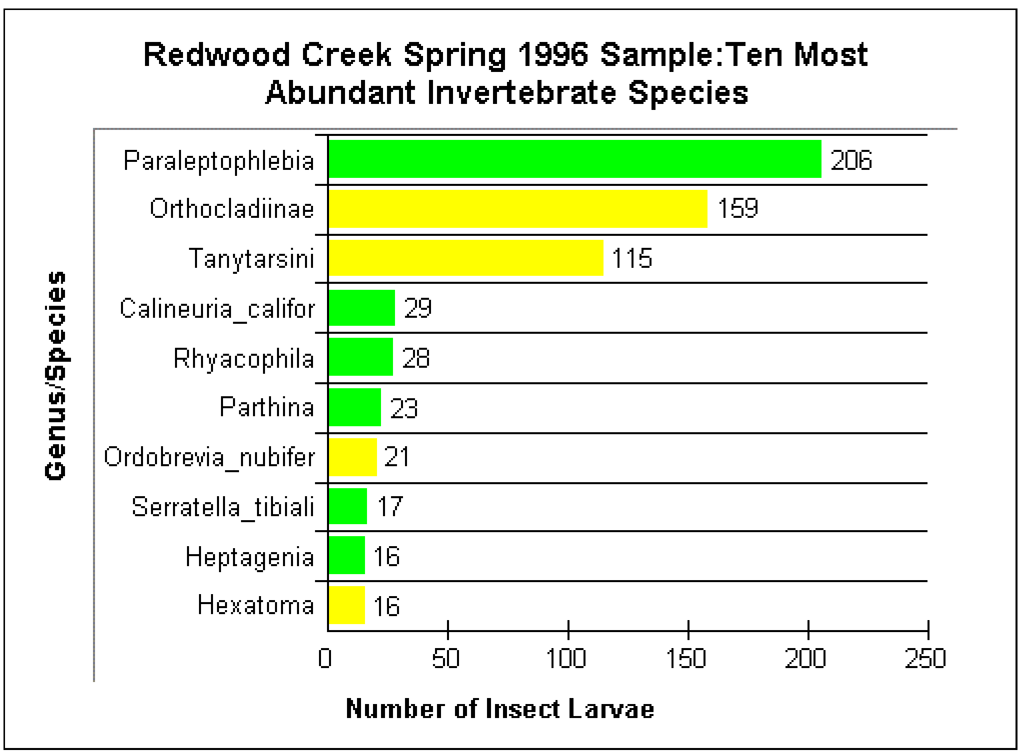


Figure 35. Ten most abundant aquatic insects from the spring 1996 Redwood Creek sample with tolerance values assigned by color.

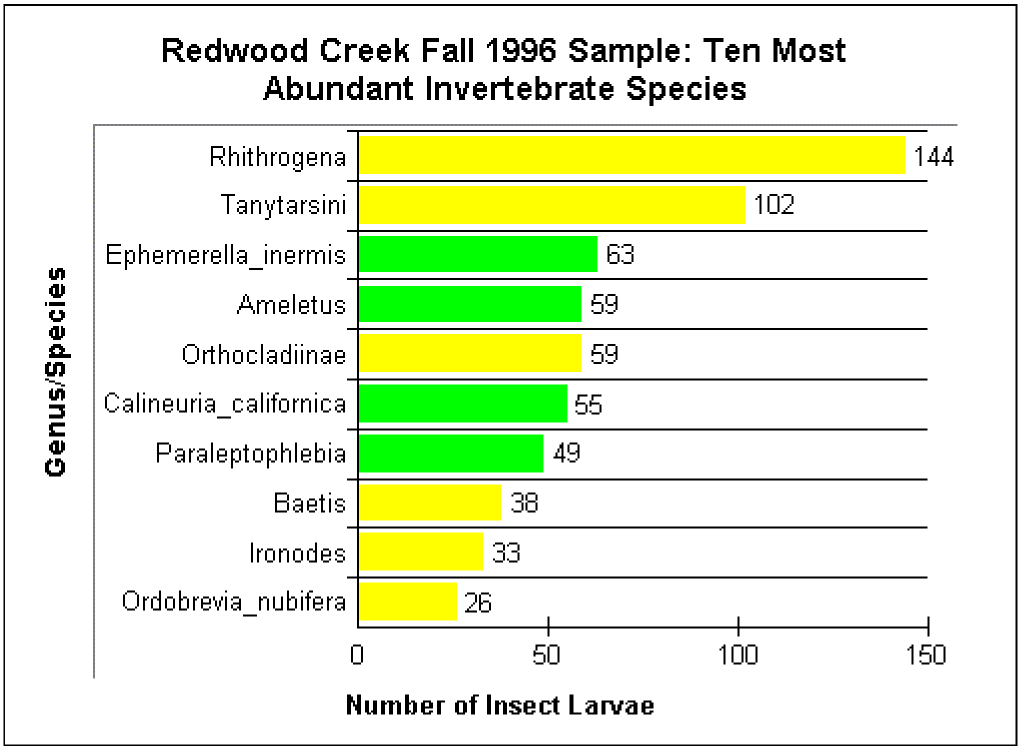


Figure 36. Ten most abundant species found in fall 1996 Redwood Creek samples with tolerance values assigned by color.

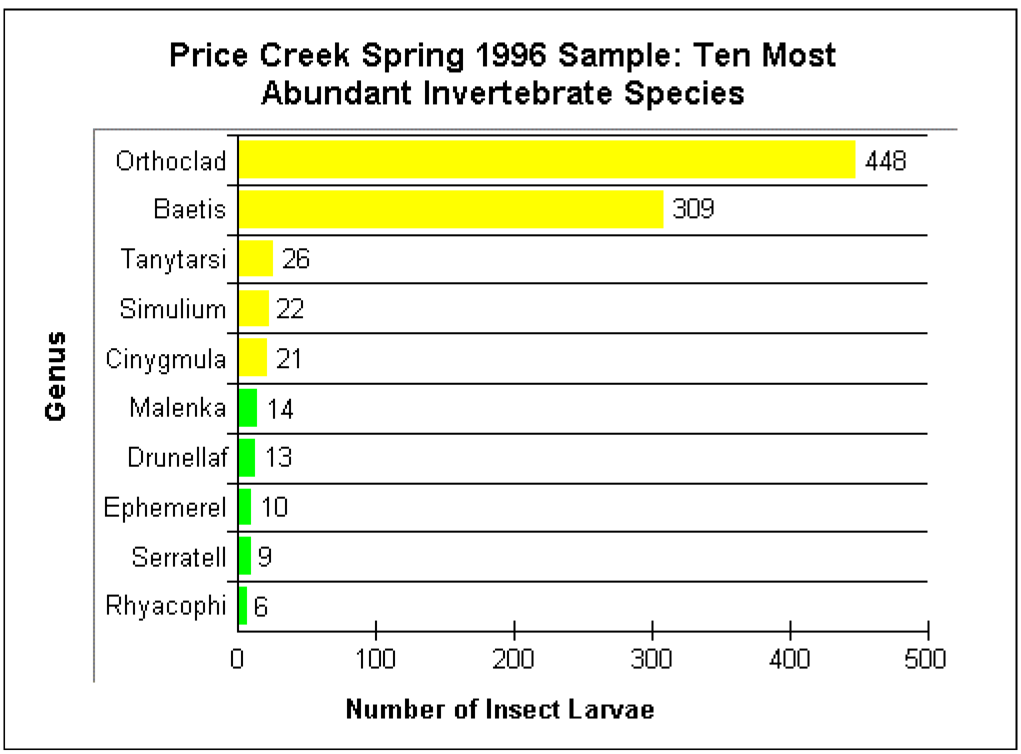


Figure 37. Graph showing ten most abundant species of aquatic invertebrates in Price Creek from spring 1996 with tolerance codes in color.

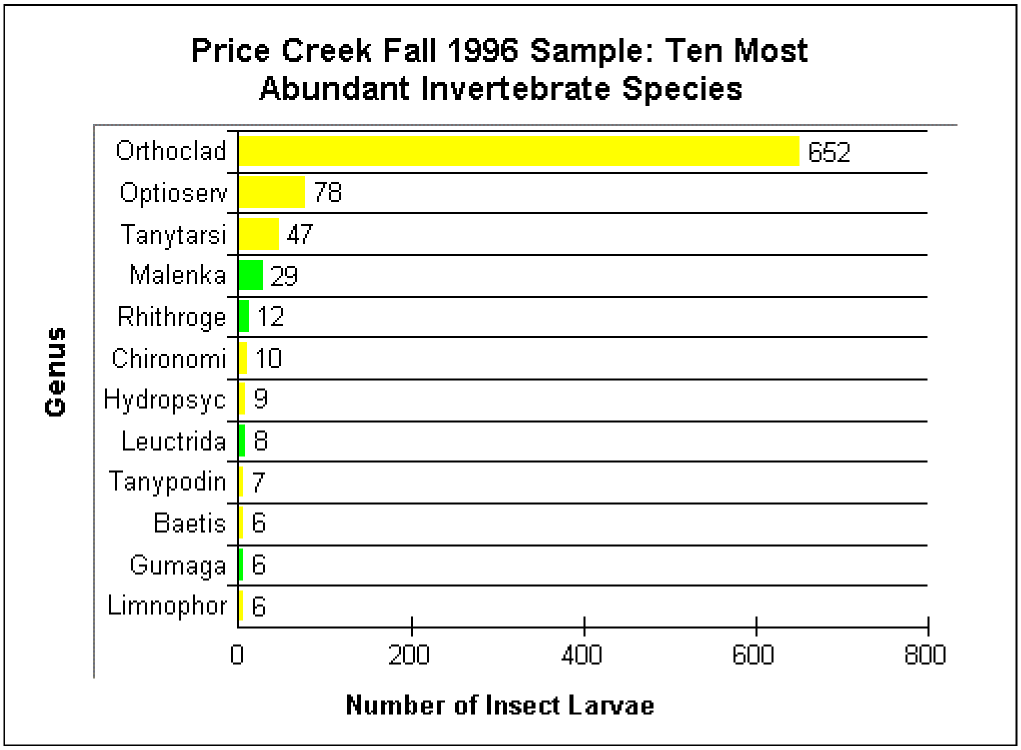


Figure 38. Ten most abundant species of aquatic invertebrates in Price Creek during fall 1996 with tolerance codes in color.

Sub-task 4.4 Education

Although not specifically required by the SWRCB contract, the HCRCD recognized the value of education to help expand the community awareness of water quality issues in this area and, to that end, the HCRCD chose to commit a level of time and effort. Education of the Eel River community is a very important factor in integrating awareness of present water quality conditions with the processes necessary to bring about a positive change in the drainage over time.

The public participation and education within this grant was enhanced through outreach to schools within the Eel River Basin. Public school teachers were contacted by telephone at the beginning of the project, and those who expressed an interest were invited to attend a one-day workshop. (See list of participating teachers above, Task 2)

Ten educators attended the workshop, which was held in April, 1996. Gary Friedrichsen, Patrick Higgins, Diane Higgins and John Lee conducted the training. Teachers saw a slide show about the Eel River, learned the purpose and procedures for the Eel River Water Quality Monitoring Project, learned to use the Hobo-Temp data loggers, practiced collecting aquatic insects, and were introduced to computer programs for handling the temperature and insect data from this project.

In the spring of 1996, visits were made to classrooms to introduce students to the project. In the classroom, students saw a slide show and examined a temperature logger and print-outs of temperature data from several streams. Most classes also went on field trips to near-by streams to collect aquatic insects. Identification of the insects was begun at the streamside, then classes returned to the classrooms to use dissecting microscopes. A few classes placed a temperature logger in their stream.

Classrooms were visited again in the fall of 1997, after the temperature and insect data had been compiled. Presentations included slide show, reviewing graphs summarizing the data and discussion of results.

Each teacher received a packet of materials, including a floppy disk containing all the insect data and summaries of the temperature data. The packet also contained lesson plans for analyzing the data, and several summaries of the data.

Teacher Packet Contents:

- A summary of the findings from the temperature and aquatic insect monitoring projects.
- A lesson for Eel River aquatic insect data analysis including:
    1. Lesson plan (2 pages)
    2. “A Few Eel River Aquatic Insects” illustrations of representative families from each order of insects. (2 pages)
    3. Metric ranking for all streams in both seasons (2 pages)
    4. Comparison of metric values at family and species taxa levels for a sample creek (Baechtel Crk.), (1 page).
    5. Spread sheets for Baechtel Crk, fall and spring. These contain total number of each species present, family and species tolerance values and functional feeding group designations (2 pages).
    6. Metric summary worksheet - Master form (1 page).
    7. California Stream Bioassessment Worksheet (1 page).

- What’s Hot and What’s Not - a lesson plan for summarizing temperature data on a basin, sub-basin, and watershed scale set of maps.
- Lesson plan.
- Map of Eel River Basin showing stream network (1 page)

Information/Data Available to Eel River Teachers Electronically:

- Excel spreadsheets of insect data for each stream in both seasons.
- Excel spreadsheet forms for each stream with insects present, totals, and blank columns for students to enter tolerance values (TV) and functional feeding groups at both family and species levels.
-

All files listed above under What in this Packet? Text files are in Microsoft Word 6.01 format.

This network of cooperating schools will continue to receive support from the HCRCD as funds are secured. All parties involved thus far have enjoyed the work together and look forward to it's continuance.

Task 5 RESTORATION RECOMENDATIONS

Much has been written pertaining to watershed restoration in the Pacific Northwest. The following recommendations are based on the general land stewardship tenants put forth in recent documents such as: The Klamath Long Range Plan (Kier 1991), Healing the Watershed (Pacific Rivers Council, Inc., 1996), An Ecosystem Approach to Salmonid Conservation, "MANTECH", (Spence, et al., 1996).

Intuitively, the most cost effective method of preserving water quality standards in the Eel River system would be the protection of the remaining high quality habitat. The cost of restoration from cumulative impacts of human disturbance and impacts from naturally occurring events has been shown to be prohibitive when viewed as a whole for a drainage the size of the Eel River (Downie 1997). The BLM has estimated that treatments of coastal salmonid systems in northern California and western Oregon have averaged $10,600/mile of stream (House, 1996). Most of the treatments reported included improvement of fish passage, channel stabilization, and construction of side channel habitat for juvenile rearing. An extrapolation of this cost estimate to the Eel River, or the portion in need of repair, would easily run into the tens of millions and this figure excludes the cost of upslope activities which watershed planners have agreed is the most important aspect of habitat recovery (Dopplet 1996).

The HCRCD, in cooperation with other RCDs, agencies, and private landowners concerned with the biological health of the Eel River, is proceeding with restoration planning and implementation. Baseline planning information, such as this temperature study, upland sediment source assessments, and continued habitat typing and biological assessment by CDF&G will continue to play a vital role in the prioritization of these restoration projects.

To manage the information attained thus far, GIS mapping has developed into a very useful tool. The Forest Science Project (FSP), CDF&G, TEAL Data Center, and the USFS Redwood Sciences Laboratory have begun regional mapping of California's north coast river systems. Information for the Eel River has been digitized and will be available for all resource management entities within the year (Mike Byrnes, CDF&G Coastal Watershed Group, personal communication.)

An electronic representation of the Eel River has been symbol coded at stream/river coordinates that correspond to the temperature study sites reported here (Forest Science Project 1998). Available for ESRI software ArcView™ and ArcInfo™, this map displays the stream routes for all sub-basins in the Eel River. Symbols are color coded to represent the highest Maximum Weekly Average Temperature (MWAT[6]).

[6] The Maximum Weekly Average Temperature, MWAT, has received considerable attention of late. Its original function related to identification of healthy/stressful/lethal temperatures with regard to species of anadromous and non-anadromous fish. As researchers debate the usefulness of this parameter watershed planning activities continue and some methodology for ranking temperature data along with other metrics is required. The interpretation used here considers the average of a seven day recording period and assigns the highest averaged temperature as the MWAT for that time period.

1) WHITE = <16.8C (62.2F)---------------------very cold,
2) PURPLE = 16.9C(62.4F)-18.3C(64.9F)------------cold
3) BLUE = 18.4C(65.1F)-22.0C(71.6F)------moderate
4) YELLOW = 22.1C(71.8F)-24.0C(75.2F)----------warm
5) RED = >24.0C(75.4F)-----------------------------hot

The temperature breaks indicated here are not based on thermal studies and their affects on anadromous fish. They are based on arbitrary sorting of these data. The attachment of the subjective epithet (cold, moderate, etc.) was not established by Forest Science Project and is only used here for convenience of discussion.

A note of caution concerning the temperature data reported here is needed before proceeding. These data were gathered over the course of two field seasons by the HCRCD and several cooperators/volunteers. Even with quality assurance guidelines and field placement protocols in place for the duration of the study, limitations to the usefulness of this type of data are a reality that must be identified. Stream temperature(s) taken at one point in a system is indicative of that portion of the stream. For this report, the output from a temperature data logger should reflect the temperature of that thermal reach. (Thermal reach: a is a specific length of stream having homogenous temperature characteristics). Generalizing, extrapolating, or inferring more than is represented can be problematic. The HCRCD requests that this data be used with these limitations in mind.

Tables (1-7) display the MWAT information arranged in tabular form by sub-basins. Streams are listed by the MWAT in a descending order with break points noted at the ranges corresponding to the FSP map plots. For ease of reporting and standardization we have followed similar basin demarcation as used by CDF&G, Bureau of Land Management, and U.S. Forest Service (Six Rivers National Forest) for their "State of the Eel" 1995 public forum Eel Swap. (See map P.13).

1) Lower Mainstem---------- Mouth to the confluence of the South Fork
2) Middle Mainstem--------- Confl. S. Fork upstream to Cape Horn Dam
3) Upper Mainstem---------- Cape Horn Dam-Lake Pillsbury, headwater tribs.
4) Van Duzen------------------ Confluence with Eel River upstream
5) South Fork Eel------------- Confluence with Eel River upstream
6) North Fork Eel------------- Confluence with Eel River upstream
7) Middle Fork Eel------------Confluence with Eel River at Dos Rios upstream

Watersheds and/or streams that presently retain cooler temperatures are reflecting cooler atmospheric and/or orientation ambient factors or have retained enough forest canopy to moderate the summer environmental conditions. Since streams that indicate a lower MWAT are cooler in comparison to their cohorts from the Eel River they would be better candidates for implementation of habitat restoration. These lower MWAT streams would therefore receive higher ranking in the prioritization scheme presented below.

TABLE 1

LOWER MAINSTEM EEL RIVER
(MOUTH T0 CONFLUENCE W/ SOUTH FORK EEL)

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
				VERY COLD		
1552	Eel River Est.	14.0	EEL	Friedrichsen	111.11032	hter01.961
1559	Frances Creek	15.2	EEL	Higgins/Sopjas	111.11030	htfr60.961
1306	Monument Creek	15.8	EEL	Moody/Palco	111.12021	htmt150.961
1523	Chadd Creek	16.0	EEL	Higgins	111.12010	htcc220.961
1330	Shively Creek	16.5	EEL	Moody/Palco	111.12011	htsv150.971
1523	Chadd Creek	16.7	EEL	Friedrichsen	11112010	htcc220.971
1306	Monument Creek	16.8	EEL	Moody/Palco	111.12021	htmt150.971
				COLD		
1322	Newman Creek	16.9	EEL	Moody/Palco	111.41061	htnw150.971
1559	Francis Creek	17.4	EEL	Friedrichsen	11111030	htfr60.971
1293	Strongs Creek	17.6	EEL	Moody/PALCO	11111020	htsg50.971
1607	Price Creek	17.7	EEL	Nakamoto	111.11012	htpr70.961
1507	Bear Creek	18.0	EEL	Noell/ Sal.Forever	111.12011	htbe91.961
1508	Bear Creek	18.1	EEL	Nakamoto	111.12011	htbe90.961
1567	Jordan Crk.	18.2	EEL	Noell/ Sal.Forever	111.12020	htjo80.961
1564	Howe Creek	18.3	EEL	Higgins	111.11011	hthw70.961
				MODERATE		
1508	Bear Creek	19.4	EEL	Friedrichsen	111.12011	htbe90.971
1507	Bear Creek	20.1	EEL	Noell/ Sal.Forever	111.12011	htbe91.971
1567	Jordan Creek	20.3	EEL	Noell/Sal.Forever	11112020	hdjo92.971
234	Eel River	20.5	EEL	Halligan/ NRM	111.11022	hter10.971
211	Eel River	21.5	EEL	Halligan/NRM	111.11022	hter21.961
1642	Steelhead Creek	21.6	EEL	Humphrey/CDFG	111.41032	htsq100.971
202	Eel near 12th St. pool	21.9	EEL	Halligan/ NRM	111.11022	hter19.961
1345	Eel River	22.0	EEL	Moody/PALCO	111.12011	hter50.971
210	Eel @ Sandy Prairie	22.2	EEL	Halligan/ NRM	111.11022	hter18.961
1642	Steelhead Creek	22.2	EEL	Goodfield, CDFG	111.41032	htsq100.961
205	Eel below Van Duzen	22.3	EEL	Halligan /NRM	111.11022	hter29.961
206	Eel (Hansen Bar)	22.4	EEL	Halligan / NRM	111.11021	hter30.961
221	Eel River	22.8	EEL	Halligan/ NRM	111.11021	hter40.971
1555	Eel River @ Dyerville	22.8	EEL	Friedrichsen	11112010	hter110.971
1555	Eel River @ Dyerville	24.1	EEL	Higgins	111.12010	hter110.961

TABLE 2

MIDDLE MAINSTEM EEL RIVER
(SOUTH FORK TO DOS RIOS)

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
				VERY COLD		
1299	Scott Creek	14.4	EEL	Moody/Palco	111.13030	htsx350.961
				COLD		
1640	Sonoma Creek	17.1	EEL	Goodfield/CDFG	111.41051	htsn160.971
1640	Sonoma Creek	17.5	EEL	Goodfield/CDFG	111.41051	htsn160.961
				MODERATE		
1571	Larabee Crk.	18.8	EEL	Friedrichsen	11113010	htla1120.971
1571	Larabee Crk.	18.8	EEL	Friedrichsen	111.13010	htla1120.961
				WARM		
1595	Dobbyns, North	21.6	EEL	Friedrichsen	11141020	htdn420.971
1202	Larabee Creek	21.8	EEL	Moody/Palco	11113030	htla150.971
1595	Dobbyns, North	22.3	EEL	Friedrichsen	111.41020	htdn420.961
1509	Burger Creek	22.9	EEL	Friedrichsen	11142010	htbg850.971
1346	Eel (abv. S. Fork)	23.0	EEL	Moody/Palco	111.41061	hter111.971
1437	Dobbyns Creek	23.1	EEL	Friedrichsen	111.41022	htdo550.971
1202	Larabee Creek	23.3	EEL	Moody/Palco	111.13030	htla150.961
1509	Burger Creek	23.6	EEL	Higgins	111.42010	htbg850.961
1527	Chamise Creek	23.8	EEL	Goodfield/CDFG	111.42052	htcm870.971
				HOT		
1527	Chamise Crk.	24.6	EEL	Goodfield/CDFG	111.42052	htcm870.961
1554	Eel @ Eel Rock	24.9	EEL	Friedrichsen	11141051	hter160.971
236	Eel River	25.5	EEL	Halligan/ NRM	111.41032	hter200.971
235	Eel River	25.5	EEL	Halligan/ NRM	111.41032	hter202.971
1550	Eel River bel. MF	26.0	EEL	Slota/MWA	111.42011	hter880.971
1554	Eel @ Eel Rock	26.2	EEL	Friedrichsen	111.41051	hter160.961
1550	Eel dnstrm of MF	26.6	EEL	Slota/MWA	111.42011	hter880.961

TABLE 3

UPPER MAINSTEM EEL RIVER
(ABOVE DOS RIOS)

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
				VERY COLD		
1626	Ryan Creek	16.5	EEL	Friedrichsen	11161020	htry1350.971
1651	Welsh Creek	16.7	EEL	Brun/USFS	111.63081	htwe1870.961
				COLD		
1627	Ryan Creek	16.9	EEL	Harris/CDFG	111.61020	htry1340.961
1626	Ryan Creek	17.0	EEL	Friedrichsen	111.61020	htry1350.961
1651	Welsh Creek	17.2	EEL	Harris/CDFG	111.63081	htwe1870.971
1652	Willets Creek	18.3	EEL	Friedrichsen	111.61014	htwi1500.971
				MODERATE		
1547	Eel @ Monkey Rock	18.7	EEL	Brun/USFS	111.63093	hter1910.961
1548	Eel abv.Van Arsdale	18.8	EEL	Brun/USFS	111.63094	hter1470.961
1546	Eel@ Cable X Scott Dam	19.0	EEL	Brun/USFS	111.63074	hter1720.961
1631	Soda Creek	19.2	EEL	Scott Harris/CDFG	111.63081	htsd1810.971
1631	Soda Creek	19.5	EEL	Brun/USFS	111.63081	htsd1810.961
1517	Broaddus Creek	19.6	EEL	Friedrichsen	111.61015	htbr1330.961
1515	Bucknell Creek	19.8	EEL	Harris/CDFG	111.63091	htbn1560.971
1605	Panther Creek	19.9	EEL	Harris/CDFG	111.63081	htpa1870.971
1521	Benmore Creek	20.2	EEL	Brun/USFS	111.63092	htbx1680.961
1574	Long Valley Creek	20.3	EEL	Friedrichsen	11161030	htlv1100.971
1519	Baechtel Creek	20.4	EEL	Friedrichsen	111.61015	htbt1330.961
1521	Benmore Creek	20.6	EEL	Harris/CDFG	111.63092	htbx1680.971
1605	Panther Creek	20.6	EEL	Brun/USFS	111.63081	htpa1870.961
1649	Tomki Creek	20.7	EEL	Schott/Mullins	111.62042	htto1860.961
1455	Eel River @ Bloody Rock	20.7	EEL	Harris/CDFG	111.63034	hter2470.971
1515	Bucknel Creek	20.8	EEL	Brun/USFS	111.63091	htbn1560.961
1652	Willits Creek	21.0	EEL	Friedrichsen	111.61014	htwi1500.961
1619	Rice Crk (upper)	21.2	EEL	Brun/USFS	111.63071	htri2030.961
1603	Outlet Creek(Middle)	21.3	EEL	Friedrichsen	111.61022	htou1200.971
1548	Eel abv Van Arsdale	21.5	EEL	Mullin/CDFG	111.63094	hter1470.971
1529	Corbin Creek	21.5	EEL	Brun/USFS	111.63011	htco2660.961
1546	Eel@ Cable X Scott Dam	22.0	EEL	Harris/CDFG	111.63074	hter1720.971
				WARM		
1414	Outlet Creek (Lower)	22.2	EEL	Friedrichsen	111.61034	htou1001.971
1618	Rice Crk (lower)	22.3	EEL	Brun/ Mullins	111.63072	htri1960.961
1603	Outlet (Middle)	22.6	EEL	Higgins	111.61022	htou1200.961
1544	Eel@Inlet Lake Pillsbury	22.6	EEL	Brun / Mullins	111.63040	hter1840.961
1529	Corbin Creek	22.6	EEL	Harris/CDFG	111.63011	htco2660.971

SITE	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
2060	Brushy Creek	22.7	EEL	Nadig / LP	111.62052	htbu1070.961
1574	Long Valley Creek	23.3	EEL	Higgins	111.61030	htlv1100.961
1648	Tomki Creek (Lower)	23.9	EEL	Slota/MWA	111.62031	htto1440.971
1648	Tomki Creek (Lower)	23.9	EEL	Brun / Mullins	111.62031	htto1440.961
1619	Rice Creek (Upper)	23.9	EEL	Harris/CDFG	111.63071	htri2030.971
				HOT		
1545	Eel above Tomki Crk	24.5	EEL	Brun / Mullins	111.62011	hter1200.961
1545	Eel above Tomki Crk	24.7	EEL	Mullin/CDFG	111.62011	hter1200.971
1602	Outlet Creek (Lower)	25.6	EEL	Slota/MWA	111.61034	htou1000.971
1549	Eel upstream from MF	25.9	EEL	Slota/MWA	11162060	hter885.971
1454	Eel River @ Hearst Riffle	25.9	EEL	Slota/MWA	11162020	hter1320.971
1549	Eel upstream from MF	26.4	EEL	Slota/MWA	111.62060	hter885.961
1602	Outlet (Lower)	26.4	EEL	Higgins	111.61034	htou1000.961
1439	Eel River @162 bridge	26.5	EEL	Slota/MWA	111.62052	hter980.971
1452	Eel River (above Outlet)	26.6	EEL	Mullin/CDFG	111.62051	hter1070.971
1403	Eel River @162 bridge	27.4	EEL	Schott/Mullins	111.62052	hter980.961

TABLE 4

VAN DUZEN RIVER

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
				VERY COLD		
1288	Corner Creek	14.5	VDR	Moody (PALCO)	111.23024	htck550.961
1351	Lawrence(Kneeland Br)	14.7	VDR	Moody/Palco	11123020	htln1450.971
1266	Cooper Mill Creek	14.8	VDR	Moody (PALCO)	111.23031	htcp150.961
1341	No Name (2nd order)	14.8	VDR	Moody/Palco	111.13021	htnn1950.971
1561	Fox Creek	14.9	VDR	Cuddyback Schl.	111.21010	htfx0200.961
1317	Bell Creek	14.9	VDR	Moody (PALCO)	111.23024	htbf1350.961
1203	Root Creek	15.3	VDR	Moody (PALCO)	111.22064	htro350.961
1404	Root Creek	15.3	VDR	Harris/Friedrichsen	111.22064	htro0310.961
1308	Cummings Creek	15.6	VDR	Moody (PALCO)	111.21011	htcu450.961
1404	Root Creek	15.6	VDR	Friedrichsen	111.22064	htro310.971
1530	Cummings Creek	16.0	VDR	Friedrichsen	111.21011	htcu0180.961
1531	Cummgins Creek	16.0	VDR	Higgins/Halstead	111.21011	htcu0178.961
1247	Lawrence Creek (@ Bell)	16.2	VDR	Moody/Palco	11123020	htln1150.971
1349	Lawrence Creek (blw Bell)	16.2	VDR	Moody/Palco	11123020	htln1149.971
1203	Root Creek	16.5	VDR	Moody/Palco	111.22064	htro350.971
1240	Shaw Creek	16.5	VDR	Moody/Palco	111.23023	htsh650.971
1266	Cooper Mill Creek	16.5	VDR	Moody/Palco	111.23031	htcp150.971
1312	Hely Creek	16.5	VDR	Moody/Palco	11121010	hthe250.971
1354	Lawrence (belw Booths)	16.5	VDR	Moody/Palco	11123020	htln1049.971
1126	Little Larabee Creek	16.6	VDR	Horner/Barnum	111.22054	htll840.971
1353	Lawrence (above Booths)	16.7	VDR	Moody/Palco	11123020	htln1051.971
1530	Cummings Creek	16.7	VDR	Friedrichsen	111.21011	htcu180.971
				COLD		
1343	Bell Creek@ Lawrence	17.2	VDR	Moody/Palco	11123020	htbl1151.971
1347	Lawrence (blw Shaw)	17.9	VDR	Moody/Palco	11123020	htln556.971
1355	Lawrence Creek(gorge)	18.1	VDR	Moody/Palco	11123020	htln1050.971
1250	Lawrence(below Corner)	18.3	VDR	Moody/Palco	111.23024	htln552.971
				MODERATE		
1465	Grizzly Creek	18.4	VDR	Friedrichsen	111.22062	htgz349.971
1248	Lawrence Creek	18.8	VDR	Moody/Palco	111.23022	htln650.971
1251	Lawrence Creek	18.8	VDR	Moody/Palco	111.23024	htln551.971
1344	Lawrence (abv Corner)	19.1	VDR	Moody/Palco	11123024	htln554.971
1432	Butte Creek	19.1	VDR	Friedrichsen	111.22043	htbz2350.971
1573	Little Larabee Creek	19.1	VDR	Friedrichsen	111.22054	htll640.971
1327	Thompson Creek	19.2	VDR	Moody/Palco	11141060	htts150.971
1423	Lawrence Creek (AIR)	19.2	VDR	Moody/Palco	111.23024	htln553.971
1311	Grizzly Creek	19.3	VDR	Moody/Palco	111.22062	htgz350.971

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
1342	Lawrence (abv Shaw)	19.4	VDR	Moody/Palco	111.23024	htln557.971
1209	Lawrence @ Confluence	19.5	VDR	Moody/Palco	111.23024	htln450.971
1249	Lawrence Creek	19.5	VDR	Moody/Palco	111.23024	htln558.971
1253	Lawrence Creek	19.8	VDR	Moody/Palco	11123024	htln510.971
1573	Little Larabee Creek	20.0	VDR	Bridgeville Schl.	111.22054	htll0640.961
1361	Yager (below Lawrence)	20.2	VDR	Moody/Palco	11123024	htya445.971
209	Van Duzen River	20.5	VDR	Halligan/ NRM	111.21012	htvd60.971
1406	Little Van Duzen/ SF VDR	20.9	VDR	Friedrichsen	111.22042	htlx2320.971
226	VDR 1 Mi above 101 Br.	21.1	VDR	Halligan / NRM	111.11021	htvd70.961
1252	Lawrence Creek	21.2	VDR	Moody/Palco	111.23024	htln550.971
1285	Yager Creek	21.2	VDR	Moody (PALCO)	111.23031	htya150.961
1360	Yager (abv Lawrence)	21.3	VDR	Moody/Palco	111.23024	htya470.971
1406	Little Van Duzen/S.F. VDR	21.4	VDR	Friedrichsen	111.22042	htlx2320.961
219	Van Duzen River	21.5	VDR	Halligan/ NRM	111.11021	htvd120.971
208	VDR 1.25 mi above 101 Br.	21.6	VDR	Halligan/ NRM	111.11021	htvd75.961
				HOT		
1405	Van Duzen @ Root Creek	22.5	VDR	Friedrichsen	111.22064	htvd310.971
220	Van Duzen River	22.6	VDR	Halligan/ NRM	111.11021	htvd115.971
1405	Van Duzen @ Root Creek	22.6	VDR	Harris/Friedrichsen	111.22064	htvd0310.961
1650	Van Duzen @ Dinsmore	23.5	VDR	Friedrichsen	111.22031	htvd2660.961

TABLE 5

SOUTH FORK EEL RIVER

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
				VERY COLD		
1780	Dutch Charlie Creek	13.5	SF EEL	Hines/ G P Timber	111.33034	htdc1615.971
1783	Coulborn Creek	14.4	SF EEL	Hines/ G P Timber	111.32053	htcb760.971
1612	Redwood Crk @ Bran.Dump	14.6	SF EEL	Noell/Sal.Forever	11133034	htrc1550.961
1480	Misery Crk, (Elder Crk)	14.9	SF EEL	Friedrichsen/ Steel	111.33042	htms1980.971
1779	Redwood Creek, Branscomb	14.9	SF EEL	Hines/ G P Timber	111.33034	htrc1515.971
1430	Burns Crk, South Fork	15.0	SF EEL	Dunklin ,HSU	111.31032	htbs1040.971
1472	Harper Crk, EF	15.2	SF EEL	Dunklin, HSU	111.31032	htha497.971
1612	Redwood Crk @Bran.Dump	15.2	SF EEL	Friedrichsen	111.33034	htrc1550.971
1469	Harper Creek	15.3	SF EEL	Dunklin, HSU	111.31032	htha488.971
1785	Lampkins Creek	15.3	SF EEL	Hines/ G P Timber	111.32054	htlp750.971
1468	Harper Creek	15.4	SF EEL	Dunklin, HSU	111.31032	htha400.971
1108	Sproul W. Branch WF	15.5	SF EEL	Horner/Barnum	11132070	htsr720.971
1116	Coulborn Creek	15.5	SF EEL	Horner/Barnum	111.32053	htcb800.971
1782	Anderson Creek	15.5	SF EEL	Hines/ G P Timb	111.32053	htan825.971
1105	Sproul, No name	15.9	SF EEL	Horner/Barnum	11132070	htnn640.971
1456	Elder Creek (# 1)	15.9	SF EEL	Friedrichsen/ Steel	111.33042	hted1880.971
1591	Mill Creek (Leggett)	15.9	SF EEL	Goodfield/CDFG	111.32041	html680.961
1613	Redwood Crk. (Branscomb)	15.9	SF EEL	Goodfield/CDFG	111.33034	htrc1460.961
1781	Indian Ck. abv Anderson Crk	15.9	SF EEL	Hines/G P Timber	111.32053	htin820.971
2034	Michael's Creek	15.9	SF EEL	Nadig/L.P.	111.32030	htme1370.961
1775	Moody Creek	16.0	SF EEL	Hines/G.P. Timb	111.32054	htmo720.971
1591	Mill Creek (Leggett)	16.1	SF EEL	Goodfield/CDFG	111.32041	html680.971
1117	Sebbas Creek	16.2	SF EEL	Hines/G P Timb	111.32053	htsb700.971
1467	Harper Creek	16.2	SF EEL	Dunklin, HSU	111.31032	htha260.971
1775	Moody Creek	16.2	SF EEL	Hines/G.P. Timb	111.32054	htmo720.961
2032	Bond Creek	16.2	SF EEL	Nadig / LP	111.32031	htbo1180.961
1305	Cow Creek	16.3	SF EEL	Moody/Palco	11131030	htcw150.971
1305	Cow Creek	16.4	SF EEL	Moody (PALCO)	111.31030	htcw200.961
1532	Cow Creek	16.4	SF EEL	Jones/Cabrera	111.31030	htcw190.961
1457	Elder Creek (# 2)	16.5	SF EEL	Friedrichsen/ Steel	111.33042	hted1750.971
1784	Sebbas Creek	16.5	SF EEL	Horner/Barnum	111.32053	htsb760.971
1302	Squaw Creek	16.6	SF EEL	Moody/Palco	111.31032	htsw240.971
1435	Cow Creek	16.6	SF EEL	Dunklin, HSU	11131030	htcw205.971
1458	Elder Creek (# 3)	16.6	SF EEL	Friedrichsen/ Steel	111.33042	hted1550.971
1412	Pollock Creek	16.7	SF EEL	Goodfield/CDFG	111.32081	htpo671.971
1429	Burns Crk, North Fork	16.7	SF EEL	Dunklin, HSU	111.31032	htbs840.971
1466	Harper Creek	16.7	SF EEL	Dunklin, HSU	111.31032	htha250.971

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
1433	Cedar Creek	16.8	SF EEL	Noell/Sal.Forever	111.32024	htce1480.971
1464	Rock Creek @ Leggett	16.8	SF EEL	Noell/Sal.Forever	11132040	htrk960.971
1566	Jack of Hearts Creek	16.8	SF EEL	Friedrichsen	111.33041	htja1400.971
				COLD		
1566	Jack of Hearts Creek	16.9	SF EEL	Goodfield/CDFG	111.33041	htja1400.961
1540	Elder Creek (# 4)	17.0	SF EEL	Friedrichsen/ Steel	111.33042	hted1440.971
1303	Canoe Creek	17.1	SF EEL	Moody/Palco	111.31012	htca150.971
1577	Mud Creek	17.1	SF EEL	Friedrichsen	111.33031	htmd1590.971
1773	Wildcat Creek	17.1	SF EEL	Hines/G P Timer	111.32042	htsw600.961
1427	Burns Creek	17.2	SF EEL	Dunklin, HSU	111.31032	htbs830.971
1431	Burns Crk, South Fork	17.2	SF EEL	Dunklin, HSU	111.31032	htbs850.971
1479	Paralyze Creek	17.3	SF EEL	Friedrichsen/Steel	111.33042	htpy1880.971
1772	Piercy Creek	17.3	SF EEL	Terwilliger/CDFG	111.32052	htpi500.961
1407	Sproul Creek	17.4	SF EEL	Goodfield/CDFG	111.32062	htsr520.971
1412	Pollock Creek	17.4	SF EEL	Goodfield/CDFG	111.32081	htpo671.961
1534	Dutch Charlie Creek	17.4	SF EEL	Friedrichsen	111.33034	htdc1400.971
1525	China Creek	17.5	SF EEL	Goodfield/CDFG	111.32081	htch670.971
1533	Dutch Charlie Creek	17.5	SF EEL	Noell/Sal.Forever	111.33034	htdc1430.961
1534	Dutch Charlie Creek	17.5	SF EEL	Goodfield/CDFG	111.33034	htdc1400.961
1576	McCoy Creek	17.5	SF EEL	Goodfield/CDFG	11132050	htmc540.971
1576	McCoy Creek	17.5	SF EEL	Goodfield/CDFG	111.32050	htmc540.961
1409	Sproul Ck. West Fork	17.6	SF EEL	Goodfield/CDFG	11132070	htsr530.971
1460	Elder Creek (# 5)	17.6	SF EEL	Friedrichsen/ Steel	111.33042	hted1400.971
1477	Little Sproul Creek	17.7	SF EEL	Goodfield/CDFG	111.32071	hdls420.971
1606	Piercy Creek	17.7	SF EEL	Hines/G.P. Timber	111.32052	htpi520.961
1409	Sproul, WF	17.8	SF EEL	Goodfield/CDFG	111.32070	htsr530.961
1461	Elder Creek (# 6)	17.8	SF EEL	Friedrichsen	111.33042	hted1390.971
1522	Canoe Creek	17.8	SF EEL	Nakamoto/USFS	111.31012	htca170.961
1636	SF Eel @ Branscomb	17.8	SF EEL	Noell/Sal.Forever	111.33031	htsf1550.961
1658	SF Eel @ Branscomb	17.8	SF EEL	Friedrichsen	111.33031	htsf1530.971
1773	Wildcat Creek	17.8	SF EEL	Hines/G P Timber	111.32042	htwc600.971
1774	Standley Creek	17.8	SF EEL	Hines/G P Timber	111.32051	htss560.971
1776	Bear Pen Crk	17.8	SF EEL	Hines/GP Timber	111.32044	htbp550.961
1303	Canoe Creek	17.9	SF EEL	Moody/PALCO	111.31012	htca169.961
1516	Bear Pen Crk.	17.9	SF EEL	Noell/Sal.Forever	111.32044	htbp870.961
1541	Elk Creek (Miranda)	17.9	SF EEL	Goodfield/CDFG	111.31011	htek180.971
1541	Elk Creek	18.0	SF EEL	Nakamoto/USFS	111.31011	htek180.961
1774	Standley Creek	18.0	SF EEL	Hines/GP Timber	111.32051	htss560.961
1776	Bear Pen Creek	18.0	SF EEL	Hines/GP Timber	111.32044	htbp550.971

1540	Elder Creek	18.1	SF EEL	Goodfield/CDFG	111.33042	hted1440.961
1447	Cuneo Crk, NF	18.3	SF EEL	Dunklin/HSU	111.31032	htcn535.971
1658	SF Eel @ Branscomb	18.3	SF EEL	Goodfield/CDFG	111.33031	htsf1530.961
SITE_ID	**CREEK**	**MWAT**	**BASIN**	**SURVEYOR**	**CALWATER**	**TXT FILE**
1786	Indian Crk b Little Manus Ck	18.3	SF EEL	Hines/G P Timber	111.32054	htin700.971
				MODERATE		
1528	Cuneo Creek	18.4	SF EEL	Nakamoto/USFS	111.31032	htcn400.961
1572	Leggett Creek (Upper)	18.4	SF EEL	Goodfield/CDFG	111.32084	htlg390.961
1577	Mud Creek	18.4	SF EEL	Noell/Sal.Forever	111.33031	htmd1590.961
1450	Cuneo Creek	18.5	SF EEL	Dunklin/HSU	111.31032	htcn590.971
1632	Seely Crk. @ Redwood	18.6	SF EEL	Noell/Sal.Forever	111.32082	htse480.961
1572	Leggett Creek	18.7	SF EEL	Goodfield/CDFG	111.32084	htlg390.971
1411	Little Sproul Creek	18.8	SF EEL	Goodfield/CDFG	111.32071	htls460.971
1424	Burns Creek	18.8	SF EEL	Dunklin/HSU	111.31032	htbs560.971
1445	Cuneo Creek	18.8	SF EEL	Dunklin/HSU	111.31032	htcn520.971
1448	Cuneo Creek	18.8	SF EEL	Dunklin/HSU	111.31032	htcn580.971
1525	China Creek	18.8	SF EEL	Goodfield/CDFG	111.32081	htch670.961
1446	Cuneo Creek	18.9	SF EEL	Dunklin/HSU	111.31032	htcn534.971
1592	Mill Creek (Salmon)	18.9	SF EEL	Goodfield/CDFG	111.31012	htmi280.971
1411	Little Sproul Creek	19.2	SF EEL	Goodfield/CDFG	111.32071	htls460.961
1476	Leggett Creek	19.2	SF EEL	Goodfield/CDFG	111.32084	htlg270.971
1524	Cedar Creek	19.2	SF EEL	Nakamoto/USFS	111.32024	htce780.961
1451	Cuneo Crk, SF	19.3	SF EEL	Dunklin/HSU	111.31032	htcn595.971
1407	Sproul Creek	19.5	SF EEL	Goodfield/CDFG	111.32062	htsr520.961
1408	Sproul Crk Camp Wirta	19.5	SF EEL	Goodfield/CDFG	111.32071	htsr460.961
1518	Burns Creek	19.5	SF EEL	Jones/Cabrera	111.31032	htbs0470.961
1592	Mill Creek (Salmon)	19.6	SF EEL	Goodfield/CDFG	111.31012	htmi280.961
1463	Elk Crk., (Rattlesnake)	19.7	SF EEL	Goodfield/CDFG	111.32012	htec1400.971
1646	Ten Mile Creek (Upper)	19.7	SF EEL	Friedrichsen	11133010	httm1700.971
1408	Sproul Crk Camp Wirta	19.8	SF EEL	Goodfield/CDFG	111.32071	htsr460.971
1453	Cuneo Crk, SF	19.8	SF EEL	Dunklin/HSU	111.31032	htcn755.971
1337	Cuneo Creek	19.9	SF EEL	Moody/Palco	111.31032	htcn650.971
1608	Rattlesnake @ Bell Springs	20.0	SF EEL	Noell/Sal.Forever	111.32012	htra1355.971
1511	Bull Creek	20.1	SF EEL	Dunklin, HSU	111.31032	htbl390.971
1611	Rattlesnake Creek	20.1	SF EEL	Goodfield/CDFG	111.32012	htra1400.961
1413	Sproul Creek	20.4	SF EEL	Nakamoto/USFS	111.32071	htsr360.961
1413	Sproul Creek	20.4	SF EEL	Goodfield/CDFG	111.32071	htsr360.971
1419	Bull Creek	20.4	SF EEL	Dunklin, HSU	111.31032	htbl394.971
1558	Foster Creek	20.4	SF EEL	Goodfield/CDFG	111.32013	htfo1180.961
1635	SF Eel below Elder	20.4	SF EEL	Noell/Sal.Forever	111.33042	htsf1150.961
1646	Ten Mile Crk (Laytonville)	20.4	SF EEL	Nightgoose	111.33010	httm1700.961

1542	Elk Crk. (Rattlesnake)	20.5	SF EEL	Goodfield/CDFG	111.32012	htec1280.971
1513	Bull Creek	20.6	SF EEL	Nakamoto/USFS	111.31030	htbl110.961
1565	Indian Creek	20.6	SF EEL	Nakamoto/USFS	111.32054	htin510.861
1608	Rattlesnake @ Bell Springs	20.6	SF EEL	Noell/Sal.Forever	111.32012	htra1355.961
1657	SF Eel above Elder	20.6	SF EEL	Friedrichsen	111.33042	htsf1200.971
SITE_ID	**CREEK**	**MWAT**	**BASIN**	**SURVEYOR**	**CALWATER**	**TXT FILE**
1524	Cedar Creek	20.7	SF EEL	Noell/Sal.Forever	111.32024	htce780.971
1426	Burns Creek	20.8	SF EEL	Dunklin, HSU	111.31032	htbs720.971
1575	Low Gap Crk (Piercy)	20.8	SF EEL	Noell/Sal.Forever	11132022	htlw540.961
1417	Bull Creek	20.9	SF EEL	Dunklin, HSU	11131030	htbl116.971
1440	Cuneo Crk, SF	20.9	SF EEL	Dunklin, HSU	111.31032	htcn1080.971
1518	Burns Creek	20.9	SF EEL	Dunklin, HSU	111.31032	htbs470.971
1558	Foster Creek	21.0	SF EEL	Goodfield/CDFG	111.32013	htfo1220.961
1463	Elk Crk, (Rattlesnake)	21.0	SF EEL	Goodfield/CDFG	111.32012	htec1400.961
1542	Elk Crk (Rattlesnake)	21.1	SF EEL	Goodfield/CDFG	111.32012	htec1280.961
1557	Foster Creek	21.1	SF EEL	Goodfield/CDFG	111.32013	htfo1220.971
1441	Cuneo Crk, SF	21.3	SF EEL	Dunklin, HSU	111.31032	htcn1240.971
1590	Mill Creek	21.4	SF EEL	Jones/Cabrera	111.31032	html330.961
1617	Redwood Creek	21.4	SF EEL	Goodfield/CDFG	111.32081	htre500.961
1609	Rattlesnake Creek	21.5	SF EEL	Noell/Sal.Forever	111.32013	htra1080.971
1630	Salmon Creek, So. Fk.	21.5	SF EEL	Goodfield/CDFG	11131020	htsc200.971
1535	Dean Creek	21.6	SF EEL	Goodfield/CDFG	111.32083	htde400.961
1621	Red Mountain Creek	21.6	SF EEL	Goodfield/CDFG	111.32044	htrm550.961
1778	Hollow Tree Creek (Lower)	21.6	SF EEL	Hines/G.P. Timber	111.32032	htho800.961
1565	Indian Creek (Lower)	21.9	SF EEL	Hines/G P Timber	111.32054	htin510.971
1628	Salmon Creek	21.9	SF EEL	Goodfield/CDFG	111.31012	htsa200.971
1778	Hollow Tree Creek (Lower)	21.9	SF EEL	Hines/ G P Timber	111.32032	htho800.971
1449	Cuneo Creek	22.0	SF EEL	Dunklin, HSU	111.31032	htcn585.971
1563	Hollow Tree Creek	22.0	SF EEL	Nakamoto/USFS	111.32032	htho750.961
				WARM		
1562	Hollow Tree Crk.	22.2	SF EEL	Noell/Sal.Forever	111.32032	htho740.961
1609	Rattlesnake @ Cummings	22.2	SF EEL	Noell/Sal.Forever	111.32013	htra1080.961
1512	Bull Creek	22.3	SF EEL	Jones/Cabrera	111.31032	htbl391.961
1637	SF Eel @ Piercy Crk.	22.5	SF EEL	Terwilliger/CDFG	111.32052	htsf500.961
1538	East Branch	22.7	SF EEL	Goodfield/CDFG	111.32062	hteb850.971
1610	Rattlesnake Creek	22.7	SF EEL	Goodfield/CDFG	111.32013	htra870.971
1610	Rattlesnake Creek	22.8	SF EEL	Nakamoto/USFS	111.32013	htra870.961
1616	Redwood Creek	22.8	SF EEL	Nakamoto/USFS	111.32081	htre310.961
1535	Dean Creek	22.9	SF EEL	Nakamoto/USFS	111.32083	htde280.961
1614	Redwood Crk. (Wally's)	23.0	SF EEL	Noell/Sal.Forever	111.32082	htre340.971
1539	East Branch	23.1	SF EEL	Goodfield/CDFG	111.32065	hteb410.961

1538	East Branch	23.2	SF EEL	Goodfield/CDFG	111.32062	hteb850.961
1621	Red Mountain Creek	23.2	SF EEL	Goodfield/CDFG	111.32044	htrm550.971
1630	Salmon Creek, So. Fk.	23.3	SF EEL	Goodfield/CDFG	111.31020	htsc200.961
1629	Salmon Creek (Miranda)	23.4	SF EEL	Goodfield/CDFG	111.31021	htsa380.971
1633	SF Eel @ Dyerville bridge	23.4	SF EEL	Friedrichsen	11112010	htsf112.971
1647	Ten Mile Crk.(lower near SF)	23.4	SF EEL	Friedrichsen/ Steel	111.33023	httm1210.971
1637	SF Eel @ Piercy Crk.	23.6	SF EEL	Goodfield/CDFG	111.32052	htsf500.971
SITE_ID	**CREEK**	**MWAT**	**BASIN**	**SURVEYOR**	**CALWATER**	**TXT FILE**
1416	SF Eel @ Piercy	23.8	SF EEL	Noell/Sal.Forever	11132050	htsf445.971
1628	Salmon Creek	23.8	SF EEL	Nakamoto/USFS	111.31012	htsa200.961
1647	Ten Mile Crk (lower near SF)	23.8	SF EEL	Nightgoose	111.33023	httm1210.961
1614	Redwood Crk, (Wally's)	23.9	SF EEL	Goodfield/CDFG	111.32082	htre340.961
1644	Ten Mile Crk Lower Streeter	23.9	SF EEL	Nightgoose	111.33021	httm1440.961
				HOT		
1536	Dean Creek	24.2	SF EEL	Goodfield/CDFG	111.32083	htde280.971
1645	Ten Mile Creek (upper)	24.2	SF EEL	Nightgoose	111.33023	httm1230.961
1638	SF (Above Rattlesnake Crk)	24.3	SF EEL	Goodfield/CDFG	111.32021	htsf850.971
1644	Ten Mile Creek @ Streeter	24.4	SF EEL	Friedrichsen	111.33021	httm1440.971
1537	East Branch	24.5	SF EEL	Nakamoto/USFS	111.32065	hteb380.961
1539	East Branch	24.5	SF EEL	Goodfield/CDFG	111.32065	hteb410.971
1634	SF Eel @ Sylvandale	24.5	SF EEL	Friedrichsen	111.32085	htsf270.971
1638	SF Eel (Abv Rattlesnake)	24.6	SF EEL	Goodfield/CDFG	111.32021	htsf850.961
1444	Cuneo Creek	24.7	SF EEL	Dunklin/HSU	111.31032	htcn445.971
1633	SF Eel @ Dyerville bridge	24.8	SFEEL	Higgins	111.12010	htsf112.961
1415	SF Miranda Bridge	25.0	SF EEL	Goodfield/CDFG	111.31012	htsf190.971
1629	Salmon Creek (Miranda)	25.1	SF EEL	Goodfield/CDFG	111.31021	htsa380.961
1634	SF Eel @ Sylvandale	27.2	SF EEL	Higgins	111.32085	htsf270.961

TABLE 6

NORTH FORK EL RIVER

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
				COLD		
1501	Asbill Creek	17.0	NF EEL	Hodson/Asbill USFS	111.50063	htas990.971
1501	Asbill Creek	17.0	NF EEL	RoundValleyTribes	111.50063	htas990.961
2025	Hulls Creek (Lower)	17.6	NF EEL	Nadig / LP	111.50012	hthu2550.961
2027	Who Who Creek	17.6	NF EEL	Nadig/ LP	111.50012	htwh2560.961
1410	Cox Creek	17.9	NF EEL	Friedrichsen	111.50034	htcx1840.971
1655	Bradburn Creek	17.9	NF EEL	Wolff USFS	111.50031	htbd2110.971
				MODERATE		
1410	Cox Creek	18.4	NF EEL	Friedrichsens	111.50034	htcx1840.961
1506	Bradburn Creek	18.9	NF EEL	Humphrey/CDFG	111.50031	htbd2390.961
2024	Pepperwood Creek	19.3	NF EEL	Nadig / LP	111.50011	htpw2845.961
2022	Bear Canyon Creek	20.0	NF EEL	Nadig/ LP	111.50062	htbc1560.961
1599	NF Eel West Fork	20.4	NF EEL	Wolff/USFS Mad R.	11150030	htnf2110.971
1599	NF Eel West Fork	21.0	NF EEL	Dresser/USFS Mad R.	11150030	htnf2110.961
1600	NF Eel West Fork	21.2	NF EEL	Humphrey/CDFG	11150030	htnf2100.961
1487	NF Eel East Fork	21.7	NF EEL	Wolff USFS Mad R.	111.50031	htnf2120.971
1438	Wilson Creek	21.8	NF EEL	Hodson/USFS Covelo	111.50033	htws880.971
1570	Kettenpom Creek	21.8	NF EEL	Friedrichsens	111.50033	htke2385.961
1620	Rock Creek	21.8	NF EEL	Friedrichsens	111.50040	htrk1760.961
				WARM		
1597	NF abv. Kettenpom Crk	22.7	NF EEL	Dresser/USFS Mad R.	111.50032	htnf1950.961
2023	Hulls Creek (Upper)	22.8	NF EEL	Nadig/ LP	111.50011	hthu2840.961
1615	Red Mountain Creek	22.9	NF EEL	Dresser/USFS Mad R.	111.50022	htrm1480.961
1653	Yellow Jacket Creek	23.0	NF EEL	Friedrichsen	111.50034	htyj1800.971
1597	NF abv. Kettenpom Crk	23.4	NF EEL	Wolff USFS Mad R	111.50032	htnf1950.971
1596	NF abv. Kettenpom Crk	23.5	NF EEL	Dresser/USFS Mad R.	111.50032	htnf1960.961
1569	Kettenpom Creek	23.7	NF EEL	Humphrey/CDFG	111.50033	htke1230.961
1639	Salt Creek	24.0	NF EEL	Friedrichsen	111.50050	htsl1860.961
1653	Yellow Jacket Creek	24.0	NF EEL	Friedrichsens	111.50034	htyj1800.961
				HOT		
1596	NF abv. Kettenpom Crk	24.3	NF EEL	Wolff USFS Mad R	111.50032	htnf1960.971
1659	NF Eel above Salt Creek	24.3	NF EEL	Friedrichsen	11150050	htnf1870.971
1656	NF Eel below Salt Creek	24.7	NF EEL	Wolff/ A Bowen FS	11150030	htnf1860.971
1598	NF below Salt Creek(1)	25.7	NF EEL	Dresser/USFS Mad R.	111.50031	htnf1990.961
1485	NF Eel @ Mina Bridge	26.0	NF EEL	Hodson/Azbill USFS	11150060	htnf1020.971
1601	NF Eel River	27.2	NF EEL	RoundValleyTribes	111.50060	htnf1000.961

TABLE 7

MIDDLE FORK EEL RIVER

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
				VERY COLD		
2067	Smokehouse Creek	14.3	MF EEL	Nadig / LP	111.63050	HTSM3520.961
				COLD		
1502	Baldy Creek	17.8	MF EEL	Burgess/Furrer USFS	111.73021	htba2800.971
1622	MF Eel @ Robinson	17.9	MF EEL	Widman/Wallace FS	111.74011	htmf5082.971
1654	Black Butte (upper)	17.9	MF EEL	Burgess/Furrer USFS	111.73021	htbb3360.971
1520	Beaver Creek	18.2	MF EEL	Jones/Widman/Brun	111.74040	HTBV2360.961
1526	Cold Creek	18.2	MF EEL	Furrer/Avila	111.73020	HTCL2520.961
				MODERATE		
1502	Baldy Creek	18.4	MF EEL	Furrer/Avila	111.73021	HTBA2800.961
1581	MF Eel @ Fern Pt. Pool	18.4	MF EEL	Harris CDFG	111.74031	htmf3894.971
1520	Beaver Creek	18.7	MF EEL	Harris/CDFG	11174040	htbv2360.971
1641	Spanish Creek	18.7	MF EEL	Hodson/Furrer/Avila	111.73011	HTSP3320.961
1526	Cold Creek	18.8	MF EEL	Hodson/Azbill USFS	11173020	htcl2520.971
1556	Fly Creek	19.0	MF EEL	Jones/Brun/Widman	111.74041	HTFL2120.961
1593	Mendenhall Creek	19.0	MF EEL	Hodson/Burgess	111.71011	HTMN2630.961
2064	Crocker Creek	19.0	MF EEL	Nadig / LP	111.71012	HTCR3120.961
1587	MF, @ WrightsVl.bel.falls	19.1	MF EEL	Widman/Ryan	111.74012	HTMF3861.961
1402	Buckhorn Creek	19.2	MF EEL	Burgess/Furrer USFS	111.73021	htbk2880.971
1402	Buckhorn Creek	19.2	MF EEL	Hodson/Furrer/Burgess	111.73021	HTBK2880.961
1504	Black Butte (upper)	19.3	MF EEL	Hodson/Furrer/Avila	111.73021	HTBB3380.961
1593	Mendenhall Creek	19.4	MF EEL	Hodson/Burgess FS	111.71011	htmn2630.971
1587	MF @ WrightsVl.bel.falls	19.5	MF EEL	Hodson/Widman FS	111.74012	htmf3861.971
2065	Sulphur Springs Creek	19.6	MF EEL	Nadig /LP	111.71012	HTSU2560.961
1585	MF Eel, North Fork	19.7	MF EEL	Jones/Brun/Widman	111.74022	HTMF1080.961
1589	Willow Creek	19.7	MF EEL	Burgess/Avila USFS	111.74021	htww1220.971
1568	Jumpoff Creek	19.8	MF EEL	Hodson/Furrer USFS	111.73042	htju1640.971
1585	MF Eel, North Fork	19.9	MF EEL	Harris/CDFG	111.74022	htmf1080.971
1623	Rattlesnake Creek, MF	19.9	MF EEL	Jones/Brun/Widman	111.74030	HTRA2870.961
1514	Balm of Gilead Creek	20.0	MF EEL	Hodson/Widman FS	111.74014	htbm4300.971
1514	Balm of Gilead Creek	20.0	MF EEL	Widman/Ryan	111.74014	HTBM2800.961
1589	Willow Crk @MF. NF	20.0	MF EEL	Widman/Ryan	111.74021	htww1220.961
1623	Rattlesnake Creek	20.3	MF EEL	Harris/CDFG	11174030	htrt2870.971
1581	MF Eel @ Fern Pt Pool	20.4	MF EEL	Jones/Brun/Widman	111.74031	HTMF3894.961
1582	MF Eel @ Fern Pt Riffle	20.6	MF EEL	Jones/Brun/Widman	111.74031	HTMF3895.961
1582	MF Eel @ Fern Pt. Riffle	20.7	MF EEL	Harris/CDFG	111.74031	htmf3895.971
1588	MF, @ WrightsVl.abv.falls	20.8	MF EEL	Hodson/Widman FS	111.74012	htmf4158.971
1588	MF, @ WrightsVl.abv.falls	20.9	MF EEL	Widman/Ryan	111.74012	HTMF4158.961

SITE_ID	CREEK	MWAT	BASIN	SURVEYOR	CALWATER	TXT FILE
1503	Black Butte (middle)	21.1	MF EEL	Avila/Azbill/Hodson FS	11173040	htbb2230.971
SITE_ID	**CREEK**	**MWAT**	**BASIN**	**SURVEYOR**	**CALWATER**	**TXT FILE**
1503	Black Butte (middle)	21.2	MF EEL	Hodson/Burgess	111.73040	HBBI2230.961
1624	Rattlesnake Pool	21.2	MF EEL	Jones/Brun/Widman	111.74030	HTRA3000.961
2028	Murphy Creek	21.4	MF EEL	Nadig/L.P.	111.72011	HTMU1920.961
1568	Jumpoff Creek	21.7	MF EEL	Furrer/Burgess	111.73042	HTJU1640.961
1583	MF Eel @ Osborn Pool	21.8	MF EEL	Harris/CDFG	111.74042	htmf2151.971
1583	MF Eel @ Osborn Pool	21.8	MF EEL	Jones/Brun/Widman	111.74042	HTMF2151.961
1584	MF Eel @ Osborn Riffle	21.8	MF EEL	Jones/Brun/Widman	111.74042	HTMF2150.961
1624	Rattlesnake Pool	21.8	MF EEL	Harris/CDFG	11174030	htrt3000.971
1625	Rattlesnake Riffle	21.8	MF EEL	Jones/Brun/Widman	111.74030	HTRA3001.961
1584	MF Eel @ Osborn Riffle	22.0	MF EEL	Harris/CDFG	111.74042	htmf2150.971
				WARM		
1586	MF Eel (upper)	22.3	MF EEL	Widman/Ryan	111.74011	HTMF4160.961
1625	Rattlesnake Riffle	22.3	MF EEL	Harris/CDFG	11174030	htrt3001.971
2043	Eastman Creek	22.5	MF EEL	Nadig / LP	111.71044	HTEA920.961
1622	MF Eel @ Robinson	24.0	MF EEL	Widman/Ryan/Hurt	111.74011	HTMF5082.961
				HOT		
2047	Salt Creek	24.3	MF EEL	Nadig / LP	111.71043	HTST1030.961
1578	MF Eel above Black Butte	24.5	MF EEL	Hodson/USFS Covelo	111.74043	htmf1470.971
1643	Thatcher Creek	24.5	MF EEL	Burgess/Furrer	111.71033	HTTH1160.961
1578	MF Eel above Black Butte	24.7	MF EEL	Brun/Jones	111.74043	HTMF1470.961
1505	Black Butte (lower)	25.0	MF EEL	Harris/CDFG	111.73043	htbb1460.971
1594	Mill Creek (upper)	25.0	MF EEL	Higgins/Ray	111.72040	HTMP1440.961
1543	Elk Creek, MF	25.4	MF EEL	Furrer/Burgess	111.71025	HTEK1150.961
1643	Thatcher Creek	25.5	MF EEL	Burgess/Furrer USFS	111.71033	htth1160.971
1505	Black Butte (lower)	25.7	MF EEL	Hodson/Smith	111.73043	HTBB1460.961
1543	Elk Creek, MF	26.4	MF EEL	Burgess/Furrer USFS	111.71025	htel1150.971
1580	MF Eel above Thatcher	26.4	MF EEL	Burgess/Furrer USFS	111.71035	htmf1155.971
1580	MF Eel above Thatcher	26.9	MF EEL	Furrer/Burgess	111.71035	HTMF1155.961

Other researchers, restoration planners, and watershed managers should refer to the verified and validated text file data to conduct their own specific analysis regarding their individual interest in the Eel River.

SEDIMENTATION AND TEMPERATURE:

California Department of Fish and Game produced a Final Draft of The Eel River Salmon and Steelhead Restoration Action Plan (Downie 1997) which acknowledges ten general actions that correlate to the ten identified types of problems currently facing the Eel River. The two primary actions recommended in this document are (1) **reduce watershed erosion** and (2) **improve fish habitat and riparian areas.** Increased sediment yields and degradation of stream canopy as they relate to elevated temperatures have been correlated and corroborated by several authors (Payne, et al.1970, Kubicek 1977, and Brown 1980). Elevated sediment loads displace pools (Lisle 1982), contribute to channel destabilization and can cause streams to widened into an abraded condition and/or flow sub-surface (Kelsey 1977).

Loss of stream side canopy is one of the most significant contributors to elevated temperatures in forest settings (Brown 1980). This is also apparent when reviewing temperature models such as SSTEMP (Bartholow 1997) where simulated loss of the riparian would correspond to a relative rise in temperature downstream.

The 1955 and 1964 storm runoff events are repeatedly blamed for these excessive depositions. After periods of lower rainfall, stored sediments and debris from human activities and natural events await delivery to the streams. Big events, such as the 1964 flood, trigger the flow of these materials from various contributors (Weaver and Hagans 1996).

Watershed Analyses (WA's) have been completed for four sub-basins in the Eel River system. These include; South Fork (Fuller et al. 1996), North Fork (USFS 1996), Middle Fork (USFS/BLM 1994), and, most recently, the Van Duzen River (USFS In press). In addition, a Preliminary Watershed Assessment was compiled for the upper Main Stem Eel River in 1994 (USDA, USFS 1994). Without exception, these documents support the CDF&G's findings that present sediment yields contribute to poor water quality in this basin. Historic and geologic information would demonstrate that the mainstem and many tributaries of the Eel River have lost pool depth and stream complexity. One of the most pronounced examples of this type of change is in evidence in the lower reaches of Bull Creek which gained 8 feet of sediment and the adjacent section of the South Fork Eel River which had gained 33feet of deposition between 1963 and 1986 (Downie 1992). The sediment yield is now judged to be in relative balance but in an aggraded form (Payne, et al. 1970).

Present conditions throughout the Eel River can be summarized as follows (USFS ????):

a. Degradation of water quality has resulted from the cumulative effects of increased sediment load from natural geologic conditions (i.e. mass wasting/slumps and high fluvial erosion that has resulted from the combination of uplifting incompetent bedrock and marine terraces and the down-cutting of stream channels into these soft, erodible materials)
b. Degradation of water quality has resulted from the cumulative effects of increased sediment load from human disturbance (i.e. road related activities, timber harvesting activities, grazing, and development) and loss or degradation of the riparian zone as the result of past and present land management practices.

As pointed out by Kubicek (1977) there are many contributing factors to stream temperature. Air temperature, relative humidity, orientation, substrate color, riparian canopy and channel morphology to name a few. Of these, only two can be dealt with in a remedial setting. Both riparian canopy and channel morphology are subject to human intervention, therefore, all sites identified for restoration will be addressed in terms of the decreased sediment yield (improvement of channel morphology) or remedial riparian activities when justified by ranking criteria.

PRIORITY RANKING SCHEME:

HCRCD has incorporated a priority ranking scheme based on the framework set forth in Healing the Watershed , a workbook developed by the Pacific Rivers Council for Oregon. This framework is based on theoretical models that maintain the cost effective value of saving the best habitat in the watershed and designing future restoration work around these "island" of health habitat. The concept being that preserved habitat will serve as refuge for natural climax community structure and would then more easily spread into adjacent areas in the watershed as those areas reach that progressive stage.

Important aspects of priority ranking criteria in the Eel River Basin include:

A. Temperature information from this study (low MWAT value).
Cooler stream temperatures generally denote higher water quality and a higher beneficial use. Streams will score a 5-1 point value based on the scale above. (I.e. a value of (4) would correspond to an MWAT between 16.9 and 18.3 degrees Celsius).

B. Aquatic invertebrate data reported in this study will be used when ranking streams that have been assessed for macro-invertebrates. An example would be the use of species diversity as an indicator of water quality. Generally higher species diversity equates to higher water quality. Macroinvertebrates would be referenced on a 5-1 point scale where (5) would correspond to high species diversity and 1 extremely low species diversity. Other metrics could also be used. (The usefulness of aquatic insects for judging water quality in the Pacific Northwest needs further refinement and accepted state protocols, Lee, personal communication).

C. Other available biological information. (i.e. habitat typing information and fish presence/absence (CDFG) (7-1 point scale).

D. Landowner Access (10-1 point scale). In that the Eel River is, predominantly, privately owned this criteria can (and should) receive higher point value.

E. Cost/Benefit Ratio. This ranking tool would specify the quantity of the work considered and the benefit to the resources vs. the amount of funds necessary to complete the task (5-1 point scale).

F. Match Availability. Based on cooperator shared expense, either in-kind service or monetary. (5-1 point scale).

The temperature and aquatic insect information gathered over the course of this program gives the HCRCD and other resource planners within the Eel River Basin a first line of organization by basin to help identify the refuge areas that need protection and restoration.

ANTICIPATED PREVENTIVE AND CORRECTIVE ACTIVITIES:

The following is a listing of general activities that would enhance/improve water quality in the Eel River. These techniques, and others, will be employed by the HCRCD in the coming years to help address high sediment yield, elevated temperature, and deteriorated riparian systems.

(1) Sediment source assessment and control:

A. Road inventory and assessment- continued support of these activities on private lands is pivotal to assisting land owners define, prioritize ,and control road related erosion on their lands.
B. Road upgrading and storm proofing- stream crossing and culvert upgrading, surface drainage improvements, removal of unstable side-cast materials, installation of critical dips and culvert inlet and outlet protection.
C. Road removal- road ripping and decompaction, excavation of unstable fill, removal of stream crossings (i.e. culverts or Humboldt type), revegetation and mulching where applicable.
D. Road maintenance- installation of rolling dips, water bars or cross-road drains, corrective treatment to all water crossings, out-sloping, and removal of old side cast materials.
E. Road construction and reconstruction, guidance for new road construction should involve planning, location design, and construction elements provided to land owners in accordance with the Handbook for Forest and Ranch Roads (Weaver and Hagans, 1994). This handbook, produced by Pacific Watershed Associates for the Mendocino RCD, California Department of Forestry, and NRCS will be made available to all cooperators the HCRCD contract with for restoration assistance.
F. Gully stabilization- while not always road related (Heede 1976), a high percentage of gullying can be traced back to poor road construction, maintenance, or abandonment. Corrective measures include: re-diversion of flow back into natural channel, flow diversion techniques, porous grade control structures such as vegetative and rock check dams, headcut control structures, and revegetation of channel banks. These techniques reduce energy of the flowing water and allow deposition of sediments prior to their arrival in anadromous habitat.

(2) Riparian and stream channel management and restoration:
Healthy riparian zones have been identified as a major contributor to reducing stream temperatures, reducing sediment delivery, maintaining channel complexity, and supplying the large woody debris (necessary for cover, distribution of spawning gravels, and scour pool production).

A. Riparian restoration- revegetation of native plants (including hardwoods and conifers) to aid in soil stabilization, thinning willow and/or alder stands to allow conifer growth, bank stabilization (rock armor, tree revetment, or vegetation mattress, placement of log/boulder structures), and channel control structures like willow waddles/baffles
B. Limiting access of livestock to riparian corridors- exclusionary fencing can greatly improve riparian conditions in the upslope range habitats. This method can prove cost prohibitive for landowners both initially (for installation) and over time (for

maintenance). However, new types of fencing and riparian zone grazing rotations are providing more choices for range managers.

In some instances this work can be done simultaneous to upslope treatments, but Best Management Practices (BMPs) would indicate the need to start at the ridge line when planning restoration activities in a watershed.

Support for conscientious and management in upslope habitat will lessen the disturbance to soil and help promote healthy land stewardship. When requested, the HCRCD and the other RCDs will assist landowners with their management planning with regard to watershed effects of their timber harvest, livestock rotation, and road construction.
The HCRCD has initiated outreach and education efforts throughout the Eel River. At this time, the HCRCD is scheduling eight watershed stewardship workshops for the purpose of exposing the landowners to present day techniques and resources with which to accomplish proactive land management . These workshops will generate dialogue between the RCDs and the landowners and continue the long range goals of the RCDs in the Eel River.

FUTURE ASSESSMENT AND MONITORING OF STREAM TEMPERATURE:

The EPA has expressed it's support for monitoring and ".. seeing that the data collection efforts are systematized so that inferences can be made of the spatial and temporal extent of stream temperature problems and better understand its relationship to past, present, and future land uses within basins" (Ralph, 1998).

The HCRCD's rationale for further assessment:

a. continued temperature monitoring in selected sub-basins may show trends over time, allow for refinement of data analysis, and improve the selection process for the restoration activities.

b. continued sediment source inventory/assessments in priority sub-basins, when project implementation is eminent, is necessary for prioritization and budgeting.

c. construction of sediment budgets for all fish bearing streams can provide useful information in deciphering biological impacts and the TMDL process.

With EPA funding, the HCRCD is continuing the temperature monitoring in the Eel River during the 1998 field season. This work will provide additional data to the present base line information presented here and contained in historical studies by Kubicek (1977), USGS (Blodgett, 1970), Pacific Gas and Electric, (Steiner,1996), and others.

Dr. Tim Lewis, director of the Forest Science Project, is using this information for regional studies of habitat and water temperatures. Generally, all efforts to standardize monitoring methodologies, protocols, and analysis will improve the dialogue between watershed management entities and provide the basis for accountability of future restoration activities.

Task 6 Implementation, Institutional, and Financial Plan

Sub-task 6.1 Implementation Plan

With this grant, the HCRCD has established a network of landowners, volunteers, and agencies that have committed themselves to the long term effort of improving water quality in the Eel River system. With an eye towards increasing the cooperation from the private sector, the HCRCD intends to work with all organized stakeholders in the basin, with the other Resource Conservation Districts and with watershed coordinators in the Eel River drainage.

The Resource Conservation Districts with the major portion of the Eel River system include: HCRCD, Trinity RCD, Mendocino RCD, and West Lake RCD (Lake Co.). At present, these RCDs have cooperated in submitting a planning grant request to the State Water Resources Control Board. The RCDs form a natural interface for exchange of ideas, technology, and funding from State and Federal granting entities to the individual landowners.

To accomplish the goal of water quality improvement, the RCDs will adhere to the following guidelines:

Basin Organization:

A. Develop a Technical Advisory Committee (TAC) of landowners, agencies, and community volunteers to assist the RCDs with assessment and implementation strategies. (TAC is in place and continuing dialogue).
B. Form a sub-committee of RCD Board members and technical advisors (NRCS, CDF&G, etc.) that will work together to identify and prioritize projects in each County that would fulfill the Priority Ranking Scheme outlined here. (This sub-committee has met three times and is continuing communication).
C. Systematically and cooperatively seek funding support for mutually advantageous activities in the Eel River. (In place. Exemplified by present 205(j) SWRCB WMI Grant request).

Phase I Implementation, 1998-99:

Using the priority ranking scheme (described above) identify Eel River sub-basins that have all necessary information for restoration ranking and seek funding to carry out the implementation of needed work.

<u>Example</u>: South Fork Eel River. Table 5, this report, would indicate that Redwood Creek (Miranda) has temperatures conducive for healthy salmonid habitat. Linking this information with habitat typing and biological survey information would disclose the limiting water quality factor in this stream is a high fine sediment load in the spawning reaches. Focus would then be placed by the TAC on working with cooperating upslope landowners to reduce in-put of fines and improve the spawning beds. This has begun as of this date and funds have been identified and obtained to assist landowners in this watershed in their efforts to improve road surface and stream crossings presently delivering fines to this tributary.

Phase II Implementation 1999-2003:

1) Continued basin and sub-basin prioritization by the TAC.
2) Assessment of problems or threats throughout drainage.(This requires additional assessment funding from State, Federal, and/or cost share from landowners.)
3) Re-development of Implementation Plan. (This is an iterative process that will continue throughout the restoration period).
4) Cost analysis, cost effectiveness analysis, and development of treatment priorities.
5) Implementation of high priority projects with willing landowners.
6) Reporting and documentation.
7) Monitoring.

Anticipated Funding Mechanisms:

The HCRCD is seeking funds to continue the present effort in the Eel River. The following is a summary of that on-going effort:

A. SB 271- The California Legislature recently passed a bill that will garner a total of 43 million dollars over the next six years for watershed recovery in the State. The RCDs have already been successful in obtaining a portion of these funds for projects in the Eel River Basin. The Landowner Stewardship Workshops to be hosted by HCRCD this coming year throughout the Eel River (eight locations) will no doubt succeed in bringing more awareness and understanding of present upland and watershed issues. The RCDs will be submitting additional grant requests in an effort to focus and continue the information/outreach and implementation effort.

B. SWRCB/EPA 319(h) Implementation funds are presently being sought by this RCD to begin implementation of projects identified by this work and existing planning completed by watershed coordinators Eel River Watershed Improvement Group (ERWIG) and the CDF&G. Future efforts will include the combined RCDs, North Western Pacific Railroad, Caltrans, ERWIG, (and other watershed groups as they come on board), Cattlemen's Association, California Farm Bureau, EPA, NCRWQCB, CDF&G, and the balance of the agency support system (see TAC above, Pages 3-4)

C. USF&WS, Jobs In The Woods program. Recent dialog with agency personnel confirms USF&WS interest in assisting the RCDs with their activities in the Eel River watershed

D. As with the Northwest Emergency Assistance Program that focused a great deal of work in the Eel River, this Federal jobs program could support similar assessment and implementation projects on private lands.

E. Landowners, whether large or small, can only dedicate a limited portion of their resources to remedial activities that would rectify erosional problems on their lands. In many instances the problems pre-date their ownership or are natural in occurrence. Their participation is none the less important and their cooperation and commitment to address these issues will continue to be the keystone for water quality improvement.

Monitoring and Assessment:

A good deal of effort has gone into identifying the deteriorating condition of this drainage. The last two to three years have produced a more coordinated atmosphere among resource planners in this basin and present outreach to private landowners during the TMDL process will continue this trend. The HCRCD will play a significant role in the Eel River watershed continuing the monitoring and assessment activities. The following outline identifies the work begun or completed at this point:

A. Basin wide watershed assessment. (Completed for all major sub-basins and a preliminary assessment in the upper mainstem. USFS, BLM, USF&WS, et. al.)
B. Basin Wide Habitat Typing and Biological Sampling. (Underway this report and CDF&G, Inland Fisheries Division Weldon Jones, Scott Harris, Scott Downie, Ruth Goodfield, Jennifer Terwilliger, et. al.).
C. Temperature monitoring-basin wide coverage of anadromous streams, mainstem, and sub-basin mainstems. (Underway this report. Effort will continue to be coordinated by the HCRCD. Information gathered to be shared by all stakeholders.)
D. Upland sediment source assessment. (These activities are underway in two of the four sub-basins. This type of work has been identified as one of the most long lasting beneficial treatments to improve water quality in forested habitat. Dopplet, et al. 1996).

Task 6.2 Implementation Checklist

Action	Schedule
A. Technical Advisory Committee formation------------	In place
B. Eel River RCD Board Committee-----------------------	In place
C. Seek additional funding to support implementation-	on going
D. Identification of implementation projects-------------	Phase I begun
E. Prioritization of implementation projects--------------	Phase I begun

Presently Selected Sub-basins and watersheds:

South Fork Eel River

Redwood Creeks (China and Seely)

Van Duzen River

Several watersheds including: Cummings Creek, Yager Creek, Butte Creek, and Little Larabee Creek.

Mainstem Eel River

Chamise Creek

F. Formulation of Memorandums of Understanding (MOUs) between RCDs and with other cooperating entities dedicated to this process ------------------------	1998
G. Submission of funding requests for implementation of Phase I--	1998

H. Phase II Implementation ---------------------------------- 1999________

I. Submission of funding requests for implementation of Phase II-- 1998-99_____

J. Continued monitoring, assessment, and project development-- 1998-2003___

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