KARUK TRIBE

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

2011
WATER QUALITY
ASSESMENT REPORT

KLAMATH RIVER, SALMON RIVER, SCOTT RIVER, SHASTA RIVER, AND BLUFF CREEK

Karuk Tribe

Water Quality Assessment Report
2011

Prepared by
Karuk Tribe
Water Quality
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Technical Staff

Crystal Bowman - Water Quality Coordinator
Grant Johnson - Water Quality Biologist
Chook Chook Hillman – Water Quality Technician

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1 Background

The Karuk Tribe 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 occurrences of toxic algae, and outbreaks of fish diseases. Impaired water quality conditions also apply extreme limitations and burdens to our cultural activities.

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 Environmental Protection Agency (USEPA), the United States Geological Survey (USGS), the Yurok Tribe, Oregon State University and PacificCorps. 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).

Table 1 - Atlas of Tribal Waters within Ancestral Territory

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 2 - Designated uses, tribal goals and parameters measured to analyze impairments to tribal uses and goals.

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

2 Purpose of the water quality monitoring program

The overarching mission of the Karuk Tribe is 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 upstream and flowing through Karuk Ancestral Territory and Tribal trust lands.

The Karuk Tribe Water Quality Program (KTWQP) is currently evaluating the overall condition of water quality on Karuk Ancestral Territory (KAT), monitoring the extent to which water quality changes over time, and identifying impacts to beneficial uses. Data the KTWQP collects is indispensable in monitoring water quality conditions within the Klamath River Basin and providing valuable information to ongoing water quality management processes. The information produced allows the Karuk Tribe to give valuable input in land management decisions and demonstrates the Tribe’s commitment to sound resource management.

The Klamath River in California is listed as an impaired water body under the Clean Water Act (CWA) Section 303(d) list for temperature, nutrients, dissolved oxygen (DO), sediment, and microcystin (NCRWQCB, 2009). The mid-Klamath River can have elevated water temperatures, low dissolved oxygen levels, elevated sediment loads, loading from organic matter, and high levels of the cyanotoxin, microcystin. These detrimental conditions are caused by a variety of factors including the presence of Iron

Gate and Copco Reservoirs, hydrological modification, agricultural use, timber harvesting, mining activities, and fire suppression (NCRWQCB, 2009). Some of the beneficial uses that are important to the Karuk Tribe and impacted by poor water quality conditions are, cultural use (CUL), subsistence fishing (FISH), cold freshwater habitat (COLD), recreation (REC-1 and 2), commercial and sport fishing (COMM), shellfish harvesting (SHELL), rare, threatened, or endangered species (RARE), migration of aquatic organisms (MIGR), spawning, reproduction, and/or early development (SPWN), and wildlife habitat (WILD) (NCRWQCB, 2007).

The data that the KTWQP collects is useful to Tribes, state and federal processes, and restoration efforts to assess current and past water quality conditions in the mid-Klamath River. For example, the North Coast Regional Water Quality Control Board (NCRWQCB) has developed a Total Maximum Daily Load (TMDL) for the Klamath River and has begun implementing TMDL's in the Scott, Shasta, and Salmon Rivers. KTWQP data was used in the development of the technical portion of the TMDL's. Compliance points for tracking water quality improvements through TMDL implementation were placed at KTWQP long-term monitoring locations. On February 18, 2010, forty-eight entities signed on to the Klamath Hydroelectric Settlement Agreement (KHSA) to remove the four lower dams of the Klamath Hydroelectric Project (KHP). For this agreement, water quality monitoring will occur to establish baseline water quality conditions before the dams are removed in 2020.

The Karuk Tribe has established water quality standards for waters within KAT. The details of these standards are outlined in the Karuk Tribe Water Quality Monitoring Plan (Karuk, 2002).

3 Collaboration/Coordination with other groups addressing water quality concerns

The KTWQP has found that the key to a successful water quality program in the Klamath is to build collaborative relationships and coordinate with other entities in the basin. This adds credibility to our data sets, builds trust in our monitoring techniques, stretches water quality dollars by combining and coordinating monitoring efforts whenever feasible, and increases the Tribe's ability to conduct research and monitoring in the mid-Klamath. Our partners include: Yurok Tribe, Klamath Tribes, Hoopa Tribe, Quartz Valley Indian Community, Resighini Rancheria, Humboldt State University, Oregon State University, UC Berkeley, U.S. Fish and Wildlife Service, EPA Region IX, North Coast Regional Water Quality Control Board, State Water Resources Control Board, U.S. Forest Service, U.S Geological Survey, Humboldt County, Salmon River Restoration Council, Mid Klamath Watershed Council, Institute for Fisheries Resources, Pacific Coast Federation of Fishermen's Associations, and Klamath Riverkeeper.

The KTWQP participates in many collaborative workgroups. We currently attend meetings, provide constructive feedback, help set research and monitoring priorities, working in technical subgroups, looking for and providing support for others grant proposals, and conduct monitoring and research. Some of the workgroups we participate in include: the Klamath Blue Green Algae Workgroup, State Blue Green Algae Workgroup, Klamath Basin Monitoring Group, Klamath Tribal Water Quality Workgroup, and the Klamath Fish Health Assessment Team.

4 Design of our water quality monitoring program

The purpose of the Karuk Tribe's water quality monitoring program is to evaluate the quality of water flowing into, through, and out of Karuk Ancestral Territory and Tribal Trust lands. We have combined the Tribe's goals with those of our collaborators listed above to establish a network of monitoring stations. We have established monitoring stations both within and above KAT. These stations form a longitudinal profile of water quality conditions along the mid-Klamath River and associated major tributaries.

Figure 1. Overview of the Karuk Tribe's water quality monitoring locations along the Klamath River in 2010.

Nutrient grab samples and phytoplankton are collected both in the Klamath River and the major tributaries, whereas public health monitoring for algal toxins occurs just in the mainstem (Table 3). With the exception of the Scott River, continuous water quality monitoring stations are located at USGS gauging stations. This sampling focuses around the summer base flow (the growing season), which is generally from May-October. This is commonly when water quality impairments stress beneficial uses. However, grab sampling may continue throughout the year to help establish annual baseline load conditions.

Frequency of sampling is greatly dependent on resources and monitoring objectives. For our sampling, we focus our resources on increasing frequency when the dynamics are changing at the greatest rate for that parameter. For example, nutrient and phytoplankton dynamics are in flux more over the growing season than during the rest of the year. Therefore, grab samples may be collected approximately bimonthly (2x/month) during the growing season (May-October) and monthly the remainder of the year. Public health monitoring frequency is aimed at being able to inform the public of health threats. Therefore, in KAT, sampling frequency increases during August and September when the peak of the algal bloom has been documented (Kann and Corum 2009).

During the winter and early spring months the KTWQP collects turbidity data at Bluff Creek and the Salmon River. These sites were chosen to monitor the effect of road decommissioning projects within these watersheds. Sediment run-off is generally during the wet, rainy winter months and during the spring when rain-on-snow events can occur.

Table 3 - Site codes and locations of Karuk sampling stations for nutrients, algal toxins and Sondes. Nutrient Suite indicates collecting nutrients, algal toxins and phytoplankton. Sonde indicates real time monitoring, and public health designates surface grab sampling for phytoplankton and algal toxins.

2009 Locations and Parameters Monitored							
Site ID	Latitude	Longitude	Nutrient Suite	Sonde	Public Health	Winter Turbidity	Location
BLC	N 41 14.417	W 123 39.417		X		X	Bluff Creek near mouth
OR	N 41 18.336	W 123 31.895	X	X	X		Klamath River at Orleans
SA	N 41 22.617	W 123 28.633	X	X		X	Salmon River at USGS Gage
HC	N 41 43.780	W 123 25.775	X		X		Klamath River downstream of Happy Camp
SV	N 41 50.561	W 123 13.132	X	X	X		Klamath River downstream of Seiad Valley
SC	N 41 46.100	W 123 01.567	X	X			Scott River at Johnson's Bar
BB	N 41 49.395	W 122 57.718	X		X		Brown Bear River Access on Klamath River
WA	N 41	W 122	X				Klamath River at

	50.242	51.895					Walker Bridge
SH	N 41 49.390	W 122 35.700	X	X			Shasta River at USGS Gage
IG	N 41 55.865	W 122 26.532	X	X			Klamath River below Iron Gate Hatchery Bridge

Further discussion of monitoring protocols and procedures can be found in the KTWQP's Annual Monitoring Report, formerly Water Quality Assessment Report, and the Mid-Klamath River Nutrient, Periphyton, Phytoplankton and Algal Toxin Sampling Analysis Plan, and the Karuk Tribe Quality Assurance Protocols and Procedures document (QAPP).

5 How water quality data is interpreted and managed

The Yurok Tribe received a grant under the Environmental Information Exchange Network Program and used it to develop the Yurok Tribe Environmental Data Storage System (YEDSS). This system has been shared with the Klamath Basin Tribal Water Quality Workgroup, including the Karuk Tribe. All sonde and nutrient sampling data will be entered and stored in YEDSS. YEDSS utilizes user defined flag criteria which are automatically applied to the data set. This is very useful in Quality Assurance and Quality Control (QA/QC) screening. Data entries that fall outside excepted ranges are automatically flagged for further analysis. See example in Figure 2.

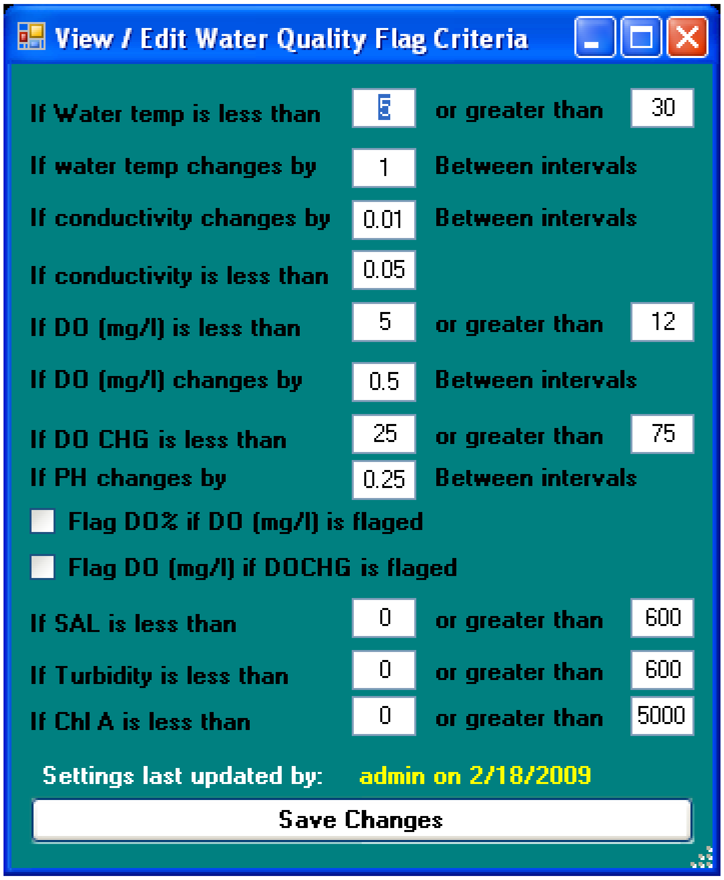

Figure 2. Flagging Criteria automatically applied to sonde data.

Raw data and data that have under-gone further QA/QC are automatically archived separately. Metadata associated with each data type are also stored within the system and can be easily accessed when questions arise. Phytoplankton and algal toxin data will be entered into Excel spreadsheets that are checked for accuracy by the Project Manager and backed up onto the KTWQP network, and an external hard drive system that is maintained offsite.

Data is compiled using spreadsheets and YEDDS. Graphical and statistical analyses are used to asses the current status and trends of monitored water bodies. In addition, comparisons between sites can also be made. (Final Guidance 106 CWA 4-21) Overall water quality is evaluated using standards put forth in the Karuk Tribe's Water Quality Control Plan. Assessment of data also includes the evaluation of field methodology and data quality. Data collected is then submitted electronically to EPA via their Water Quality Exchange network (WQX) and made publicly available. Data may be utilized by other Tribes, agencies, and entities to help direct water resource management actions.

6 Results of water quality monitoring during this project period

The associated Water Quality Assessment Report spreadsheet describes current impairments.

The sonde data presented in Figures 3-8 shows seasonal temperature, dissolved oxygen and pH trends at mainstem Klamath River monitoring sites. In 2011, Seiad Valley (SV) and Orleans (OR) monitoring locations had similar thermographs when comparing daily averages. The Iron Gate (IG) site had less variability in average temperature fluctuations than SV or OR. Iron Gate also had a lower peak average temperature during July-August (Figure 3). This trend is further emphasized when looking at the average temperature over a six year period from 2006-2011 (Figure 4). The IG site is just downstream of Iron Gate dam. The dam released water has a moderating effect on water temperature, providing slightly warmer water in the fall and winter and colder water during summer peak temperatures. Comparing figure 4 and 3 there is a notable shift in the timing of peak water temperatures. These figures also show temperatures hovered around 12C for a couple weeks longer this spring than on average. The Tribally adopted chronic average temperature threshold of 15.5ºC is when average temperatures may be lethal for salmonids (Karuk, 2002). Despite an abnormally cool and wet spring all sites exceed this standard. This data supports the designation for impaired water temperature.

Average daily dissolved oxygen (DO) levels are generally higher at OR and decreased at more upstream sites in 2011 (Figure 5). Six-year DO daily averages show the seasonal DO differences between sites are less extreme in the middle of the summer when water temperatures are the highest (Figures 4 and 6). Iron Gate dam has a negative impact on DO levels in late September and October. At this time, DO levels below the dam are dropping, whereas at other locations along the Klamath River, the DO levels are increasing (Figure 5 and 6). This is of concern since this timing overlaps with fall-run salmonid migration and spawning. The Seiad site shows a DO shift during the middle of June, this is most likely due to improper calibration. There is a data gap in IG data that occurred due to an equipment failure caused by lightning.

Average daily pH trends vary between mainstem sites (Figures 7-8). Orleans has the least seasonal variability; daily average pH stays below 8.5. The Karuk Tribe has an adopted standard of $6.5<pH<8.5$ (Karuk Tribe, 2002). In 2011, all sites have incomplete data sets due to probe malfunction and battery failure. Looking at the 6-year trend shows that pH generally peaks in late July and August at SV, with daily average pH exceedances above 8.5. Of all the mainstem sites, IG has the most exceedances, with a spike in pH occurring between mid-August into mid-September. The average daily pH at IG for 2006-2011 exceeded 8.5 for most of August and September. The spike in pH occurs during peak in river primary productivity and the lowest DO readings.

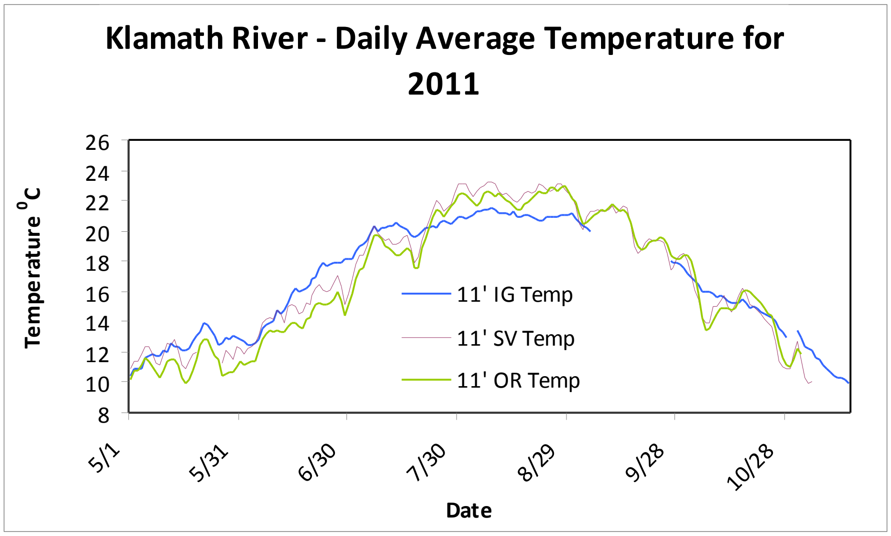

Figure 3. Daily average temperatures for 3 mainstem Klamath River sites in 2011: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

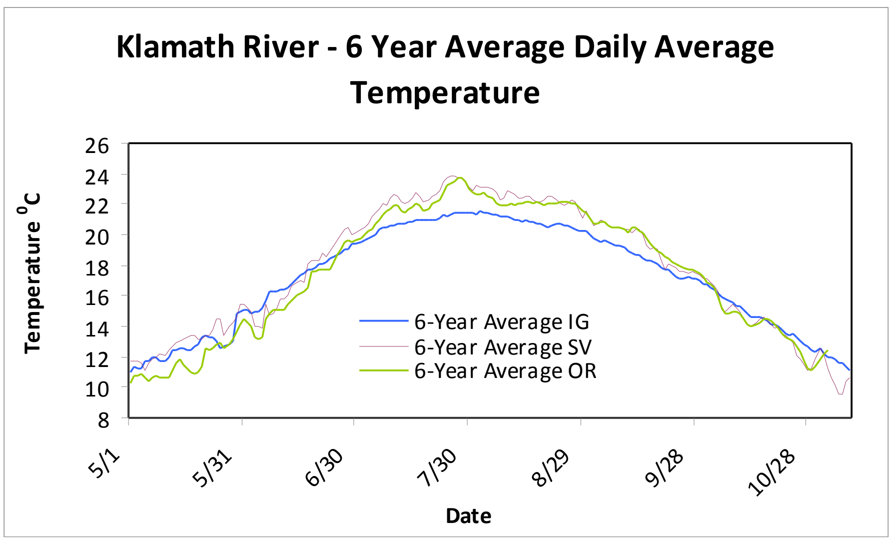

Figure 4. Average of daily average temperature from 2006-2011 at mainstem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

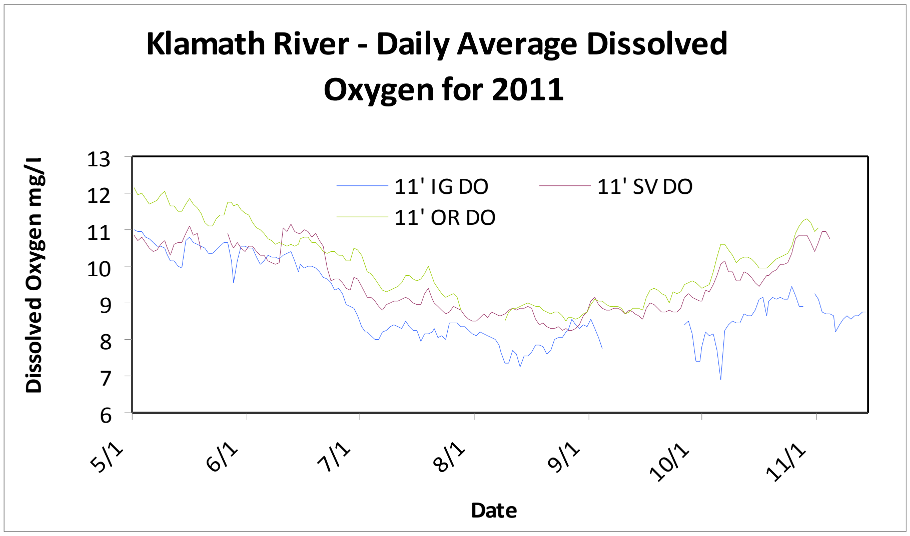

Figure 5. Daily average dissolved oxygen levels for 3 mainstem Klamath River sites in 2011: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

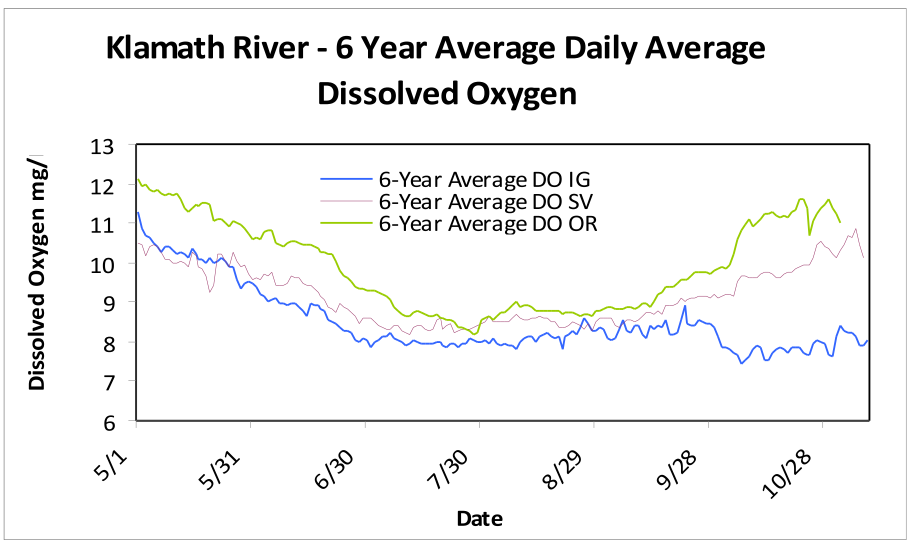

Figure 6. Average of average daily dissolved oxygen levels from 2006-2011 at mainstem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

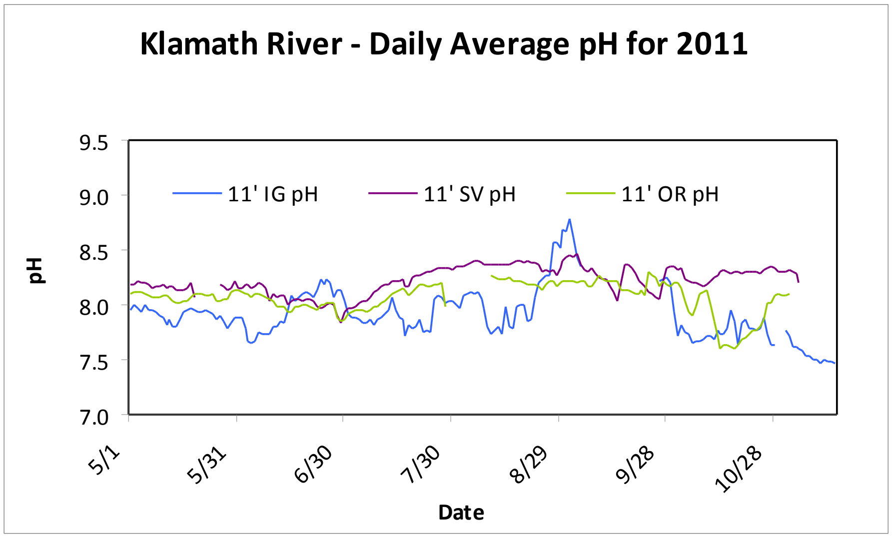

Figure 7. Daily average pH levels for 3 mainstem Klamath River sites in 2011: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

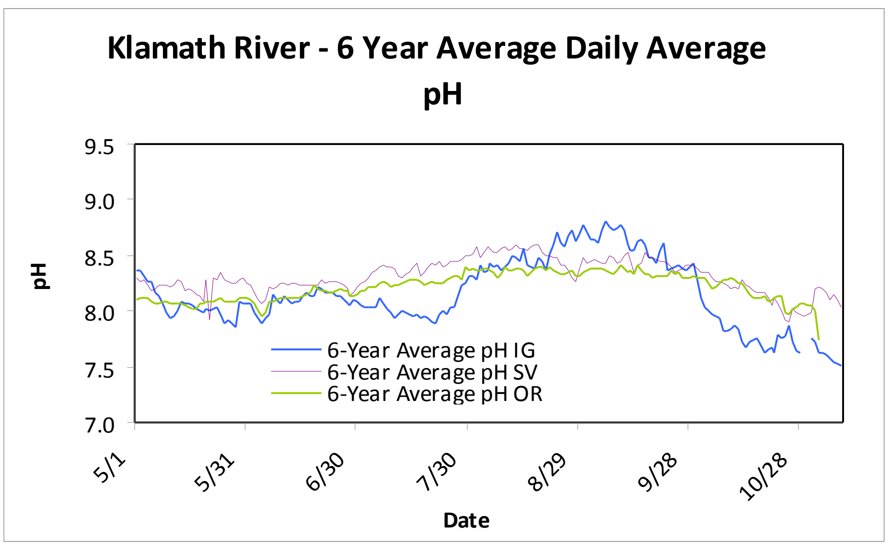

Figure 8. Average of average daily dissolved oxygen levels from 2006-2011 at mainstem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

The KTWQP have monitored three major Klamath tributaries with datasondes since 2006: the Shasta, Scott, and Salmon Rivers. Each of the tributaries has some similar seasonal trends in regards to water quality parameters. The Shasta River experiences much warmer temperatures in the early spring. This is due in part to ground water influences which tend to moderate water temperature. Compare this to the very similar temperature conditions in the Scott and Salmon River (Figure 9). In 2011, all monitored tributaries had highest daily average temperatures in mid August, followed by a drop in temperature around the last week of August (Figures 9-11). These water temperatures correlate with high air temperatures in late July and early August. At all sites in 2011, water temperatures started to decline steadily by mid August. All sites exceeded the chronic temperature threshold of 15.5C (Karuk Tribe, 2002). Water temperature differed among sites towards the beginning of summer. Temperatures in the tributaries were much cooler this year overall then the previous 3 (Figure 10-12). Peak temperatures were delayed due to a cooler than average spring and greater than average snowfall.

At the Shasta river monitoring site DO dropped below the Tribal standard of 8.0 mg/l in 2011 (Figures 13). Keep in mind that these figures are daily averages of DO, and a figure with daily minimums would show greater exceedances. Salmon and Scott River did not fall below the 8.0mg/L DO threshold, based on daily averages. In 2011, the lowest DO levels occurred in late June to early August. This follows the general trend seen at all tributary site during the last 4 years (Figures 14-16).

Average daily pH varies between tributary sites (Figures 17). The Salmon River site had a pH just under 8 for most of the season. The Scott River site had 1 documented exceedance of 8.5 in 2011. The Scott River sonde experienced failure near the peak of pH readings. The Shasta River is listed as impaired for pH and had levels around 8.5 for most of the season monitored from May-October (Figure 18). Elevated pH levels in the Shasta are probably due in part to higher alkalinity levels.

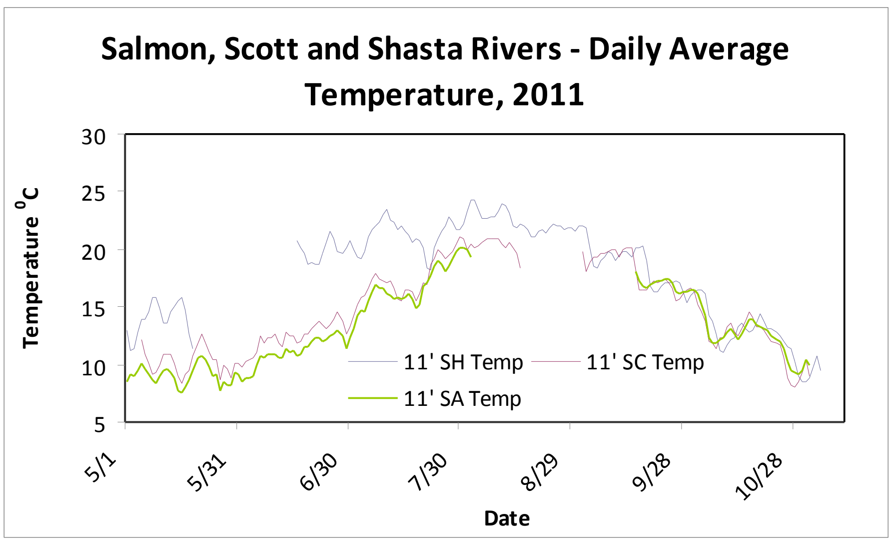

Figure 9. Daily average water temperature for Scott, Shasta, and Salmon Rivers, 2011.

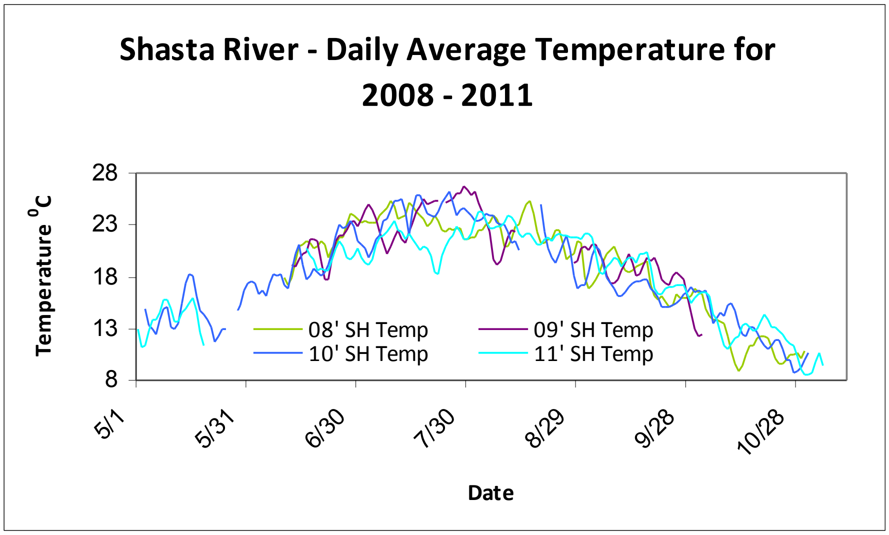

Figure 10. Daily average water temperatures for the Shasta River from 2008-2011.

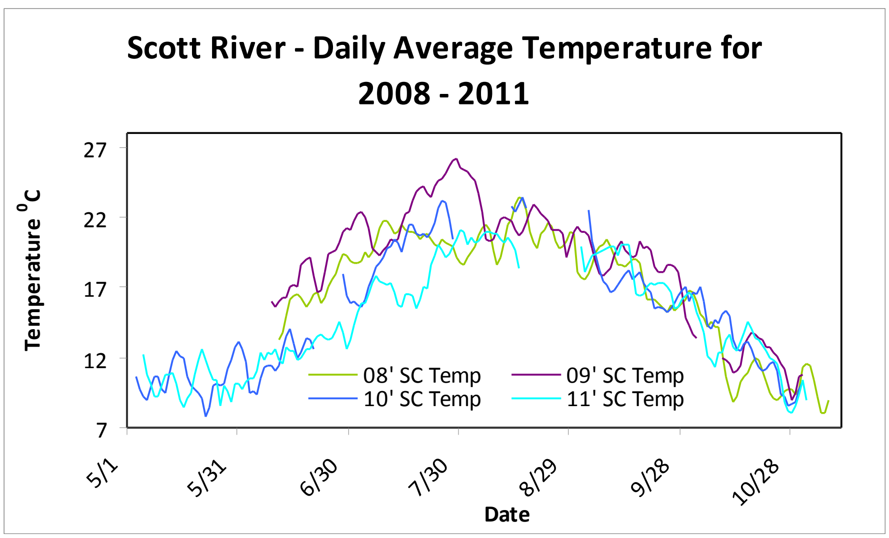

Figure 11. Daily average water temperatures for the Scott River from 2008-2011.

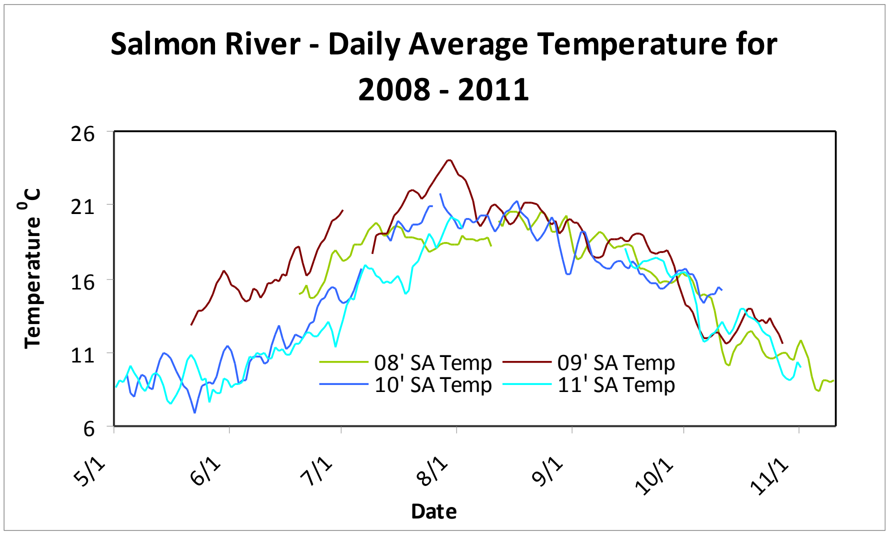

Figure 12. Daily average water temperatures for the Salmon River from 2008-2011.

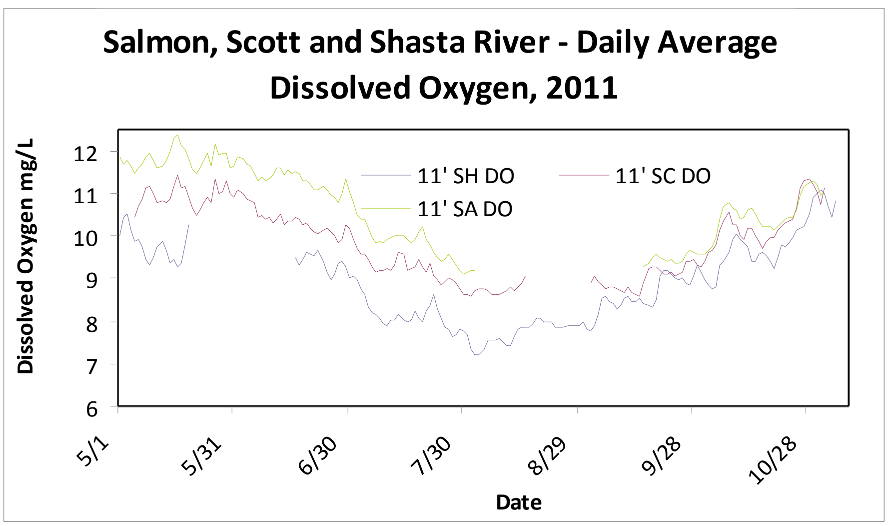

Figure 13. Daily average dissolved oxygen for Salmon, Scott and Shasta River, 2011.

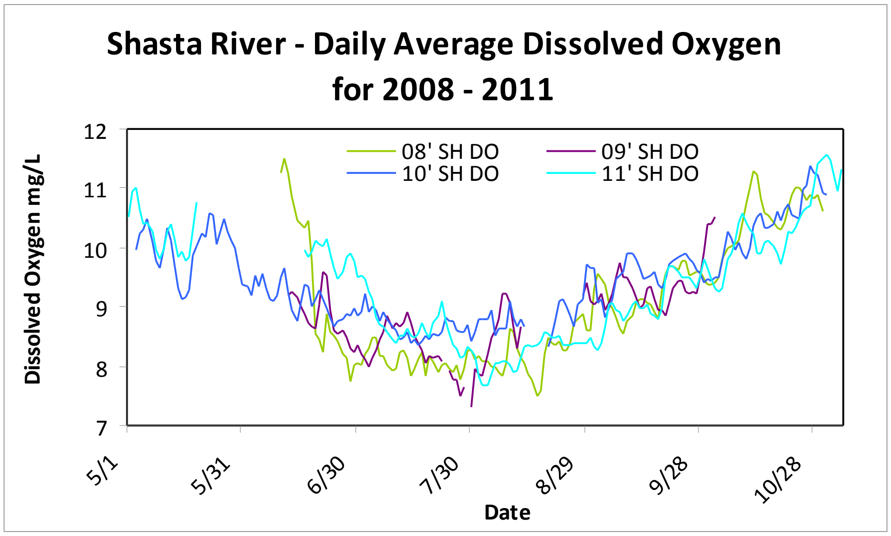

Figure 14. Daily average dissolved oxygen concentrations for the Shasta River from 2008-2011.

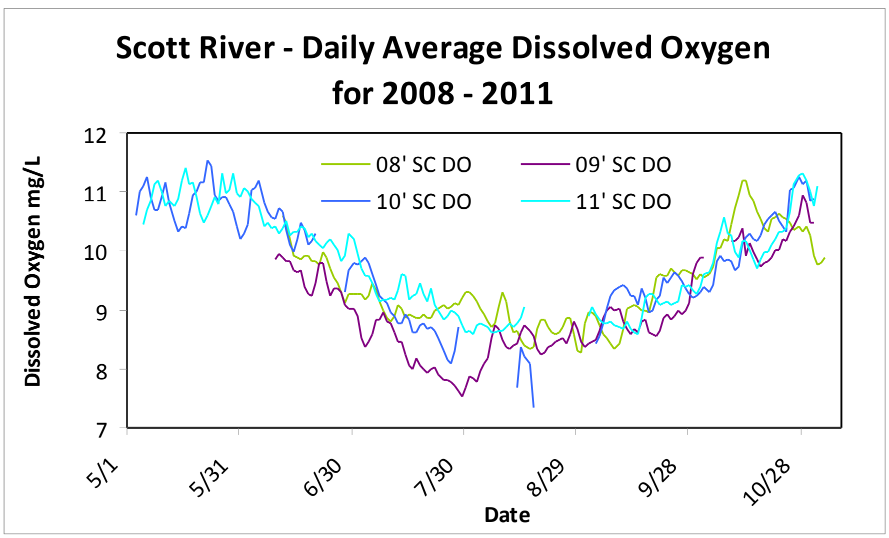

Figure 15. Daily average dissolved oxygen concentrations for the Scott River from 2008-2011.

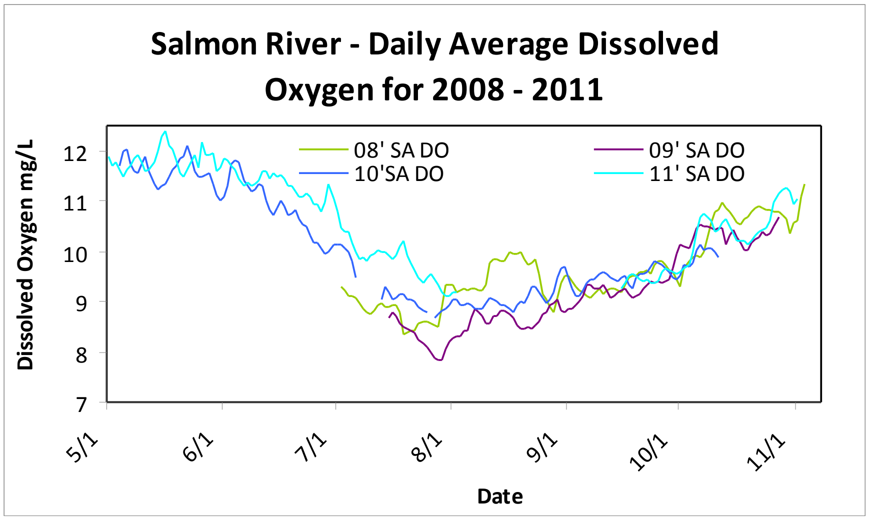

Figure 16. Daily average dissolved oxygen concentrations for the Salmon River from 2008-2011.

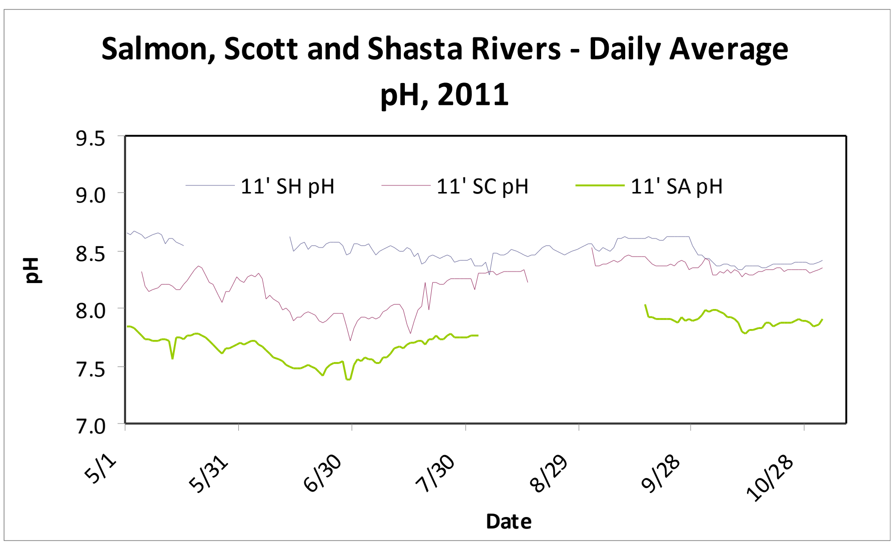

Figure 17. Daily average pH for Scott, Shasta, and Salmon Rivers, 2011.

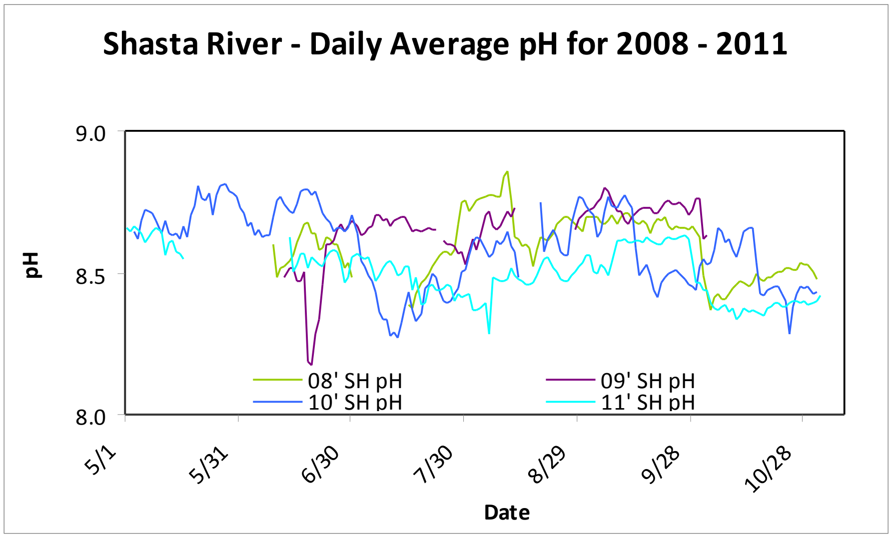

Figure 18. Daily average pH concentrations for the Shasta River from 2008-2011.

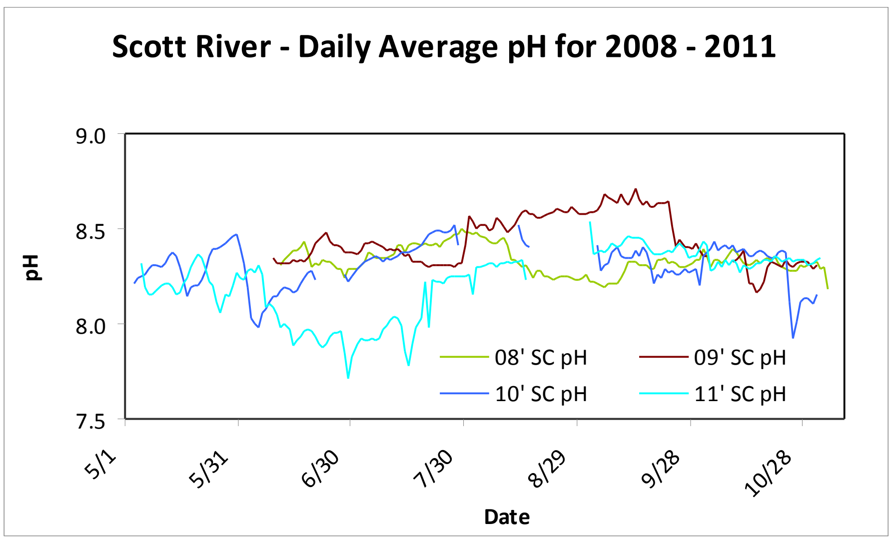

Figure 19. Daily average pH concentrations for the Scott River from 2008-2011.

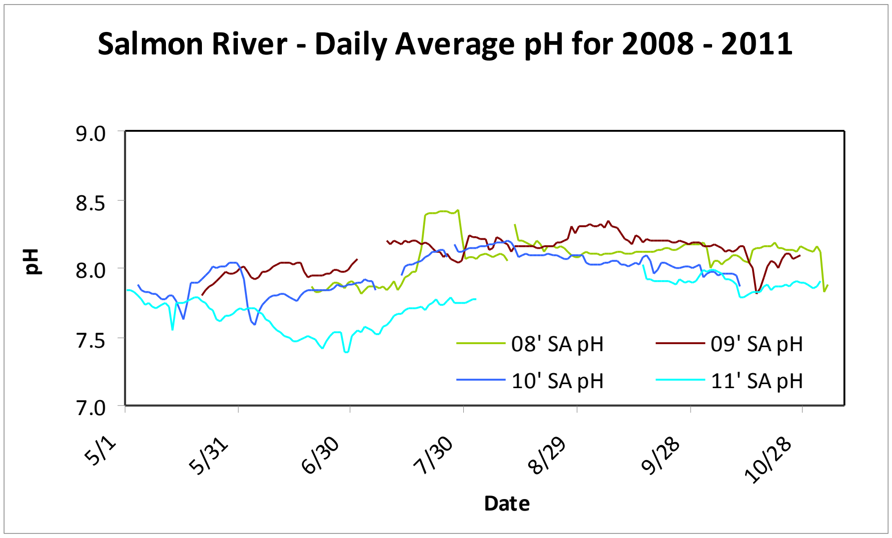

Figure 20. Daily average pH concentrations for the Salmon River from 2008-2011.

Nutrient samples were collected by the KTWQP in 2011 from the mainstem Klamath and major tributaries. Total phosphorus (TP) results for 2011 from the mainstem show the Iron Gate and Walker Bridge sites have the highest overall levels (Figure 21). TP levels decrease as one travels down river to SV, HC and OR sites. The longitudinal trends were similar in 2008-2011 (Figure 22). In 2008-2011 the Shasta River had the highest TP concentration, and the Scott and Salmon Rivers the lowest. For total nitrogen (TN), mainstem concentrations were highest at the most upriver sites (IG and WA) (Figures 23-24). TN concentrations increased throughout the season, at least doubling between May and October. Overall the Shasta River had the highest TN, compared to other tributaries.

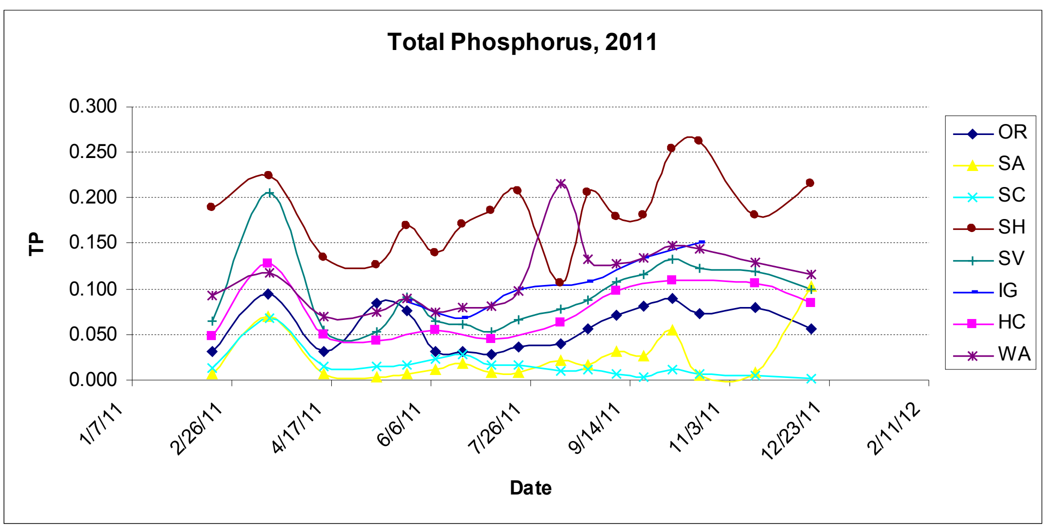

Figure 21. Total Phosphorus measured in mg/L for all monitored sites during 2011.

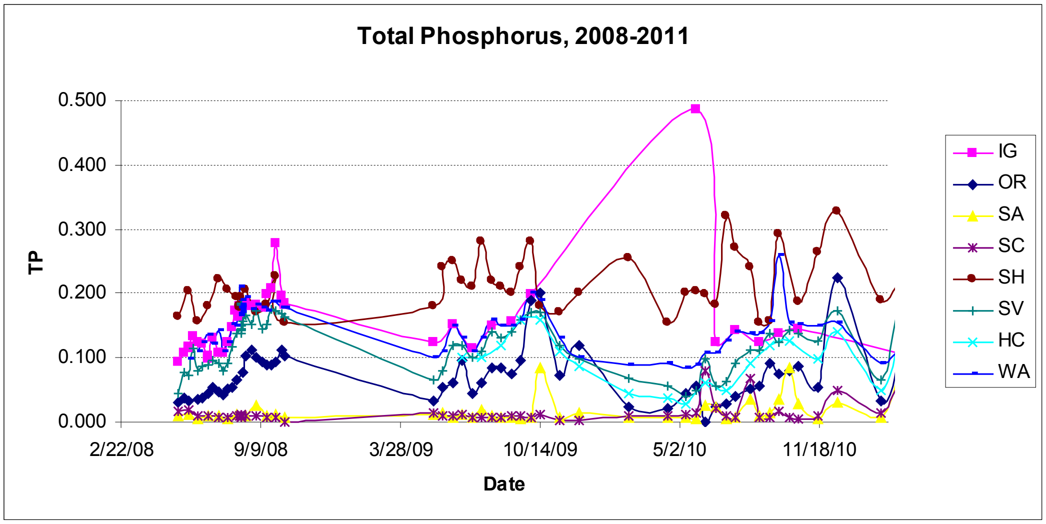

Figure 22. Total Phosphorus measured in mg/L for all monitored sites during 2008-2011.

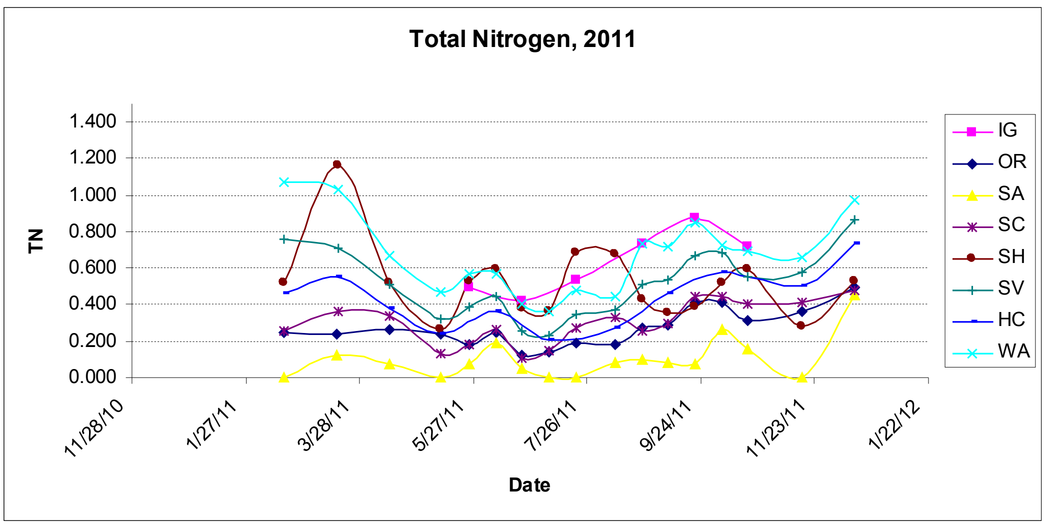

Figure 23. Total Nitrogen measured in mg/L for all monitored sites during 2011.

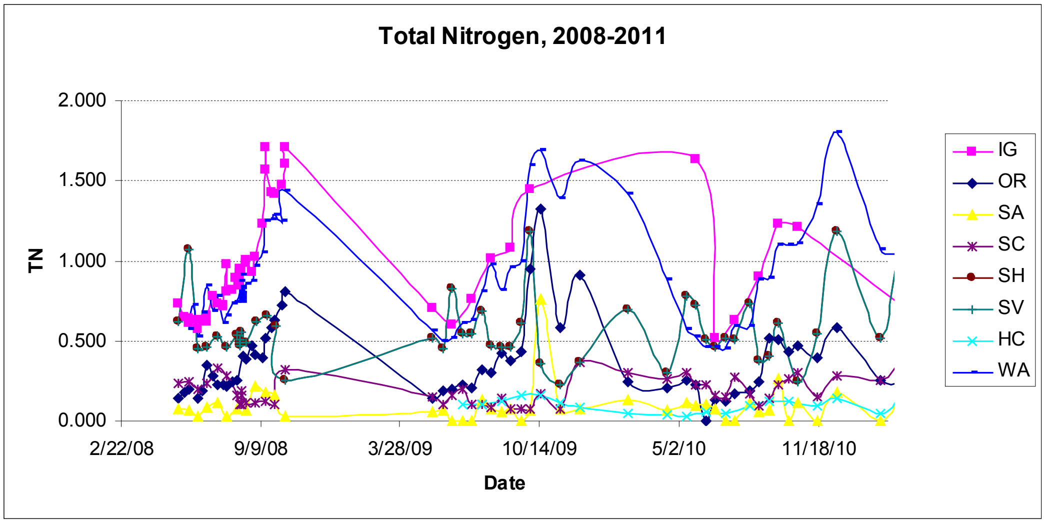

Figure 24. Total Nitrogen measured in mg/L for all monitored sites during 2008-2011.

Turbidity data gathered on Bluff Creek and Salmon River during the winter and spring shows similar peaks in March turbidity due to seasonal rain and snowmelt events (Figures 25-26). The magnitude between sites is very different. Bluff creek had higher turbidity levels during all peak events. Salmon River had relatively low turbidity throughout the monitoring season. In 2011, Bluff creek experienced a major sediment discharge during mid March to April. During this event our sonde was buried in sediment and our turbidity probe was damaged.

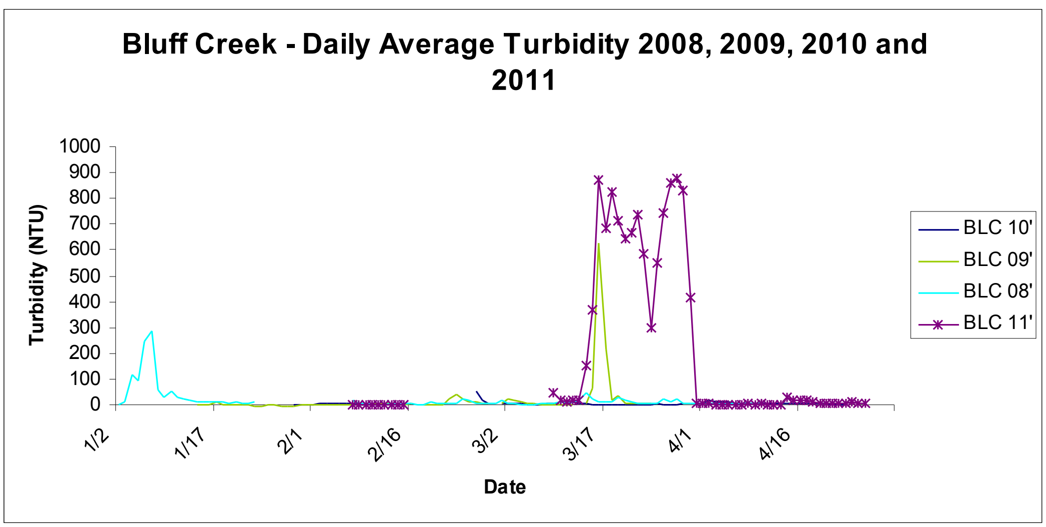

Figure 25. Daily average turbidity, winters of 2008, 2009, 2010 and 2011 on Bluff Creek.

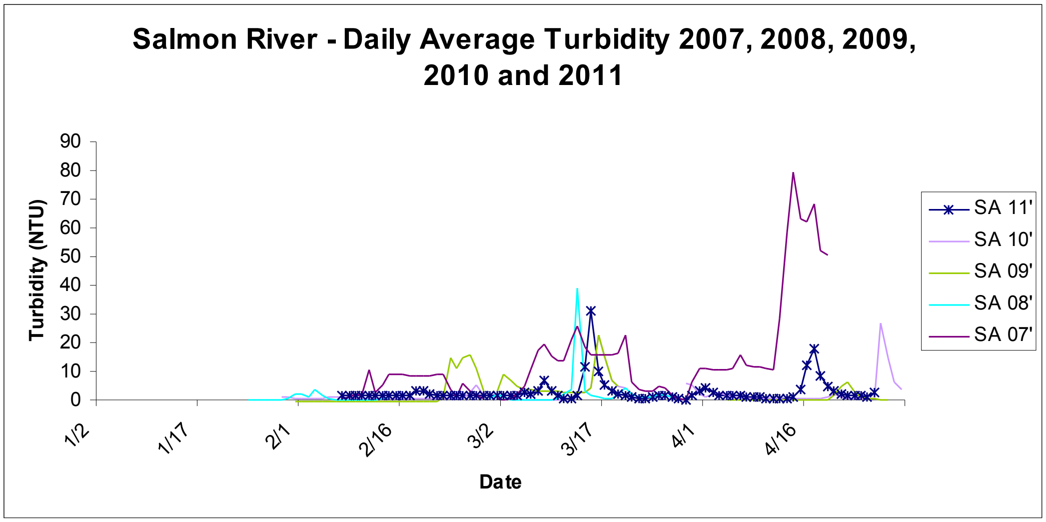

Figure 26. Daily average turbidity, winters of 2007, 2008, 2009, 2010 and 2011 on Salmon River.

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