# KARUK TRIBE

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

# 2012
# WATER QUALITY
# ASSESMENT REPORT

## KLAMATH RIVER, SALMON RIVER, SCOTT RIVER, SHASTA RIVER, AND CAMP CREEK

# Karuk Tribe

Water Quality Assessment Report
2012

Prepared by
Karuk Tribe
Water Quality
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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 4 -** 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 5 -** 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 Program Purpose

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 and Coordination

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 Karuk Water Quality Program Design

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.

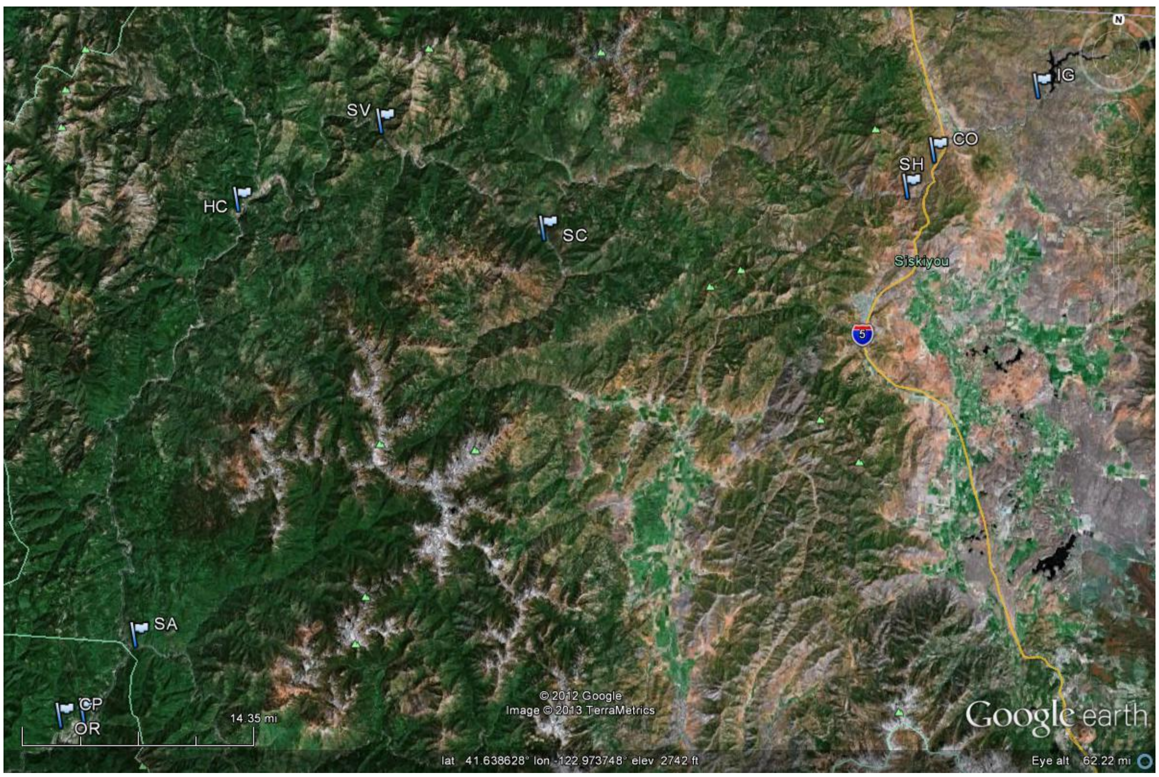


**Figure 21.** Overview of the Karuk Tribe's water quality monitoring locations along the Klamath River in 2012.

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). In 2012, the KTWQP added 3 continuous monitoring sites; Camp Creek (CP), Happy Camp (HC), and Colliers Rest Area or I-5 Bridge (CO). The Camp Creek site was added in lieu of the Bluff Creek site for winter turbidity monitoring. This change was made to support monitoring of upcoming work in the Karuk Tribe Restoration Department. Happy Camp and Colliers Rest Area were recently identified, during a 5 year analysis of continuous water quality monitoring probes, to be the poorest water quality throughout the Klamath River below Iron Gate dam. The Orleans (OR), Salmon River (SA), Seiad Valley (SV), Shasta River (SH), and Iron Gate (IG) 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 when the most water quality impairments stress beneficial uses. However, grab sampling continues throughout the year to help establish annual baseline load conditions and turbidity monitoring occurs in the winter when impairments are typically observed.

The frequency at which sampling occurs is dependent on resources and monitoring objectives. We focus on increasing a parameters collection frequency when the dynamics are changing at the greatest rate. 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. Another example is our toxic algae and toxin sampling; it is aimed at being able to inform the public of health threats and is therefore collected at an increased frequency when threats are highest, August and September (Kann and Corum 2009).

**Table 6 -** 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.

| **2012 Locations and Parameters Monitored** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Site ID | Latitude | Longitude | Nutrient Suite | Sonde | Public Health | Winter Turbidity | Location |
| CP | N41 17.96886 | W123 33.50988 | | X | | X | Camp 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 |
| HC | N41 46.48242 | W123 23.77854 | | X | | | |
| 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 50.242 | W 122 51.895 | X | | | | Klamath River at Walker Bridge |
| SH | N 41 49.390 | W 122 35.700 | X | X | | | Shasta River at USGS Gage |
| CO | N41 51.80682 | W122 33.87930 | | X | X | | Colliers rest area above I-5 Bridge |
| 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 Data Interpretation and Management

The Yurok Tribe received a grant under the Environmental Information Exchange Network Program to develop the Yurok Tribe Environmental Data Storage System (YEDSS). This system has been shared with the Klamath Basin Tribal Water Quality Workgroup, which the Karuk Tribe is part of. 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.

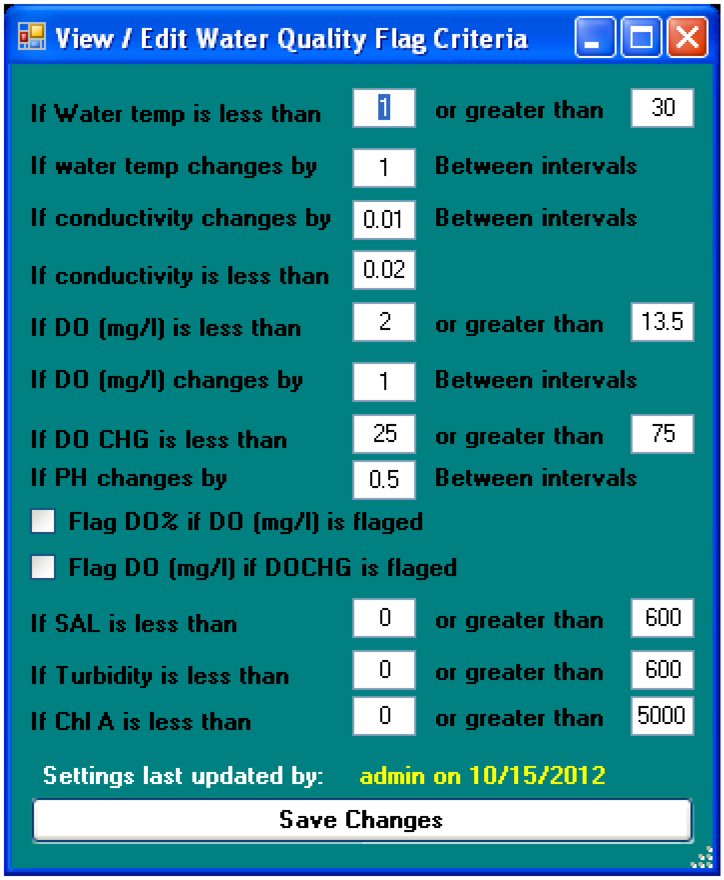


**Figure 22.** Flagging Criteria automatically applied to sonde data.

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 assess the current status and trends of monitored water bodies. In addition, comparisons between sites can also be made. Overall, water quality is evaluated using standards put forth in the Karuk Tribe's Water Quality Control Plan and QAPP. 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 2012 Water Quality Results

The associated Water Quality Assessment Report spreadsheet describes current impairments.

## MAINSTEM KLAMATH

The sonde data presented in Figures 3-8 depicts seasonal temperature, dissolved oxygen and pH trends at mainstem Klamath River monitoring sites.

**Temperature:**

In 2012, 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 seven year period from 2006-2012 (Figure 4). The IG site is just downstream of Iron Gate dam (IGD). Water released from the dam has a moderating effect on water temperature, providing slightly warmer water in the fall and winter and colder water during summer peak temperatures when compared to historic conditions and upstream un-impounded tributary contributions. The chronic average temperature threshold for salmonids adopted by the Tribe, is 15.5ºC (Karuk, 2002). Despite the 2012 cool and wet spring, all sites exceed this standard. This data supports the designation of impaired water temperature.

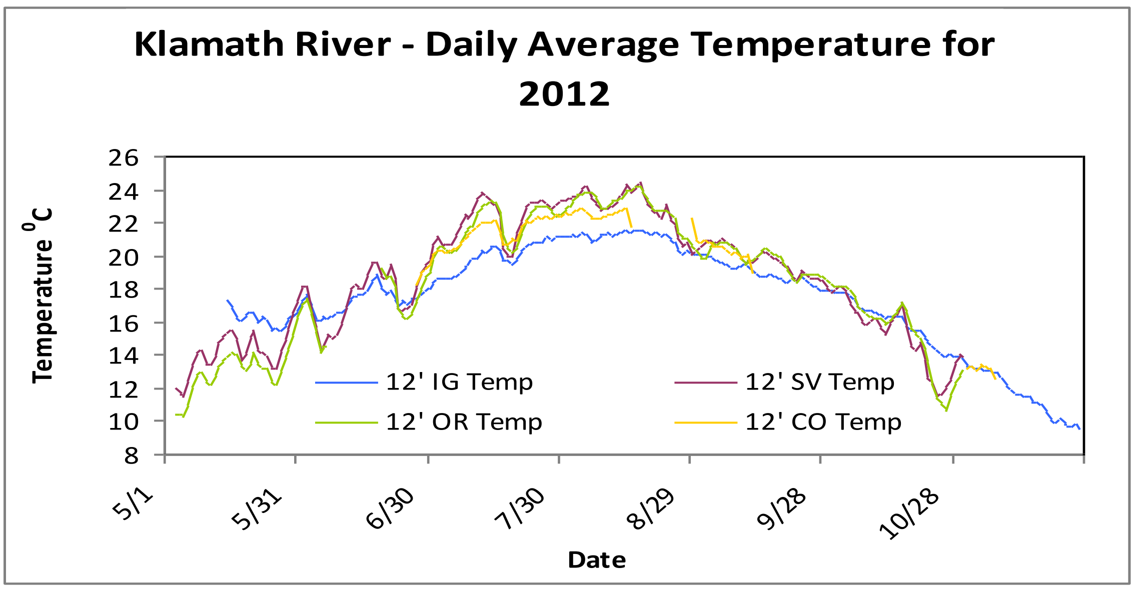


**Figure 23.** Daily average temperatures for 3 mainstem Klamath River sites in 2012: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

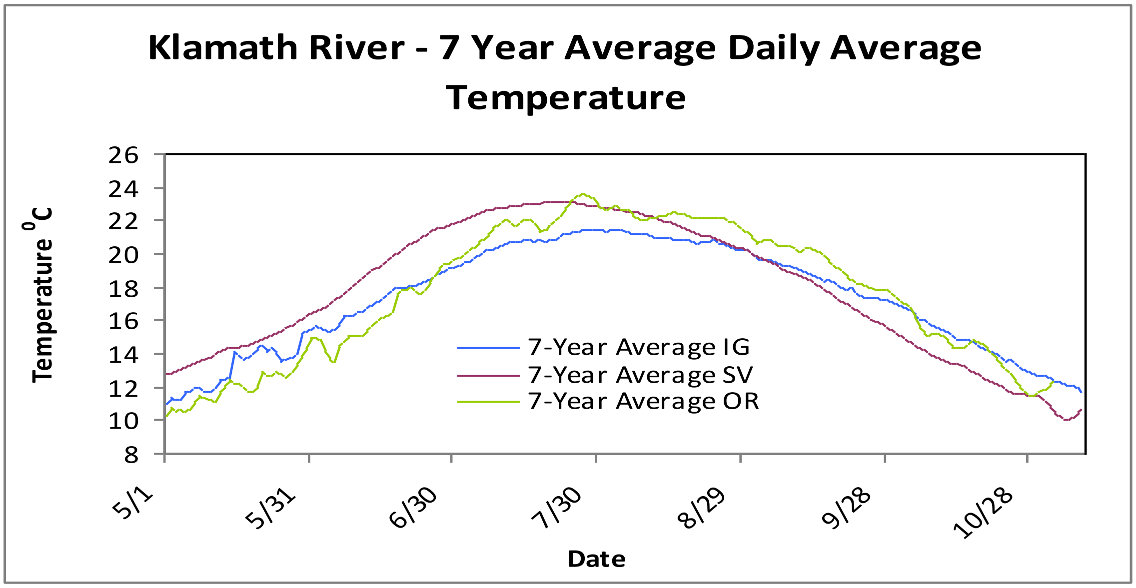


**Figure 24.** Average of daily average temperature from 2006-2012 at mainstem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

**Dissolved Oxygen:**

Instantaneous dissolved oxygen (DO) levels in 2012 were the highest at the Seiad Valley (Figure 7) and the daily average DO is greatest at Orleans (Figure 9). Iron Gate dam has a negative impact on DO levels from August through the end of sampling in 2012, November. DO levels below the dam drop while increasing at all other Karuk mainstem Klamath sampling locations (Figure 5 - 8). The timing overlaps with fall-run salmonid migration and spawning and is an impairment of the beneficial use. (There is a data gap in the Orleans data set due to battery failure.)

Seven-year daily averages for DO depict the annual differences between sites are less extreme in the middle of the summer when water temperatures are the highest (Figures 4 and 5).

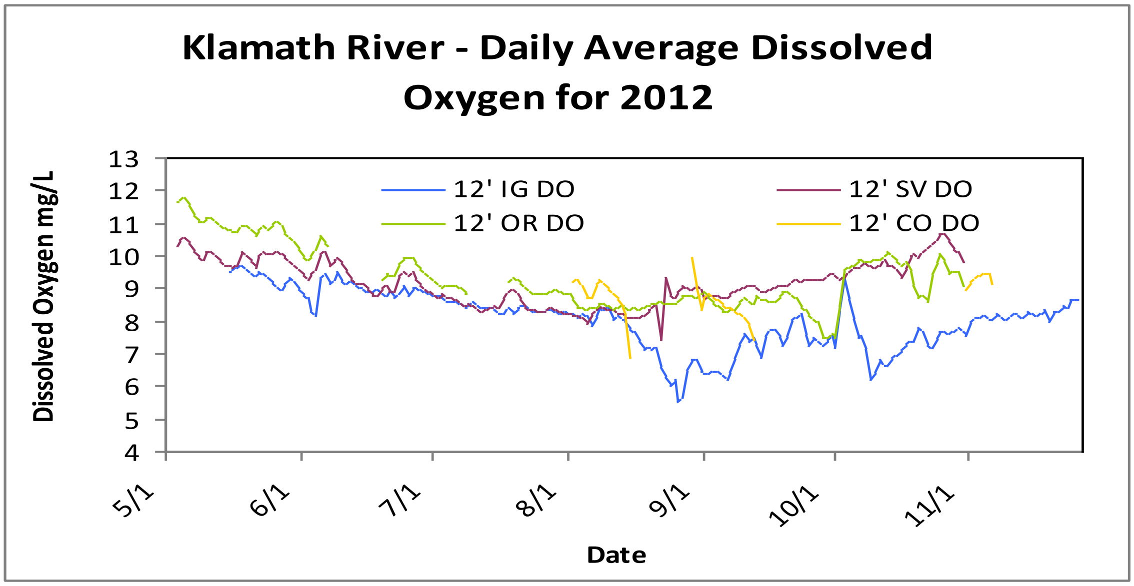


**Figure 25.** Daily average dissolved oxygen levels for 3 mainstem Klamath River sites in 2012: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

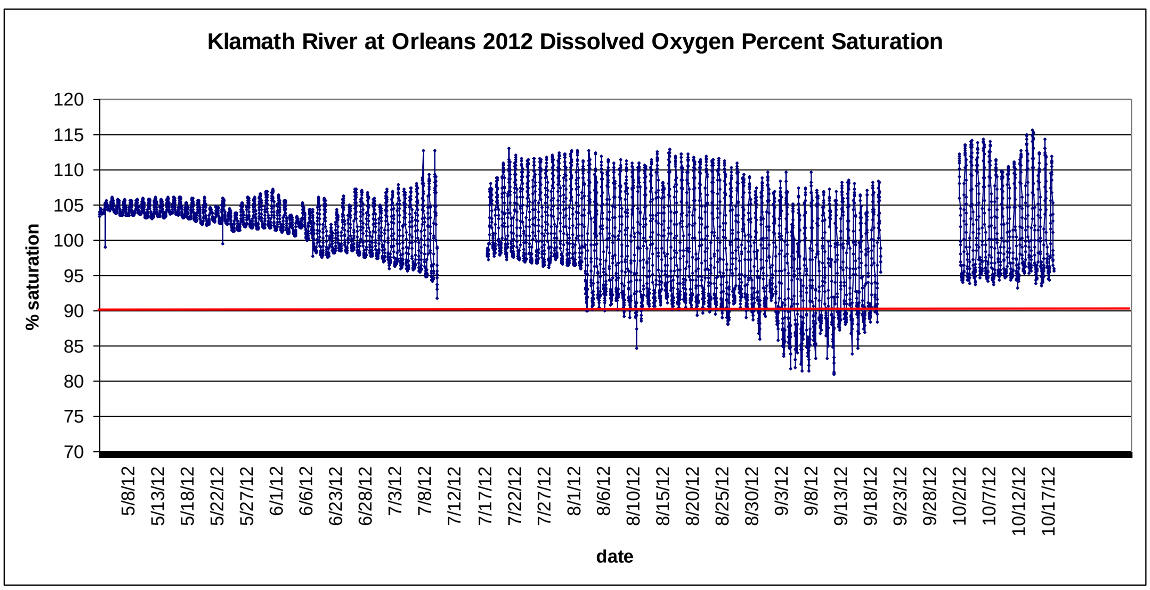


**Figure 26.** Percent saturation dissolved oxygen readings recorded every 30-minutes for Klamath River at Orleans (OR) in 2012. The red line indicates the NCRWQCB Basin Plan Klamath River site specific dissolved oxygen water quality objective: from the mouth of the Scott River to Hoopa, >90% saturation year-round.

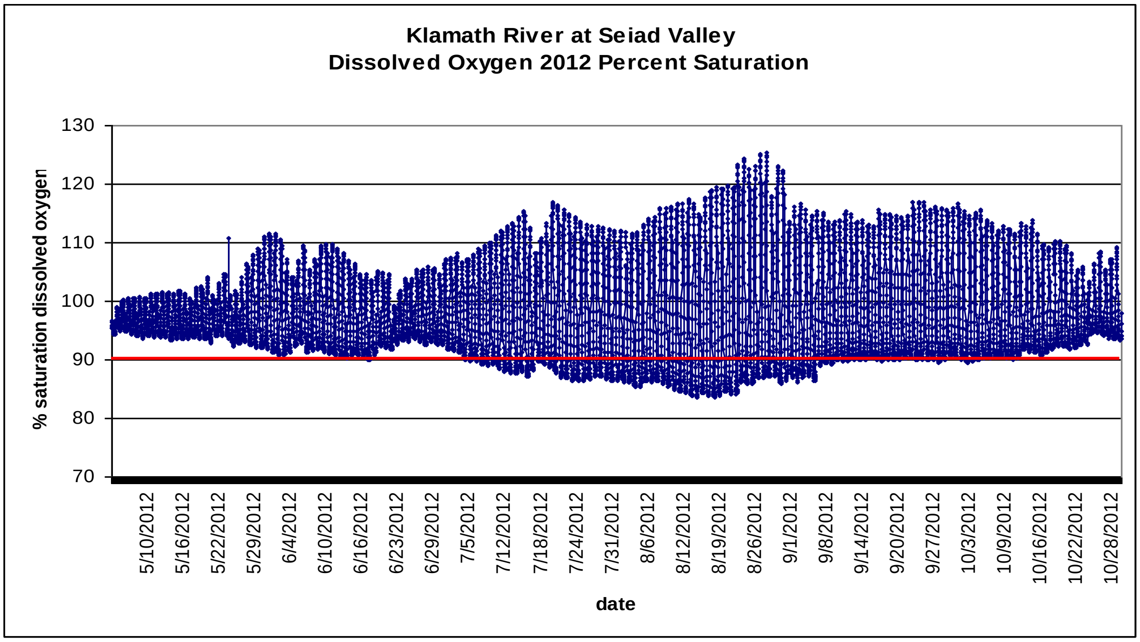


**Figure 27.** Percent saturation dissolved oxygen readings recorded every 30-minutes for Klamath River at Seiad Valley (SV) in 2012. The red line indicates the NCRWQCB Basin Plan Klamath River site specific dissolved oxygen water quality objective: from the mouth of the Scott River to Hoopa, >90% saturation year-round.

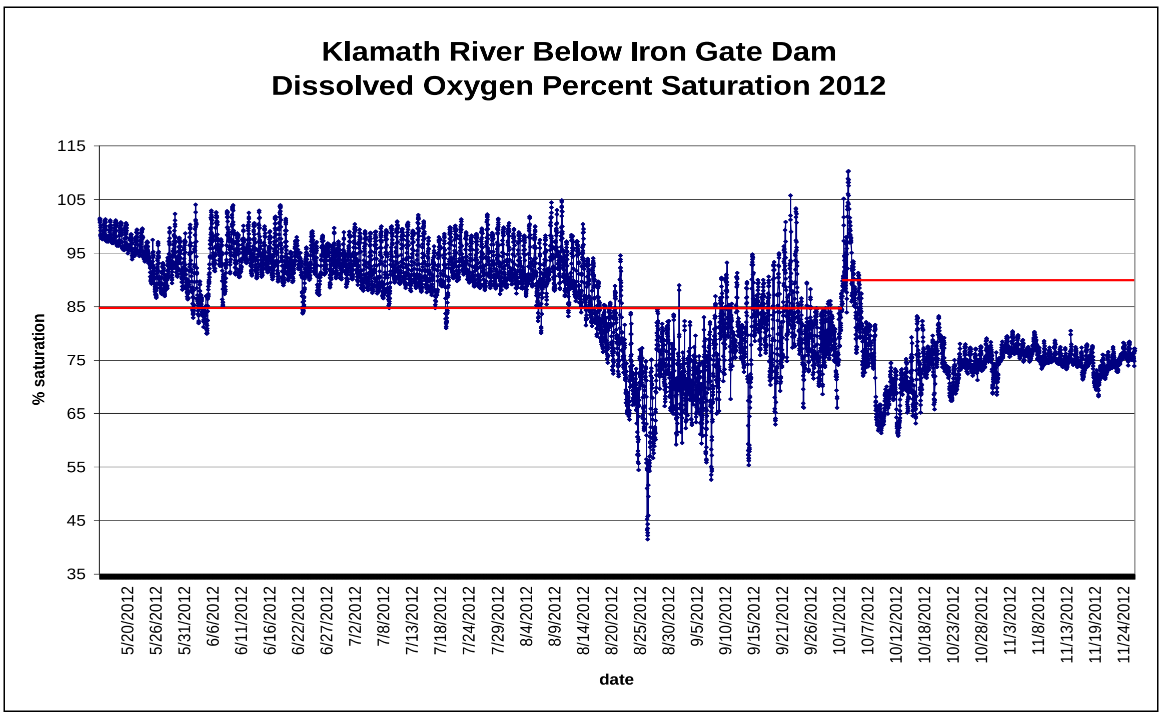


**Figure 28.** Percent saturation dissolved oxygen readings recorded every 30-minutes for Klamath River below Iron Gate Dam (IG) in 2012. The red line indicates the NCRWQCB Basin Plan Klamath River site specific dissolved oxygen water quality objective from Stateline (OR/CA) to the mouth of the Scott River, >90% saturation from Oct 1- March 30 and >85% from April 1-Sept 30.

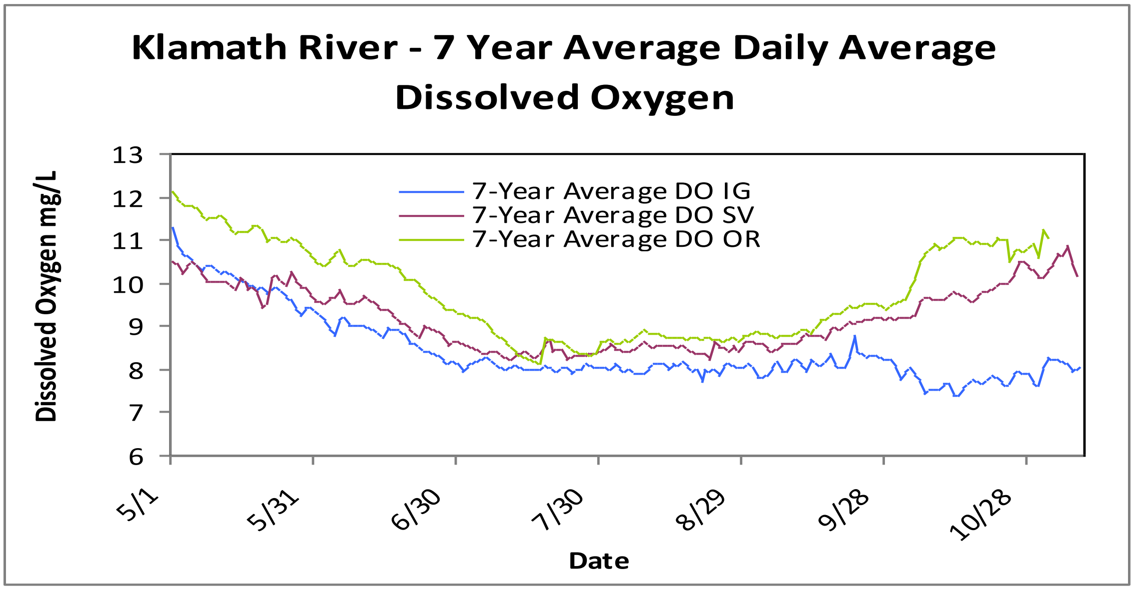


**Figure 29.** Average of average daily dissolved oxygen levels from 2006-2012 at mainstem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

**pH:**

Daily average and instantaneous pH trends vary between mainstem sites in 2012 (Figures 10 - 14). OR has the least seasonal variability; daily average pH stays below 8.5 and the instantaneous pH has a diurnal swing of approximately 0.8 pH units (Figure 10 and 11). Of the Klamath mainstem sites, SV has the most instantaneous exceedances in 2012 to the NCRWQCB Basin Plan water quality objective for the Klamath River.

Seven-year trend comparison (Figure 14) depicts daily average pH peaking in late July and August, with daily average pH exceedances above 8.5 at IG from August through September.

The spike in pH occurs during peak in river primary productivity and the lowest DO readings, indicative of water quality impairments associated with photorespiration. (In 2012, all sites have some data gaps due to probe malfunction and battery failure.)

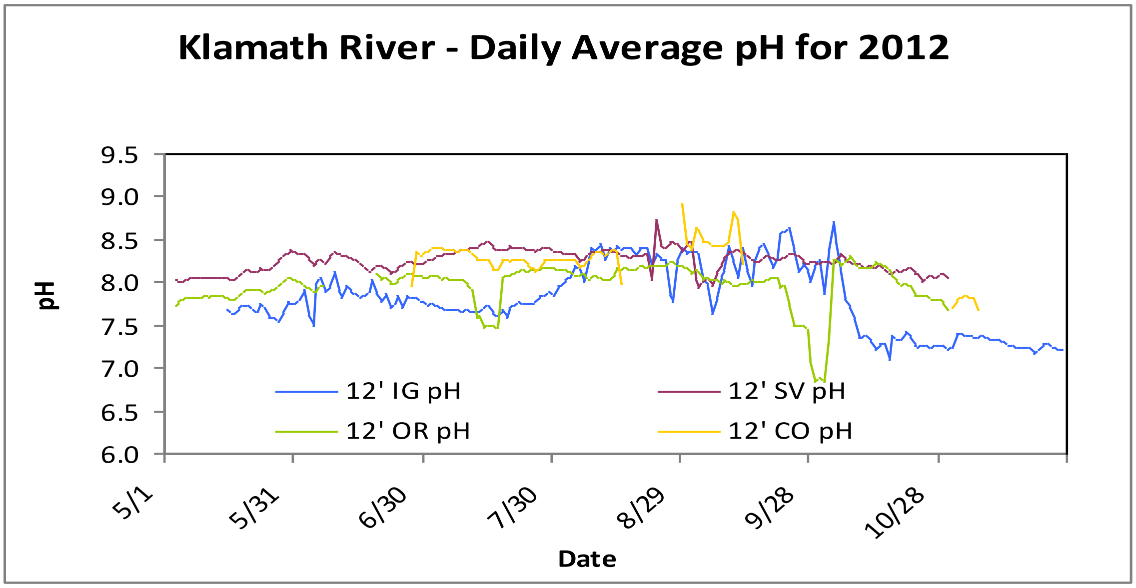


**Figure 30.** Daily average pH levels for 3 mainstem Klamath River sites in 2012: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

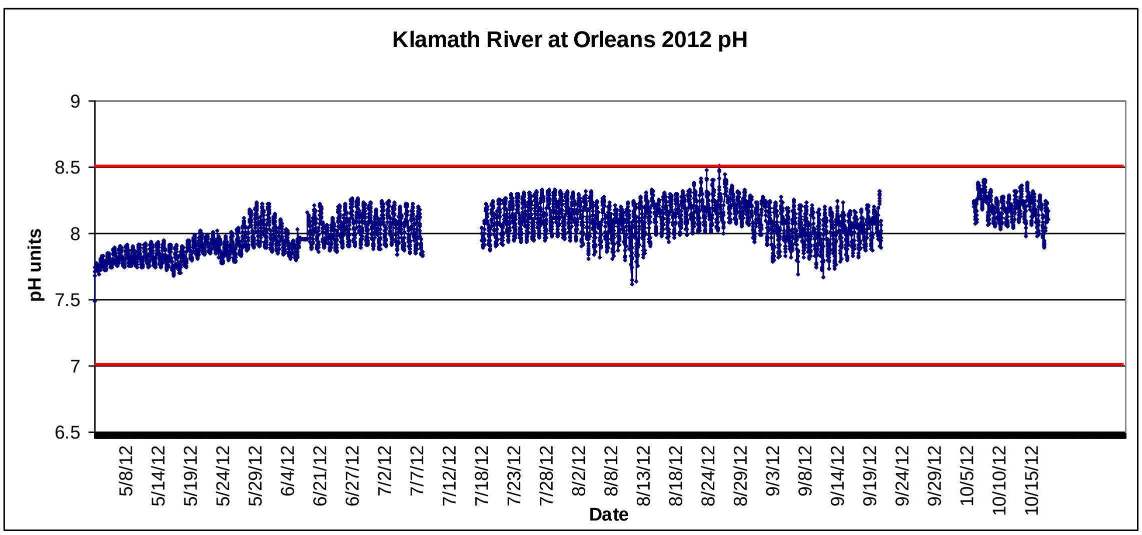


**Figure 31.** Instantaneous pH readings recorded every 30-minutes for Klamath River at Orleans (OR) in 2012. The red lines are the NCRWQCB Basin Plan water quality objectives for the Klamath River, 7< X > 8.5.

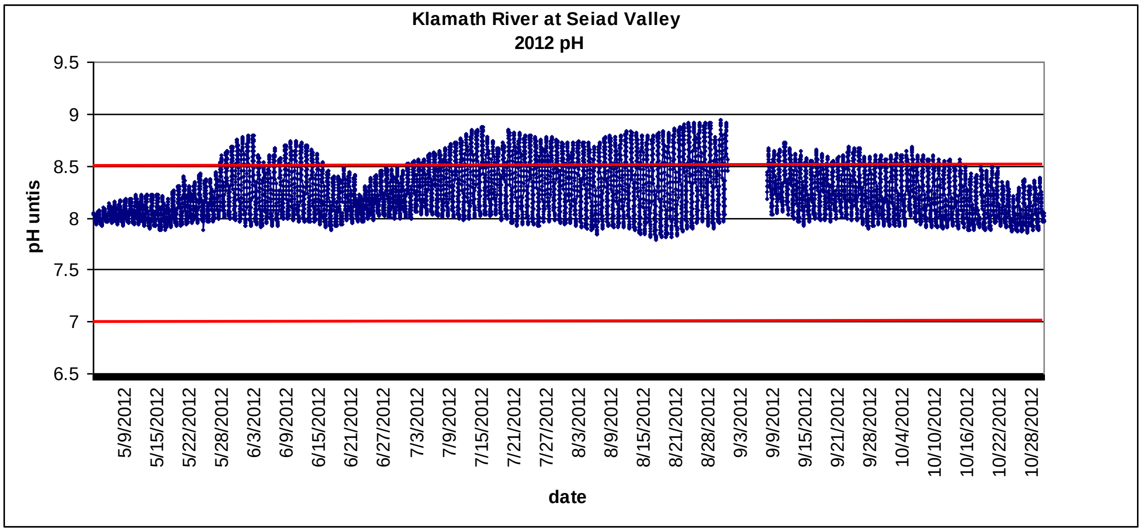


**Figure 32.** Instantaneous pH readings recorded every 30-minutes for Klamath River below Seiad Valley (SV) in 2012. The red lines are the NCRWQCB Basin Plan water quality objectives for the Klamath River, 7< X > 8.5

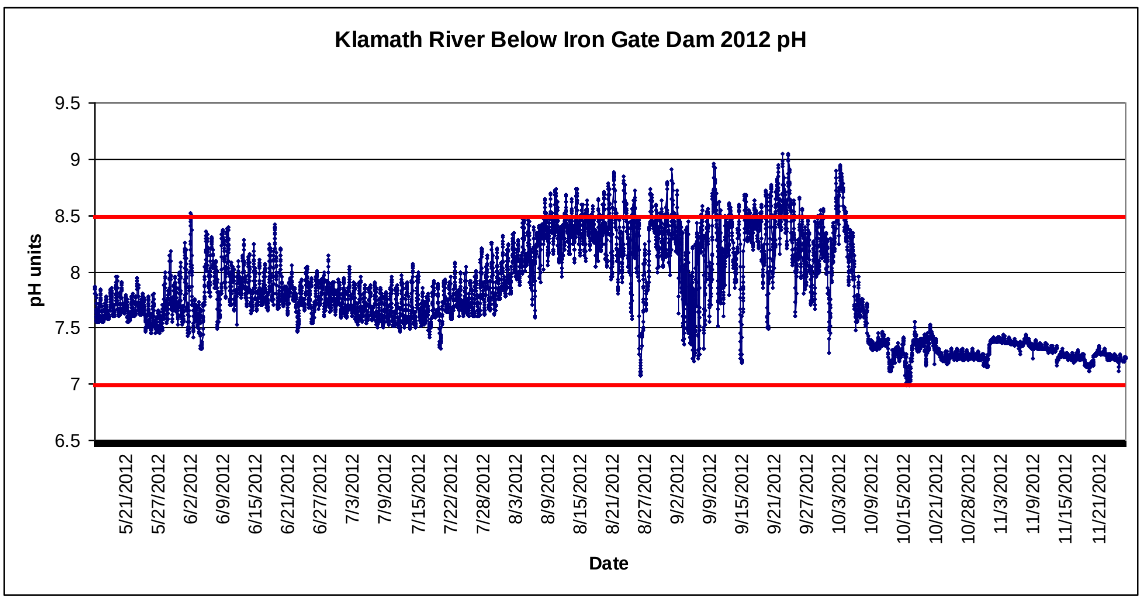


**Figure 33.** Instantaneous pH readings recorded every 30-minutes for Klamath River below Iron Gate (IG) in 2012. The red lines are the NCRWQCB Basin Plan water quality objectives for the Klamath River, 7< X > 8.5

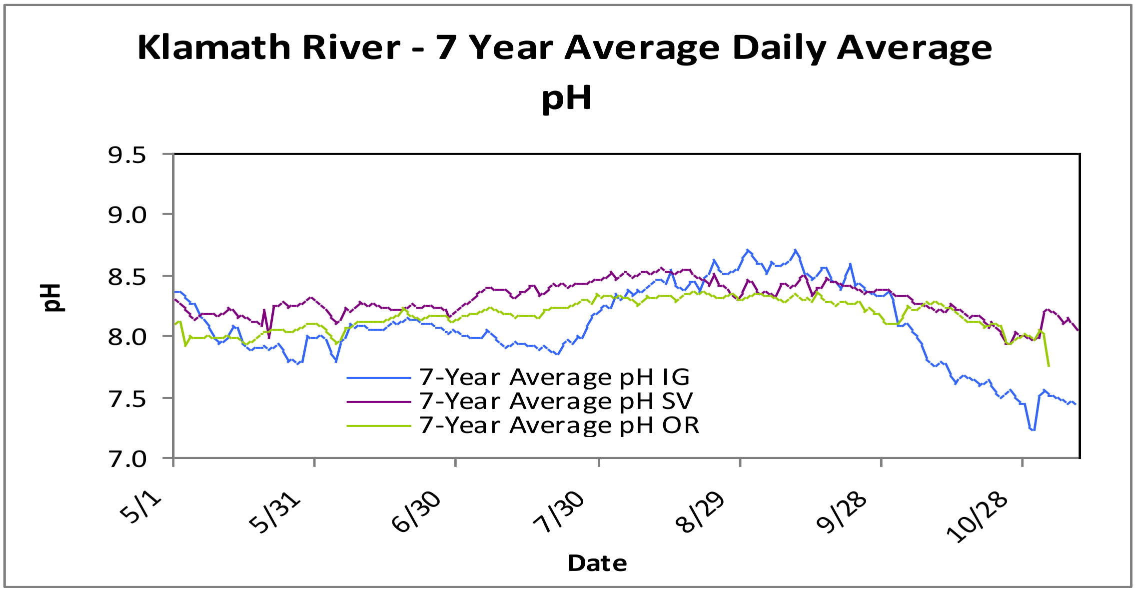


**Figure 34.** Daily average pH, 2006-2012 at mainstem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

***Mainstem Klamath Conclusions from Datasonde Data 2012:*** Instantaneous dissolved oxygen and pH data indicate the impacts to water quality due to photorespiration are most intense at Seiad Valley, but also experienced at all sites to a lesser degree. Temperature impacts are greatest at Seiad Valley at the beginning of the summer but Orleans is greatest from August through September; below Iron Gate Dam has the lowest temperature due to multiple factors associated with the reservoirs and controlled water release. Temperature is impacted heavily by ambient air temperature and the temperature of receiving waters; these could be the controlling factors between Seiad and Orleans.

**TRIBUTARIES**

The KTWQP have monitored three major Klamath tributaries just upstream from the confluence with the Klamath since 2006: the Shasta, Scott, and Salmon Rivers.  Each of the tributaries has some similar seasonal water quality trends.

**Temperature:**

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, which fed by a mix of groundwater and snow-melt; and the Salmon, which is a snow-melt dominated system (Figure 15).

In 2012, all monitored tributaries depict the highest daily average temperatures in mid August, followed by a drop in temperature around the last week of August (Figures 15 - 18).  These water temperatures correlate with high ambient air temperatures in late July through early August. Peak temperatures in 2012 were delayed due to cooler ambient air temperatures than average.

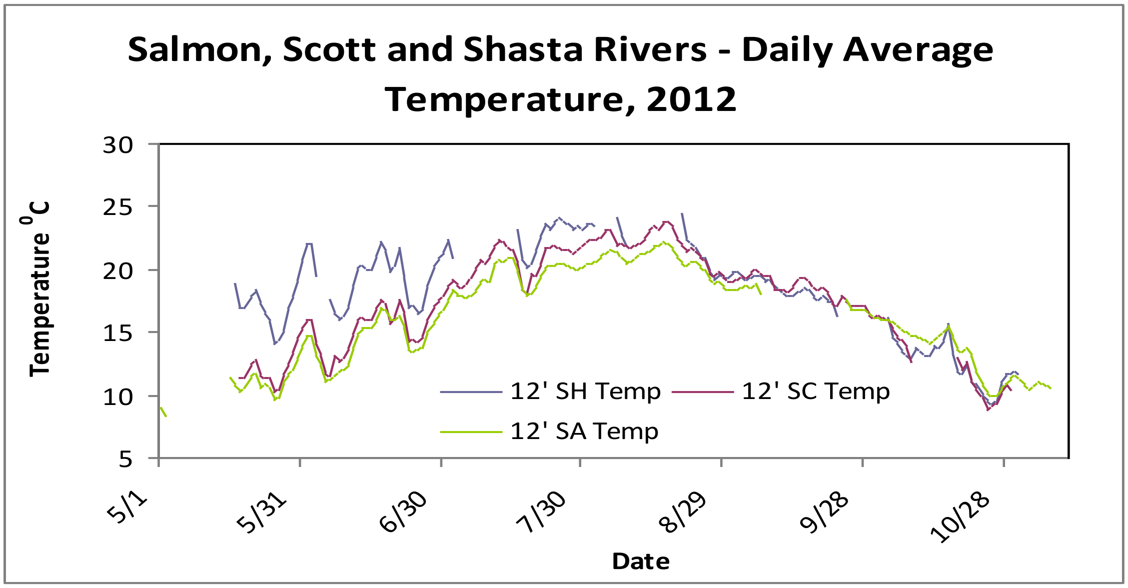


**Figure 35.** Daily average water temperature for Scott, Shasta, and Salmon Rivers, 2012.

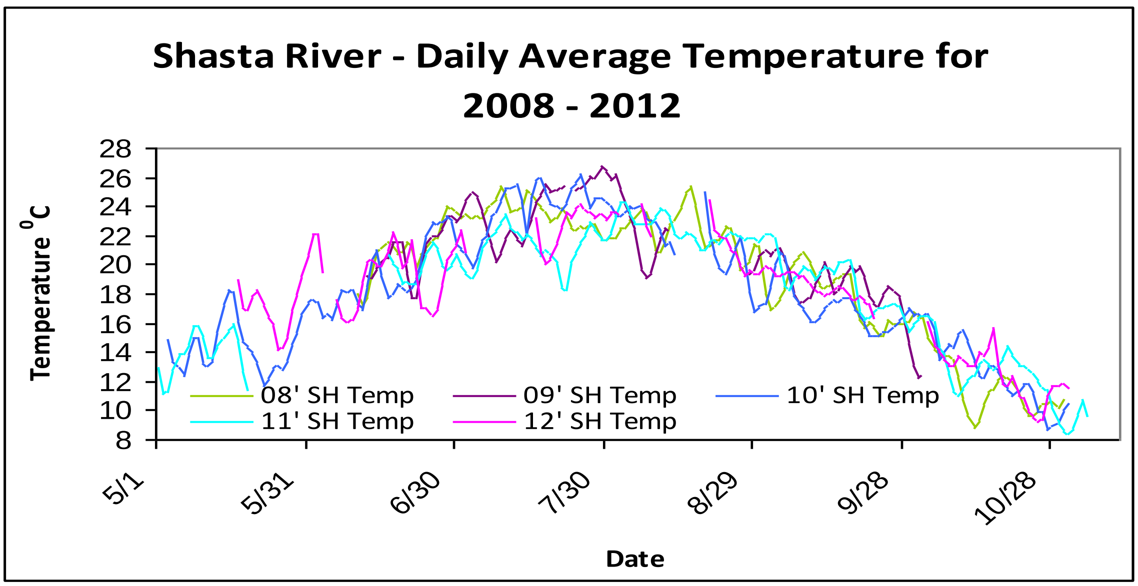


**Figure 36.** Daily average water temperatures for the Shasta River from 2008-2012.

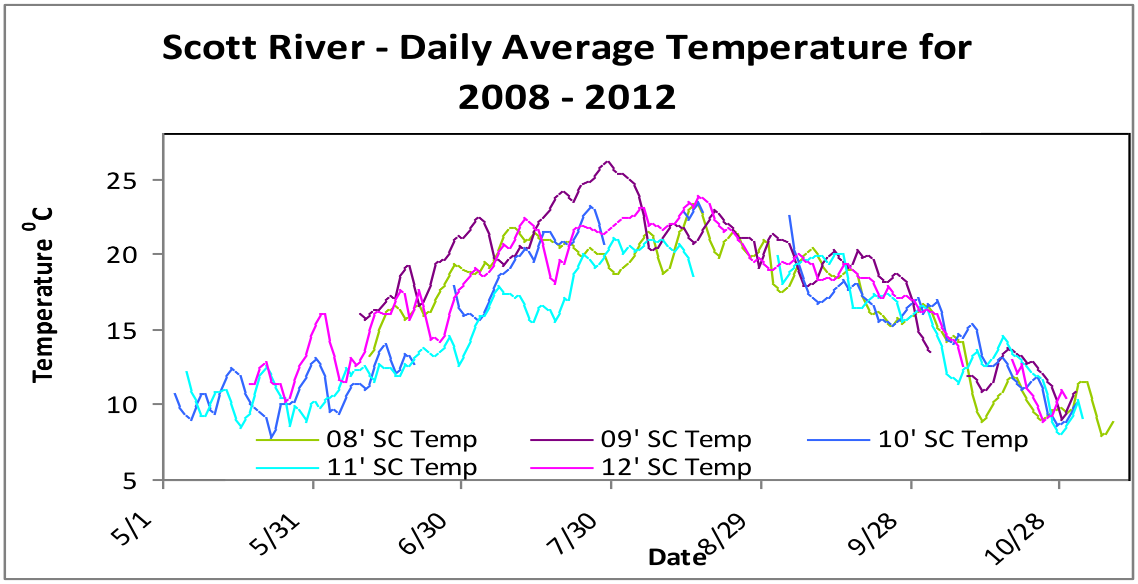


**Figure 37.** Daily average water temperatures for the Scott River from 2008-2012.

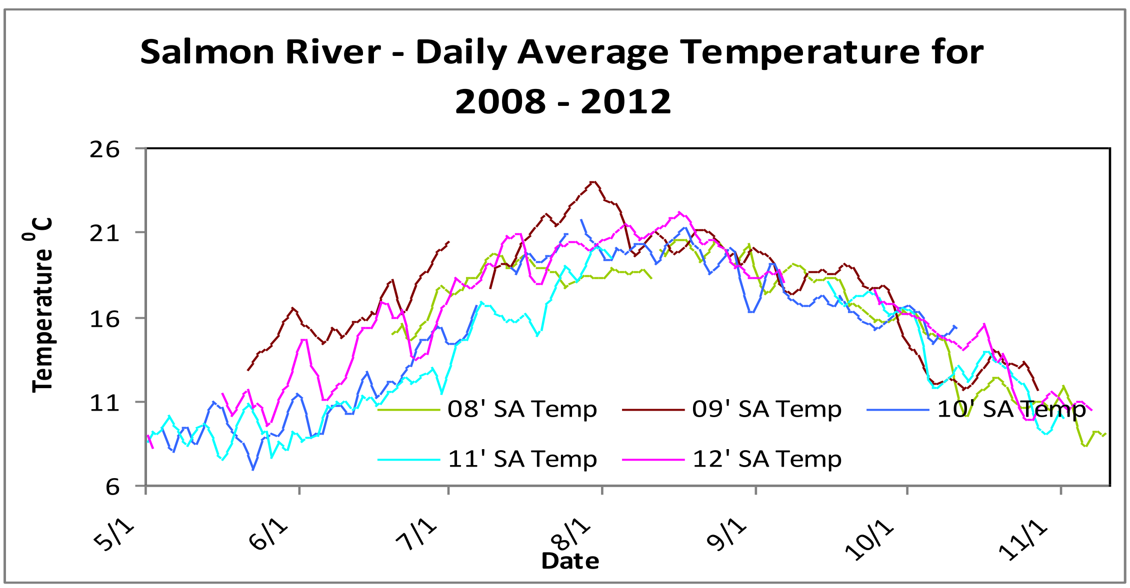


**Figure 38.** Daily average water temperatures for the Salmon River from 2008-2012.

**Dissolved Oxygen:**
Daily average dissolved oxygen for 2012 depicts the usual annual trend, Shasta River with the lowest daily averages, Scott next and the Salmon River the highest daily average DO. The lowest DO levels occurred in late June to early August, this is the general trend at all tributary sites from 2008-2012 (Figures 19 -25).

The NCRWQCB Basin Plan establishes water quality objectives for each tributary based on instantaneous readings. The Shasta dropped below the DO threshold (x>7 mg/L) between the end of July and mid-August (Figure 21). The Scott River dropped below the threshold (x>7 mg/L) only for a short period in mid-August. The Salmon River dropped below its threshold (x>9 mg/L) the longest, between early July through the end of August (Figure 25).

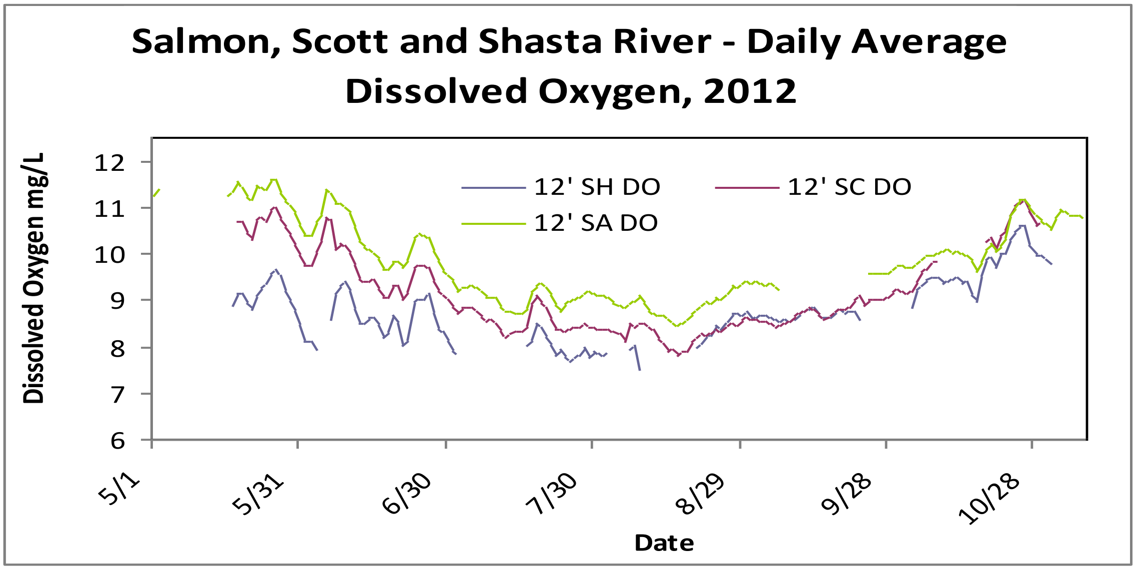


**Figure 39.** Daily average dissolved oxygen for Salmon, Scott and Shasta River, 2012.

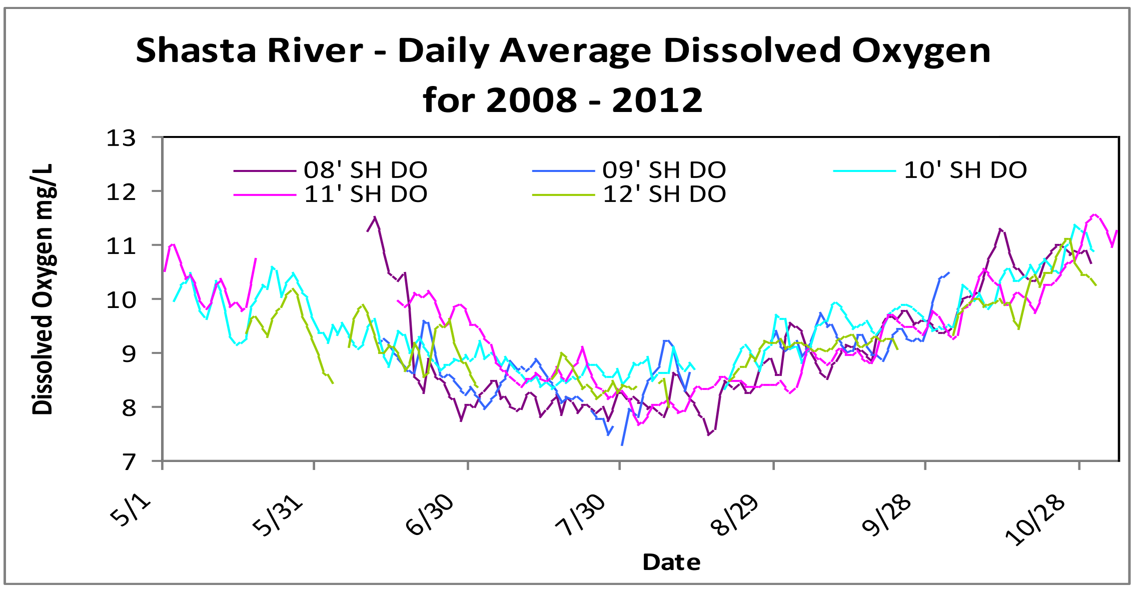


**Figure 40.** Daily average dissolved oxygen concentrations for the Shasta River from 2008-2012.

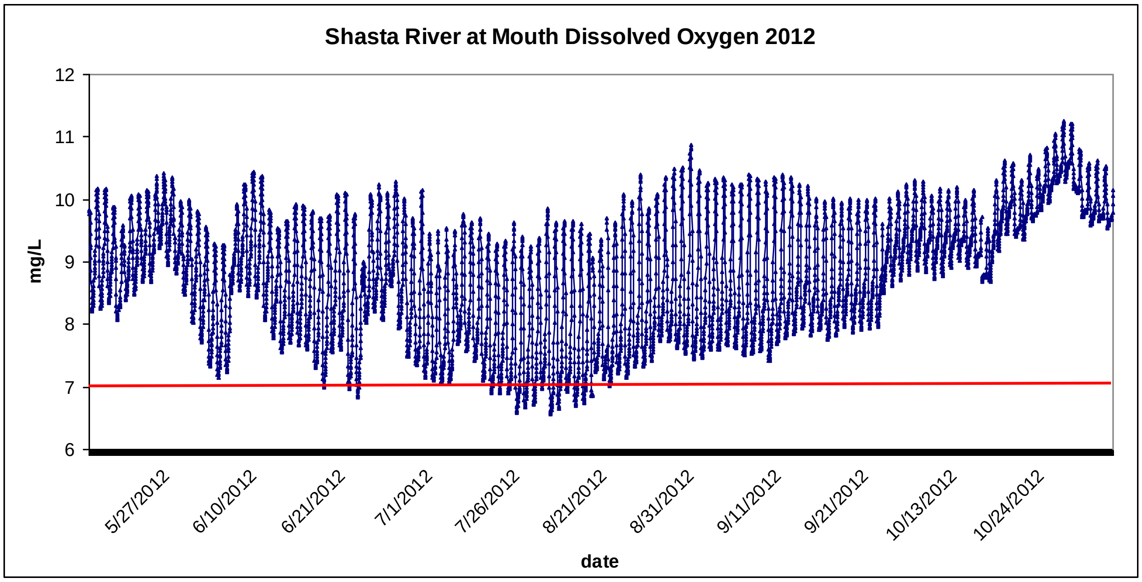


**Figure 21.** Instantaneous dissolved oxygen recorded every 30-minutes for the mouth of the Shasta River (SH) in 2012. The red line indicates the NCRWQCB Basin Plan site specific dissolved oxygen water quality objective for Shasta River, >7mg/L.

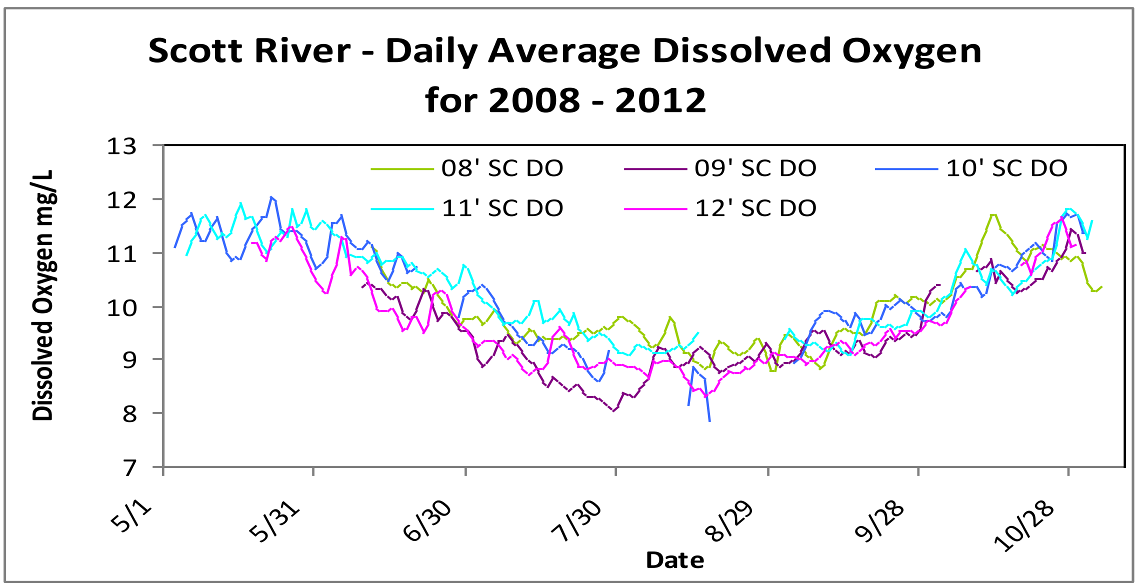


**Figure 22.** Daily average dissolved oxygen concentrations for the Scott River from 2008-2012.

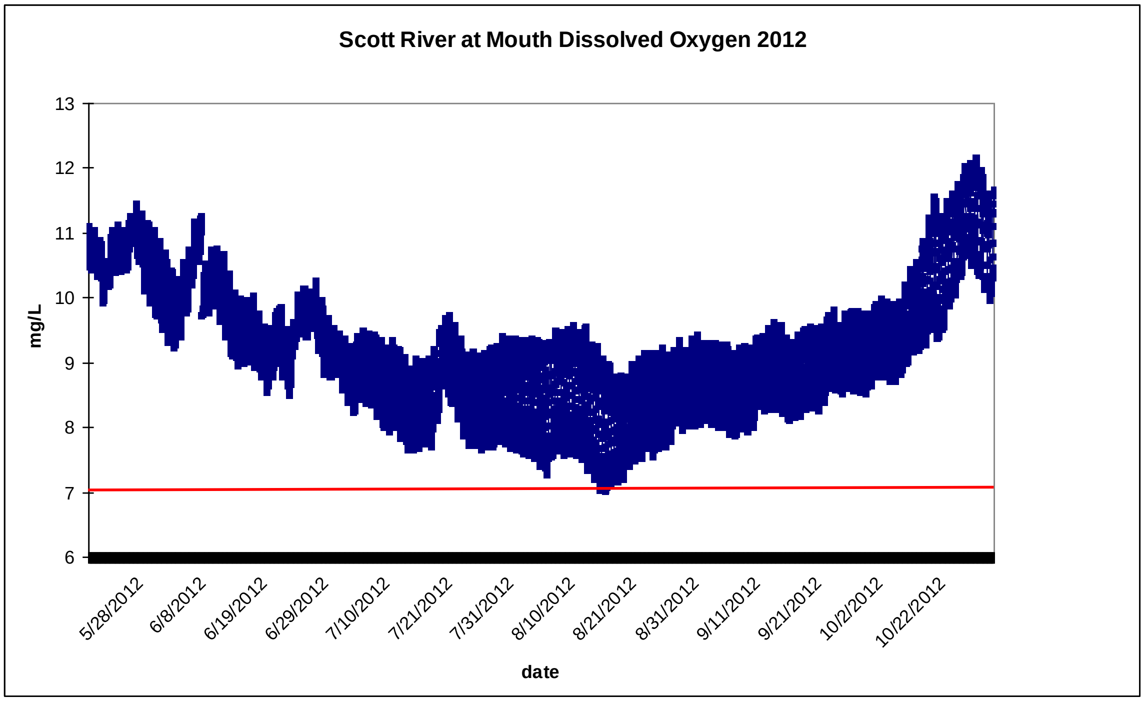


**Figure 23.** Instantaneous dissolved oxygen readings recorded every 30-minutes for the mouth of the Scott River (SC) in 2012. The red line indicates the NCRWQCB Basin Plan site specific dissolved oxygen water quality objective for Scott River, >7mg/L.

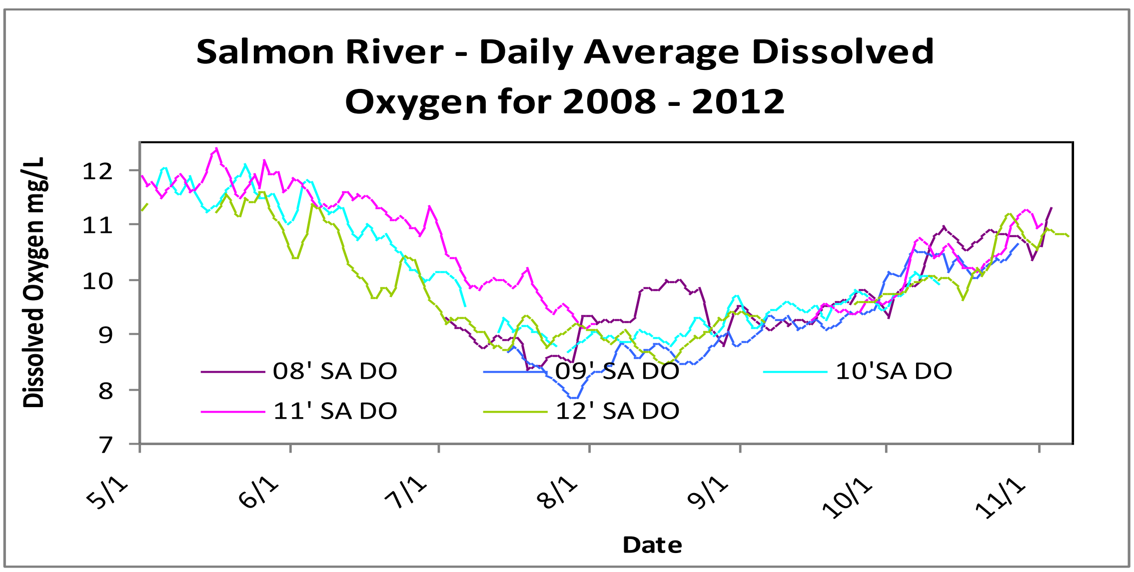


**Figure 24.** Daily average dissolved oxygen concentrations for the Salmon River from 2008-2012.

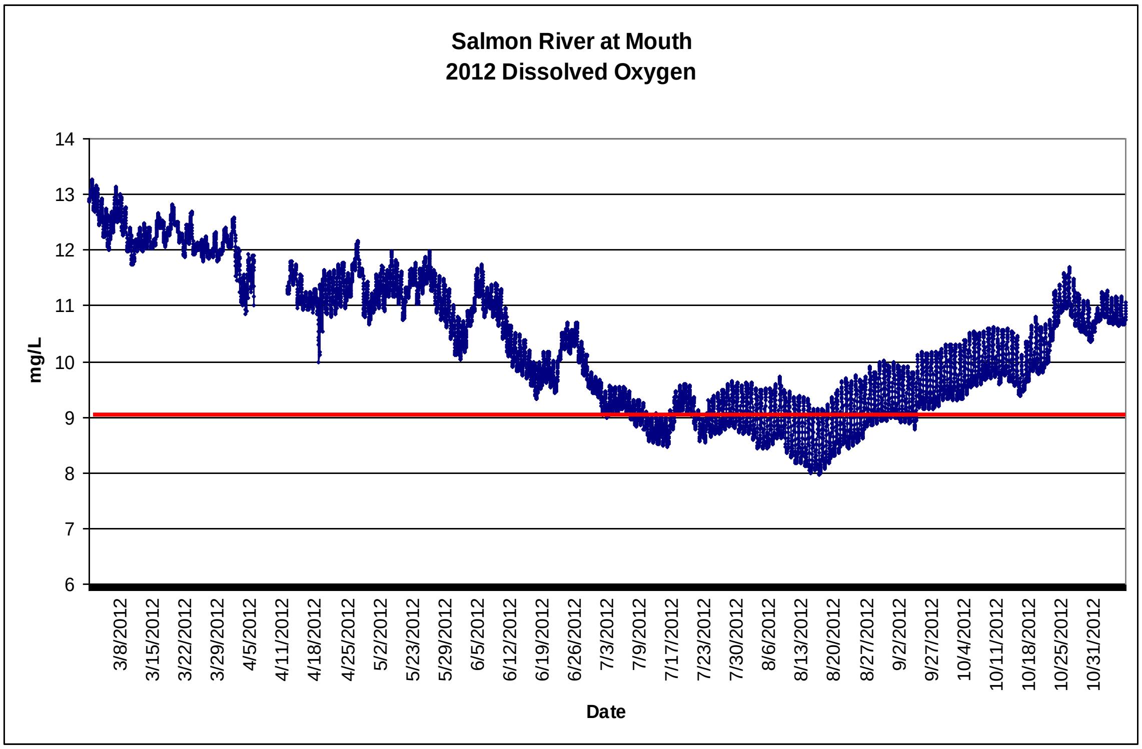


**Figure 25:** Instantaneous dissolved oxygen readings recorded every 30 minutes for the mouth of the Salmon River (SA) in 2012. The red line indicates the NCRWQCB Basin Plan site specific dissolved oxygen water quality objective for Salmon River, >9mg/L.

**pH:**

Daily average pH in 2012 varied between tributary sites (Figure 26) but was an average year within each site for the past four years daily average comparison graphs for each tributary (Figures 27, 29 and 31).

The Salmon River pH was just between 8 and 8.4 units for most of the season, meeting the NCRWQCB Bain Plan water quality objective for all three tributaries, 7< x >8.5. The Scott River exceeded the Basin Plan objective from the end of May through mid-June and again from the beginning of July through the end of August where it hovers around 8.5 through the end of October and then increases beyond 8.5 throughout the month of October (Figure 30). (The Scott River sonde experienced failure near the peak of pH readings which has been edited from these graphs.) The Shasta River was between 8.4 and 9 pH units for the entire sampling season (Figure 28).

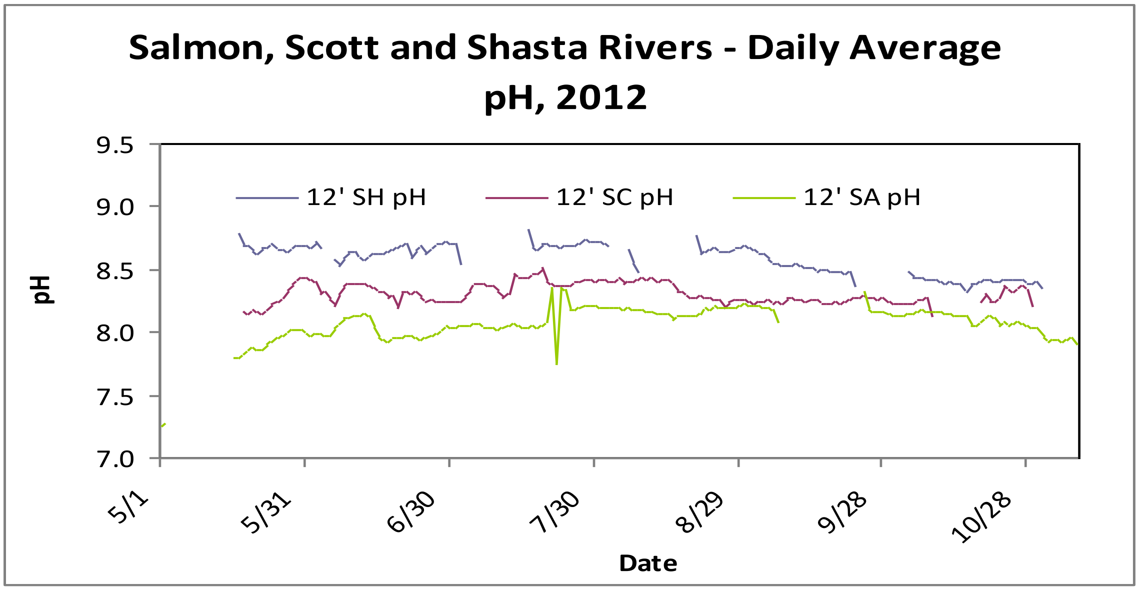


**Figure 26.** Daily average pH for Scott, Shasta, and Salmon Rivers, 2012.

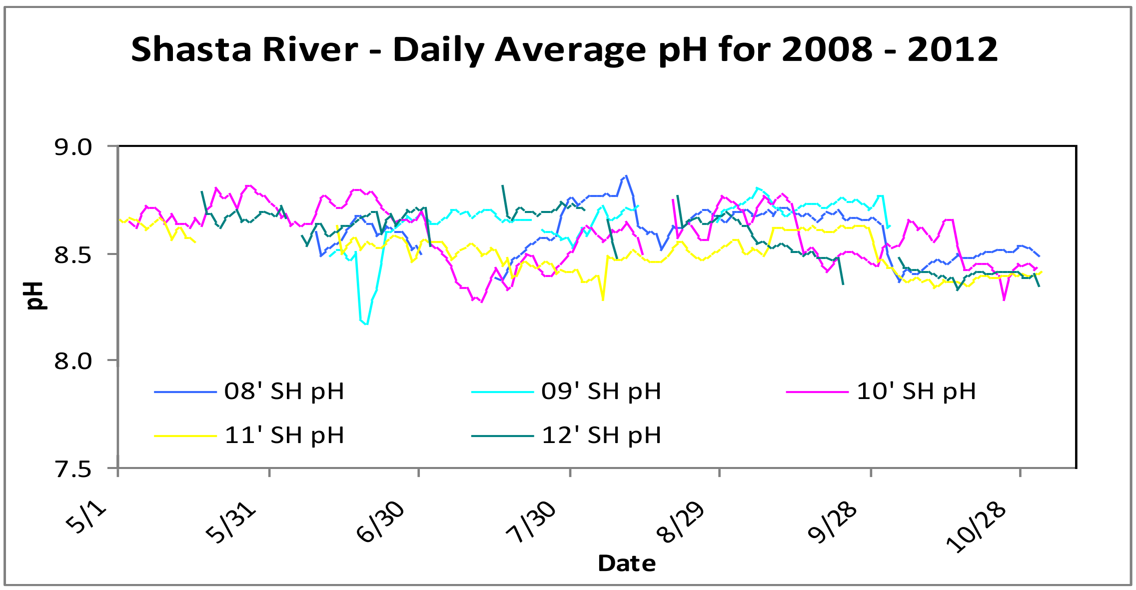


**Figure 27.** Daily average pH concentrations for the Shasta River from 2008-2012.

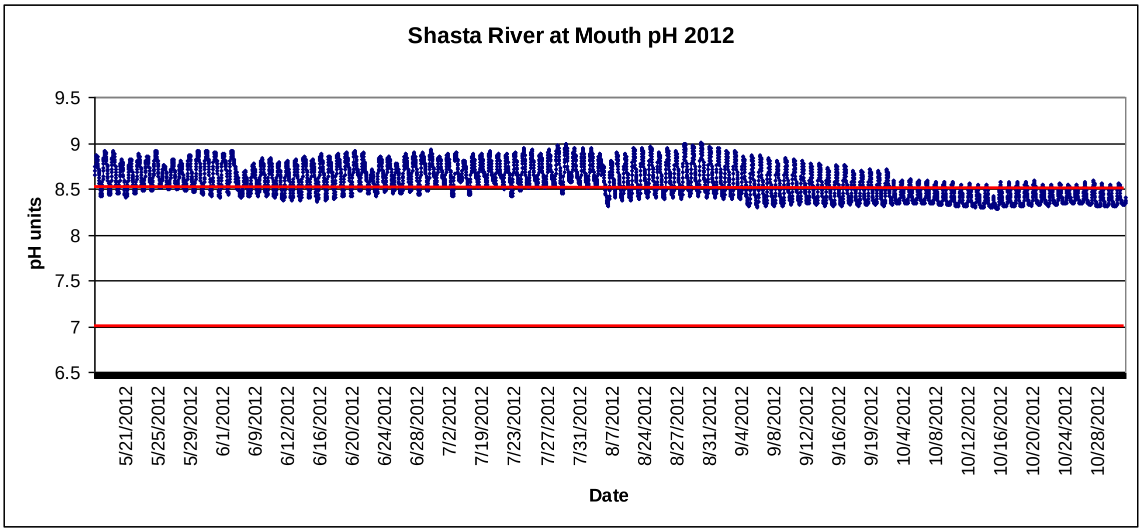


**Figure 28**. Instantaneous pH readings recorded every 30 minutes for the mouth of the Shasta River (SH) in 2012. The red line indicates the NCRWQCB Basin Plan pH water quality objective for Shasta River, 7< X > 8.5.

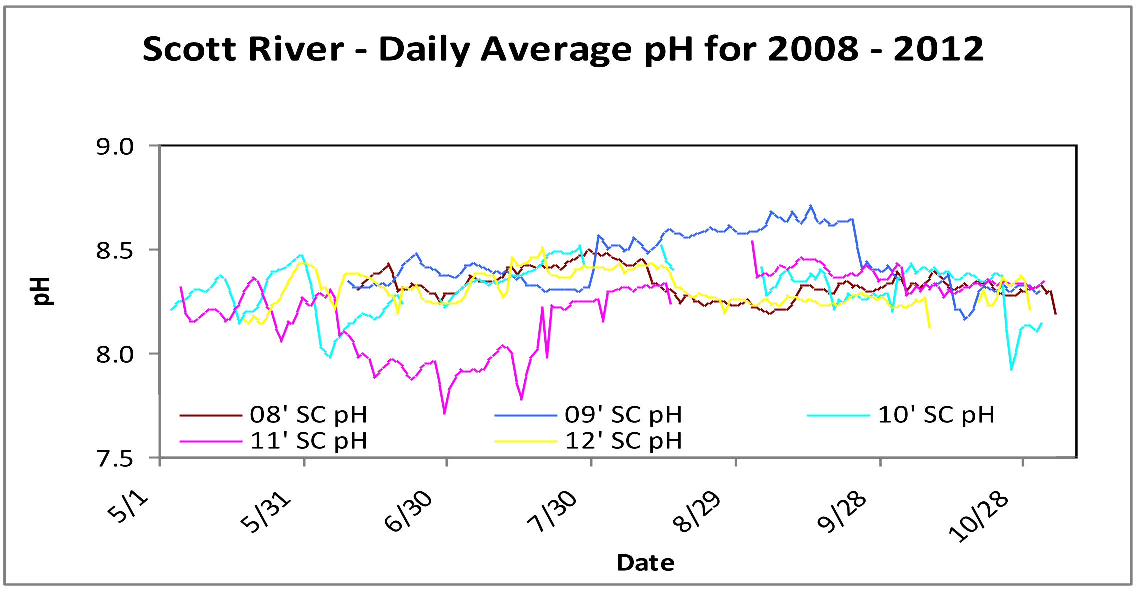


**Figure 29.** Daily average pH concentrations for the Scott River from 2008-2012.

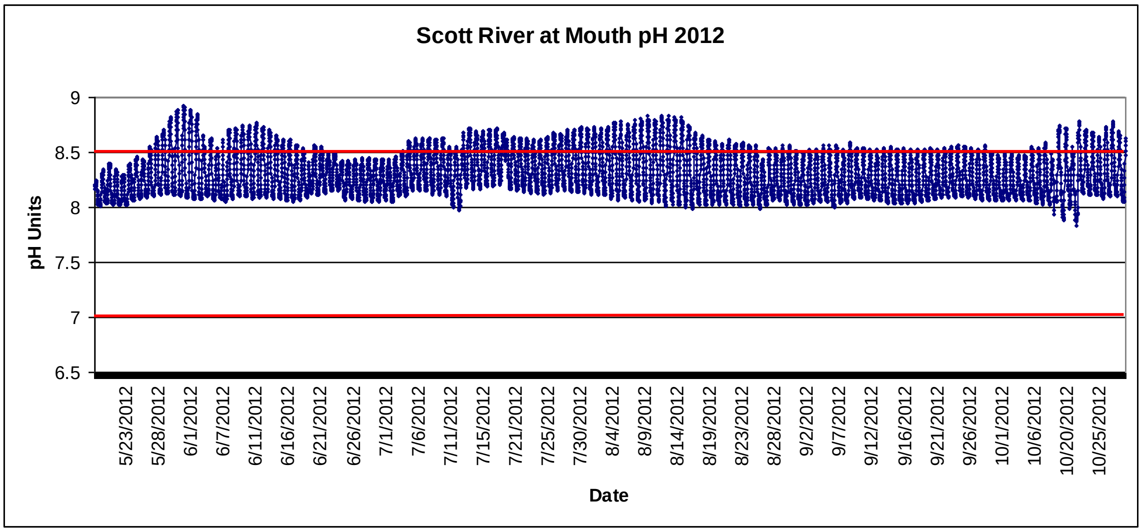


**Figure 30**. Instantaneous pH readings recorded every 30 minutes for the mouth of the Scott River (SC) in 2012. The red line indicates the NCRWQCB Basin Plan pH water quality objective for Scott River, 7< X > 8.5.

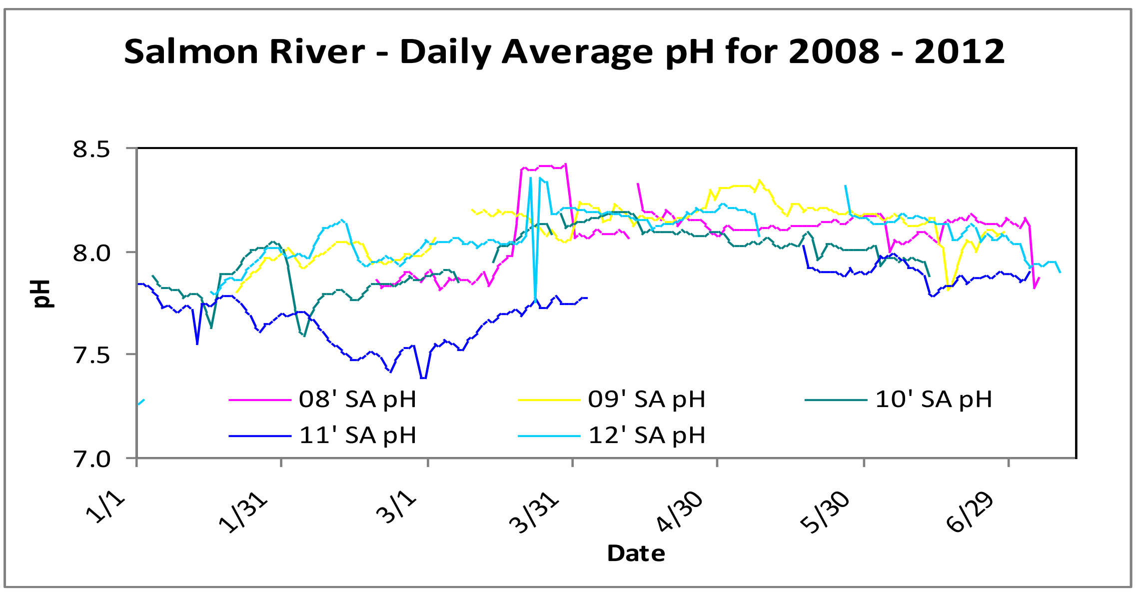


**Figure 31.** Daily average pH concentrations for the Salmon River from 2008-2012.

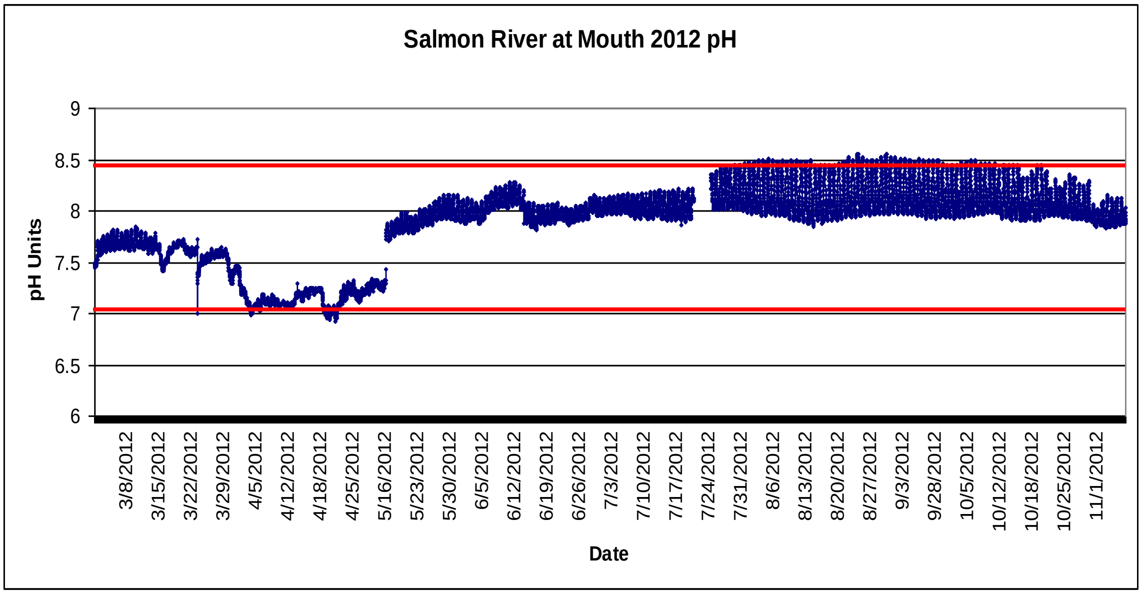


**Figure 32.** Instantaneous pH readings recorded every 30 minutes for the mouth of the Salmon River (SA) in 2012. The red line indicates the NCRWQCB Basin Plan pH water quality objective for Salmon River, 7< X > 8.5.

**Turbidity:**

Turbidity data gathered on Bluff Creek and Salmon River during winter and spring depict similar trends in response to seasonal rain and snowmelt events (Figures 33 and 34). The magnitude between sites is very different. Bluff creek had higher turbidity levels during all peak rainfall events. Salmon River had relatively low turbidity throughout the monitoring season with the largest peaks depicted during snowmelt.

In 2012, 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. We have eliminated that data from our results.

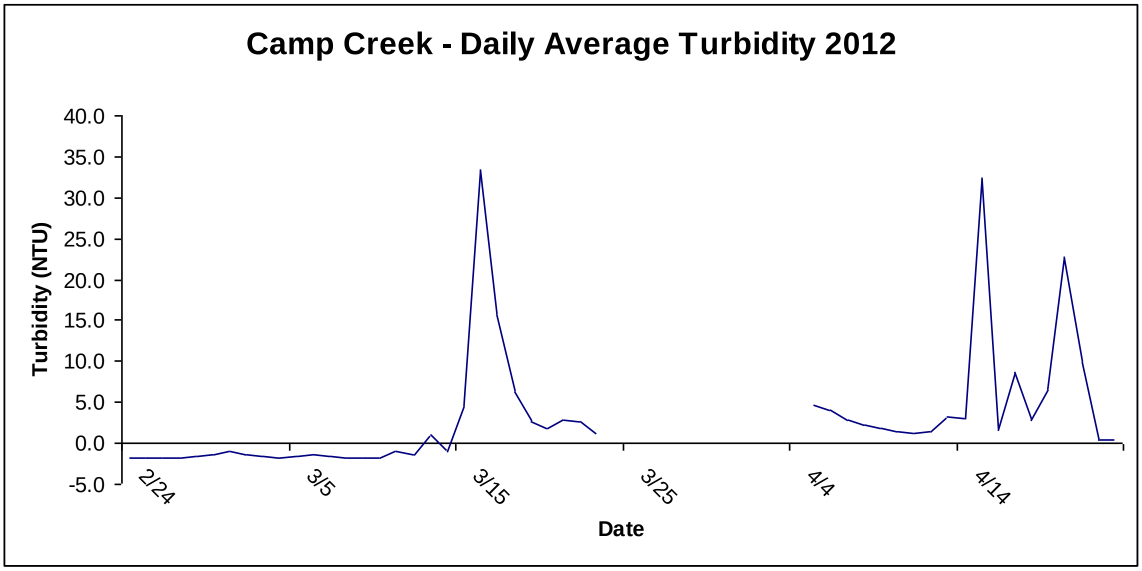


**Figure 33.** Daily average turbidity, winter of 2012 on Camp Creek.

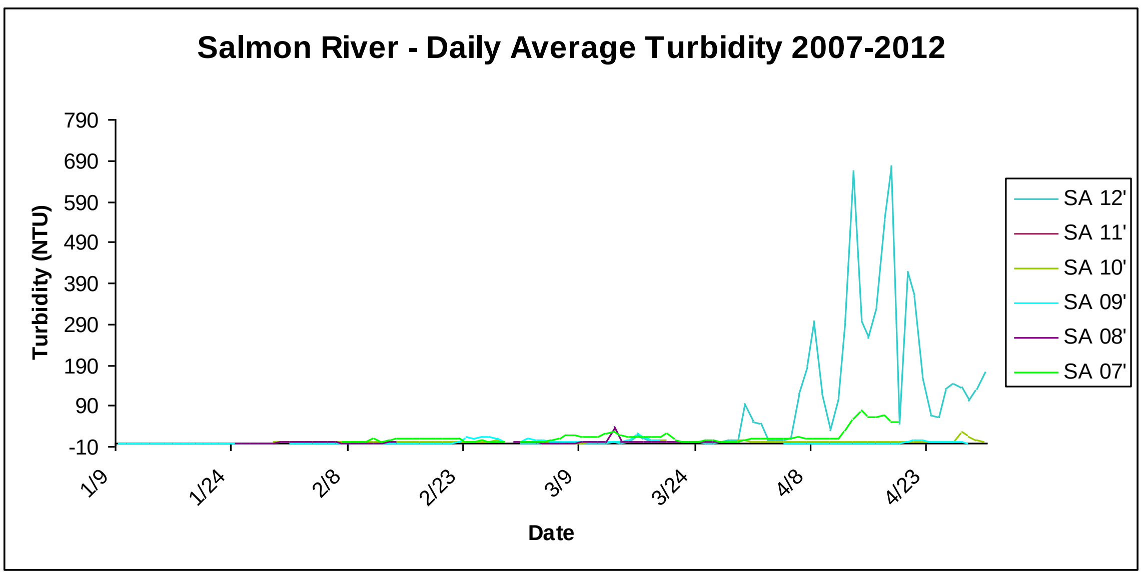


**Figure 34 .** Daily average turbidity, winters of 2007 - 2012 on Salmon River (SA).

***Major Tributary Conclusions from Datasonde Data 2012:*** Water temperature differed among sites during the beginning of summer more likely due to sub basin hydrology differences (snow melt vs spring fed) and differed less once in stream flows dropped and air temperature became the dominant controlling factor. This trend has been recorded annually for the past five years. Dissolved oxygen levels in the lower Salmon were the worst recorded among the three major tributaries for 2012, this drop corresponds with the Salmon's lowest water temperature readings indicating the rivers decreased ability to hold oxygen with increased water temperature. The pH in the Shasta and Scott River were high in 2012 compared to the Salmon; but average when compared to there own four year trends.

## MAINSTEM AND TRIBUTARIES

**Nutrients:**
Nutrient samples were collected by the KTWQP in 2012 from the mainstem Klamath and major tributaries.

Total phosphorus (TP) results for 2012 from the mainstem Klamath and major tributaries depict Iron Gate (IG), Walker Bridge (WA) and Shasta River (SH) as the highest levels (Figure 35). TP levels decrease at all monitoring sites longitudinally downstream from IG. The 2007-2012 (Figure 36) data depicts the same trend. The Shasta River had the highest TP concentration among all sites sampled from 2007-2012, Scott and Salmon Rivers the lowest.

Total nitrogen (TN) mainstem concentrations were highest at the most upriver sites (IG and WA) (Figures 37 and 38). TN concentrations increased throughout the season, doubling between May and October in 2012 (Figure 37). The Shasta River had the highest TN, compared to other major tributaries, which supports the nutrient enrichment TMDL impairment listing of dissolved oxygen and temperature.

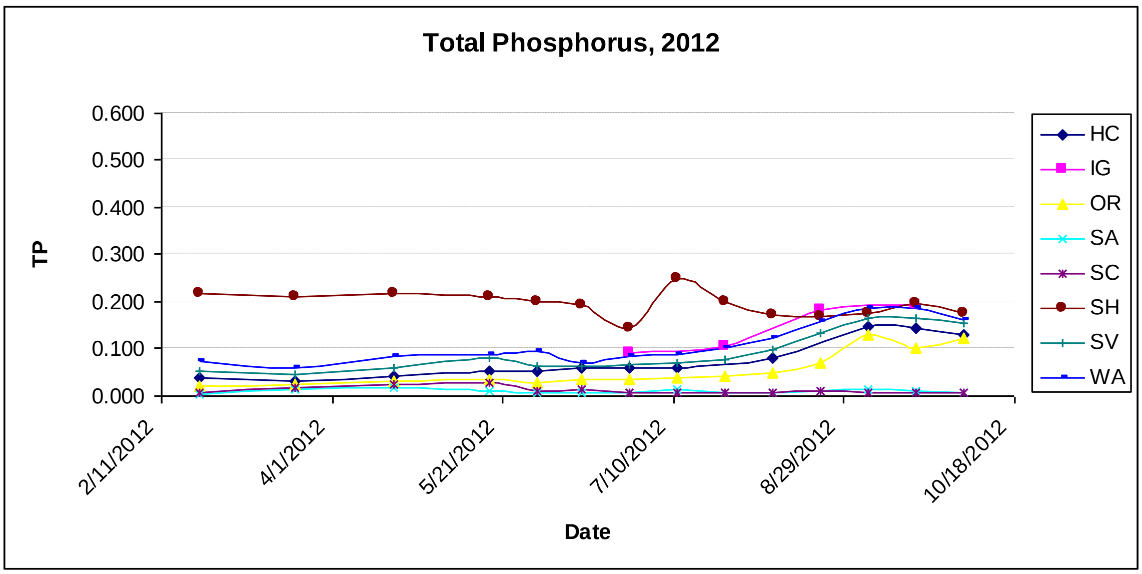


**Figure 35.** Total Phosphorus measured in mg/L for all monitored sites during 2012.

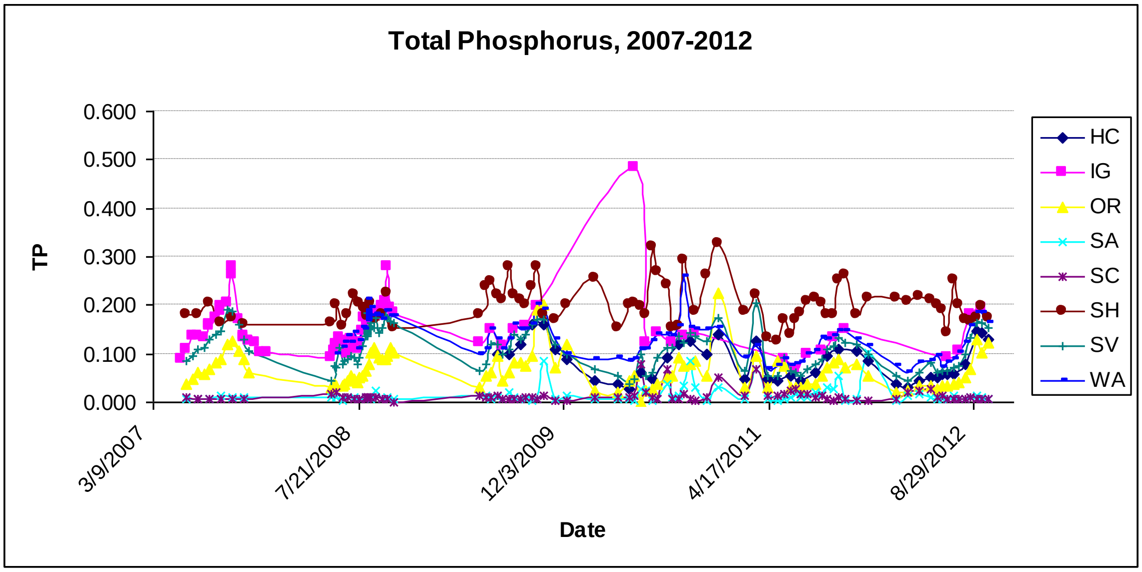


**Figure 36.** Total Phosphorus measured in mg/L for all monitored sites during 2007-2012.

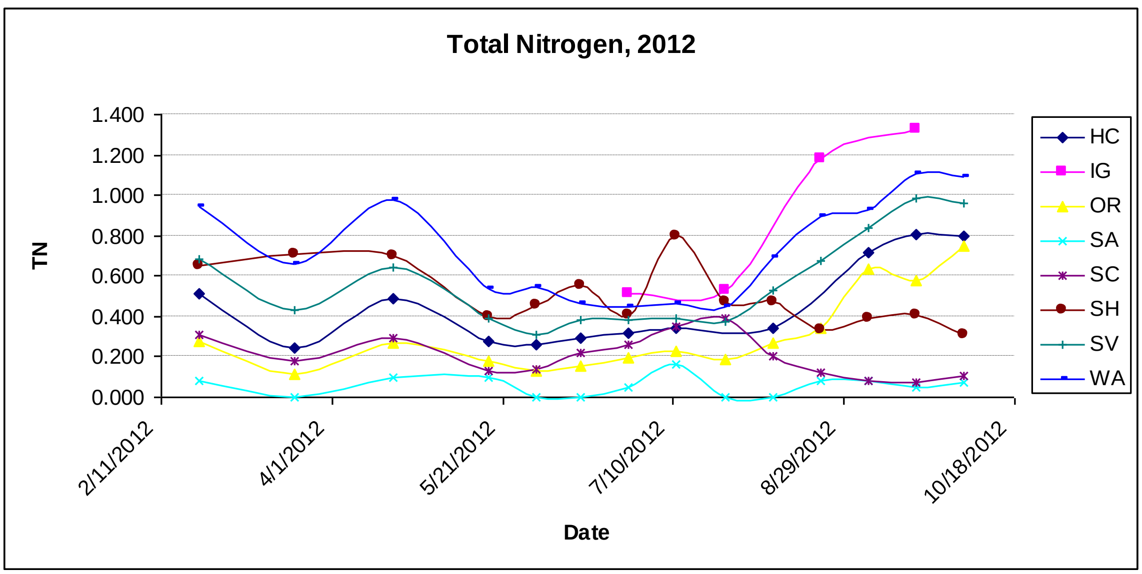


**Figure 37.** Total Nitrogen measured in mg/L for all monitored sites during 2012.

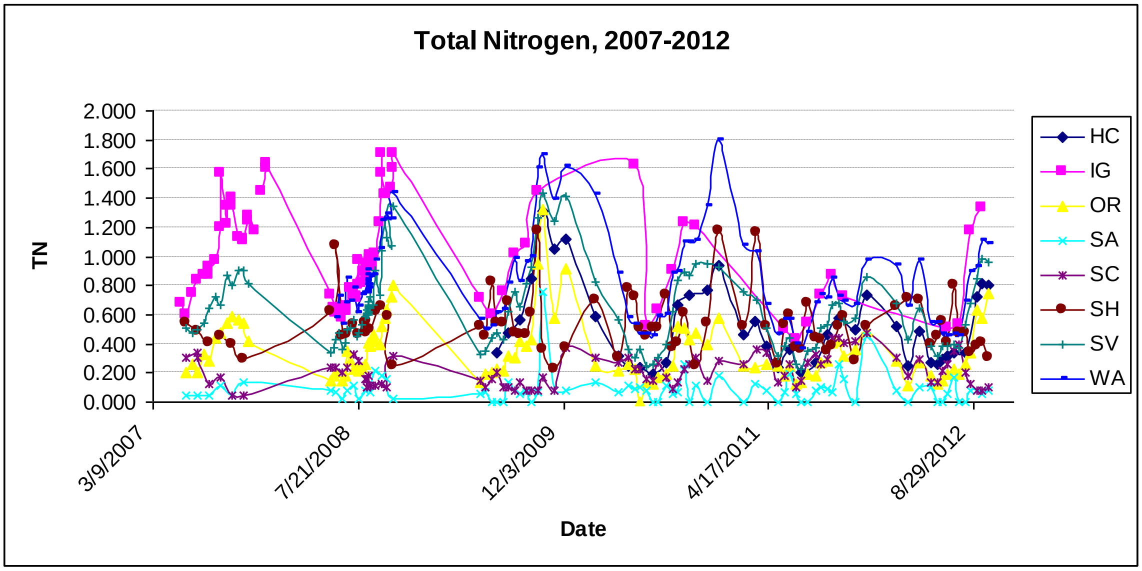


**Figure 38.** Total Nitrogen measured in mg/L for all monitored sites during 2007-2012.

***Mainstem and Tributary Nutrient Conclusions:*** Agricultural land uses in the upper Klamath Basin and major tributaries of Shasta and Scott Rivers are the majority of nutrient contributions in the basin. Grab sample results support this land use assessment. Trends are consistent throughout the six sampling years.

## 7 References


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