KARUK TRIBE OF CALIFORNIA

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

2007
WATER QUALITY ASSESSMENT REPORT

KLAMATH RIVER, SALMON RIVER, SCOTT RIVER, SHASTA RIVER, TI-BAR CREEK AND IRVING CREEK

Karuk Tribe of California

Water Quality Assessment Report
2007

Prepared by
Karuk Tribe of California
Water Resources
June 2007

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JUNE - OCTOBER 2007

1 BACKGROUND

The Karuk Tribe of California is the second largest Tribe in California, with over 3,500 Tribal members currently enrolled. The Karuk Tribe is located along the middle Klamath River in northern California. Karuk Ancestral Territory covers over 90 miles of the mainstem Klamath River and numerous tributaries. The Klamath River system is central to the culture of the Karuk People, as it is a vital component of our religion, traditional ceremonies, and subsistence activities. Degraded water quality and quantity has resulted in massive fish kills, increased populations of toxic algae, and pandemic fish diseases, in addition to the extreme limitations and burdens applied to our cultural activities.

2 PURPOSE

It is the mission of the Karuk Tribe of California to protect, promote, and preserve the cultural, resources, natural resources, and ecological processes upon which the Karuk People depend. This mission requires the protection and improvement of the quality and quantity of water flowing through Karuk Ancestral Territory and Tribal trust lands. The Karuk Tribe's Department of Natural Resources has been monitoring daily water quality conditions in the Klamath River since January of 2000 and tributaries to the Klamath River since 1998. The Karuk Tribe has been collaboratively involved in maintaining water quality stations along the Klamath River and its tributaries with the United States Fish and Wildlife Service (USFWS), the United States Geological Survey (USGS), and the Yurok Tribe.

This data is important to state and federal processes currently underway and provides information for Tribal Council and resource managers to make informed decisions. The Klamath Hydroelectric Project (KHP) is undergoing relicensing by the Federal Energy Regulatory Commission (FERC). Along with this process both Oregon and California will have to issue 401 certifications for the KHP. The North Coast Regional Water Quality Control Board (NCRWQCB) is developing and/or implementing Total Maximum Daily Loads (TMDL's) for the Scott, Shasta, Salmon, and Klamath Rivers. Tribes, counties, and the state of California have developed draft guidance for public health for a toxic blue green algae *Microcystis aeruginosa* and associated toxin microcystin. The water quality data the Karuk Tribe collects is essential to providing quality data regarding processes that involve and affect the Karuk Tribe.

The purpose of this study is to monitor the quality of water flowing into and out of Karuk Ancestral Territory and Tribal trust lands. The information produced allows the Karuk Tribe to give valuable input on land management decisions and demonstrates the Tribe's commitment to sound resource management. The data produced is indispensable in monitoring water quality conditions within the Klamath River System. We are building a long-term monitoring data set that lets us track these conditions and monitor for improvement. During 2007, Karuk Water Quality employees performed all data collection, QA/QC, and database management. Funding for this project has come mainly through the Karuk Tribe's EPA 106 Water Pollution Control Program with some support from the Klamath Basin Water Quality Workgroup and the USFWS Habitat Assessment Program.

3 MONITORING METHODS & QA/QC Summary

Monitoring Methods

The Karuk Tribe monitored six water quality stations in the summer of 2007 and three sites in the winter of 2007. Summer monitoring sites included the Klamath River near Orleans, the Klamath River near Seiad Valley, the Klamath River below Iron Gate dam, and the Scott, Salmon and Shasta Rivers. Parameters collected included water temperature, dissolved oxygen (DO), pH, and specific conductance. These parameters were measured using YSI 6600 V2 multiparameter probes, which collected the aforementioned parameters every half-hour. The Orleans and Seiad sites were linked to satellites to allow real time monitoring via the Internet. This was accomplished by collaboration with USGS and the Yurok tribe. The 2007 winter turbidity data was collected using HydroLab DataSonde 4a multiparameter instruments; Turbidity measurements were taken every half hour using an optical turbidity probe. Sites for winter monitoring included Irving Creek, Salmon River, and Ti-Bar Creek. Nutrient data was obtained biweekly in the mainstem Klamath and monthly in the tributaries, using grab samples that were then analyzed by an independent lab.

Water quality monitoring sites utilizing multiparameter probes were visited at biweekly intervals. At this time audits were performed with a Hydrolab Quanta, a hand-held water quality instrument. The audits allowed field personnel to compare Quanta and YSI or HydroLab readings taken before and after calibration. Calibration of the YSIs and HydroLabs was performed in the field to minimize the amount of time the instruments were out of the water and thus not collecting data. Water quality probes were calibrated and serviced according to USFWS Quality Assurance/Quality Control protocol. These calibrations followed the specific manufacturer's instructions as outlined in the section 2.6.1 ***Calibration Procedures***[1] of the YSI manual and the ***Maintenance, Calibration and Storage***[2] section of the HydroLab manual. During these regular visits, data was downloaded from the probes, bought back to the office, and reviewed.

QA/QC

The Department of Natural Resources Water Quality Program developed an EPA-approved Quality Assurance Project Plan (QAPP) to ensure that data generated from environmental measurement studies are technically sound and legally defensible. The QAPP summarizes procedures to be followed in administering federally funded programs that involve measurement of environmental parameters. The QAPP applies to special water quality studies involving surface and ground water bodies, as well as surveillance and compliance monitoring of discharges.

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[1] YSI Incorporated. "Calibration Procedures. "6-Series Environmental Monitoring Systems Operations Manual.

[2] Hydrolab, Corporation. "Maintenance, Calibration and Storage. "DataSonde 4 and MiniSonde Water Quality Multiprobes User's Manual. Revision G. 1999.

Briefly, the QAPP requires that (a) physical and professional capabilities be adequate to perform the analysis for all parameters in the sampling plan; (b) sample collection, handling, and preservation be conducted according to EPA manuals; (c) time-sensitive samples be transported and analyzed within specific holding times; (d) sample integrity be provided for a legal chain of custody of samples collected for support of enforcement actions; (e) analytical methods be in accordance with standardized methods; and (f) analytical quality control procedures be established for intra-laboratory checking of reference samples. Laboratory records including reference sample results are to be available for EPA.

A detailed description of our QA/QC is available in our QAPP; however a brief summary for our YSI and HydroLab monitoring data follows. For monitoring with YSIs and HydroLabs, QA/QC was performed in both the field and the office. Every two weeks in the field, probes were examined, cleaned, and calibrated. In the office, data was reviewed to help locate failed probes or other malfunctions in a timely manner. Daily values (based on at least 46 of 48 measurements since data was collected in ½ hour intervals) were obtained utilizing an Excel spreadsheet. If there were less than 46 measurements for a 24-hour period that day’s data was not used in the daily maximum, mean, and minimum calculations. In 2007, optical dissolved oxygen (DO) probes were utilized on all YSI instruments thereby eliminating the 24-hour “rest” period associated with the Clark’s membrane probe used in previous years. All data collected has gone through QA/QC, outliers and instances of improper calibration were removed from further analysis.

4 WATER QUALITY PARAMETERS

Water quality data collected included water temperature, dissolved oxygen, pH, specific conductivity, nutrients and turbidity. These parameters are outlined and described below. Karuk tribal water quality standards are included where applicable.

4.1 Water Temperature

Water temperature varies both seasonally and diurnally (within a twenty-four hour period). Elevated temperatures may lead to increased metabolic rates in organisms and algal growth. Many factors can affect stream temperature, including discharge, 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.

Temperature has an impact on many beneficial uses in the Klamath River, including cold-water fish, subsistence fishing, cultural use, and recreational use. A common method to assess water temperature for streams that support salmonid populations is to compare sustained water temperatures to an acute and chronic temperature standard. The acute standard represents the lethal temperature for salmonids . The chronic temperature designation represents the maximum weekly average temperature (MWAT), which is the upper limit for optimum growth for salmonids. The Karuk Tribe’s water quality objectives have set the maximum temperature threshold at 21°C and MWAT of 15.5°C[3]. The NCRWQCB is currently working on adding numeric temperature objectives for the Basin Plan.

4.2 Dissolved Oxygen

Dissolved oxygen (DO) varies both seasonally and diurnally, particularly in the summer when photosynthesis adds oxygen to the system during the day and respiration consumes it at night. In cold water, oxygen is more soluble; therefore the amount of available oxygen for salmonids is greater. Oxygen levels lower when water temperatures are elevated and more photosynthesis is occurring. 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 water quality objectives have established minimum DO levels for waters designated as Cold Freshwater Habitat (COLD) in the Karuk Tribe Water Quality Control plan, to be 6.0 mg/L. Areas providing Spawning, Reproduction, and/or Early Development habitat (SPWN) need to maintain a minimum DO of 9.0 mg/L for tribal trust fish species. The state of California has established a minimum DO level of 8.0 mg/L.

4.3 pH/Alkalinity

The pH level or alkalinity of water refers to the concentration of hydrogen and hydroxide ions in the water. Water becomes more acidic with higher concentrations of hydrogen ions and lower concentrations of hydroxide ions, likewise water will be more basic if there are more hydroxide ions present than hydrogen ions. Water temperature has a significant impact on the concentrations of these ions in water. As water temperatures rise, algae and plant photosynthesis increases, leading to a daily fluctuation of pH. Photosynthesis extracts dissolved CO_2 from the water column, which was previously in the form of carbonic acid, H_2CO_3. High levels of photosynthesis cause the pH to rise during the day and lower at night when respiration is occurring. High pH levels cause ammonium ions to go from an ionized state to a de-ionized form that is vastly more toxic to fish. The Klamath River has abundant ammonium ions due, in a large part, to agricultural runoff and nitrogen fixation by algae within the reservoirs. The pH or alkalinity also determines the solubility and biological availability of nutrients and other chemicals in water. Changes in pH can greatly influence how much of a nutrient or chemical is available for use by aquatic organisms. The Karuk Tribe has established a minimum pH objective of 6.5 and a maximum of 8.5. Changes in normal ambient pH levels shall not exceed 0.5 units within the range specified above in fresh waters with designated COLD or WARM beneficial uses[4].

4.4 Specific Conductance

Specific conductance is a measure of the electrical conductivity of water at 25°C, and is a function of the concentration of dissolved solids in solution. A solution with a high concentration of dissolved solids will yield a greater value for the specific conductance than a solution with lower concentrations of dissolved solids. Specific conductivity measures how well water can

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[3] Tripp, Sandi, and Susan Corum. Karuk Tribe of California. Department of Natural Resources. Water Quality Control Plan. Orleans, CA: 2002.

[4] Tripp, Sandi, and Susan Corum. Karuk Tribe of California. Department of Natural Resources. Water Quality Control Plan. Orleans, CA: 2002.

conduct an electrical current across a particular length. Conductivity increases with increasing amounts of unbound ions. These ions, which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. Therefore, specific conductivity 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 specific conductance objective is consistent with the NCRWQCB, which is 350 µs/cm for a 90% upper limit and 275 µs/cm for a 50% upper limit. The 90% upper and lower limits represent the 90th percentile values for a calendar year. Ninety percent or more of the values must be less than or equal to an upper limit and greater than or equal to a lower limit. The 50% upper and lower limits represent the 50 percentile values of the monthly means for a calendar year. Fifty percent or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit.

4.5 Nutrients

Nutrient grab sampling was conducted at 6 sites. Mainstem sites were located just upstream of the Orleans Bridge, Sluice Box river access downstream of Seiad Valley, and just below Iron Gate dam. These sites were sampled on a biweekly basis. Tributary sites were located near the mouths of the Salmon River, Scott River and Shasta River. These sites were sampled monthly. The sampling protocol was adapted from USFWS and the Yurok tribes grab sample protocol. Nutrient samples were then sent to Aquatic Research in Seattle, Washington to be analyzed.

4.6 Turbidity

Turbidity data was collected from February to April on Irving Creek, Salmon River, and Ti Bar Creek using HydroLab DataSonde 4a optical turbidity probes. These streams were selected based on road decomissioning efforts occurring in prior years by the Karuk Watershed Restoration crew. The monitoring was timed to capture sediment flushes in the watersheds from both rain and rain-on-snow events.
These were calibrated to the specifications outlined in the ***Maintenance/Calibration/Logging Procedures*** [5] section in the manufactures manual.

4.7 Flow

Stream flow (ft^3/sec) data are from USGS gauging stations located in the Klamath Basin and its tributaries. All water quality monitoring stations are directly associated with USGS gauging stations except the Scott River site. The nearest USGS flow gage on the Scott is about 20 miles upriver of the monitoring site. Flow rates in the Klamath Basin are affected by a variety of variables including rainfall, snow pack, dam releases, agricultural use, domestic use, evapotranspiration rates, and groundwater levels.

Stream flow has an impact on all of the water quality parameters mentioned above as well as for listed beneficial uses. For example, subsistence fishing for the Karuk Tribe at Ishi Pishi Falls is a flow-dependent fishery. Flow is also critical to provide ample habitat for Tribal Trust fish

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[5] Hydrolab, Corporation. "Maintenance, Calibration and Storage. "DataSonde 4 and MiniSonde Water Quality Multiprobes User's Manual. Revision G. 1999.

species. Adequate flows allow fish access to rearing, feeding, and cover habitat. Flows also need to be high enough to allow connectivity to cold water refugias and tributaries, so that fish may move freely into and out of these habitats to find relief from high summer water temperatures and other detrimental water quality parameters. Flow and how it relates to fish disease and toxic algae blooms is also being investigated in other studies.

5 WATER QUALITY STATIONS

The Karuk Ancestral Territory, located along the middle course of the Klamath River and the lower Salmon River in Northern California, includes an estimated 1.38 million acres within the Klamath River Basin. This portion of the Klamath Basin has over 1,900 miles of perennial streams, thousands of acres of wetlands and riparian areas, and approximately 107 lakes. Approximately 90 miles of the Klamath River transects the Territory. Several major tributaries flow into the Klamath within the Ancestral Territory. The USDA-Forest Service has defined 19 watersheds or sub-basins that exist wholly or partially in the Territory. The following tables summarize waters within the ancestral territory, tribal uses and goals of these waters, and impairments to these uses and goals (Tables 1-2).

Atlas of Tribal Waters Within Ancestral Territory	
Total number of Klamath River miles	90
Total number of perennial stream miles	1,900
Total number of lake acres	442
Total number of wetland acres	UNKNOWN

Table 1 - Atlas of Tribal Waters within Ancestral Territory

Making Assessment Decisions	
Designated Beneficial Uses and Tribal Goals	**Parameter(s) to be Measured to Determine Support of Use of Goal**
Rare, Threatened, or Endangered Species (RARE)	Temperature, DO, pH, Conductivity,
Subsistence Fishing (FISH)	Temperature, DO, pH, Conductivity
Cold Freshwater Habitat (COLD)	Temperature, Turbidity
Cultural Contact Water (CUL-1)	Temperature, Phosphorus, Nitrogen
Cultural Non-Contact Water (CUL-2)	Temperature, Phosphorus, Nitrogen
Fish Consumption (FC)	Temperature, Phosphorus, Nitrogen
Water Contact Recreation (REC-1)	Temperature, Phosphorus, Nitrogen
Non-Contact Water Recreation (REC-2)	Temperature, Phosphorus, Nitrogen
Spawning, Reproduction, and/or Early Development (SPWN)	Temperature, DO, pH, Conductivity, Turbidity

Table 2 - Designated uses and tribal goals and what parameters are measured to monitor impairments to these uses and goals.

Use/Goal Support in Tribal Streams				
Designated Use or Tribal Goal	No. of Stream Miles Monitored/Assessed	No. of Stream Miles Fully Supporting Use or Goal	No. of Stream Miles Supporting Use or Goal but Threatened	No. of Stream Miles Not Supporting Use or Goal
RARE	178	0	156	22
FISH	178	0	0	178
COLD	178	0	16	162
CUL-1	178	0	16	162
CUL-2	178	0	16	162
FC	178	0	0	178
REC-1	178	0	16	162
REC-2	178	0	16	162
SPWN	178	0	0	178

Table 3 – Extent to which rivers meet designated uses or tribal goals.

For 2007, water quality monitoring stations were located at three fixed points along the mainstem Klamath River. These stations create a longitudinal profile of water entering and exiting the Mid-Klamath region. Three monitoring sites have been established on larger tributaries to the Klamath River, which are within and upstream of Karuk Ancestral Territory. The tributary sites are on the Salmon, Scott and Shasta Rivers. These sites are located near the mouths to highlight their influence on the mainstem Klamath. These tributaries also supported abundant runs of spring and fall chinook, coho, steelhead, lamprey, and sturgeon (Salmon River only). The health of these tributaries is closely tied to the well being of the Klamath River, the Karuk people, and the River's ability to support beneficial uses.

5.1 Klamath River Stations

The following section describes the Klamath River monitoring sites. Tables 3 and 4 summarize impairments to the Klamath River and identify sources of these impairments. The Klamath River is currently listed under the federal Clean Water Act (CWA) section 303(d) for temperature, dissolved oxygen, and nutrients. A TMDL is being developed for the Klamath and should be adopted by 2010.

Causes of Impairment in Klamath River		
Parameter	**No. Of Stream Miles Monitored or Assessed**	**No. Of Stream Miles Not Supporting Use or Goal**
Dissolved Oxygen	**140**	**140**
pH	**140**	**140**
Water Temperature	**140**	**140**
Phosphorous	**140**	**140**
Total Nitrogen	**140**	**140**

Table 4 - Causes of impairments in Klamath River

Sources of Impairment in Klamath River		
Source of Impairment	**Number Of Stream Miles Monitored or Assessed**	**Number Of Stream Miles Not Supporting Use or Goal**
Hydrological modification	**140**	**140**
Agriculture (livestock grazing)	**50**	**50**
Legacy Roads	**140**	**140**
Timber Harvesting	**140**	**140**
Mining Activities	**140**	**140**

Table 5 - Sources of impairments in Klamath River

5.1.1 Below Iron Gate Dam

This monitoring site is located just downstream of Iron Gate dam, the fish hatchery, and Bogus Creek at the USGS gauging site. Data collected here monitors the quality of water exiting the dam and entering the Mid-Klamath region. Nutrient grab samples were taken at the Iron Gate River Access upstream of the fish hatchery and Bogus Creek but still downstream of the dam (Figure 2). This site monitors a drainage area of approximately 4,630 square miles. This area of the Klamath is much drier than down river and is vegetated by oak woodlands.

The approximate location of this station is:
Latitude: 41°55'41" N
Longitude 122°26'35" W NAD27
Elevation: 2,162.44 feet above sea level

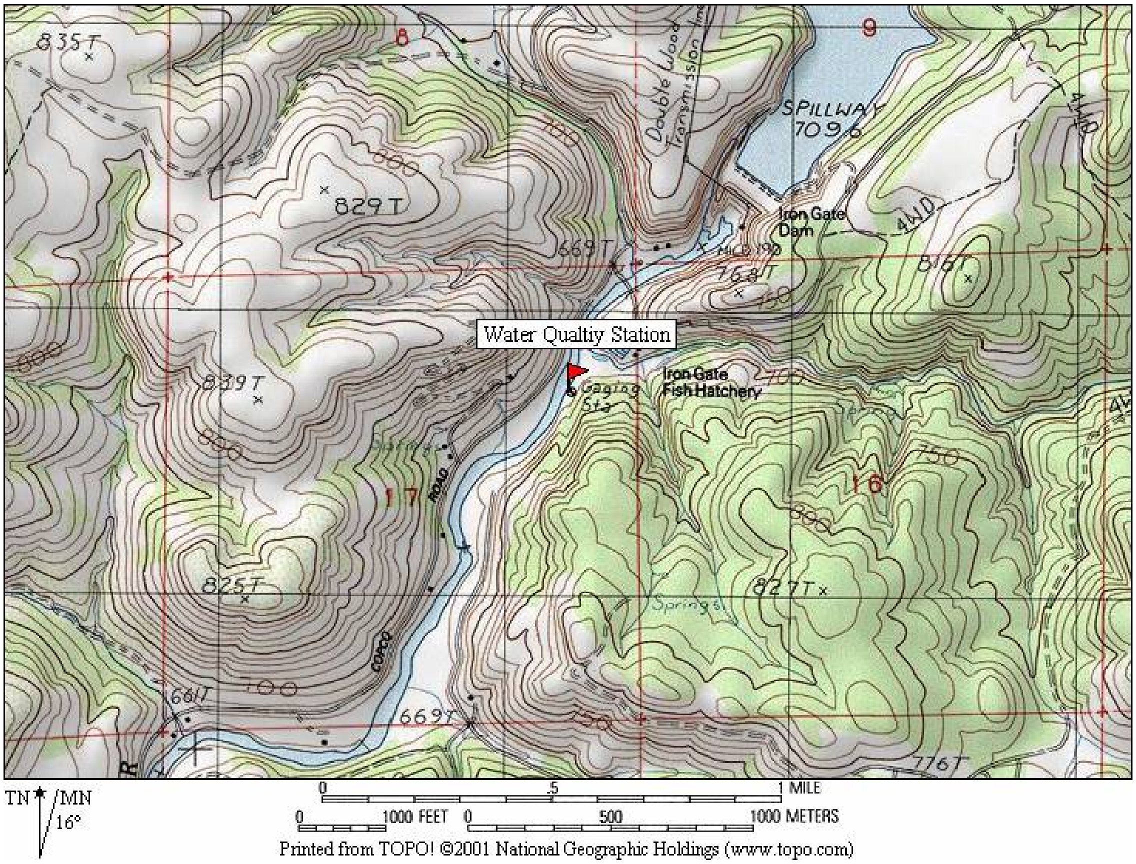

Figure 1 - Klamath River below Iron Gate Dam water quality station.

Figure 2 - Klamath River below Iron Gate Dam across river looking up from water quality station.

5.1.2 Near Seiad Valley

This monitoring site is located at the USGS gauging station approximately 62 miles downriver from the Iron Gate Monitoring site and 2.2 miles south of Seiad Valley. Nutrient grab samples were taken at the Sluice Box river access upstream of the gage but downstream of Seiad Valley. The Seiad Valley site is at the more upstream end of Karuk Ancestral Territory and monitors a drainage area of approximately 6,940 square miles. Conifers dominate this area and the topography is much steeper than the area surrounding the Iron Gate site. These landscape changes are captured in Figures 1-4.

The exact location of this station is:
Latitude: 41°51'14" N
Longitude 123°13'52" W NAD27
Elevation: 1,320.00 feet above sea level

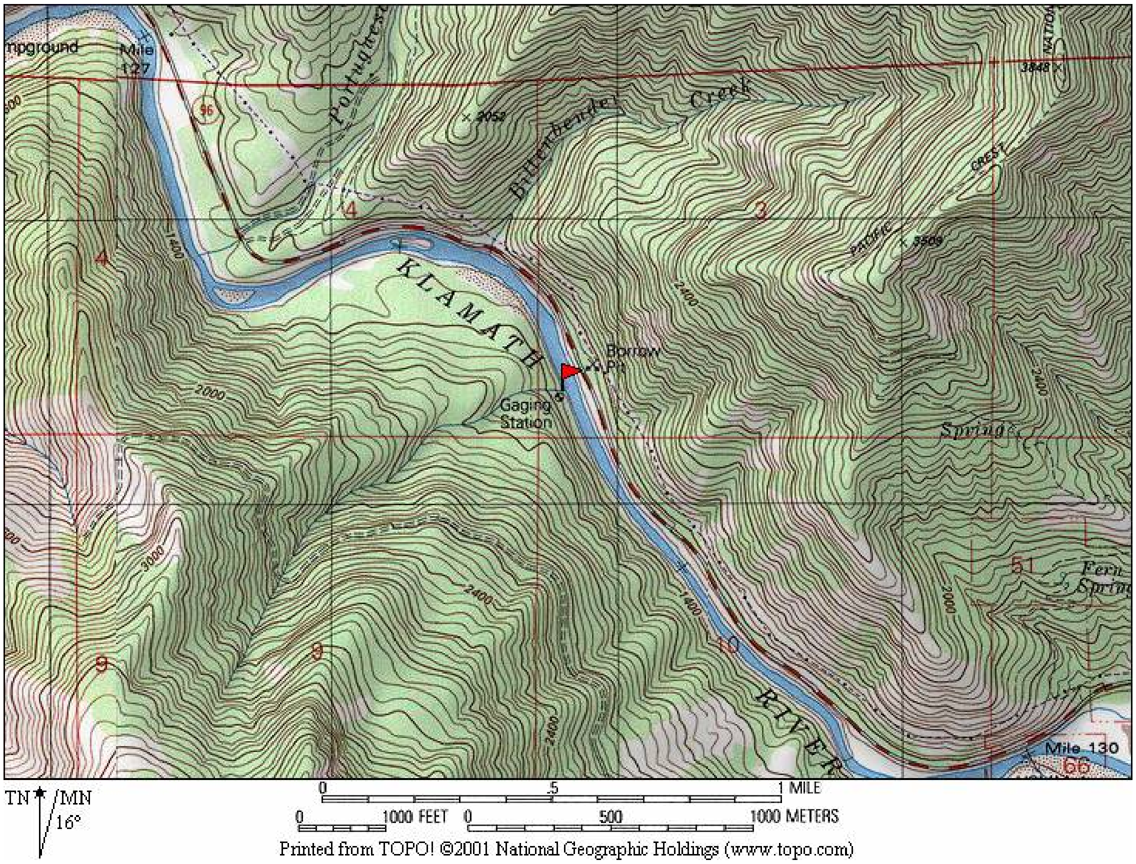

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Figure 3 - Klamath River near Seiad Valley water quality station.

Figure 4 - Klamath River near Seiad Valley upstream of water quality station looking up river.

5.1.3 Near Orleans

The Klamath River station near Orleans is the lowest monitoring station on the mainstem. It is located at the more downstream end of Karuk Ancestral Territory. This station provides data for water quality parameters after the river has traveled through the Mid-Klamath region. Nutrient data was gathered on the opposite side of the river in a riffle just upstream from where the YSI was placed (Figure 6). This site monitors a drainage area of approximately 8,475 square miles. In this area the Klamath begins to fan out more and create larger flood plains and gravel bars (Figure 5-6). By this point, 12 major tributaries designated Key Watersheds by the Northwest Forest Plan have entered the Klamath, in addition to numerous smaller tributaries.

The exact location of this station is:
Latitude: 41°18'13" N
Longitude: 123°32'00" W NAD 27
Elevation: 355.98 feet above sea level

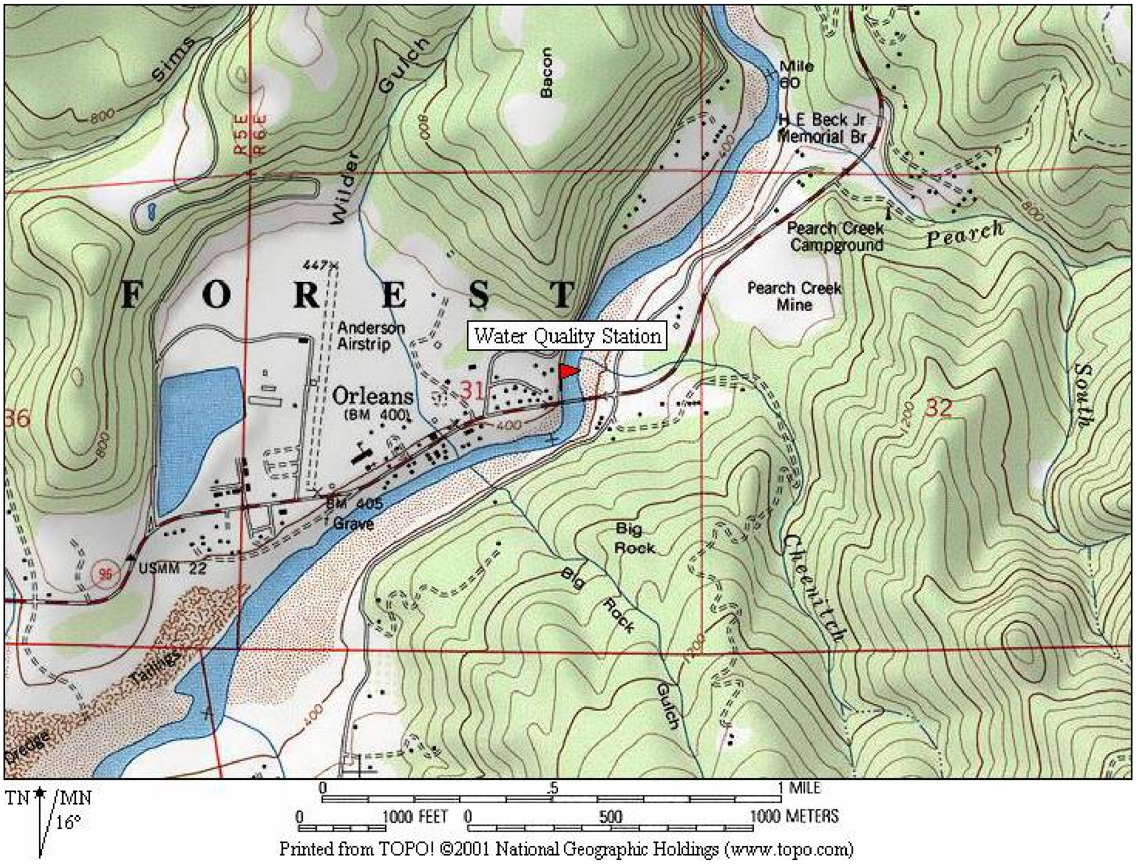

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Figure 5 - Klamath River near Orleans water quality station.

Figure 6 - Klamath River near Orleans across the river of water quality station looking up river.

5.2 Tributaries

The Klamath River is a unique river in that it starts in flat land. It meanders through what were once massive wetlands and makes its way into the mountainous mid-Klamath region. Here the overall gradient and volume of the river increases and the water gets colder due to the many tributaries, which cascade into the Klamath. These tributaries are critical in maintaining water quality during the summer months. The Scott, Shasta and Salmon rivers were historically the largest tributaries in the mid-Klamath region. These rivers provided excellent spawning and rearing habitat for salmonids, steelhead, and lamprey. Mining, logging and agricultural uses of these watersheds have degraded the quantity and quality of habitat and water in these areas (Table 5-6).

Causes of Impairment in Major Tributaries		
Parameter	**Number Of Stream Miles Monitored of Assessed**	**Number Of Stream Miles Not Supporting Use or Goal**
Dissolved Oxygen	**38**	**38**
Water Temperature	**38**	**38**
pH	**38**	**38**
Total Nitrogen	**38**	**22**
Phosphorous	**38**	**22**

***** Shasta River measured from Yreka Creek to mouth-7 miles, Scott River from Canyon Creek to mouth- 15 miles, and Salmon River from Nordheimer Creek to mouth-16 miles.

Table 6 - Causes of Impairment in tributaries to Klamath River.

Sources of Impairment in Tributaries		
Source of Impairment	**Number Of Stream Miles Monitored or Assessed**	**Number Of Stream Miles Not Supporting Use or Goal**
Hydrological modification	**38**	**22**
Agriculture	**38**	**22**
Legacy Roads	**38**	**38**
Timber Harvesting	**38**	**38**
Mining Activities	**38**	**31**

Table 7 - Sources of impairment in tributaries to Klamath River

5.2.1 Salmon River

The water quality station on the Salmon River is located approximately 1 mile above the confluence with the Klamath River (Figure 7) at the USGS gage station. Winter turbidity data and nutrient grab samples were also collected at this site. The Salmon River watershed drains an area of 480,178 acres. The Salmon River is listed in California’s 303(d) list for temperature. The State and EPA have adopted the temperature TMDL for the Salmon River and implementation has begun. The Salmon River also provides crucial habitat for Tribal Trust species such as green sturgeon, lamprey, Spring Chinook, Fall Chinook, and Coho salmon. The data being collected is an important part of long-term monitoring of the system to see how well the implementation plan is working and the health of the watershed for Tribal Trust fish species.

The exact location is:
Latitude: 41° 22’ 37’’ N
Longitude: 123° 28’ 38’’ W
Elevation: 167 m

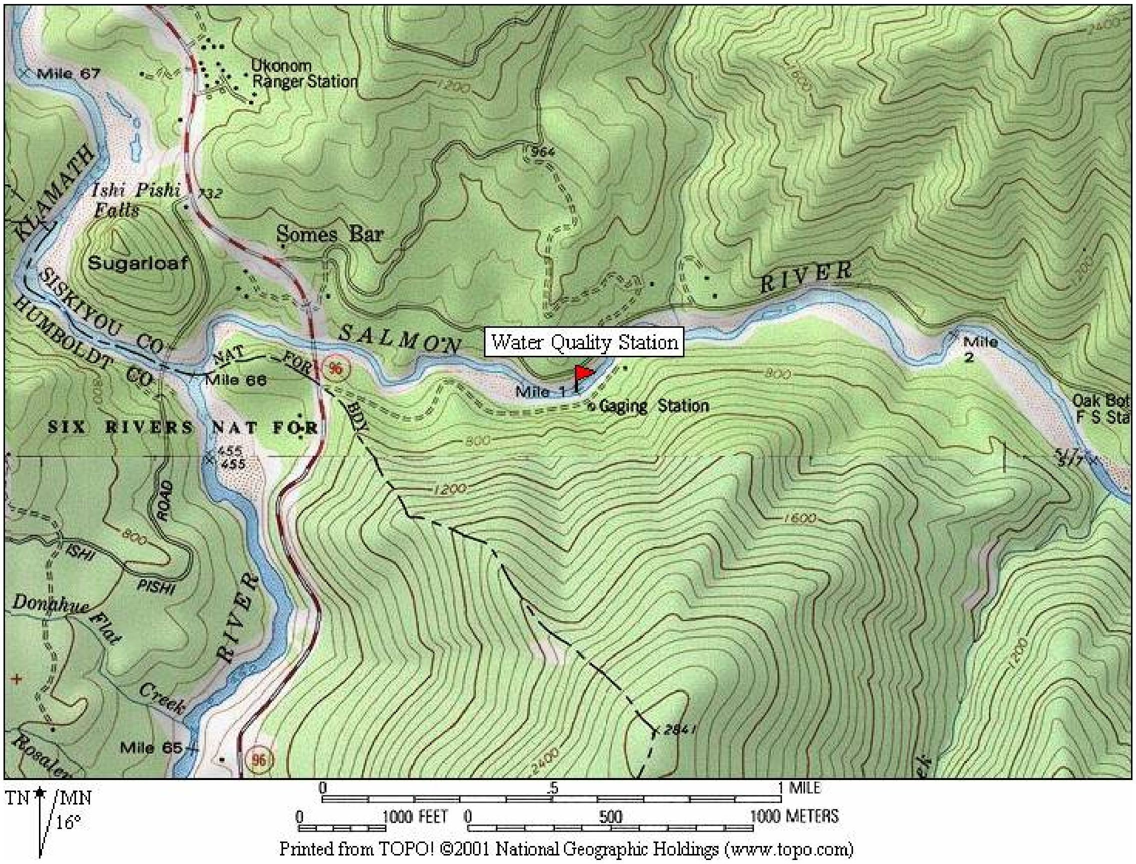

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Figure 7 - Salmon River water quality station.

Figure 8 - Salmon River water quality station looking across the river and up stream.

5.2.2 Scott River

The Scott River water quality station is located about 1.25 miles from the confluence with the Klamath River at Johnson’s Bar (Figure 9). The drainage area for the Scott River water quality station is 520,612 acres. The Scott River is heavily diverted for agricultural use and listed on CWA section 303(d) list for sediment and temperature impairment. The State and EPA have adopted the TMDL and implementation has begun. Even though the Scott River is a major tributary to the Klamath, it contributes very little water once heavy irrigation begins in July (Figure 45). The Scott River used to be one of the predominant rearing locations for Coho and fall Chinook. The restoration of this tributary is critical to the future of the Karuk Tribal Trust fishery.

The approximate location of this station is:
Latitude: 41° 46’ 06” N
Longitude: 123° 01’ 34” W
Elevation: 489 m

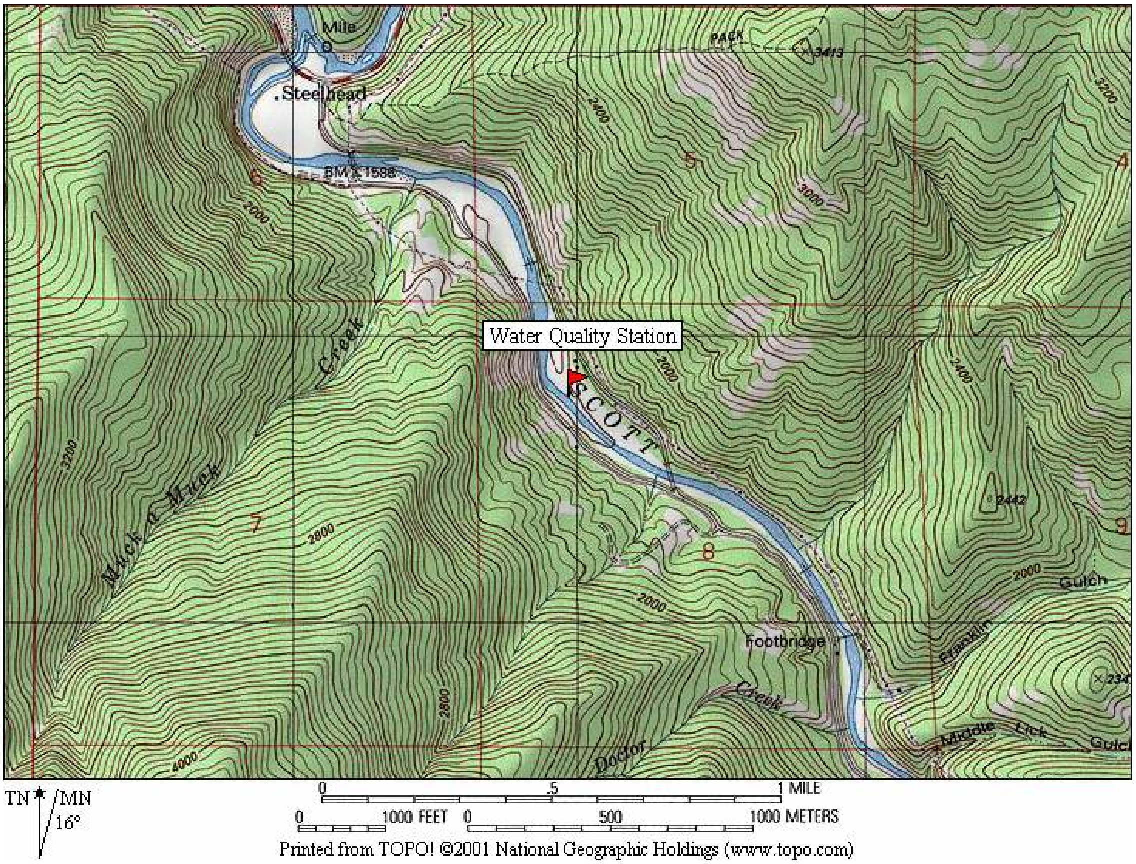

Figure 9 - Scott River water quality station.

Figure 10 - Scott River water quality station looking downstream.

5.2.3 Shasta River

The Shasta River is fed by rain and snowmelt coming down from the Klamath Mountains, in addition to numerous cold-water springs. The glacier on Mt. Shasta is one of the few expanding glaciers in the country. Therefore, the Shasta River should be an important source of cold water in the hot summer months and provide excellent rearing habitat for spring Chinook, fall Chinook, Coho, and steelhead. However, the Shasta Valley has been altered by agricultural diversions and the construction of Dwinell Dam, creating Lake Shastina, which blocks fish passage about 40 miles upstream from the mouth of the River. The Shasta River is 303(d) listed for temperature and DO. As part of TMDL implementation, the NCRQCB says there needs to be an additional 45 cfs of cold spring flow in the Shasta River to meet temperature requirements. This site monitors a drainage area of approximately 793 square miles. The Shasta River ran under 200cfs throughout the summer months (Figure 39).

The approximate location of this station is:
Latitude: 41° 49’ 23” N
Longitude: 122° 35’ 40” W NAD 27
Elevation: 2,000.00 feet above sea level

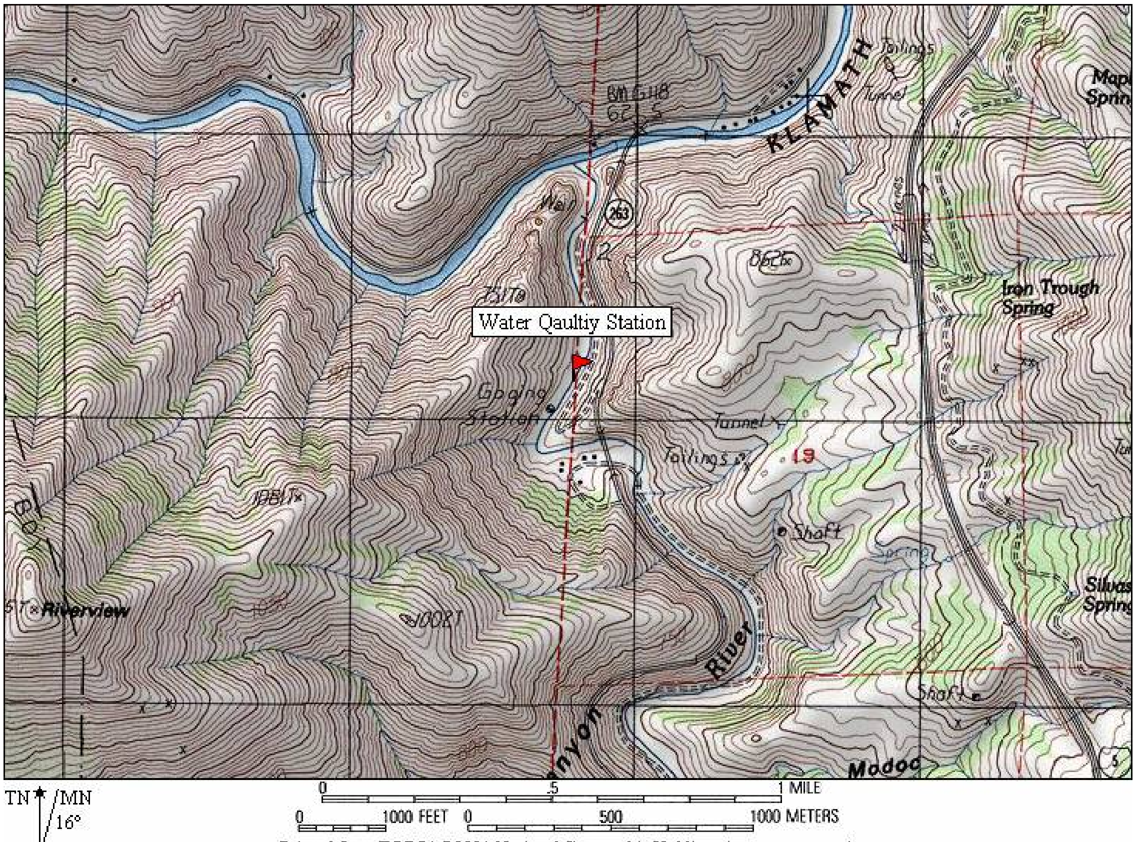

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Figure 11 - Shasta River Water Quality Station.

Figure 12 - Shasta River water quality station looking downstream.

6 RESULTS

The following graphs summarize the data collected during the summer of 2007. Temperature, dissolved oxygen, pH, conductivity and flow rates are given for each of the monitoring sites. Graphs depicting accepted Karuk tribal water quality standards as compared to measured water quality conditions are also included. Nutrient data for all the Klamath River sites and tributary sites are found at the end of their respective sections.

6.1 Klamath River

6.1.1 Near Iron Gate Dam

6.1.1.1 Water Temperature

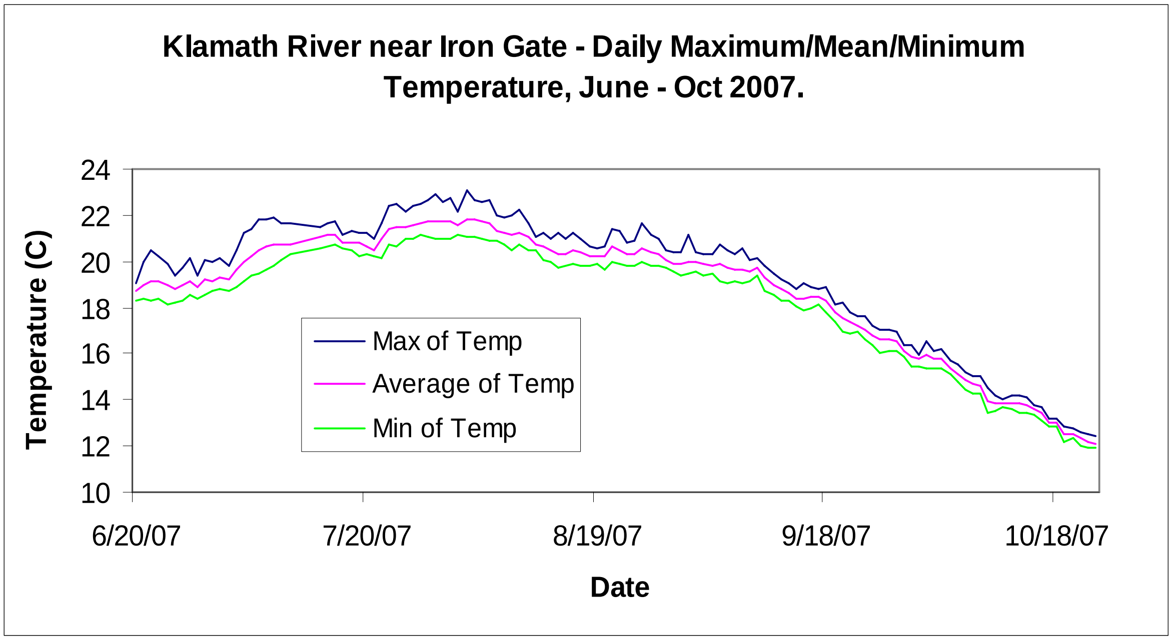

Figure 13 - Daily maximum, mean, and minimum water temperature in the Klamath River near Iron Gate from June to November, 2007

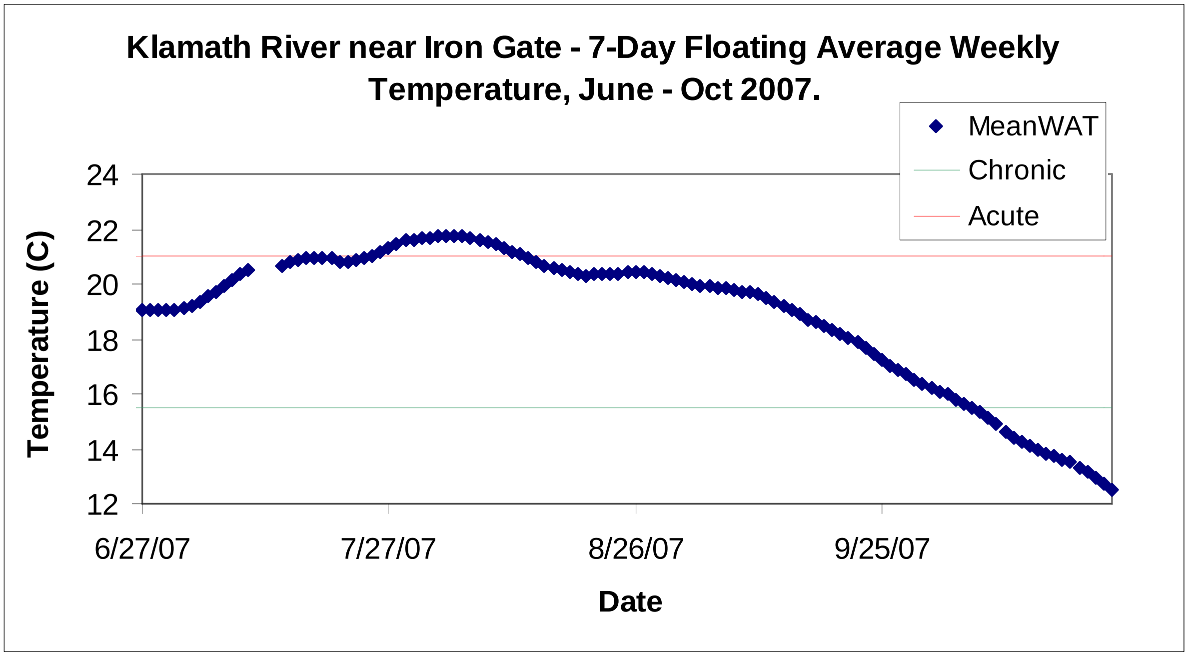

Figure 14 – 7-Day floating average temperature for the Klamath River near Iron Gate dam from June to October, 2007

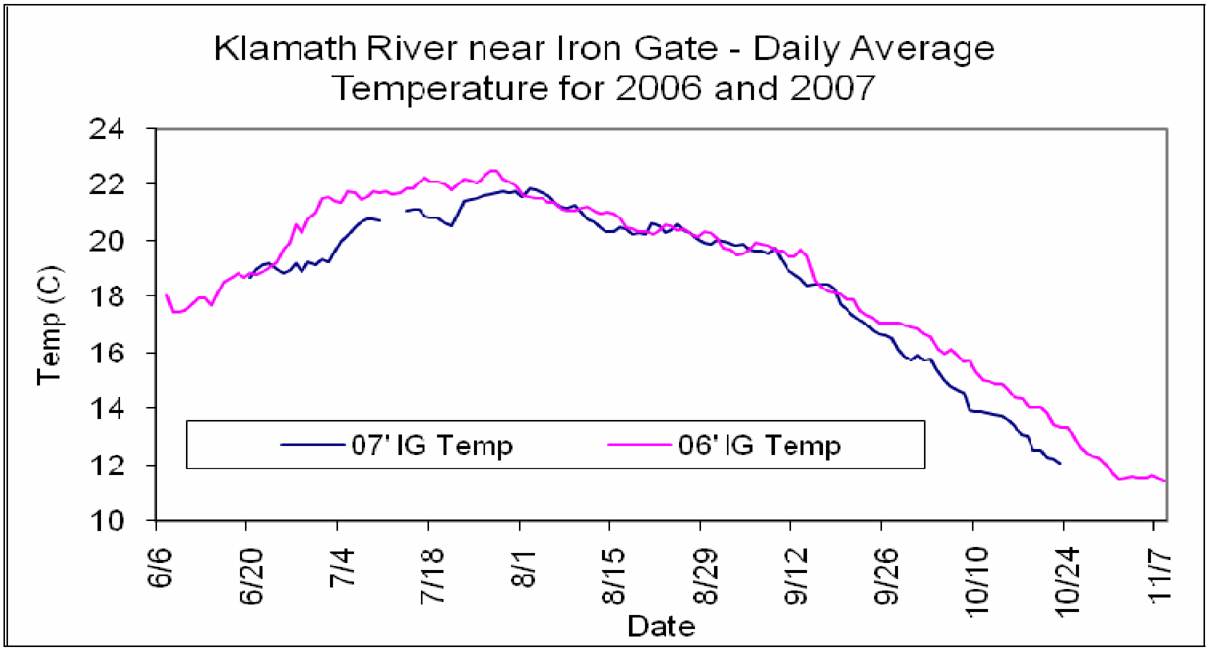

Figure 15 – Daily average temperature for the Klamath River near Iron Gate dam for the 2006 and 2007 monitoring season.

6.1.1.2 Dissolved Oxygen

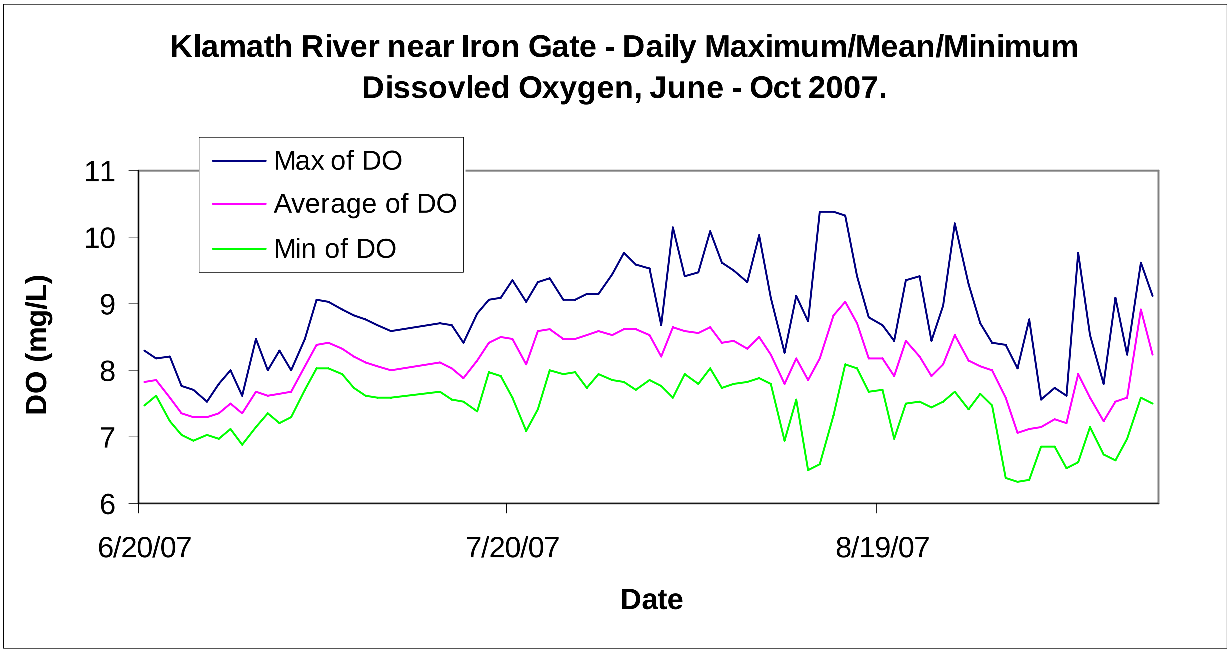

Figure 16 - Daily maximum, mean, and minimum dissolved oxygen in the Klamath River near Iron Gate Dam from June to October, 2007

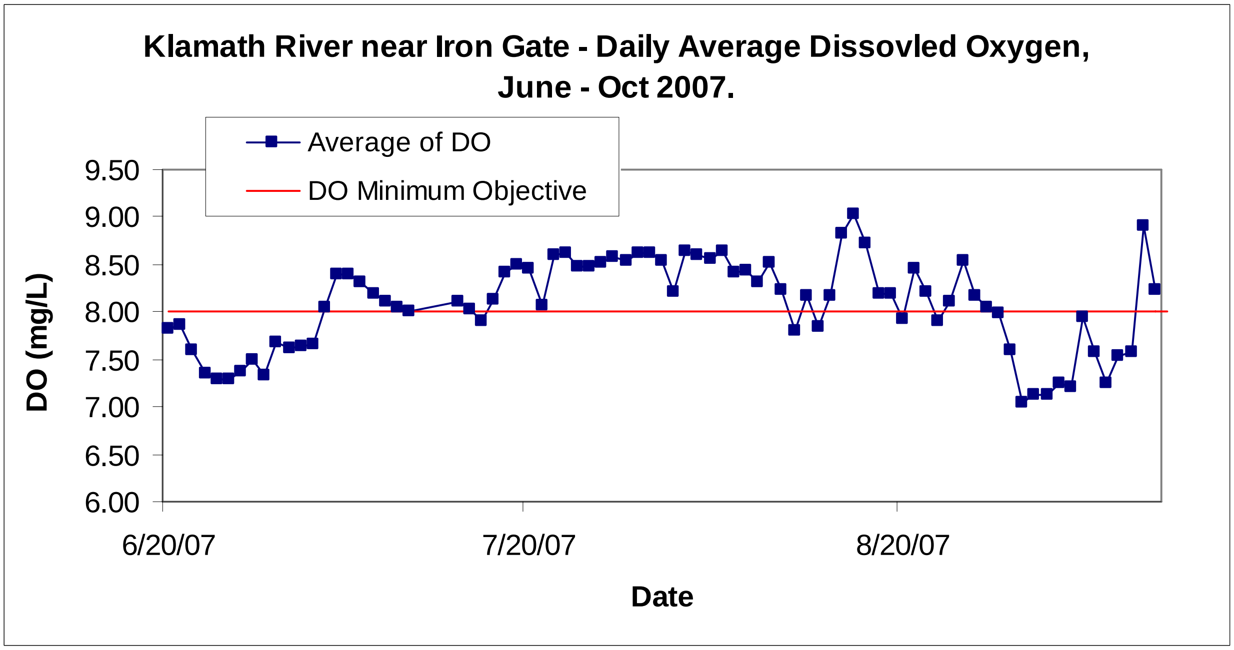

Figure 17 - Daily mean for dissolved oxygen in the Klamath River near Iron Gate Dam from June to October, 2007

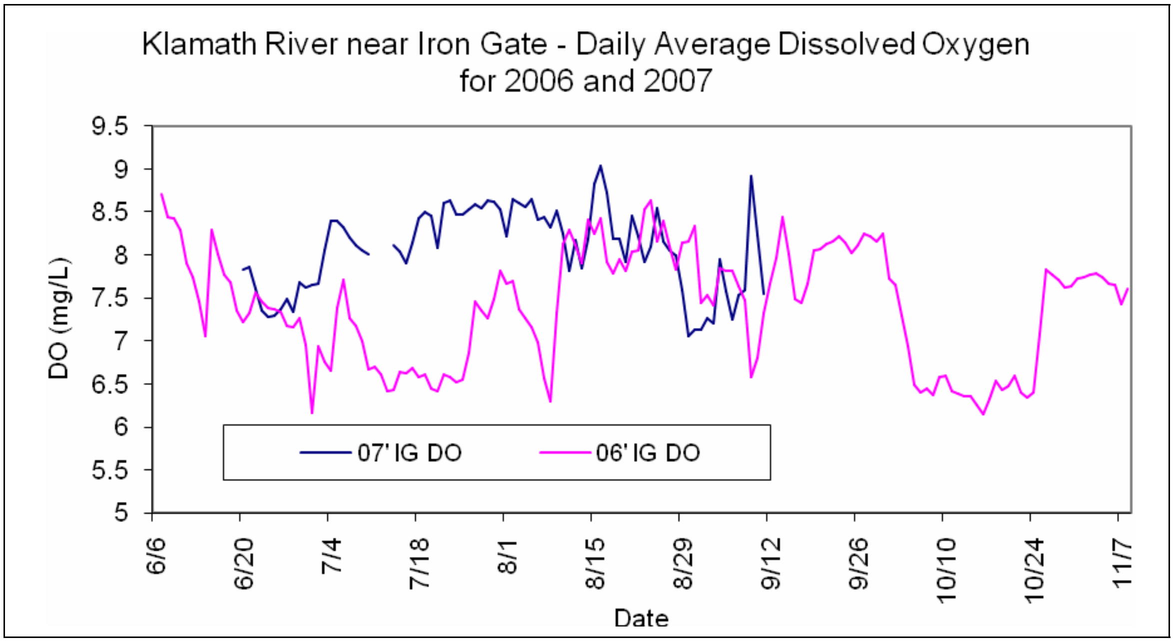

Figure 18 – Klamath River near Iron Gate daily average dissolved oxygen for the 2006 and 2007 monitoring season

6.1.1.3 pH

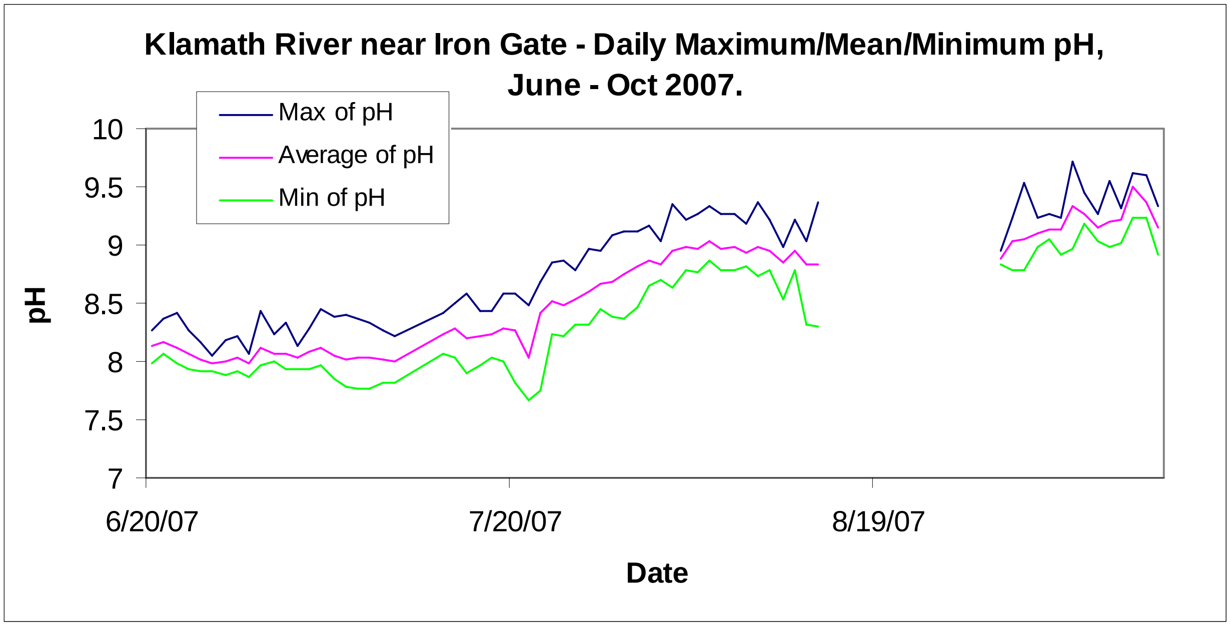

Figure 19 - Daily maximum, mean and minimum pH values on the Klamath River near Iron Gate from June to October, 2007

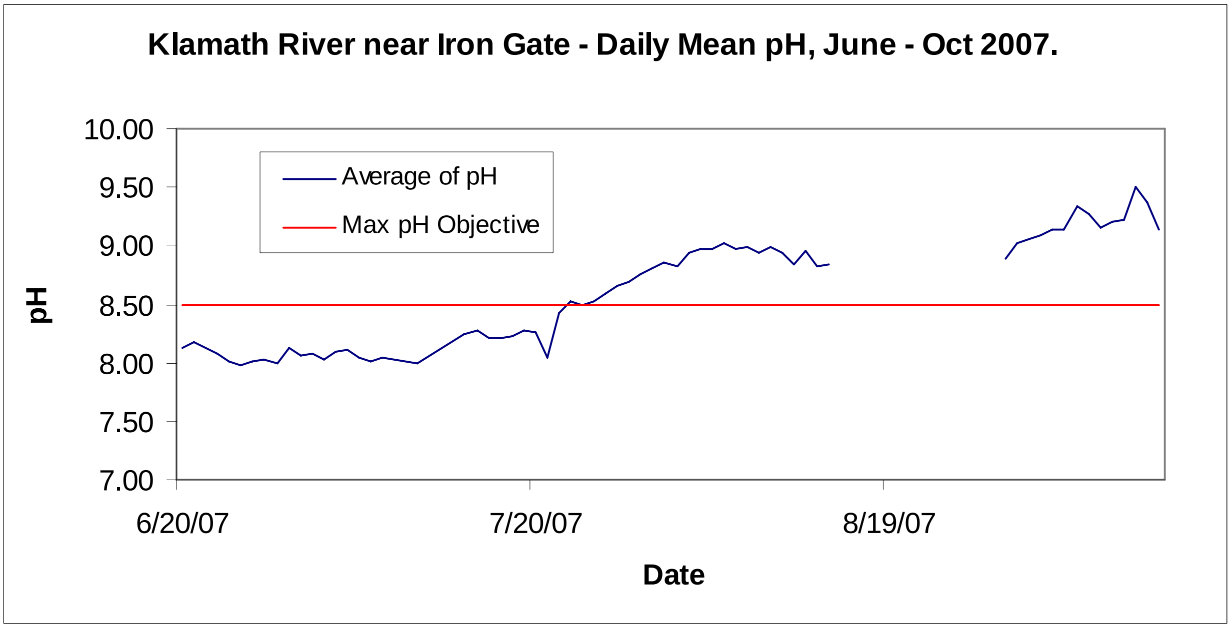

Figure 20 - Daily mean pH values on the Klamath River near Iron Gate from June to October, 2007

6.1.1.4 Specific Conductance

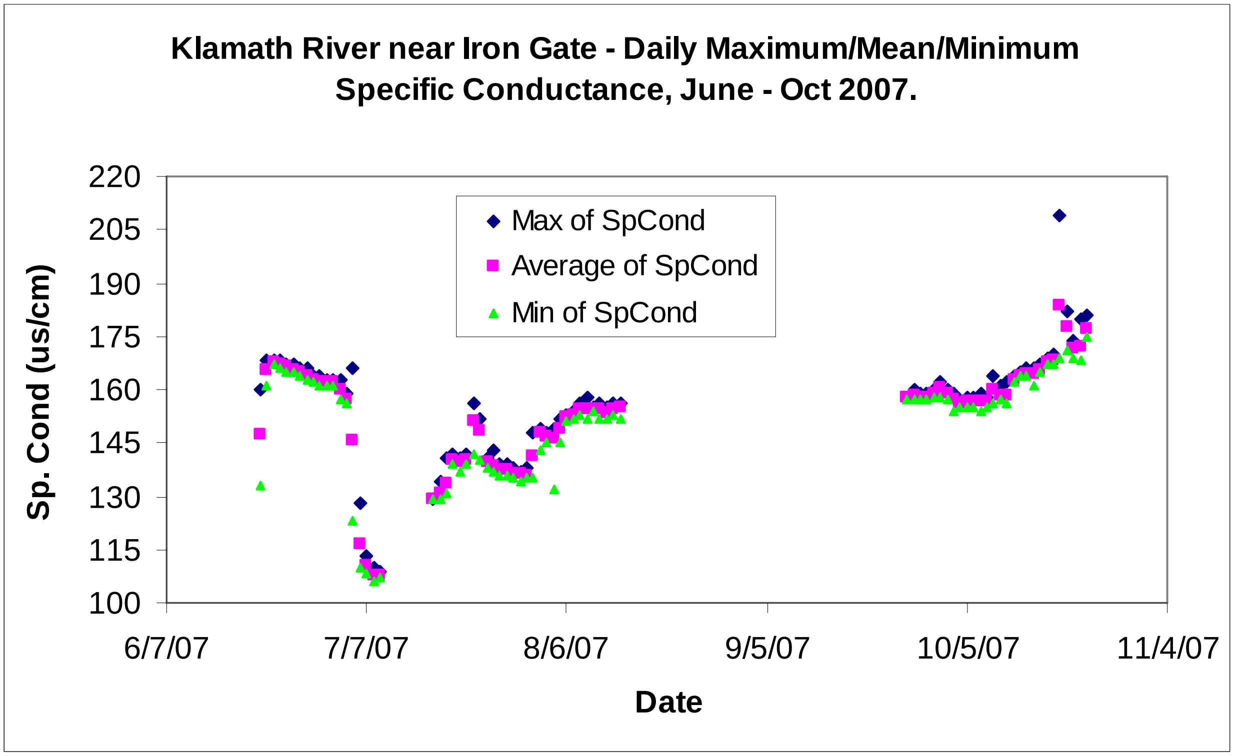

Figure 21 - Daily maximum, mean, and minimum specific conductivity in the Klamath River near Iron Gate from June to October, 2007

6.1.1.5 Flow

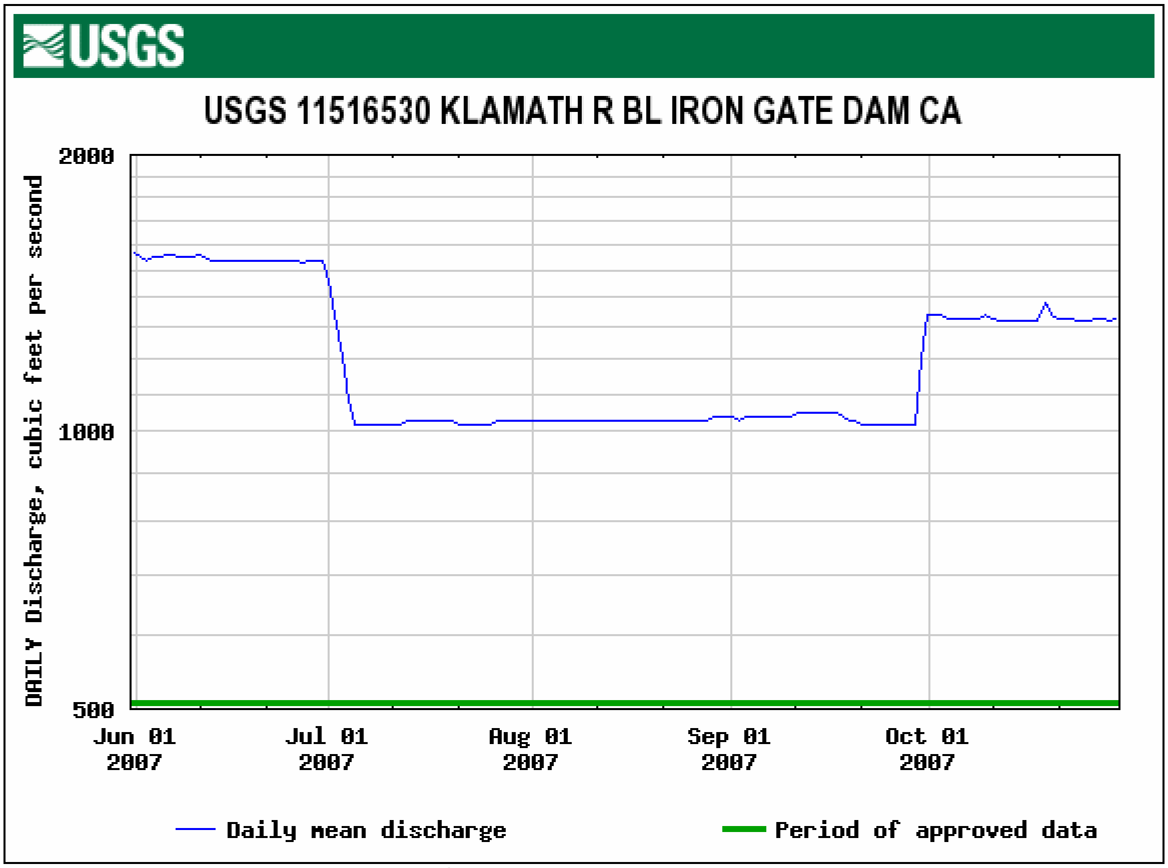

Figure 22 - Daily mean stream flow (Ft^3/sec) from the Klamath River below Iron Gate Dam USGS flow gauge from June to October, 2007

6.1.2 Near Seiad Valley

6.1.2.1 Water Temperature

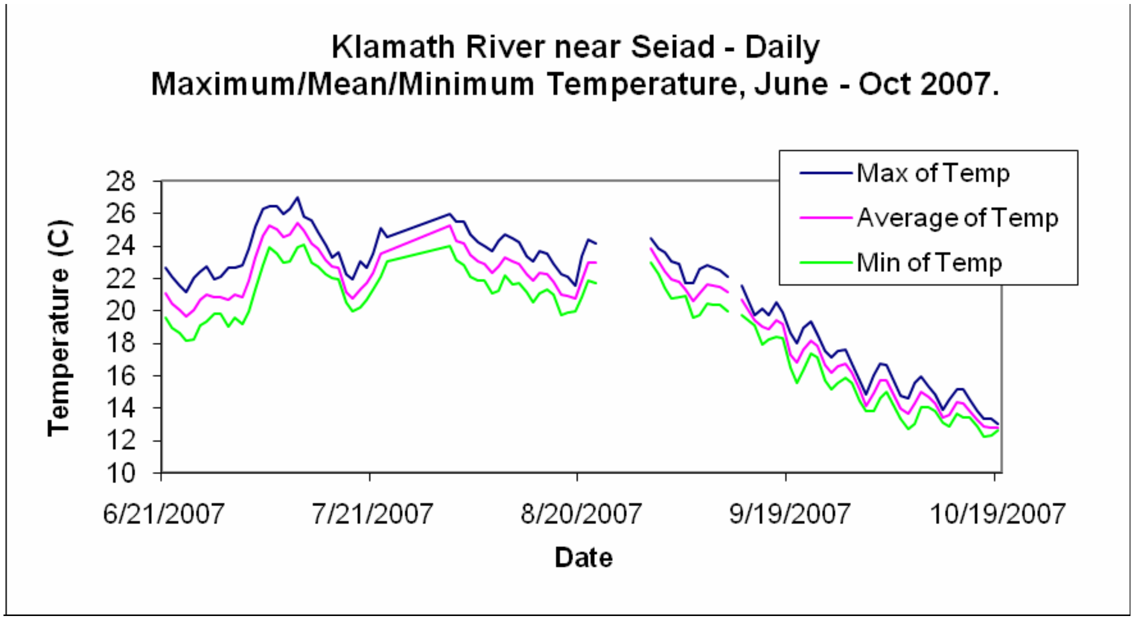

Figure 23 - Daily maximum, mean, and minimum water temperature in the Klamath River near Seiad from June to October, 2007

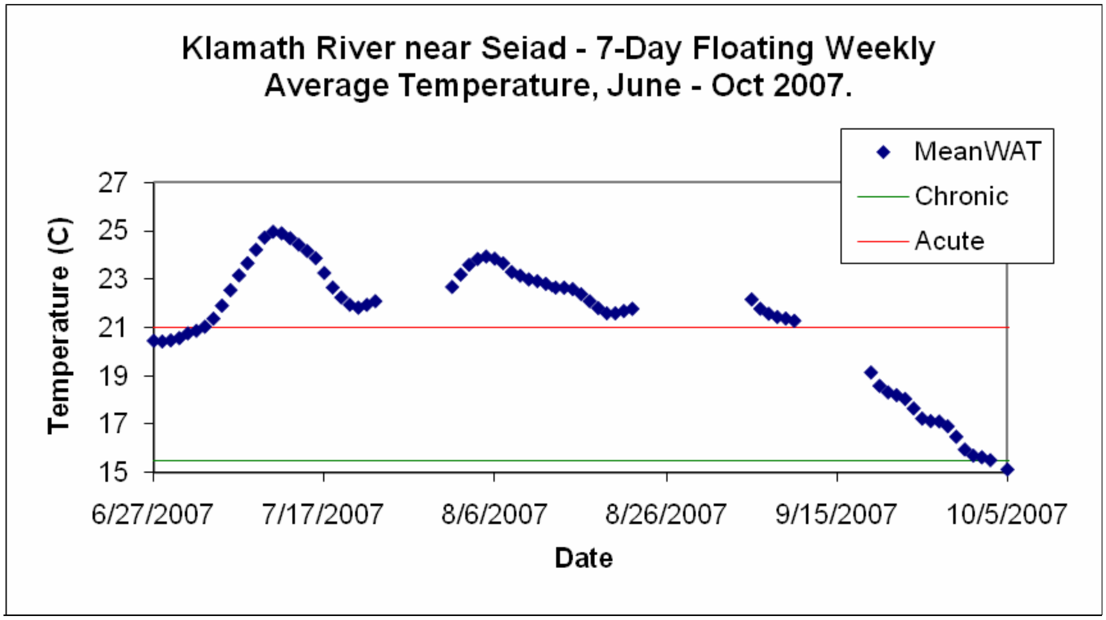

Figure 24 – 7-day floating average temperature for the Klamath River near Seiad from June to October, 2007

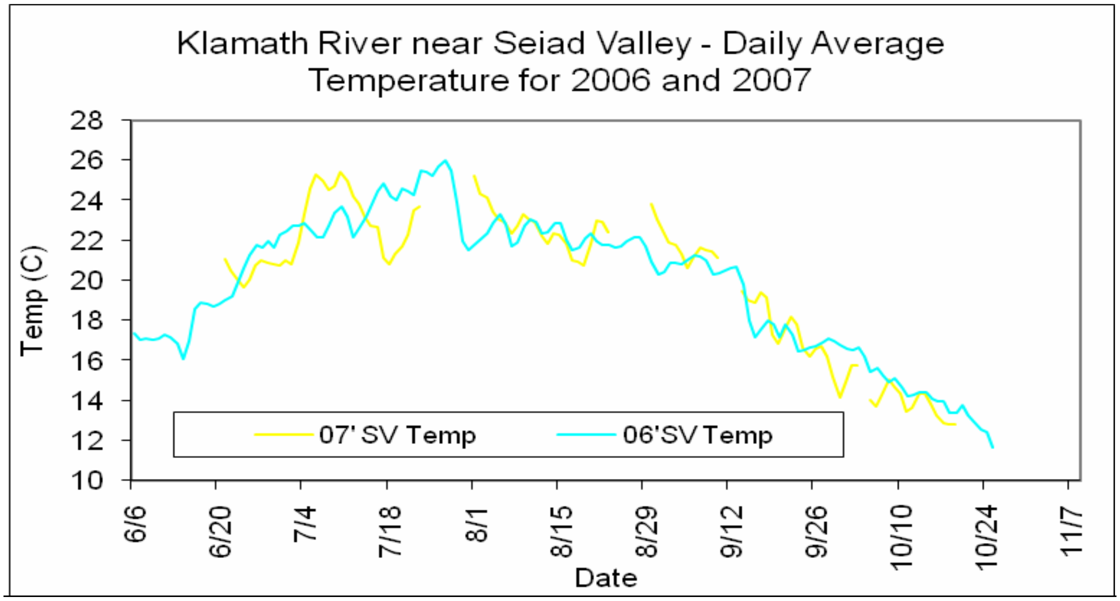

Figure 25 – Klamath River near Seiad Valley daily average temperature for the 2006 and 2007 monitoring season

6.1.2.2 Dissolved Oxygen

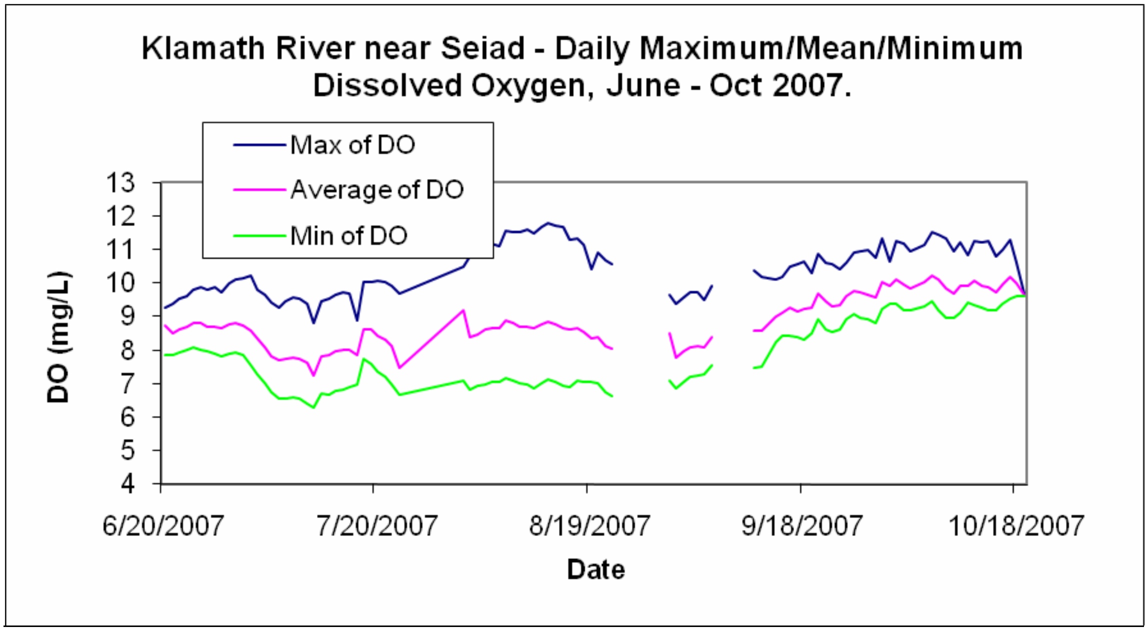

Figure 26 - Daily maximum, mean, and minimum dissolved oxygen in the Klamath River near Seiad from June to October, 2007

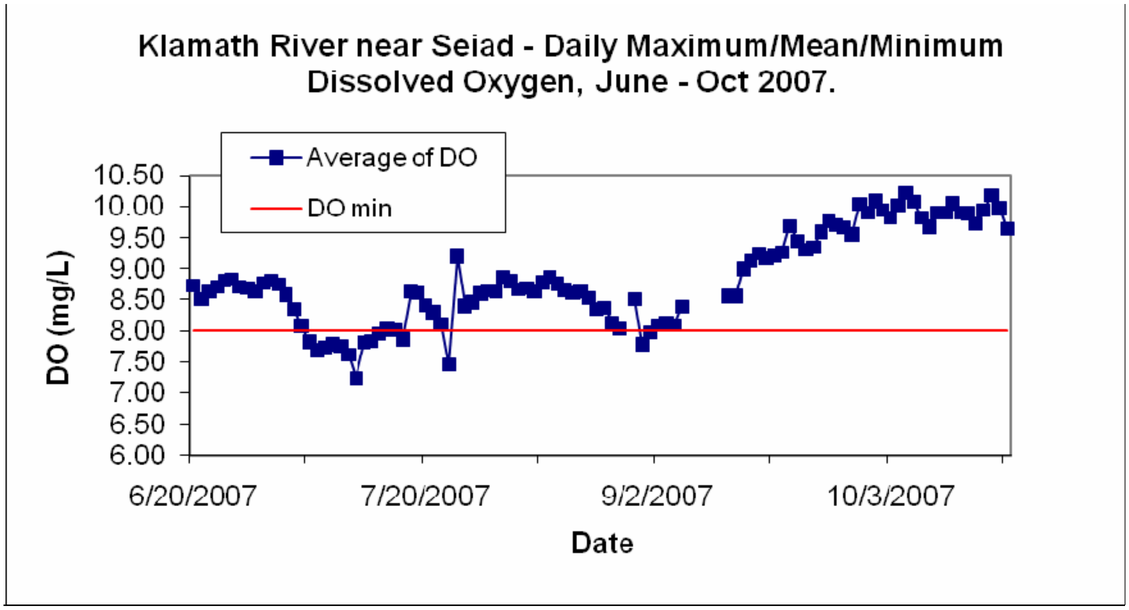

Figure 27 - Daily mean dissolved oxygen in the Klamath River near Seiad from June to October, 2007

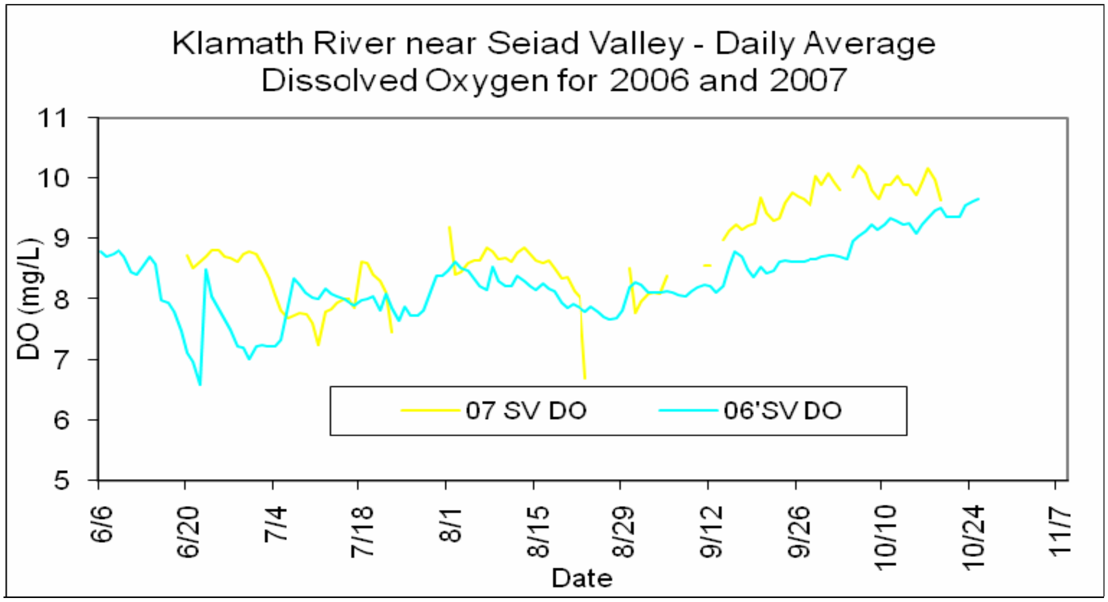

Figure 28 – Klamath River near Seiad Valley daily average dissolved oxygen for the 2006 and 2007 monitoring season

6.1.2.3 pH

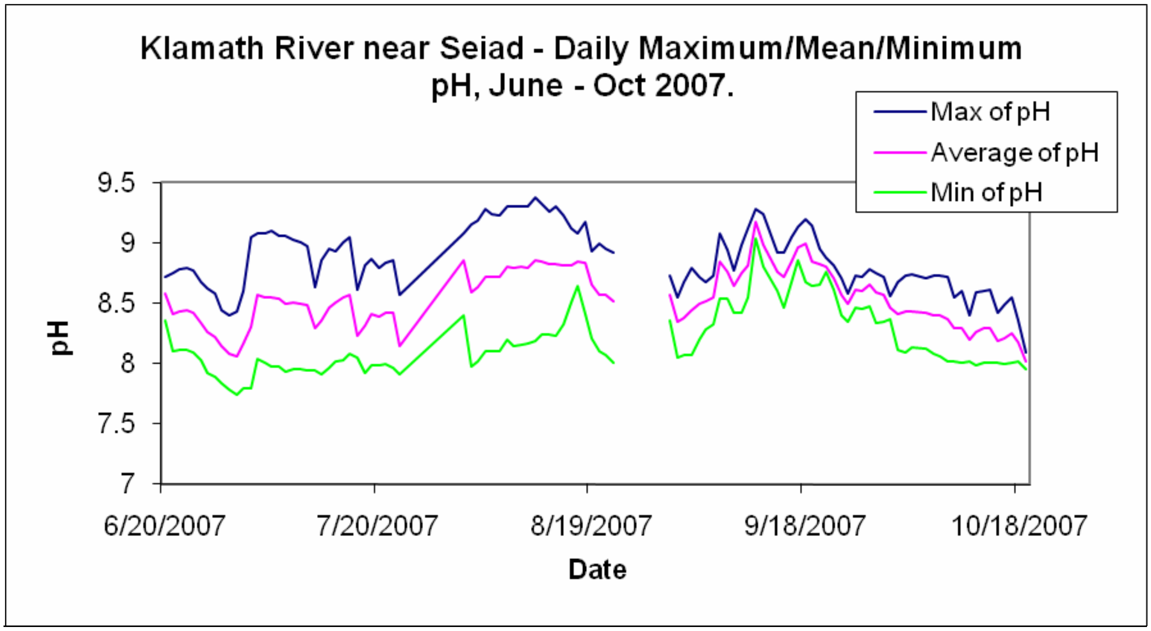

Figure 29 - Daily maximum, mean and minimum pH values on the Klamath River near Seiad from May to October, 2007

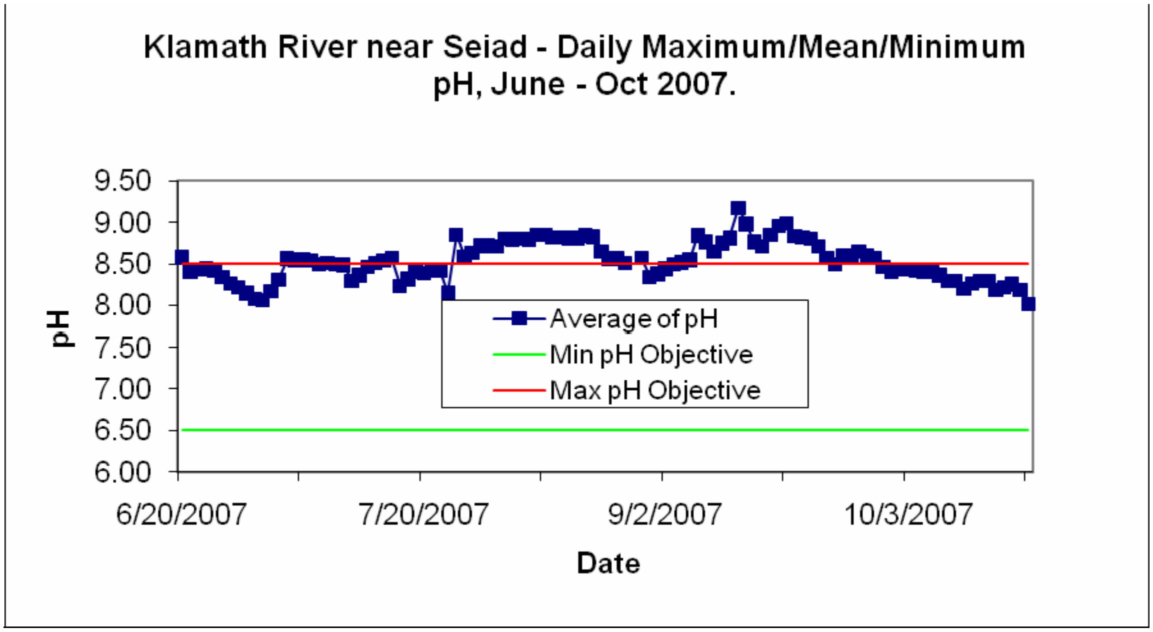

Figure 30 - Daily mean pH values on the Klamath River near Iron Gate from June to October, 2007

6.1.2.4 Specific Conductance

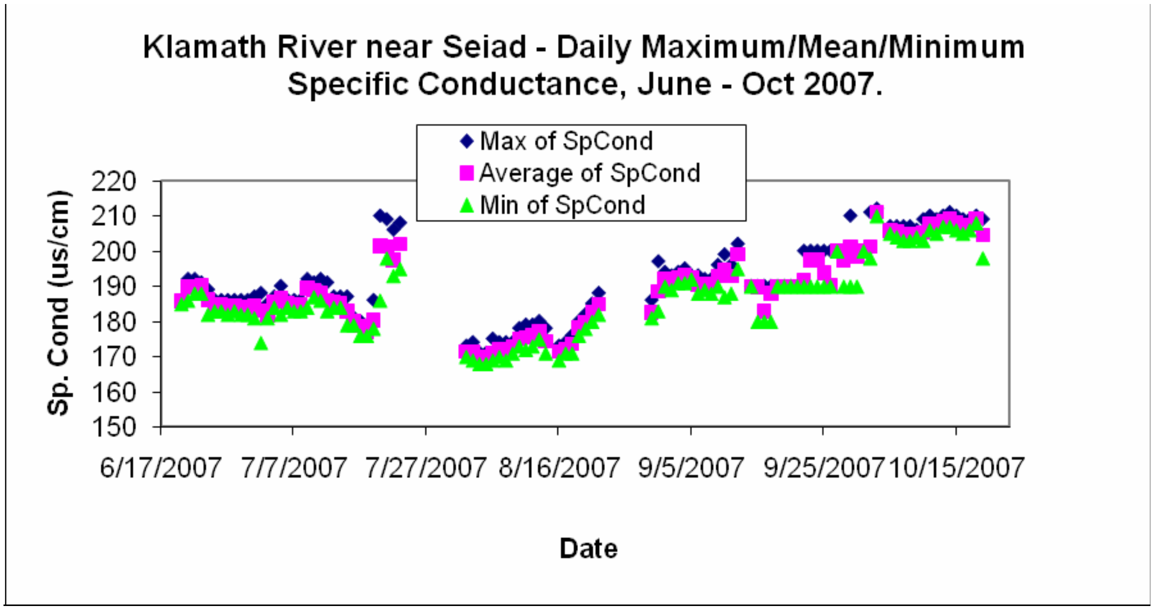

Figure 31 - Daily maximum, mean, and minimum specific conductivity in the Klamath River near Seiad from June to October, 2007

6.1.2.5 Flow

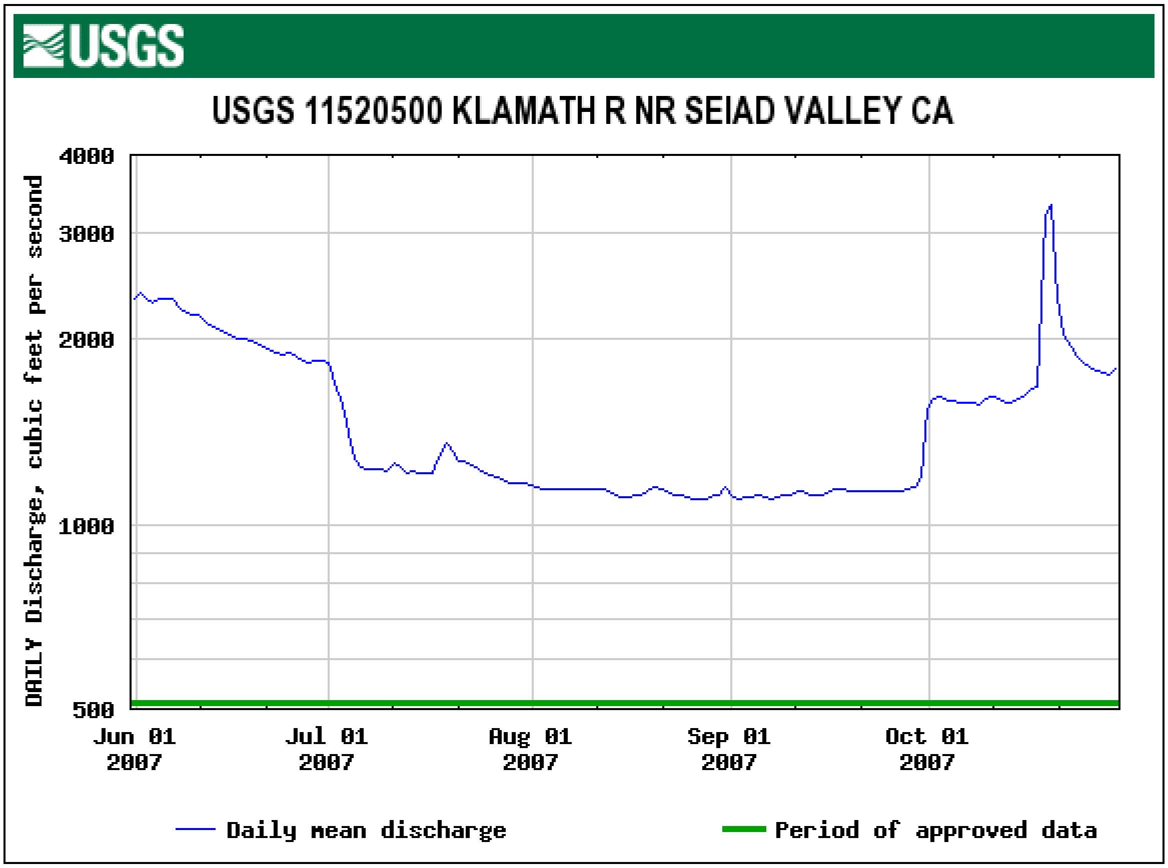

Figure 32- Daily mean stream flow (Ft^3/sec) from the Klamath River at the Seiad USGS flow gauge from June to October, 2007

6.1.3 Near Orleans

6.1.3.1 Water Temperature

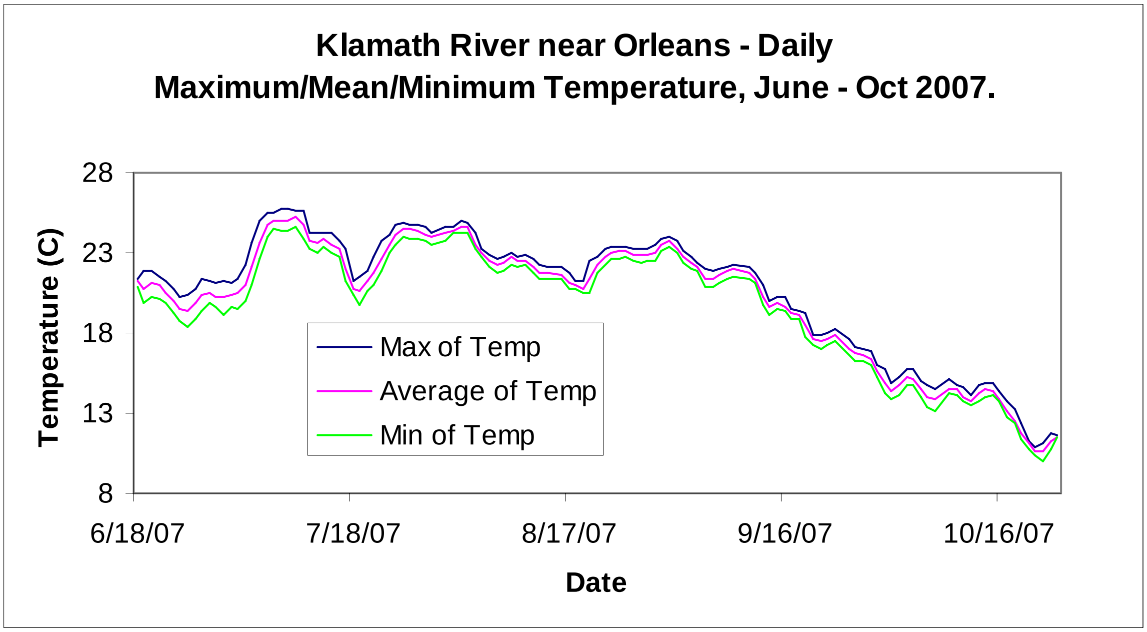

Figure 33 - Daily maximum, mean, and minimum water temperature in the Klamath River near Orleans from June to October, 2007

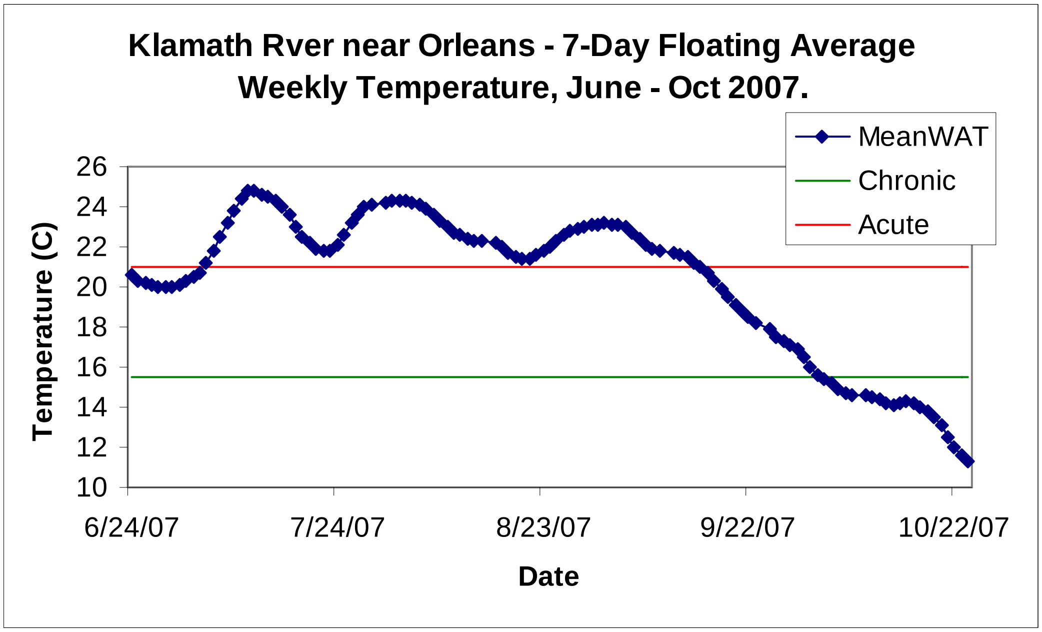

Figure 34 - Maximum weekly average temperature for the Klamath River near Orleans from May to October, 2007

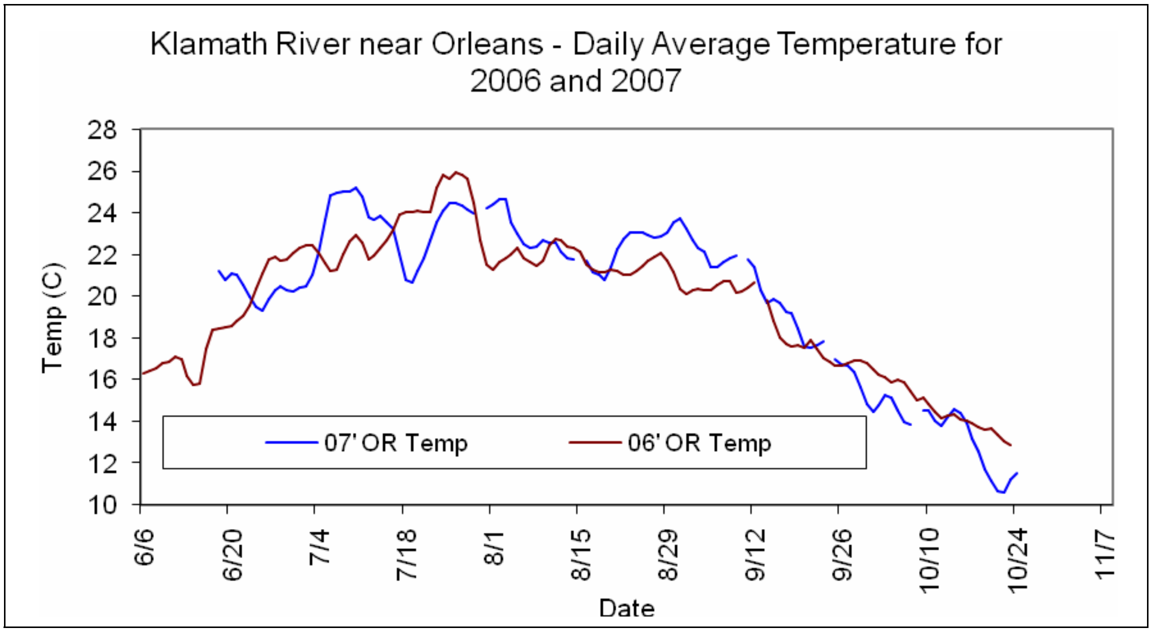

Figure 35 – Klamath River near Orleans daily average temperature for the 2006 and 2007 monitoring season

6.1.3.2 Dissolved Oxygen

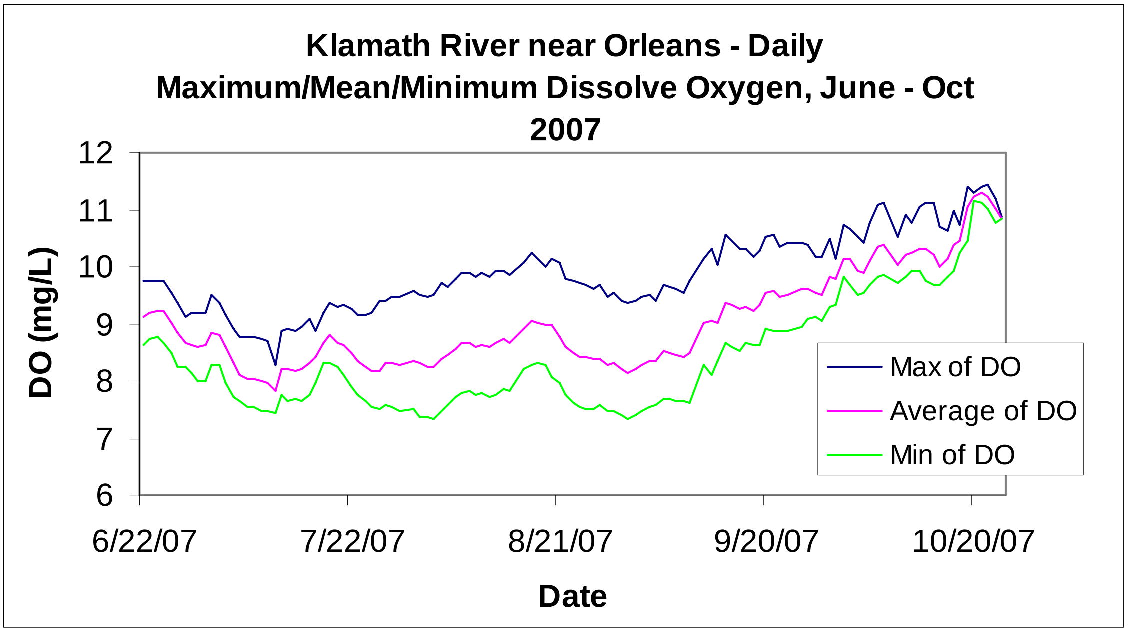

Figure 36 - Daily maximum, mean, and minimum dissolved oxygen in the Klamath River near Orleans from June to October, 2007

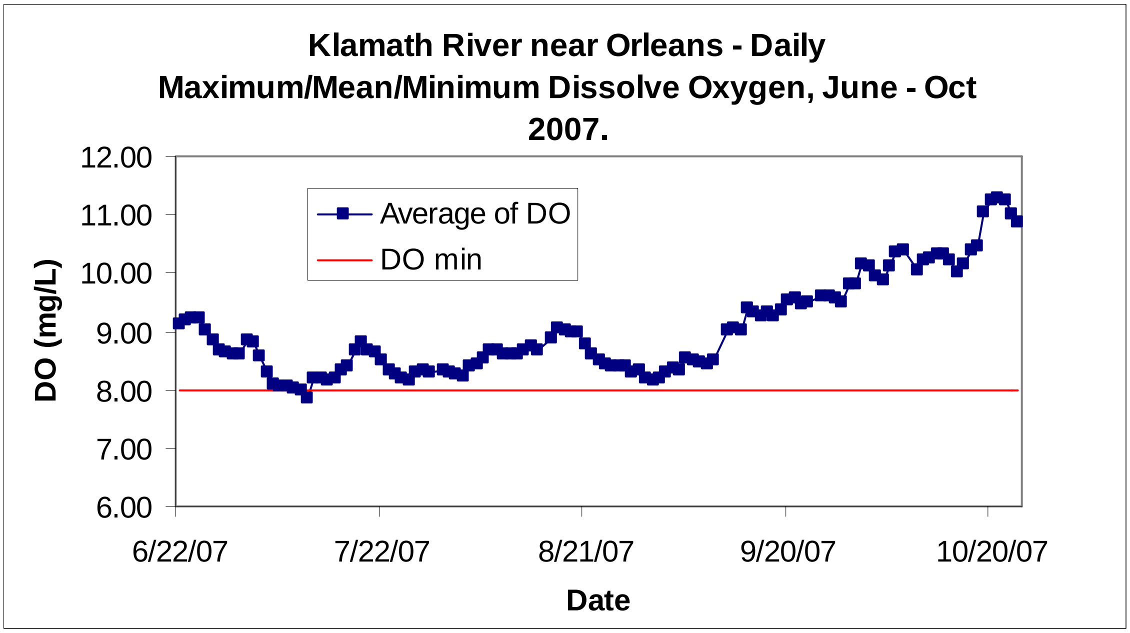

Figure 37 - Daily mean dissolved oxygen in the Klamath River near Orleans from June to October, 2007

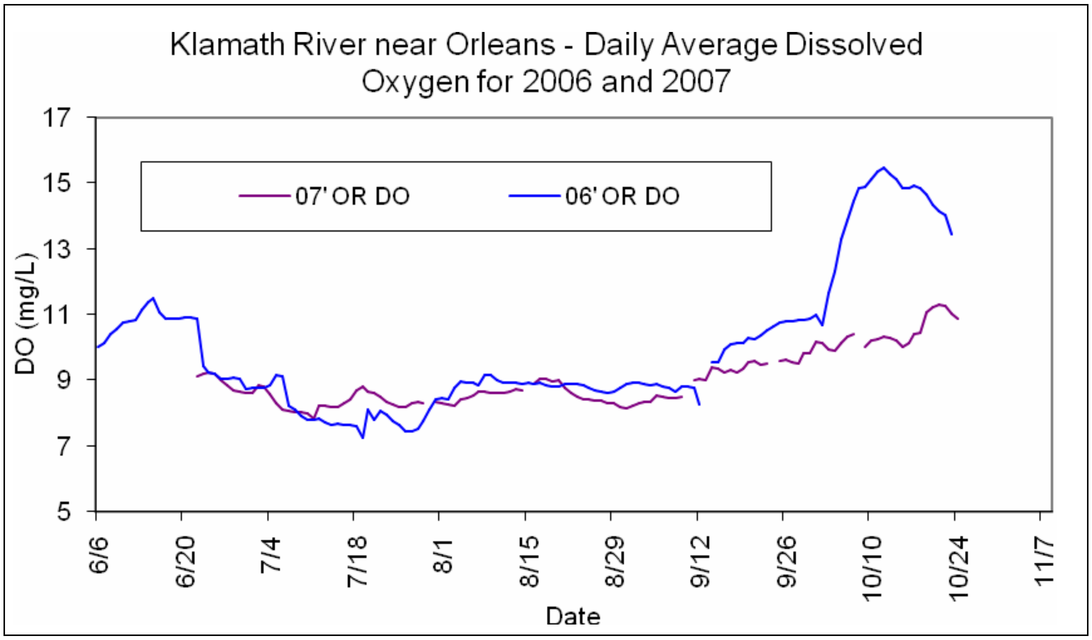

Figure 38 – Klamath River near Orleans daily average dissolved oxygen for the 2006 and 2007 monitoring season

6.1.3.3 pH

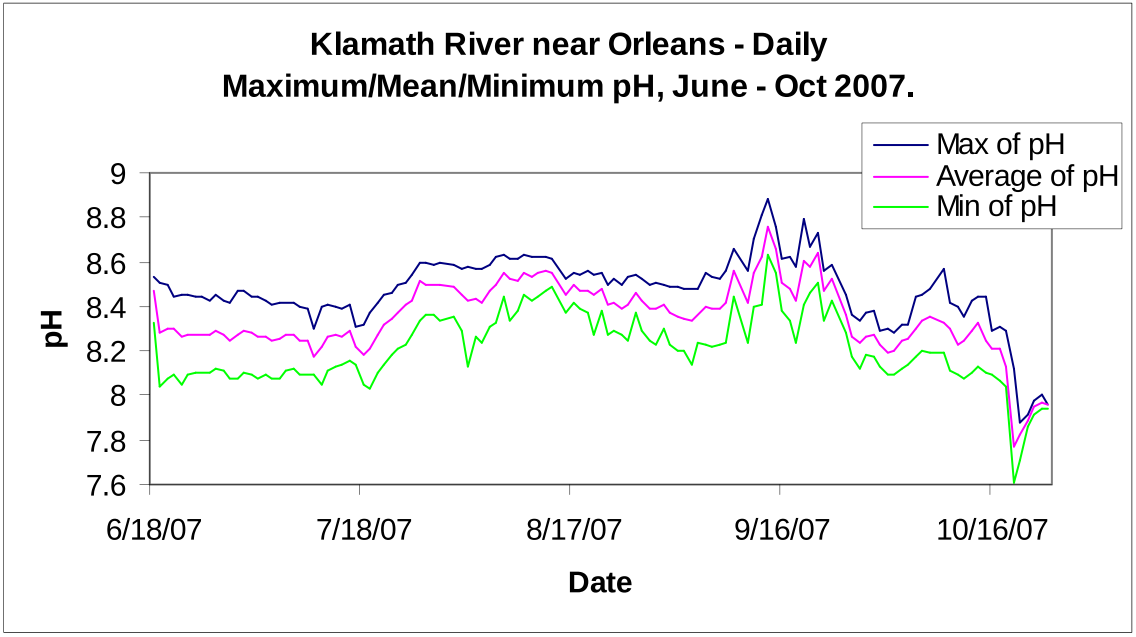

Figure 39 - Daily maximum, mean and minimum pH values on the Klamath River near Orleans from June to October, 2007

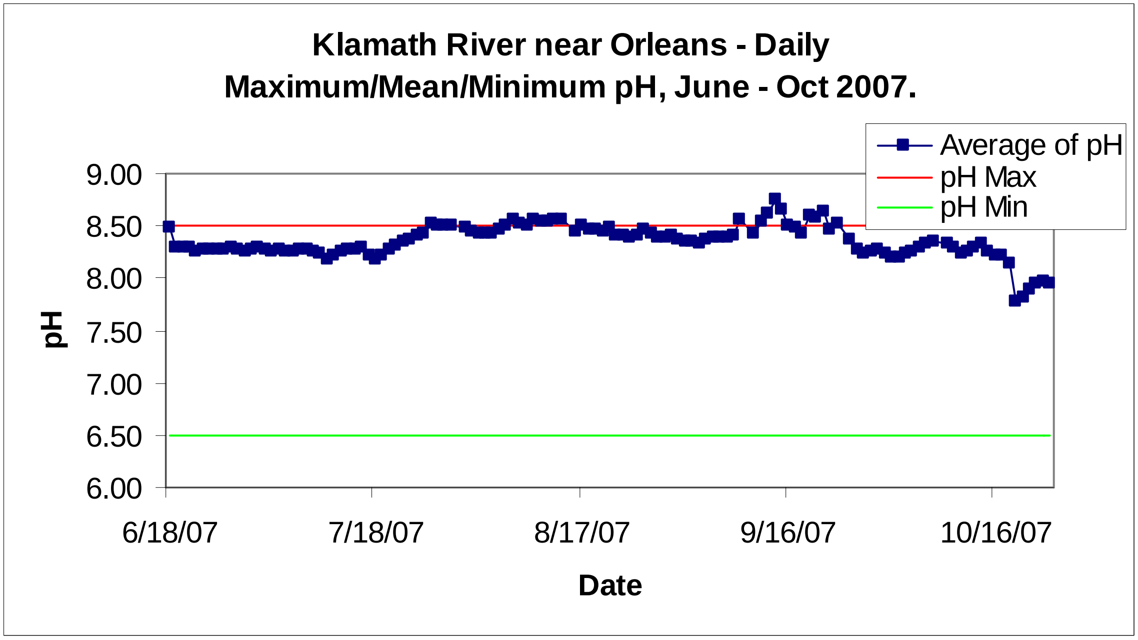

Figure 40 - Daily mean pH values on the Klamath River near Orleans from June to October, 2007

6.1.3.4 Specific Conductance

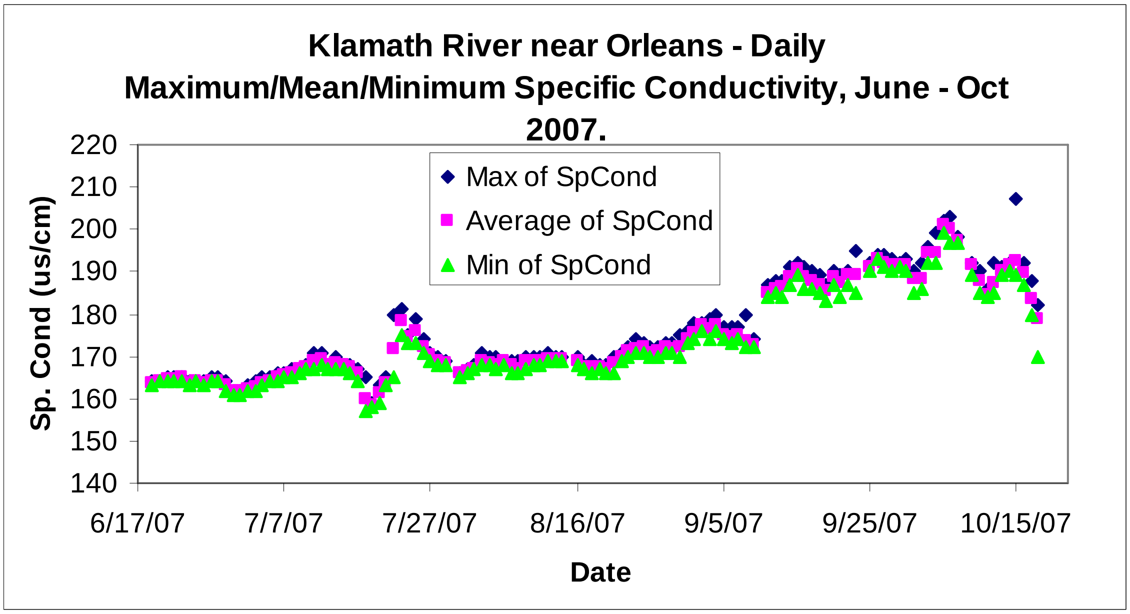

Figure 41 - Daily maximum, mean, and minimum specific conductivity in the Klamath River near Orleans from June to October, 2007

6.1.3.5 Flow

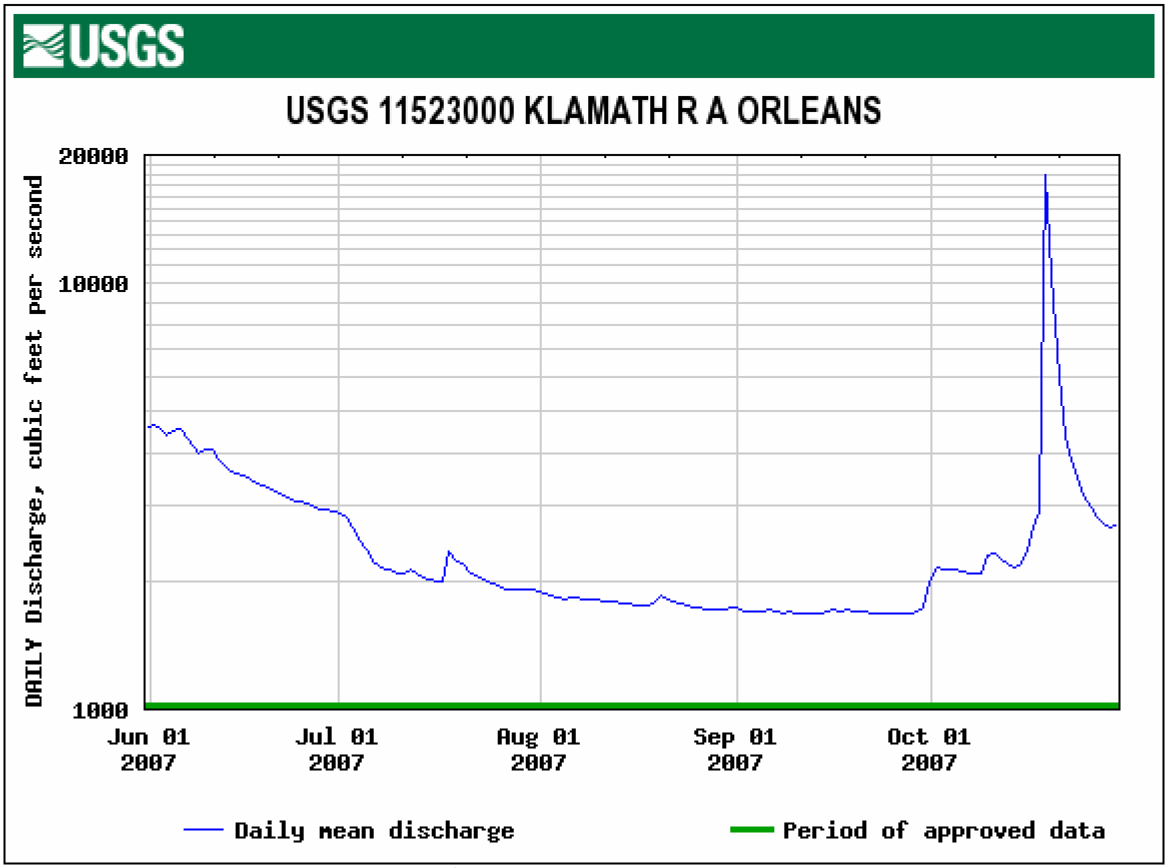

Figure 42 - Daily mean stream flow (Ft^3/sec) from the Klamath River at the Orleans USGS flow gauge from June to October, 2007

6.1.4 Nutrients

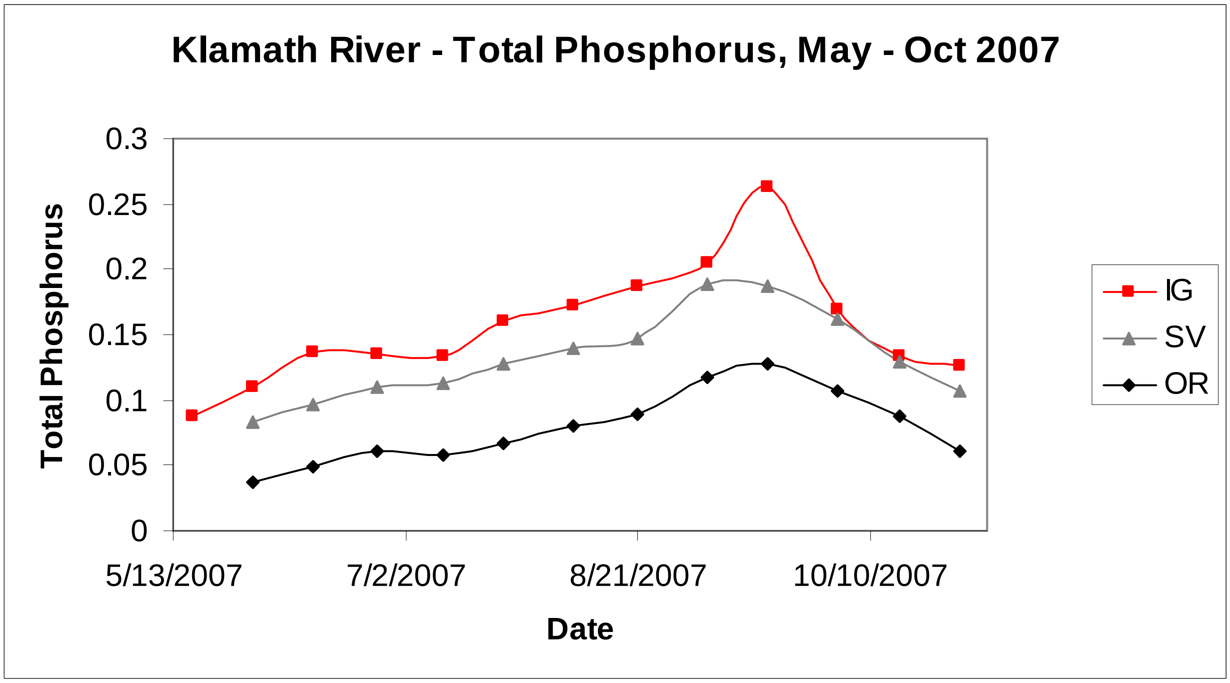

Figure 43– Total phosphorus in mg/L for Klamath River sites from May to Oct, 2007.

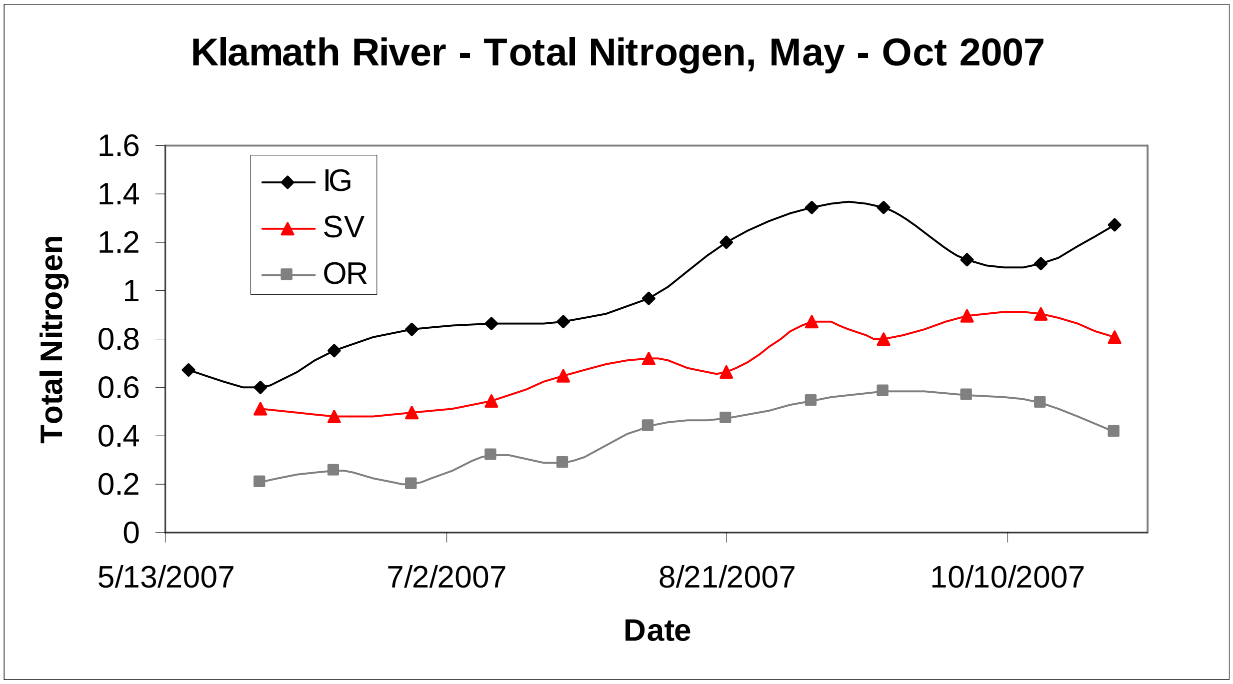

Figure 44 – Total nitrogen in mg/L for Klamath River sites from May to Oct, 2007.

6.2 Tributaries

6.2.1 Shasta River

6.2.1.1 Water Temperature

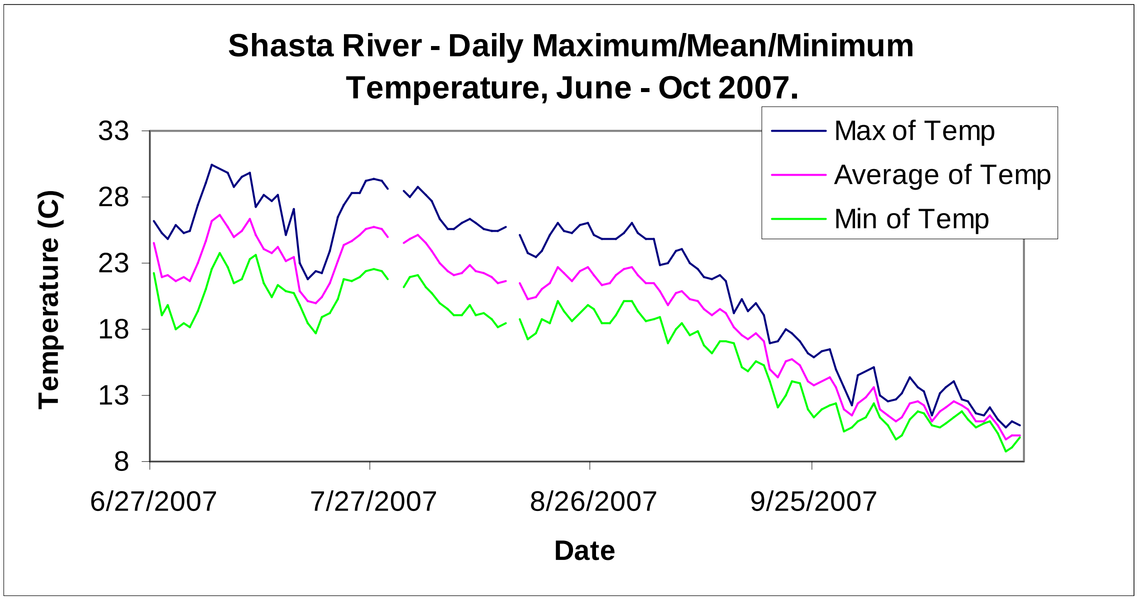

Figure 45- Daily maximum, mean, and minimum water temperature in the Shasta River from June to October, 2007

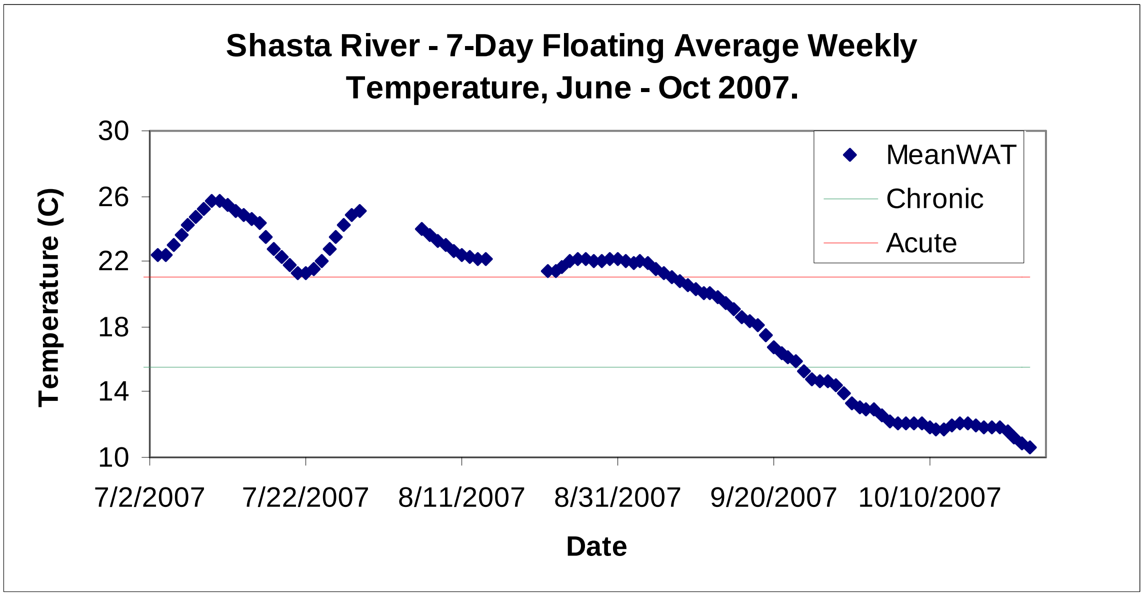

Figure 46 - Maximum weekly average temperature for the Shasta River from June to October, 2007

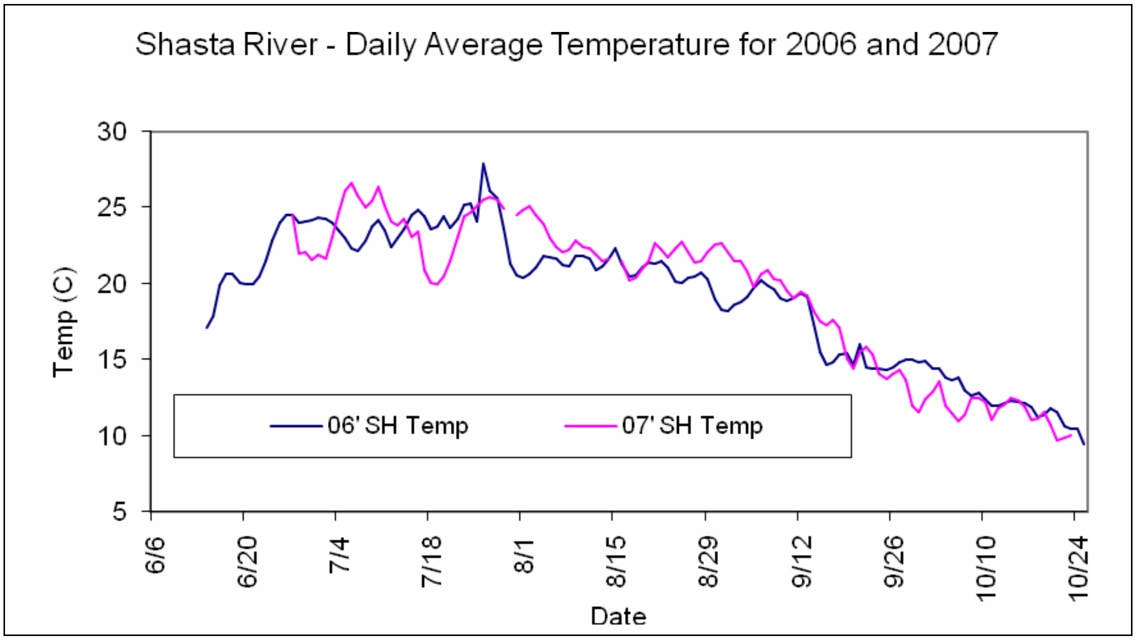

Figure 47 – Daily average temperature for the Shasta River during the 2006 and 2007 monitoring season

6.2.1.2 Dissolved Oxygen

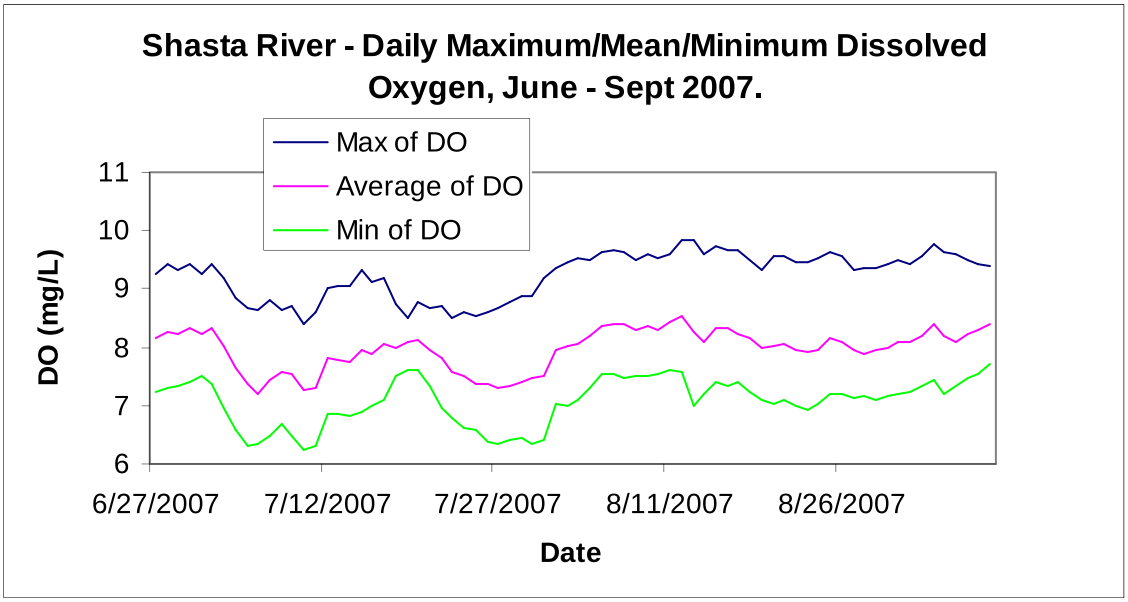

Figure 48 - Daily maximum, mean, and minimum dissolved oxygen in the Shasta River from June to October, 2007

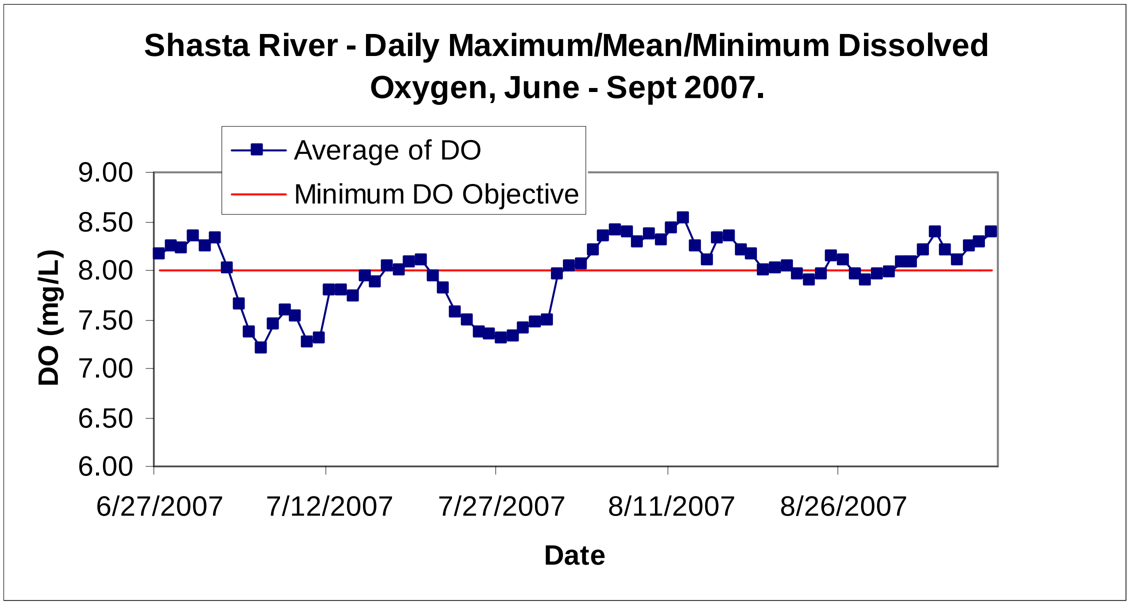

Figure 49 - Daily mean dissolved oxygen in the Shasta River from June to October, 2007

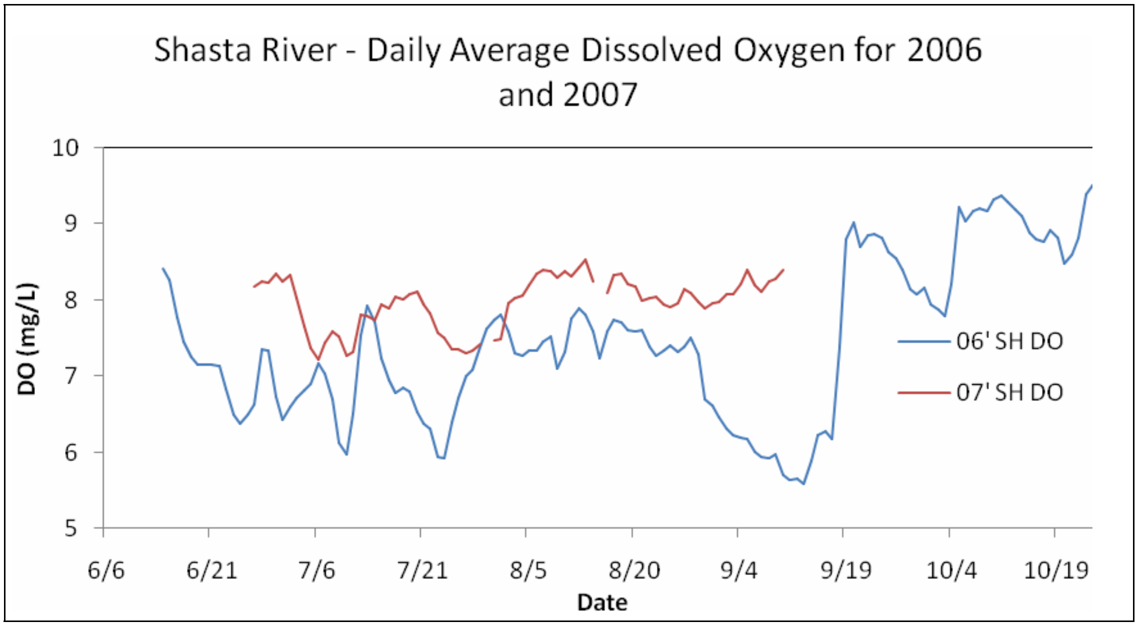

Figure 50 – Daily average dissolved oxygen for the Shasta River for the 2006 and 2007 monitoring seasons

6.2.1.3 pH

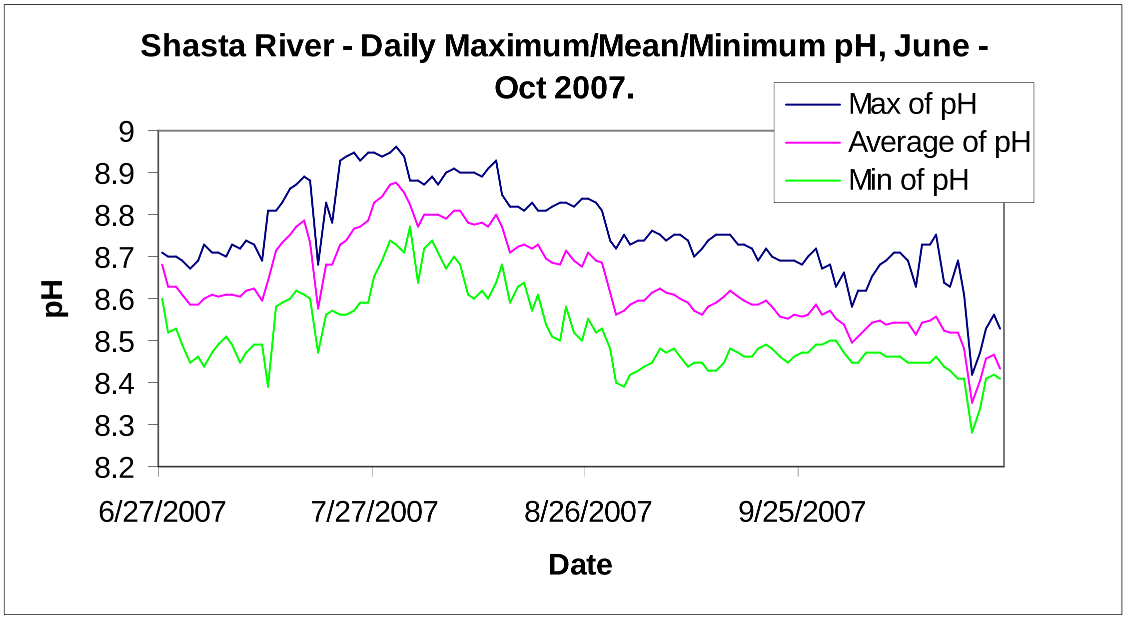

Figure 51 - Daily maximum, mean and minimum pH values on the Shasta River from June to October, 2007

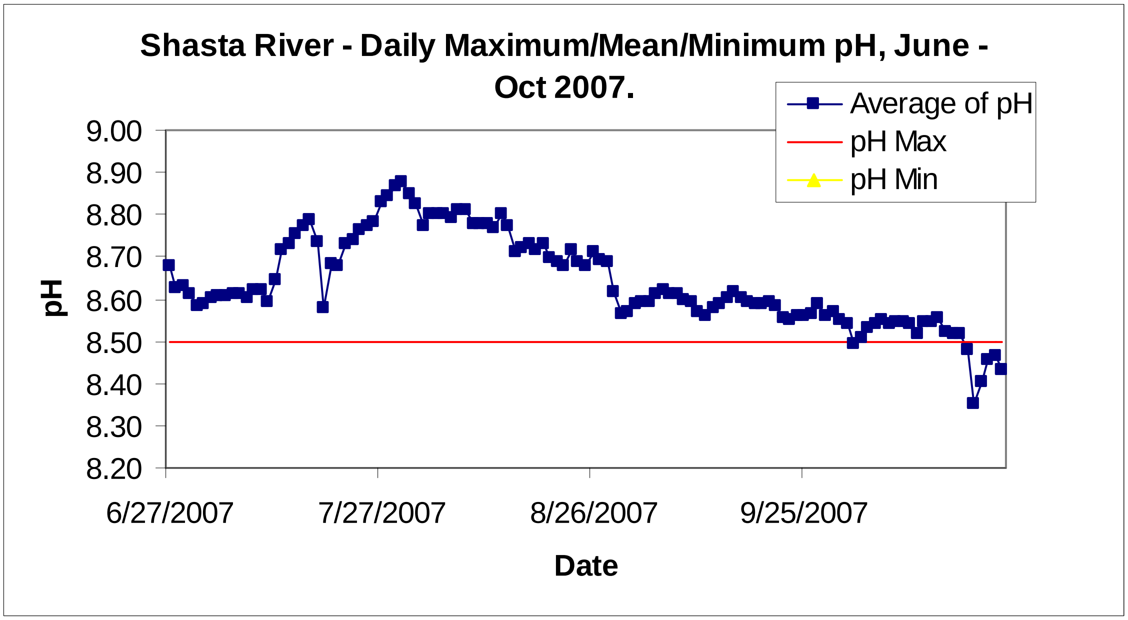

Figure 52 - Daily mean pH values on the Shasta River from June to October, 2007

6.2.1.4 Specific Conductance

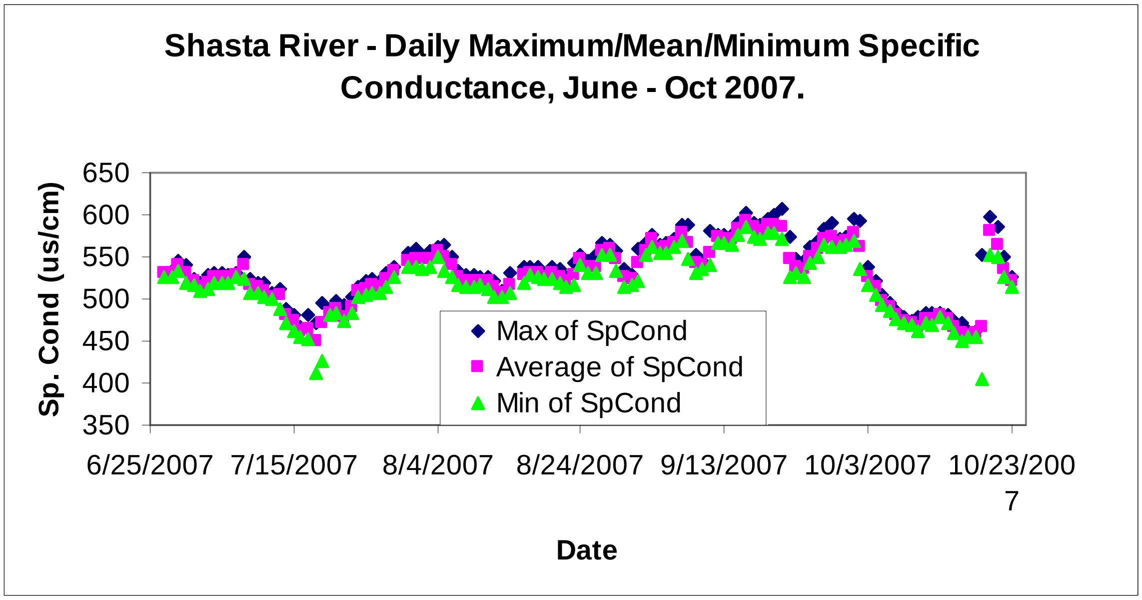

Figure 53 - Daily maximum, mean and minimum specific conductance values on the Shasta River from June to October, 2007

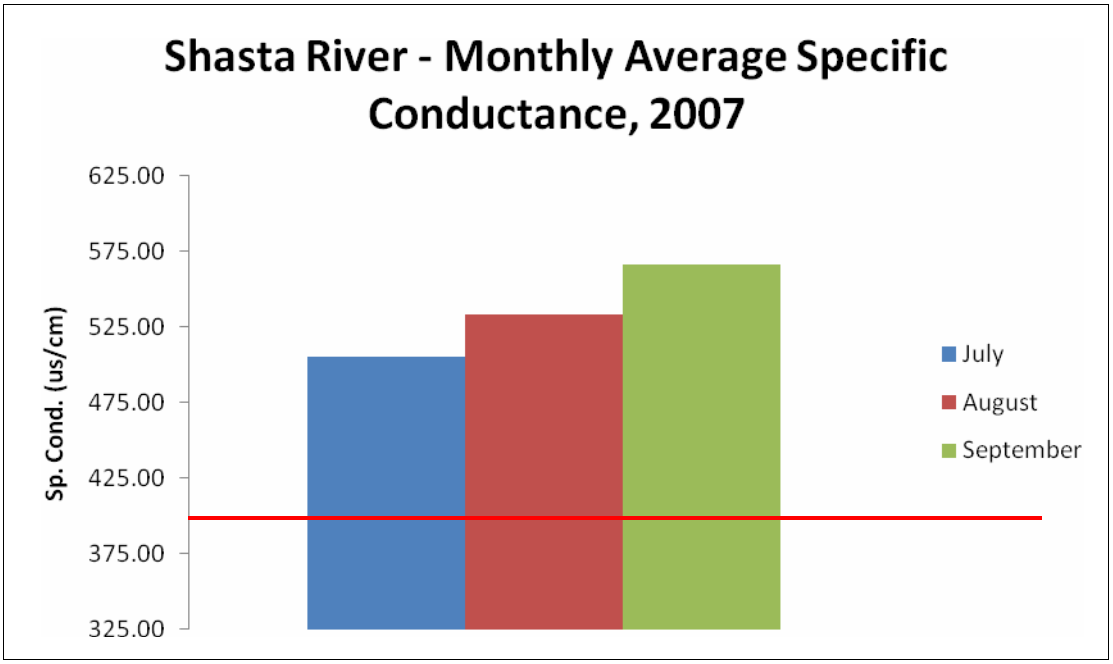

Figure 54 - Monthly average specific conductance from July to September, 2007 with maximum monthly specific conductance objective.

6.2.1.5 Flow

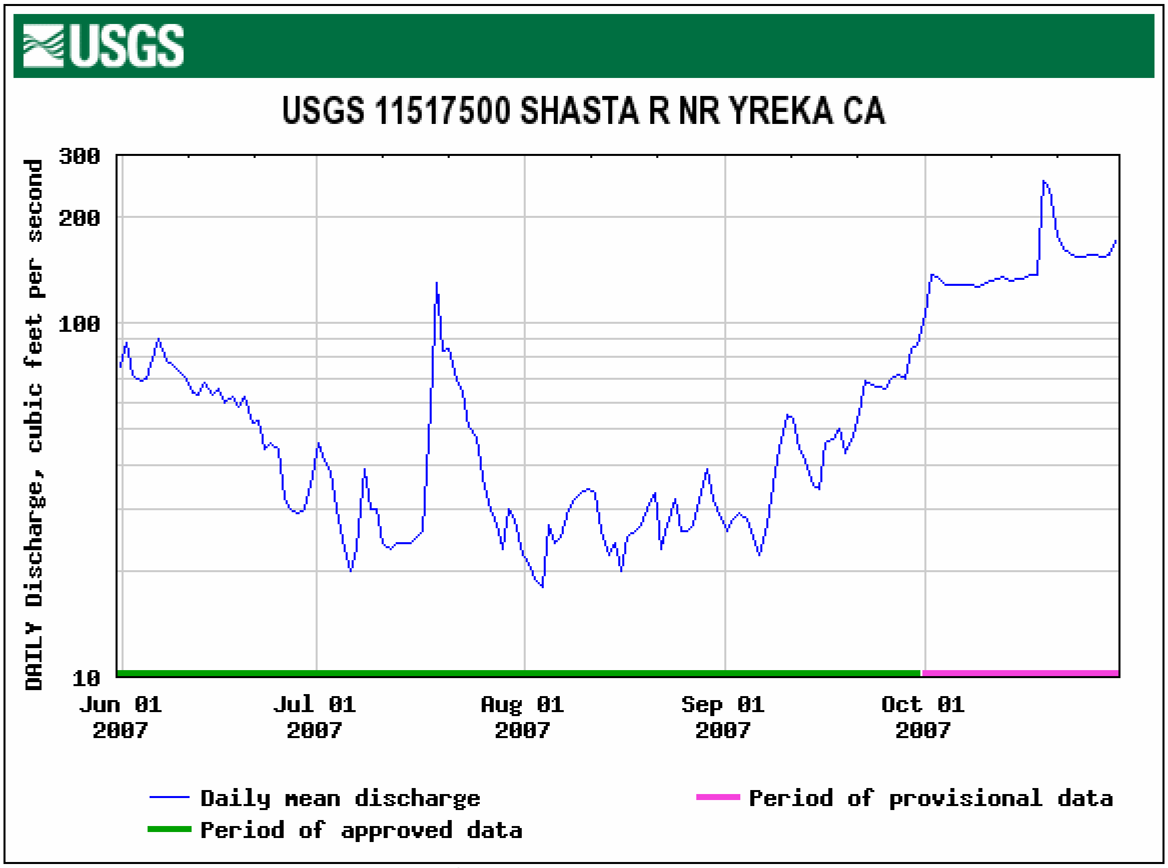

Figure 55 - Daily mean stream flow (Ft^3/sec) from the Shasta River at USGS flow gauge from June to October, 2007

6.2.2 Scott River

6.2.2.1 Water Temperature

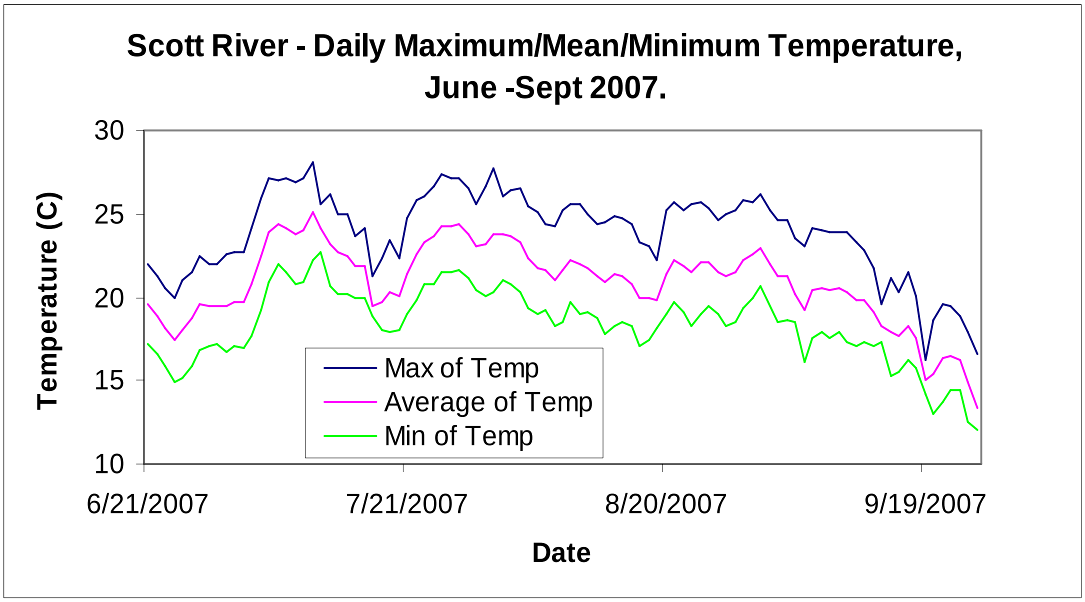

Figure 56 - Daily maximum, mean, and minimum water temperature in the Scott River from June to October, 2007

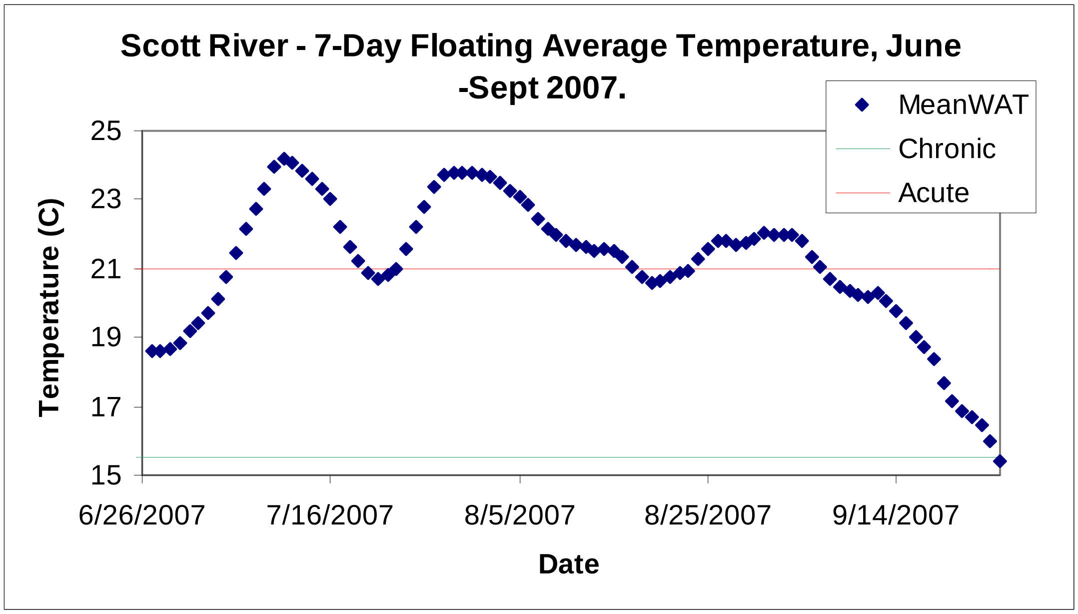

Figure 57 – 7-day floating average temperature for the Scott River from June to October, 2007

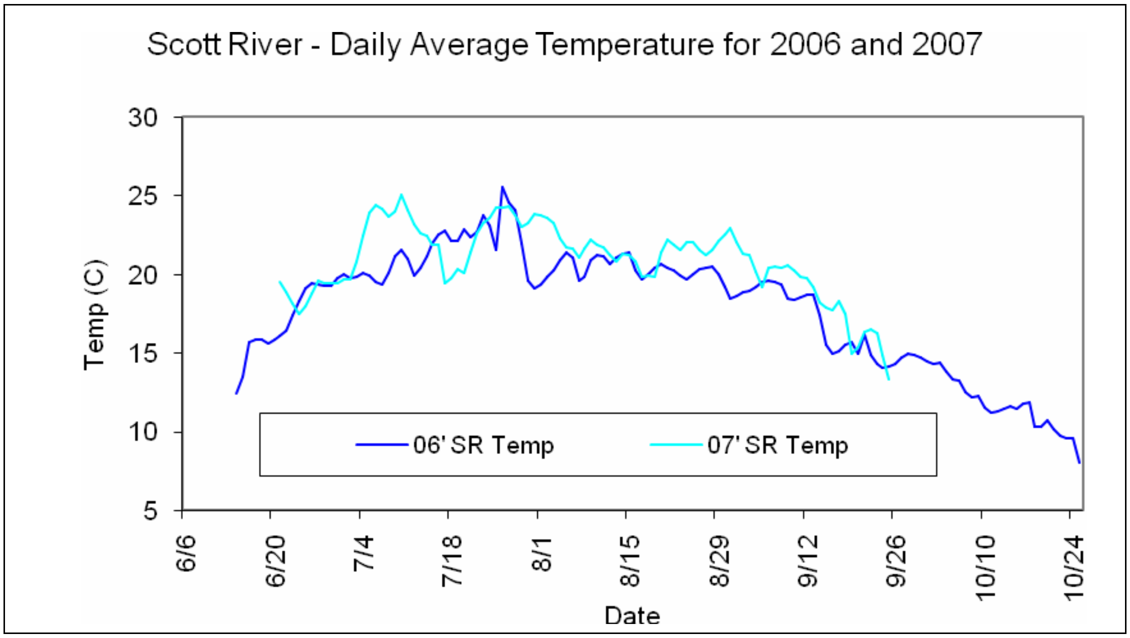

Figure 58 – Daily average temperature for the Scott River during the 2006 and 2007 monitoring seasons

6.2.2.2 Dissolved Oxygen

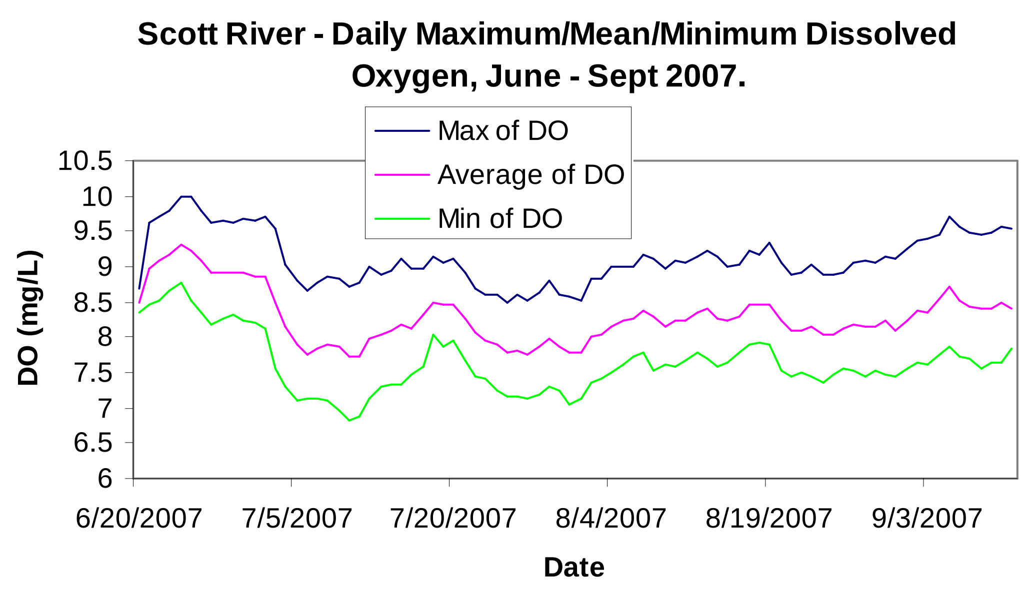

Figure 59 - Daily maximum, mean, and minimum dissolved oxygen in the Scott River from June to October, 2007

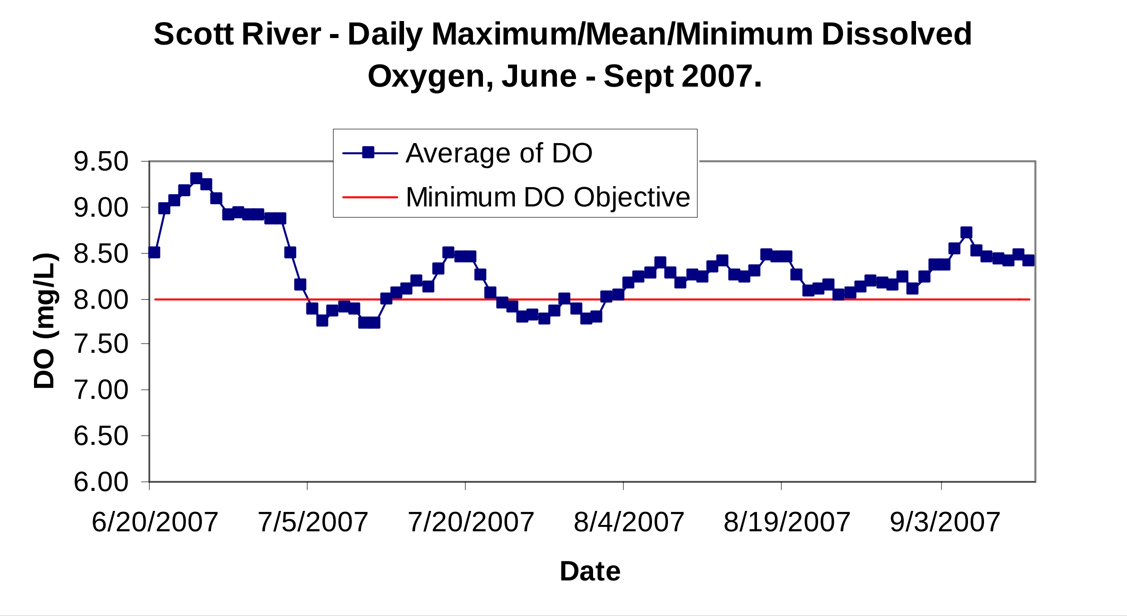

Figure 60 - Daily mean dissolved oxygen in the Scott River from June to October, 2007

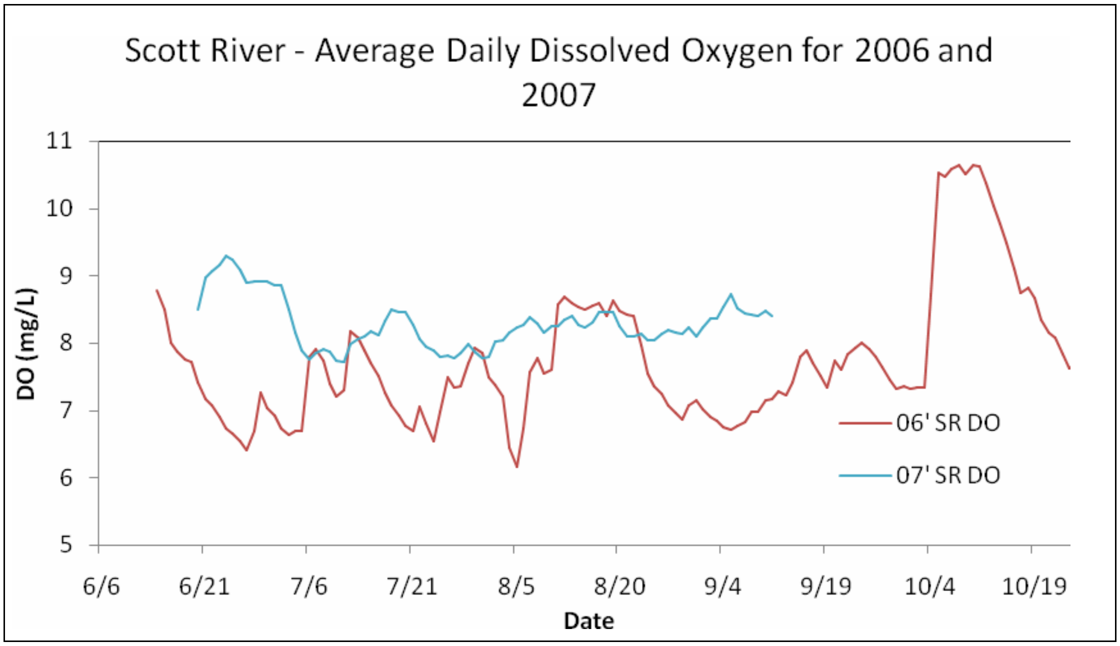

Figure 61 - Daily average dissolved oxygen for the Scott River during the 2006 and 2007 monitoring season

6.2.2.3 pH

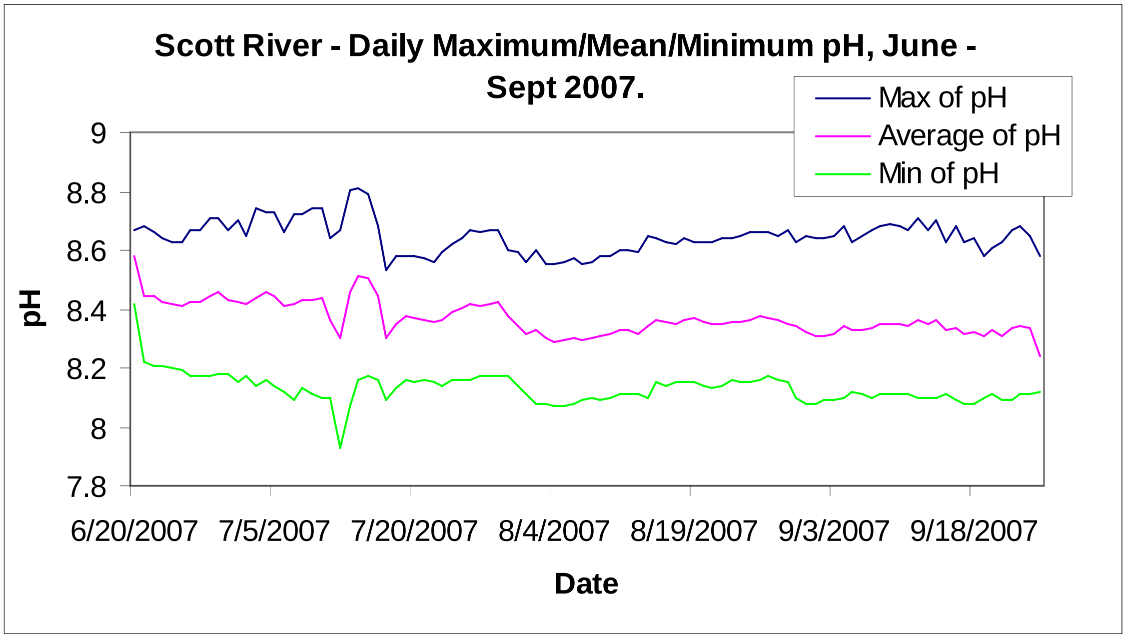

Figure 62 - Daily maximum, mean, and minimum pH values on the Scott River from June to October, 2007

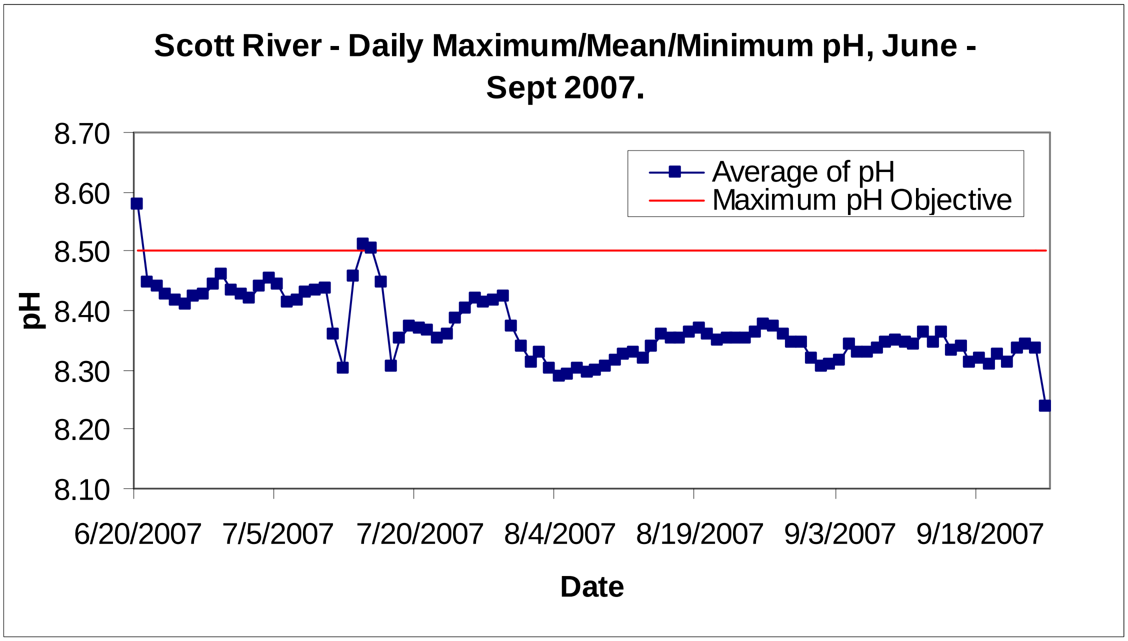

Figure 63 - Daily mean pH values on the Scott River from June to October, 2007

6.2.2.4 Specific Conductance

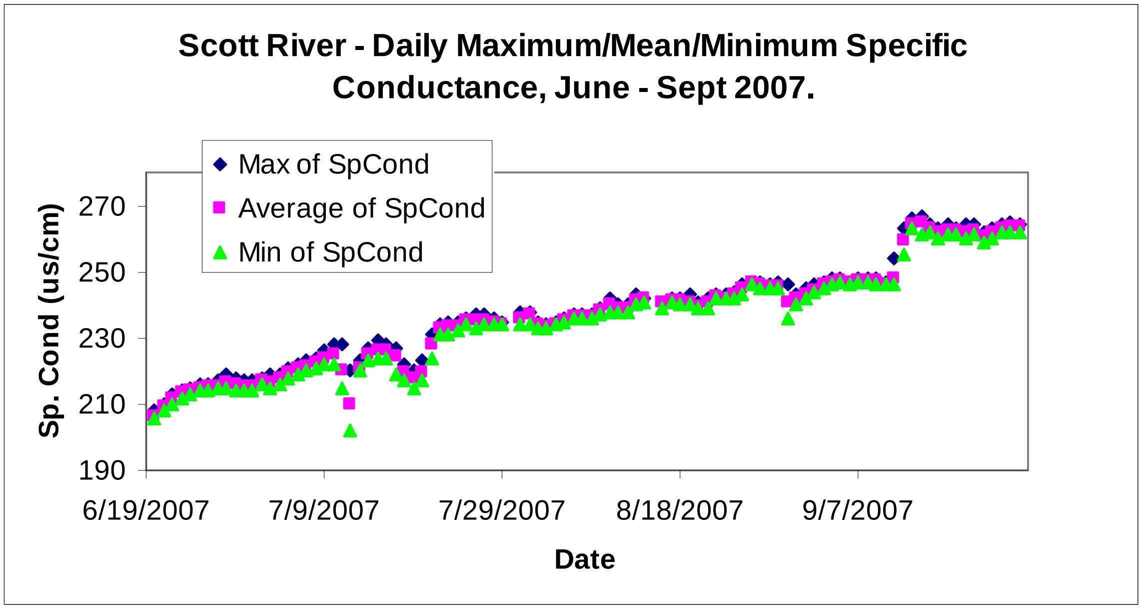

Figure 64 - Daily maximum, mean, and minimum specific conductivity in the Scott River from June to October, 2007

6.2.2.5 Flow

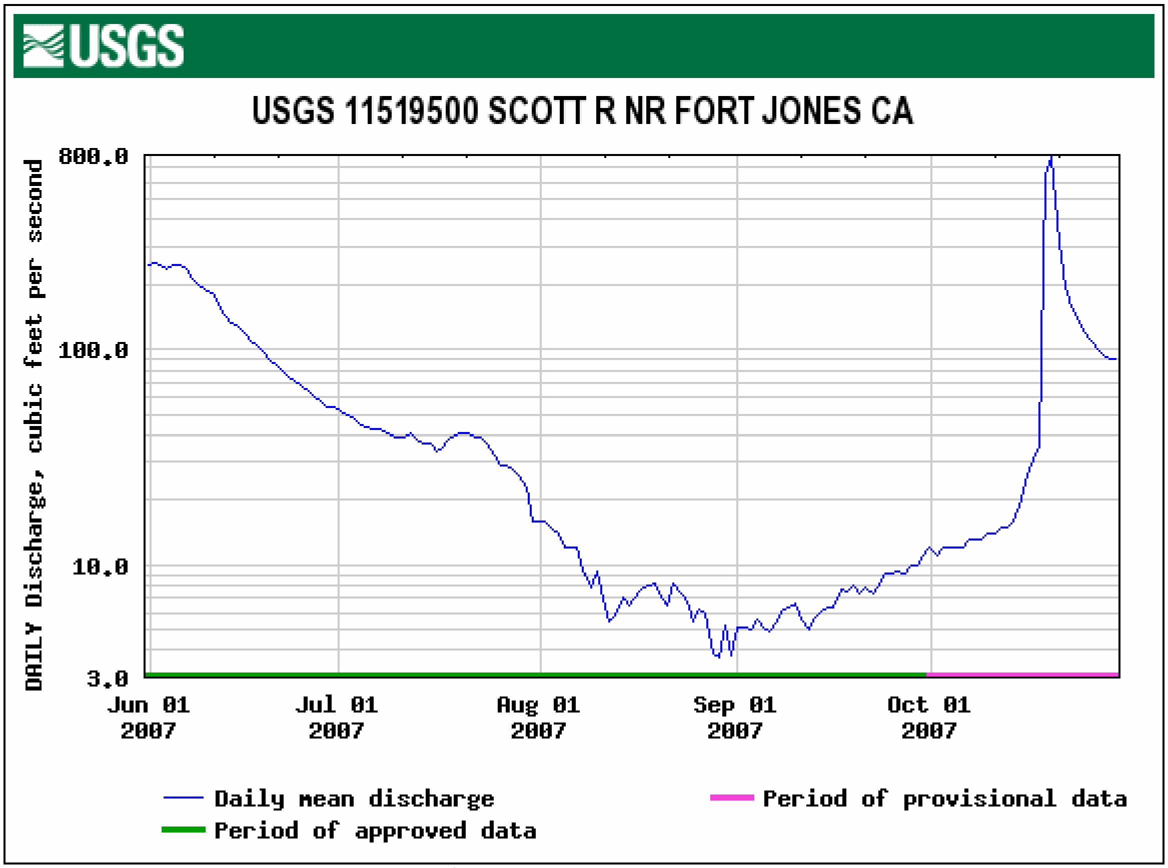

Figure 65 - Daily mean stream flow (ft^3/sec) from the Scott River at the Fort Jones USGS flow gauge from June to October, 2007

6.2.3 Salmon River

6.2.3.1 Water Temperature

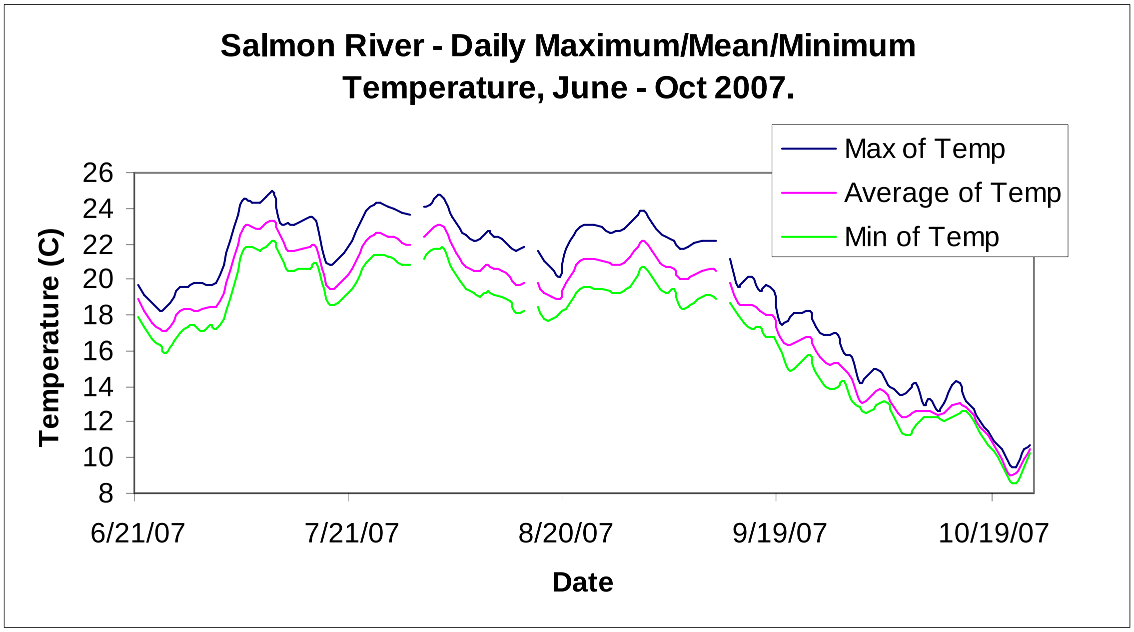

Figure 66 - Daily maximum, mean, and minimum water temperature in the Salmon River from June to October, 2007

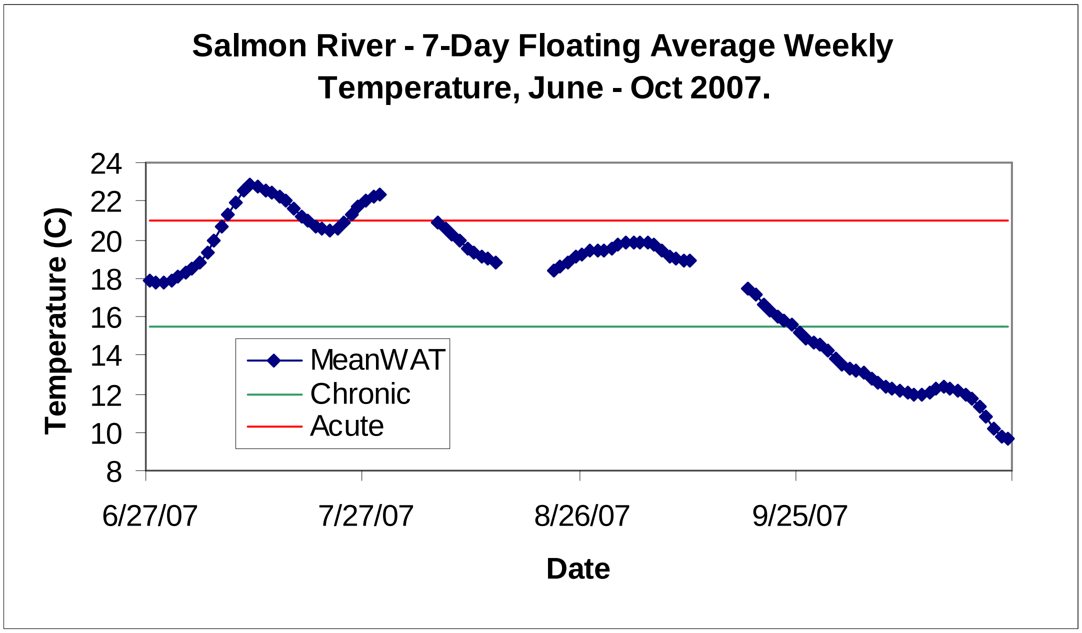

Figure 67 – 7-day floating average temperature for the Salmon River from May to October, 2007

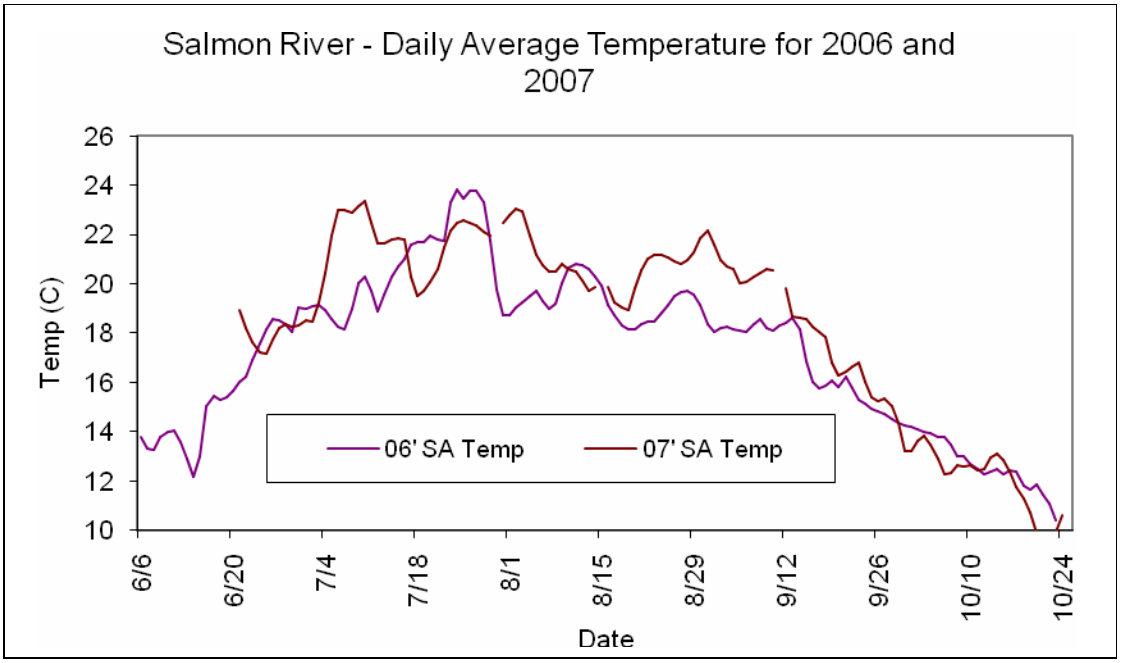

Figure 68 – Daily average temperature for the Salmon River during the 2006 and 2007 monitoring seasons

6.2.3.2 Dissolved Oxygen

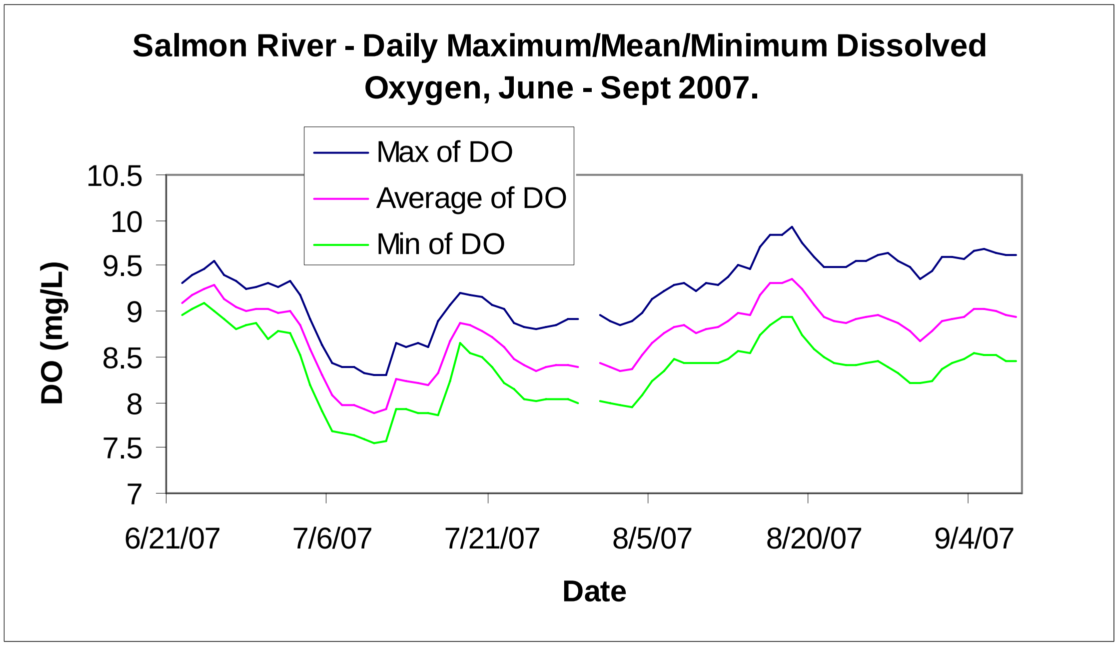

Figure 69 - Daily maximum, mean, and minimum of dissolved oxygen in the Salmon River from May to October, 2007

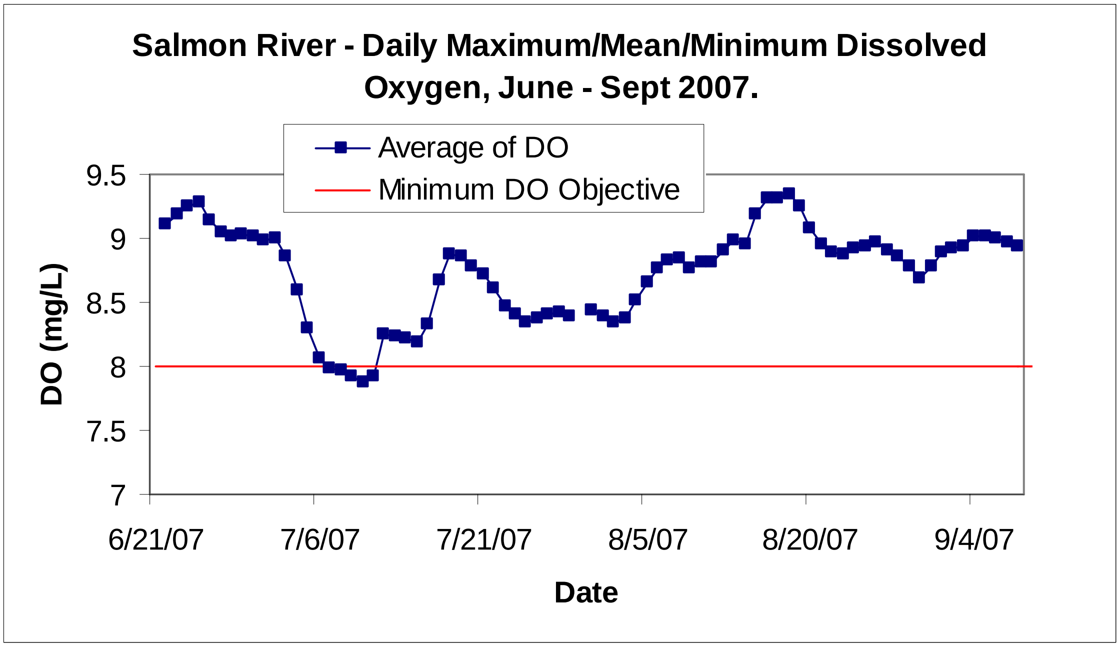

Figure 70 - Daily mean dissolved oxygen in the Salmon River from June to October, 2007

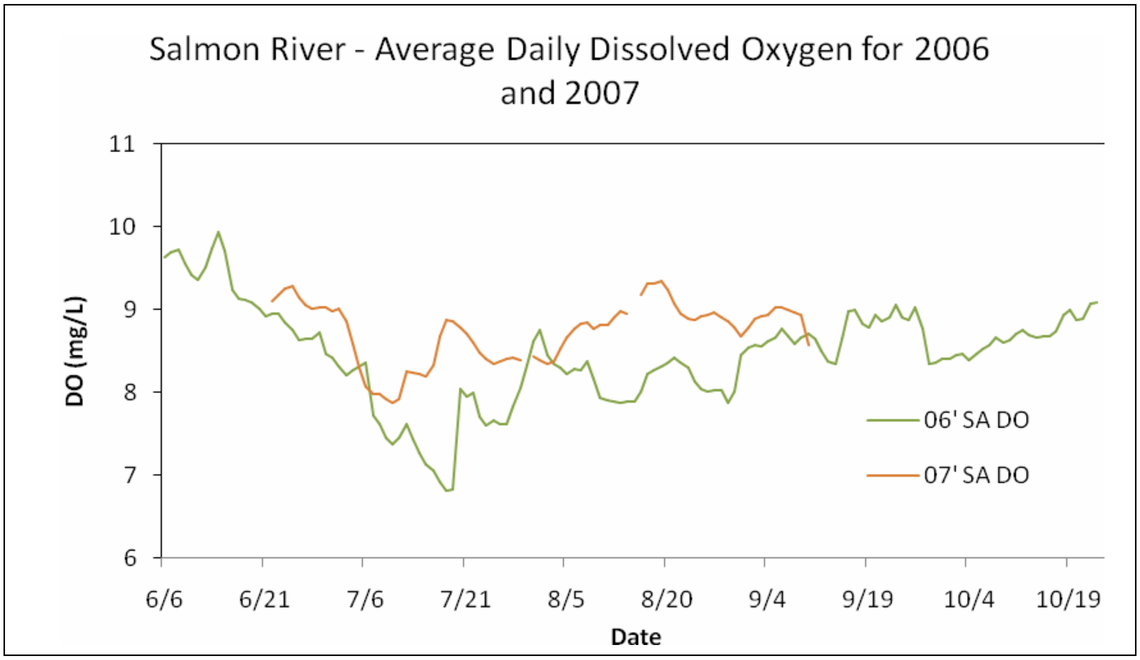

Figure 71 – Daily average dissolved oxygen for the Salmon River during the 2006 and 2007 monitoring seasons

6.2.3.3 pH

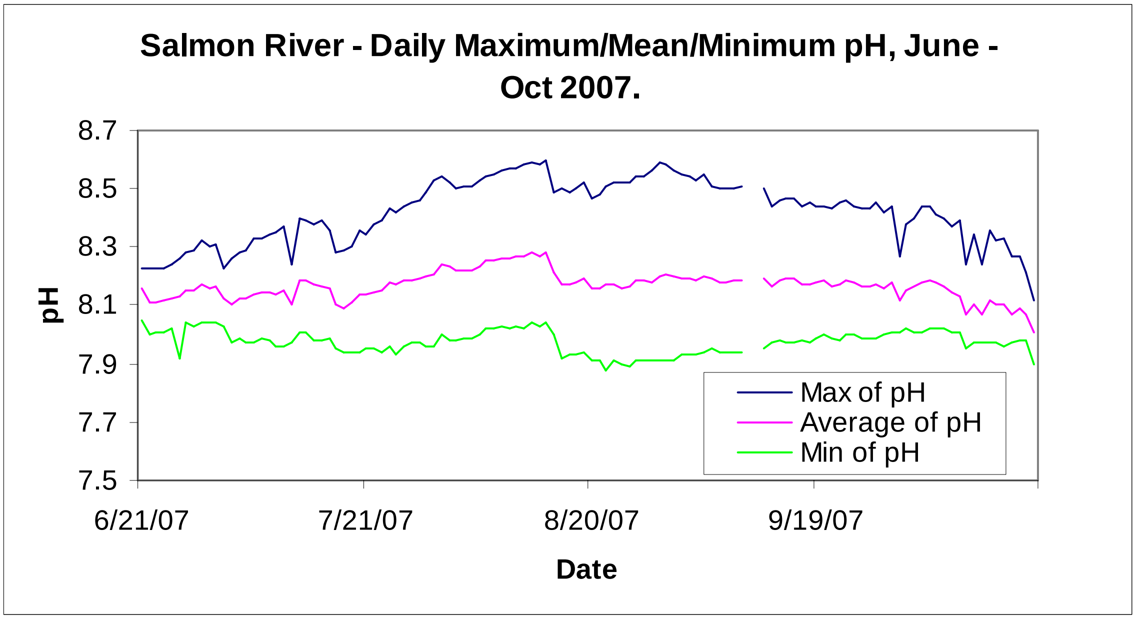

Figure 72 - Daily maximum, mean and minimum pH values on the Salmon River from June to October, 2007

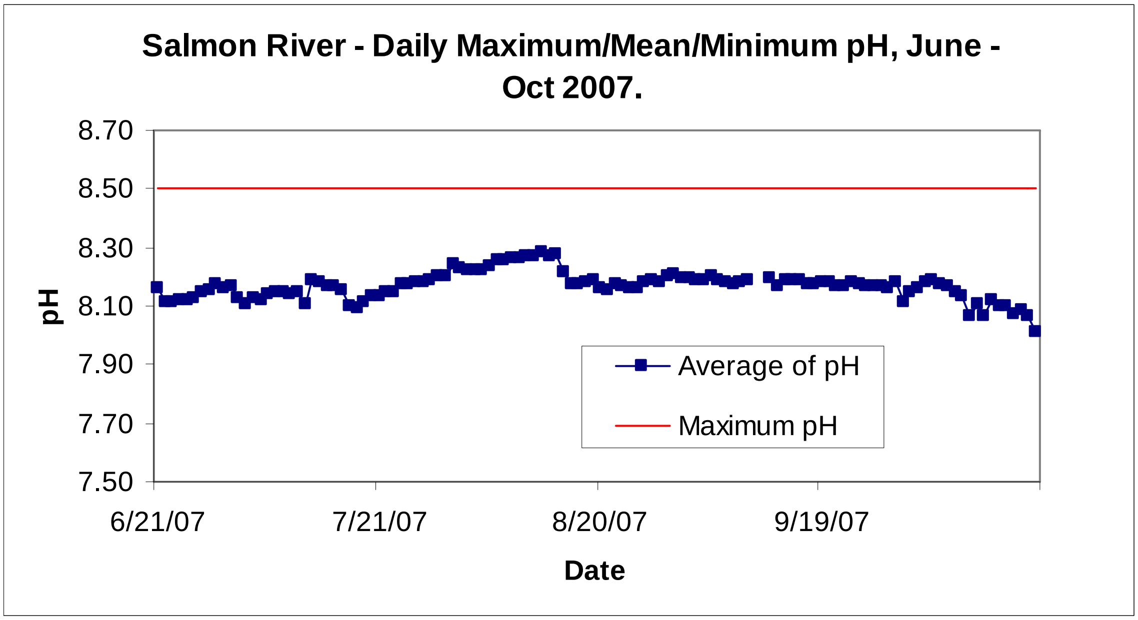

Figure 73 - Daily mean pH values on the Salmon River from June to October, 2007

6.2.3.4 Specific Conductance

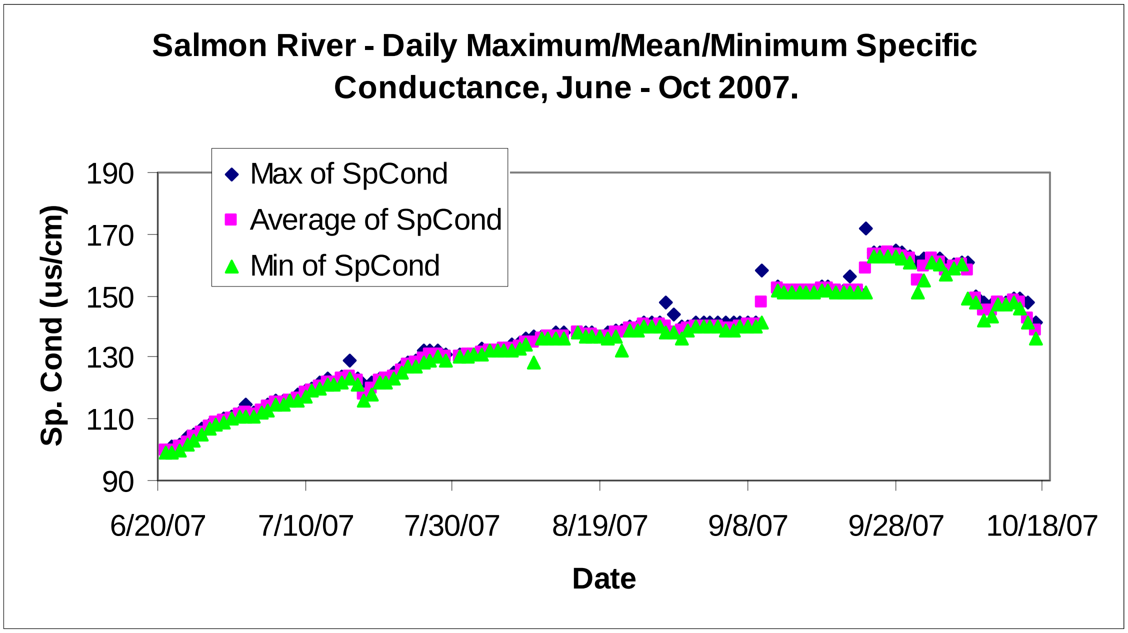

Figure 74 - Daily maximum, mean, and minimum specific conductivity values in the Salmon River from June to October, 2007

6.2.3.5 Flow

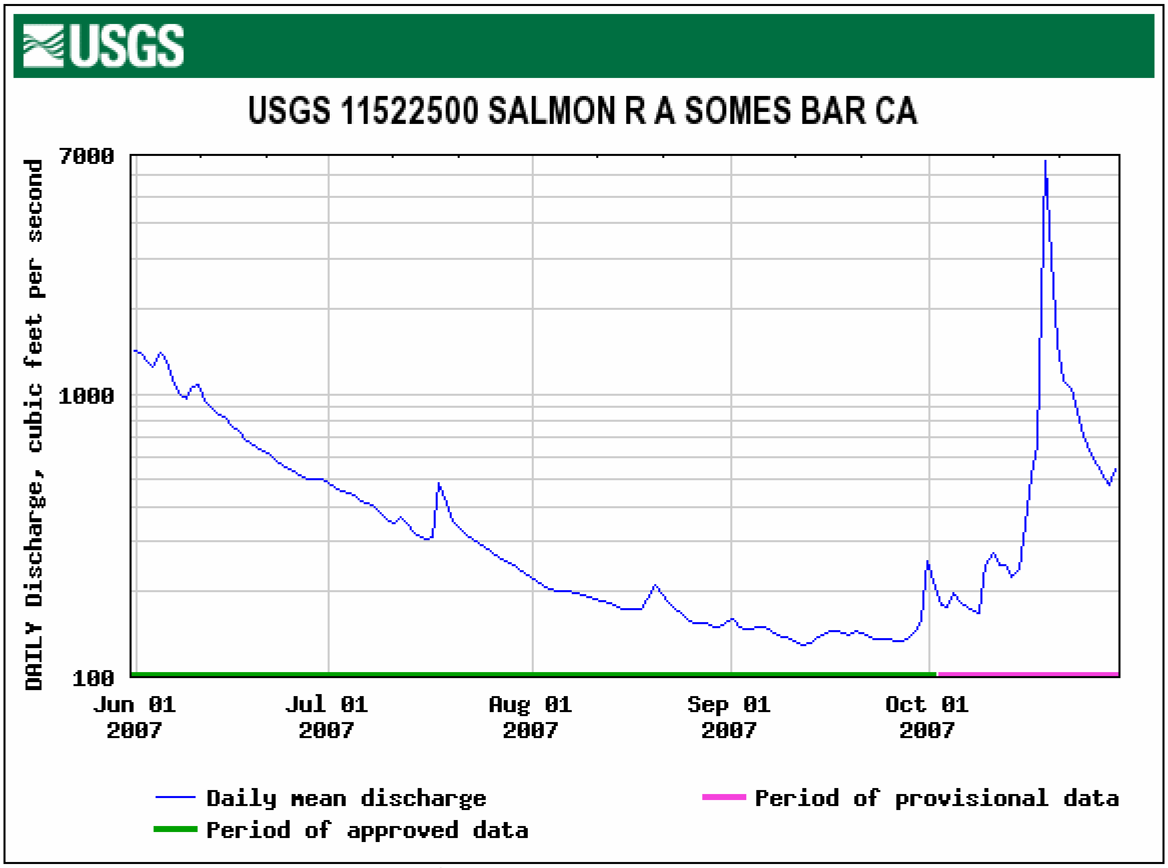

Figure 75 - Daily mean stream flow (ft^3/sec) from the Salmon River at the Somes Bar USGS flow gauge from June to October, 2007

6.2.4 Nutrients

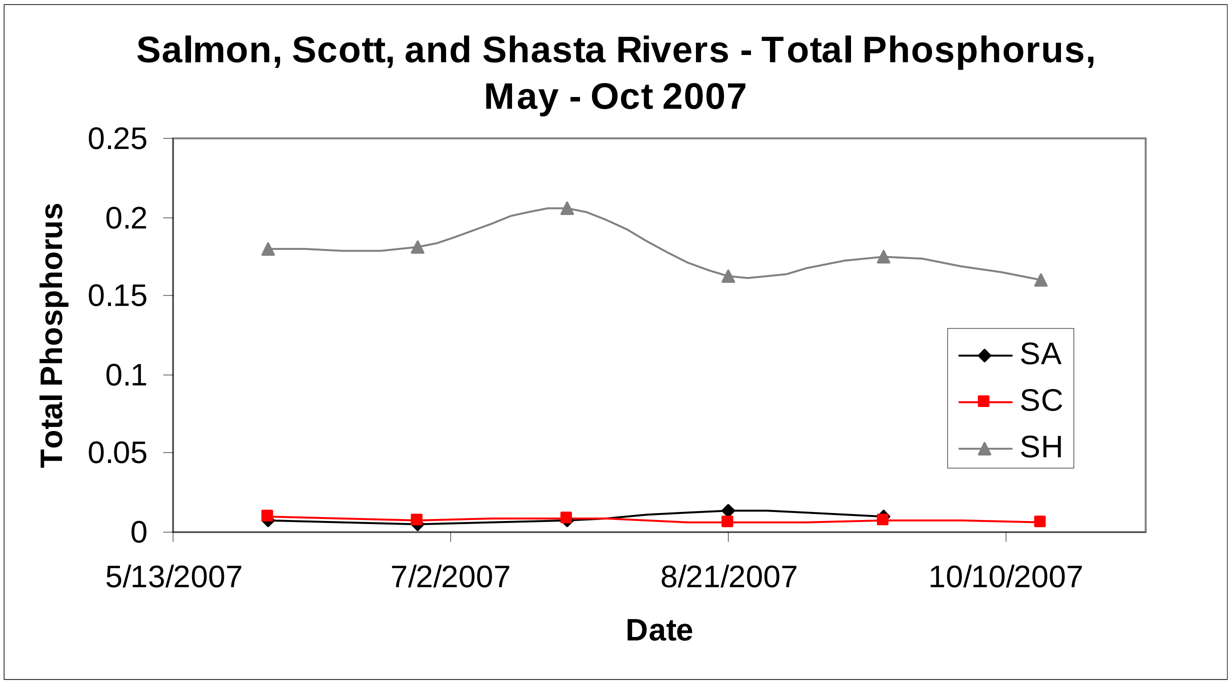

Figure 76 - phosphorus in mg/L for tributary sites from May to Oct, 2007.

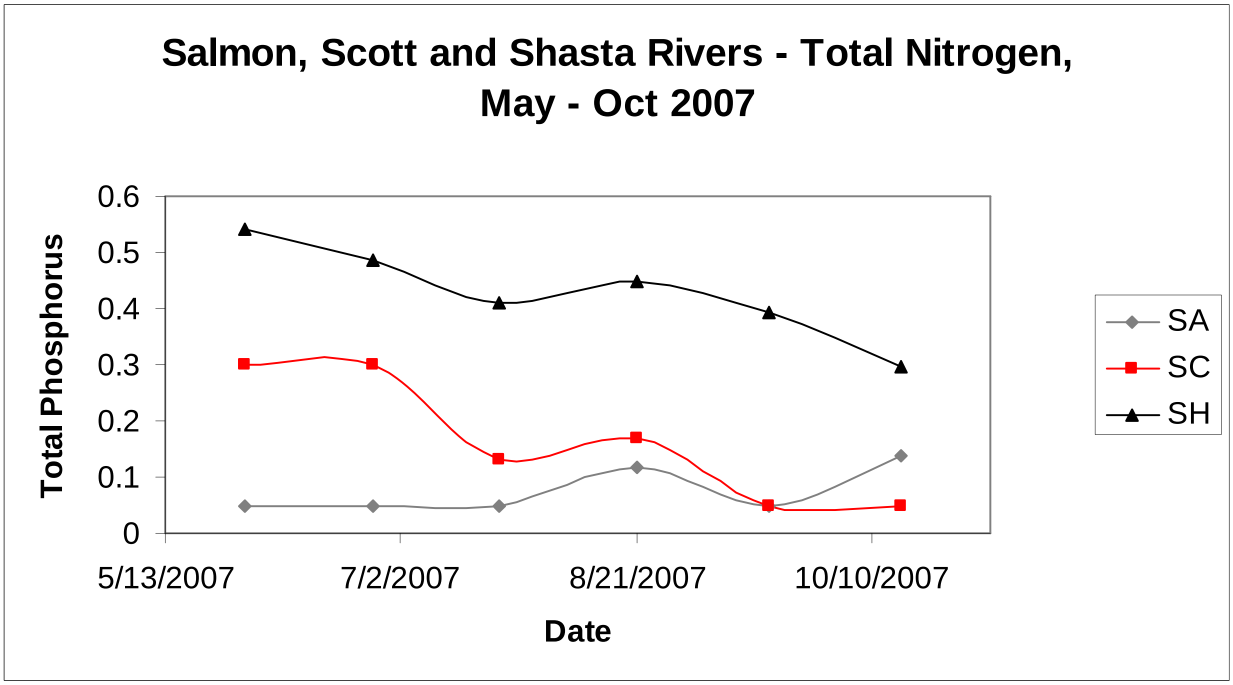

Figure 77 - Nitrogen in mg/L for tributary sites from May to Oct, 2007.

6.3 Turbidity

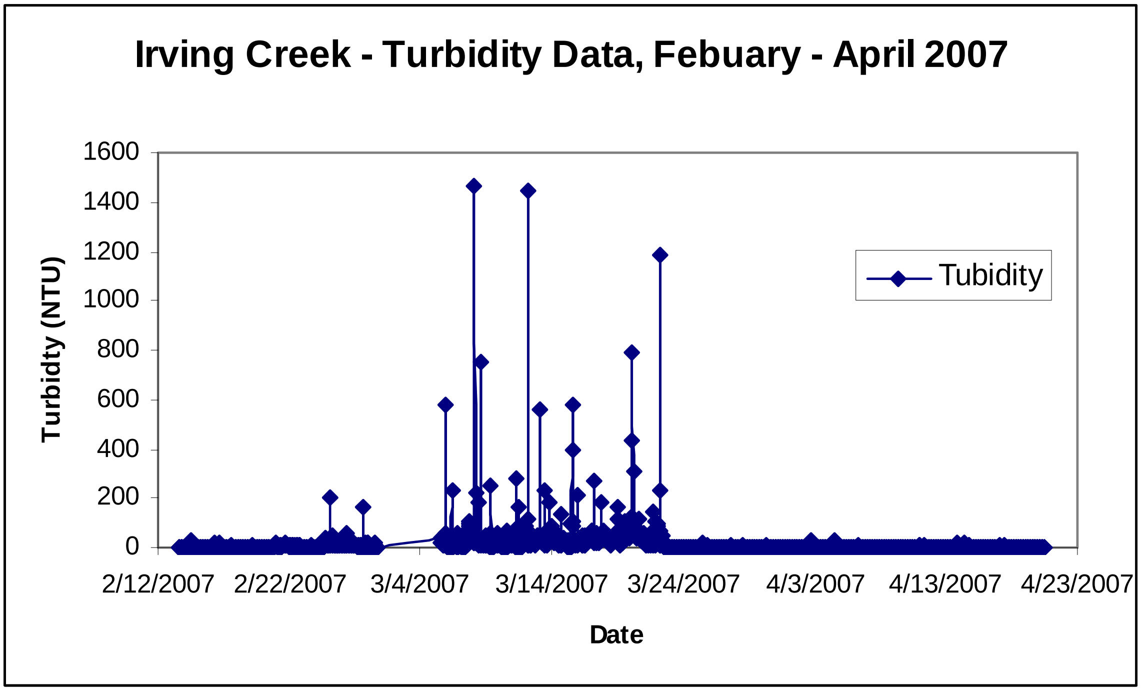

Figure 78 – winter turbidity data for Irving Creek

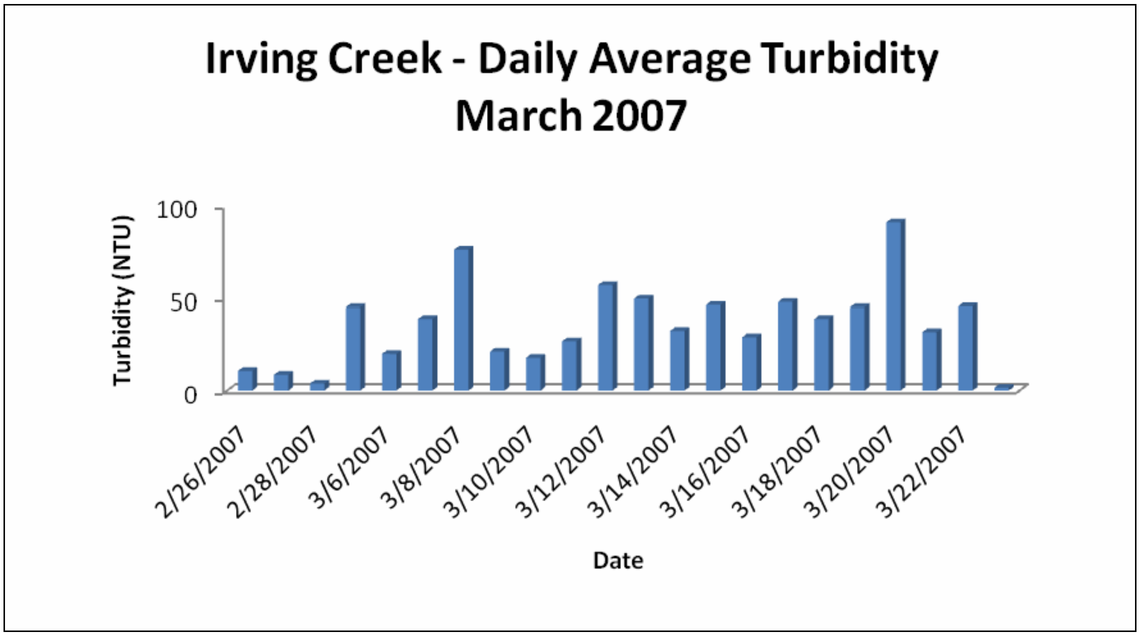

Figure 79 – Daily average turbidity for Irving creek during peak

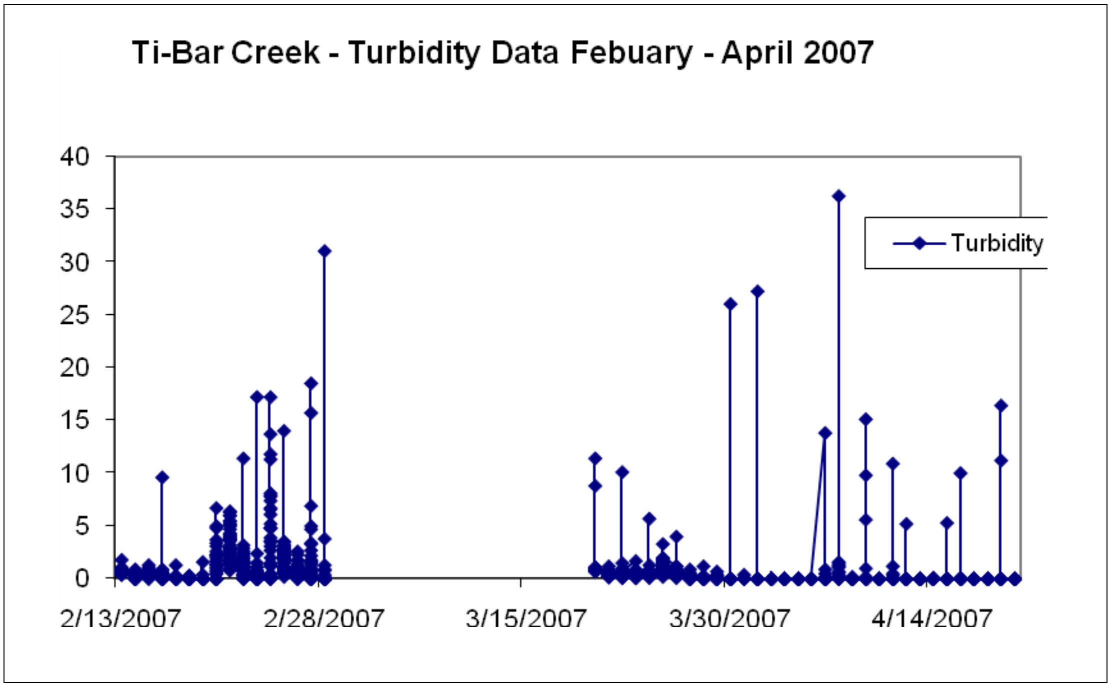

Figure 80 – winter turbidity data for Ti-Bar Creek

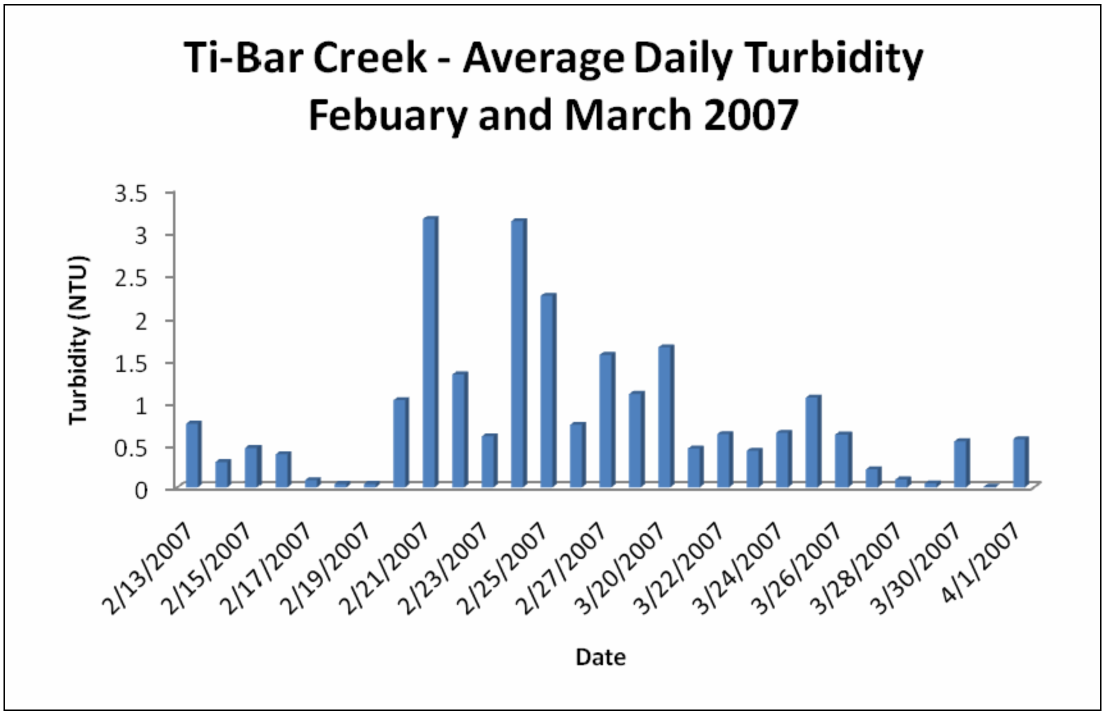

Figure 81 – Daily average turbidity data for Ti-Bar Creek during peak

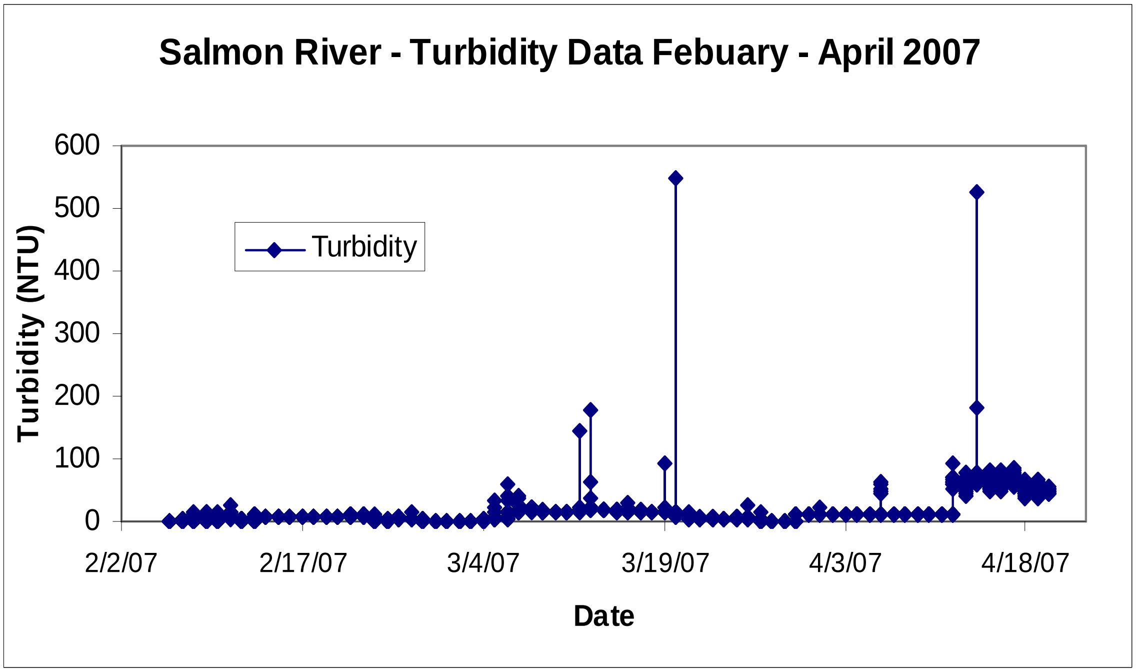

Figure 82 – Winter turbidity data for Salmon River

7.0 DISCUSSION

Water temperature, for all of the monitoring sites, increased rapidly during July, peaked in August, and held through mid-September. This rise in temperature occurs as snow pack melts, air temperatures rise, and flows drop (Figures 13, 23, 33, 45, 56, 66) and is exacerbated by the reservoirs located above the monitoring sites.

Floating weekly average temperatures (FWAT) are a common method of assessing water temperatures. These calculations require 7 consecutive days of data, thus if one day of data is missing FWAT cannot be calculated for the next 6 days. Gaps in the FWAT graphs are a result of missing days of data. However, the general trends are clear (Figures 14, 24, 34, 46, 57, 67). For all the monitored waters, water temperatures were continually above the chronic temperature level (upper limit for optimum growth for salmonids) from July to September and above the acute (lethal) level from mid-July to the end of August. The Shasta River experienced the highest temperatures for the longest period of time, 60 days above the acute temperature threshold (Table 9). The Klamath River mainstem was in exceedance of the Karuk temperature objectives throughout the summer until October (Figures 14, 24, 34) and showed higher overall temperatures for a longer duration as one moves down the river (Table 8). In comparing temperatures during the summer of 2006 and 2007 we see similar trends with a slightly delayed peak temperature in 2007 (Figures 15, 25, 35).

For dissolved oxygen levels (DO) in the Klamath, there was an increase in days the DO levels meet the Karuk water quality objective as one travels downstream (Table 8). Traveling downriver from Iron Gate the negative influence of the reservoirs on DO decreases, mixing increases, there is decreased aquatic vegetative material, and the volume of water increases. The site below Iron Gate Dam had 31 monitored days out of the summer in which the Karuk DO objective was not met, whereas at Orleans (the most downriver site) only 2 days were below the minimum level (Table 7). The Scott and Shasta Rivers had moderate DO levels throughout the summer months (Figures 47, 58). Overall, DO levels were slightly higher in 2007 than 2006 (Figures 18, 28, 40, 50, 61). This could be due in part to the use of a new technology, optical DO probes.

All the monitoring sites had pH measurements on the basic side. The Shasta River had the most days in non compliance with the pH objective (Table 9). The Klamath River site near Iron Gate had the greatest number of days in exceedance of the pH water quality standard (Table 9).

The Shasta River was the only site to exceed the objective of specific conductance. The Shasta was not in compliance with this objective throughout the summer months (Figure 44). All other sites were well below the threshold for specific conductivity (Figures 21, 31, 43, 53, 64, 74).

The 2007 nutrient data for the Klamath River showed that water exiting the reservoir had higher concentrations of both total nitrogen and total phosphorus throughout the monitoring season than the two sites downriver (Figures 39, 40). It appears there was a pulse of total phosphorus in mid September. In the tributaries total nitrogen is at its highest concentration at the beginning of the monitoring season and drops of as the season progresses (Figure 77). The Shasta River had the highest total phosphorus and nitrogen concentrations throughout the monitoring season (Figure 76).

Turbidity data for Irving creek showed an increase during the month of March (Figure 78, 79). Daily turbidity averages show Irving creek reaching levels just under 100 NTU during March (Figure 79). Ti Bar creek had a data gap running from February 28th to the 20th of March (Figure 80). The maximum average daily turbidity reading was around 3.5 NTU (Figure 81). The Salmon River had low turbidity readings throughout the winter with a few high outliers (Figure 82).

Some of the changes and improvements anticipated for the 2008 monitoring season include hooking up the Iron Gate site for real-time monitoring. All data will be entered into the YEDSS database, developed by the Yurok tribe to submit data electronically to the EPA. This database will also generate grades based on the USGS criteria to allow for further quality assurance and the examination of drift of instruments during deployment. Data will then be corrected using the USGS method.

The Karuk Water Resources Program wishes to thanks the EPA for their generous grants, the USFWS for their continued financial support, the Yurok Tribe for their technical assistance, North Coast Regional Water Quality Control Board Swamp Program for loaning us two datasondes, and the Klamath Basin Tribal Water Quality Workgroup for funding Tribal water quality efforts and critical collaboration.

Number of Monitored Days Klamath River Was in Exceedance of Tribal Water Quality Objectives

Water Quality Objective	Klamath River near Iron Gate 2007	Klamath River near Seiad 2007	Klamath River near Orleans 2007
Temperature Chronic (Daily Average >15.5C)	103	86	100
Temperature Acute (Daily Average >21.0C)	22	53	69
Dissolved Oxygen (Daily Average <8 mg/L)	31	15	2
Specific Conductance (Monthly Average >350 us/cm)	0	0	0
pH (Daily Average <6.5 or >8.5)	65	57	20

Table 8 – Temperature based on 7-day floating average temperature. DO and pH use daily average.

Number of Monitored Days Tributaries Were in Exceedance of Tribal Water Quality Objectives

Water Quality Objective	Shasta River 2007	Scott River 2007	Salmon River 2007
Temperature Chronic (Daily Average >15.5C)	84	93	93
Temperature Acute (Daily Average >21.0C)	60	53	34
Dissolved Oxygen (Daily Average <8 mg/L)	33	18	5
Specific Conductance (Monthly Average >350 us/cm)	3	0	0
pH (Daily Average <6.5 or >8.5)	112	3	0

Table 9 - Temperature based on 7-day floating average temperature. DO and pH use daily average.