KARUK TRIBE

DEPARTMENT OF NATURAL RESOURCES

P.O. Box 282 * Orleans, California 95556

2023

Annual Monitoring Report

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

Karuk Tribe

Annual Monitoring Report
2023

Prepared by
Karuk Tribe Water Quality Program
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<u>Technical Staff</u>

Grant Johnson – Water Quality Program Manager
John R. Oberholzer Dent – Natural Resources Biologist
Larry Alameda – Water Quality Technician III
Javon Mitchell – Water Quality Technician II
Manuel Mendes – Water Quality Technician I
Rex Harrison – Water Quality Technician I

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1 Background

The Karuk Tribe is the second largest Tribe in California, with over 3,700 Tribal members currently enrolled and over 4,900 descendants. 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, the Hoopa Tribe, Resighini Rancheria, Oregon State University, Stanford University, and PacifiCorp. The following tables summarize waters within the aboriginal 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 Karuk 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, 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, cannabis cultivation, 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, Shasta, Scott, and Salmon Rivers. KTWQP data were used in the development of the technical portion of the TMDLs. 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 occurred through 2023 to establish baseline water quality conditions before the dams are removed. Year-round monitoring for the removal itself began in 2023 and will continue through at least 2026.

The Karuk Tribe has established water quality standards for waters within Karuk Ancestral Territory. The details of these standards are outlined in the Karuk Tribe Water Quality Monitoring Plan (Karuk Tribe, 2002/2014).

3 Collaboration and Coordination

The KTWQP has found that the key to a successful water quality program in the Klamath region 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: the Yurok Tribe, the Klamath Tribes, the Hoopa Tribe, Quartz Valley Indian Reservation, 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 (USFS), USGS, 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 Karuk Ancestral Territory. These stations form a longitudinal profile of water quality conditions along the mid-Klamath River and associated major tributaries.

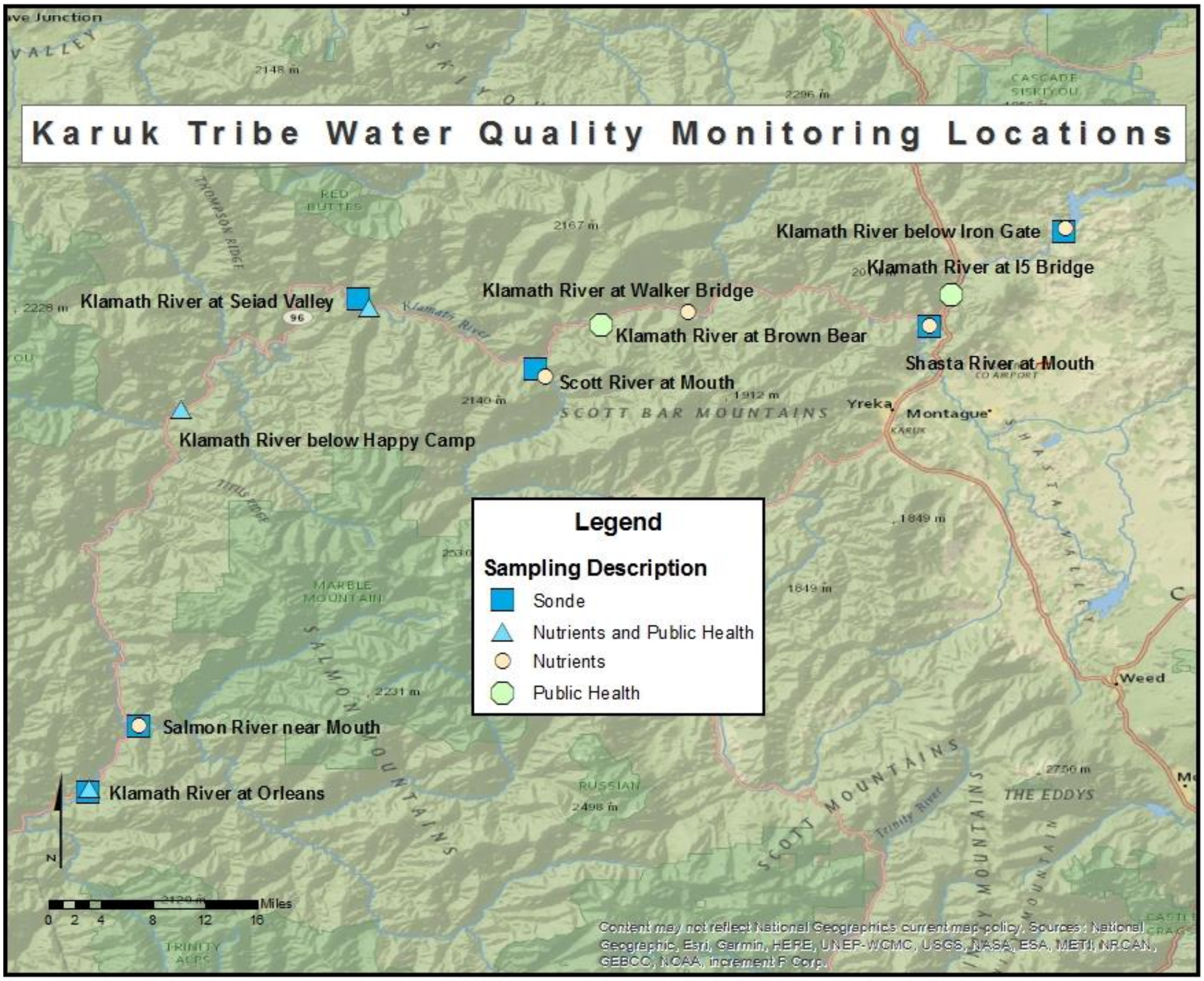

Figure 1 Overview of the Karuk Tribe's water quality monitoring locations along the Klamath River in 2023

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 winters of 2007-2023, turbidity monitoring occurred at the Salmon River and main stem sites. Iron Gate winter monitoring evaluates turnover in Iron Gate reservoir and influence 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 is focused 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, in 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.

Locations and Parameters Monitored in 2023							
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

Locations and Parameters Monitored in 2023							
Site ID	**Latitude**	**Longitude**	**Nutrient Suite**	**Sonde**	**Public Health**	**Winter Turbidity**	**Location**
WA	N 41 50.242	W 122 51.895	X	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 Reports (formerly Water Quality Assessment Reports), the Mid-Klamath River Nutrient, Periphyton, Phytoplankton and Algal Toxin Sampling Analysis Plan, and the Karuk Tribe Quality Assurance Protocols and Procedures document (QAPP) (Karuk Tribe, 2000-2002, 2006-2022; Karuk Tribe, 2009; Karuk Tribe, 2018).

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 are 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, R, and the AI 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), 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 2023 Water Quality Results

6.1 Main Stem Klamath

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

6.1.1 Main Stem Temperature

Monitoring locations at Seiad Valley (SV) and Orleans (OR) have similar thermographs when comparing daily averages in 2023 (Figure 2). The site below Iron Gate dam (IG), however, is elevated in spring and depressed in July and August comparatively (Figure 2). These trends are reinforced by comparing the aggregated 15-year aggregated daily averages 2009-2023 (Figure 3). Water released from the Iron Gate reservoir has a moderating effect on temperature, reducing summer highs and raising winter lows as compared to historic conditions and upstream un-impounded tributary contributions. Furthermore, the effect of the Iron Gate “curtain” can be seen from early June to early July when the sites diverge as water was drawn from the lower depths of the reservoir (Figures 2 and 3).

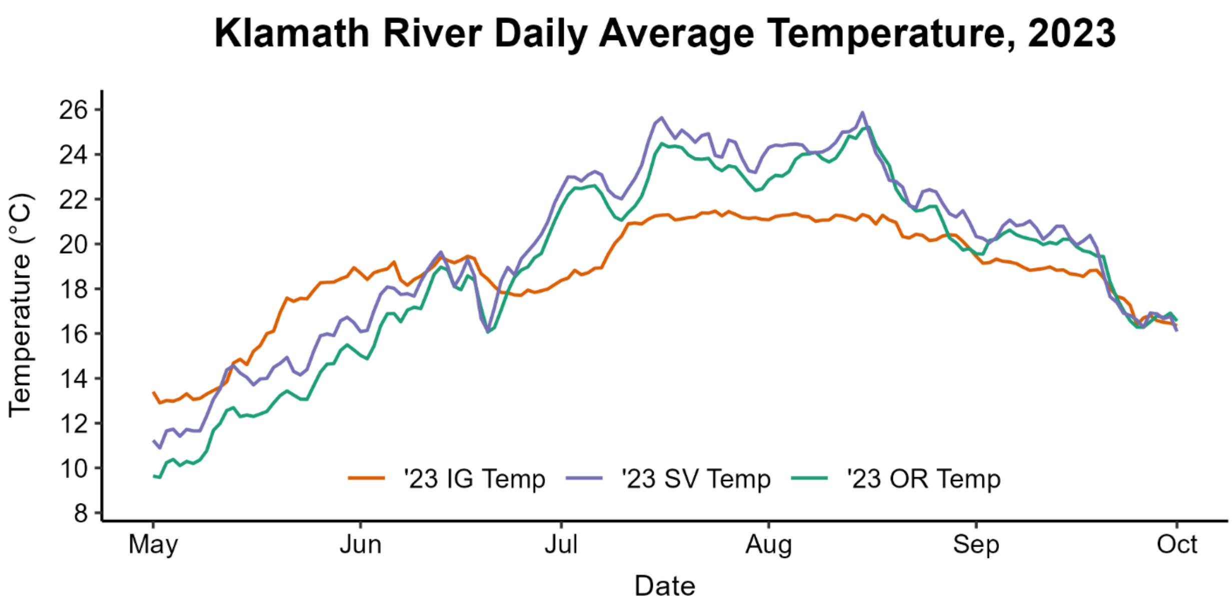

Figure 2 Daily average water temperatures in 2023 at three main stem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR)

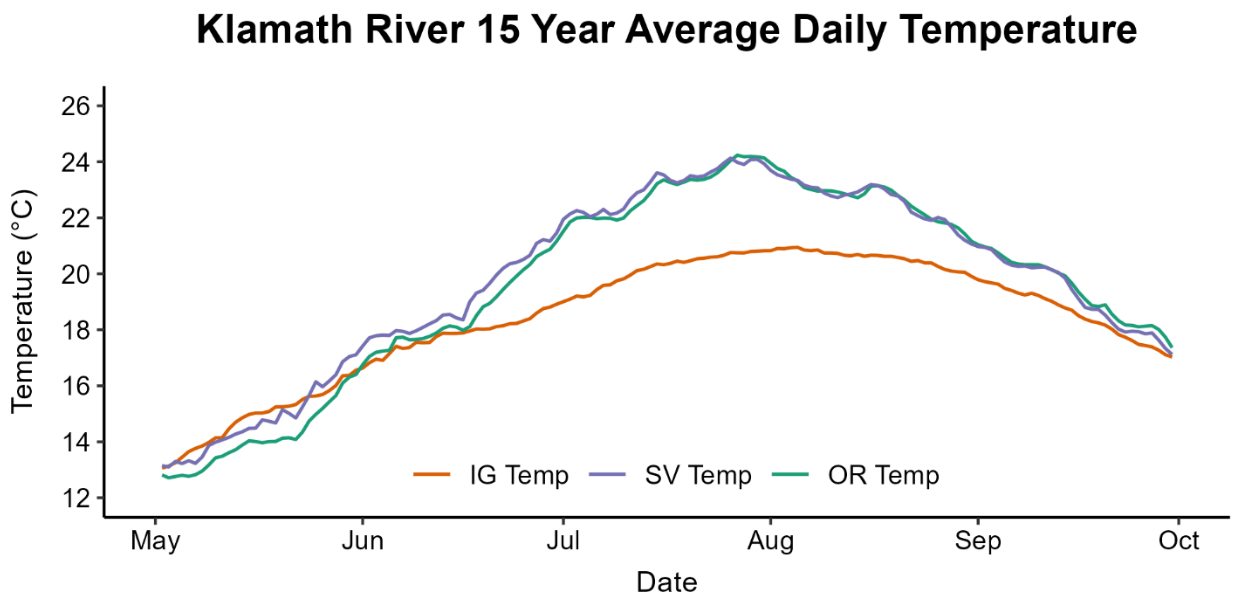

Figure 3 Aggregated daily average water temperatures from 2009-2023 at main stem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR)

6.1.2 Main Stem Dissolved Oxygen

Iron Gate dam impairs dissolved oxygen levels from mid-July through February, dropping while downstream sites rise (Figures 4-7). This timing overlaps with fall-run salmonid migration and impairs beneficial use. This is also true when comparing to the 15-year historical record; spring levels are also lower than downstream sites. The Orleans and Seiad Valley sites have similar profiles and conform with their historical averages (Figure 8). Evidence of a Salmon River turbidity event can be seen in the dissolved oxygen drop at Orleans in mid June (Figures 4 and 5). Extreme drops in dissolved oxygen occurred at Seiad Valley in late August due to debris flows in burn scars that clogged the river with ash and debris (Figures 4 and 6). Dissolved oxygen levels at the three sites converge during the summer when water temperatures are highest (Figures 3 and 8). Again, the impact of the curtain can be seen in depressed dissolved oxygen levels in early June when it is deployed and water released from the dam comes from deeper, anoxic reservoir waters (Figures 4 and 7). The most impaired site according to the North Coast Regional Water Quality Control Board (NCRWQCB) is Iron Gate, followed by Seiad Valley and then Orleans (Figures 5-7). This demonstrates the dam's negative influence on dissolved oxygen, which is mitigated by distance and other inputs downstream.

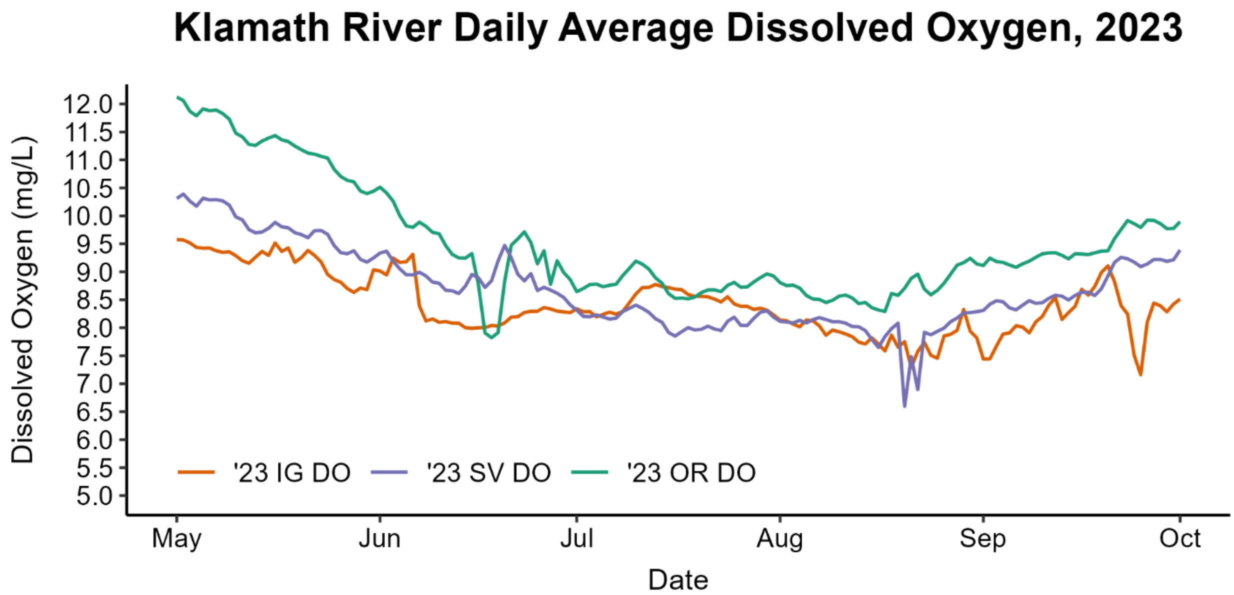

Figure 4 Daily average dissolved oxygen levels in 2023 at mainstem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR)

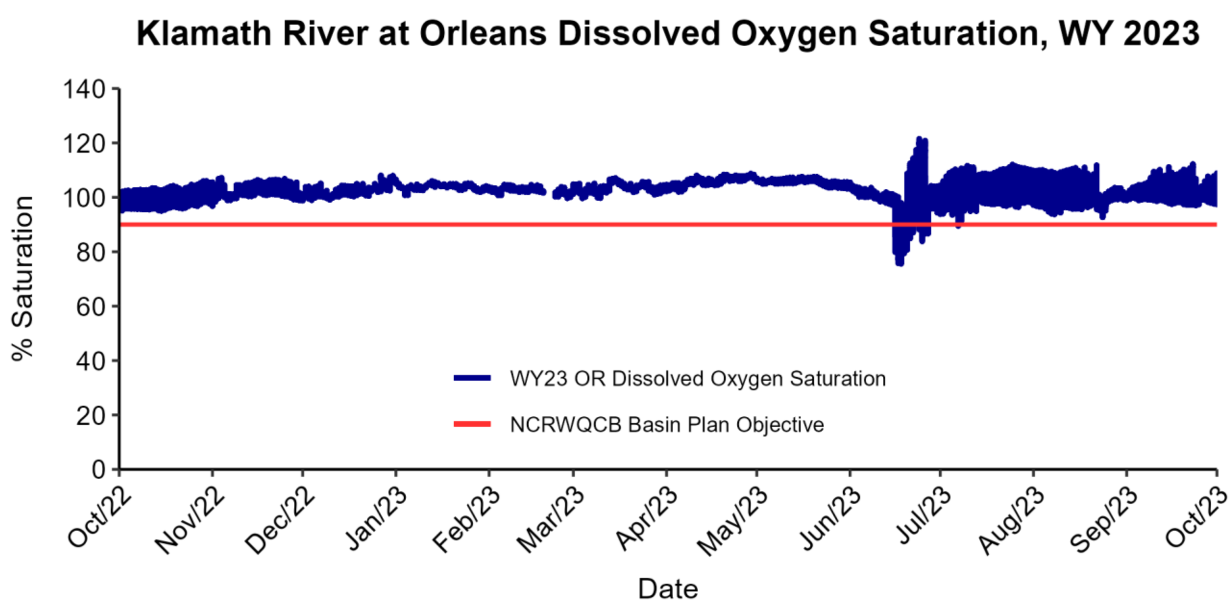

Figure 5 Dissolved oxygen saturation readings recorded instantaneously every 15 minutes in 2023 at the Klamath River at Orleans (OR) and the NCRWQCB Basin Plan Klamath River site-specific dissolved oxygen water quality objective: > 90% saturation year-round from the Scott River confluence to Hoopa

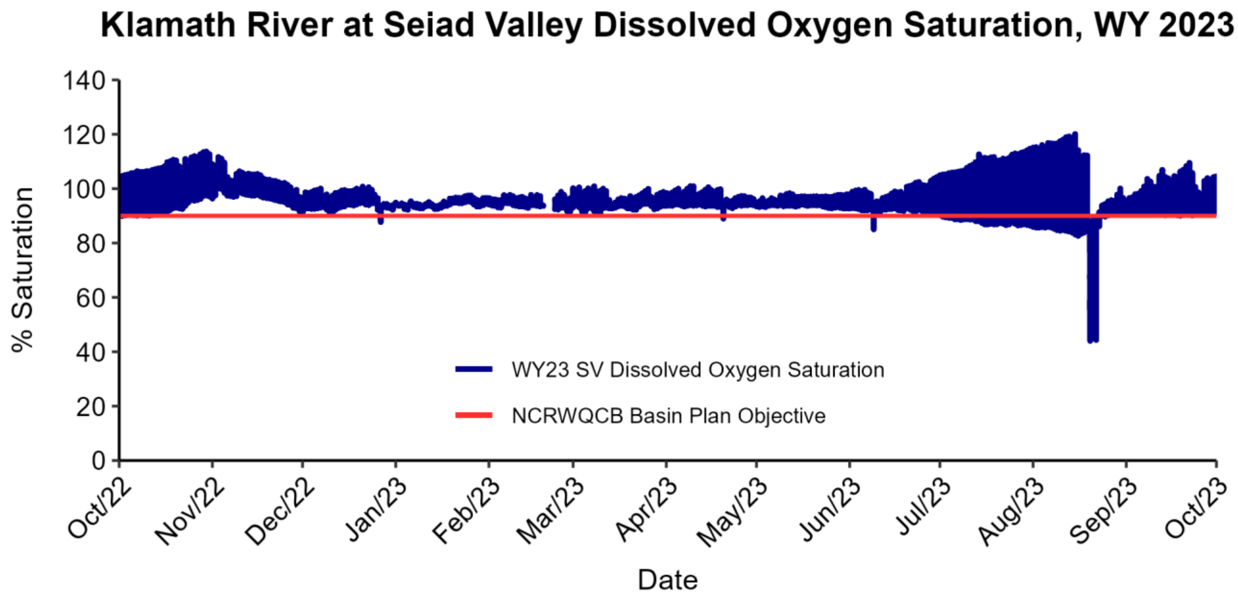

Figure 6 Dissolved oxygen saturation readings recorded instantaneously every 15 minutes in 2023 at the Klamath River at Seiad Valley (SV) and the NCRWQCB Basin Plan Klamath River site-specific dissolved oxygen water quality objective: > 90% saturation year-round from the Scott River confluence to Hoopa

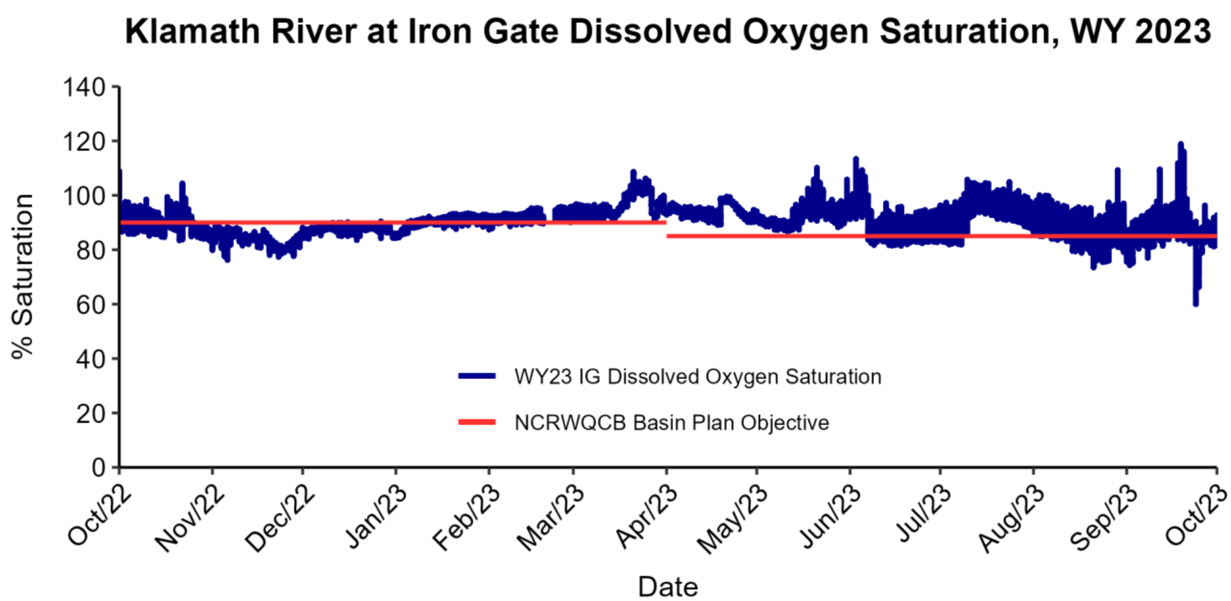

Figure 7 Dissolved oxygen saturation readings recorded instantaneously every 15 minutes in 2023 at the Klamath River below Iron Gate dam (IG) and the NCRWQCB Basin Plan Klamath River site-specific dissolved oxygen water quality objective: > 90% saturation Oct 1 – March 30 and > 85% saturation April 1 – Sept 30 from the OR/CA state line to the mouth of the Scott River

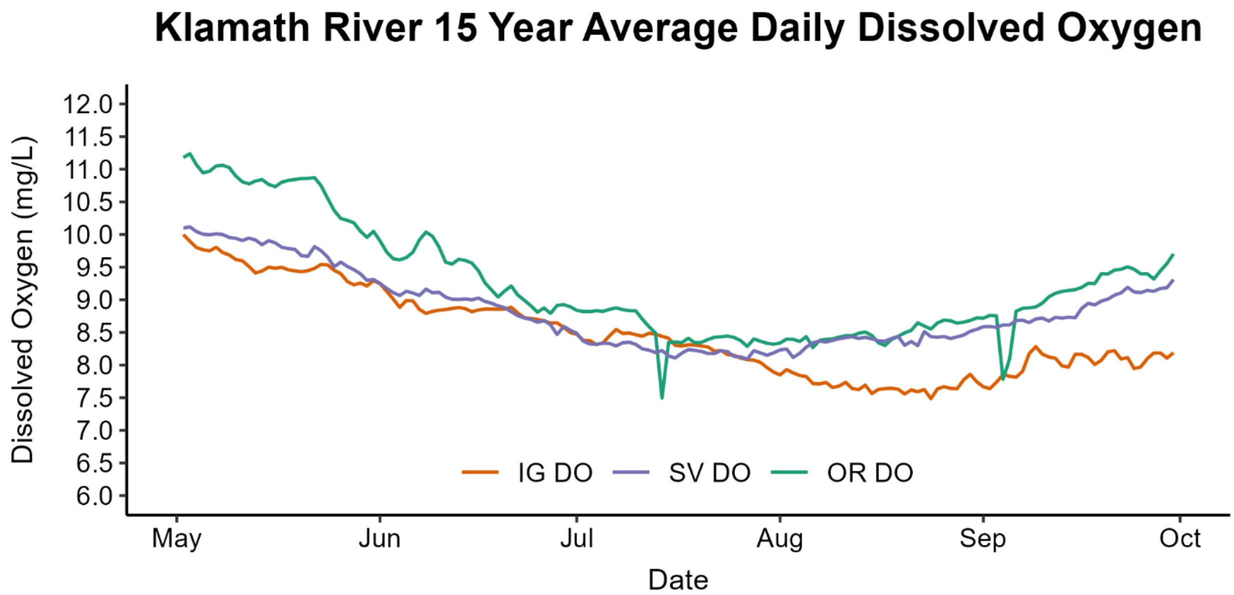

Figure 8 Aggregated daily average dissolved oxygen levels from 2009-2023 at main stem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR)

6.1.3 Main Stem pH

pH levels vary among sites, with Iron Gate being the most basic and having the most exceedances of the NCRWQCB Basin Plan water quality objective for the Klamath River, including entire diel cycles raised above the objective in fall (Figures 9-12). The Iron Gate pH levels are the most dynamic, owing to the use of the curtain beginning in early June which depresses pH levels followed by rapidly increasing productivity in the reservoir when it is removed in early July (Figures 9 and 12).

Historic 15-year trends are replicated this year with pH levels peaking between August and October and regular daily exceedances of the Basin Plan objective (Figures 9 and 13). This late summer pH increase coincides with the peak of in-river productivity and the lowest dissolved oxygen readings, indicative of water quality impairments associated with photorespiration. Changes in Iron Gate pH in late summer may be attributed to the variable use of the curtain and spillway supporting dam removal (Figures 9 and 13).

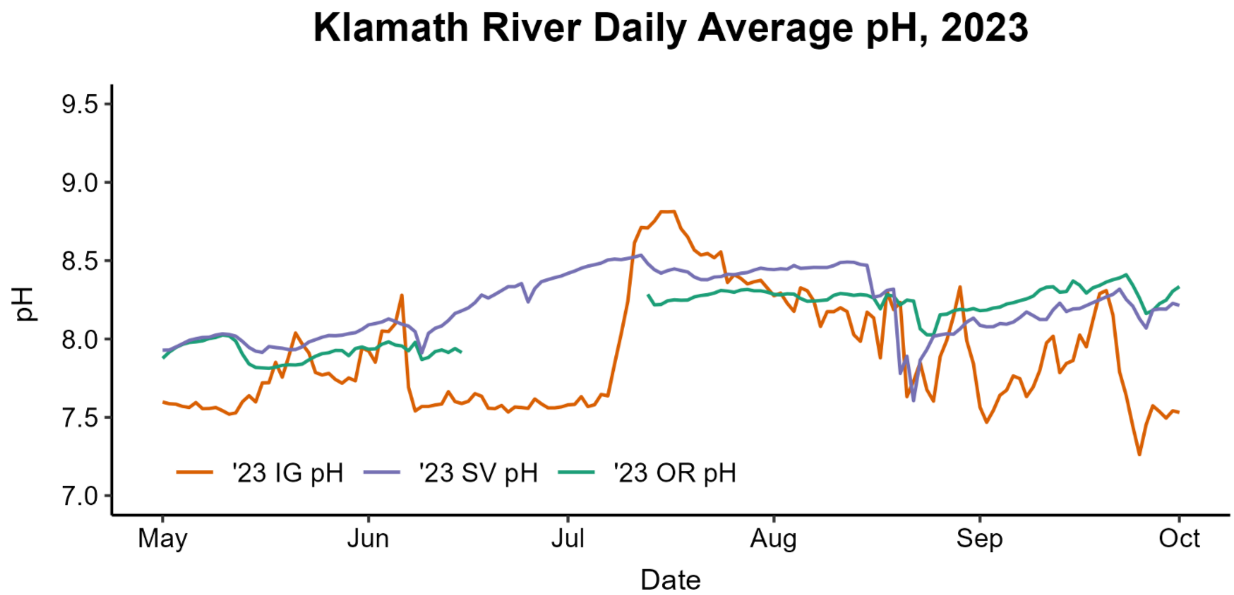

Figure 9 Daily average pH levels in 2023 at main stem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR)

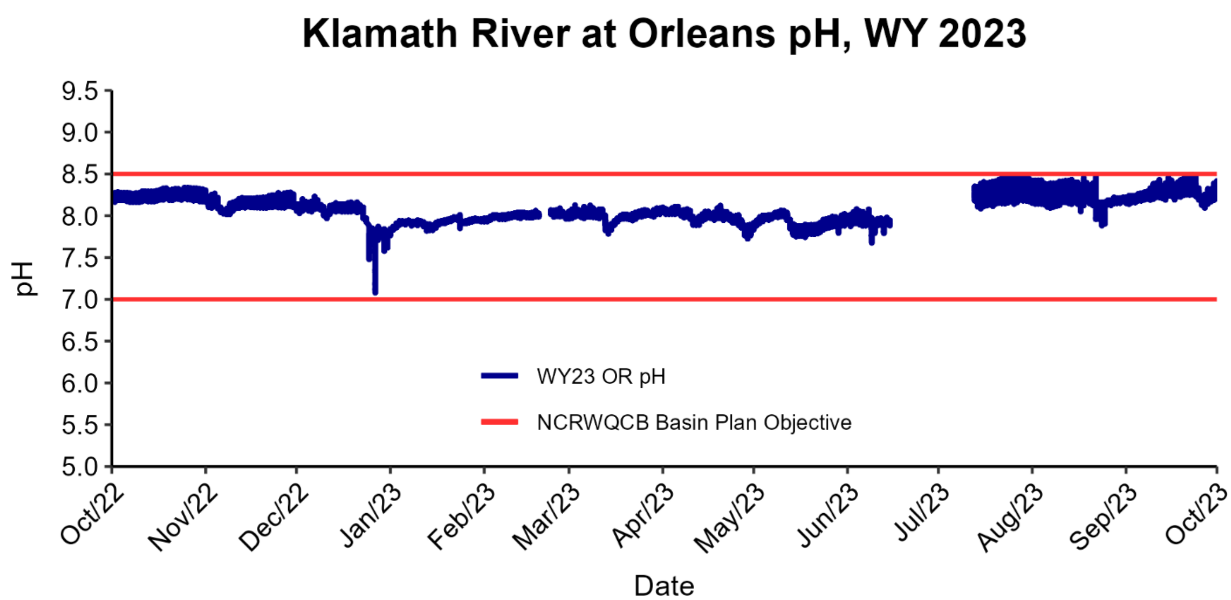

Figure 10 pH readings recorded instantaneously every 15 minutes water year 2023 at the Klamath River at Orleans (OR) and the NCRWQCB Basin Plan objective for the Klamath River: 7 < x < 8.5

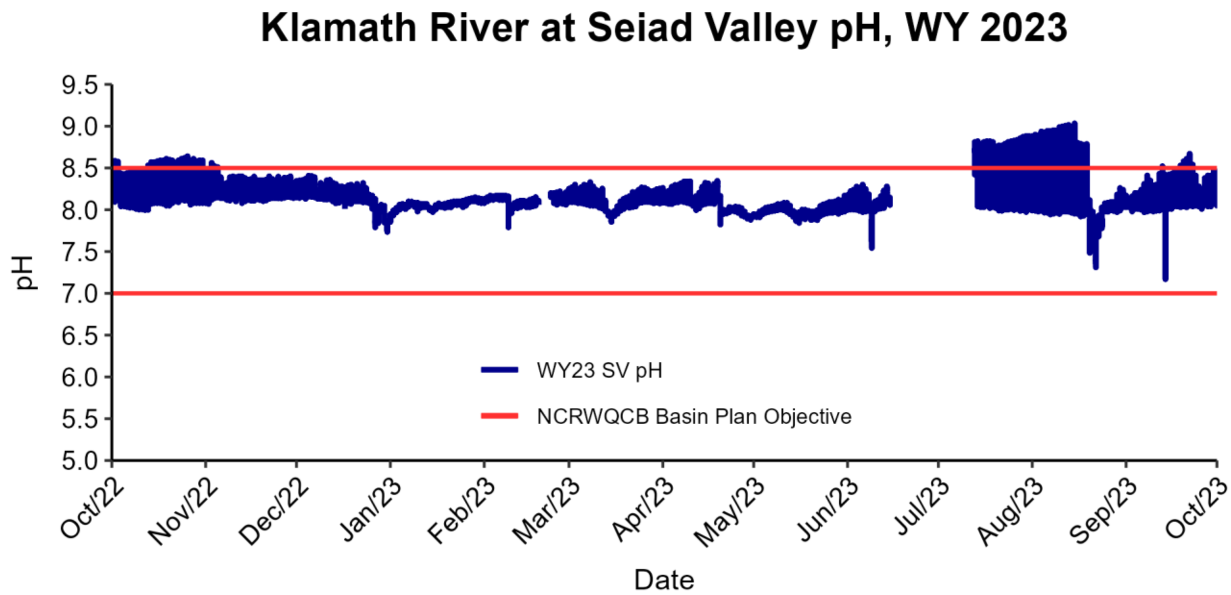

Figure 11 pH readings recorded instantaneously every 15 minutes in water year 2023 at the Klamath River at Seiad Valley (SV) and the NCRWQCB Basin Plan objective for the Klamath River: 7 < x < 8.5

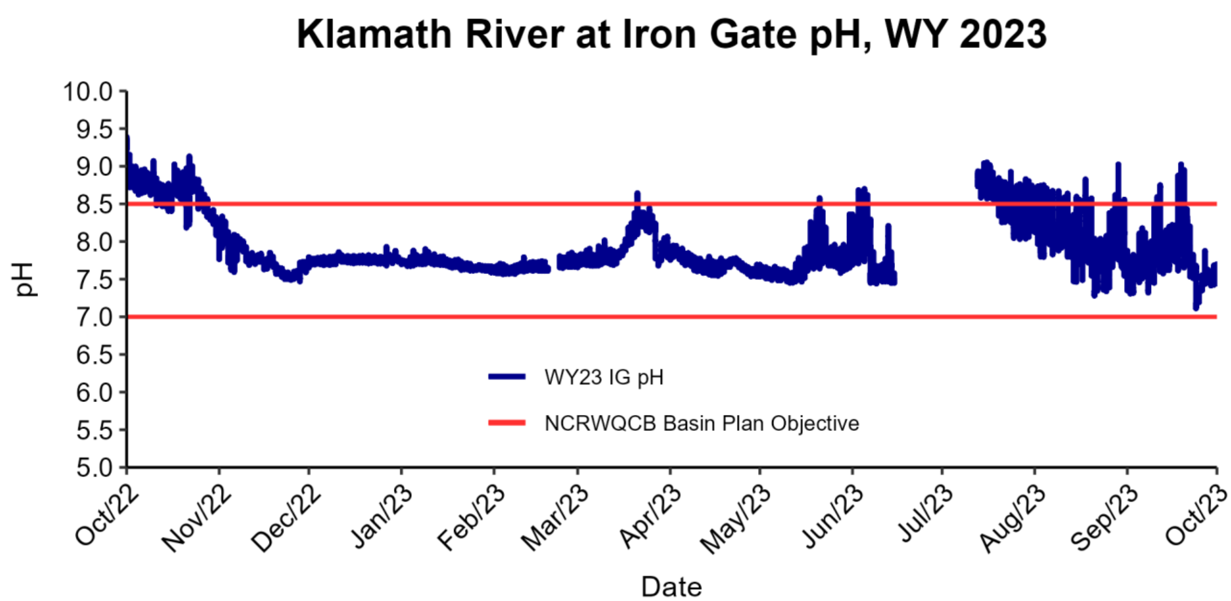

Figure 12 pH readings recorded instantaneously every 15 minutes in water year 2023 at the Klamath River below Iron Gate dam (IG) and the NCRWQCB Basin Plan objective for the Klamath River: 7 < x < 8.5

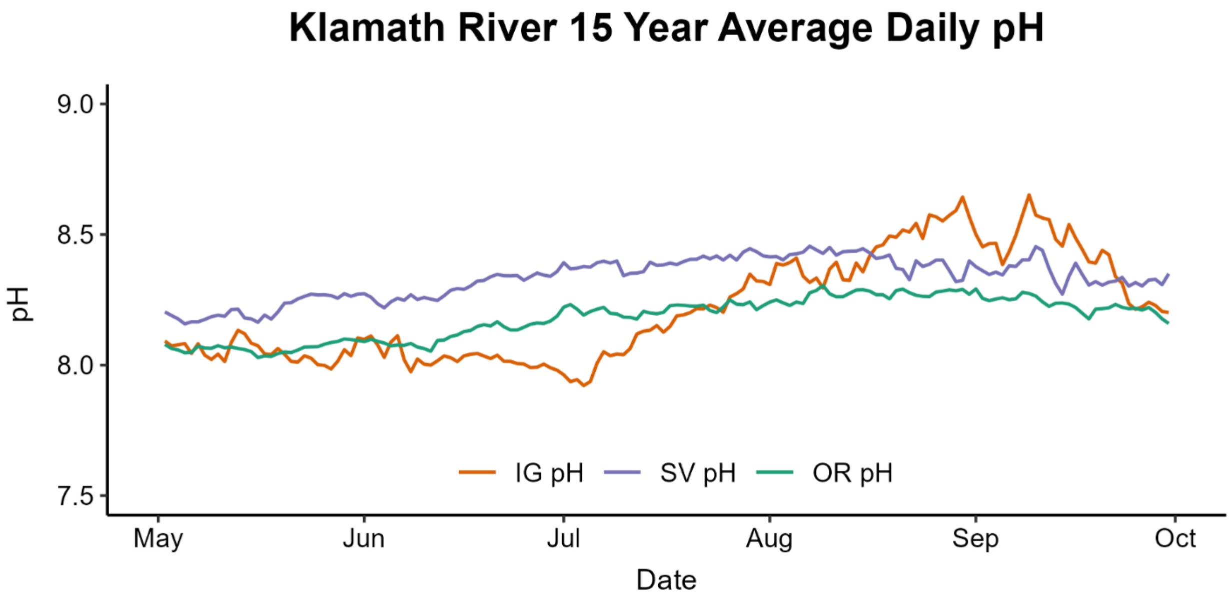

Figure 13 Aggregated daily average pH levels from 2009-2023 at main stem Klamath River sites: below Iron Gate dam (IG), Seiad Valley (SV), and Orleans (OR)

6.2 Tributaries

The Karuk Tribe Water Quality Program has monitored three major Klamath tributaries just upstream from their confluences with the Klamath since 2006: the Shasta, Scott, and Salmon Rivers. Each of the tributaries has similar seasonal water quality trends.

6.2.1 Tributary Temperature

Typically, temperatures in spring are stratified among the tributaries due to variable input: the Shasta River is warmer with lower annual variability due to groundwater influences which moderate temperature, the Scott River is intermediate with a mix of groundwater and snowmelt, and the Salmon River is the coldest with a snowmelt-dominated system. However, the significant snowpack this winter contributed more cold water to the Scott River, resulting in greater similarity to the Salmon River thermograph. Over time, temperatures converge as solar radiation becomes the dominant driver (Figure 14). Due to the high snowpack, the Scott and Salmon Rivers show colder temperatures as compared with previous years, even through fall (Figures 16-17). In comparison, average temperatures on the Shasta River suggest that this year’s temperatures were primarily impacted by flow rather than air temperature (Figures 15).

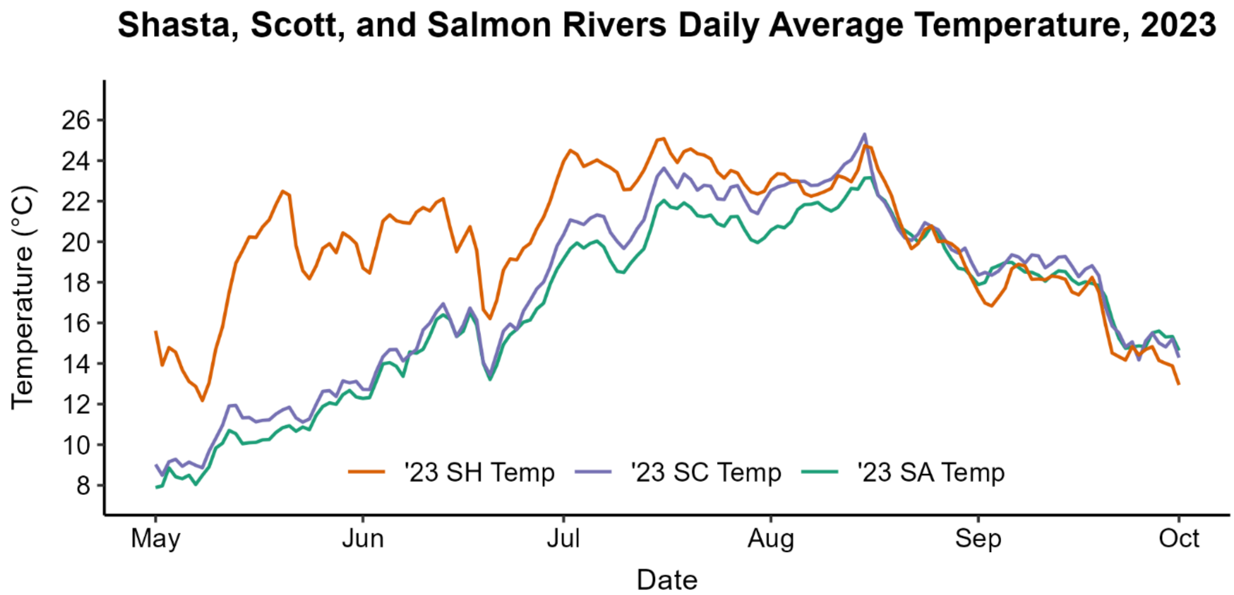

Figure 14 Daily average water temperature in 2023 at Shasta (SH), Scott (SC), and Salmon (SA) Rivers

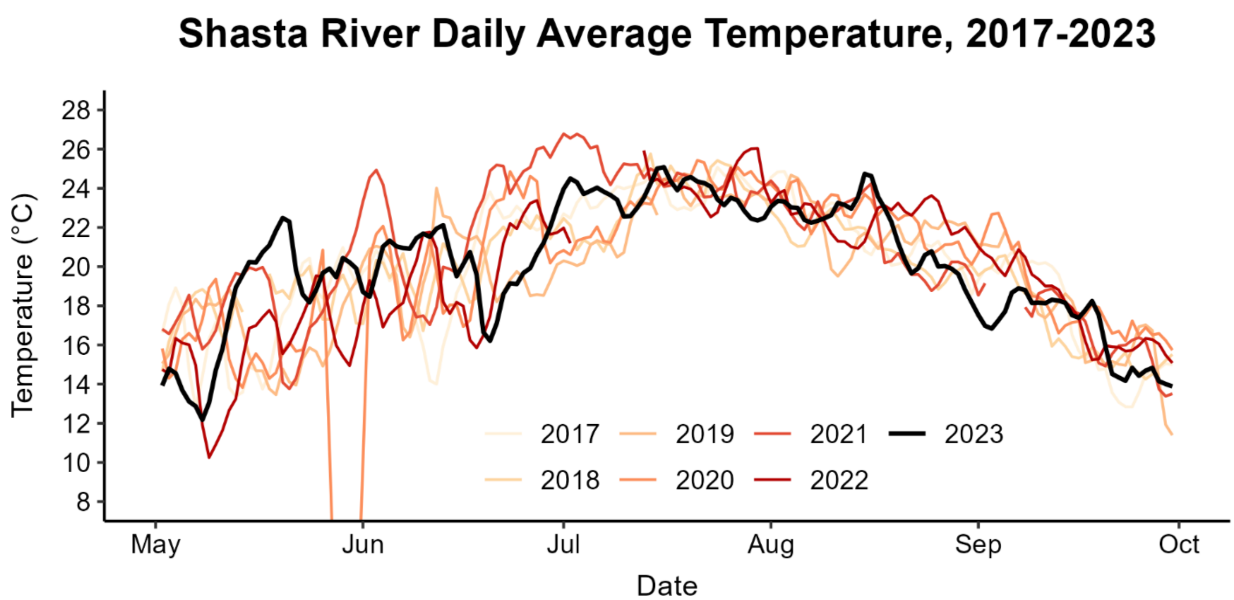

Figure 15 Daily average water temperatures from 2017-2023 at the Shasta River

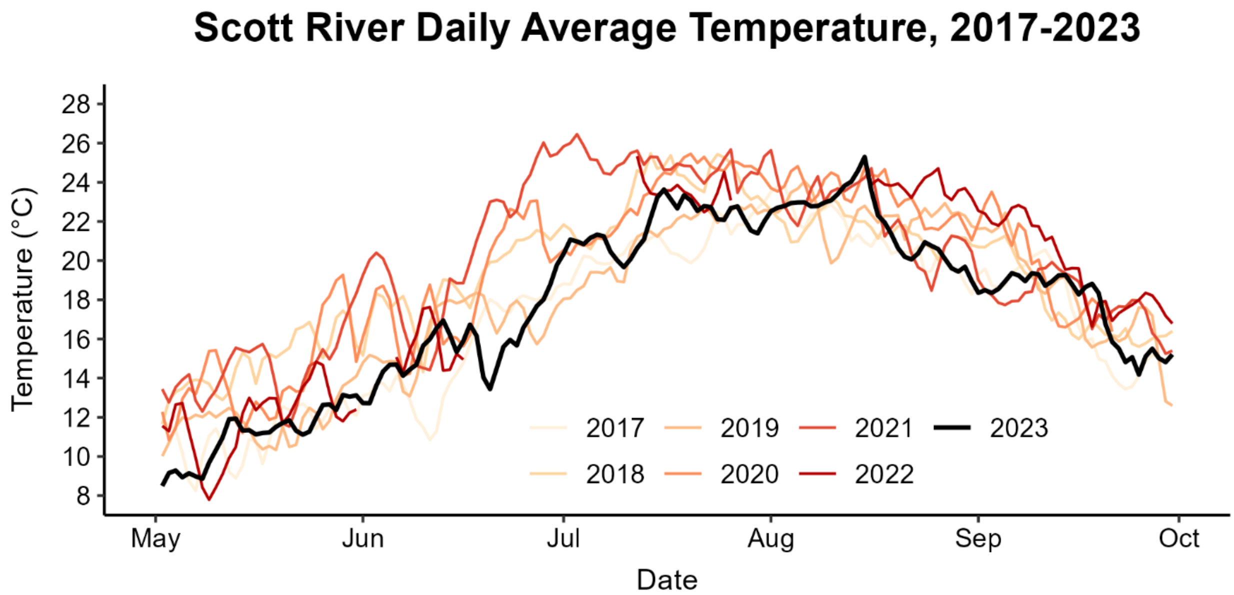

Figure 16 Daily average water temperatures from 2017-2023 at the Scott River

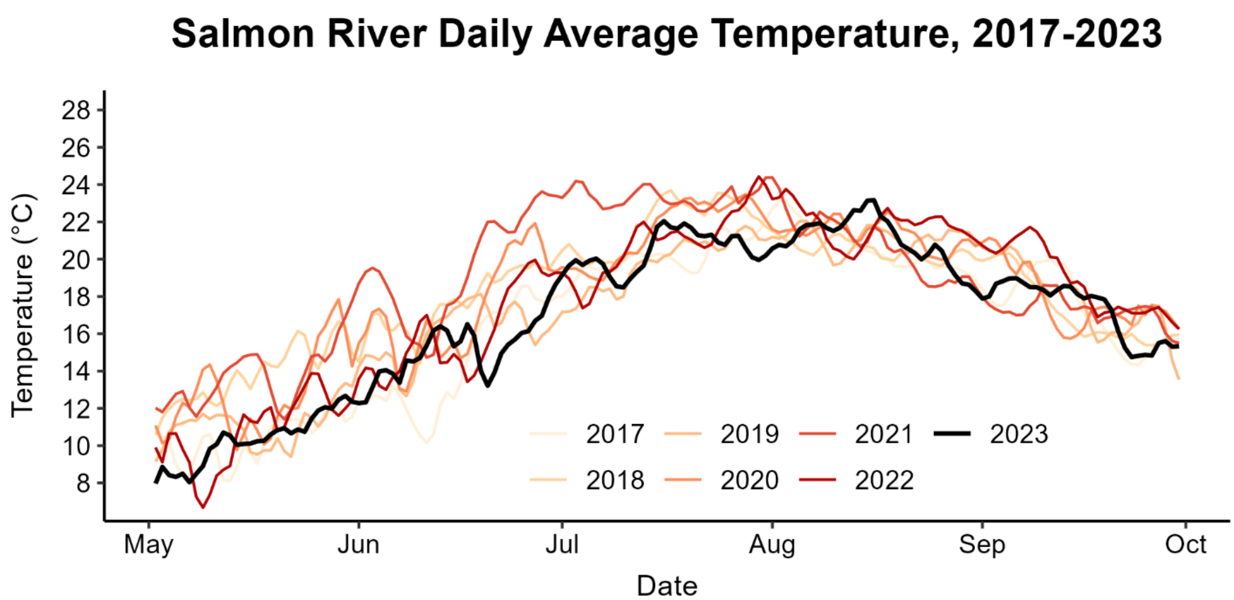

Figure 17 Daily average water temperatures from 2017-2023 for the Salmon River

6.2.2 Tributary Dissolved Oxygen

The relationship between dissolved oxygen and temperature is represented by the differing spring dissolved oxygen levels, with the Salmon River having the highest levels (and coldest temperature) and the Shasta River having the lowest levels (and warmest temperatures) (Figure

18). Reflecting the trends discussed in the previous section, the Scott River resembles the Salmon River more closely due to the influence of high snowpack, and dissolved oxygen was higher in the Scott and Salmon Rivers as compared to previous years (Figures 18, 21, and 23). The Scott River saw a significant outage this year in dissolved oxygen and pH due to sonde failure.

The NCRWQCB Basin Plan establishes water quality objectives for each tributary based on instantaneous readings. The Shasta River was regularly impaired April-October (< 7 mg/L); the Scott River was slightly impaired June-October (< 7 mg/L); and the Salmon River had the least impairment, restricted to June-September (< 9 mg/L) (Figures 20, 22, and 24). Accordingly, these tributaries are impaired at a time of critical importance for salmon migration.

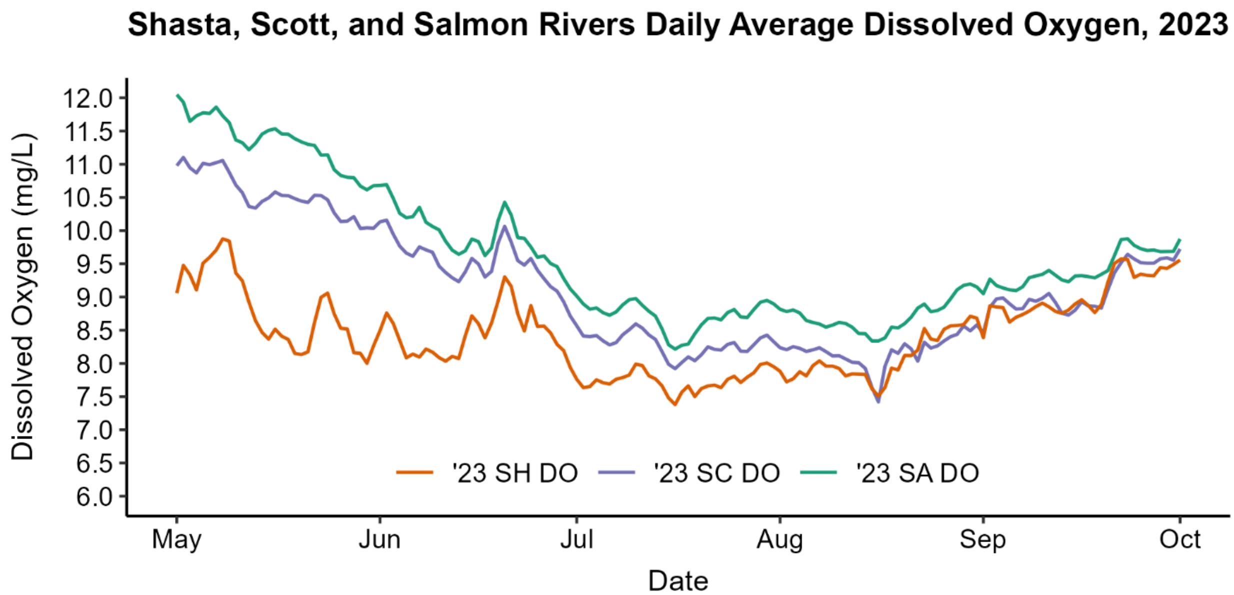

Figure 18 Daily average dissolved oxygen levels in 2023 at Shasta (SH), Scott (SC), and Salmon (SA) Rivers

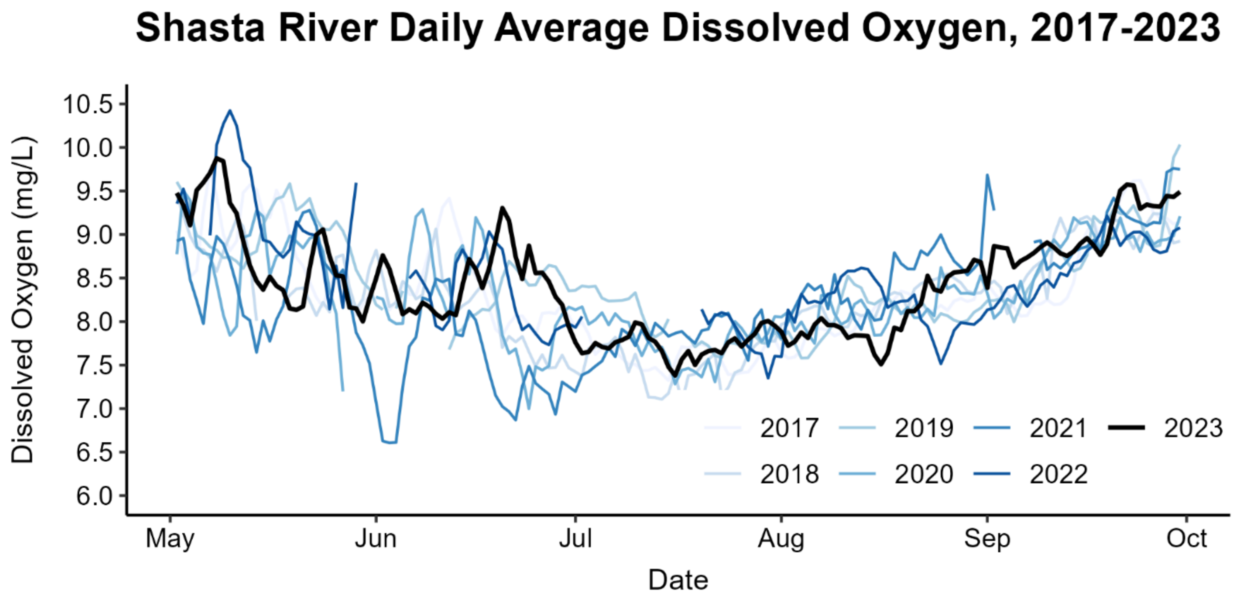

Figure 19 Daily average dissolved oxygen levels from 2017-2023 at the Shasta River

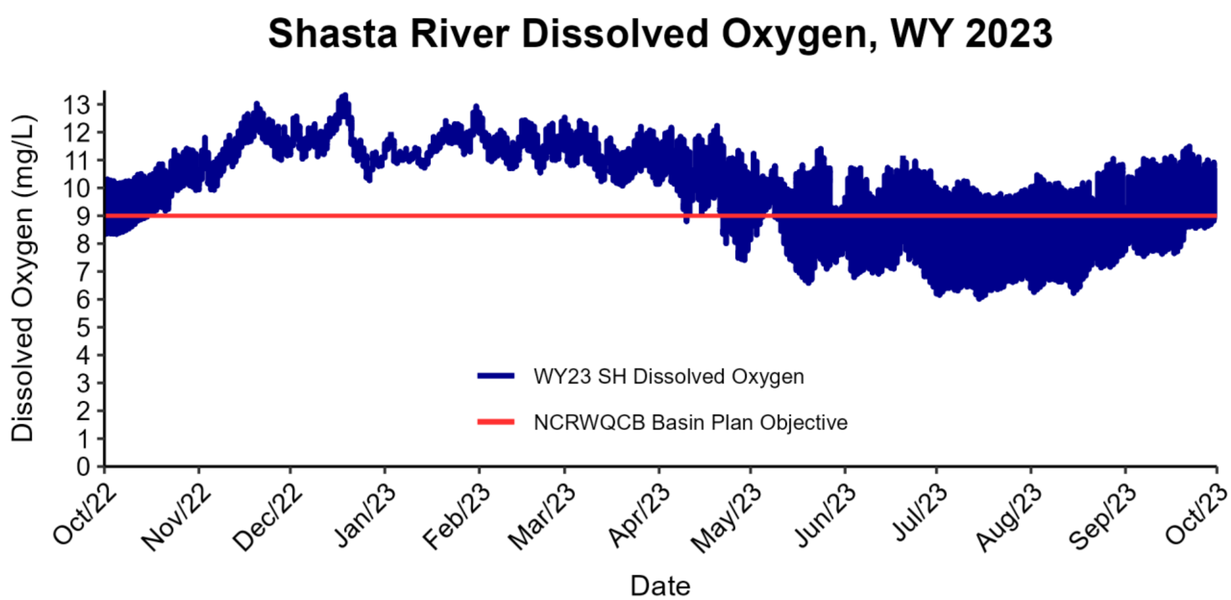

Figure 20 Dissolved oxygen readings recorded instantaneously every 15 minutes in 2023 at the Shasta River and the NCRWQCB Basin Plan site-specific water quality objective for the Shasta River, > 7 mg/L

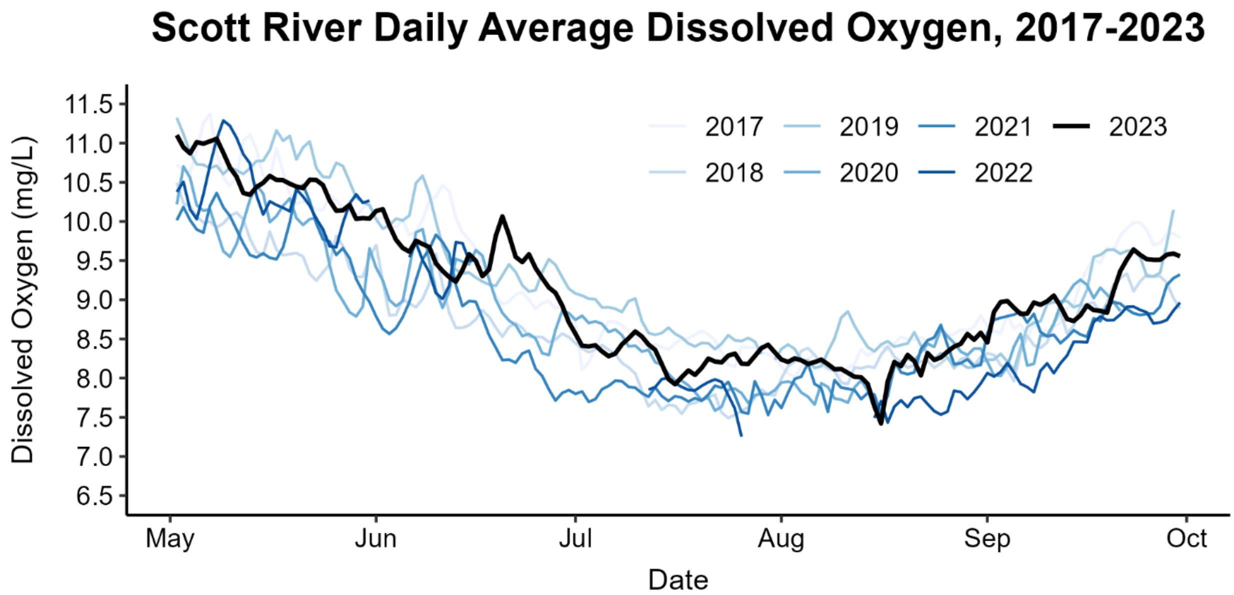

Figure 21 Daily average dissolved oxygen levels from 2017-2023 at the Scott River

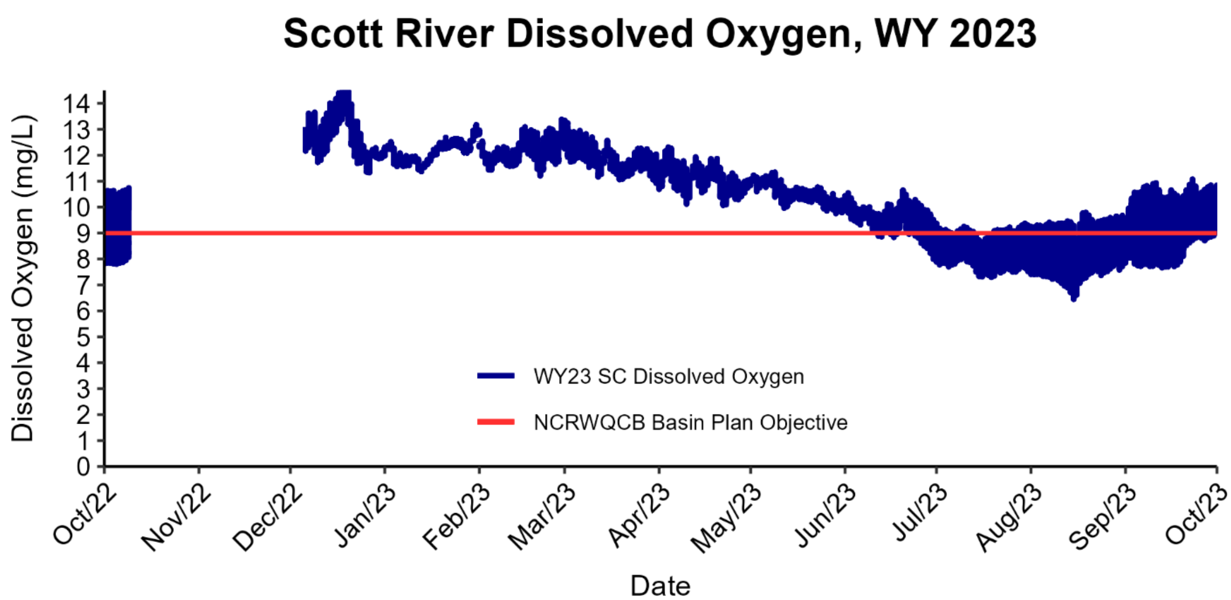

Figure 22 Dissolved oxygen readings recorded instantaneously every 15 minutes in 2023 at the Scott River and the NCRWQCB Basin Plan site-specific water quality objective for the Scott River, > 7 mg/L

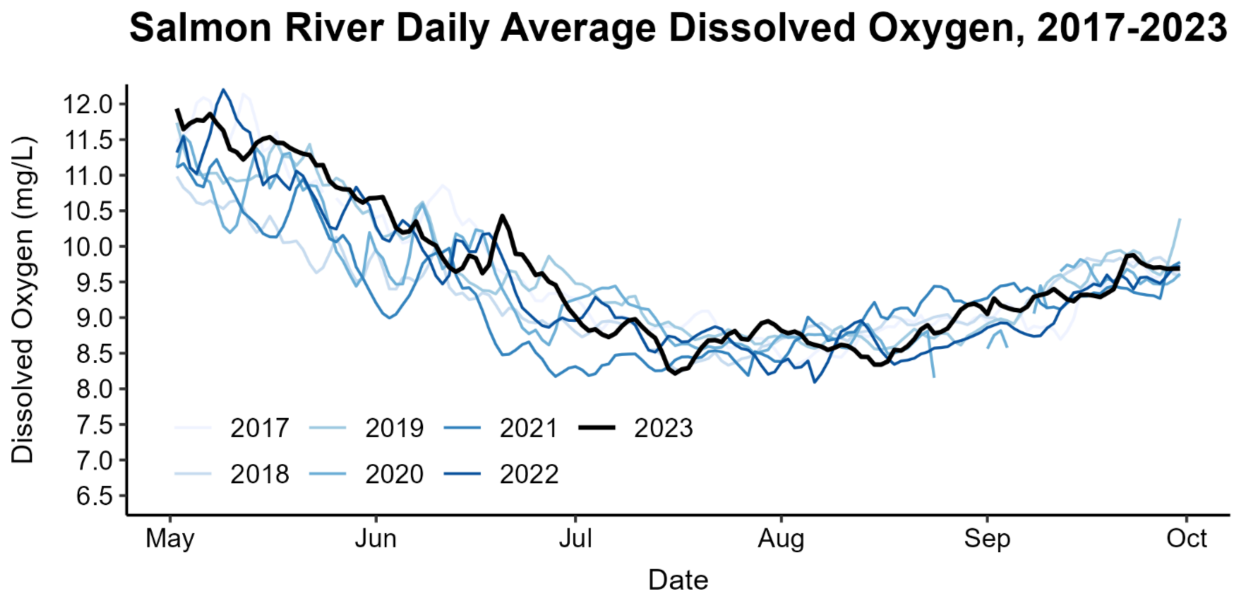

Figure 23 Daily average dissolved oxygen levels from 2017-2023 at the Salmon River

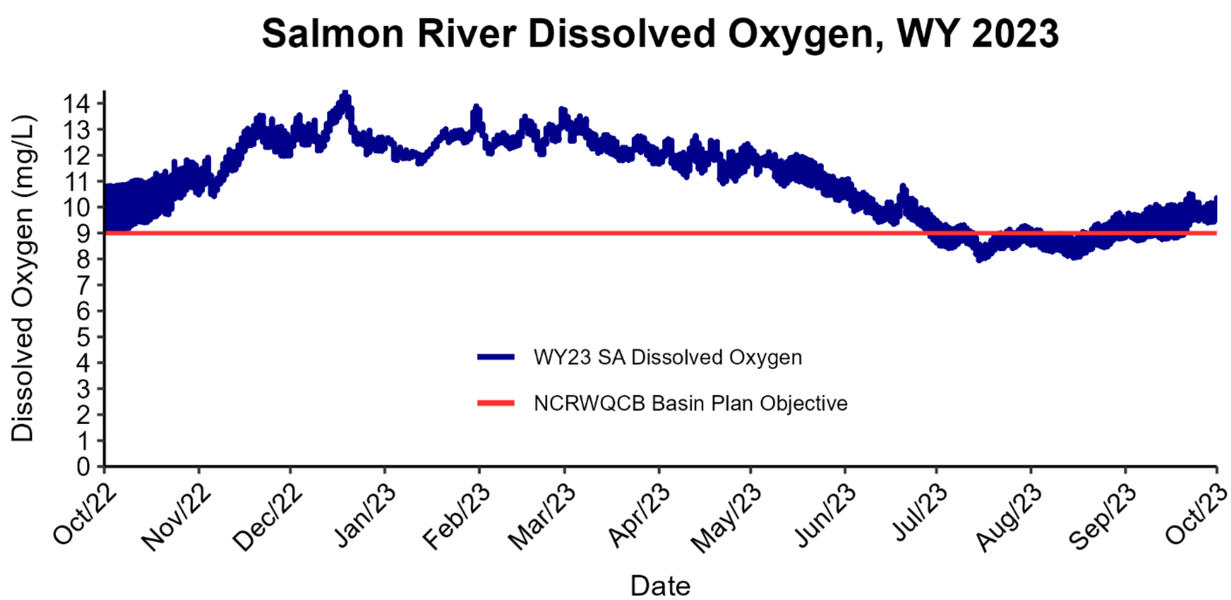

Figure 24 Dissolved oxygen readings recorded instantaneously every 15 minutes in water year 2023 at the Salmon River and the NCRWQCB Basin Plan site-specific water quality objective for the Salmon River, > 9 mg/L

6.2.3 Tributary pH

Daily average pH readings are stratified among tributaries, with Shasta River as the most basic due to groundwater input hardness and heightened productivity deriving from land use and Salmon River as the least (Figure 25). The Shasta River trend is generally stable throughout the year, while the Scott and Salmon Rivers' pH climbs from spring to fall (Figures 26, 28, and 30). This, and the more frequent and severe drops in pH throughout the year, are tied to distinct geology that reflects a position lower in the Klamath basin. Steep topography and rapid releases of snowmelt result in larger flow peaks and stronger scour, which negatively impact benthic producers and lead to drops in pH. The Scott River trend is lower in magnitude compared to the Salmon River, reflecting its intermediate position in the basin.

Comparison with earlier years, pH was significantly lower than usual in the Scott and Salmon Rivers and similar in the Shasta River (Figures 26, 28, and 20). All three tributaries exceeded the NCRWQCB Basin Plan site-specific water quality objectives for pH in 2023. Magnitudes of exceedance matched their stratified pH levels, with the Shasta River most impaired in terms of pH and the Salmon River least. Notably, exceedances are confined to the fall season at the Salmon River; are regularly exceeded by diurnal highs at the Scott River; and are the dominant state in the Shasta River except for nocturnal lows (Figures 27, 29, and 31).

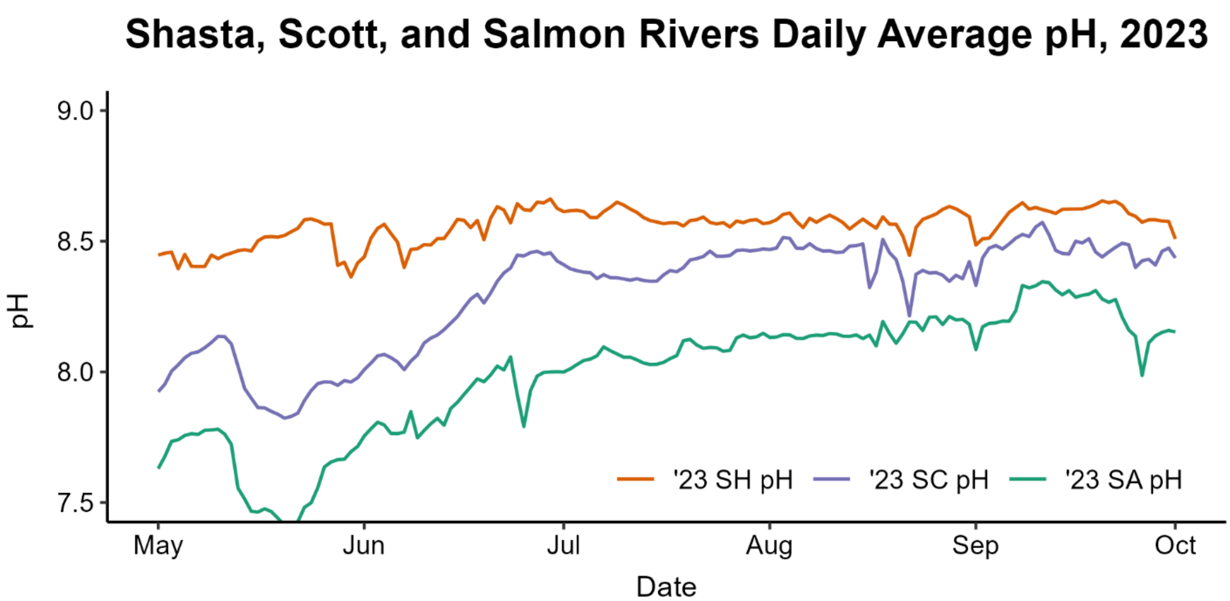

Figure 25 Daily average pH levels in 2023 at Shasta (SH), Scott (SC), and Salmon (SA) Rivers

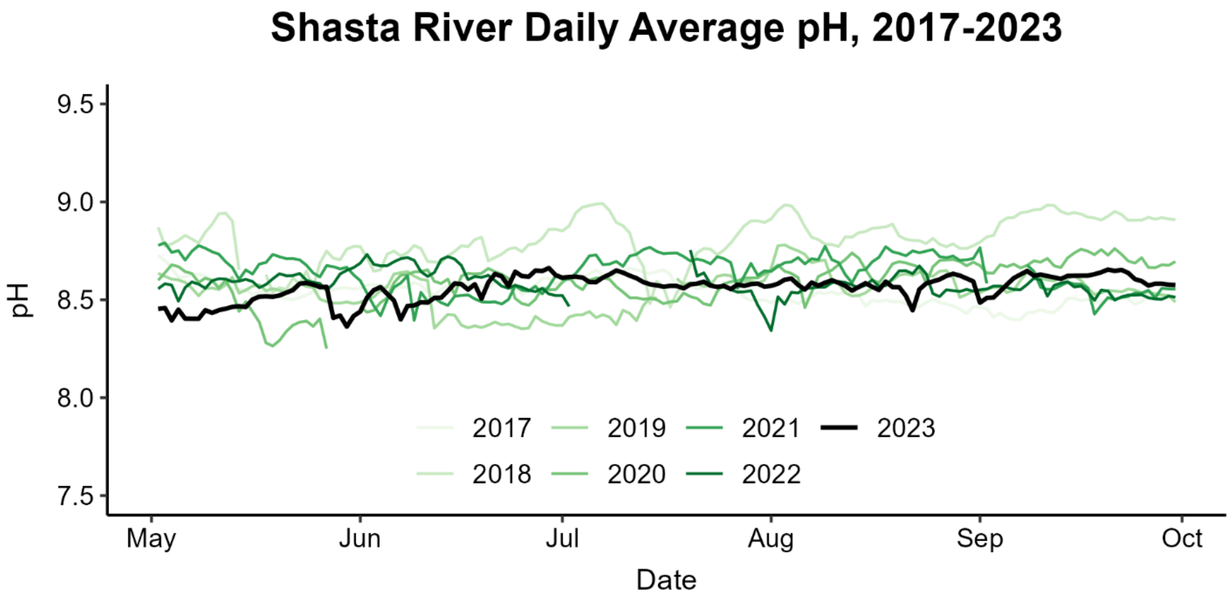

Figure 26 Daily average pH levels from 2017-2023 at the Shasta River

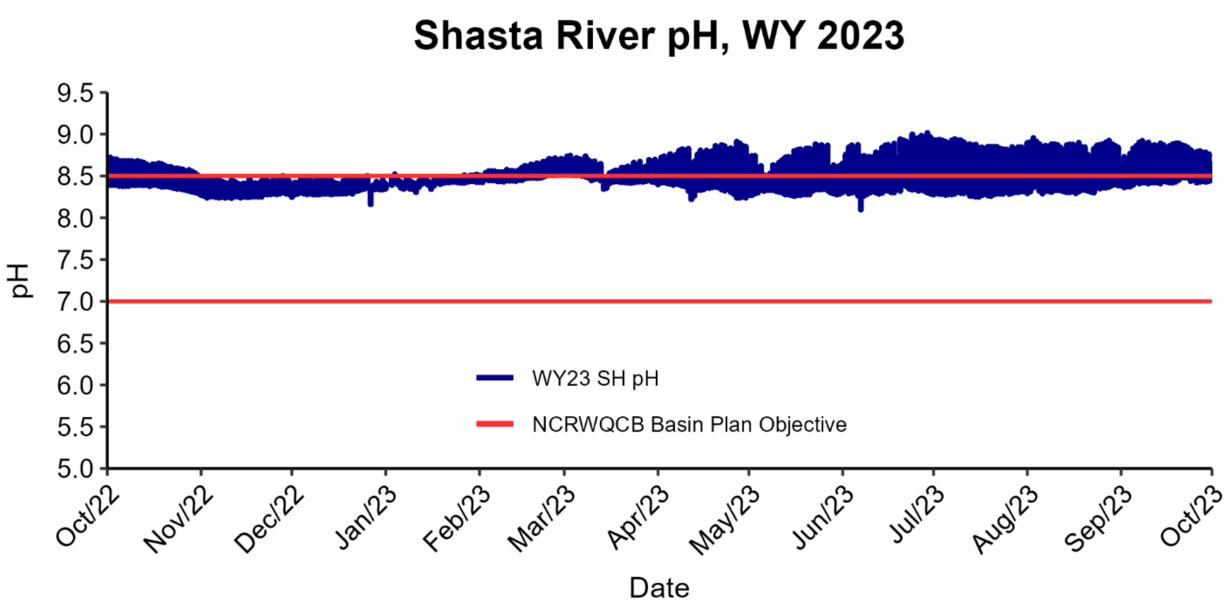

Figure 27 pH readings recorded instantaneously every 15 minutes in 2023 at the Shasta River and the NCRWQCB Basin Plan site-specific water quality objective for the Shasta River, 7 < x < 8.5

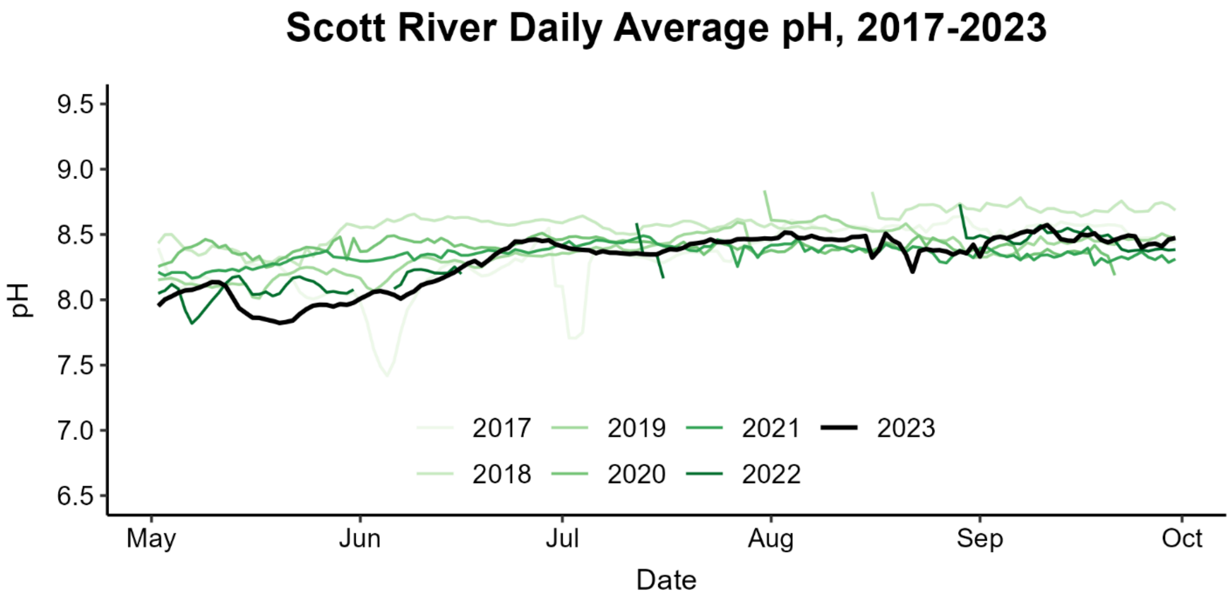

Figure 28 Daily average pH levels from 2017-2023 at the Scott River

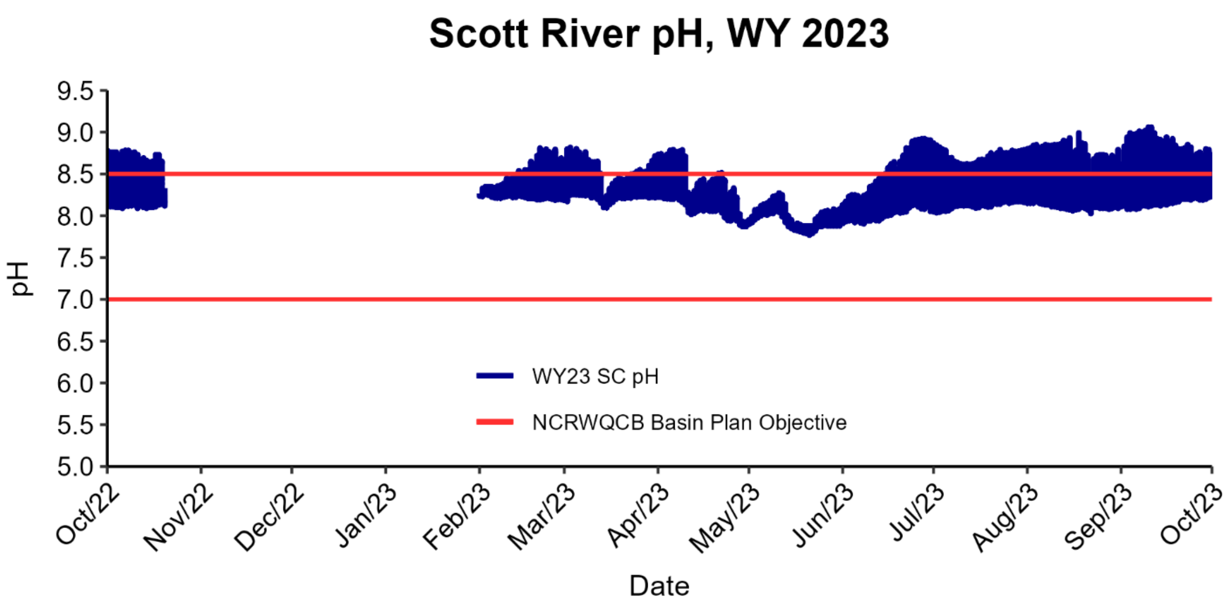

Figure 29 pH readings recorded instantaneously every 15 minutes in 2023 at the Scott River and the NCRWQCB Basin Plan site-specific water quality objective for the Scott River, $7 < x < 8.5$

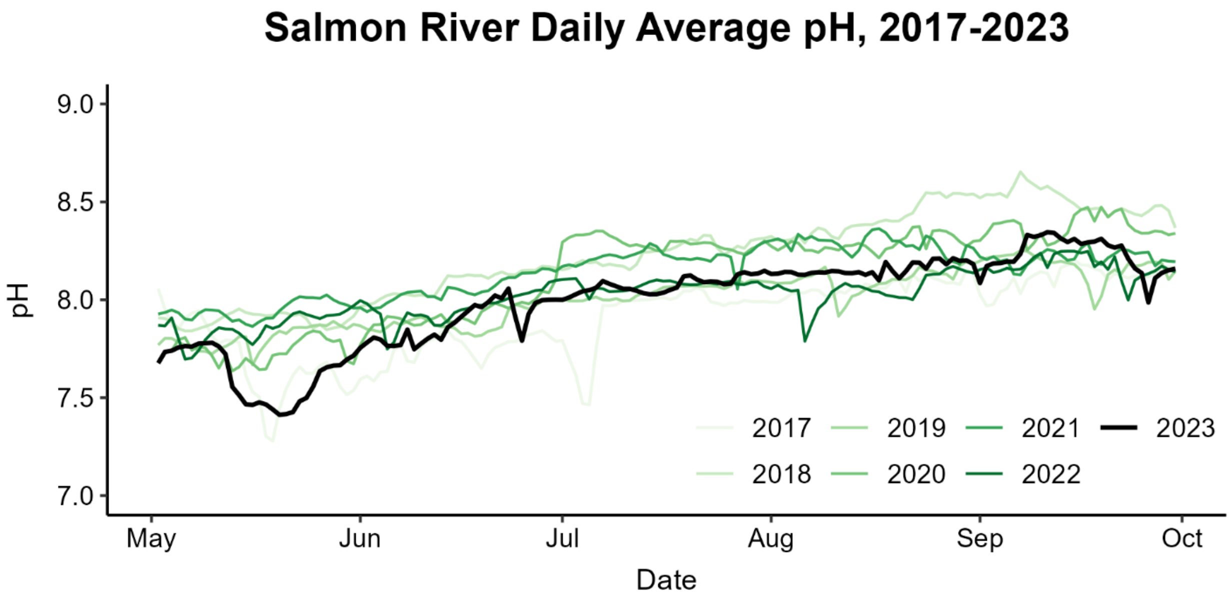

Figure 30 Daily average pH from 2017-2023 at the Salmon River

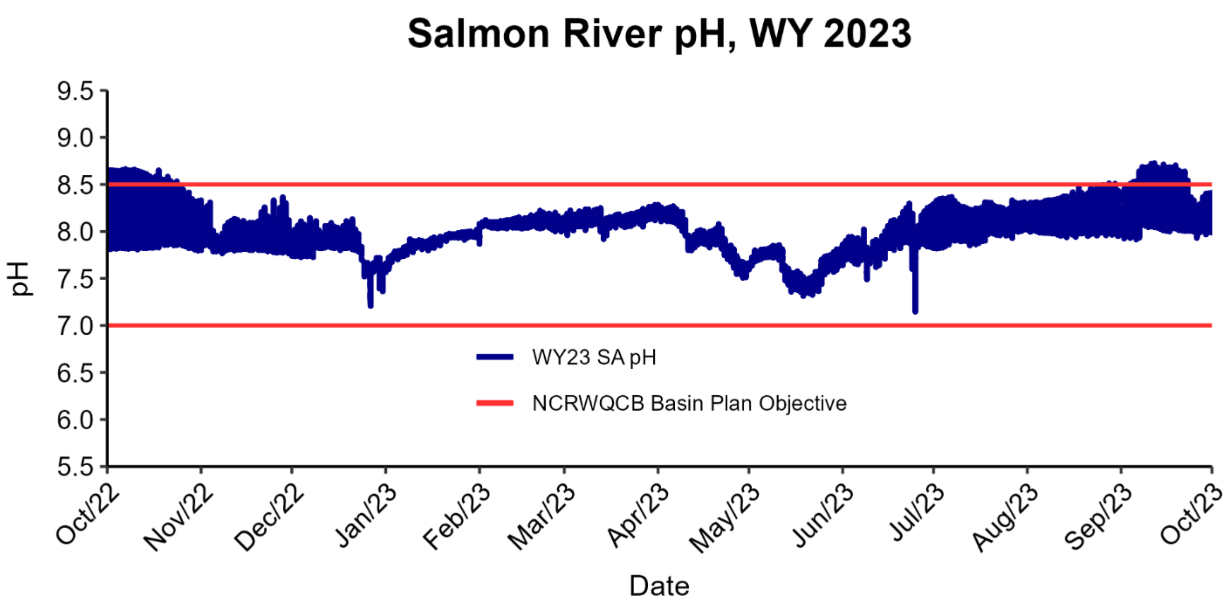

Figure 31 pH readings recorded instantaneously every 15 minutes in water year 2023 at the Salmon River and the NCRWQCB Basin Plan site-specific water quality objective for the Salmon River, 7 < x < 8.5

6.2.4 Salmon River Turbidity

Turbidity data collected at the Salmon River show a higher number of spikes than previous years with events in January, March, and April, but with lower magnitude. This reflects high precipitation inputs in 2023 (Figure 32).

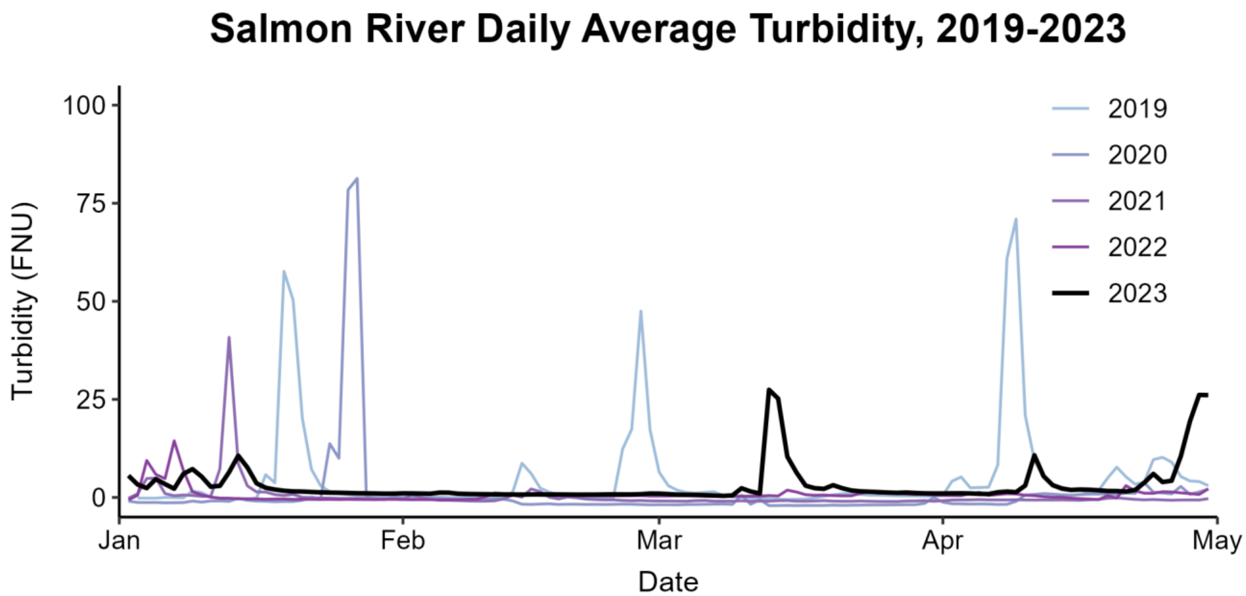

Figure 32 Daily average turbidity from 2019-2023 at the Salmon River

6.3 Nutrients

Nutrient samples were collected by the Karuk Tribe Water Quality Program from both the main stem Klamath and tributaries. Nutrient concentrations are largely driven by discharge and differing land use, with increases in both total phosphorus and, with larger magnitude, total nitrogen during lower-flow summer and fall months. These trends were subdued in 2023 due diluting high flows (Figures 33 and 36). Historical records show spikes in summer months as low flows and precipitation result in increased concentrations (Figures 34, 35, 37, and 38). These trends and nutrient concentrations in general are muted in the Scott and Salmon Rivers and elevated in the Shasta River with respect to main stem sites (Figures 33 and 36). This reflects a higher degree of nutrient inputs from agriculture in the Shasta River and from Upper Klamath Lake in the main stem Klamath River.

In main stem sites, there is a spatial trend of nutrient concentrations decreasing longitudinally in the downriver direction as they are processed metabolically and diluted by tributaries (Figures 35 and 38). This year's peaks in phosphorus were lower than the historic record, while nitrogen peaks were average (Figures 34, 35, 37, and 38). Elevated nutrients also impact dissolved oxygen and pH by boosting productivity.

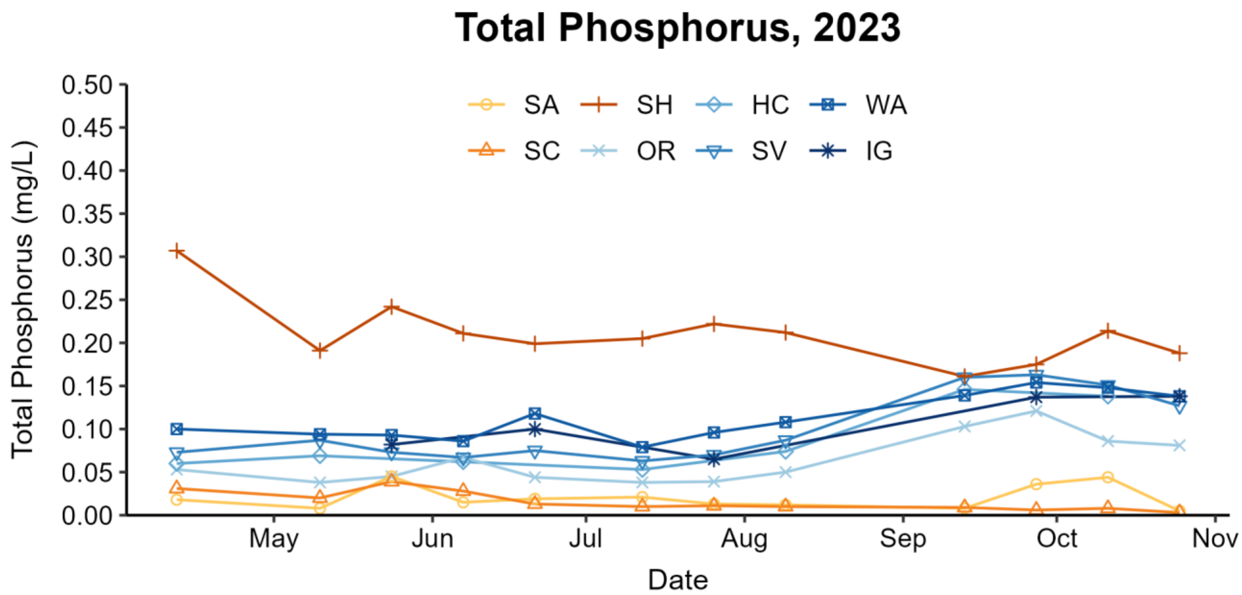

Figure 33 Total phosphorus measurements in 2023 at all monitored sites

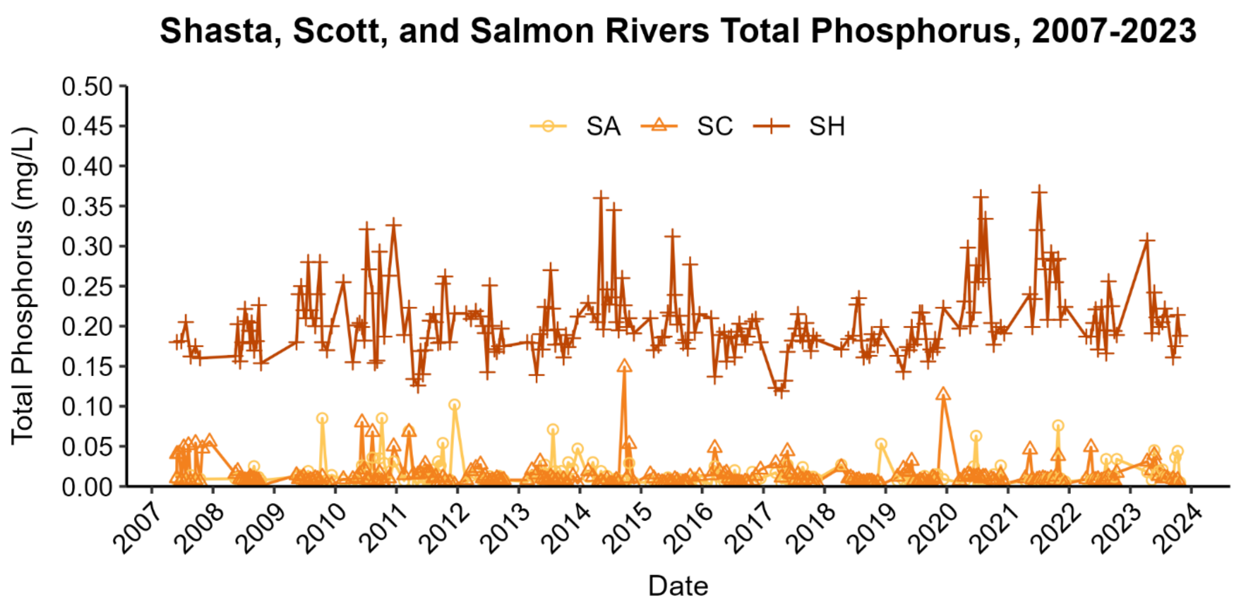

Figure 34 Total phosphorus measurements from 2007-2023 at the Salmon (SA), Scott (SC), and Shasta (SH) Rivers

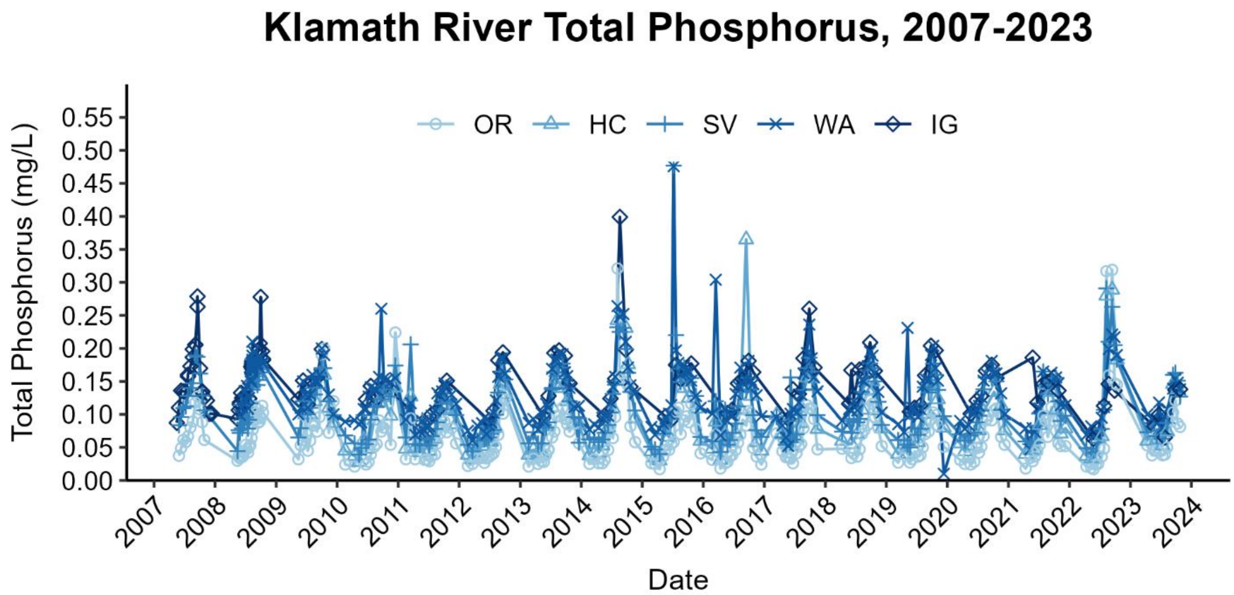

Figure 35 Total phosphorus measurements from 2007-2023 at main stem Klamath River sites: below Iron Gate dam (IG), at Walker Bridge (WA), at Seiad Valley (SV), at Happy Camp (HC), and at Orleans (OR)

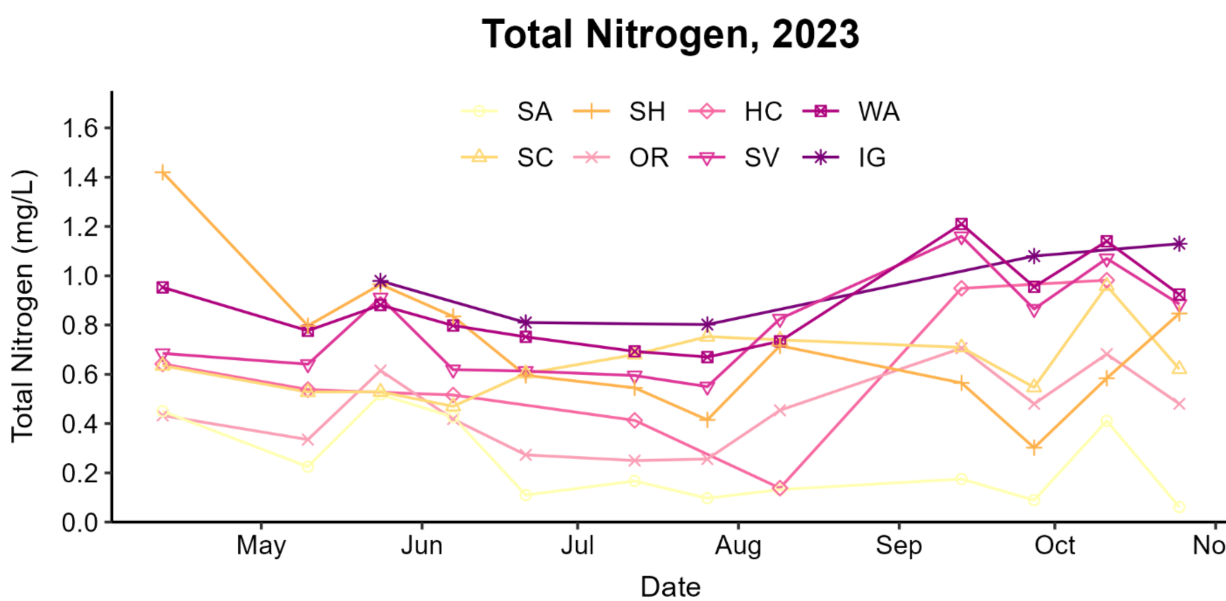

Figure 36 Total nitrogen measurements in 2023 at all monitored sites

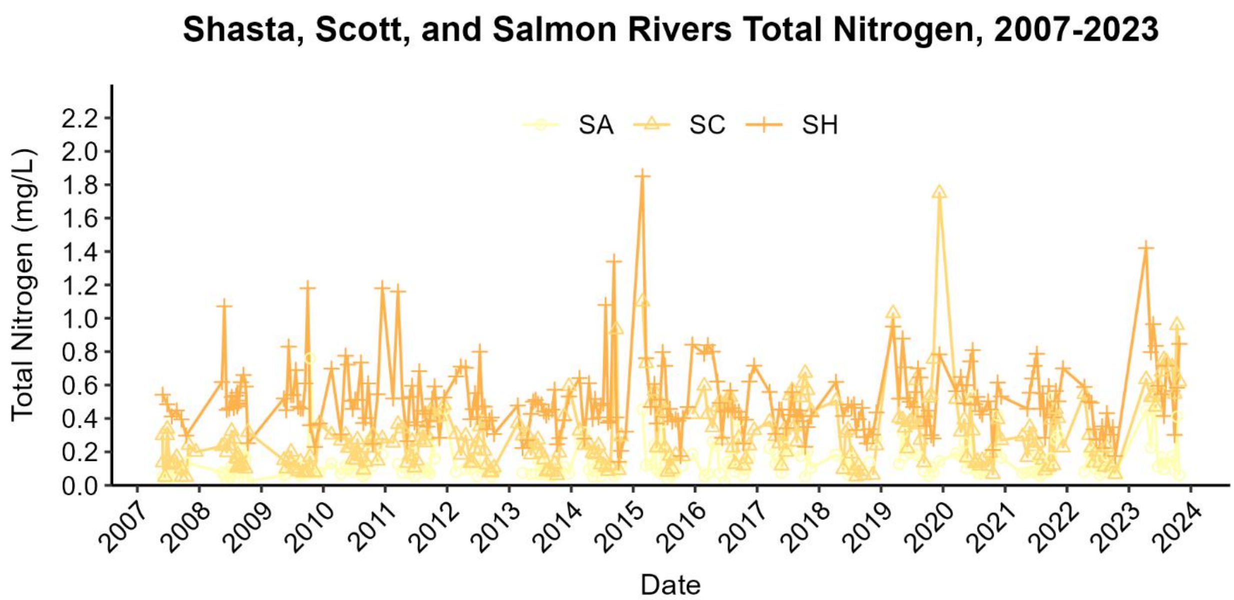

Figure 37 Total nitrogen measurements from 2007-2023 at the Salmon (SA), Scott (SC), and Shasta (SH) Rivers

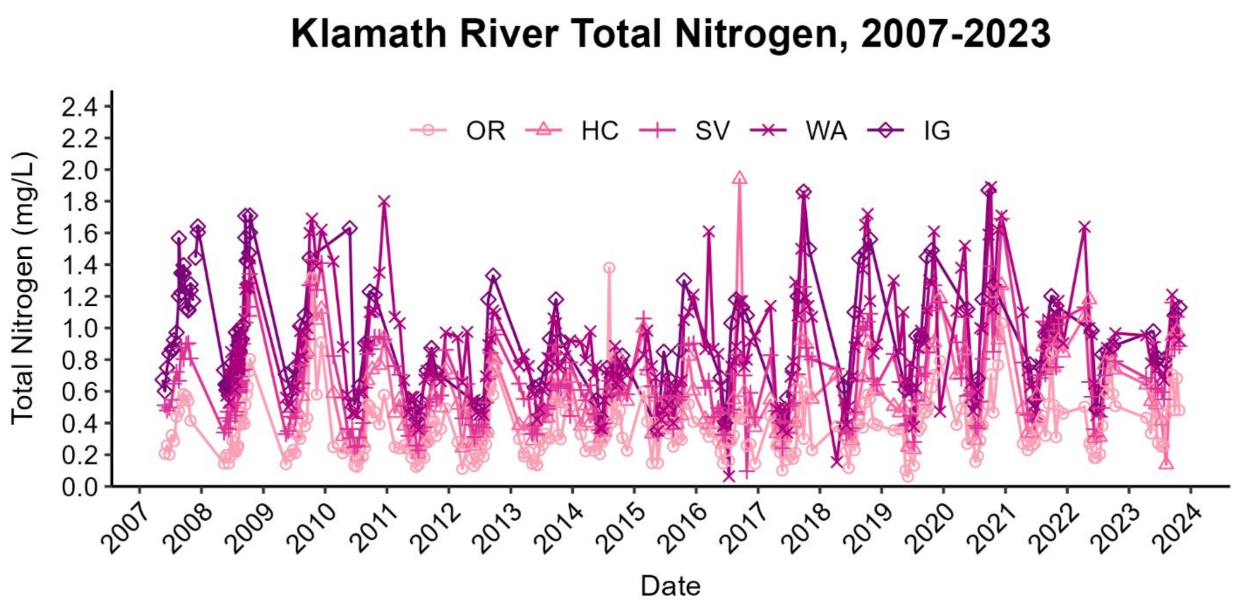

Figure 38 Total nitrogen measurements from 2007-2023 at main stem Klamath River sites: below Iron Gate dam (IG), at Walker Bridge (WA), at Seiad Valley (SV), at Happy Camp (HC), and at Orleans (OR)

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