KARUK TRIBE

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

2019

Annual Monitoring Report

KLAMATH RIVER, SALMON RIVER, SCOTT RIVER, AND SHASTA RIVER

Karuk Tribe

Annual Monitoring Report
2019

Prepared by
Karuk Tribe
Water Quality
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Technical Staff

Susan Fricke - Water Quality Program Manager
Grant Johnson - Project Manager
Larry Alameda - Water Quality Technician II
Jon Mohr - Water Quality Technician

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1 Background

The Karuk Tribe is the second largest Tribe in California, with over 3,700 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 main stem 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 Bureau of Reclamation (BOR), the Yurok Tribe, Quartz Valley Indian Reservation, Hoopa Tribe, and Resighini Rancheria, Oregon State University and PacifiCorp. 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, Microcystin
Cold Freshwater Habitat (COLD)	Temperature, Turbidity
Cultural Contact Water (CUL-1)	Temperature, Phosphorus, Nitrogen, Microcystin
Cultural Non-Contact Water (CUL-2)	Temperature, Phosphorus, Nitrogen
Fish Consumption (FC)	Temperature, Phosphorus, Nitrogen
Water Contact Recreation (REC-1)	Temperature, Phosphorus, Nitrogen, Microcystin
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 are 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 are 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) developed and began implementing Total Maximum Daily Loads (TMDLs) for the Klamath, 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). This agreement was amended on April 6, 2019. For this agreement, water quality monitoring will occur to establish baseline water quality conditions before the dams are removed in 2021.

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, 2014).

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, Stanford University, U.S. Fish and Wildlife Service, EPA Region IX, EPA Region X, Oregon Department of Environmental Quality, 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, work in technical subgroups, look for and provide support for others' grant proposals, and conduct monitoring and research. Some of the workgroups we participate in include: the Klamath Blue Green Algae Workgroup, California Cyanobacteria Harmful Algae Bloom Workgroup, Klamath Basin Monitoring Program, Klamath Tribal Water Quality Consortium, 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 Karuk 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.

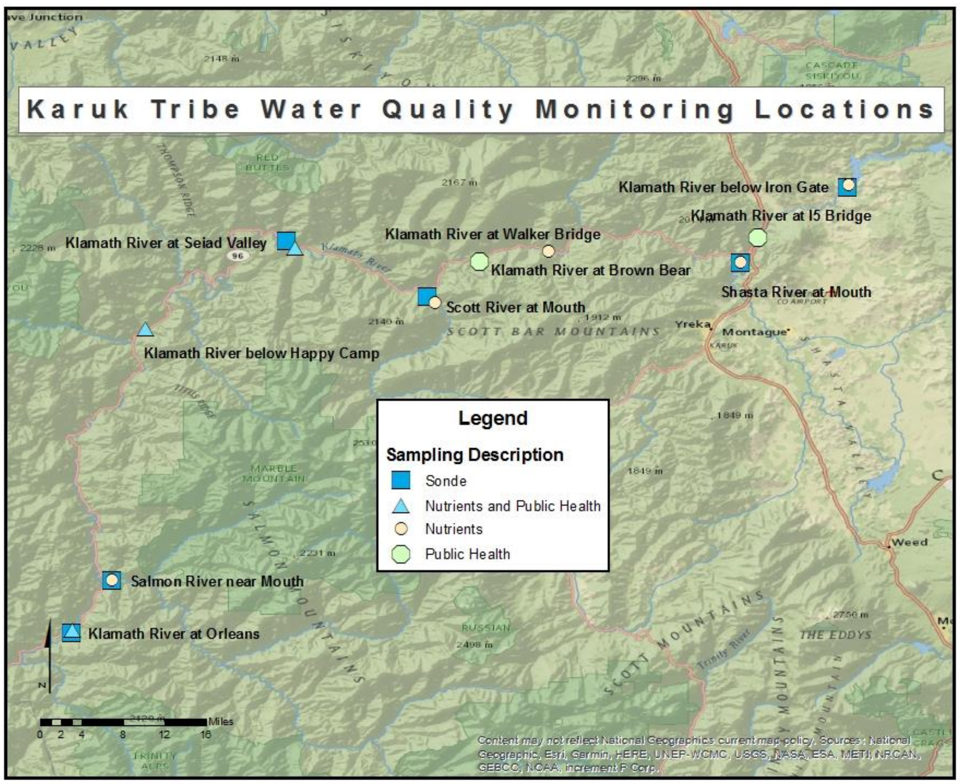

Figure 1. Overview of the Karuk Tribe's water quality monitoring locations along the Klamath River in 2019.

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 main stem (Table 3). During the winter of 2017-2019 winter turbidity monitoring occurred at the Salmon River and Iron Gate sites. Iron Gate winter monitoring evaluates turnover in Iron Gate reservoir and influences on dissolved oxygen and pH. 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 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 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.

2019 Locations and Parameters Monitored							
Site ID	Latitude	Longitude	Nutrient Suite	Sonde	Public Health	Winter Turbidity	Location
OR	N 41 18.336	W 123 31.895	X	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	X	Klamath River downstream of Seiad Valley
SC	N 41 46.100	W 123 01.567	X	X			Scott River near mouth
BB	N 41 49.395	W 122 57.718			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
IB	N 41 51.424	W 122 34.245			X		Klamath River at I-5 Bridge
IG	N 41 55.865	W 122 26.532	X	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 Karuk Tribe purchased Aquatic Informatics (AI) Time-Series software in 2015 to manage, QA/QC, and in conjunction with AI's Webportal software, disseminate our continuous 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 are compiled using spreadsheets and the Time-Series software. 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 are then submitted electronically to EPA via the California Environmental Data Exchange (CEDEN) and cross walked to EPA's Water Quality Exchange (WQX) and made publicly available. Data may be utilized by other Tribes, agencies, and entities to help direct water resource management actions.

6 2019 Water Quality Results

The associated Water Quality Assessment Report spreadsheet describes current impairments.

MAIN STEM KLAMATH

The sonde data presented in Figures 2-13 depicts seasonal temperature, dissolved oxygen and pH trends at main stem Klamath River monitoring sites.

Temperature:
In 2019, 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 2). This trend is further emphasized when looking at the average temperature over a 14 year period from 2006-2019 (Figure 3). 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. When comparing figure 2 and, 2019 was an average year regarding temperature.

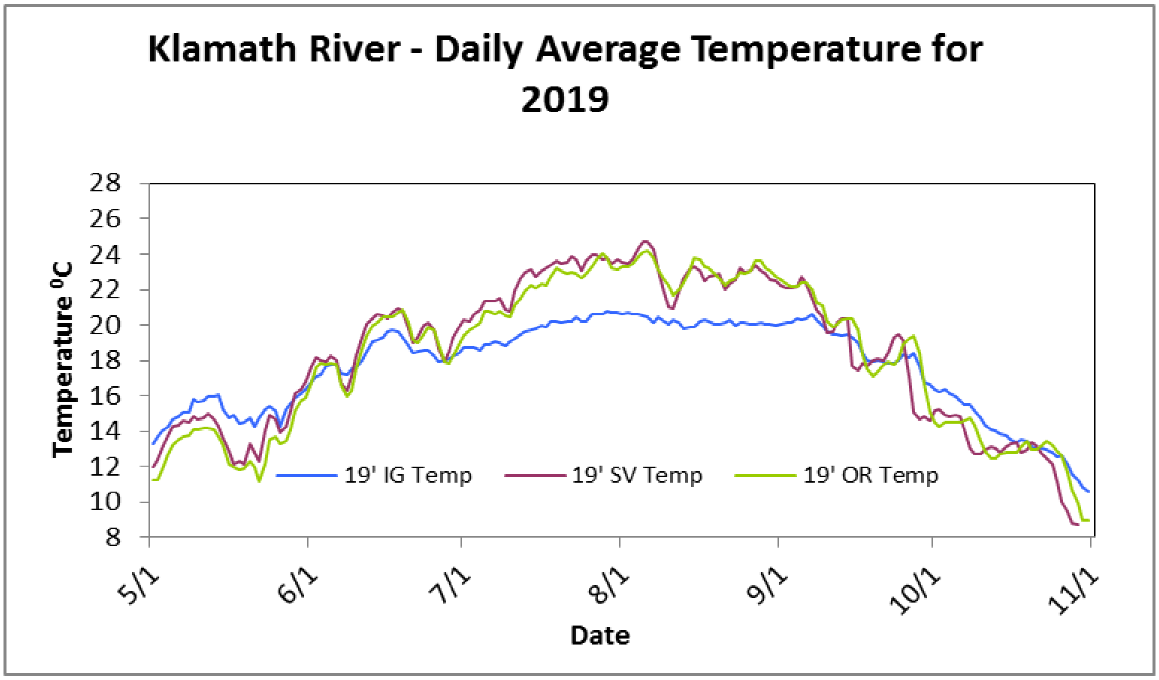

Figure 2. Daily average temperatures for 3 main stem Klamath River sites in 2019: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

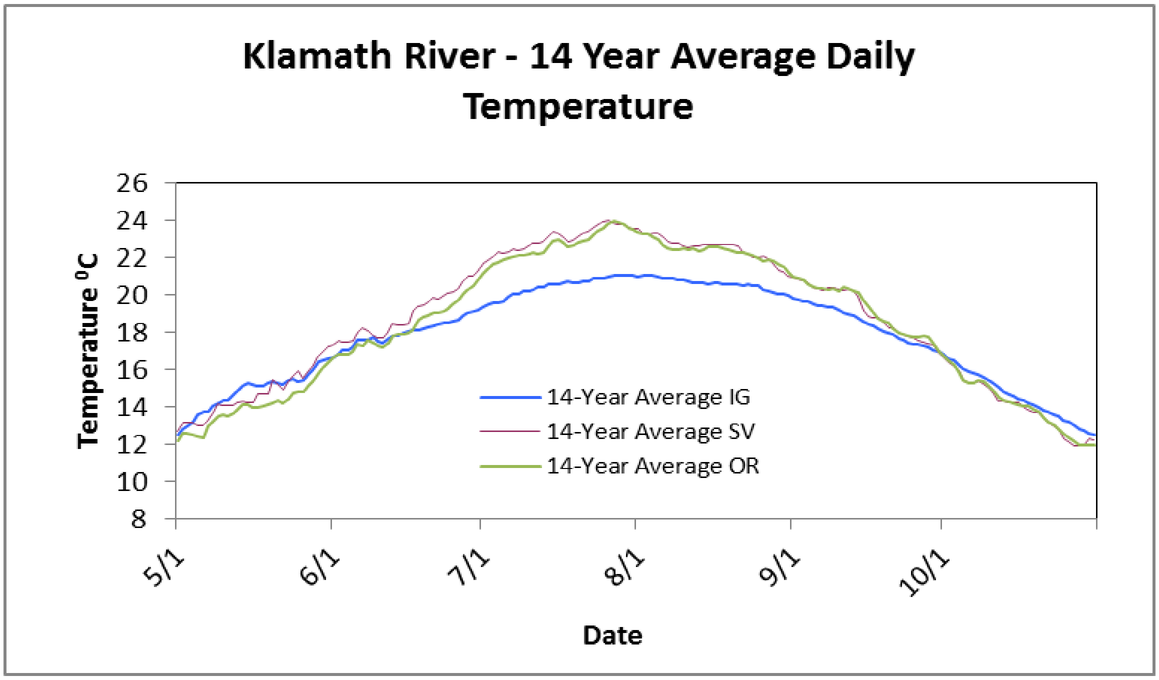

Figure 3. Averaged daily temperature from 2006-2019 at main stem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

Dissolved Oxygen:

Iron Gate dam has a negative impact on DO levels from mid-August through the end of sampling in 2019. DO levels below the dam drop while increasing at all other Karuk main stem Klamath sampling locations (Figure 4 - 7). The timing overlaps with fall-run salmonid migration and spawning and is an impairment of the beneficial use. Comparing figures 4 and 8, the below Iron Gate dam site had lower average spring and summer time DO levels compared to the 13 year average. The Orleans and Seiad sites had very similar trends to the 14 year average. The Seiad site had the highest magnitude diurnal swings (Figure 6), followed by Iron Gate (Figure 7)

Thirteen-year daily averages for DO, which depict the annual differences between sites, are less extreme in the middle of the summer when water temperatures are the highest (Figure 8).

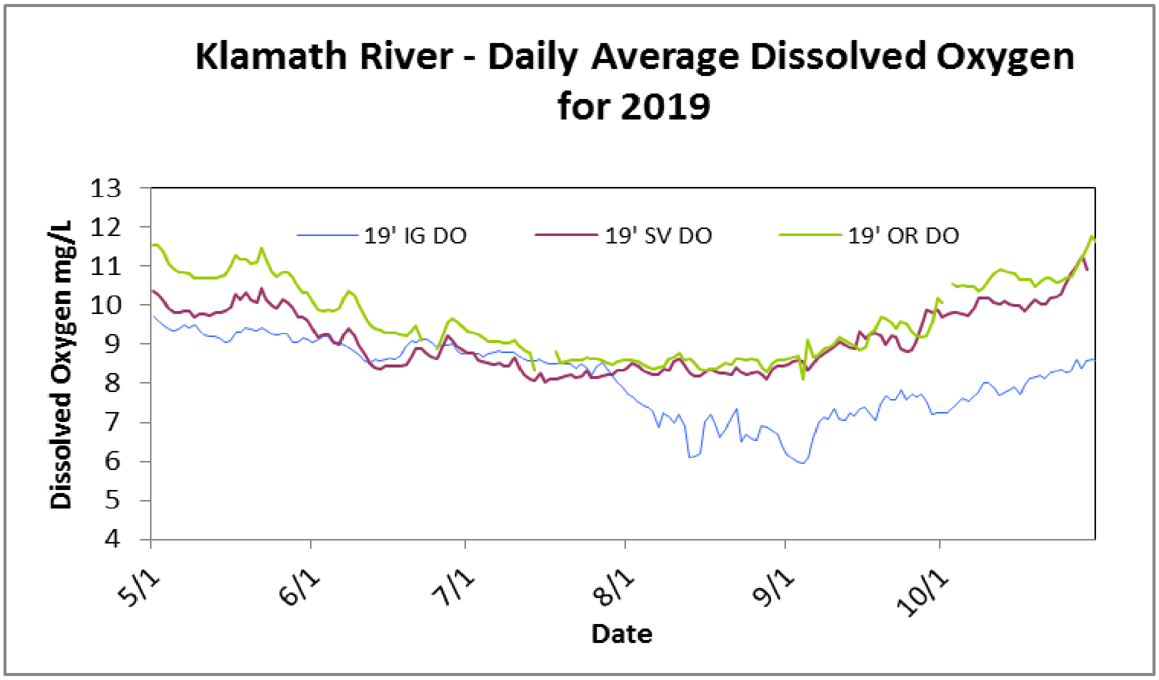

Figure 4. Daily average dissolved oxygen levels for 3 main stem Klamath River sites in 2019: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

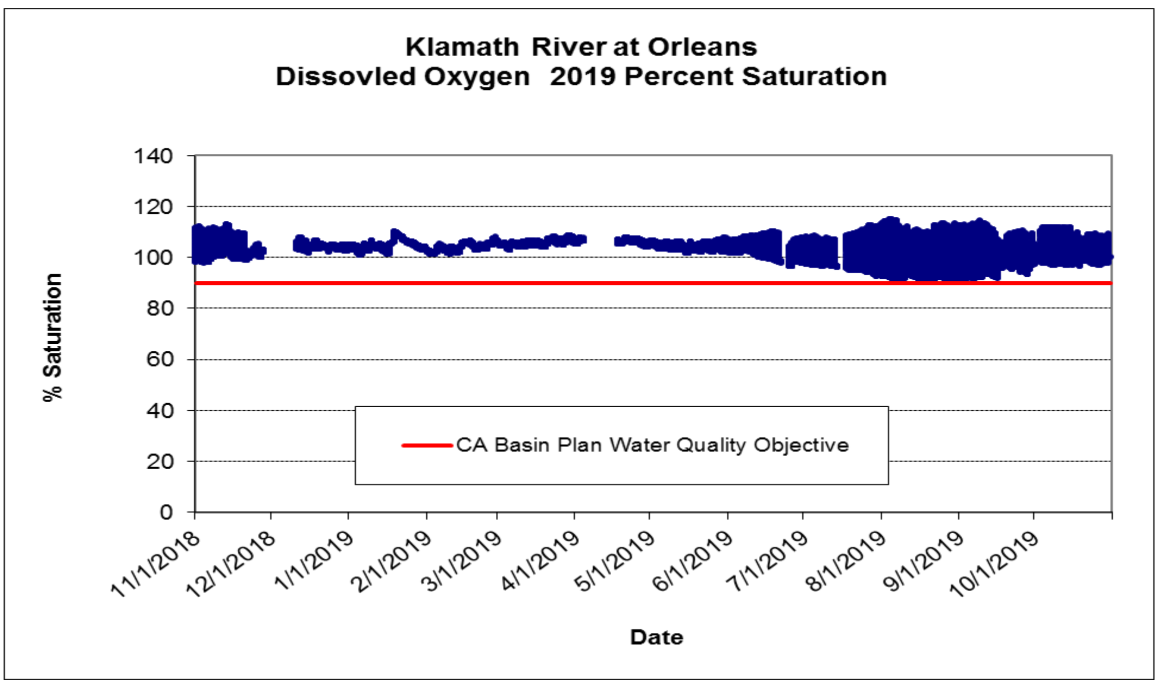

Figure 5. Percent saturation dissolved oxygen readings recorded every 30-minutes for Klamath River at Orleans (OR) in 2019. The red line indicates the NCRWQCB Basin Plan Klamath River site specific dissolved oxygen water quality objective: from the mouth of the Scott River to Hoopa, >90% saturation year-round.

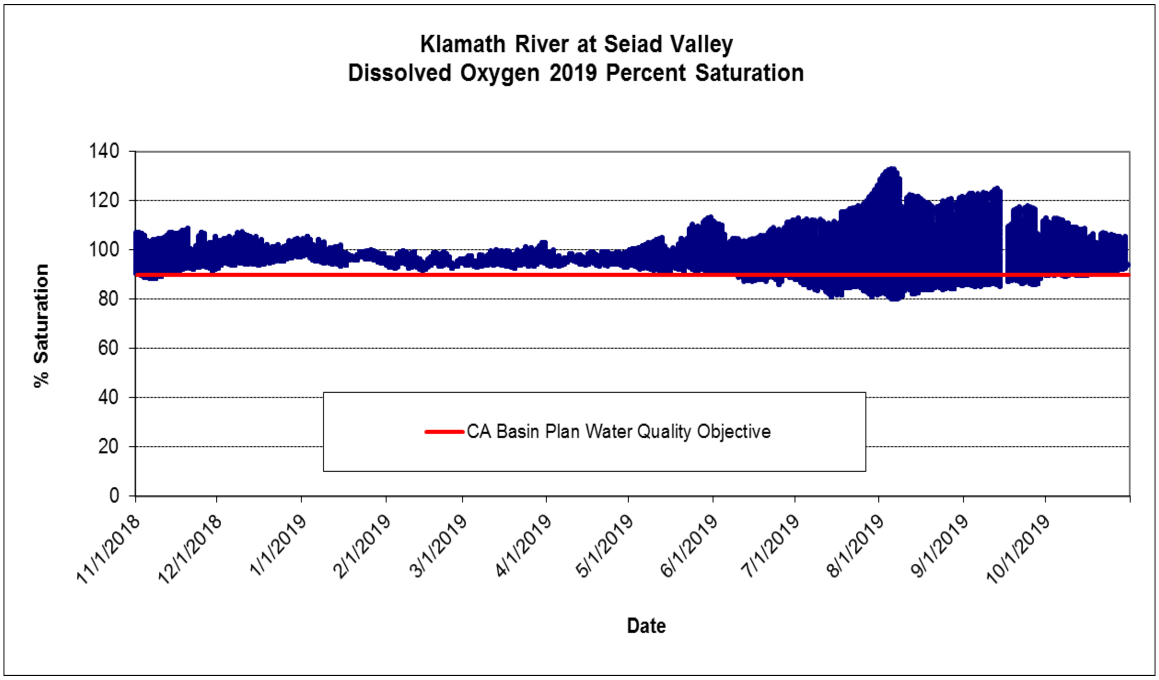

Figure 6. Percent saturation dissolved oxygen readings recorded every 30-minutes for Klamath River at Seiad Valley (SV) in 2019. The red line indicates the NCRWQCB Basin Plan Klamath River site specific dissolved oxygen water quality objective: from the mouth of the Scott River to Hoopa, >90% saturation year-round.

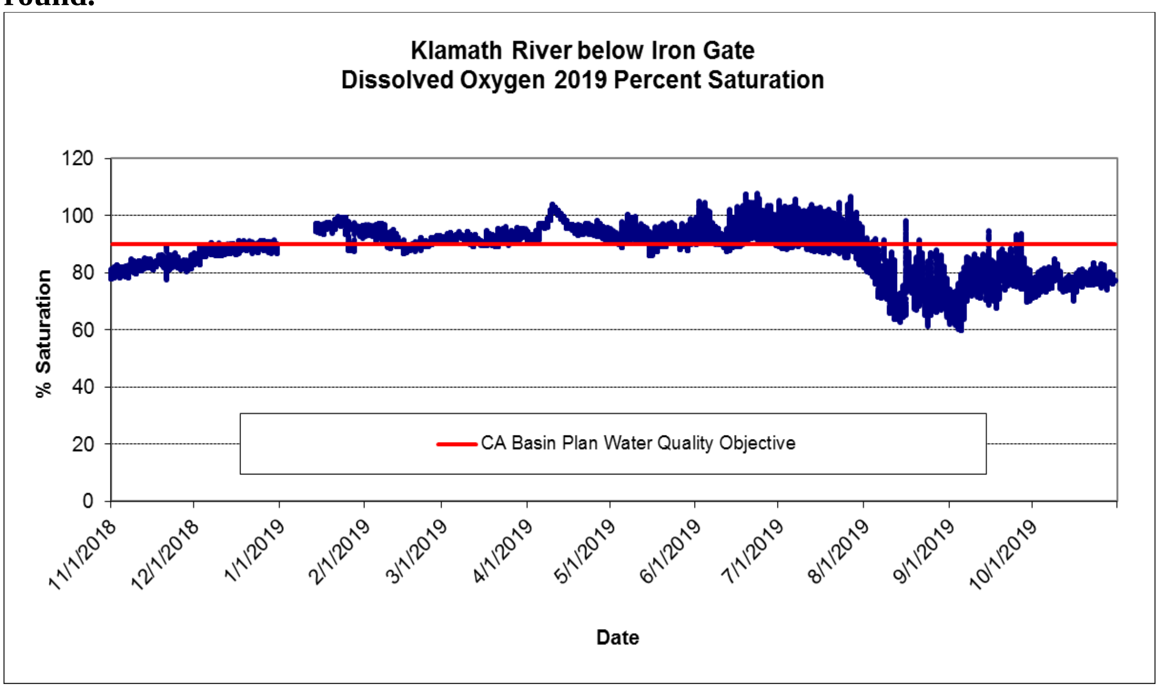

Figure 7. Percent saturation dissolved oxygen readings recorded every 30-minutes for Klamath River below Iron Gate Dam (IG) in 2019. The red line indicates the NCRWQCB Basin Plan Klamath River site specific dissolved oxygen water quality objective from Stateline (OR/CA) to the mouth of the Scott River, >90% saturation from Oct 1- March 30 and >85% from April 1-Sept 30.

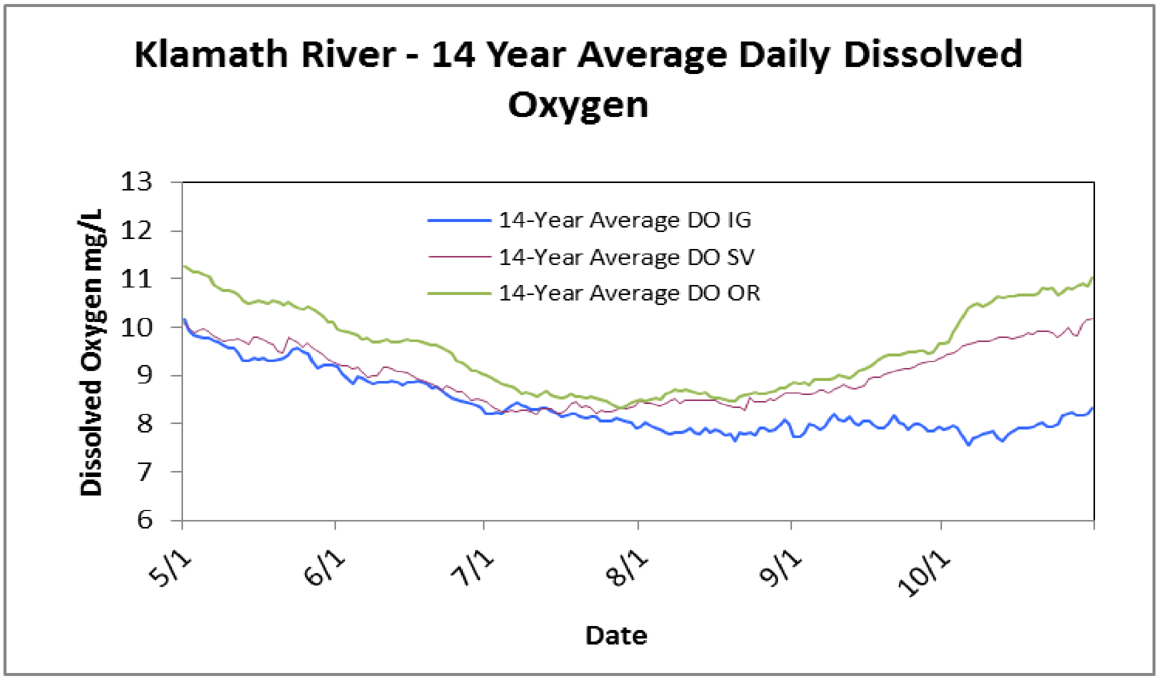

Figure 8. Average daily dissolved oxygen levels from 2006-2019 at main stem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

pH:
The daily average and instantaneous pH trends vary between main stem sites in 2019 (Figures 9 - 13). SV had the most basic pH readings (Figure 9). Of the Klamath main stem sites, SV has the most instantaneous exceedances in 2019 to the NCRWQCB Basin Plan water quality objective for the Klamath River.

Thirteen-year trend comparison (Figure 13) 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 the peak of in-river primary productivity and the lowest DO readings, indicative of water quality impairments associated with photorespiration.

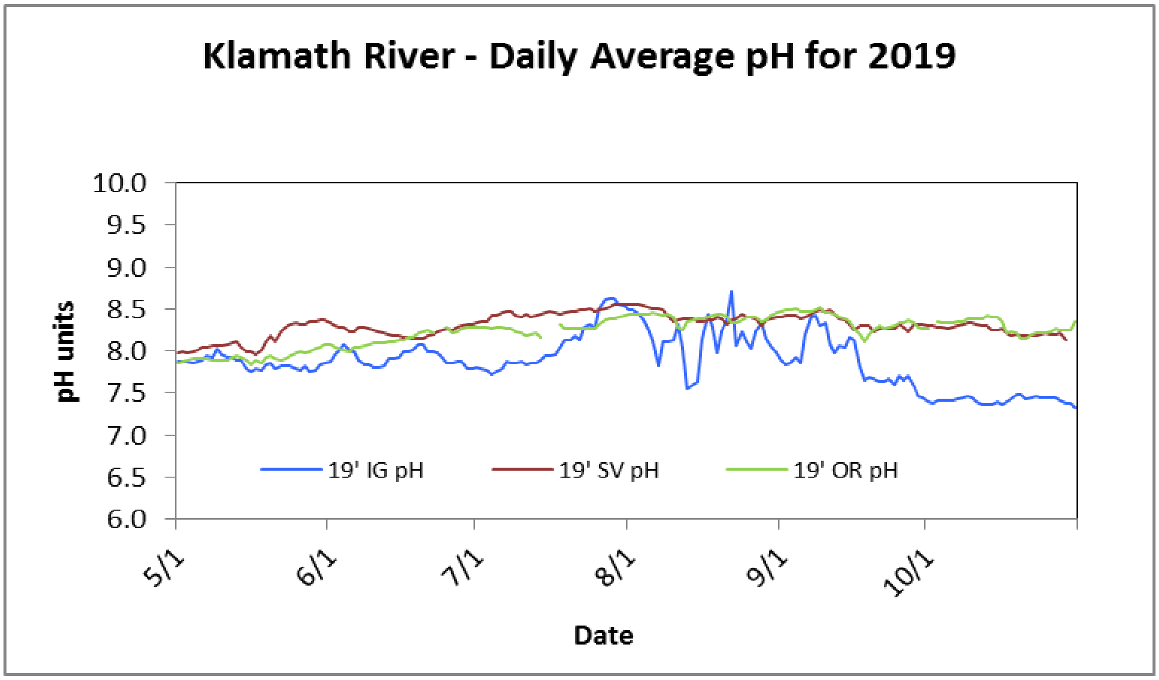

Figure 9. Daily average pH levels for 3 main stem Klamath River sites in 2019: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

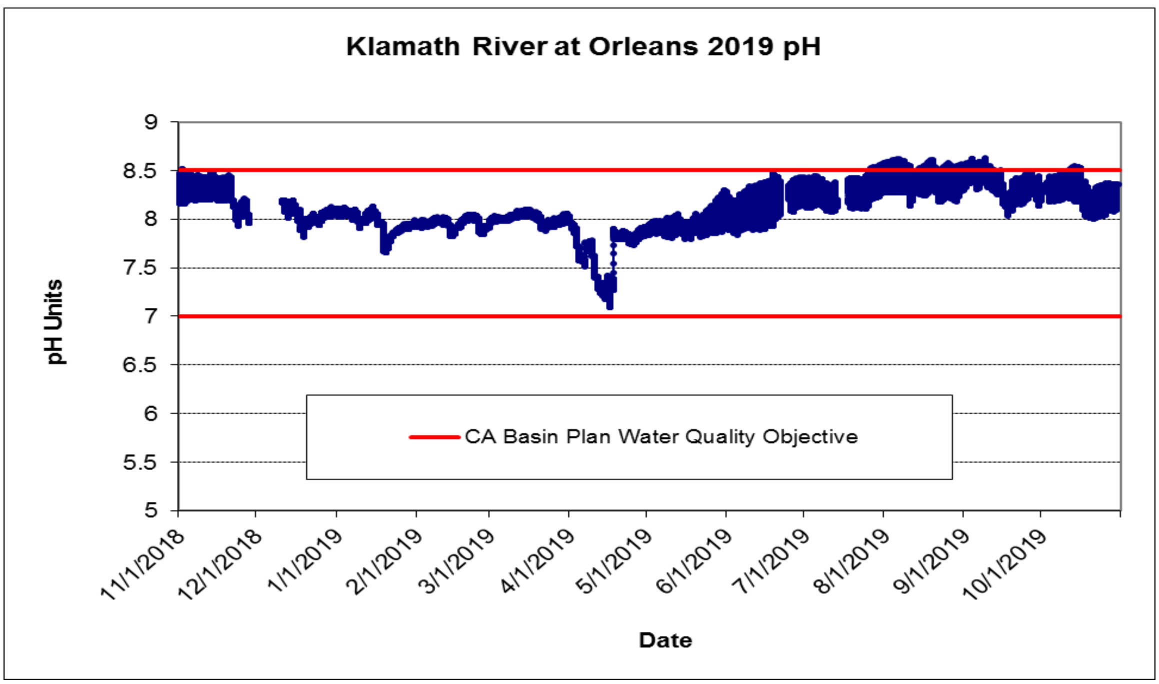

Figure 10. Instantaneous pH readings recorded every 30-minutes for Klamath River at Orleans (OR) in 2019. The red lines are the NCRWQCB Basin Plan water quality objectives for the Klamath River, 7< X > 8.5.

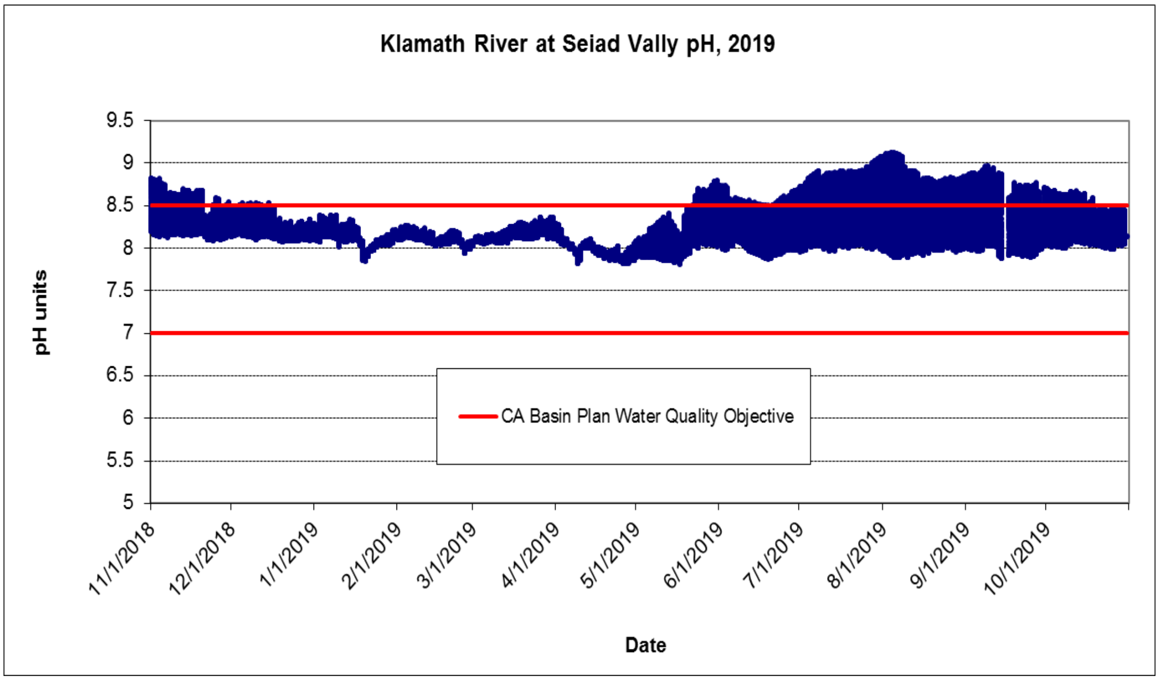

Figure 11. Instantaneous pH readings recorded every 30-minutes for Klamath River below Seiad Valley (SV) in 2019. The red lines are the NCRWQCB Basin Plan water quality objectives for the Klamath River, 7< X > 8.5

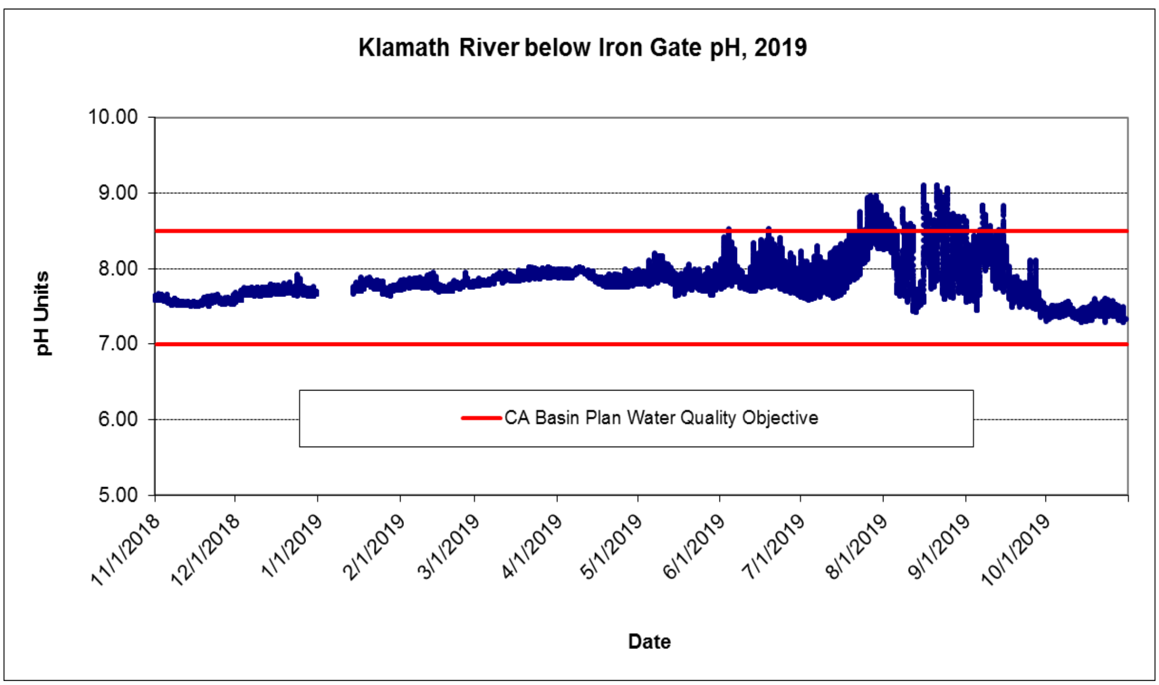

Figure 12. Instantaneous pH readings recorded every 30-minutes for Klamath River below Iron Gate (IG) in 2019. The red lines are the NCRWQCB Basin Plan water quality objectives for the Klamath River, 7< X > 8.5

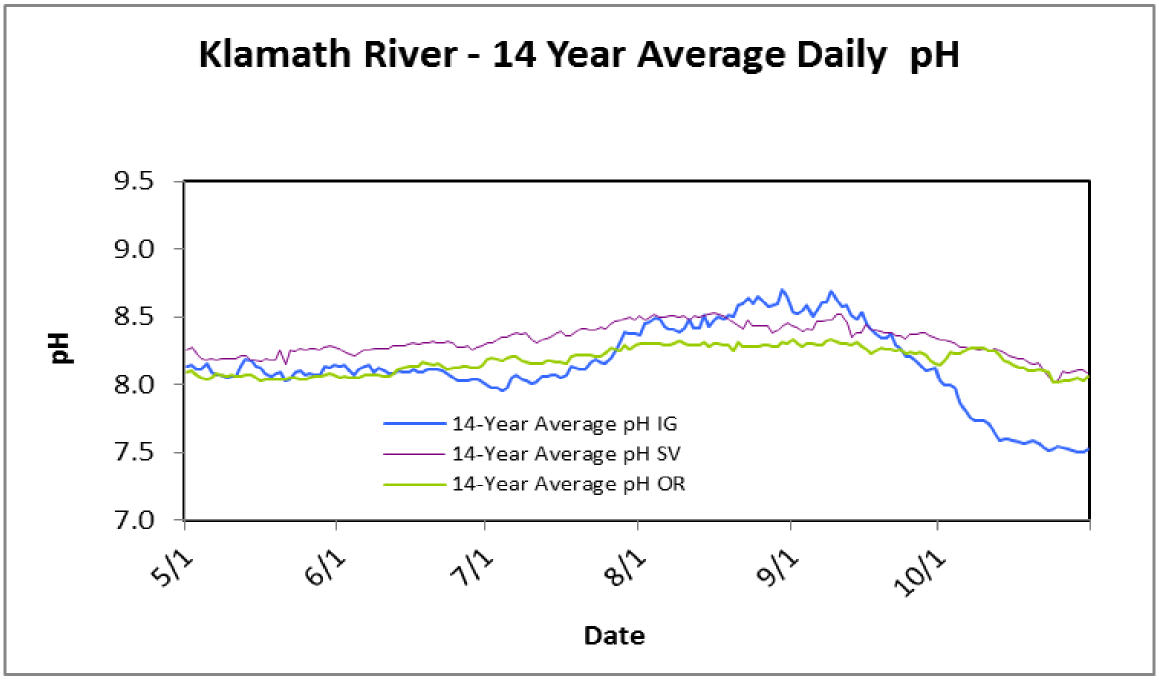

Figure 13. Daily average pH, 2006-2019 at main stem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR).

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 similar seasonal water quality trends.

Temperature:

The Shasta River usually 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 is fed by a mix of groundwater and snow-melt; and the Salmon, which is a snow-melt dominated system (Figure 14).

In 2019, all monitored tributaries depict the highest daily average temperatures during early August, followed by a drop in temperature (Figure 14). These water temperatures correlate with high ambient air temperatures in early August. The Scott and Salmon Rivers had lower overall temperatures than the previous 5 years which were predominately drought years (Figures 16 – 17).

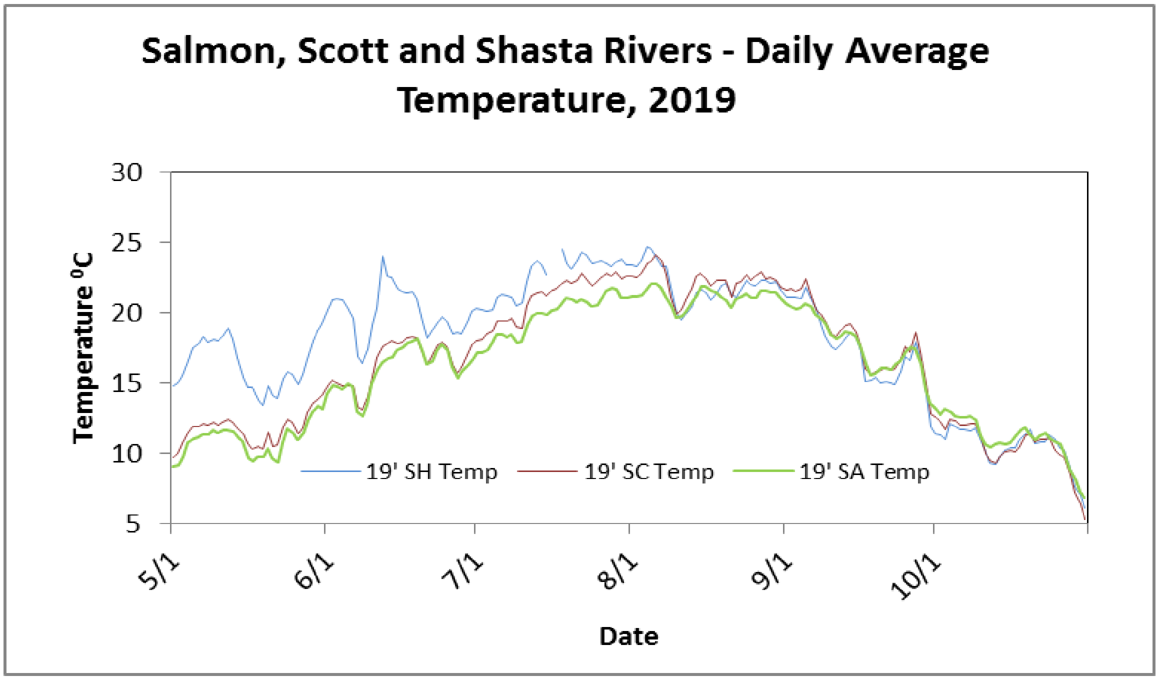

Figure 14. Daily average water temperature for Scott, Shasta, and Salmon Rivers, 2019.

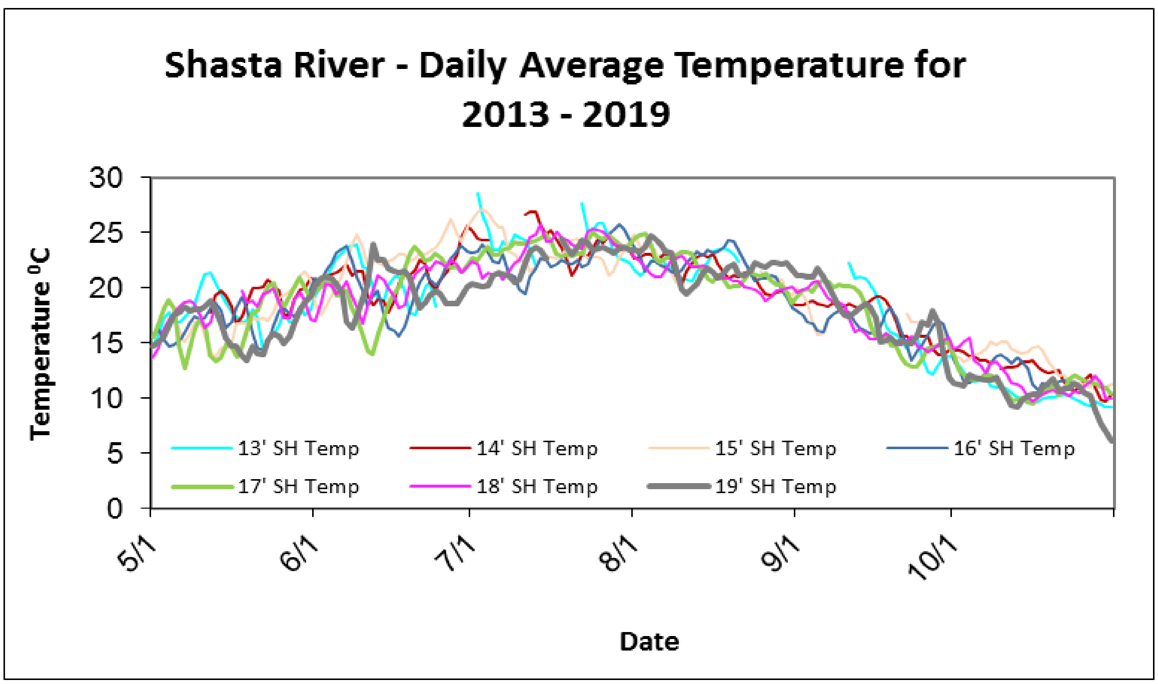

Figure 15. Daily average water temperatures for the Shasta River from 2013-2019.

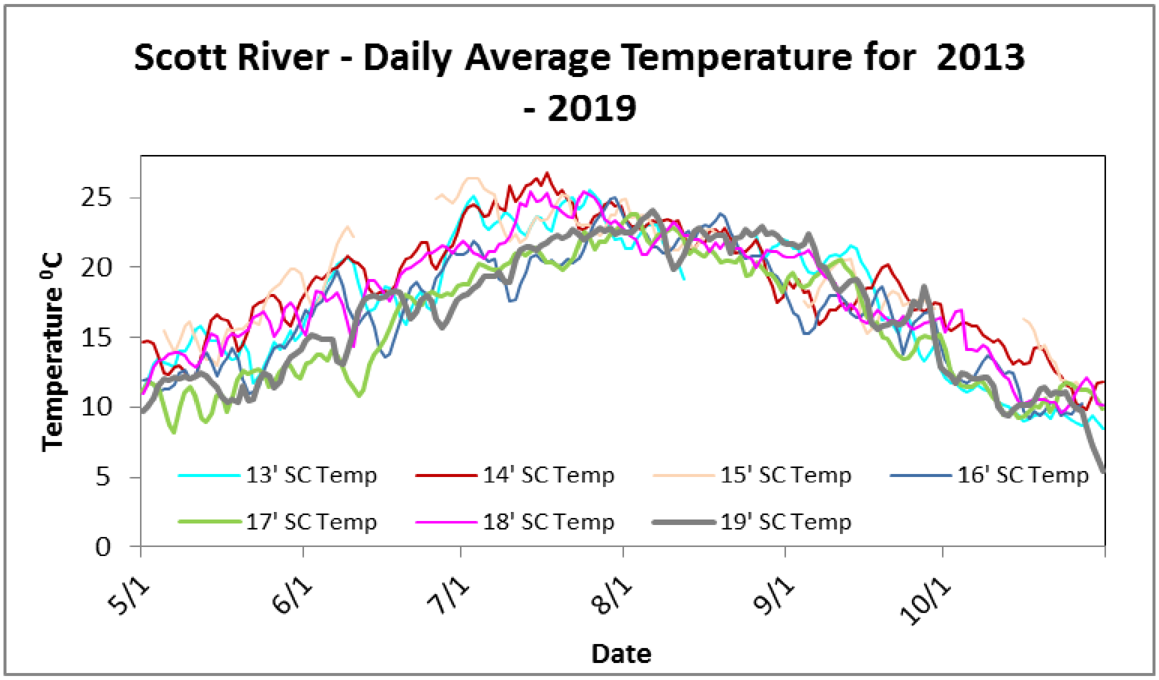

Figure 16. Daily average water temperatures for the Scott River from 2013-2019.

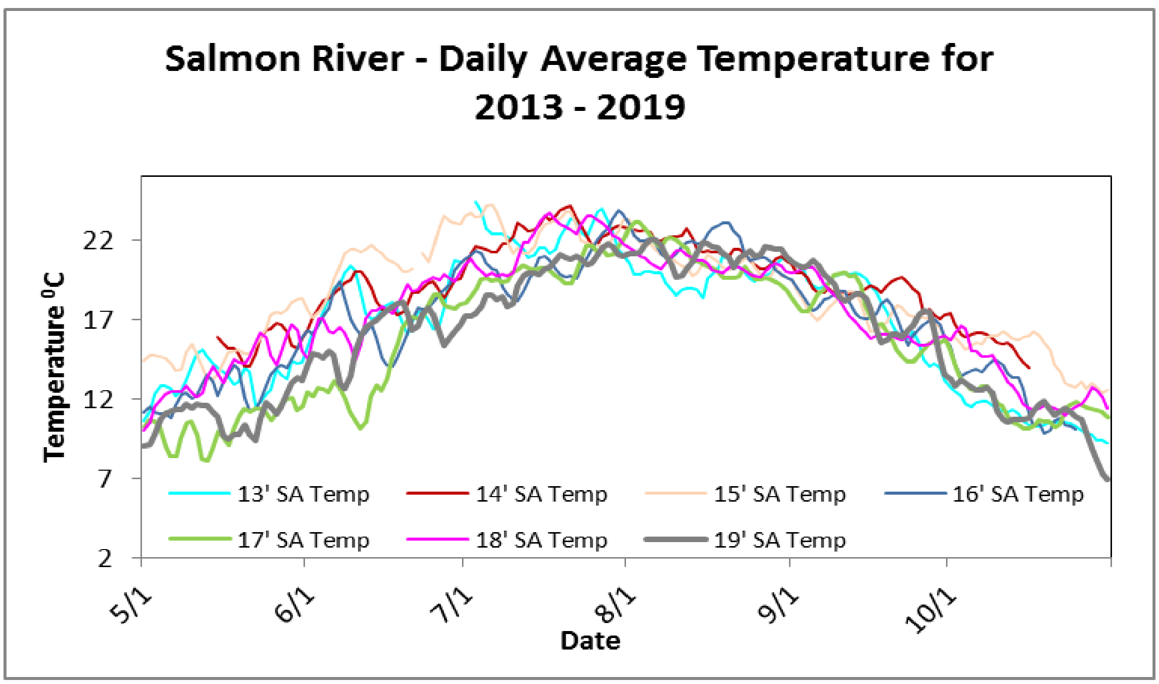

Figure 17. Daily average water temperatures for the Salmon River from 2013-2019.

Dissolved Oxygen:

The lowest DO levels occurred in July this corresponds with highest temperatures and is the general trend at all tributary sites from 2013-2019 (Figures 18 -24). 2019 showed an improvement in DO levels, most notably at Salmon and Scott, over the previous drought dominated years.

The NCRWQCB Basin Plan establishes water quality objectives for each tributary based on instantaneous readings. The Scott River had a few daily minimums below the water quality objective of (x>7 mg/L) July and August (Figure 22). The Shasta daily minimums dropped in July and were below the DO threshold (x>7 mg/L) into early August (Figure 20). The Salmon River dropped below its threshold (x>9 mg/L) the longest, July into September (Figure 24).

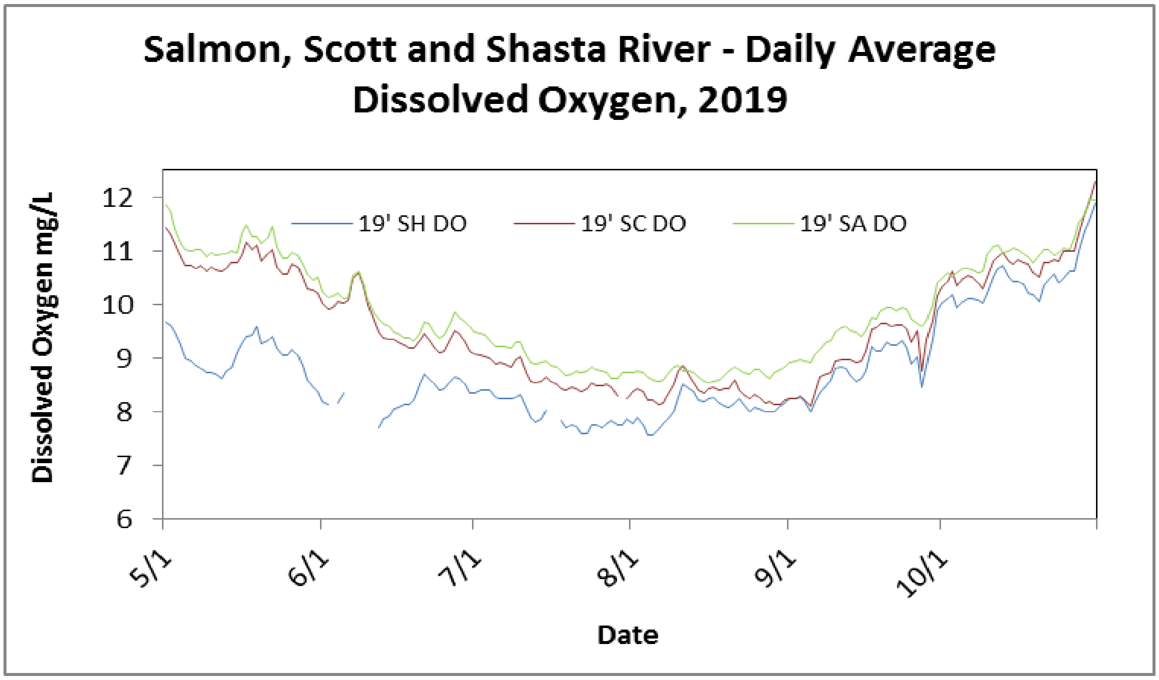

Figure 18. Daily average dissolved oxygen for Salmon, Scott and Shasta River, 2019.

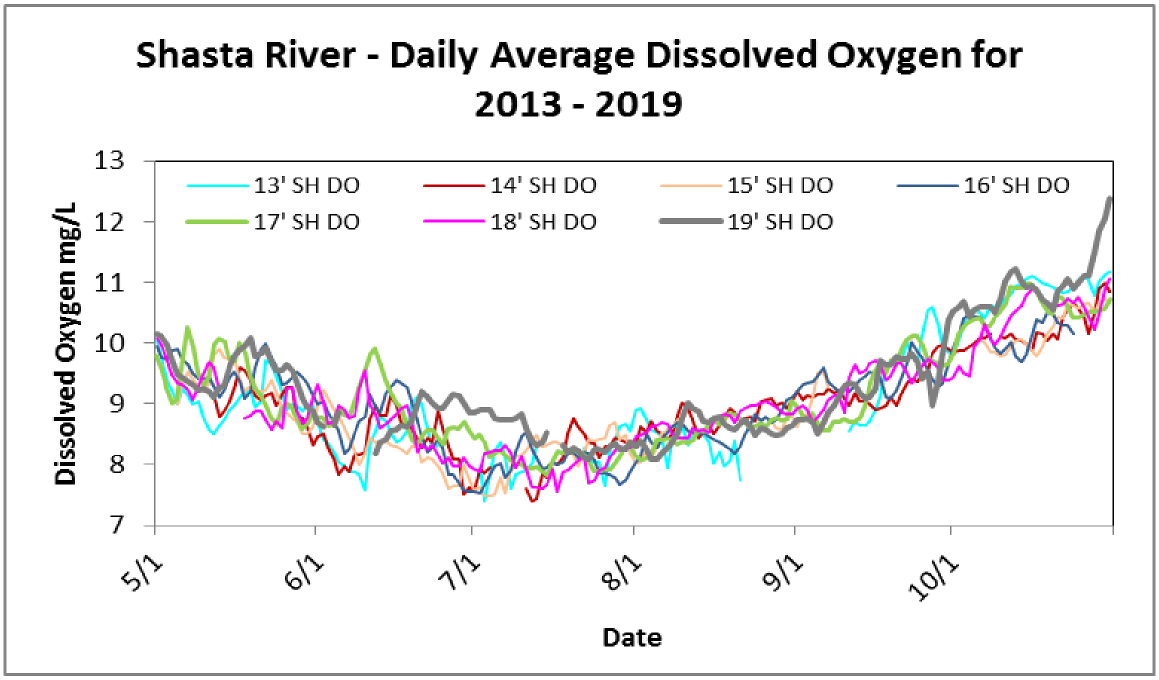

Figure 19. Daily average dissolved oxygen concentrations for the Shasta River from 2013-2019.

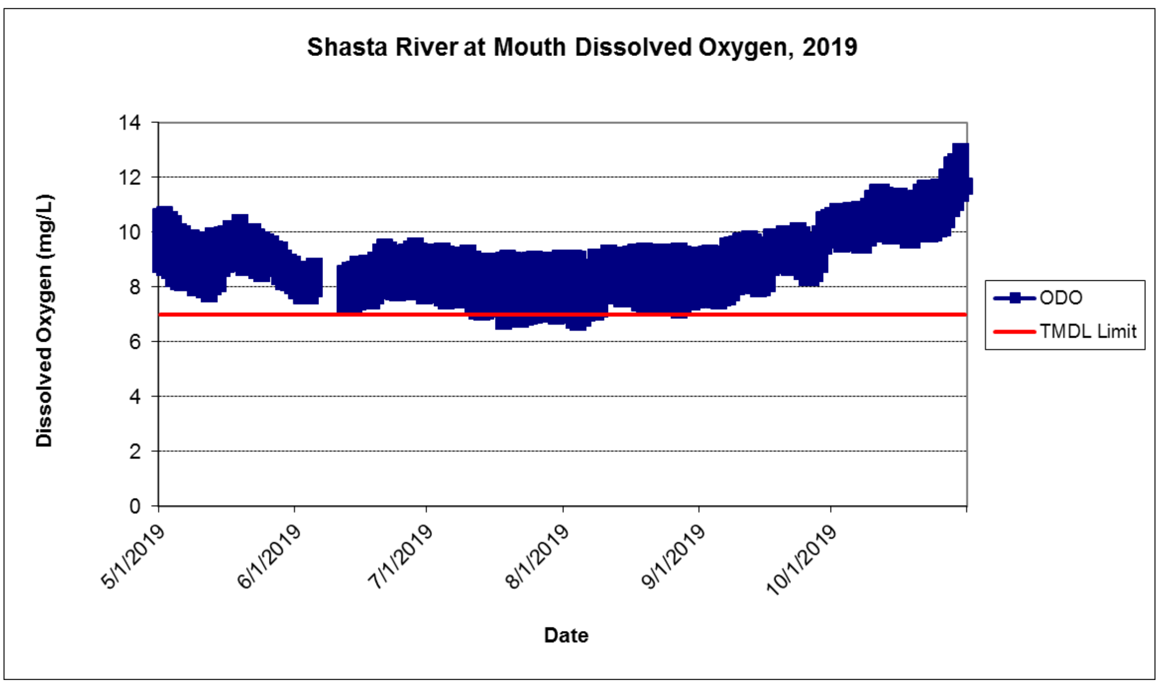

Figure 20. Instantaneous dissolved oxygen recorded every 30-minutes for the mouth of the Shasta River (SH) in 2019. The red line indicates the NCRWQCB Basin Plan site specific dissolved oxygen water quality objective for Shasta River, >7mg/L.

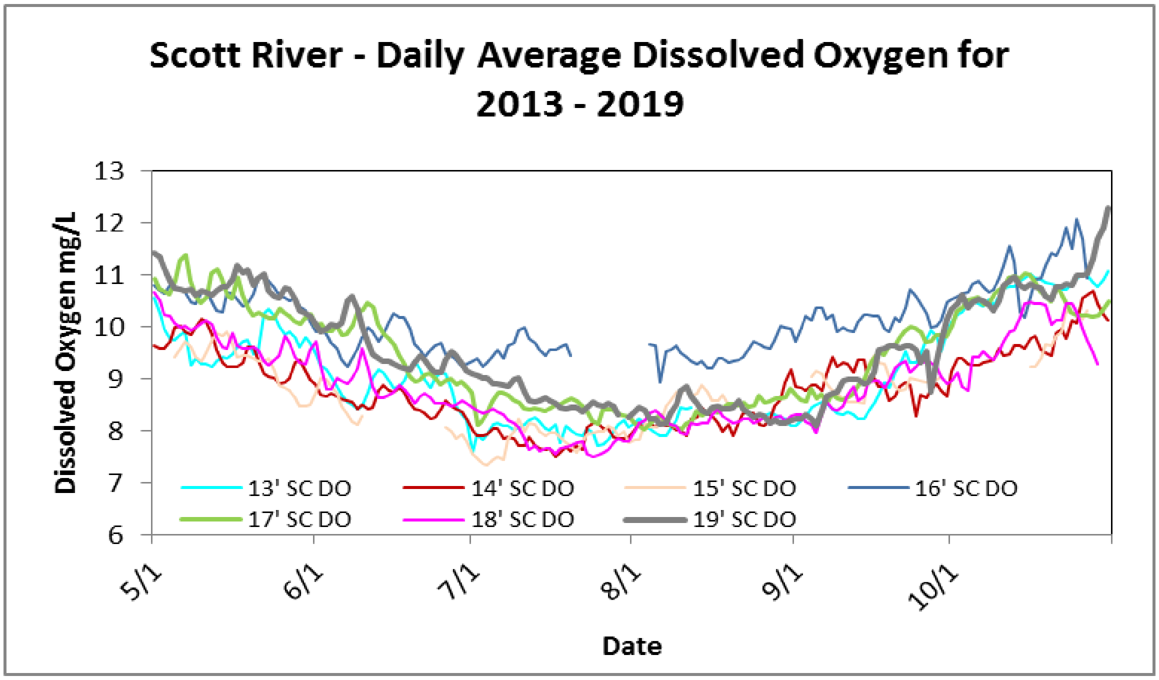

Figure 21. Daily average dissolved oxygen concentrations for the Scott River from 2013-2019.

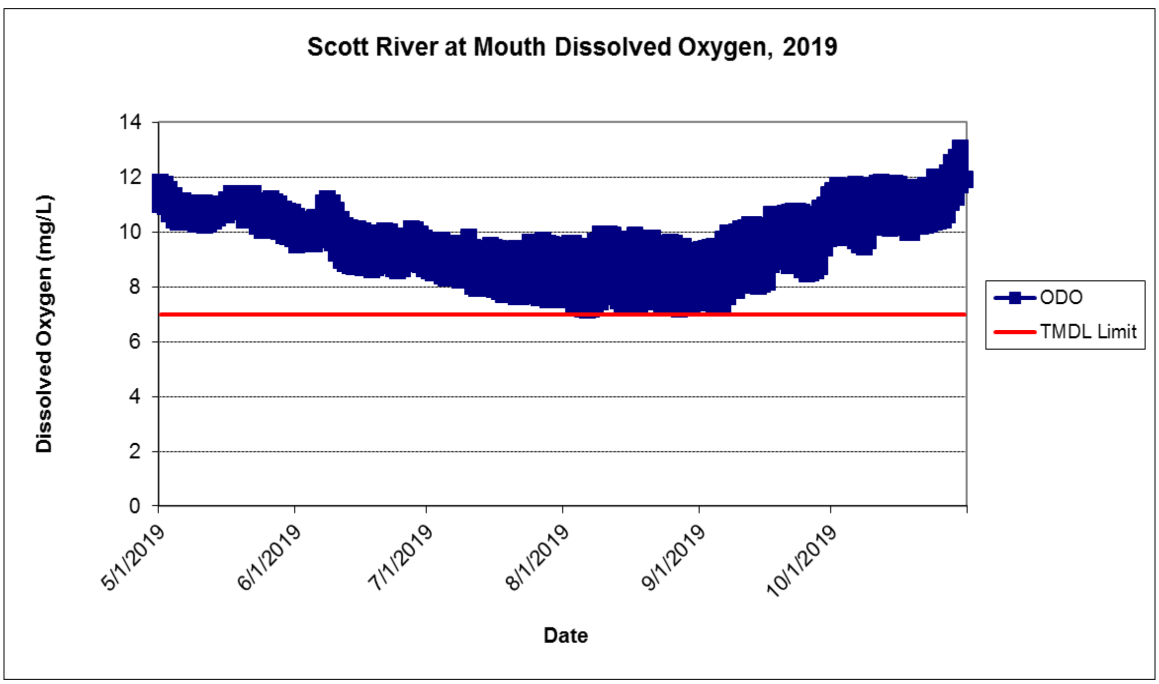

Figure 22. Instantaneous dissolved oxygen readings recorded every 30-minutes for the mouth of the Scott River (SC) in 2019. The red line indicates the NCRWQCB Basin Plan site specific dissolved oxygen water quality objective for Scott River, >7mg/L.

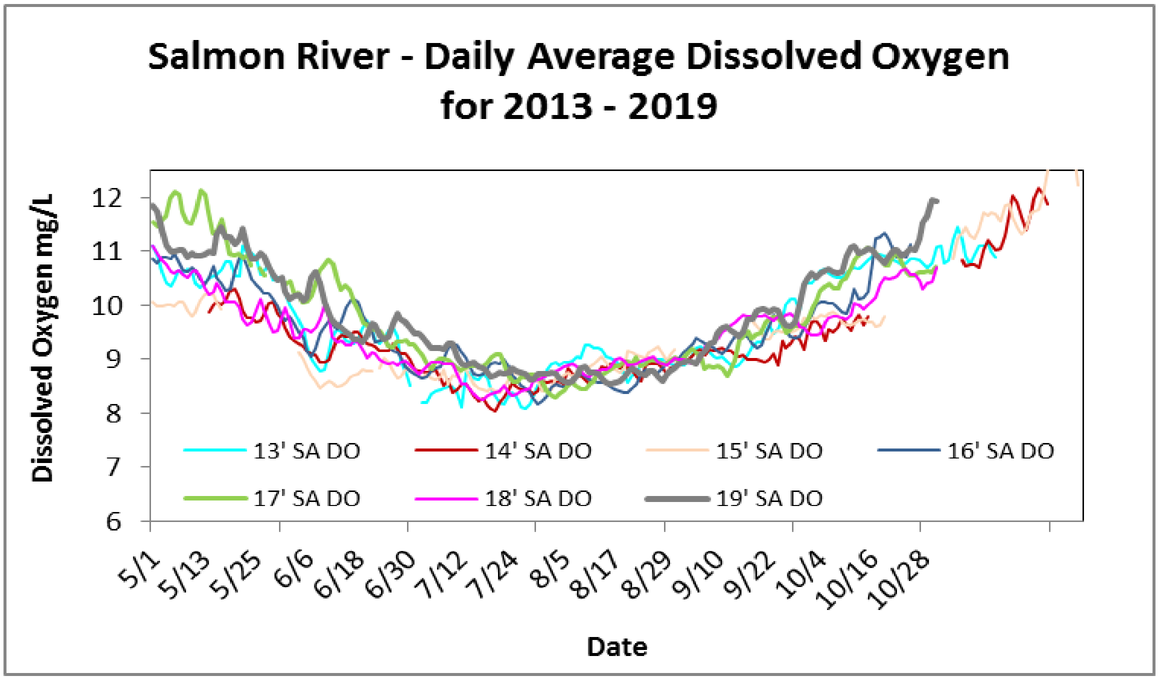

Figure 23. Daily average dissolved oxygen concentrations for the Salmon River from 2013-2019.

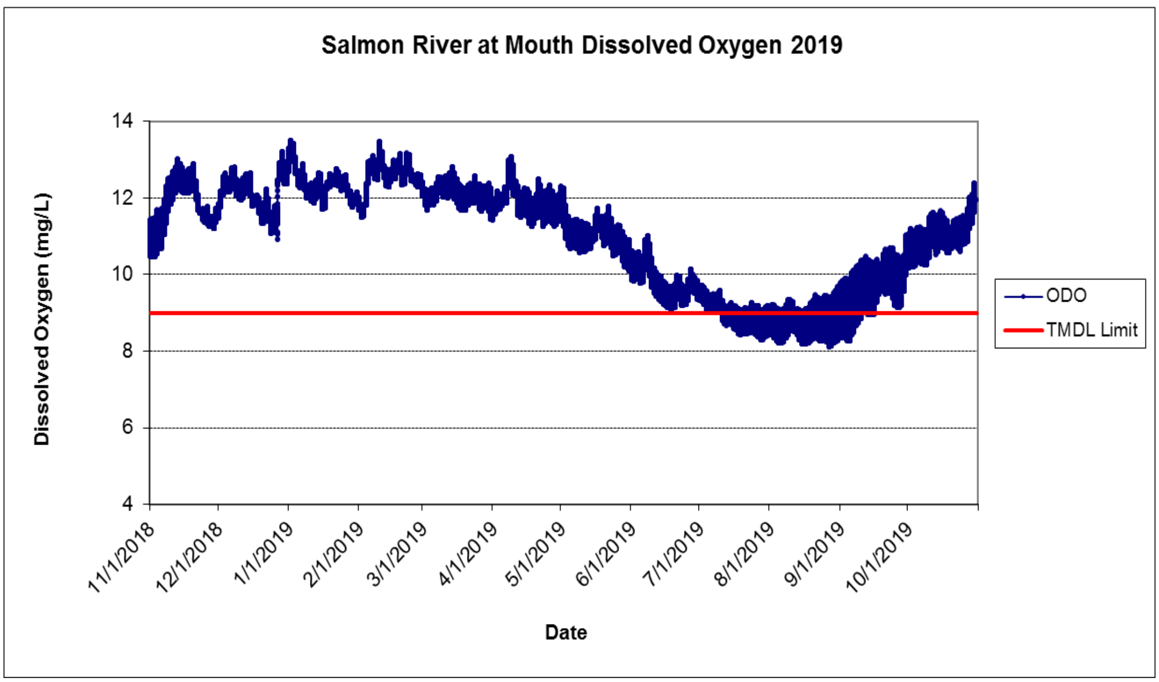

Figure 24: Instantaneous dissolved oxygen readings recorded every 30 minutes for the mouth of the Salmon River (SA) in 2019. The red line indicates the NCRWQCB Basin Plan site specific dissolved oxygen water quality objective for Salmon River, >9mg/L.

pH:
Daily average pH in 2019 varied between tributary sites (Figure 25). We observed average pH values as compared to previous 5 years at all tributary sites (Figures 26, 28, 30).

All tributary sites exceeded the NCRWQCB Basin Plan water quality objective for pH during 2019 (Figures 27, 29, 31).

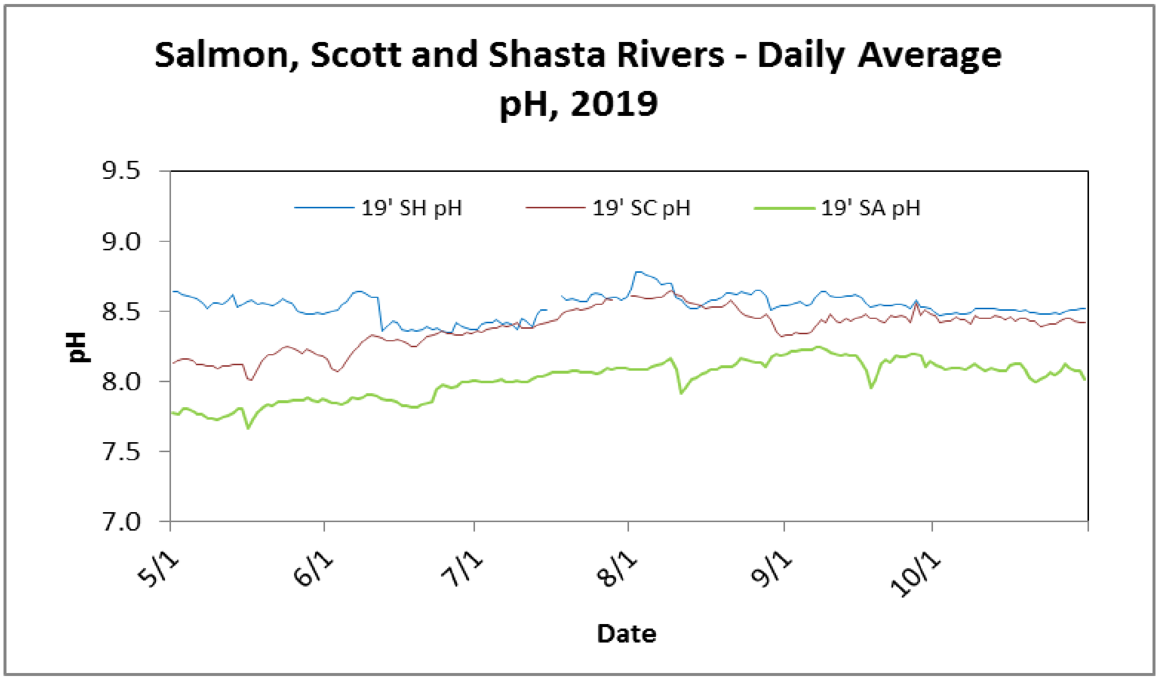

Figure 25. Daily average pH for Scott, Shasta, and Salmon Rivers, 2019.

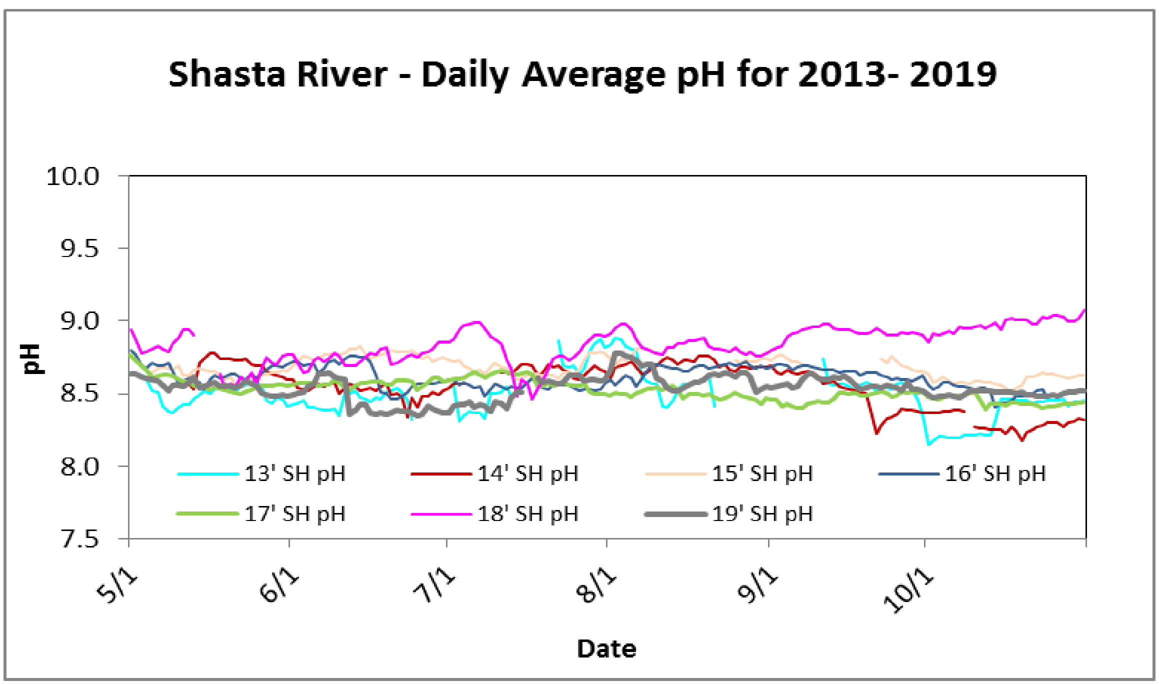

Figure 26. Daily average pH concentrations for the Shasta River from 2013-2019.

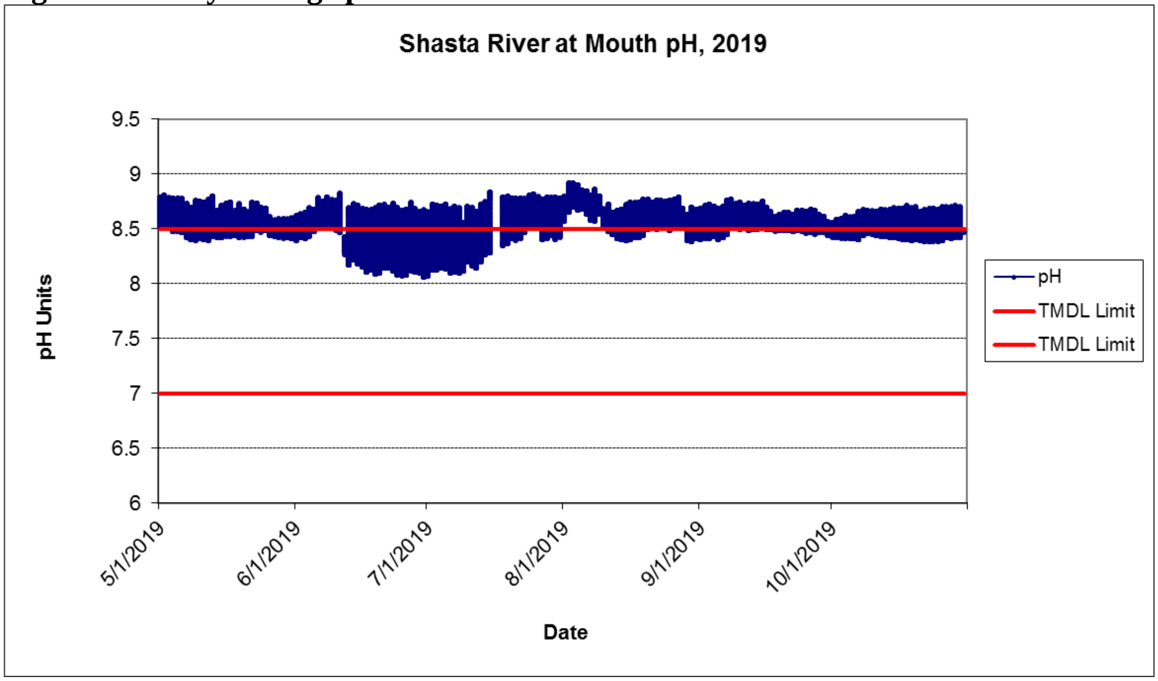

Figure 27. Instantaneous pH readings recorded every 30 minutes for the mouth of the Shasta River (SH) in 2019. The red line indicates the NCRWQCB Basin Plan pH water quality objective for Shasta River, 7< X > 8.5.

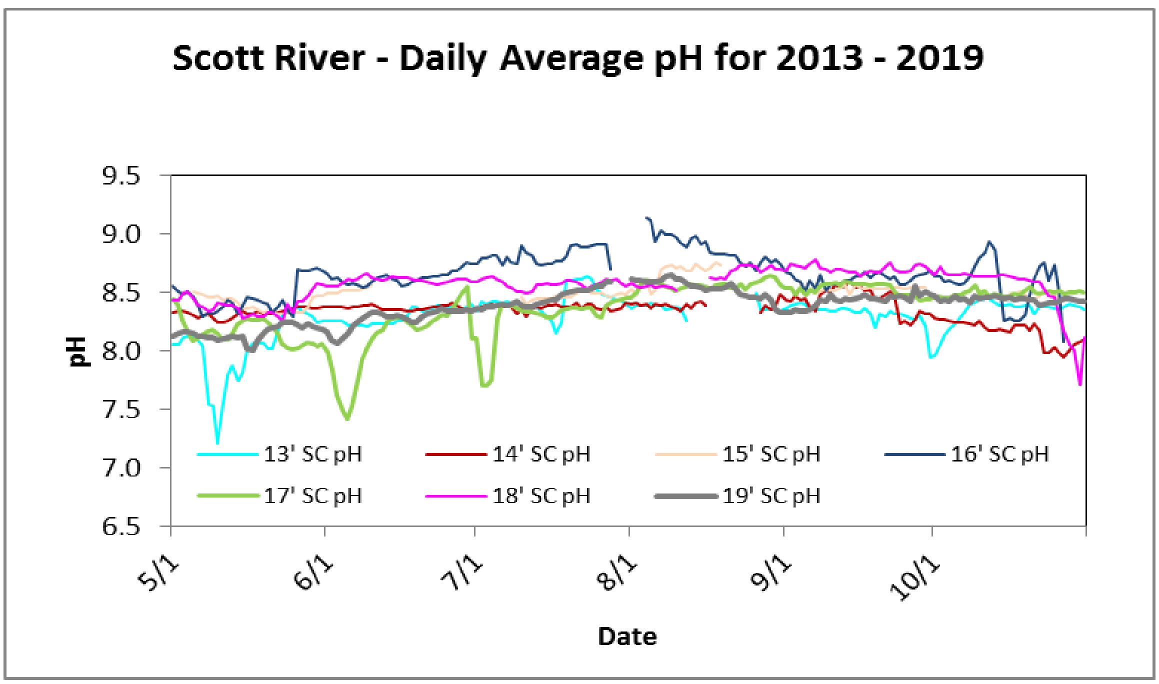

Figure 28. Daily average pH concentrations for the Scott River from 2013-2019.

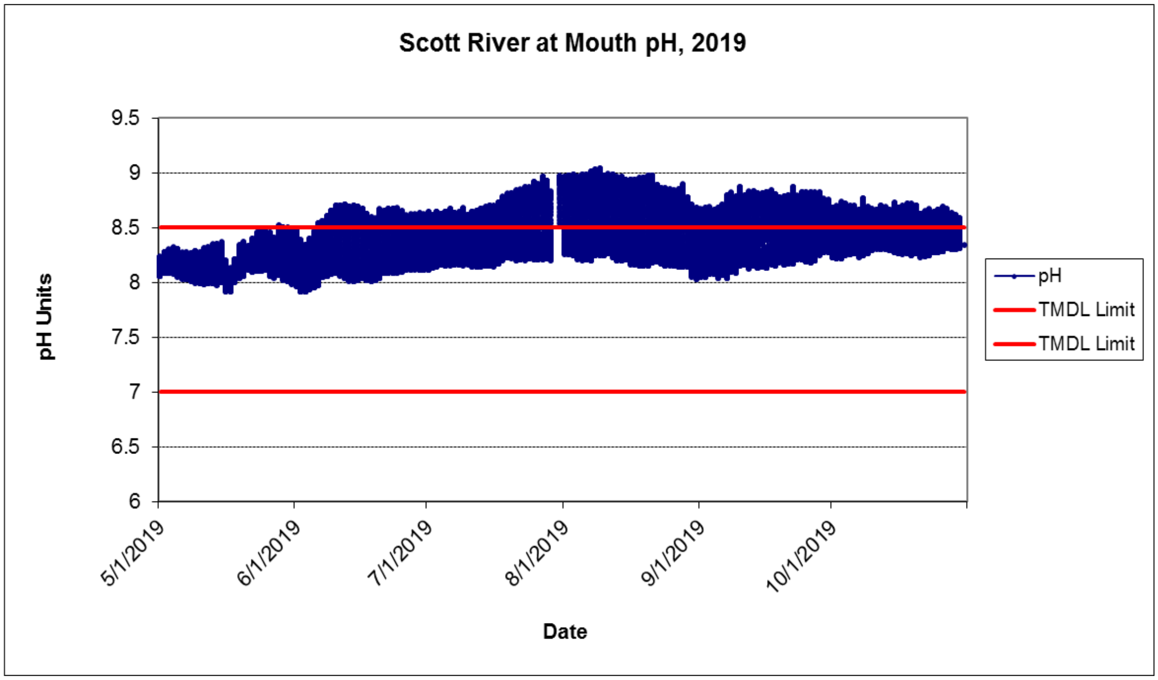

Figure 29. Instantaneous pH readings recorded every 30 minutes for the mouth of the Scott River (SC) in 2019. The red line indicates the NCRWQCB Basin Plan pH water quality objective for Scott River, 7< X > 8.5.

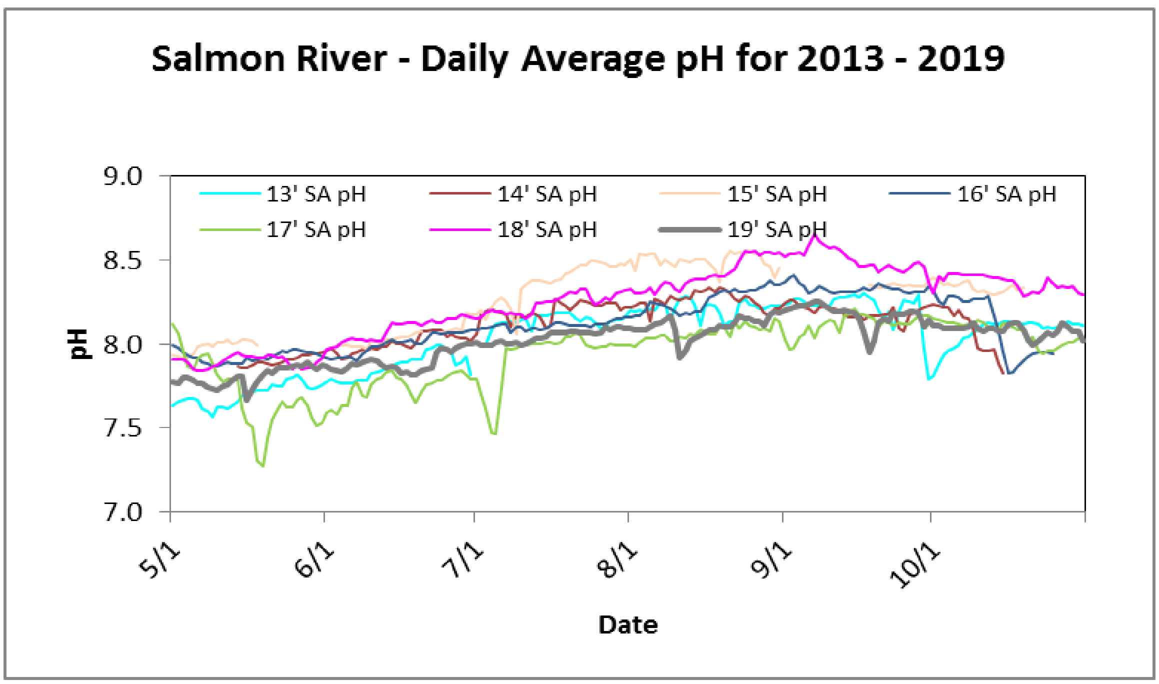

Figure 30. Daily average pH concentrations for the Salmon River from 2013-2019.

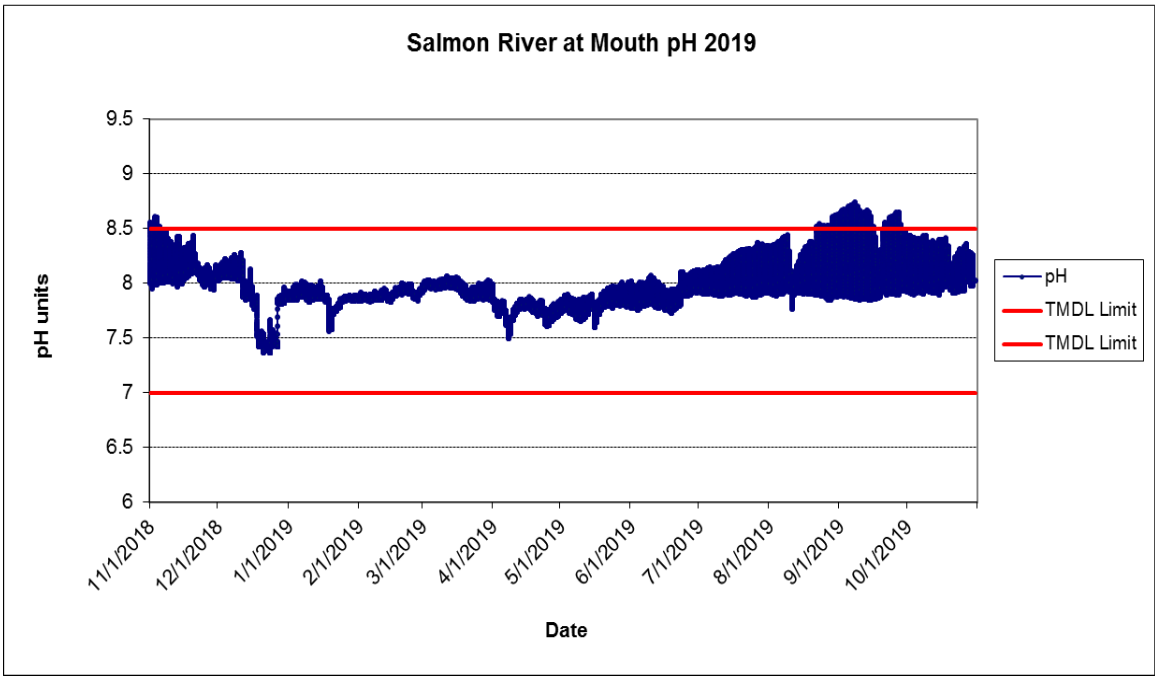

Figure 31. Instantaneous pH readings recorded every 30 minutes for the mouth of the Salmon River (SA) in 2019. The red line indicates the NCRWQCB Basin Plan pH water quality objective for Salmon River, 7< X > 8.5.

Turbidity:

Turbidity data gathered on the Salmon River during winter and spring of 2019 show a few small spikes throughout the winter and spring (Figure 32).

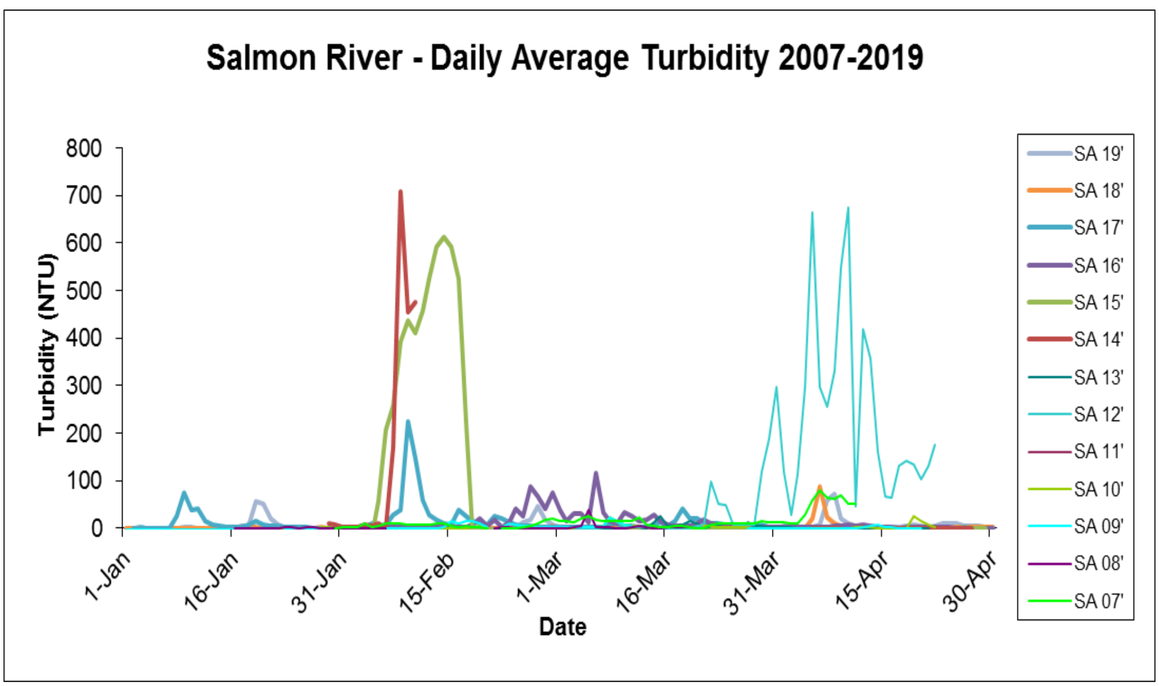

Figure 32. Daily average turbidity, winters of 2007 - 2019 on Salmon River (SA).

***Major Tributary Conclusions from Datasonde Data** 2019:* 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 stream flows dropped and air temperature became the dominant controlling factor. 2019 saw an improvement to water quality conditions as compared to previous drought years.

MAIN STEM AND TRIBUTARIES

Nutrients:

Nutrient samples were collected by the KTWQP in 2019 from the main stem Klamath and major tributaries.

Total phosphorus (TP) results for 2019 from the main stem Klamath and major tributaries depict Iron Gate (IG), Walker Bridge (WA) and Shasta River (SH) as the highest levels (Figure 33). TP levels decrease at all monitoring sites longitudinally downstream from IG. The 2008-2019 (Figure 35) data depict the same trend. The Shasta River had the highest TP concentration among all sites sampled from 2008-2019, Scott and Salmon Rivers the lowest (Figure 34).

Total nitrogen (TN) main stem concentrations were highest at the most upriver sites (IG and WA) (Figures 36 and 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.

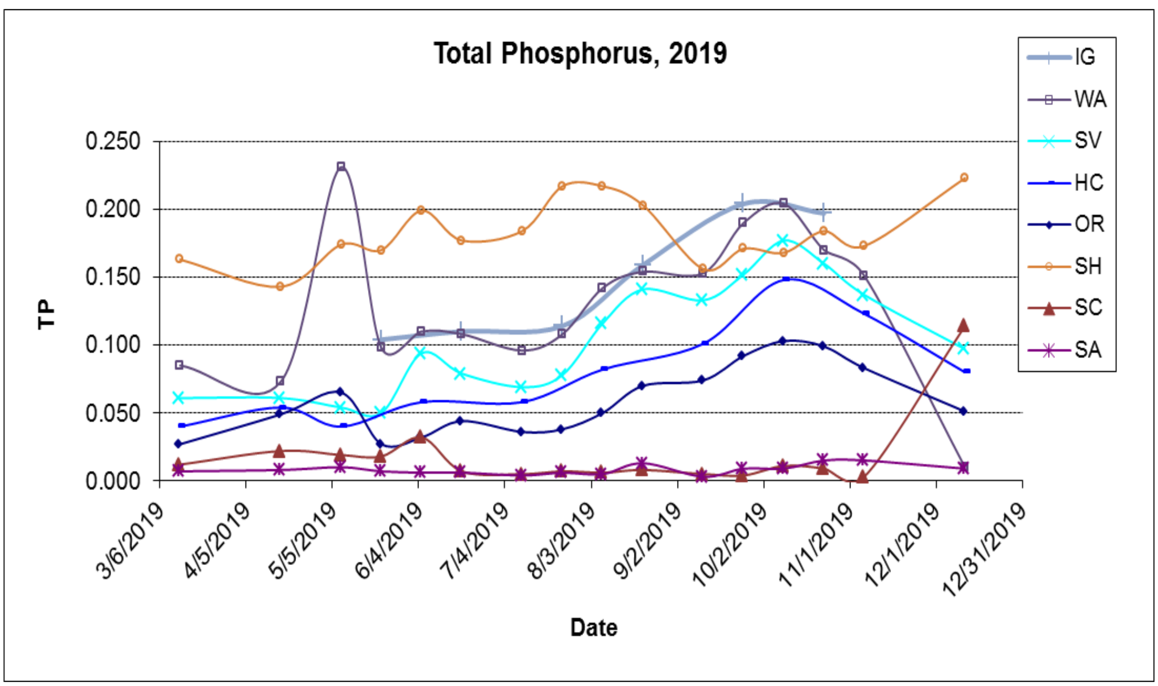

Figure 33. Total Phosphorus measured in mg/L for all monitored sites during 2019.

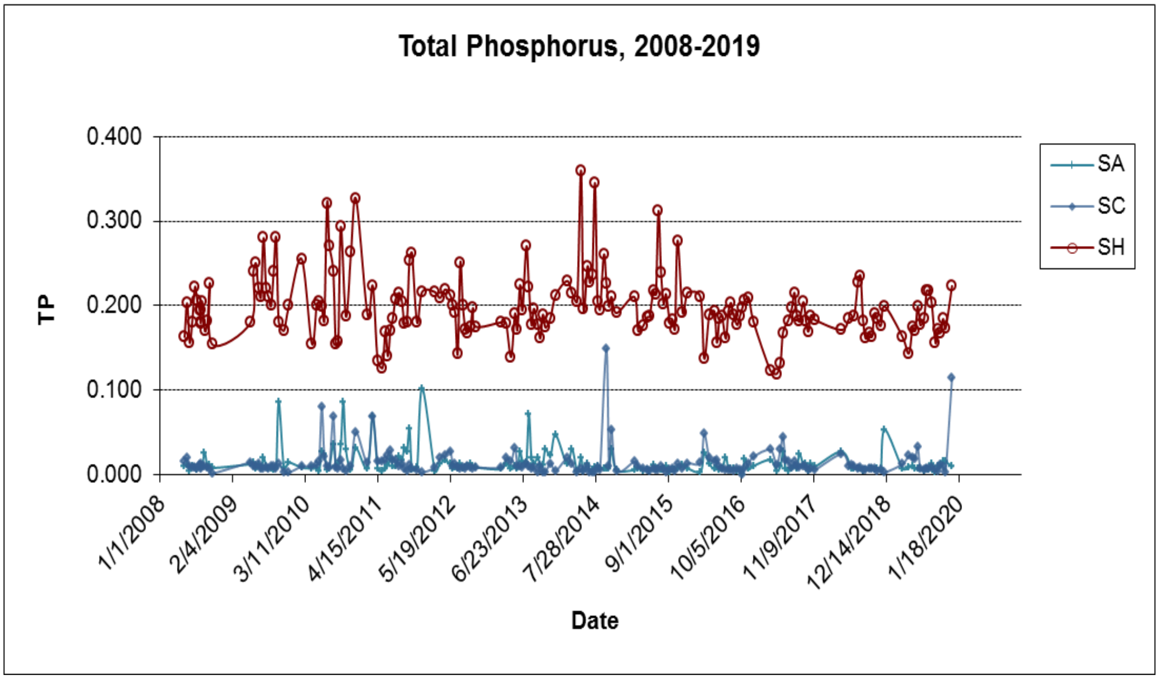

Figure 34. Total Phosphorus measured in mg/L for Salmon, Scott and Shasta Rivers sites during 2008-2019.

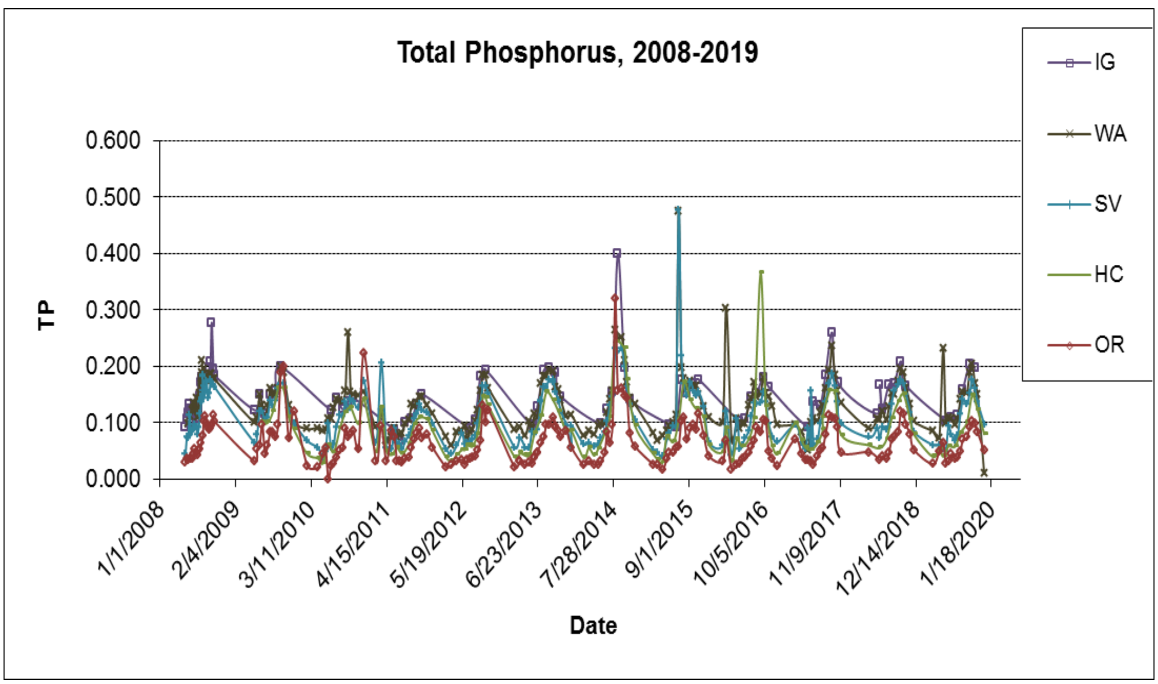

Figure 35. Total Phosphorus measured in mg/L for Klamath River sites during 2008-2019.

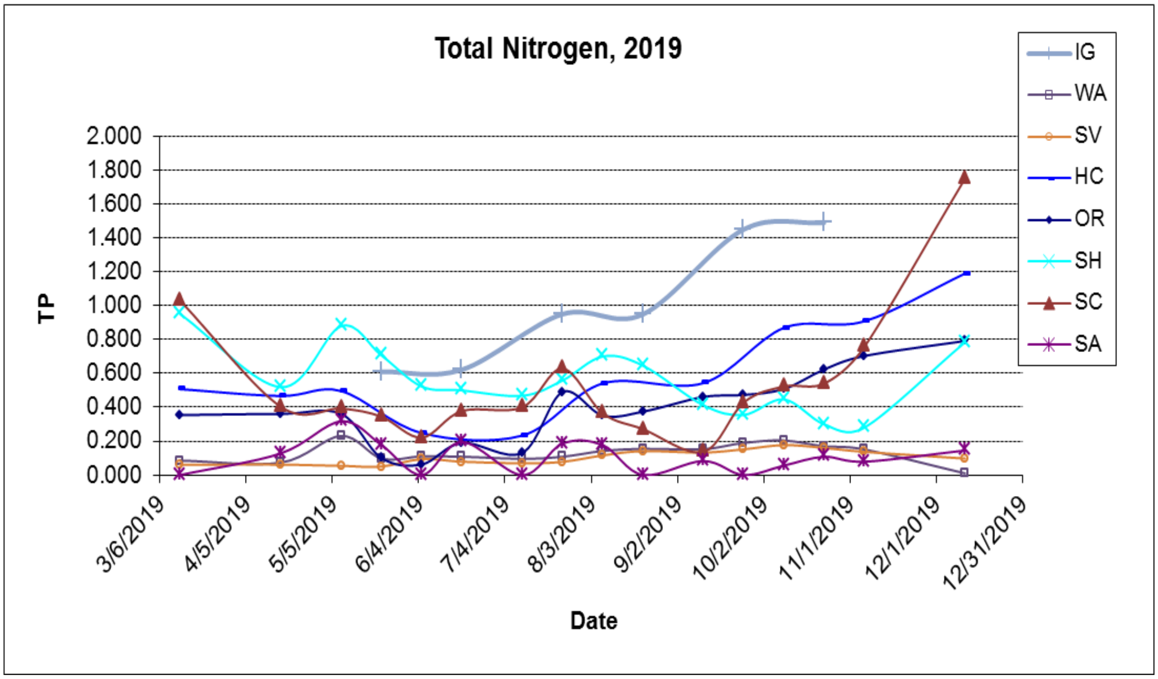

Figure 36. Total Nitrogen measured in mg/L for all monitored sites during 2019.

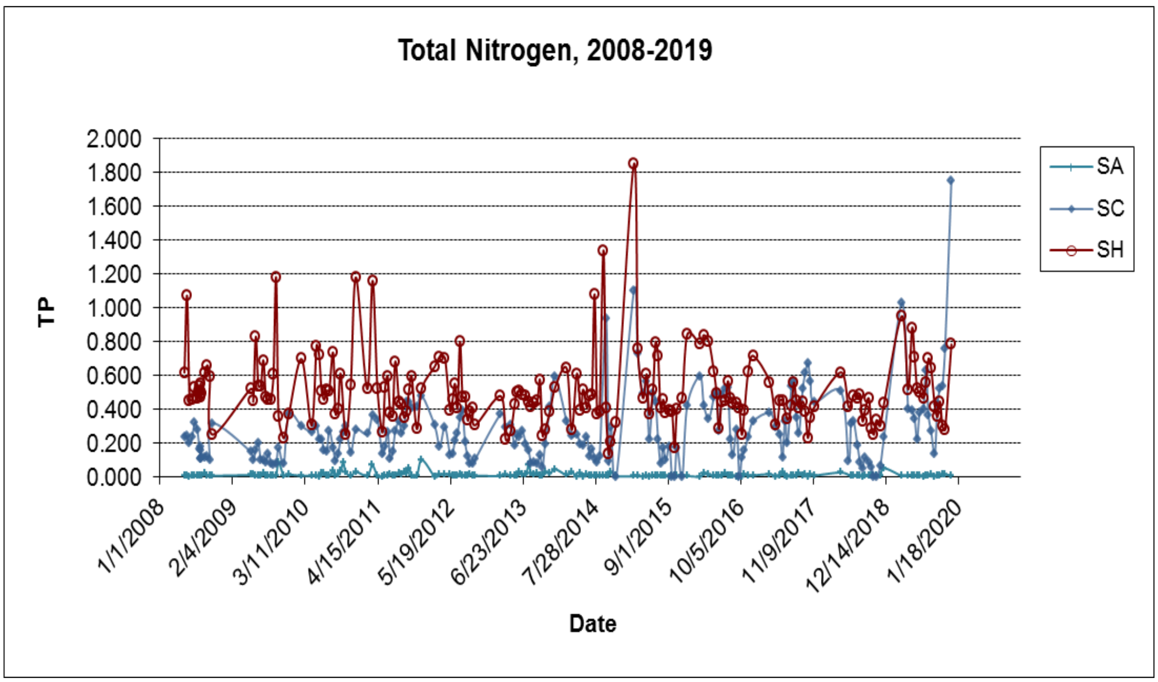

Figure 37. Total Nitrogen measured in mg/L for Salmon, Scott and Shasta Rivers during 2008-2019.

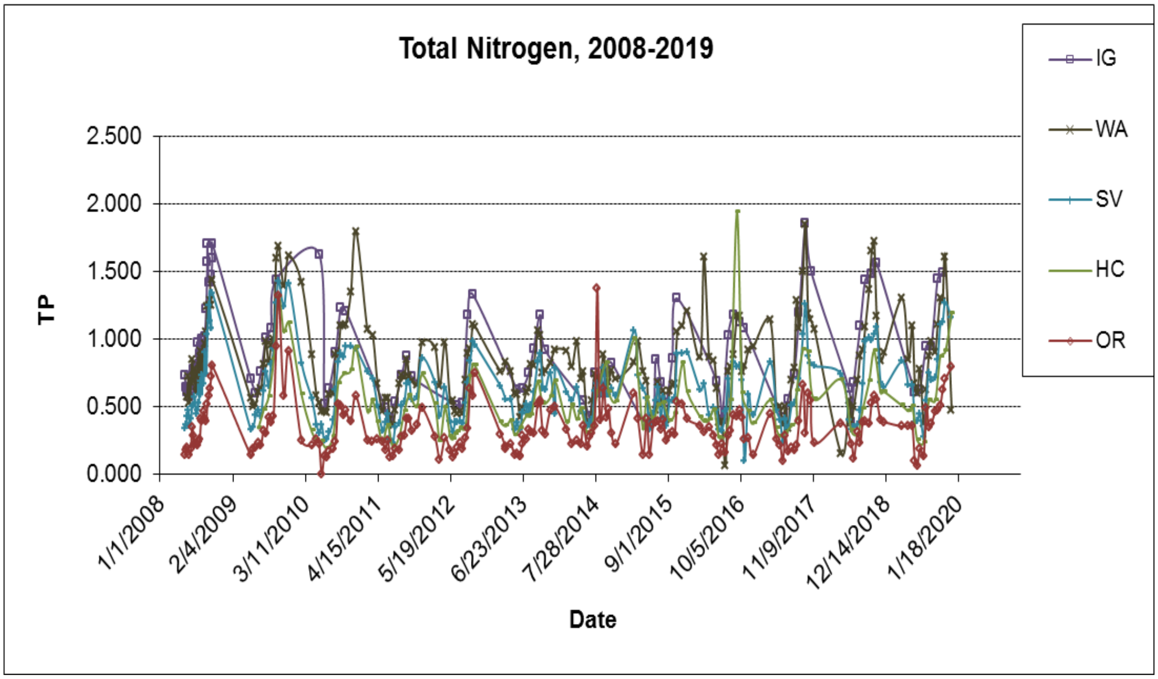

Figure 38. Total Nitrogen measured in mg/L for Klamath River during 2008-2019.

Main stem 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 sampling years.

7 References

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