KARUK TRIBE OF CALIFORNIA

DEPARTMENT OF NATURAL RESOURCES
P.O. Box 282 * Orleans, California 95556

Water Years 2000 & 2001
Klamath River Mainstem

Iron Gate
Seiad Valley
Orleans
Indian Creek

WATER QUALITY MONITORING REPORT

Karuk Tribe of California

Water Quality Monitoring Report
Water Years 2000 & 2001

Prepared by
Karuk Tribe of California
Water Resources
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KARUK TRIBE OF CALIFORNIA

KLAMATH RIVER MAINSTEM
WATER QUALITY MONITORING REPORT

Water Years 2000 & 2001
(October 1st to September 30th)

1.0 BACKGROUND

The Karuk Tribe began monitoring daily water quality conditions on the Klamath River mainstem in January of 2000. This monitoring was accomplished through the establishment of a Cooperative Water Resources Program with the U.S. Geological Survey (USGS). Gauging stations below Iron Gate dam, near Seiad Valley and at Orleans were upgraded to collect multiple water quality parameters using in-stream water quality collection instruments.

During water years (WY) 2000 and 2001, the USGS was contracted with to maintain the water quality instruments and data for the Iron Gate and Seiad Valley sites. Training Karuk tribal members in the data collection and quality assurance process was also a component of the USGS contract. During 2000 and 2001 the USGS provided oversight for all maintance, calibration, and data processing.

Funding for this project has come mainly through the Karuk Tribe's EPA 106 Water Pollution Control Program, although the National Marine Fisheries Service, U.S. Fish and Wildlife, and U.S. Geological Survey have also contributed to this effort.

2.0 WATER QUALITY STATIONS

All Karuk Water Quality gauges are located along the Klamath River near USGS flow gauges. The relationship of flow to a measured pollutant at the same location is important. This relationship allows the observer to determine the total volume of the pollutant being passed through the system.

2.1 Iron Gate

The water quality station at Iron Gate is located approximately 767 meters below the Iron Gate Reservoir spillway, and about 150 meters below Bogus Creek. The exact location is:

Latitude: 41° 55.664’ 0’’ N
Longitude: 122° 26.615’ 0’’ W
Elevation: 2176 ft.

The drainage area for the Iron Gate water quality gauge is 5,194,092 acres. The Bureau of Reclamation’s Klamath Project, and subsequent operations plan, regulates Klamath River flows at Iron Gate.

Two small tributaries, Bogus and Brush Creeks, exist between the spillway and the water quality station at Iron Gate. The drainage influence for these two creeks is 30,490 acres. Flow for the Iron Gate gauge is further influenced by the outflow of the California Department of Fish and Game operated fish hatchery located just above the water quality gauge. This is an important fact when evaluating the minimum flow requirement from Iron Gate Reservoir.

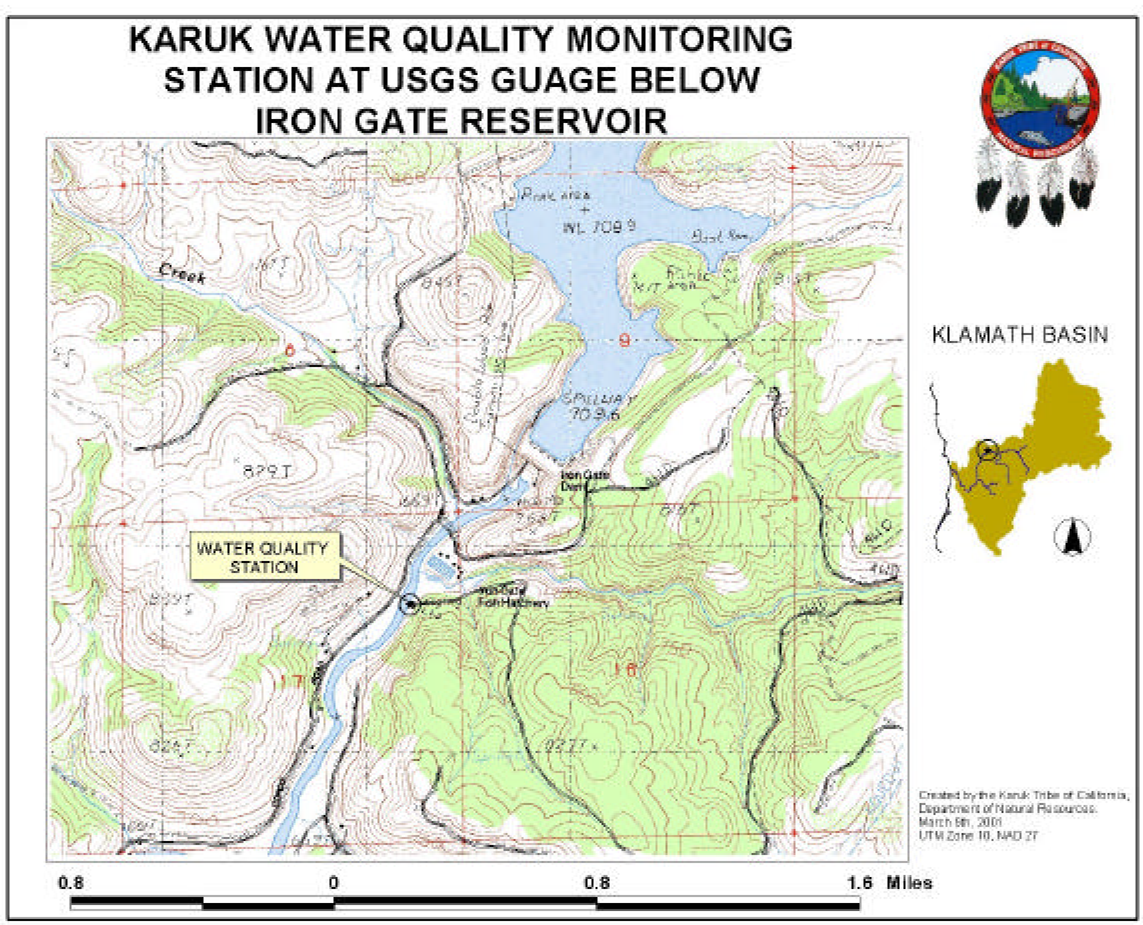

Fig. 1. Location of Iron Gate water quality station.

2.2 Seiad Valley

The Seiad Valley water quality gauge is located 2.2 miles west of the town of Seiad along Highway 96. The drainage area for the Seiad Valley water quality gauge is 6,672,492 acres. The exact location of this station is:

Latitude: 41° 51.227’ 0’’ N
Longitude: 123° 13.944’ 0’’ W
Elevation: 1350 ft.

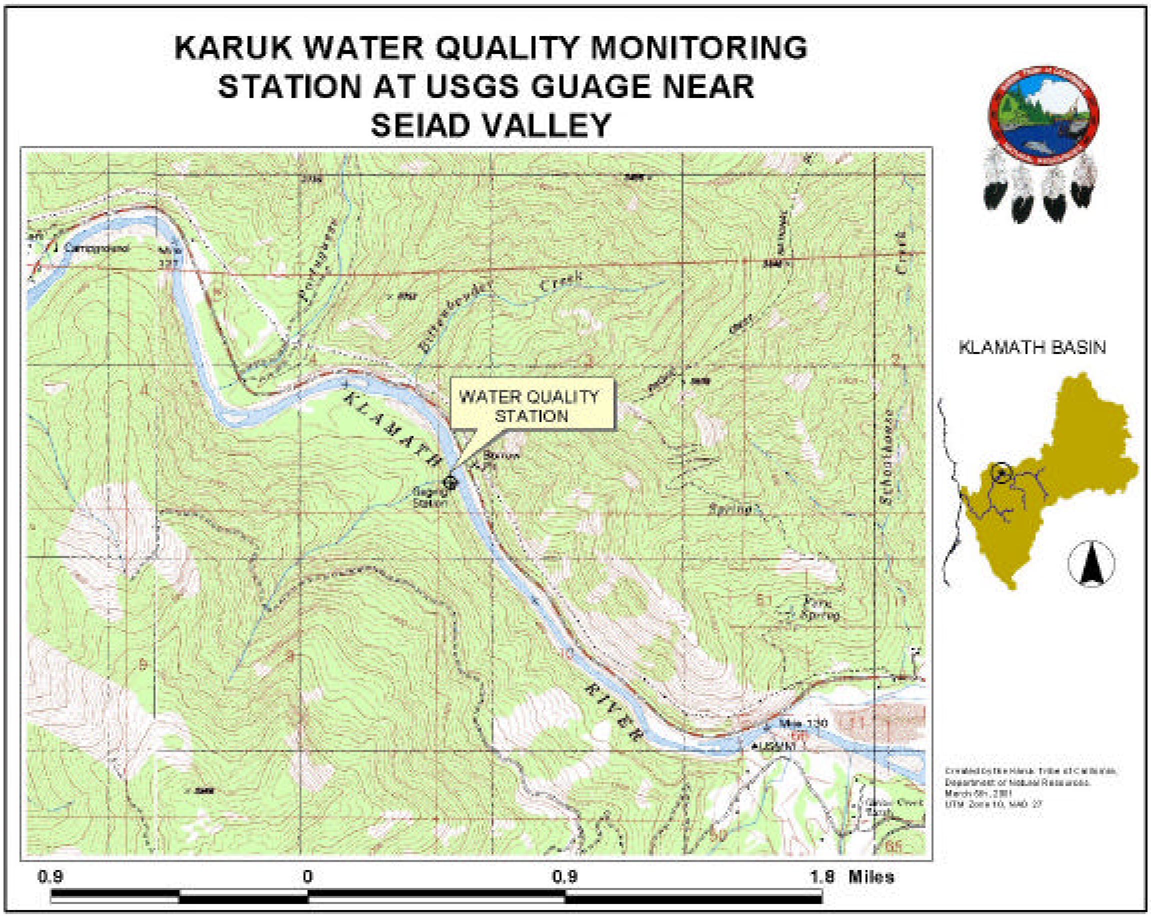

Fig. 2. Location of Seiad Valley water quality station.

2.3 Orleans

The Orleans water quality gauge is located under the Klamath River Bridge in the town of Orleans. The drainage area for the Orleans water quality gauge is 7,654,982 acres. The exact location of this station is:

Latitude: 41° 18.204’ 0’’ N
Longitude: 123° 32.069’ 0’’ W

Elevation: 389 ft.

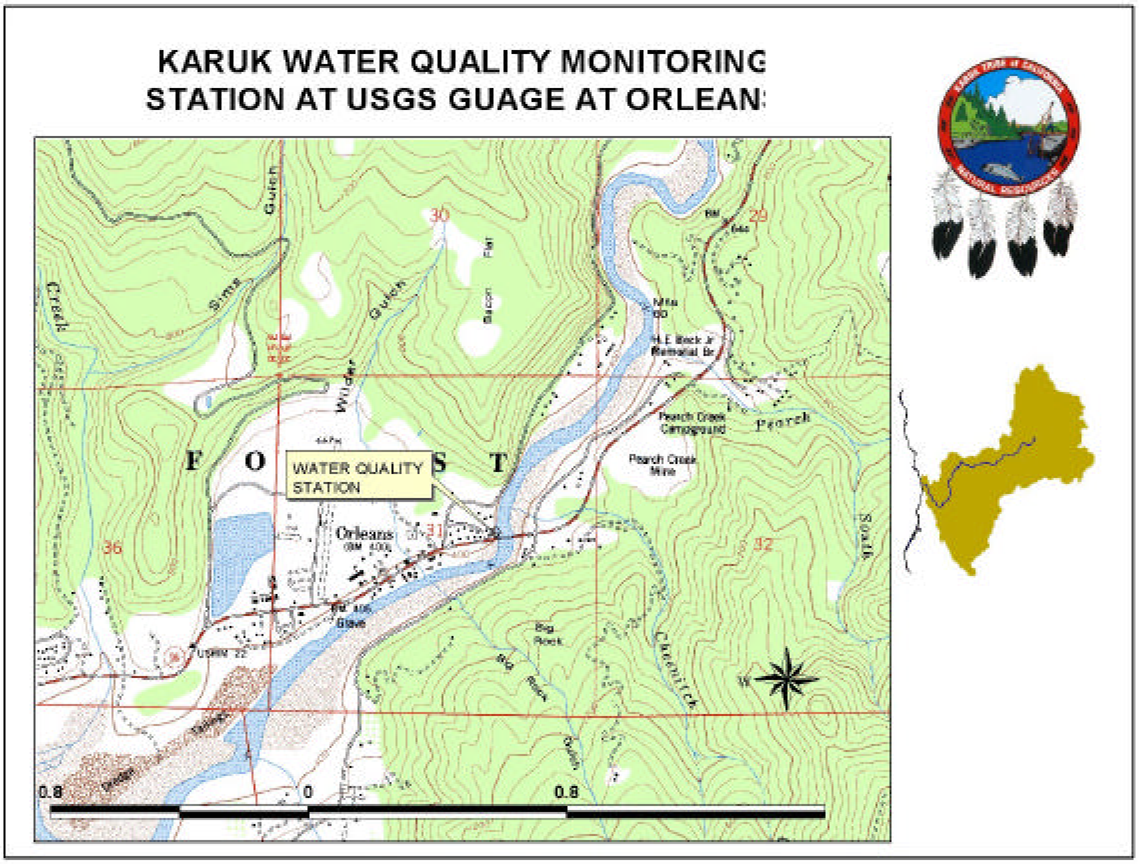

Fig. 3. Location of Orleans water quality station.

2.4 Indian Creek

The Indian Creek flow gauge is on a minor tributary to the Klamath, upstream of the Karuk Tribal Administration building in the town of Happy Camp. The gauge is located 3.4 miles north of the town of Happy Camp along Indian Creek Road. The drainage area for the Indian Creek flow gauge is approximately 76,800 acres. The exact location of this station is:

Latitude: 41° 50.093’ 0’’ N
Longitude: 123° 23.013’ 0’’ W
Elevation: 1215 ft.

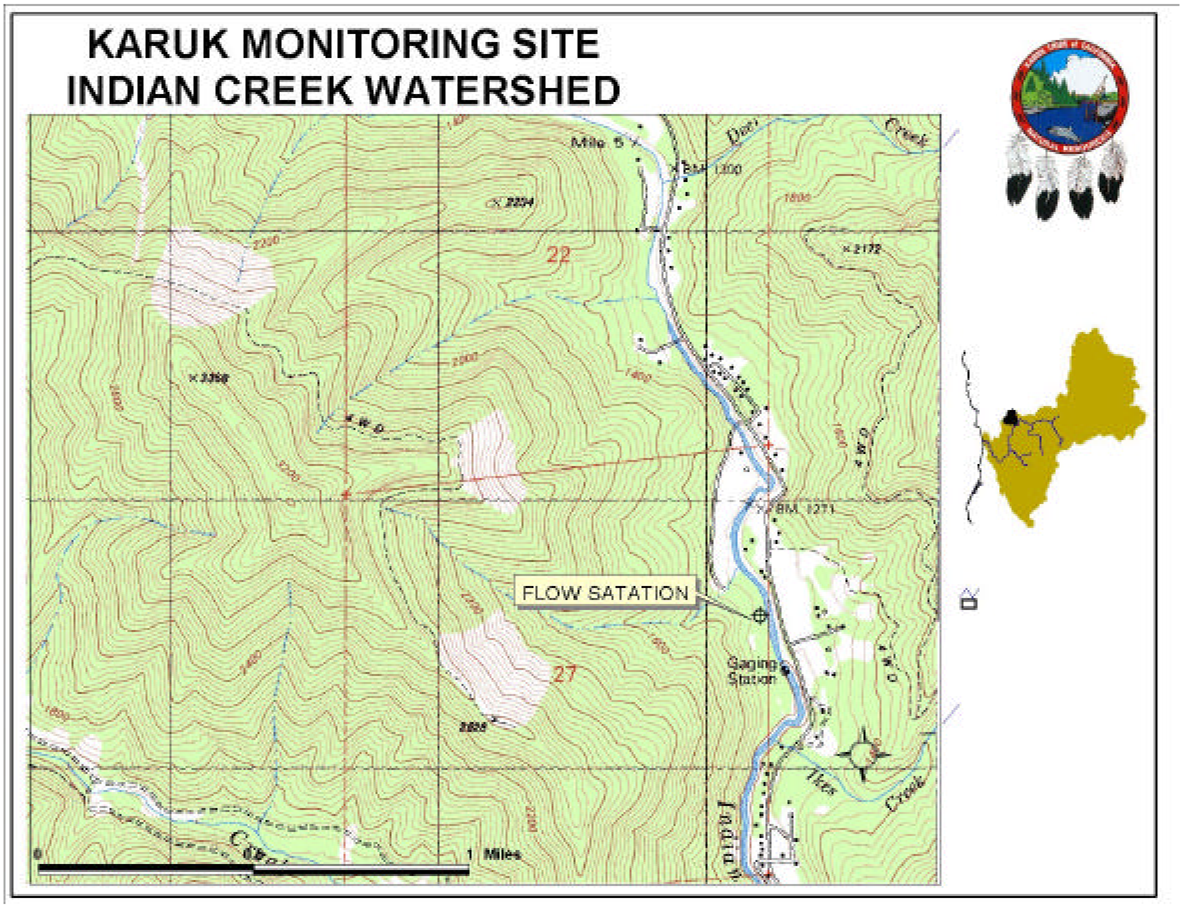

Fig. 4. Location of Indian Creek flow gauge.

3.0 PURPOSE

The value of water is determined by its potential uses. In turn, the uses that can be made of water are determined by its quality. The purpose of this study is to collect essential water quality data, and to continue the goals of the Karuk Tribe of California and it's water resources program. The information produced allows the Karuk Tribe to give valuable input on land management decisions and helps to fill data gaps on information that is either not available or does not adequately meet the needs of the Karuk Tribe and other land management agencies. The data produced is essential in helping to understand the complex water quality and quantity problems that exist within the Klamath Basin.

4.0 IMPLEMENTATION DATA COLLECTION

The water quality stations at Iron Gate, Seiad Valley, and Orleans collect water temperature, dissolved oxygen (DO), pH, specific conductance, flow, and air temperature in fifteen-minute intervals. This information provides interested stakeholders with sub-daily response of multiple water quality parameters. This data is critical to interpretation and definition of water quality response throughout the river system, as well as valuable maximum, minimum, mean values, and the rate of change of constituents.

The USGS and Karuk Tribe have provided staff to maintain and calibrate the water quality stations. Quality Assurance procedures are followed, and a high level confidence in the quality of the data is obtained before it is published.

5.0 WATER QUALITY MONITORING/QUALITY ASSURANCE

The Karuk Tribe has an interim Quality Assurance Project Plan (QAPP) for monitoring water quality conditions throughout the Karuk Tribes Ancestral Waters. The QAPP documents the best available scientific methods for testing water quality. During WY 2000 and 2001 water quality probes were calibrated and serviced according to U.S. Geological Service (USGS) QA/QC protocol. Calibration and servicing took place at the monitoring site. Calibration standards were kept in a cooler to equalize with the river temperature. These calibrations followed the manufacturer's instructions as outlined in the ***Maintenance/Calibration/Logging Procedures*** for that specific probe. The calibration procedure's determined the amount of error in the data due to bio-fouling and electronic drift. Standards or reference solutions were used for calibration of equipment that measured a particular environmental parameter. Use of reference standards is an integral component of quality control. Both water quality field equipment and laboratory equipment must be periodically calibrated to assure the instrument's accuracy. Automated water quality field equipment requires regular calibration. Calibration data were recorded on field sheets, which are filed at the USGS Field Office in Redding California (WY 2000 & 2001).

The Karuk Tribes Water Resources staff began to independently operate the water quality portion of the Iron Gate, Seiad Valley, and Orleans gauges during water year 2002. Water quality training was an important component with the Karuk/USGS Cooperative Water Resources Program during Fiscal Years (FY) 2000 and 2001. Karuk Water Resources staff also gained valuable experience by operating three Hydrolab Datasondes for the U.S. Fish & Wildlife Service (USF&W) during FY 2001, and conducting maintenance according to their QA/QC plan and Standard Operating Procedures. During WY 2000 and 2001 water quality probes were maintained at two-week intervals during the summer months (May-September) when water temperatures are high. This procedure helped to minimize lost DO data due to bio fouling of the DO membrane. During the winter months (October to April), the probes were maintained monthly. The Karuk Tribes current Quality Assurance Protocol is based on past experience working with both the USGS and USF&W water quality staff. Karuk water resources staff has found that calibration and maintance have had the best results in a controlled lab environment. We calibrate our instruments at our water quality lab in Somes Bar. Our staff have also found that weekly maintance during the summer months reduces biofouling drift (mainly in the DO readings). This maintance schedule eliminates the need to apply correction factors (such as the USGS ADAPS program) to manipulate the data.

6.0 WATER QUALITY PARAMETERS

Data for the water quality parameters listed below was collected using YSI 6820 multi-parameter probes at the Iron Gate and Seiad sites. A Hydrolab Datasonde 4a was used in Orleans. Flow is collected by the USGS using a gas pressure system. The data is included in this report to examine the relationship of flow with water quality.

6.1 Flow

Flow for the Iron Gate station is directly related to the flows released from the Iron Gate reservoir, although Bogus and Brush Creeks also influence the gauge, along with the discharge from the Iron Gate fish hatchery. In order to determine the flow out of the Iron Gate spillway, these three flow influences have to be subtracted.

There is a flow gauge operated by the PacificCorp power company at the penstock for the dam. There is also a non-operational flow gauge for the hatchery intake pipe (Rushton 2002). The intake for the hatchery has a maximum flow of 55 cfs, thru a thirty-inch pipe, which draws directly from the reservoir. This water is utilized for the holding ponds and spawning areas. There are two valves for the intake, one seventy feet deep (for cold water) and another at the seventeen foot depth (Rushton, 2002). There are two discharge points for the fish hatchery outflow, one at the fish ladder and another at the outflow pipe. Both discharge points require a National Pollution Discharge Elimination System (NPDES) permit. The hatchery also operates two settling ponds next to the river, between the water quality gauge and the spillway.

Water flow rates have a direct effect on aquatic habitat. Low flows restrict the flushing of fine sediment and can increase the embeddedness of spawning gravels. Increased flows decrease transit time (time it takes for the water to travel), moderating the diurnal temperature range and providing modest temperature benefits (Deas et al, 1999). Suitable water velocity is important for migration, spawning, incubation, and rearing of salmonids (CDF&G 1997). Optimal velocity for suitable spawning habitat is on the order of 1 to 3.5 fps. and 0.5 to 3.0 feet in depth (Reynolds et al., 1990). This is why it is important to establish how flow rates affect edge habitat (near the edge of the river). As fish get larger, their ability to utilize habitat with higher velocities increases.

The rate of flow change can also affect aquatic habitat. Juvenile salmonid stranding has been known to occur within the portion of the river below the influence of the furthest downriver dam on the Klamath River, Iron Gate. Stranding on the mainstem Klamath River can occur when the flow rate being discharged from Iron Gate is reduced drastically over a short period of time, causing side channels and edge habitat to become extremely shallow. Fish stranding can also occur naturally when the river recedes following excessive rain and snow melting.

Timing of water flow can also have a significant effect on salmonids. Flow rates on the Klamath River are highly influenced by diversion, especially during the spring and summer, when seasonal flushes of water are needed to assist juveniles on their migration downriver to the Pacific Ocean.

Figures 5 and 6 show the mean discharge at the Iron Gate gauge and the minimum flow requirements from the Bureau of Reclamation's Annual Operations Plan.

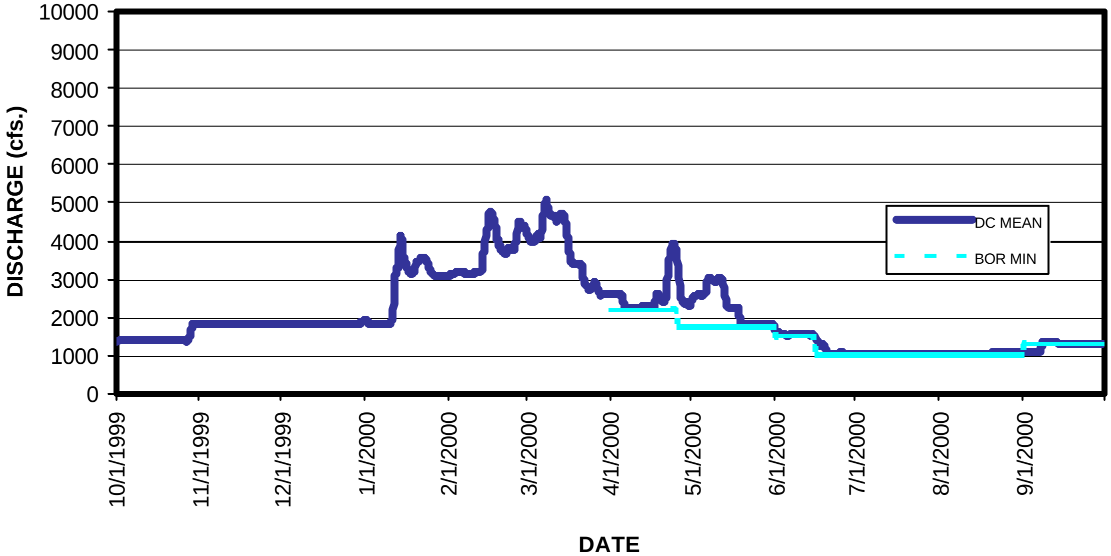

Fig. 5. Mean discharge below Iron Gate and BOR flow requirements for WY 2000.

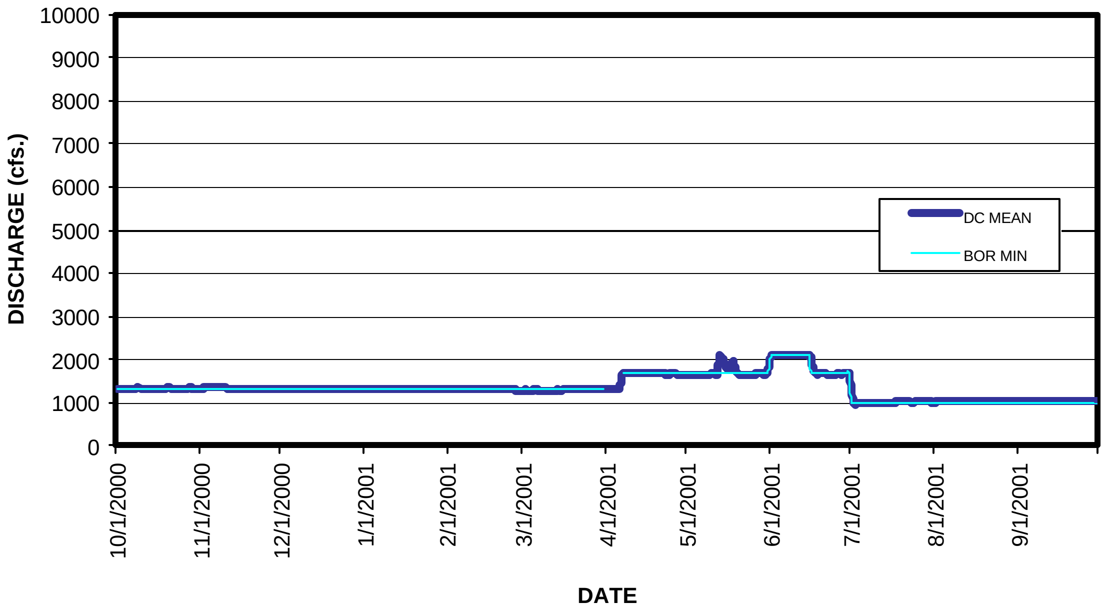

Fig. 6. Mean discharge below Iron Gate and BOR flow requirements for WY 2001.

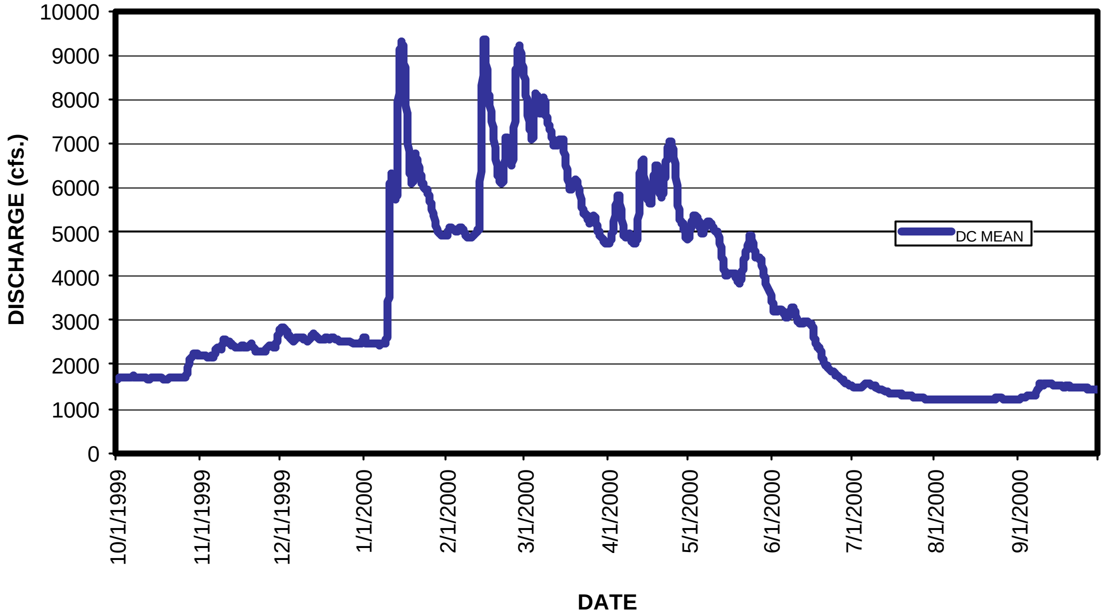

Fig. 7. Mean discharge near Seiad Valley for WY 2000.

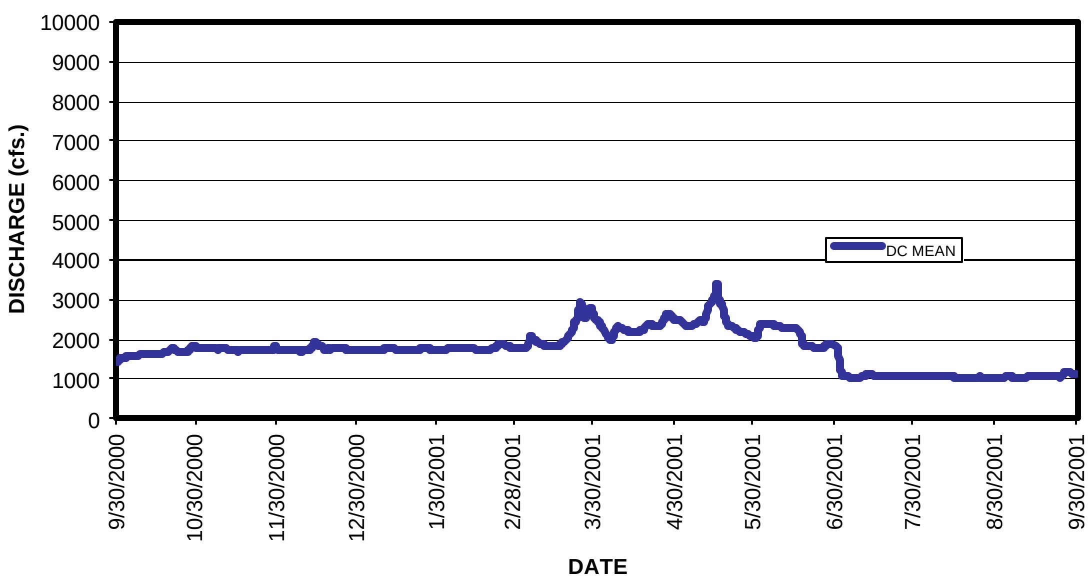

Fig. 8 Mean discharge near Seiad Valley for WY 2001.

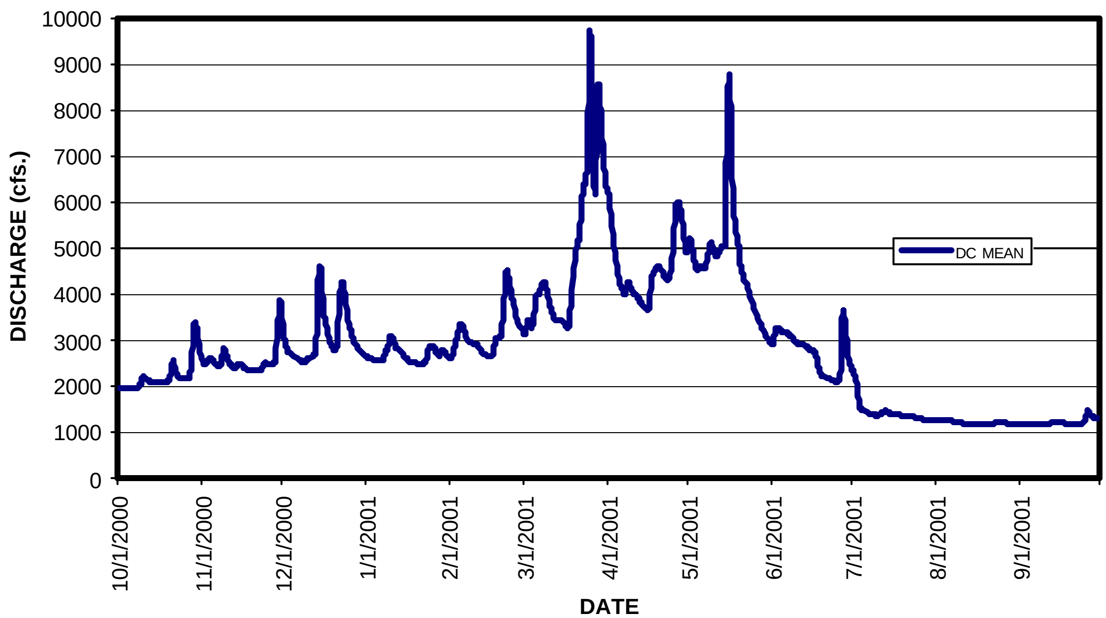

Fig. 9. Mean discharge at Orleans for WY 2001.

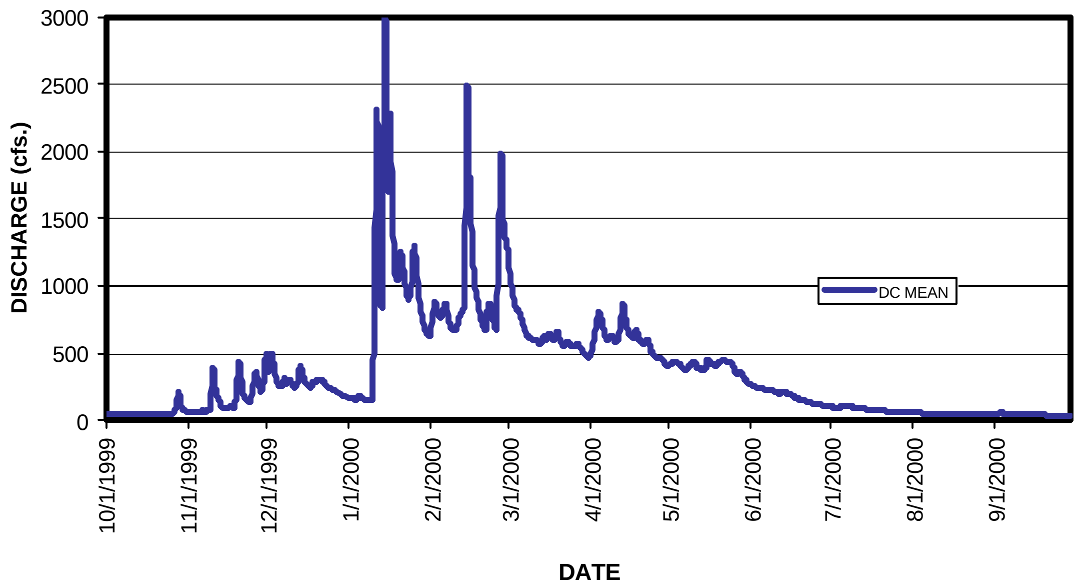

Fig. 10. Mean discharge at Indian Creek for WY 2000.

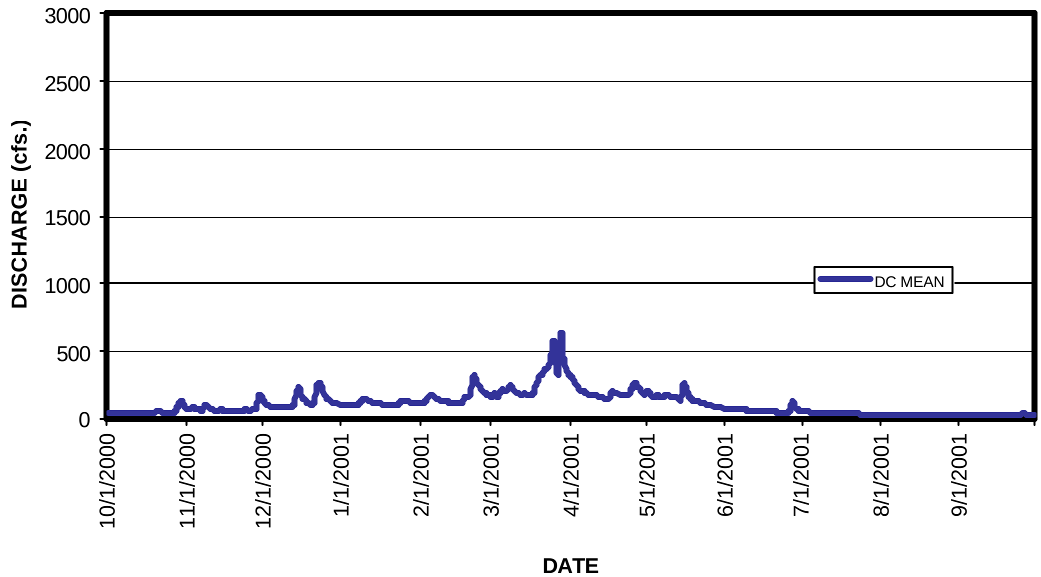

Fig. 11. Mean discharge at Indian Creek for WY 2001.

6.2 Water Temperature

Water temperature varies through space and time, both seasonally and diurnally (within a twenty-four hour period). Elevated temperatures may lead to increased metabolic rates in organisms and algal growth. Stream temperature is neither uniform in space nor time. Many factors can affect stream temperature, including air temperature, the amount of shaded cover (which significantly influences smaller streams), contribution of snow melt and springs (or cold water tributaries), aspect, amount of runoff from human influenced areas, and the length the stream must travel, which gives it the potential to heat up.

The most common method to assess water temperature for streams that support salmonids is to compare the temperature to an acute (lethal) and chronic (sub-lethal) temperature standard. The acute standard represents the temperature at which life cannot continue for the salmonids. The chronic temperature standard represents the maximum weekly average (mean) temperature (MWAT). This number represents an upper limit for optimum growth for salmonids. The Karuk Tribe's Interim Water Quality Standards have set chronic and lethal temperatures at 15.5°C and 21°C respectively. The state of California currently has no numeric temperature standard on the Klamath, although it is on their 303(d) list.

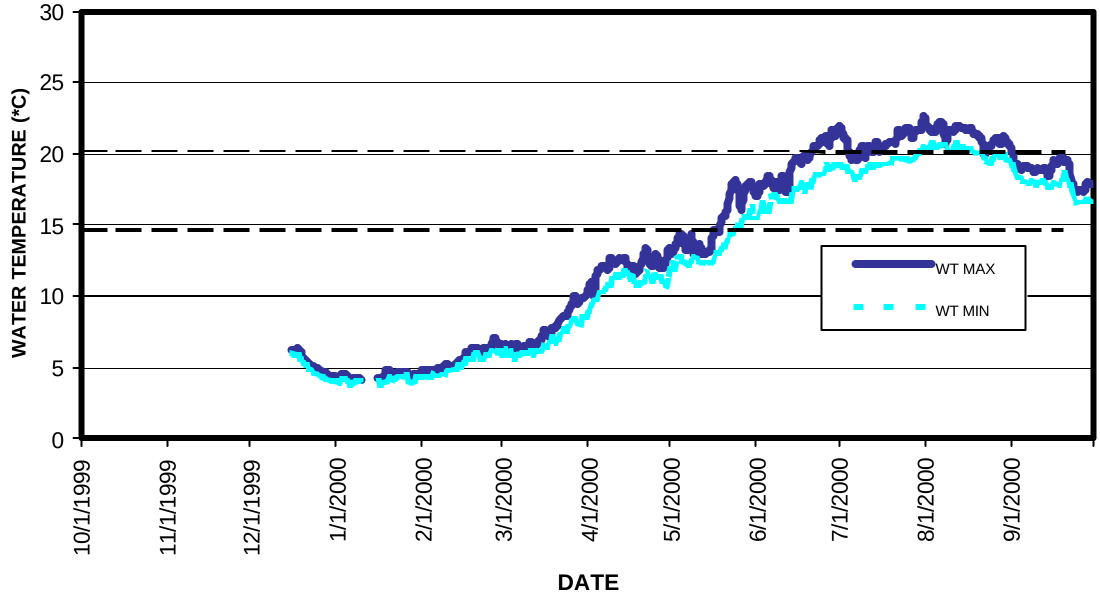

Fig. 12. Minimum and maximum water temperature at Iron Gate for WY 2000.

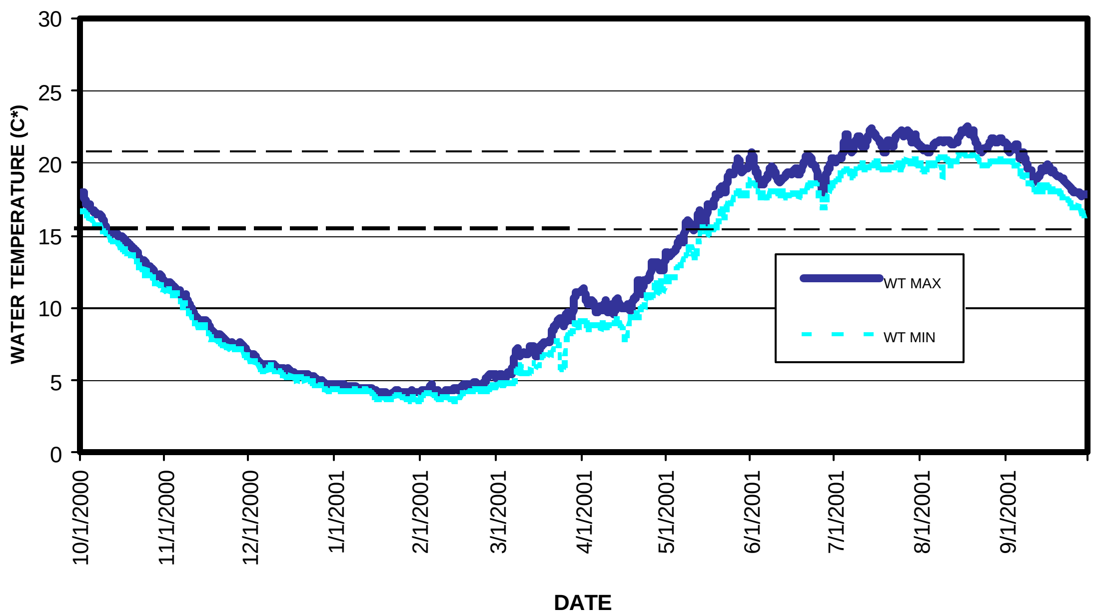

Fig. 13. Minimum and maximum water temperature at Iron Gate for WY 2001

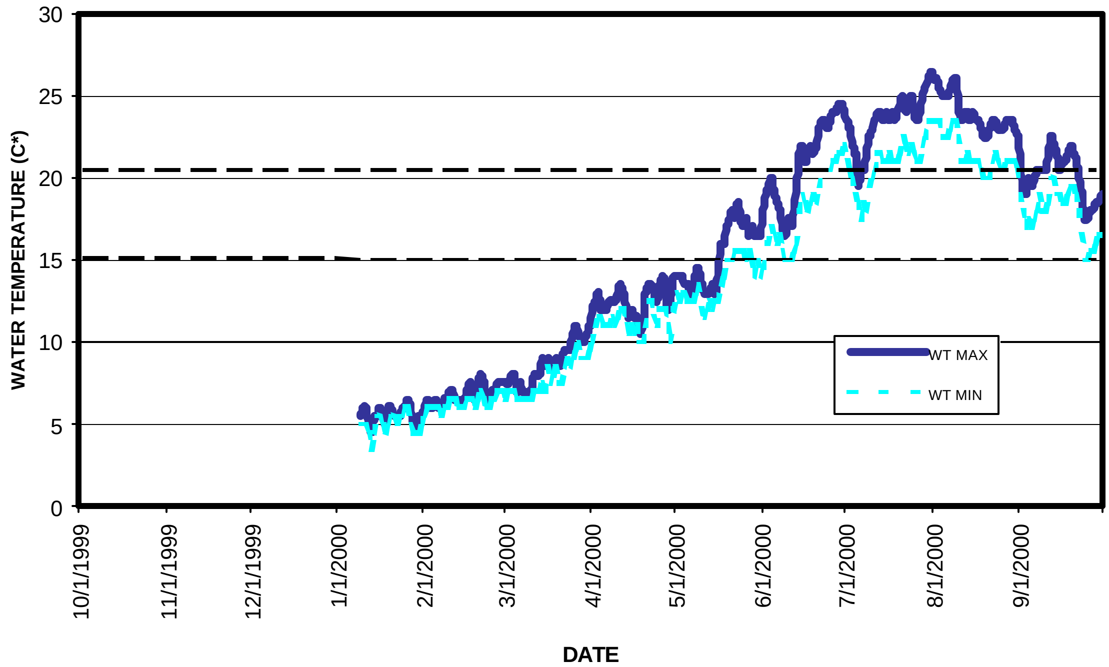

Fig. 14. Minimum and maximum water temperature near Seiad Valley WY 2000.

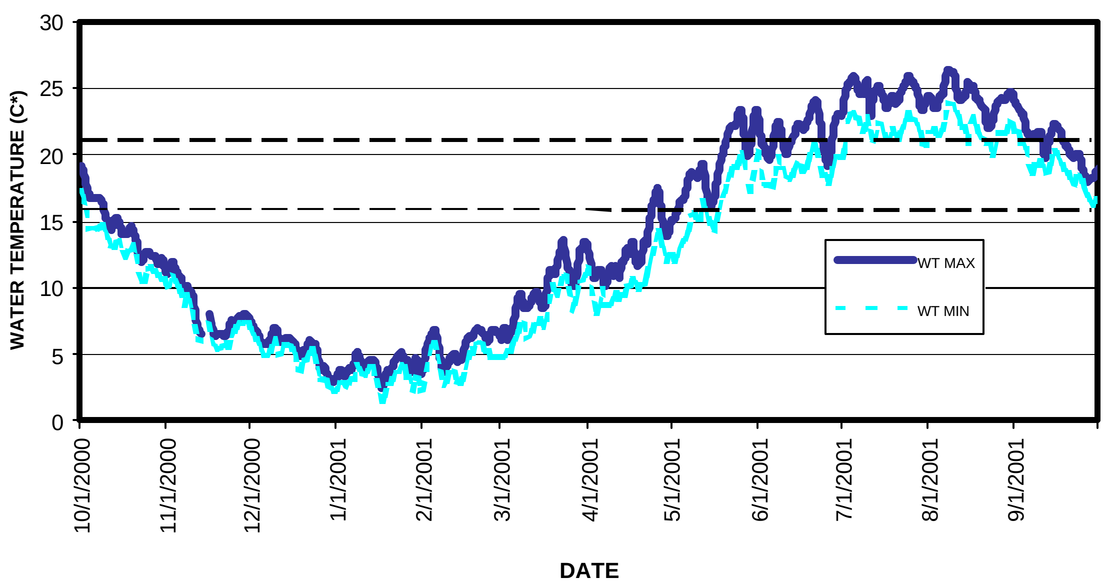

Fig. 15. Minimum and maximum water temperature near Seiad Valley WY 2001.

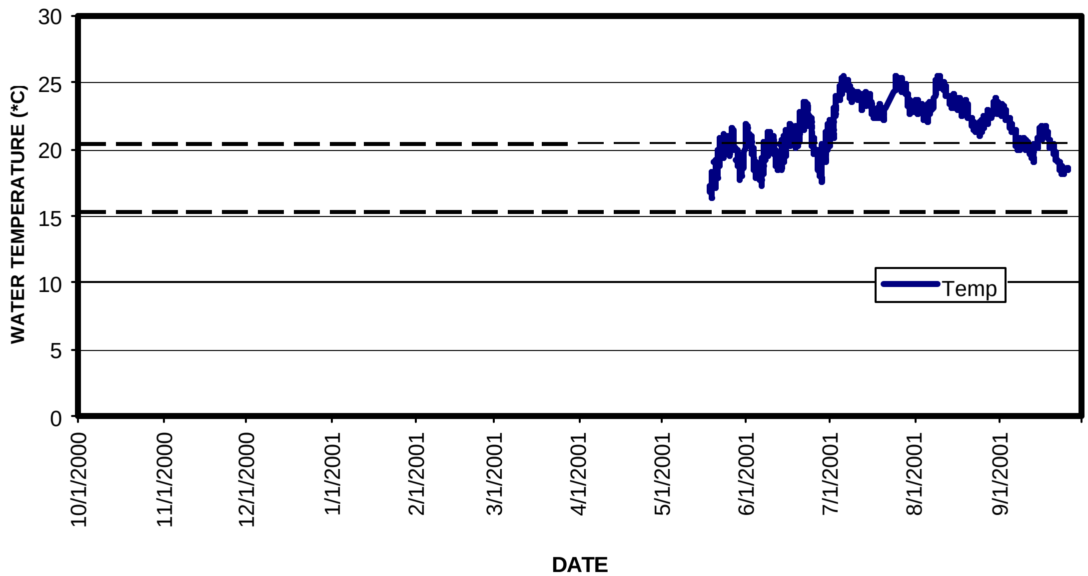

Fig. 16. Water temperature at Orleans WY 2001.

6.3 Dissolved Oxygen

Dissolved oxygen varies both seasonally and diurnally, particularly in the spring and summer when photosynthesis adds oxygen to the system during the day and respiration consumes it at night (Clawson, 1986). In cold water, oxygen is more soluble; therefore the amount of available oxygen for salmonids is greater. Oxygen levels become reduced when water temperatures are elevated. A supersaturated (very high DO) environment may exist during daytime hours, but at night DO levels may drop to lethal levels due to microbial respiration and lack of photosynthesis.

The Karuk Tribe's Interim Water Quality Standards have established minimum DO levels for waters designated as COLD Waters to be 6.0 mg/L, and SPWN (spawning) Waters to be 9.0 mg/L during egg incubation. The state of California has established a minimum DO level of 8.0 mg/L, and put the Klamath on their 303(d) list for having DO levels that do not meet their Basin Plan Objectives.

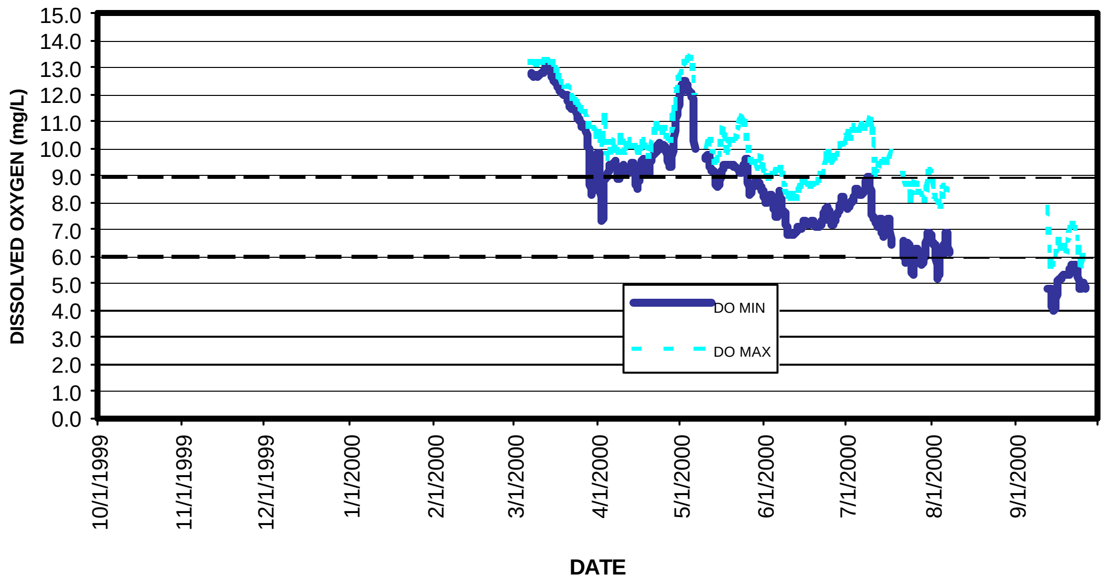

Fig. 17. Minimum and maximum dissolved oxygen at Iron Gate for WY 2000.

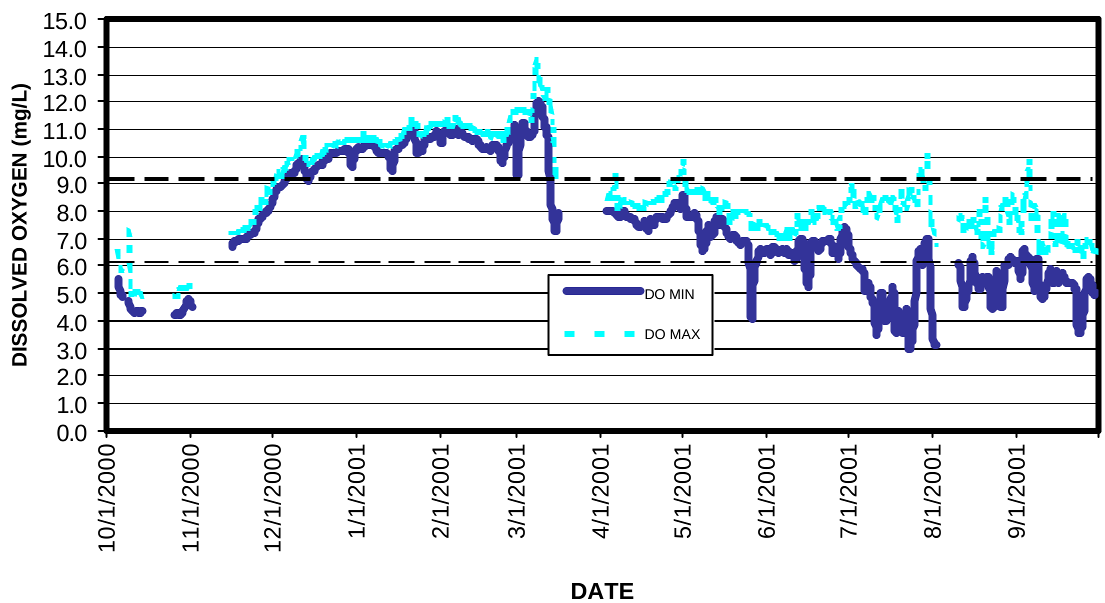

Fig. 18. Minimum and maximum dissolved oxygen at Iron Gate for WY 2001.

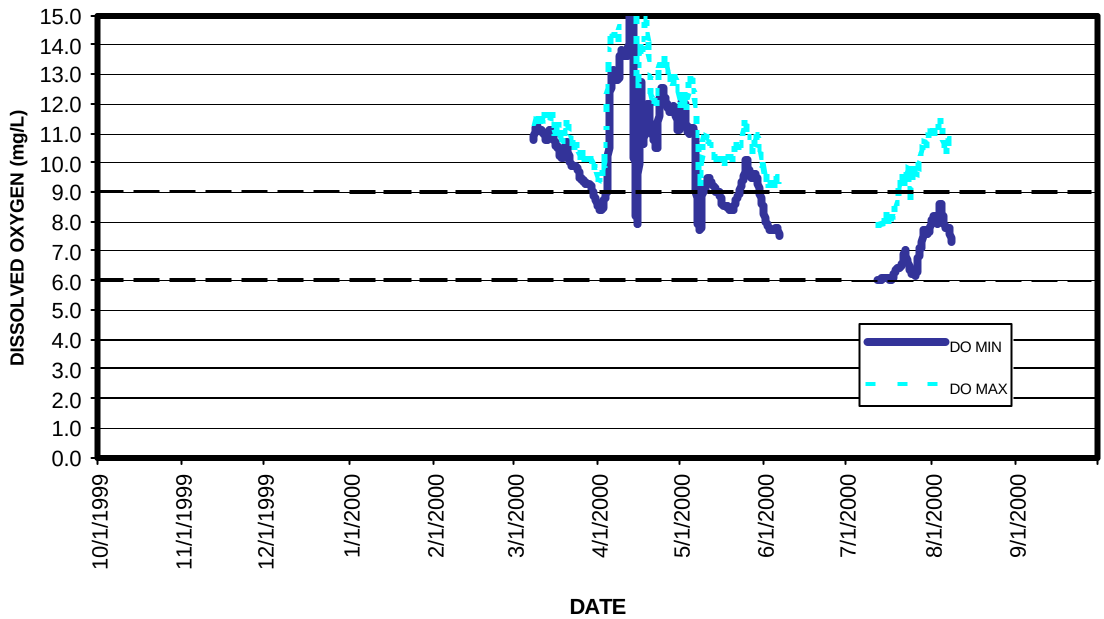

Fig. 19. Minimum and maximum dissolved oxygen at Seiad Valley for WY 2000.

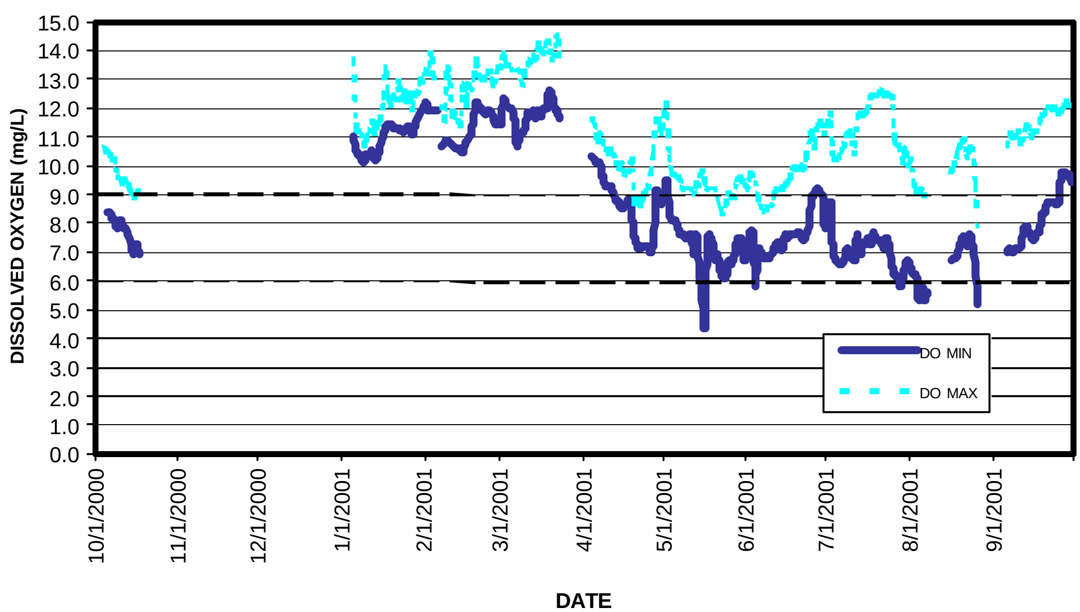

Fig. 20 Minimum and maximum dissolved oxygen at Seiad Valley for WY 2001.

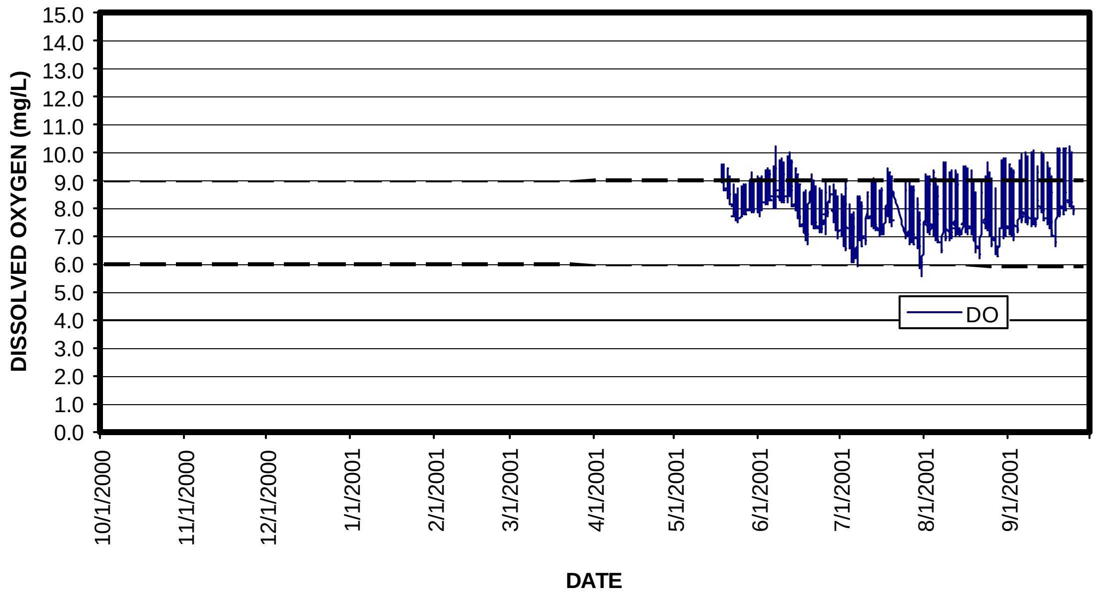

Fig. 21. Minimum and maximum dissolved oxygen at Orleans for WY 2001.

6.4 pH/Alkalinity

Alkalinity of water refers to an ability to accept hydrogen ions, to neutralize acid, and is a direct counterpart to acidity. High alkalinity has the effect of buffering or resisting pH change, and consequently reducing effects on pH from biological sources (Gwynne, 1993). Buffering occurs in the presence of carbon monoxide (CO). CO enters the water through decomposition, plant and algal respiration, and from the atmosphere. Diel fluctuations are caused by increased photosynthesis during the day, removing CO from the water, and allowing the pH to rise. The reverse occurs at night, with plant respiration and decomposition releasing CO to the water and driving pH downward (Gwynne, 1993). The Karuk Tribe has established a minimum pH standard of 7 and a maximum of 8.5. These standards reflect the State of California's numeric standards for pH.

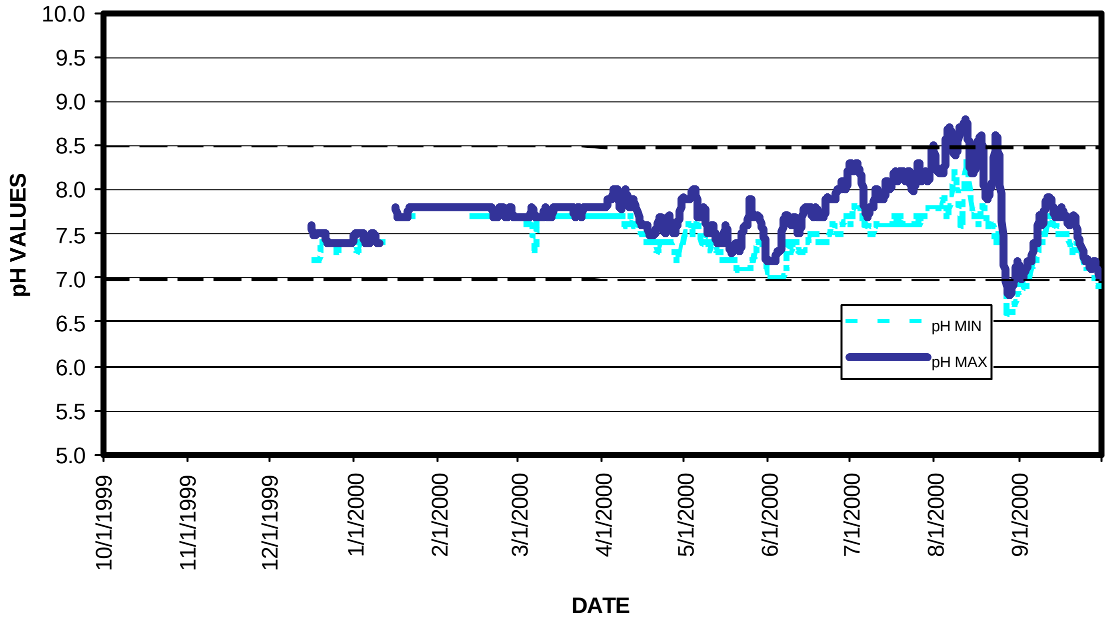

Fig. 22. Minimum and maximum pH values at Iron Gate for WY 2000.

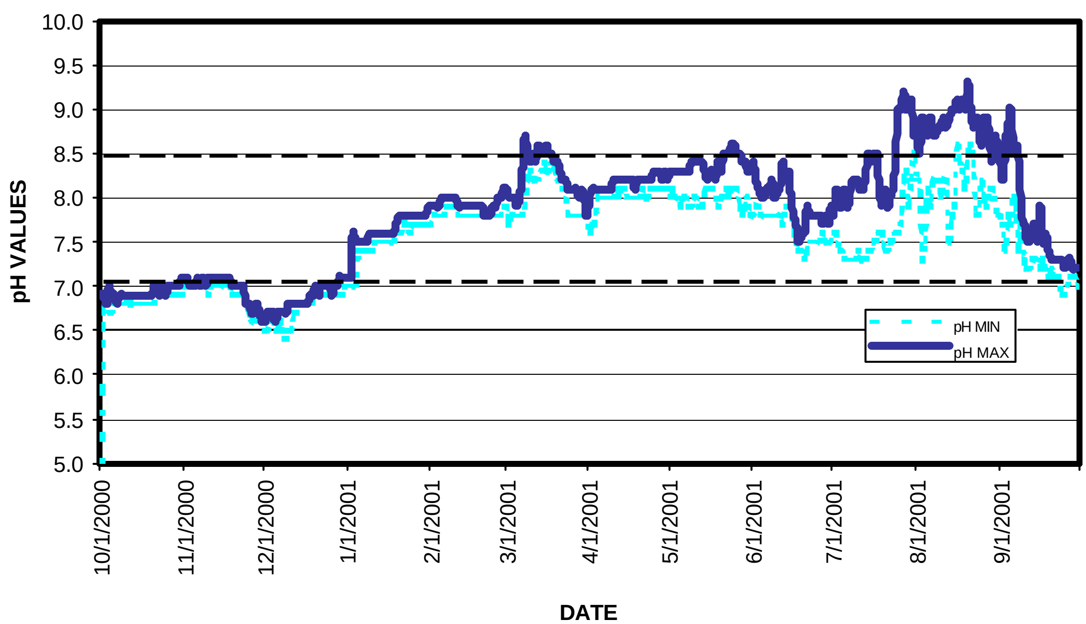

Fig. 23. Minimum and maximum pH values at Iron Gate for WY 2001.

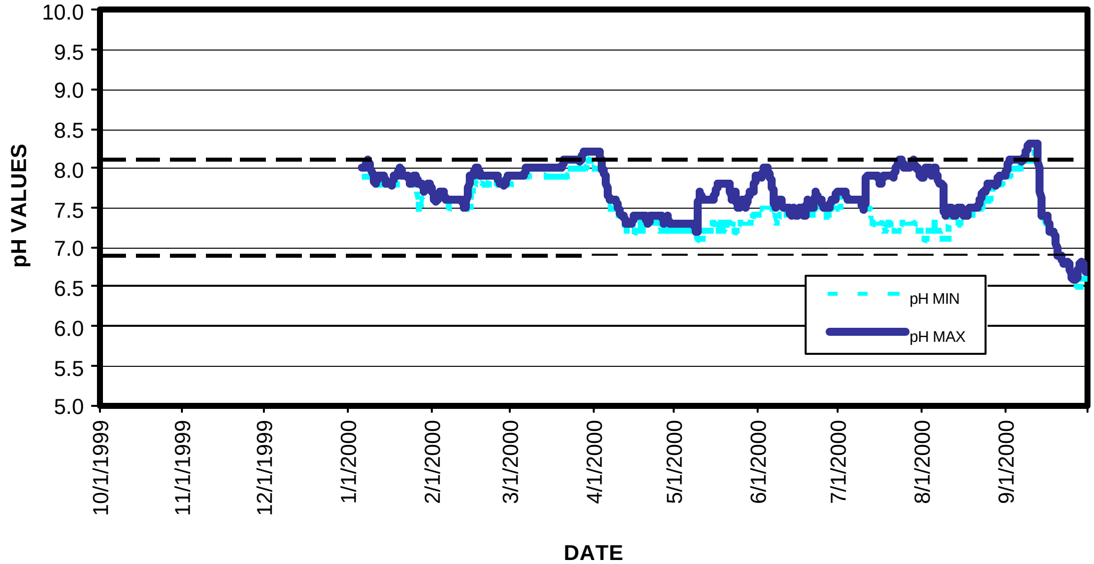

Fig. 24. Minimum and maximum pH values at Seiad Valley for WY 2000.

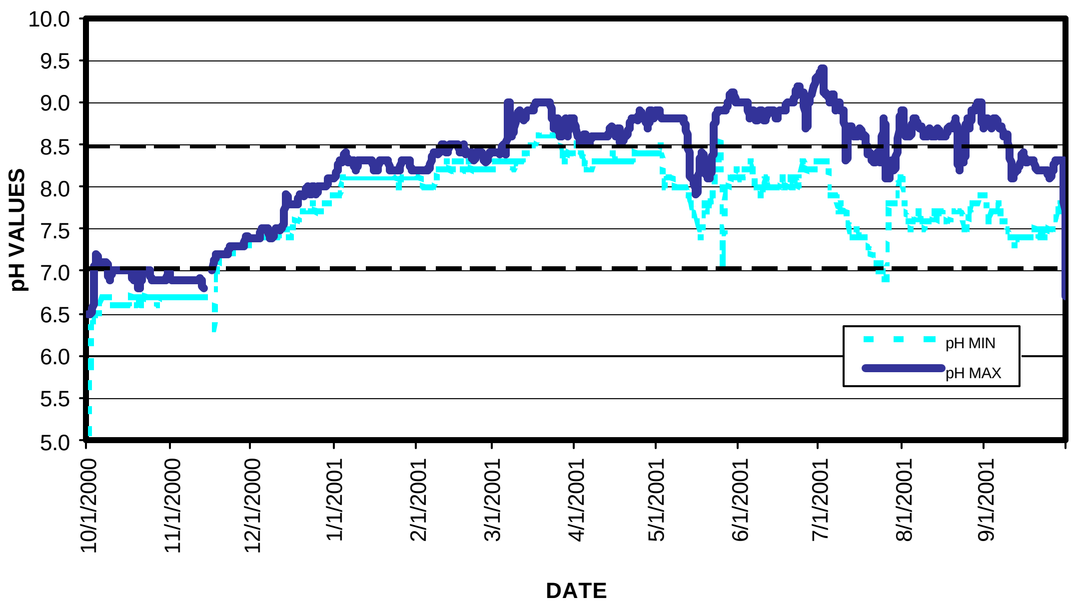

Fig. 25. Minimum and maximum pH values at Seiad Valley for WY 2001.

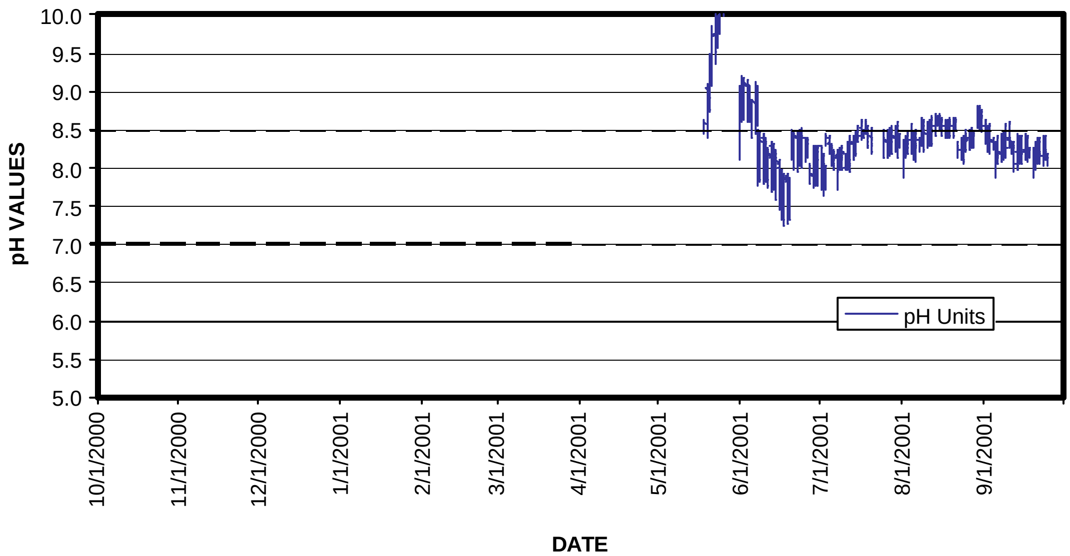

Fig. 26. pH values at Orleans for WY 2001.

6.5 Specific Conductance

Specific conductance (SC) is a measure of the electrical conductance by water at 25°C, and is a function of the concentration of dissolved solids in solution. The higher the concentration of dissolved solids in solution, the higher the SC of the water (Gwynne, 1993). SC measures how well water can conducts an electrical current across a particular length.

Conductivity increases with increasing amount and mobility of ions. These ions, which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. Therefore, SC is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron, and can be used as an indicator of water pollution. The Karuk Tribe's standard is consistent with the state of California's, which is 350 µmhos/cm for a 90% upper limit and 275µmhos/cm for a 50% upper limit.

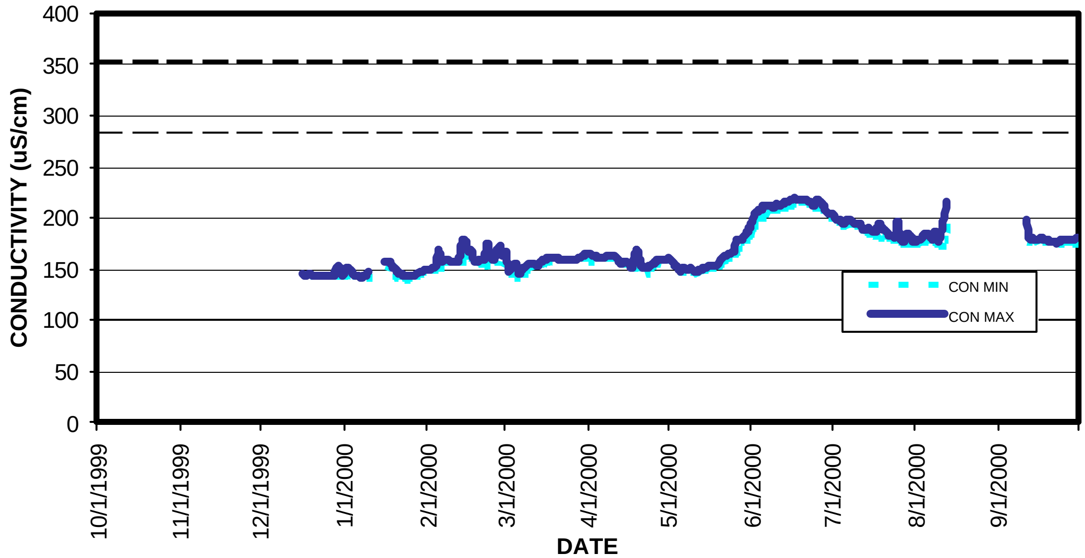

Fig. 27. Minimum and maximum conductivity values at Iron Gate for WY 2000.

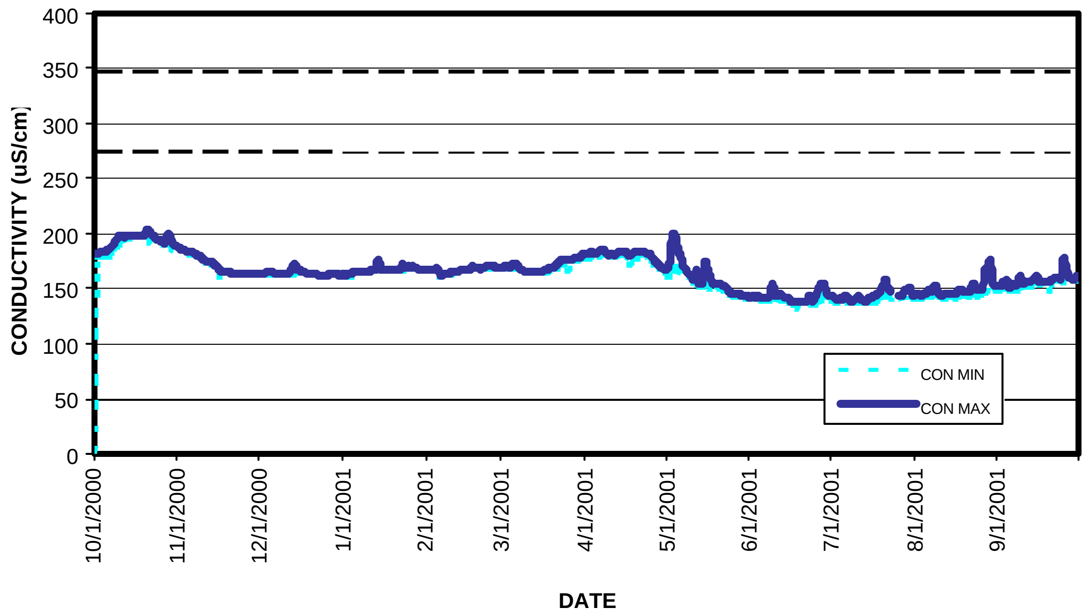

Fig. 28. Minimum and maximum conductivity values at Iron Gate for WY 2001.

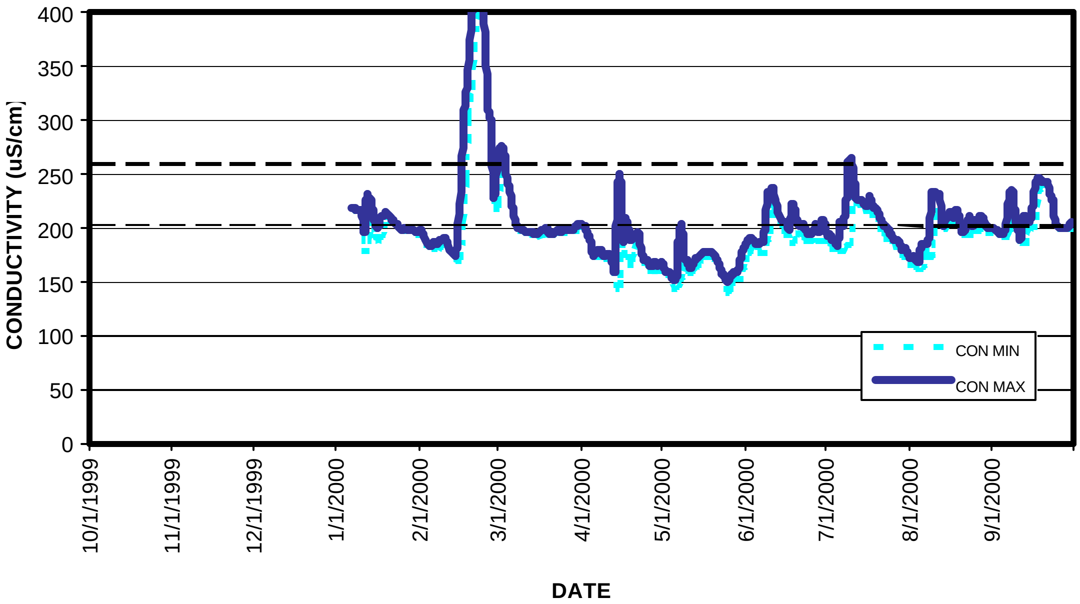

Fig. 29. Minimum and maximum conductivity values at Seiad Valley for WY 2000.

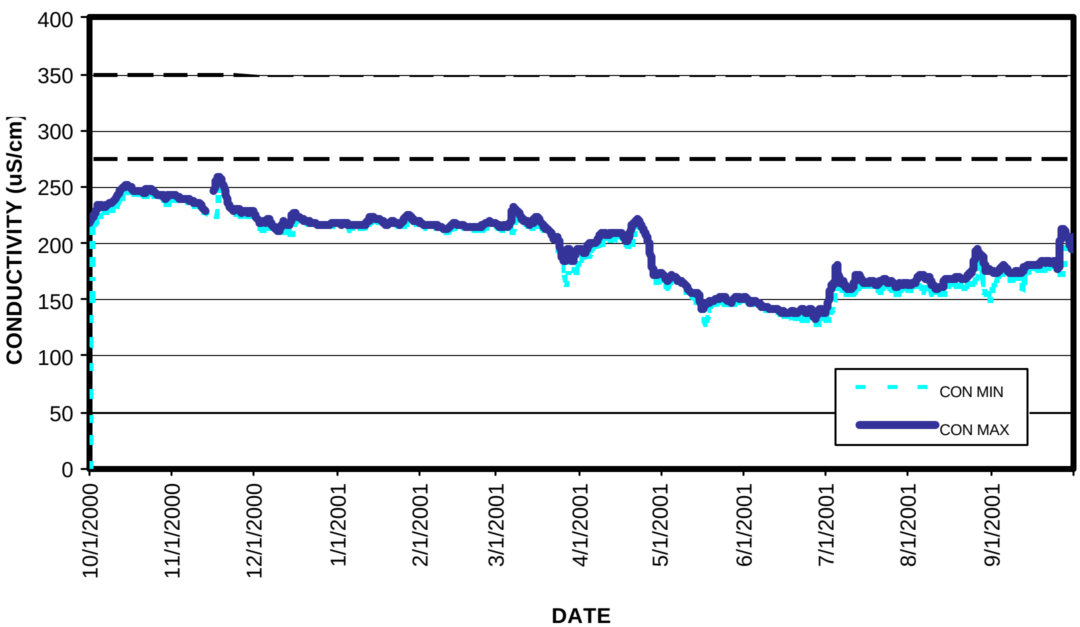

Fig. 30. Minimum and maximum conductivity values at Seiad Valley for WY 2001.

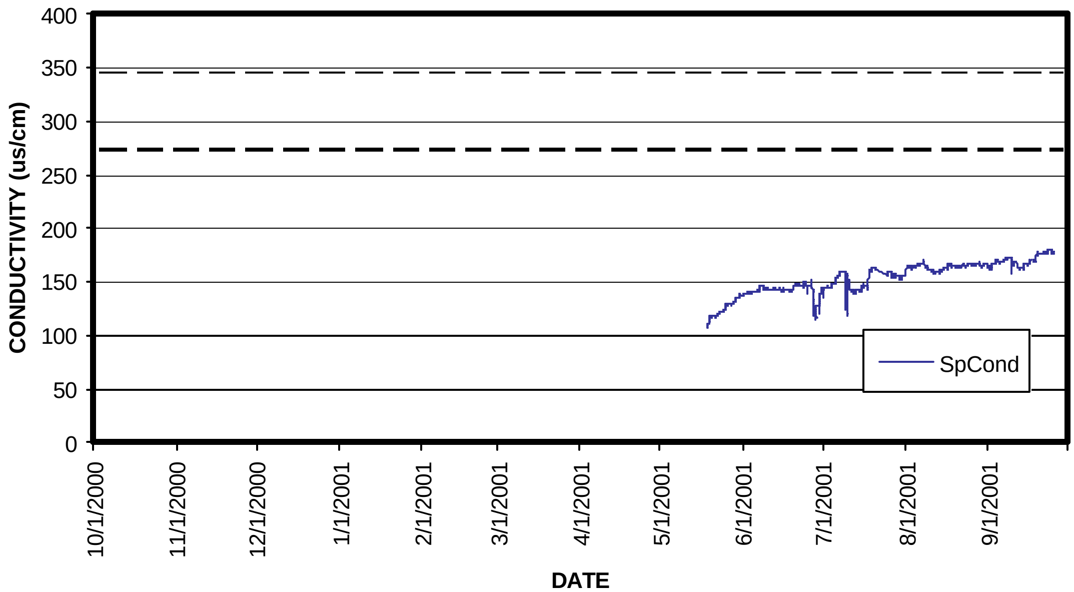

Fig. 31. Conductivity values at Orleans for WY 2001.

6.6 Air Temperature

Air temperature has a direct and substantial effect on the temperature of water. Aside from possible global warming, most air temperature fluctuations can be thought of as natural. Water possesses many important thermal qualities. For instance, water has a high specific heat, which means water is not subject to rapid temperature fluctuations because it can absorb or lose large amounts of heat with relatively small changes in temperature. Small water bodies will be influenced by air temperature more quickly than larger water bodies. This attribute causes water temperature to change gradually in response to seasonal changes. Water temperature is most influenced by the temperature of the air during the summer season, when we have both long and hot days and nights.

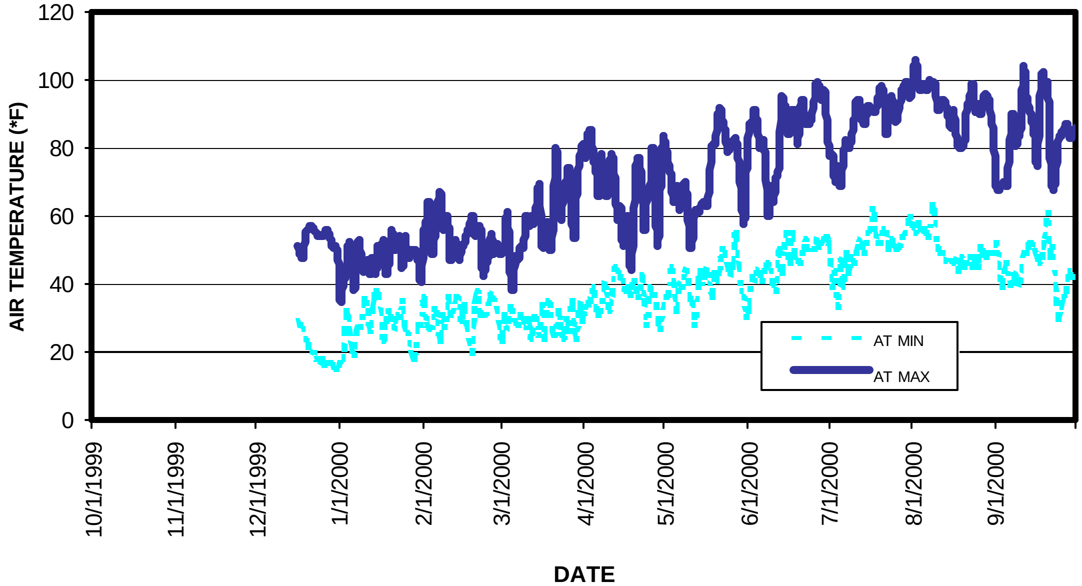

Fig. 32. Minimum and maximum air temperature at Iron Gate for WY 2000.

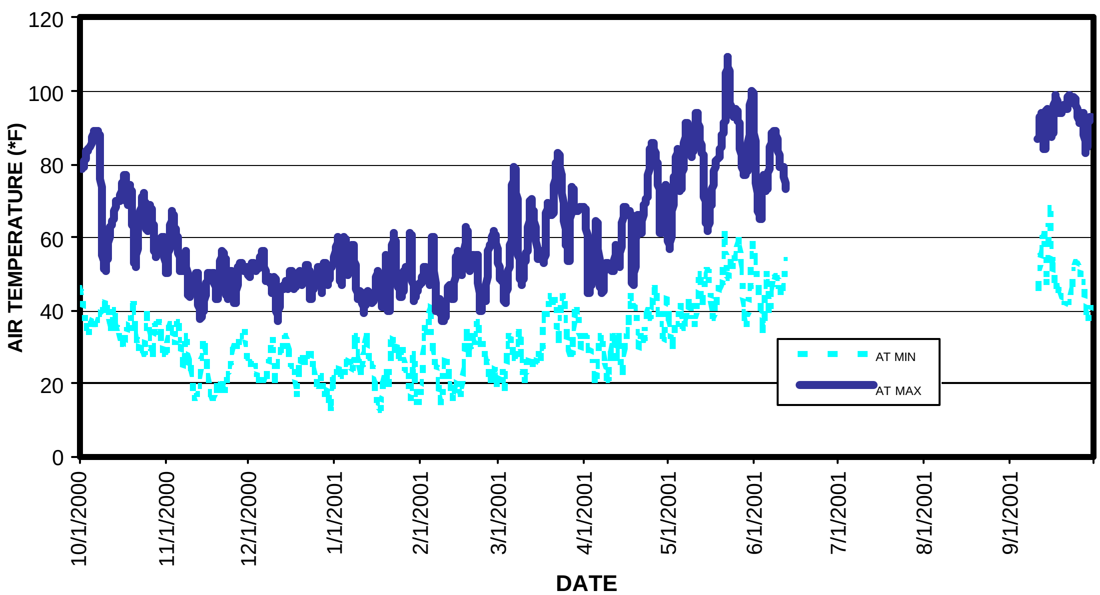

Fig. 33. Minimum and maximum air temperature at Iron Gate for WY 2001.

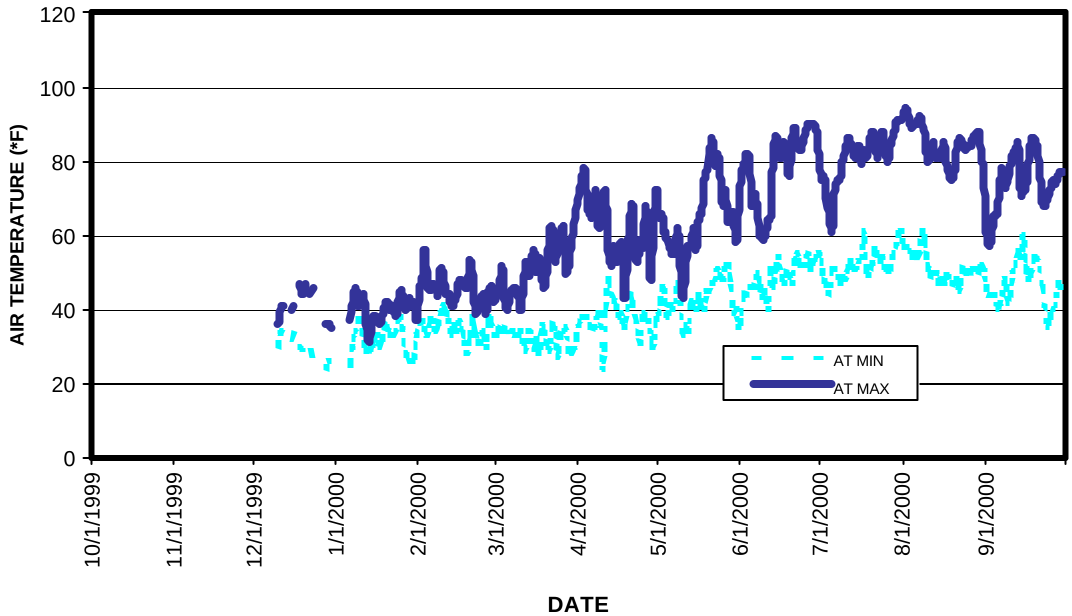

Fig. 34. Minimum and maximum air temperature for Seiad Valley WY 2000.

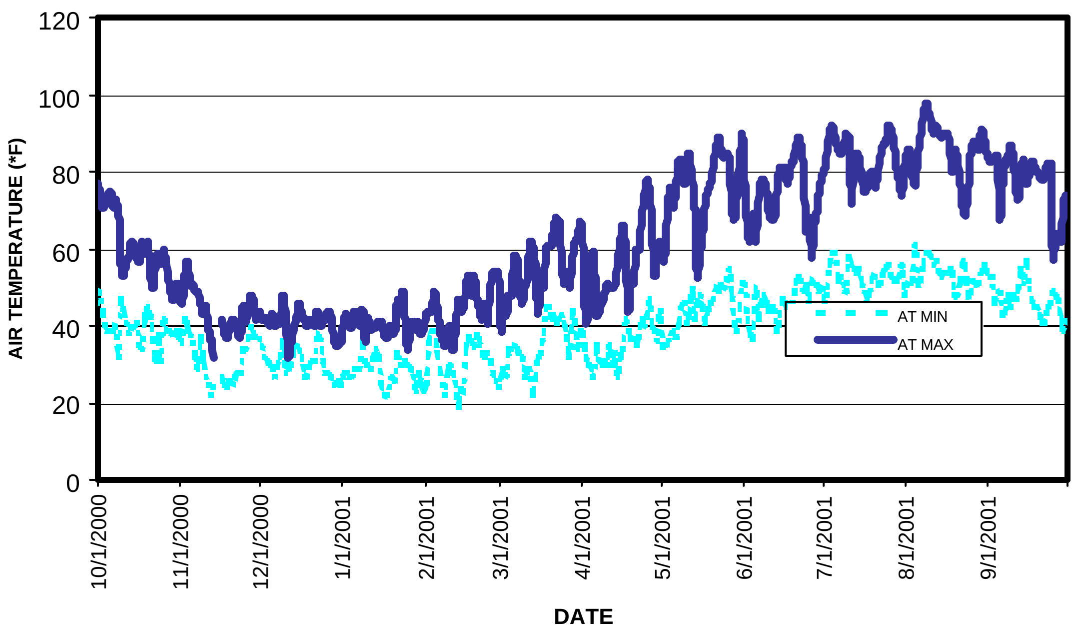

Fig. 35. Minimum and maximum air temperature for Seiad Valley WY 2001.

6.7 Precipitation

Data from October 1st 1999 to December 15th 2000 was obtained from the Oregon Climate Service, Klamath Falls Station.

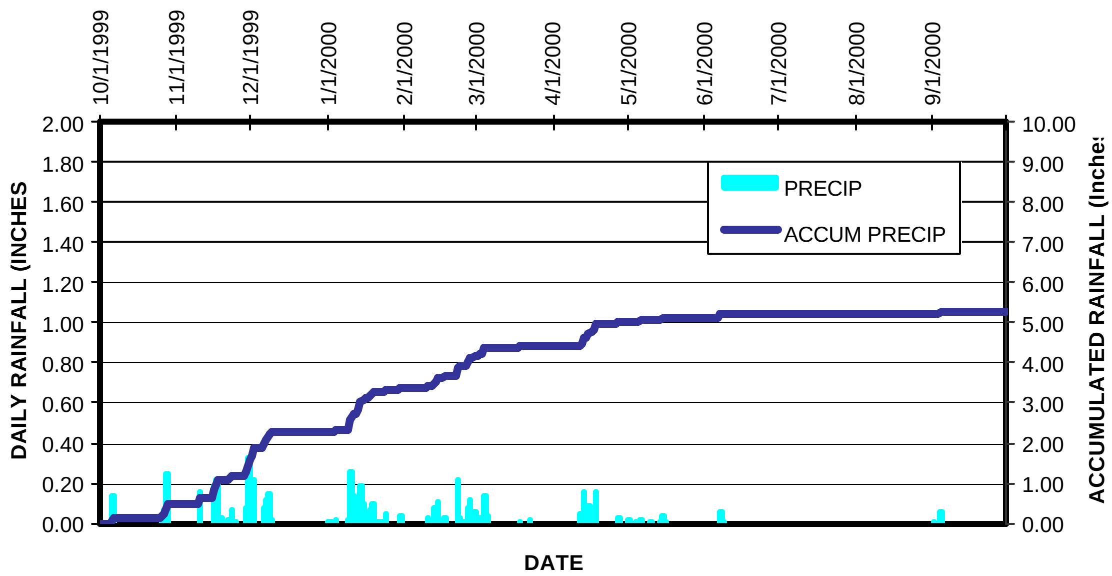

Fig. 36. Daily and accumulated precipitation at Iron Gate for WY 2000.

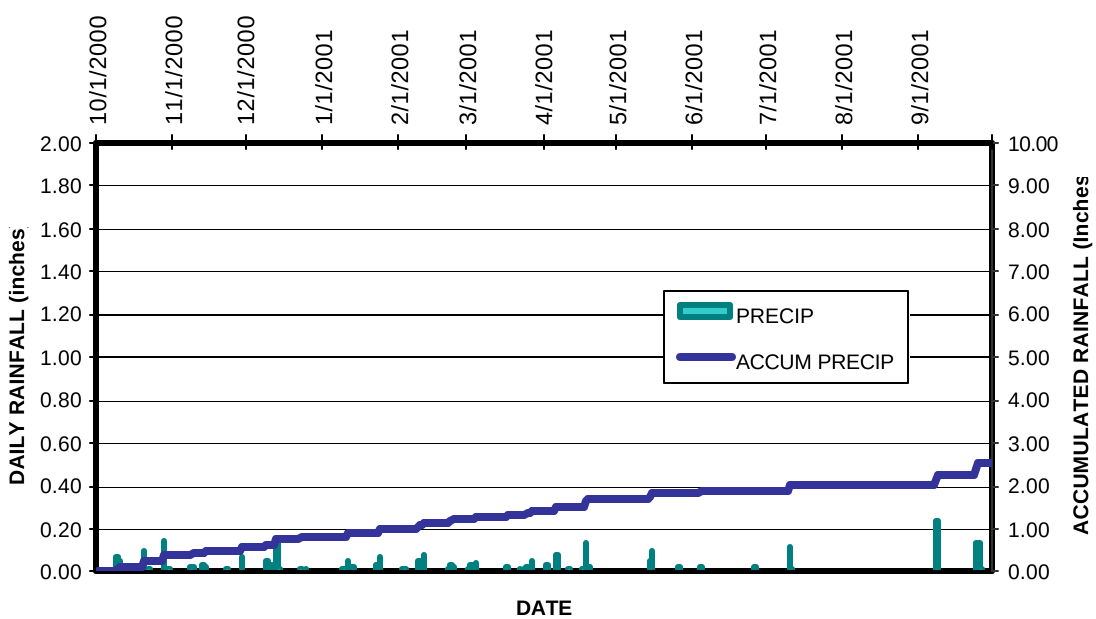

Fig. 37. Daily and accumulated precipitation at Iron Gate for WY 2001.

7.0 DATA MANAGEMENT

During water years 2000 and 2001 the USGS collected all water quality data via a data collection platform located at each water quality station. Data was downloaded with a laptop computer and transported to the field office. Once the data was downloaded, correction factors were applied to the raw data using a program called ADAPS housed at the USGS Water Resource Division in Sacramento, California. This program converts raw data by applying a correction factor over time based on field measurements. This data is published through the USGS Annual Report for Water Resources Data.

Data gaps occur at the Iron Gate, Seiad Valley and Orleans gauges. The figure below lists the gauge, the dates the probe was non-operational, the affected sensor, and the reason for the gap in the data.

Table 1. List of non-operational sensors and dates of non-operation.

Gauge	Date	Sensor	Reason
Iron Gate	10/01/1999 to 12/16/1999	All Sensors	Probe not installed
Iron Gate	01/11/2001 to 01/15/2002	pH	Faulty Sensor
Iron Gate	10/01/1999 to 03/07/2000	Dissolved Oxygen	Sensor not installed
Iron Gate	05/07/2000 to 05/09/2000	Dissolved Oxygen	Faulty Sensor
Iron Gate	07/18/2000 to 07/20/2000	Dissolved Oxygen	Faulty Sensor
Iron Gate	08/08/2000 to 09/11/2000	Dissolved Oxygen	Faulty Sensor
Iron Gate	09/27/2000 to 09/30/2000	Dissolved Oxygen	Faulty Sensor
Iron Gate	08/13/2000 to 09/10/2000	Conductivity	Faulty Sensor
Iron Gate	03/17/2001 to 04/02/2001	Dissolved Oxygen	Faulty Sensor
Iron Gate	06/13/2001 to 09/10/2001	Air Temperature	Faulty Sensor
Seiad Valley	10/01/1999 to 01/05/2000	All Sensors	Probe not installed
Seiad Valley	05/05/2000 to 03/07/2000	Dissolved Oxygen	Faulty Sensor
Seiad Valley	06/07/2000 to 07/11/2000	Dissolved Oxygen	Faulty Sensor
Seiad Valley	08/09/2000 to 09/30/2000	Dissolved Oxygen	Faulty Sensor
Seiad Valley	10/01/2000 to 10/04/2000	Dissolved Oxygen	Faulty Sensor
Seiad Valley	10/18/2000 to 01/04/2001	Dissolved Oxygen	Faulty Sensor
Seiad Valley	03/24/2001 to 04/03/2001	Dissolved Oxygen	Faulty Sensor
Seiad Valley	08/08/2001 to 08/15/2001	Dissolved Oxygen	Faulty Sensor
Seiad Valley	08/27/2001 to 09/05/2001	Dissolved Oxygen	Faulty Sensor
Orleans	10/01/1999 to 05/17/2001	All Sensors	Probe not installed

Water quality data, as well as reports and appendixes, are available via the Karuk Tribe's Department of Natural Resources web site at www.pcweb.net/karukdnr, or through the California Data Exchange Center (CDEC) at http://cdec.water.ca.gov/. Search for KIW for the Iron Gate water quality station, and KSW for the Seiad Valley water quality station.

8.0 SUMMARY

The purpose of this study is to develop baseline information that the Tribe, other agencies, and interested groups, can utilize in assessing the condition of the Klamath River. During this ongoing water quality monitoring effort, a significant amount of resources have been expended to produce the data. Included are the Karuk Tribe's "Interim", as well as the state of California's numeric water quality standards where appropriate.

Both the state of California as well as the Karuk Tribe's "Interim" water quality standards were violated numerous times during this study. The most alarming violations are to the acute and chronic water temperature standards, as well as the minimum dissolved oxygen standard. These standards are continually exceeded between May and October at the Iron Gate, Seiad and Orleans gauges.

The data within this document should help the reader develop an opinion as to the water quality conditions that exist within the Klamath River. It is the intention of the Karuk Tribe's Water Resources staff to paint an accurate picture as possible of the condition of our water resources, using the best available science.

9.0 LITERATURE CITED

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Appendix A

Iron Gate Water Quality Data, Water Year 2000

Appendix B

Iron Gate Water Quality Data, Water Year 2001

Appendix C

Seiad Valley Water Quality Data, Water Year 2000

Appendix D

Seiad Valley Water Quality Data, Water Year 2001