State Water Resources Control Board
Order 5/19/2023
Term 5 - Russian River Water Quality Summary

Sonoma Water

March 2024

American Disabilities Act Compliance

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Contents

1.0 Introduction

On 27 April 2023, the Sonoma County Water Agency (Sonoma Water) filed Temporary Urgency Change Petitions (TUCPs) with the State Water Resources Control Board (SWRCB) pursuant to the September 24, 2008, National Marine Fisheries Service (NMFS) Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance (2008 Biological Opinion) conducted by the U.S. Army Corps of Engineers (USACE), Sonoma Water, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed and to address an obsolete hydrologic index that establishes minimum instream flow requirements that do not align with the current watershed conditions.

In summary, the terms of the SWRCB Order approved the following temporary changes to the Decision 1610 (D1610) instream flow requirements from 19 May 2023 through 15 October 2023 to the following:

(1) The minimum instream flow requirements in the Russian River, as specified in Term 20 of Permit 12947A, Term 17 of Permits 12949 and 12950, and Term 13 of Permit 16596, shall be modified as follows:
    a. Minimum instream flow in the upper Russian River shall remain at or above 125 cubic feet per second (cfs);
    b. Minimum instream flow in the lower Russian River shall remain at or above 70 cfs.

    For purposes of compliance with this term, the minimum instream flow requirements shall be measured based on a 5-day running average of average daily stream flow measurements, provided that instantaneous flows shall be no less than 110 cfs in the upper Russian River and no less than 60 cfs in the lower Russian River.

Approval of the TUCPs will also preserve reservoir storage levels in Lake Mendocino in the fall, which will preserve storage for water supplies to meet human health and safety needs, will be used for releases of stored water to benefit returning adult Chinook salmon, and improve the likelihood of carryover storage for use in 2024 in the event 2024 is a dry year. The SWRCB issued the Temporary Urgency Change Order (Order) on 19 May 2023.

2.0 2022 Russian River Flow Summary

By mid-January 2023, following a relatively dry winter in 2022 and water storage levels as low as 37,000 acre-feet in December 2022, water storage levels in Lake Mendocino recovered during winter storms to above 95,000 acre-feet, which is similar to storage levels experienced in 2017, a normal water year. Overall storage in 2023 was higher than most years in the last ten years of monitoring (Figure 2-1). Storage levels in Lake Mendocino increased through April, peaking in late April at approximately 100,000 acre-feet, and remained above 80,000 acre-feet through mid-September, and above 70,000 acre-feet by 15 October. Storage levels continued to decline and were just below 60,000 acre-feet by mid-December before increasing back above 60,000 acre-feet by the end of the year (Figure 2-1).

The 2023 average daily flows at the Talmage, Hopland, Cloverdale, Jimtown, Digger Bend, and Hacienda USGS gaging stations are shown in Figure 2-2.

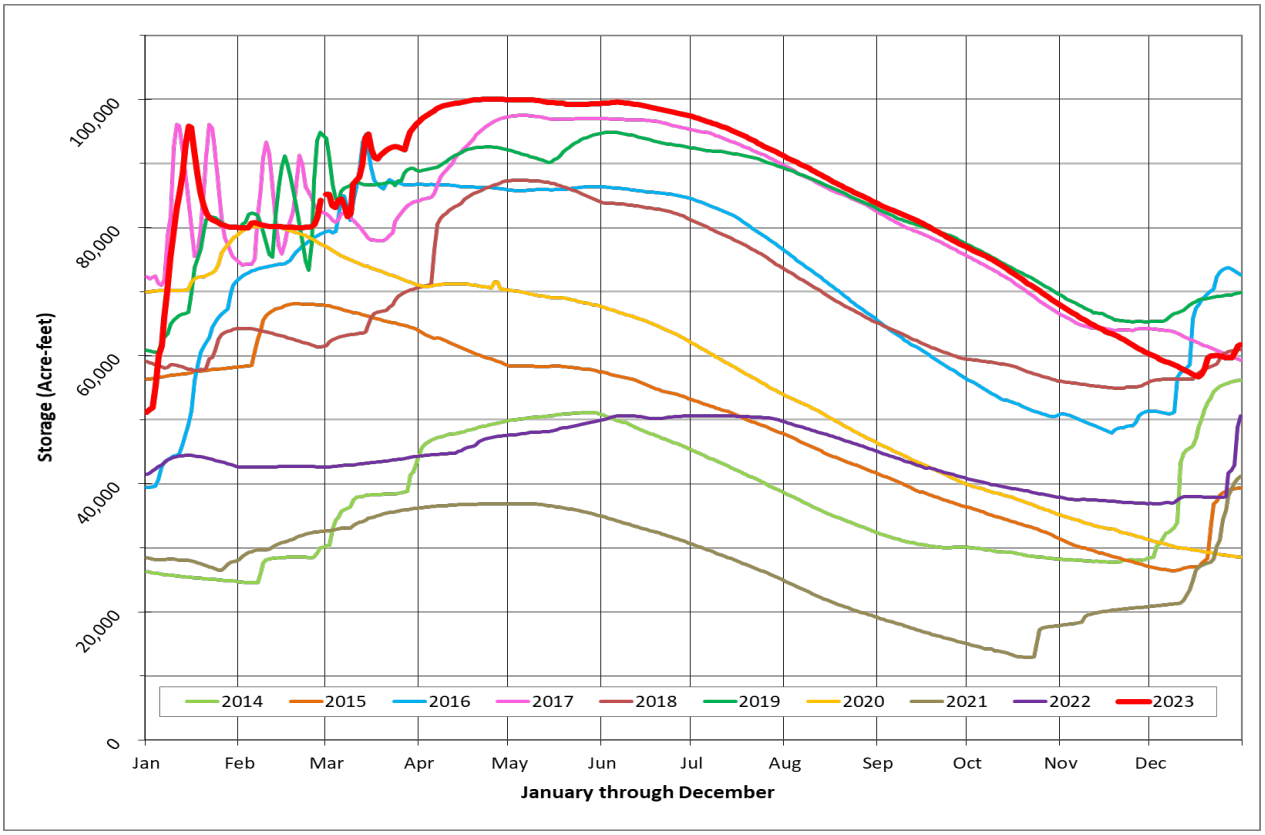


Figure 2-1. Lake Mendocino water storage levels, in acre-feet, from 2014 through 2023.

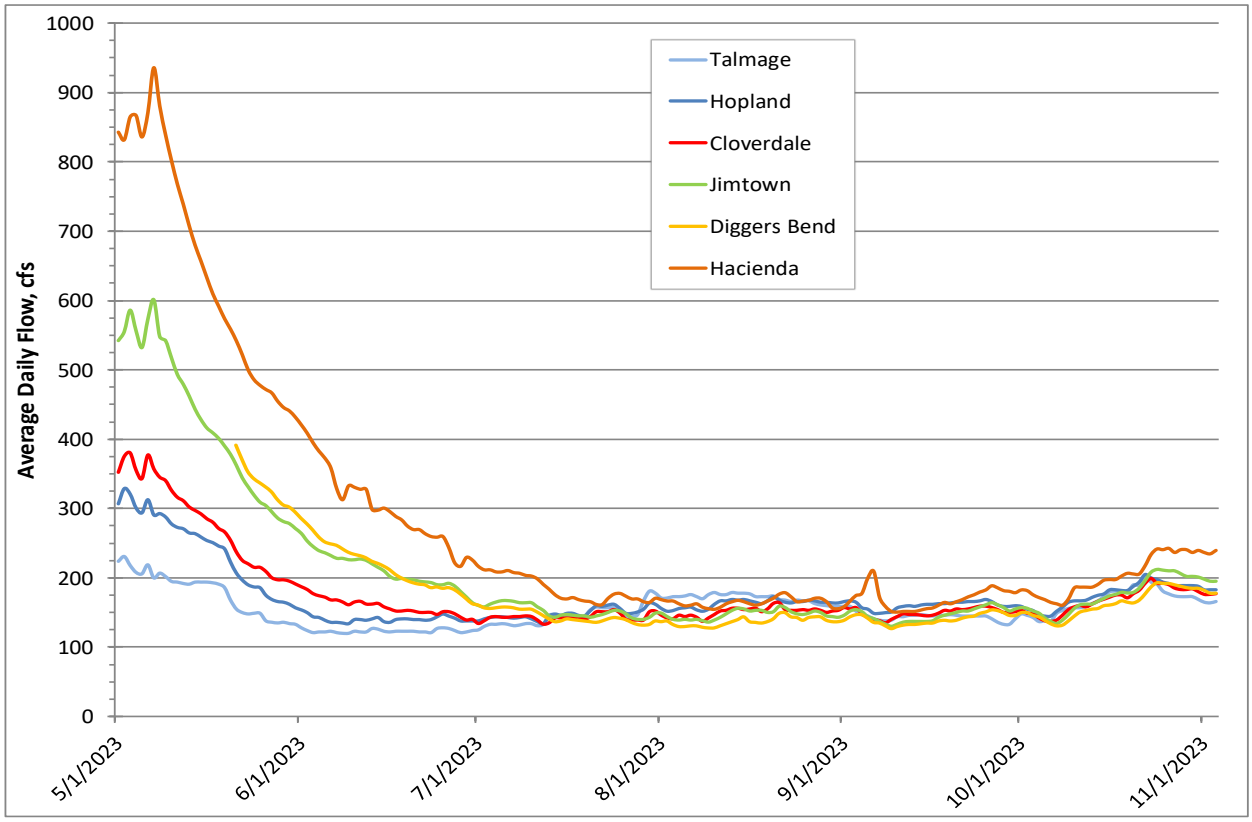


Figure 2-2. 2023 average daily flows in the Russian River as measured at U.S. Geological Survey (USGS) gages in cubic feet per second (cfs). Flow rates are preliminary and subject to final revision by USGS.

The changes in upper Russian River minimum instream flow requirements authorized by the Order allowed flows to decline below D1610 minimum instream flows of 185 cfs in late May at the Talmage and Hopland gages, at the beginning of June at the Cloverdale gage, and in late June at the Jimtown and Diggers Bend gages (Figure 2-3). Flows were also periodically below the D1610 minimum instream flows of 150 cfs that were in effect on 1 September. Additionally, upper Russian River flows did briefly decline below the TUC minimum daily average flows of 125 cfs at the Talmage station, but did not drop below the instantaneous minimum flow of 110 cfs authorized by the Order (Figure 2-3).

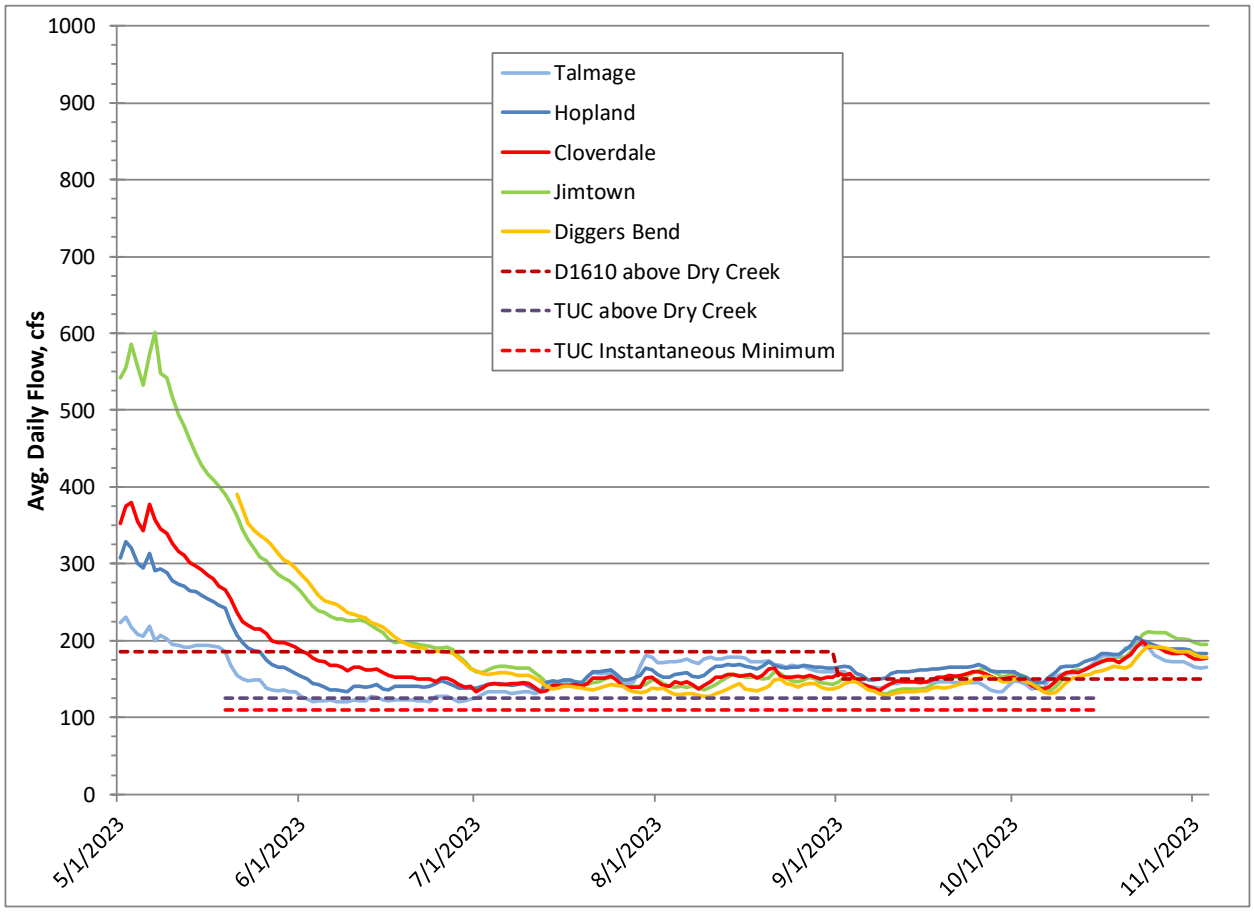


Figure 2-3. 2023 average daily flows in the upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

While the Order was in effect, lower Russian River flows at Hacienda (downstream of the confluence with Dry Creek) did not drop below the D1610 minimum flows of 125 cfs or the TUC minimum daily average flows of 70 cfs authorized by the Order (Figure 2-4).

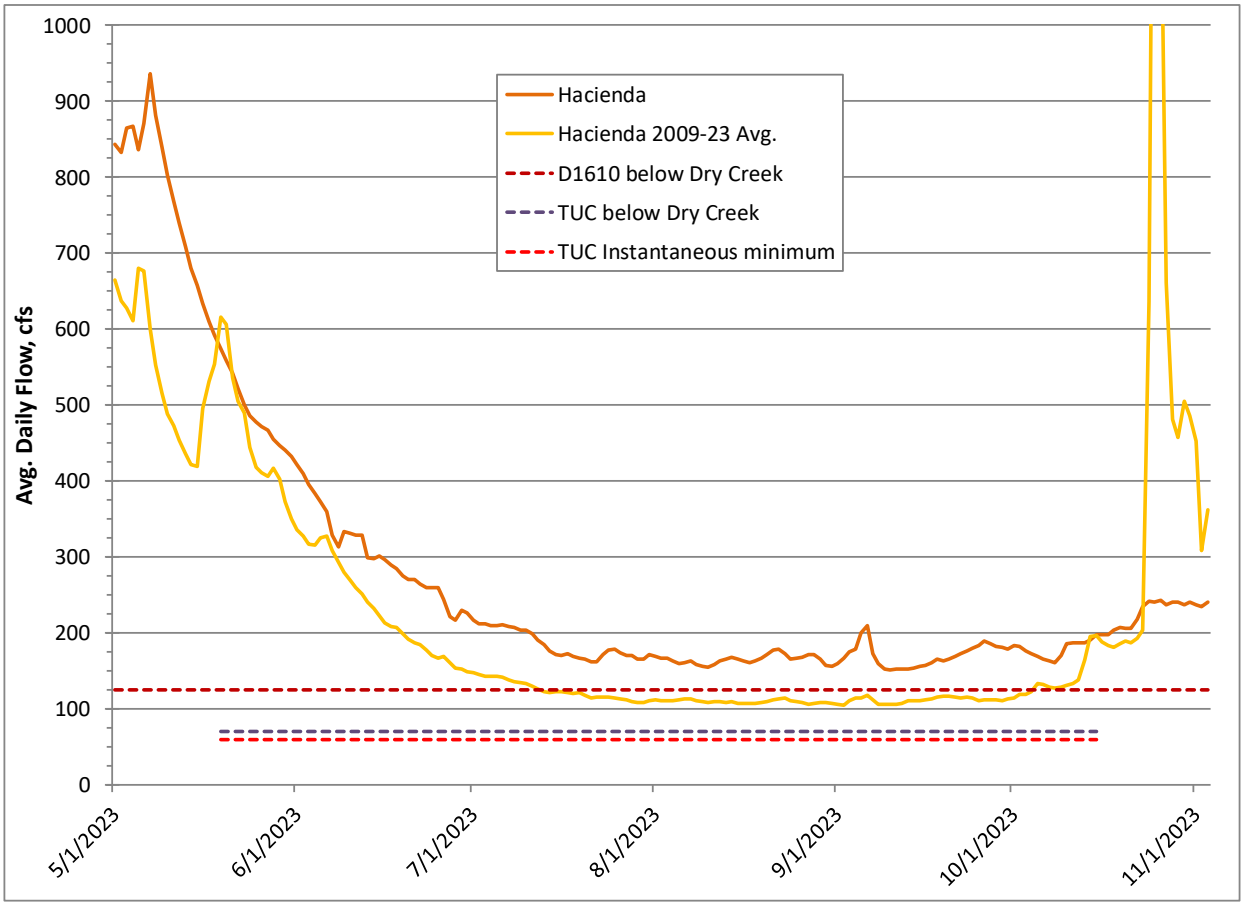


Figure 2-4. 2023 average daily flows in the lower Russian River as measured at USGS gages below the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

3.0 Water Quality Monitoring

Water quality data was collected to monitor TUC flows for potential effects to recreation and available aquatic habitat for salmonids. The data was used to supplement existing data to provide a more complete basis for analyzing spatial and temporal water quality trends due to Biological Opinion-stipulated changes in river flow and estuary management. Additional monitoring was conducted prior to and/or following the terms of the TUC Order, depending on monitoring effort. This was done to provide additional context on conditions in the watershed leading up to the period in which the Order was active and following. The results discussed below include the data collected from the period prior to and following the Order taking effect.

3.1 Mainstem Russian River Water Quality Monitoring

The North Coast Regional Water Quality Control Board (NCRWQCB), Sonoma County Department of Health Services (DHS), Sonoma Water, and Sonoma County Department of Parks and Recreation (Regional Parks) formed a workgroup to coordinate a monitoring approach for assessing cyanobacteria in the Russian River during the summer of 2016. Sonoma Water staff continue to consult and coordinate with NCRWQCB staff regarding monitoring activities related to the workgroup. As a result of ongoing consultation, Sonoma Water has made modifications to their existing Water Quality Monitoring Plan for the Russian River Estuary Management Project to include mainstem freshwater monitoring for

the purpose of assisting in the evaluation of cyanobacteria harmful algal bloom (cyanoHAB) conditions and the risk of co-factors contributing to biostimulatory conditions and nuisance blooms (e.g., flow, temperature, nutrient, etc.).

In 2023, Sonoma Water staff continued monitoring the East Fork Russian River above and below Lake Mendocino, as well as in Lake Mendocino itself, as part of their overall TUC Order monitoring effort to provide a better understanding of lake limnology and potential effects on water quality in the upper Russian River mainstem.

In 2023, the Sonoma County DHS conducted weekly bacteriological sampling at ten (10) beaches with recreational activities involving the greatest body contact on the Russian River between Cloverdale and Patterson Point. Sonoma Water staff conducted vertical profiling and nutrient grab sampling at three (depths) in Lake Mendocino and conducted nutrient grab sampling at two (2) stations in the East Fork Russian River located above and below the lake. Sonoma Water also conducted mainstem sampling for nutrients at five (5) sites, and algae and cyanobacteria at four (4) sites, along the Russian River between Hopland and Patterson Point to support NCRWQCB analysis and evaluation of water quality data relating to biostimulatory conditions and cyanotoxins. In addition, Sonoma Water continued to conduct long-term water quality monitoring and weekly grab sampling for nutrients, bacteria, and algae in the middle and upper reaches of the Russian River Estuary and the upper extent of inundation and backwatering during lagoon formation, between Patty's Rock in Jenner and Vacation Beach in Guerneville, including in two tributaries.

3.1.1 Sonoma County DHS Seasonal Mainstem Bacterial Sampling (Beach Sampling)

The Sonoma County DHS conducts seasonal bacteriological sampling to monitor levels of pathogens at ten (10) Russian River beaches with recreational activities involving the greatest body contact. Results are used by the Sonoma County DHS to determine whether or not bacteria levels fall within State guidelines. The 2023 Sonoma County DHS seasonal beach sampling locations consisted of: Cloverdale River Park; Del Rio Woods Beach; Camp Rose Beach; Healdsburg Veterans Memorial Beach; Steelhead Beach; Forestville Access Beach; Sunset Beach; Johnson's Beach; Monte Rio Beach; and Patterson Point. Bacteriological samples were generally collected weekly beginning 30 May and continued until 5 September. The Public Health Division of the DHS Environmental Health & Safety monitors bacterial levels in the water at beaches along the Russian River and at Spring Lake Swimming Lagoon by collecting and testing weekly water samples between Memorial Day and Labor Day (Sonoma County 2022a). The samples were analyzed using the Colilert quantitray MPN method for Total Coliform and *E. coli*.

The California Department of Public Health (CDPH) developed the "Draft Guidance for Fresh Water Beaches," which describes bacteria levels that, if exceeded, may require posted warning signs in order to protect public health (CDPH, 2011). The CDPH draft guideline for single sample maximum (SSM) concentrations is: 10,000 most probable numbers (MPN) per 100 milliliters (mL) for Total Coliform; 235 MPN per 100 mL for *E. coli*; and 61 MPN per 100 mL for *Enterococcus*. In 2012, the United States Environmental Protection Agency (EPA) issued Clean Water Act (CWA) §304(a) Recreational Water Quality Criteria (RWQC) for States (EPA, 2012). The RWQC recommends using two criteria for assessing water quality relating to *E. coli* and *Enterococcus*: the geometric mean (GM) of the dataset, and changing the single sample maximum (SSM) to a Statistical Threshold Value (STV) representing the 75th percentile of an acceptable water-quality distribution. The EPA recommends using STV values for

potential recreational beach posting. However, EPA also suggests that states may use a (Beach Action Value) BAV as a more conservative, precautionary tool for making beach notification decisions. The BAV for *E. coli*, which is consistent with the CDPH SSM value, is not a component of EPA's recommended criteria, but a tool that states may choose to use as a "do not exceed" value for beach notification purposes (such as advisories). Exceedances of the CDPH SSM value for Total Coliform and the EPA BAV value for *E. coli* are highlighted in Table 3-1. It must be emphasized that these are draft guidelines and criteria, not adopted standards, and are therefore both subject to change (if it is determined that the guidelines and/or criteria are not accurate indicators) and are not currently enforceable.

There were no exceedances of the SSM for Total Coliform during the season at the ten monitoring stations. There was one (1) exceedance of the BAV for *E. coli* that occurred at the Johnson Beach station and two (2) exceedances of the BAV for *E. coli* that occurred at the Monte Rio Beach station. Results from the sampling program were reported by the Sonoma County DHS at their website and on the Sonoma County DHS Beach Sampling Hotline (Sonoma County DHS, 2022a). The 2023 seasonal results are shown in Table 3-1 and in Figures 3-1 and 3-2.

Table 3-1. Sonoma County DHS 2023 Seasonal Mainstem Bacteria Sampling Results (Sonoma County DHS, 2022a).

Date Sampled	Cloverdale River Park		Del Rio Woods Beach		Camp Rose Beach		Healdsburg Veterans		Steelhead Beach		Forestville Access Beach		Sunset Beach		Johnson's Beach		Monte Rio Beach		Patterson Point	
	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC
5/30/2023	5,485	41	1,785	30	1,223	20	154	20	960	41	1,223	10	987	31	86	10	785	10	767	<10
6/5/2023	5,172	31	4,106	73	2,142	20	3,448	41	1,860	30	1,401	20	1,467	<10	1,616	10	1,539	41	1,061	20
6/12/2023	3,873	31	1,119	<10	1,086	41	1,153	86	1,145	41	933	31	882	10	1,162	41	1,211	327*	1,354	10
6/13/2023																	1,050	63		
6/19/2023	1,616	10	1,607	41	1,039	<10	2,359	41	888	20	762	10	1,291	41	2,224	73	1,354	41	1,607	20
6/26/2023	5,794	10	988	31	911	63	801	52	638	41	794	10	613	10	1,515	41	2,247	183	987	31
7/3/2023	3,873	75	1,333	52	1,162	10	4,884	41	1,860	41	2,224	31	2,282	30	1,789	41	4,106	189	3,250	31
7/10/2023	2,755	63	1,354	20	1,259	<10	1,726	52	1,071	10	2,359	<10	1,720	41	1,553	10	9,804	63	7,270	31
7/17/2023	2,755	31	2,613	10	2,909	20	3,076	20	3,076	31	4,611	20	2,359	10	3,448	41	7,270	537*	4,352	10
7/18/2023																	3,448	139		
7/24/2023	3,076	52	2,247	31	3,873	10	1,850	31	2,247	20	3,448	63	4,611	94	5,794	63	8,664	<10	4,884	20
7/31/2023	3,255	41	3,255	<10	3,255	<10	2,755	20	2,481	<10	1,850	10	2,613	10	3,255	20	7,270	98	5,475	10
8/7/2023	2,187	<10	2,755	<10	3,448	20	2,613	10	2,098	41	2,613	<10	3,448	20	3,255	<10	4,611	199	5,172	<10
8/14/2023	4,352	63	2,014	10	3,873	20	2,247	10	1,918	10	2,967	31	3,255	<10	2,909	31	3,968	183	3,076	10
8/21/2023	2,909	109	2,046	20	2,613	10	2,755	<10	3,076	30	2,755	<10	1,723	10	3,255	345	2,481	10	2,481	<10
8/22/2023															1,935	20				
8/28/2023	3,076	74	2,247	10	2,359	31	2,247	10	1,497	10	2,359	10	2,247	10	1,989	<10	4,352	31	1,956	75
9/5/2023	2,481	110	1,187	<10	1,119	10	1,576	10	1,354	10	1,439	10	1,576	10	1,956	10	1,860	187	2,481	10

* Resample conducted for confirmatory test.

** Resample conducted for lab accident.

GREEN indicates the beach is open - bacterial level results are within State guidelines.

YELLOW indicates the beach is open, but swimming is not advised - bacterial level results exceed State guidelines.

RED indicates the beach is closed - bacterial level results exceed State guidelines and are associated with a known or suspected human sewage release.

Recommended California Department of Public Health (CDPH) Draft Guidance - Single Sample Maximum (SSM):

Total Coliform (SSM): 10,000 per 100ml

Environmental Protection Agency (EPA) Recreational Water Quality Criteria - Beach Action Value (BAV):

E. coli (BAV): 235 per 100 ml

(Beach notification is recommended when indicator organisms exceed the SSM for Total Coliform or the BAV for *E. coli*) - Indicated by yellow or red text

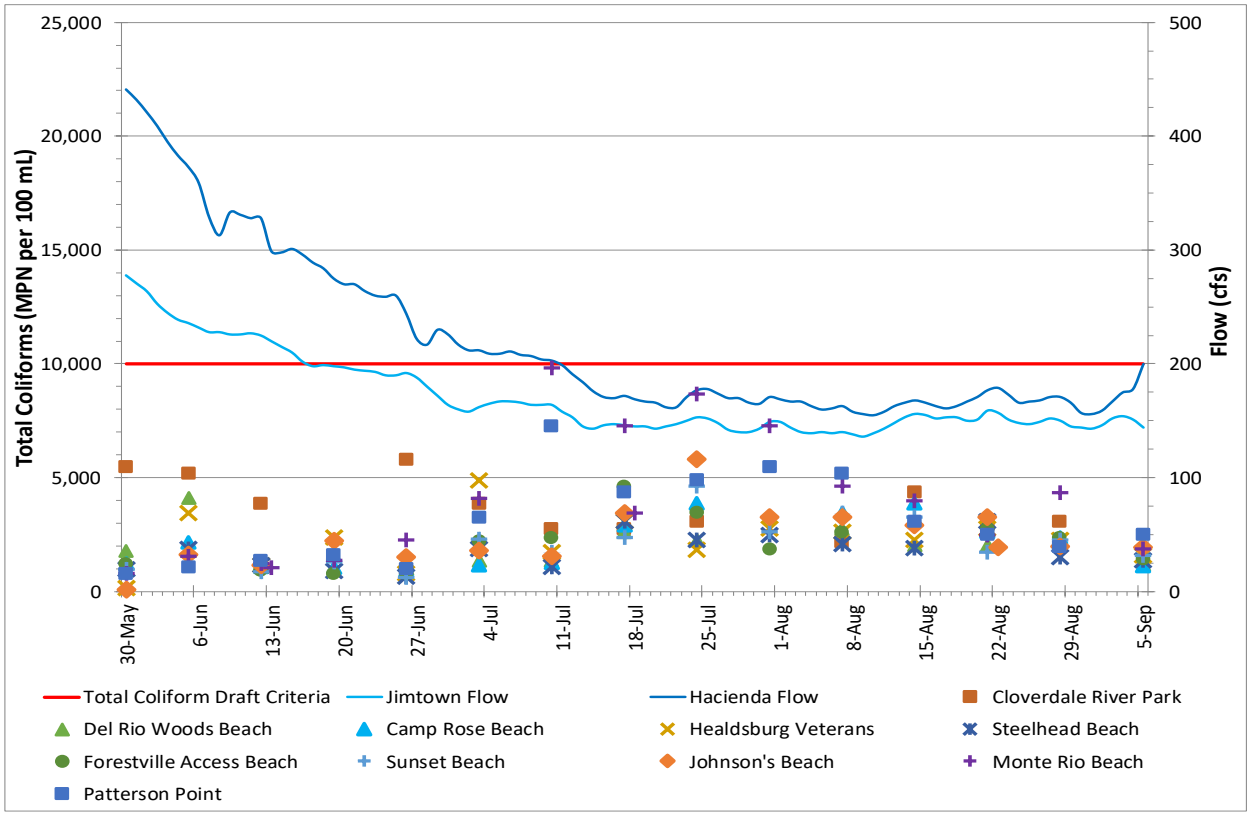


Figure 3-1. Sonoma County DHS 2023 Seasonal Mainstem Russian River Bacteria Sample Results for Total Coliform. Flow rates are preliminary and subject to final revision by USGS.

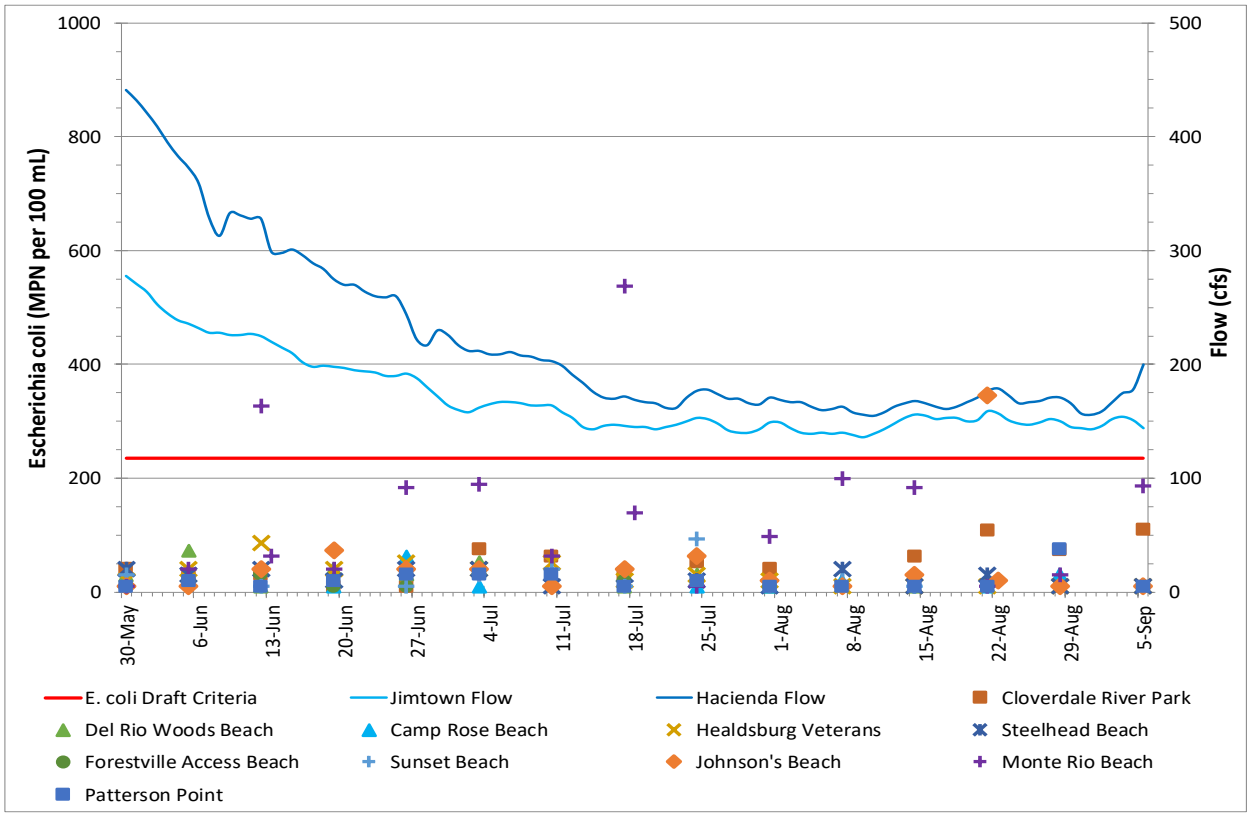


Figure 3-2. Sonoma County DHS 2023 Seasonal Mainstem Russian River Bacteria Sample Results for *E. coli*. Flow rates are preliminary and subject to final revision by USGS.

3.1.2 Sonoma County DHS Seasonal Mainstem Cyanotoxin Sampling (Beach Sampling)

The Sonoma County DHS did not conduct seasonal cyanotoxin sampling in 2023 (Sonoma County DHS, 2022b).

3.1.3 Sonoma Water Seasonal Lake Mendocino and East Fork Russian River Monitoring

Lake Mendocino Vertical Profiles

In 2023, Sonoma Water staff collected vertical profiles at Lake Mendocino near the dam using a datasonde. Vertical profiles were collected on a biweekly to monthly basis for temperature, dissolved oxygen, and turbidity from June to November as weather and access allowed (including one sample collected in January) (Figures 3-3 through 3-5). Vertical profiling was conducted in large part to track the timing and strength of stratification of the lake into a three-layered profile including: a colder, generally anoxic bottom layer known as the hypolimnion; a transitional middle layer known as the metalimnion where temperatures and dissolved oxygen rapidly increase; and a warm oxygenated layer on the surface known as the epilimnion (Figures 3-3 and 3-4). Water temperature and density differences typically form between the bottom and top layers in the spring as surface temperatures begin to rise with increasing air temperatures, creating a stratified lake profile. Stratification of the lake typically begins to break down in the fall as surface temperatures decrease, diminishing the density gradient between layers, and wind driven events contribute to the mixing of the lake. Stratification of the lake was observed at the beginning of monitoring in June and did not break down into a mixed system until early November. Turbidity values were generally observed to be higher in the hypolimnion than in the epilimnion (Figure 3-5).

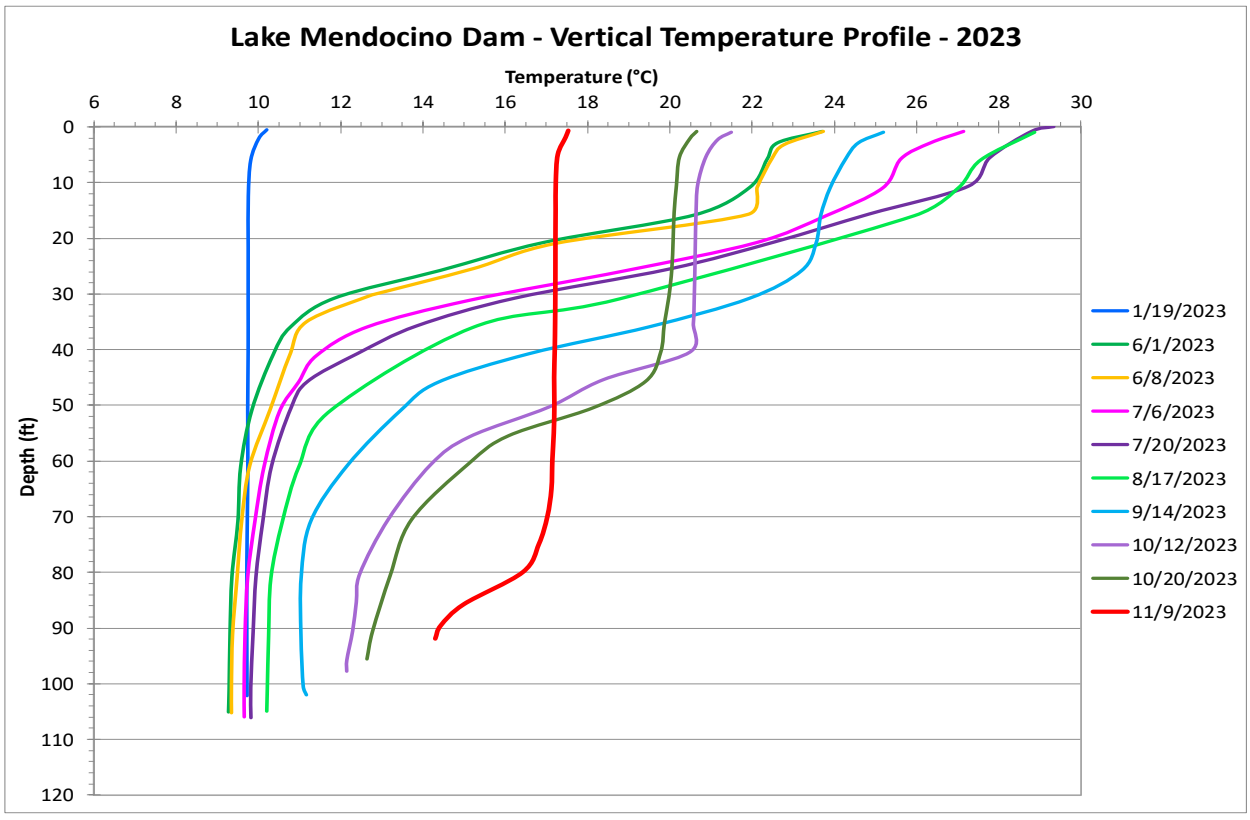


Figure 3-3. Sonoma Water 2023 Vertical Temperature Profiles in Lake Mendocino near Coyote Valley Dam.

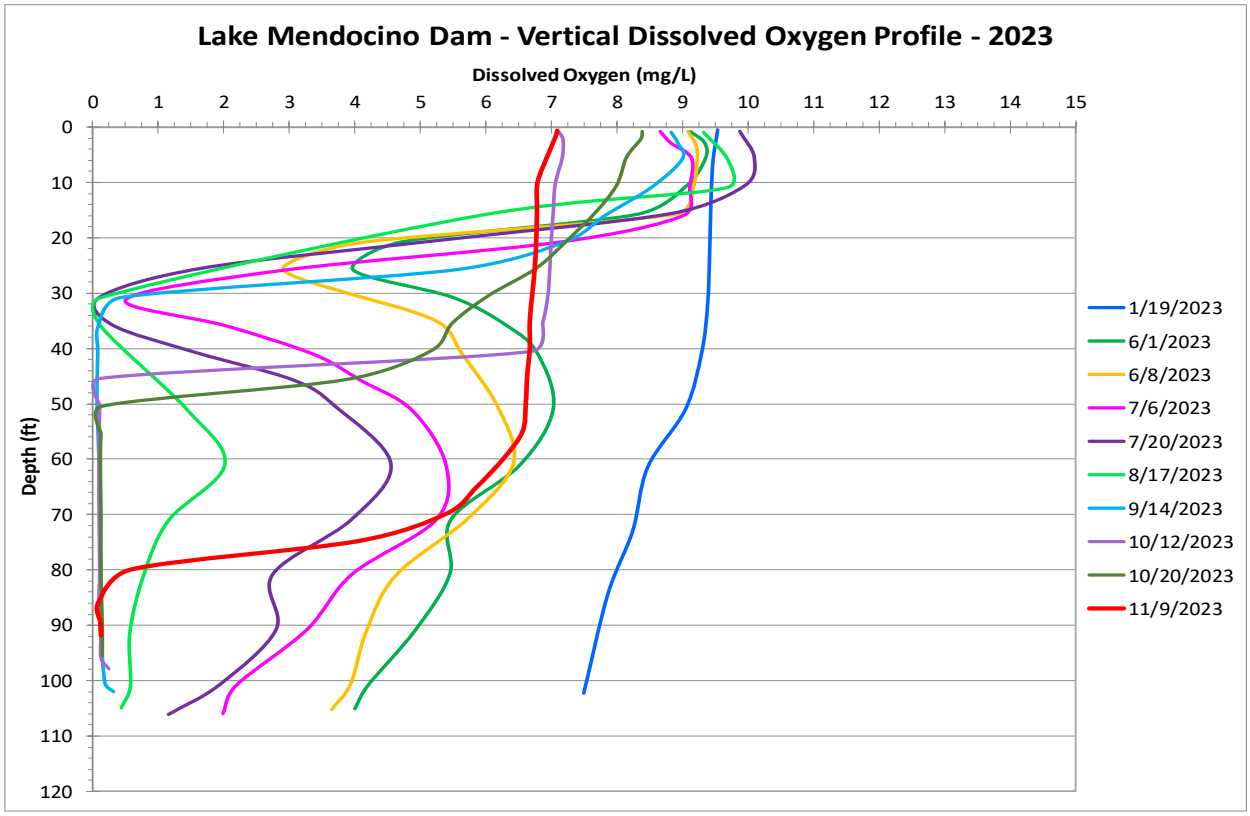


Figure 3-4. Sonoma Water 2023 Vertical Dissolved Oxygen Profiles in Lake Mendocino near Coyote Valley Dam.

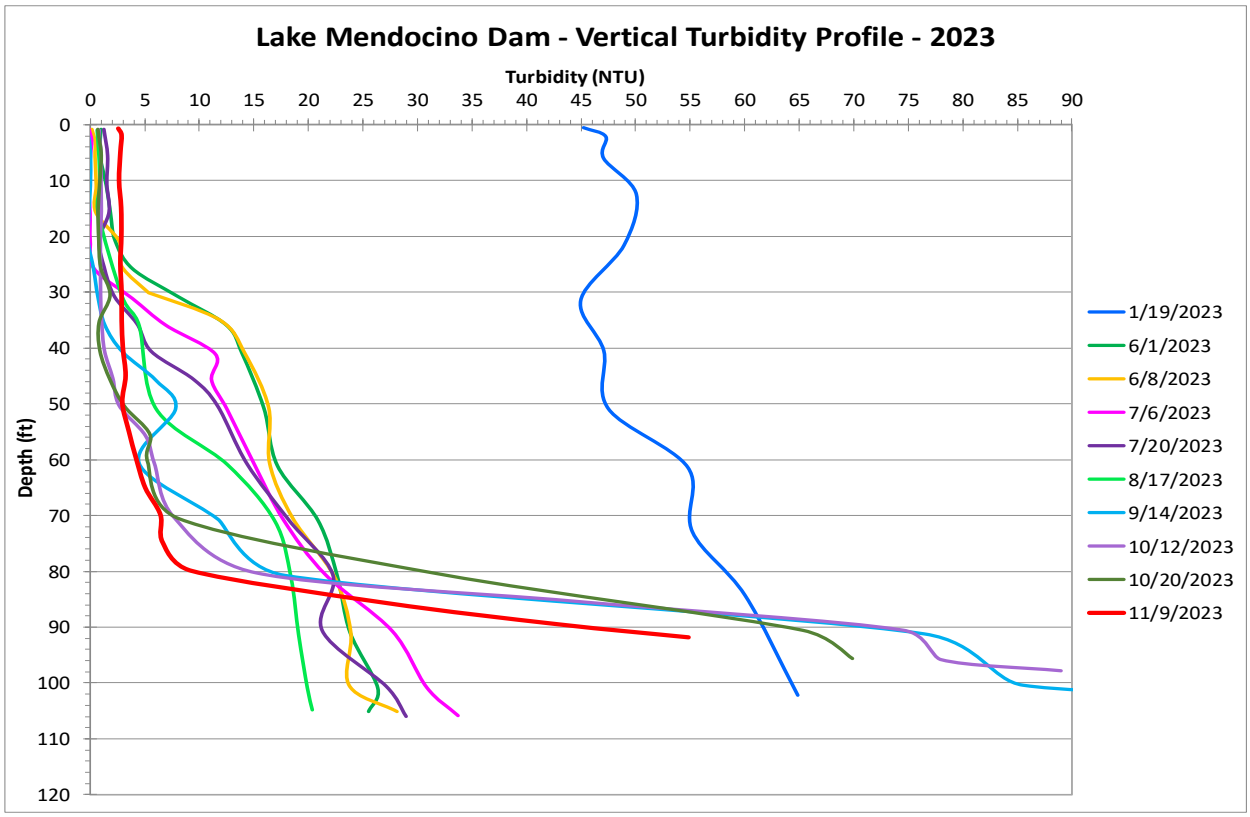


Figure 3-5. Water Vertical 2023 Turbidity Profiles in Lake Mendocino near Coyote Valley Dam.

Lake Mendocino and East Fork Russian River Grab Sampling

Sonoma Water staff generally conducted nutrient grab sampling on a bi-weekly to monthly basis during the terms of the Order at three depths in Lake Mendocino including the bottom (hypolimnion) layer, the middle transitional (metalimnion) layer, and the surface (Epilimnion) layer. Nutrient grab samples were also generally collected bi-weekly to monthly at the USGS East Fork near Calpella station (East Fork Calpella) located upstream of Lake Mendocino, and the East Fork Russian River below Dam station (East Fork below Dam) located approximately 1/3 mile downstream of Lake Mendocino.

All grab samples were analyzed for nutrients including: total organic nitrogen, ammonia, unionized ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus, and total orthophosphate. Samples were also analyzed for total dissolved solids, total and dissolved organic carbon, turbidity, and *chlorophyll a* (a measurable parameter of algal growth). Grab samples were submitted to Alpha Analytical Labs in Ukiah for analysis.

The sampling results for total nitrogen, total phosphorus, turbidity, and *chlorophyll a* are discussed below and summarized in Tables 3-2 through 3-6 and Figures 3-6 through 3-9.

The United States Environmental Protection Agency (EPA) has established section 304(a) nutrient criteria across 14 major ecoregions of the United States. The Russian River is located in Aggregate Nutrient Ecoregion III (EPA, 2022).

Highlighted values for both stations located on the East Fork of the Russian River indicate those values exceeding EPA recommended ambient water quality criteria for "Rivers and Streams in Nutrient Ecoregion III" (EPA, 2000). Lab analysis constraints in 2023 resulted in a method detection limit (MDL) for *chlorophyll a*, which is the level of accuracy for a given lab analysis to provide a valid concentration of a given constituent, that was higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Put simply, the EPA exceedance criteria for *chlorophyll a* in rivers and streams is approximately 0.0018 mg/L, whereas the lab analysis MDL for *chlorophyll a* was 0.0030 mg/L. Therefore, some lab results for *chlorophyll a* that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL, which in turn could result in an under representation of the actual number of exceedances observed. However, for reporting purposes, only those exceedances that are quantified are included in the summation.

Highlighted values for the three vertical stations located in Lake Mendocino indicate those values exceeding EPA recommended ambient water quality criteria for "Lakes and Reservoirs in Nutrient Ecoregion III" (EPA, 2001). The EPA criteria for *chlorophyll a* in lakes and reservoirs is 0.0034 mg/L, which is above the lab MDL for *chlorophyll a*, therefore, exceedance values are accurately represented for Lake Mendocino results.

Finally, it must be emphasized that the EPA criteria are not adopted standards and are therefore both subject to change (if it is determined that the guidelines or criteria are not accurate indicators) and are not currently enforceable. Sampling results for other nutrient components, dissolved and total organic carbon, and total dissolved solids are included in the tables; however, a discussion of these constituents is not included in this report.

Total Nitrogen

The EPA desired goal for total nitrogen in Aggregate Ecoregion III is 0.38 mg/L for rivers and streams (EPA, 2000). The EPA desired goal for total nitrogen in Aggregate Ecoregion III is 0.40 mg/L for lakes or reservoirs (EPA, 2001).

Calculating total nitrogen values requires the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (referred to as Total Kjeldahl Nitrogen or TKN), and nitrate/nitrite nitrogen. The EPA criteria for total nitrogen for rivers and streams was exceeded five (5) times during and following the terms of the Order, representing 27.8% of the total samples collected (5 out of 18) at the upper and lower East Fork Russian River stations (Tables 3-2 and 3-6, and Figure 3-6). The EPA criteria for lakes and reservoirs was exceeded one (1) time that occurred during the terms of the Order, representing 3.9% of the total samples collected (1 out of 26) in Lake Mendocino (Tables 3-3 through 3-5).

The East Fork Calpella station had zero (0) exceedances of the total nitrogen criteria during and following the terms of the Order out of 9 samples collected (0%), under flows that ranged from 35.5 cfs to 137 cfs (Table 3-2 and Figure 3-6). The maximum concentration occurred during the terms of the Order and measured 0.3135 mg/L on 12 October with a flow of 40.3 cfs (Table 3-2). The minimum concentration was non-detect (ND), which occurred on 9 November with a flow of 43.0 cfs. The minimum concentration during the terms of the Order was 0.058 mg/L, which occurred on 14 September with a flow of 89.9 cfs.

Table 3-2. Sonoma Water 2023 Seasonal Grab Sampling Results at East Fork Russian River near Calpella.

East Fork Russian River near Calpella	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11461500 RR Near Calpella***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
6/1/2023	14:30	16.9	8.0	ND	ND	ND	0.090	ND	ND	0.090	**0.042**	ND	1.16	1.97	90	**4.9**	**0.0040**	137
6/8/2023	14:30	18.1	8.0	ND	ND	ND	0.12	ND	ND	0.12	**0.033**	ND	1.06	1.56	78	**3.3**	ND	98.2
7/6/2023	14:10	20.7	8.1	ND	ND	ND	0.11	ND	ND	0.11	**0.057**	0.13	1.65	2.05	100	**3.7**	ND	90.2
7/20/2023	14:20	22.2	8.0	ND	ND	ND	0.12	ND	ND	0.12	**0.044**	ND	1.76	1.81	66	1.7	**0.0051**	72.9
8/17/2023	14:20	23.9	7.9	ND	ND	ND	0.12	ND	ND	0.12	**0.12**	0.64	1.80	1.77	91	1.4	**0.0096**	75.3
9/14/2023	15:10	21.3	8.1	ND	ND	ND	0.058	ND	ND	0.058	**0.055**	0.12	2.01	2.06	94	1.2	**0.0045**	89.9
10/12/2023	14:30	15.3	8.1	ND	0.24	0.0025	0.071	ND	ND	0.3135	**0.045**	ND	2.09	2.23	120	0.95	**0.0040**	40.3
10/20/2023	13:40	16.0	8.1	ND	ND	ND	0.077	ND	ND	0.077	**0.040**	0.072	2.23	1.87	120	1.2	**0.0051**	35.5
11/9/2023	13:40	11.1	7.9	ND	ND	ND	ND	ND	ND	ND	**0.030**	0.051	2.05	2.23	120	0.50	**0.0035**	43.0

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station.

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Chlorophyll a: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

The Lake Mendocino epilimnion had zero (0) exceedances of the total nitrogen criteria during and following the terms of the Order out of nine (9) samples collected (0%) at a depth of 5 feet (Table 3-3 and Figure 3-6). The maximum concentration occurred during the terms of the Order and measured 0.127 mg/L, which occurred on 6 July (Table 3-3). The minimum concentration was ND, which occurred seven (7) times during and following the terms of the Order at a depth of 5 feet.

Table 3-3. Sonoma Water 2023 Seasonal Grab Sampling Results in Lake Mendocino Epilimnion.

Lake Mendocino Epilimnion	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	Depth of Sample
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	feet
6/1/2023	13:30	22.4	8.4	ND	ND	ND	ND	ND	ND	ND	**0.029**	ND	2.55	3.17	100	1.2	**0.0061**	5
6/8/2023	13:10	22.5	8.4	ND	ND	ND	0.056	ND	ND	0.056	ND	ND	2.55	2.95	88	1.4	ND	5
7/6/2023	13:10	25.6	8.5	ND	0.11	0.017	ND	ND	ND	0.127	**0.024**	ND	2.86	3.34	100	1.7	0.0032	5
7/20/2023	13:30	27.8	8.9	ND	ND	ND	ND	ND	ND	ND	**0.026**	ND	2.96	3.20	94	**2.4**	**0.013**	5
8/17/2023	13:00	27.6	9.1	ND	ND	ND	ND	ND	ND	ND	**0.026**	ND	3.07	3.40	92	1.6	**0.012**	5
9/14/2023	13:50	24.3	8.8	ND	ND	ND	ND	ND	ND	ND	**0.026**	ND	3.00	3.14	68	1.4	**0.0067**	5
10/12/2023	13:30	20.9	8.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.68	2.90	94	1.0	**0.0099**	5
10/20/2023	12:40	20.2	8.2	ND	ND	ND	ND	ND	ND	ND	**0.022**	ND	2.93	2.64	110	1.3	**0.0083**	5
11/9/2023	12:50	17.3	7.6	ND	ND	ND	ND	ND	ND	ND	**0.024**	ND	2.38	2.38	120	2.3	**0.013**	5

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.017 mg/L (17.00 ug/L) Chlorophyll a: 0.0034 mg/L (3.40 ug/L)

Total Nitrogen: 0.40 mg/L

The Lake Mendocino metalimnion had zero (0) exceedances of the total nitrogen criteria during, and following the terms of the Order out of nine (9) samples collected (0%) at depths ranging from 20 to 70 feet (Table 3-4 and Figure 3-6). The maximum concentration was ND during all sampling events through the monitoring season (Table 3-4).

Table 3-4. Sonoma Water 2023 Seasonal Grab Sampling Results in Lake Mendocino Metalimnion.

Lake Mendocino Metalimnion	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	Depth of Sample
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	feet
6/1/2023	13:40	16.9	6.9	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	2.23	3.12	90	2.1	**0.0072**	20
6/8/2023	13:20	17.2	6.9	ND	ND	ND	ND	ND	ND	ND	**0.028**	ND	2.09	2.80	90	**2.4**	**0.015**	20
7/6/2023	13:20	18.9	6.8	ND	ND	ND	ND	ND	ND	ND	**0.028**	ND	2.14	2.54	86	2.2	**0.0080**	25
7/20/2023	13:20	20.0	7.0	ND	ND	ND	ND	ND	ND	ND	**0.028**	ND	2.53	2.61	100	1.8	**0.0093**	25
8/17/2023	13:10	18.8	6.9	ND	ND	ND	ND	ND	ND	ND	**0.041**	ND	2.31	2.40	98	1.9	**0.0048**	30
9/14/2023	14:00	19.5	7.0	ND	ND	ND	ND	ND	ND	ND	**0.023**	ND	2.52	2.62	85	**2.4**	**0.0045**	35
10/12/2023	13:40	17.1	6.9	ND	ND	ND	ND	ND	ND	ND	**0.036**	ND	2.52	2.59	110	3.1	ND	50
10/20/2023	12:50	18.1	7.0	ND	ND	ND	ND	ND	ND	ND	**0.027**	ND	2.68	2.52	110	2.5	**0.036**	50
11/9/2023	13:00	17.0	7.3	ND	ND	ND	ND	ND	ND	ND	**0.023**	ND	2.33	2.43	100	5.2	**0.0069**	70

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.017 mg/L (17.00 ug/L) Chlorophyll a: 0.0034 mg/L (3.40 ug/L)

Total Nitrogen: 0.40 mg/L

The Lake Mendocino hypolimnion had one (1) exceedance of the total nitrogen criteria that occurred during the terms of the Order out of 9 samples collected (11.1%) at a depth of 70 feet (Table 3-5 and Figure 3-6). The exceedance was also the maximum seasonal value, which measured 0.61 mg/L on 6 July at a depth of 70 feet (Table 3-5). The minimum concentration was ND, which occurred twice during and following the terms of the Order, on 12 October and 20 October at a depth of 70 feet (Table 3-5).

Table 3-5. Sonoma Water 2023 Seasonal Grab Sampling Results in Lake Mendocino Hypolimnion.

Lake Mendocino Hypolimnion	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	Depth of Sample
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	feet
6/1/2023	13:50	9.5	7.0	ND	ND	ND	0.22	ND	ND	0.22	**0.070**	0.12	1.98	3.23	110	**23**	ND	70
6/8/2023	13:30	9.6	7.0	ND	ND	ND	0.25	ND	ND	0.25	**0.066**	0.098	2.18	3.27	100	**22**	ND	70
7/6/2023	13:30	9.9	6.8	0.40	ND	ND	0.21	ND	0.40	**0.61**	**0.059**	0.11	2.34	2.68	110	**21**	ND	70
7/20/2023	13:10	10.1	6.9	ND	ND	ND	0.24	ND	ND	0.24	**0.055**	ND	2.88	2.97	220	**20**	ND	70
8/17/2023	13:20	10.6	6.8	ND	ND	ND	0.15	ND	ND	0.15	**0.069**	ND	2.73	2.93	94	**15**	ND	70
9/14/2023	14:10	11.3	7.0	ND	ND	ND	0.13	ND	ND	0.13	**0.052**	0.052	2.92	3.05	97	**9.2**	**0.0035**	70
10/12/2023	13:50	13.2	6.8	ND	ND	ND	ND	ND	ND	ND	**0.060**	ND	2.64	2.94	99	**11**	**0.0051**	70
10/20/2023	13:00	13.7	6.8	ND	ND	ND	ND	ND	ND	ND	**0.069**	0.096	3.02	3.07	110	**13**	**0.0037**	70

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.017 mg/L (17.00 ug/L) Chlorophyll a: 0.0034 mg/L (3.40 ug/L)

Total Nitrogen: 0.40 mg/L

The East Fork below Dam station had five (5) exceedances of the total nitrogen criteria during and following the terms of the Order out of 9 samples collected (55.6%), under flows that ranged from 110 cfs to 219 cfs (Table 3-6 and Figure 3-6). The maximum concentration occurred following the terms of the Order and measured 1.1 mg/L on 9 November with a flow of 179 cfs (Table 3-6). The maximum concentration during the terms of the Order measured 0.96 mg/L on 6 July with a flow of 144 cfs (Table 3-6). The minimum concentration was 0.1303 mg/L, which occurred during the terms of the Order on 12 October with a flow of 185 cfs (Table 3-6).

Table 3-6. Sonoma Water 2023 Seasonal Grab Sampling Results at East Fork Russian River below Dam.

East Fork Russian River below Dam	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USACE COY (Lake Mendocino)***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Outflow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
6/1/2023	11:50	9.9	7.3	ND	ND	ND	0.24	ND	ND	0.24	**0.077**	0.13	1.97	3.15	110	**28**	ND	110
6/8/2023	11:10	9.9	7.1	0.43	ND	ND	0.37	ND	0.43	**0.80**	**0.079**	0.10	1.63	3.49	94	**29**	**0.0072**	110
7/6/2023	11:30	10.2	6.9	0.34	0.10	0.00016	0.48	0.043	0.44	**0.96**	**0.072**	0.12	2.40	3.38	96	**30**	ND	144
7/20/2023	11:10	10.2	6.9	ND	0.12	0.00018	0.25	ND	ND	0.370	**0.074**	0.092	3.21	3.57	110	**28**	ND	170
8/17/2023	13:40	10.8	7.2	ND	ND	ND	0.18	ND	ND	0.18	**0.11**	ND	2.84	3.10	110	**21**	**0.0043**	201
9/14/2023	14:40	11.5	7.1	0.35	0.10	0.00027	0.084	ND	0.45	**0.53**	**0.19**	0.098	2.93	3.58	95	**60**	**0.0061**	189
10/12/2023	12:10	12.7	7.0	ND	0.13	0.00030	ND	ND	ND	0.1303	**0.13**	0.045	2.69	3.20	110	**37**	**0.0040**	185
10/20/2023	11:30	13.3	7.0	0.36	0.16	0.00039	ND	ND	0.52	**0.52**	**0.14**	0.10	2.98	3.42	110	**55**	**0.010**	219
11/9/2023	11:20	16.0	7.1	1.0	0.10	0.00039	ND	ND	1.1	**1.1**	**0.078**	0.063	2.52	2.80	120	**15**	ND	179

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Army Corps of Engineers (USACE) Continuous-Record Gaging Station.

**** Flow rates are preliminary and subject to final revision by USACE.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L Chlorophyll a: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Total Nitrogen: 0.38 mg/L Turbidity: 2.34 FTU/NTU

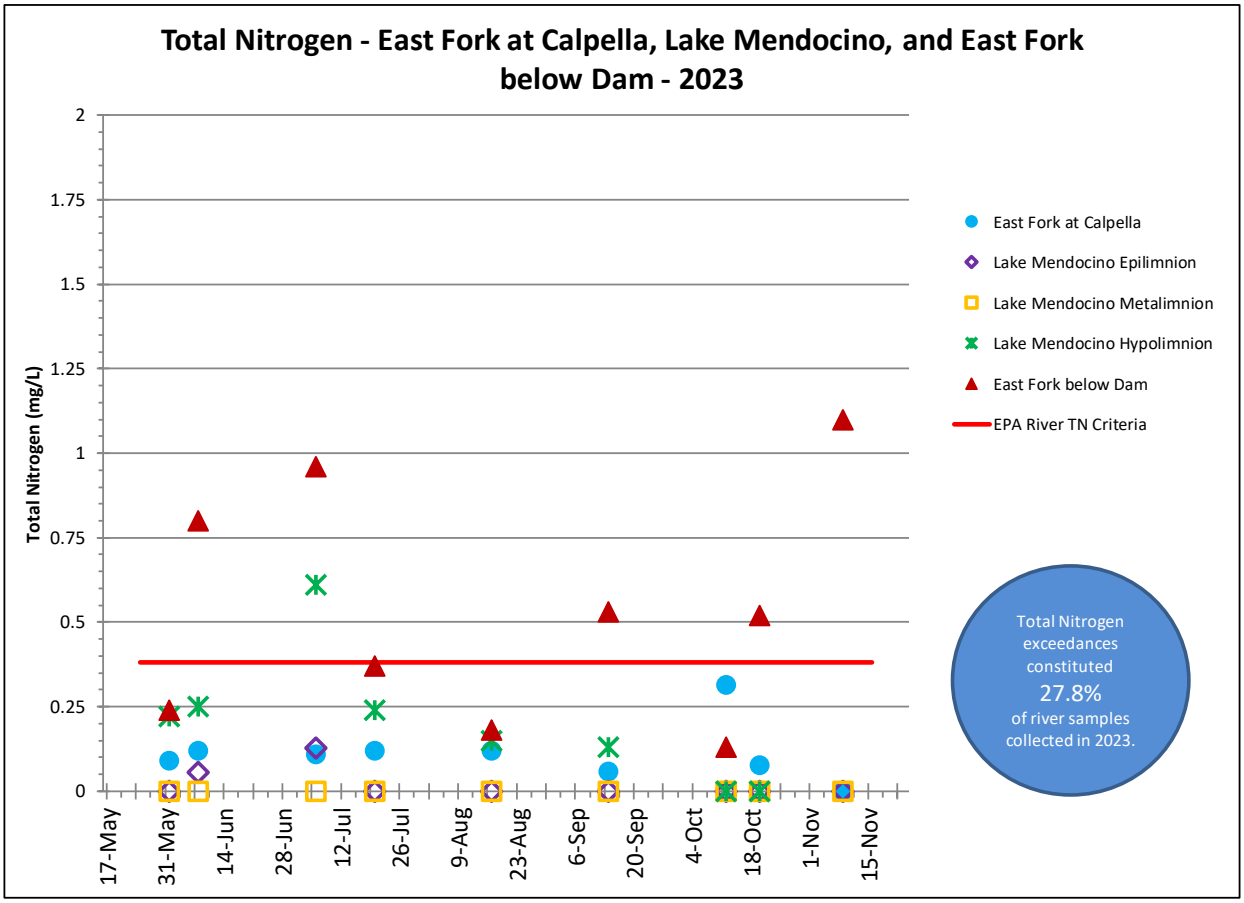


Figure 3-6. Sonoma Water Total Nitrogen results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Coyote Valley Dam in 2023. Percent exceedances only apply to samples collected at East Fork river stations.

Total Phosphorus

The EPA's desired goal for total phosphates as phosphorus for rivers and streams in Aggregate Ecoregion III has been established as 21.88 micrograms per liter (µg/L), or approximately 0.022 mg/L (EPA, 2000). The EPA's desired goal for total phosphates as phosphorus for lakes and reservoirs in Aggregate Ecoregion III has been established as 17.00 micrograms per liter (µg/L), or approximately 0.017 mg/L (EPA, 2001).

The total phosphorus criteria for rivers and streams was exceeded eighteen (18) times during and following the terms of the Order, representing 100% of the total samples collected (18 out of 18) at the East Fork Russian River stations located above and below Lake Mendocino (Tables 3-2 and 3-6, and Figure 3-7). The total phosphorus criteria for lakes and reservoirs was exceeded twenty-four (24) times during and following the terms of the Order, representing 92.3% of the total samples collected (24 out of 26) in Lake Mendocino during the monitoring effort (Tables 3-3 through 3-5).

Calpella exceeded the total phosphorus EPA criteria throughout the season during and following the terms of the Order (9 of 9 samples or 100%), under flows that ranged from 35.5 cfs to 137 cfs (Table 3-2 and Figure 3-7). The maximum concentration occurred during the terms of the Order and measured 0.12 mg/L on 17 August with a flow of approximately 75.3 cfs (Table 3-2 and Figure 3-7). The minimum concentration was 0.030 mg/L, which occurred on 9 November with a flow of approximately 43.0 cfs

(Table 3-2). The minimum concentration during the terms of the Order was 0.033 mg/L, which occurred on 8 June with a flow of approximately 98.2 cfs.

The Lake Mendocino epilimnion exceeded the total phosphorus EPA criteria for a majority of the season during and following the terms of the Order, including 7 of 9 samples (77.8%) at a sampling depth of 5 feet (Table 3-3 and Figure 3-7). The maximum concentration occurred during the terms of the Order and measured 0.029 mg/L on 1 June (Table 3-3). A minimum concentration of ND occurred twice at the Lake Mendocino epilimnion during the terms of the Order on 8 June and 12 October (Table 3-3).

The Lake Mendocino metalimnion exceeded the total phosphorus EPA criteria throughout the season during and following the terms of the Order (9 of 9 samples or 100%) at a sampling depth that ranged from 20 to 70 feet (Table 3-4 and Figure 3-7). The maximum concentration occurred during the terms of the Order and measured 0.041 mg/L on 17 August at a depth of 30 feet (Table 3-4). The minimum concentration at the Lake Mendocino metalimnion was 0.023 mg/L, which occurred twice, on 14 September at a depth of 35 feet and on 9 November at a depth of 70 feet.

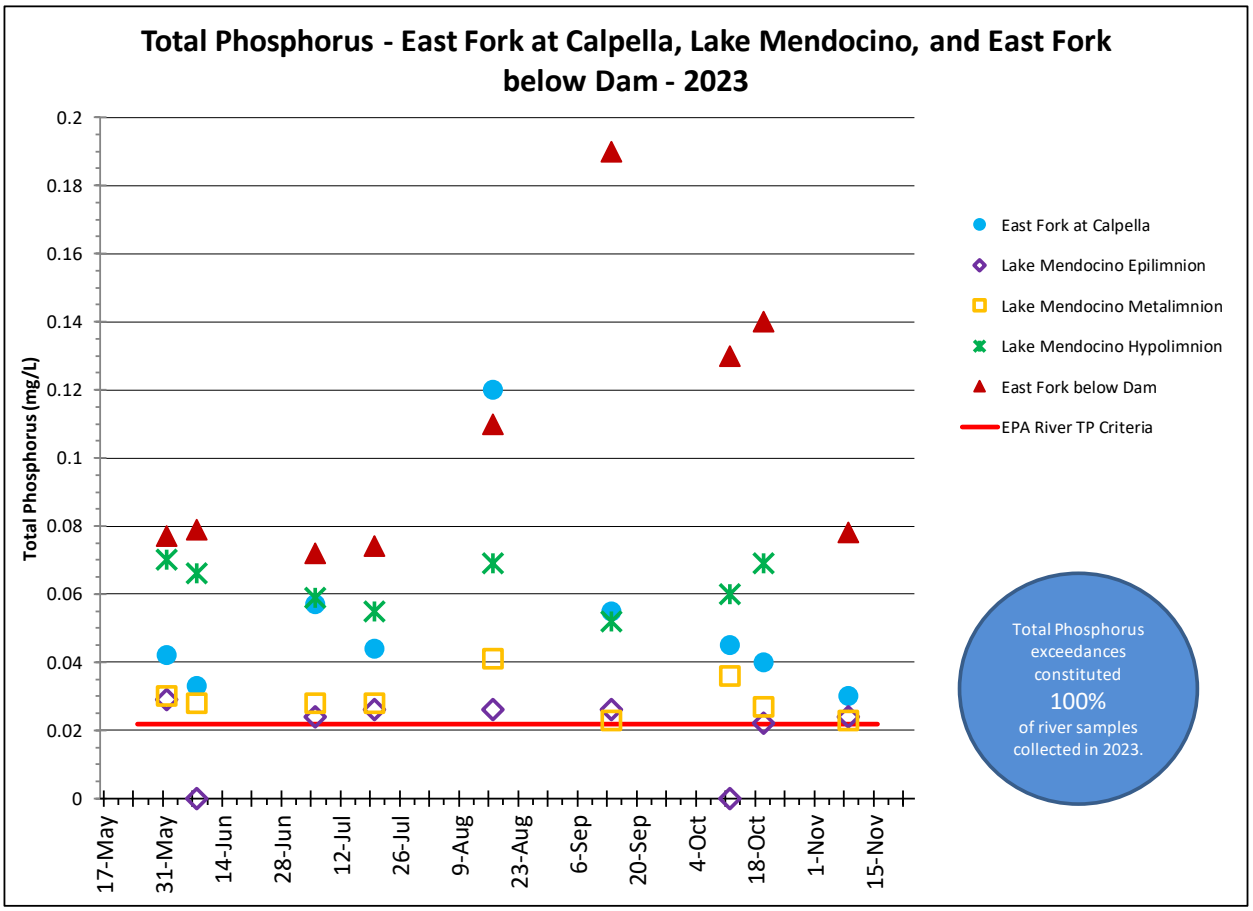


Figure 3-7. Sonoma Water Total Phosphorus results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Dam in 2023. Percent exceedances only apply to samples collected at East Fork river stations.

The Lake Mendocino hypolimnion also exceeded the total phosphorus EPA criteria throughout the season during and following the terms of the Order (8 of 8 samples or 100%) at a sampling depth of 70 feet (Table 3-5 and Figure 3-7). The maximum concentration occurred during the terms of the Order and measured 0.070 mg/L, which occurred on 1 June (Table 3-5). The minimum concentration at the

Lake Mendocino hypolimnion occurred during the terms of the Order and was 0.052 mg/L, which occurred on 14 September (Table 3-5).

The East Fork below Dam exceeded the total phosphorus EPA criteria throughout the season during and following the terms of the Order, including 9 of 9 samples (100%) at flows that ranged from 110 to 219 cfs (Table 3-6). The East Fork below Coyote Valley Dam was observed to have the highest overall concentration with a maximum value of 0.19 mg/L which occurred during the terms of the Order on 14 September with a flow of 189 cfs (Table 3-6 and Figure 3-7). The minimum concentration at the East Fork below Coyote Valley Dam occurred during the terms of the Order and was 0.072 mg/L, which occurred on 6 July with a flow of 144 cfs (Table 3-6).

Turbidity

The EPA recommended criteria for turbidity in rivers and streams is 2.34 Nephelometric Turbidity Units (NTU) (EPA, 2000). The EPA recommended criteria for turbidity in lakes and reservoirs is based on a secchi depth of 2.7 meters (EPA, 2001). Measuring the depth of visibility of a secchi disk to assess water clarity was not conducted in Lake Mendocino as part of a vertical profiling effort because two of the stations sampled occur well below visible depth. Turbidity was measured using NTU in the lake to provide additional context and a comparison to values observed in water being released from the lake as measured at the East Fork below Dam station. The EPA criteria for turbidity for rivers and streams was exceeded twelve (12) times during and following the terms of the Order, representing 66.7% of the total samples collected (12 out of 18) at the upper and lower East Fork Russian River stations (Tables 3-2 and 3-6, and Figure 3-8).

Turbidity values at Calpella were observed to remain relatively low through the monitoring season during and following the terms of the Order, with flows ranging from 35.5 cfs to 137 cfs (Table 3-2). The EPA criteria was exceeded three (3) times during the terms of the Order out of nine (9) samples collected (33.3%). A maximum value of 4.9 NTU occurred during the terms of the Order on 1 June with a flow of 137 cfs (Table 3-2). The minimum value was 0.50 NTU, which occurred following the terms of the Order on 9 November with a flow of 43.0 cfs (Table 3-2 and Figure 3-8). The minimum value during the terms of the Order was 0.95 NTU, which occurred on 12 October with a flow of 40.3 cfs (Table 3-2 and Figure 3-8).

Turbidity levels exceeded the EPA criteria at the East Fork below Dam throughout the monitoring season (9 of 9 samples or 100%) during and following the terms of the Order, with flows ranging from 110 cfs to 219 cfs (Table 3-6 and Figure 3-8). A maximum value of 60 NTU was observed during the terms of the Order on 14 September with a flow of 189 cfs (Table 3-6). The minimum turbidity value observed was 15 NTU which occurred following the terms of the Order on 9 November with a flow of 179 cfs (Table 3-6 and Figure 3-8). The minimum value during the terms of the Order was 21 NTU, which occurred on 17 August with a flow of 201 cfs (Table 3-6 and Figure 3-8).

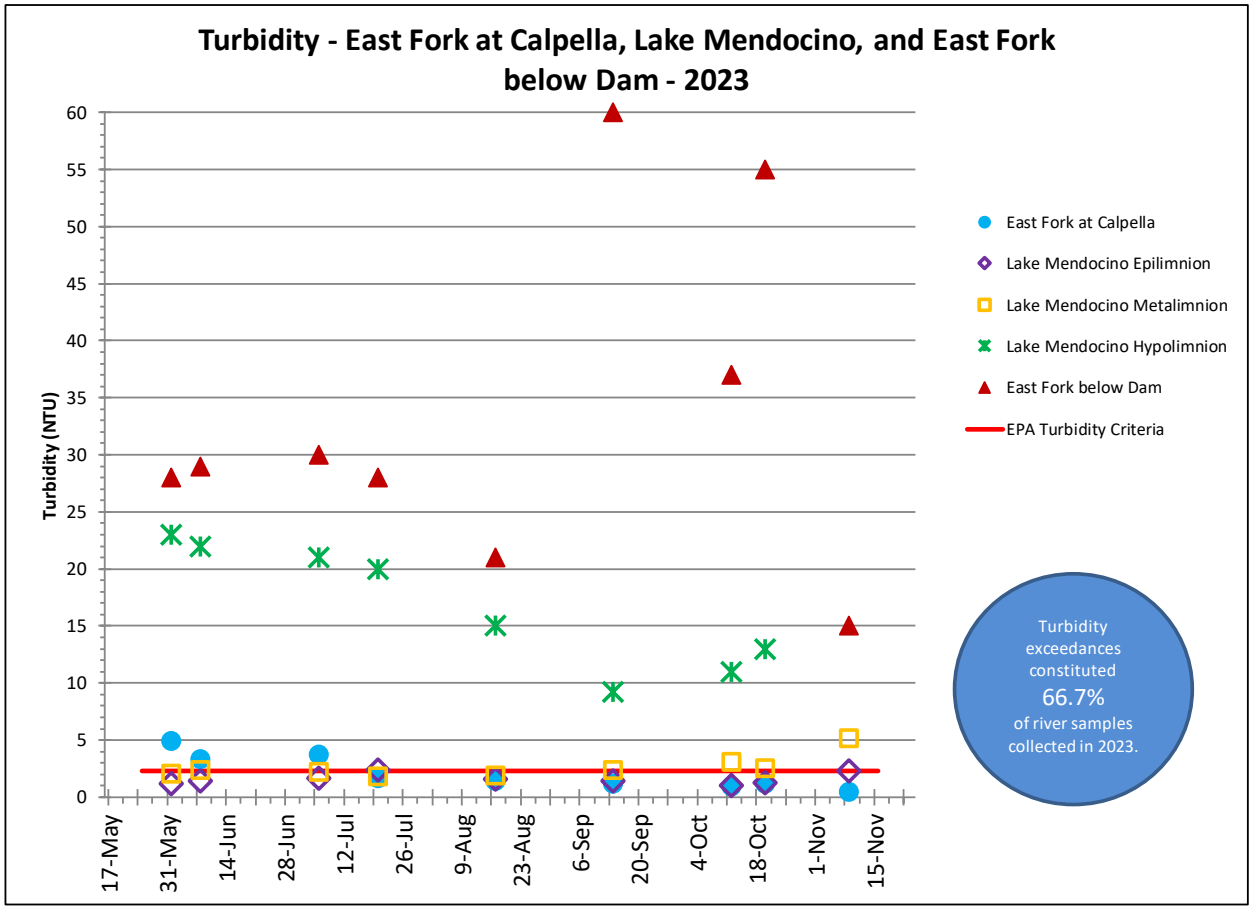


Figure 3-8. Sonoma Water Turbidity results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Coyote Valley Dam in 2023. Percent exceedances only apply to samples collected at river stations.

Chlorophyll a

The EPA criteria for *chlorophyll a* for rivers and streams in Aggregate Ecoregion III is 1.78 µg/L, or approximately 0.0018 mg/L (EPA, 2000). As mentioned above, lab analysis constraints in 2023 resulted in the MDL for *chlorophyll a* being higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Therefore, some lab results for *chlorophyll a* in rivers and streams that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL. However, for reporting purposes, only those exceedances that are quantified will be included in the summation.

In 2023, the *chlorophyll a* criteria for rivers and streams was exceeded twelve (12) times during and following the terms of the Order, representing 66.7% of the total samples collected (12 out of 18) in the East Fork Russian River at Calpella and East Fork Russian River below Coyote Valley Dam stations during the monitoring effort (Tables 3-2 and 3-6, and Figure 3-9).

The EPA criteria for *chlorophyll a* for lakes and reservoirs in Aggregate Ecoregion III is 3.40 µg/L, or approximately 0.0034 mg/L (EPA, 2001). The *chlorophyll a* criteria for lakes and reservoirs was exceeded eighteen (18) times during and following the terms of the Order, representing 69.2% of the total samples collected (18 out of 26) in Lake Mendocino during the monitoring effort (Tables 3-3 through 3-5).

Chlorophyll a exceedances occurred more predominantly at the Calpella and Lake Mendocino epilimnion and metalimnion stations and less predominantly at the Lake Mendocino hypolimnion and East Fork below Dam stations (Tables 3-2 through 3-6 and Figure 3-9).

Calpella had seven (7) *chlorophyll a* exceedances (7 of 9 or 77.8%) and two (2) non-detects, including a maximum value of 0.0096 mg/L that occurred during the terms of the Order on 17 August with a flow of 75.3 cfs (Table 3-2 and Figure 3-9). The ND concentrations occurred during the terms of the Order on 8 June and 6 July with flows of 98.2 and 90.2 cfs, respectively (Table 3-2).

The Lake Mendocino epilimnion had seven (7) *chlorophyll a* exceedances (7 of 9 or 77.8%), including a maximum value of 0.013 mg/L that occurred twice, during and following the terms of the Order, on 20 July and 9 November at a depth of 5 feet (Table 3-3 and Figure 3-9). There was one ND that occurred during the terms of the Order on 8 June (Table 3-3).

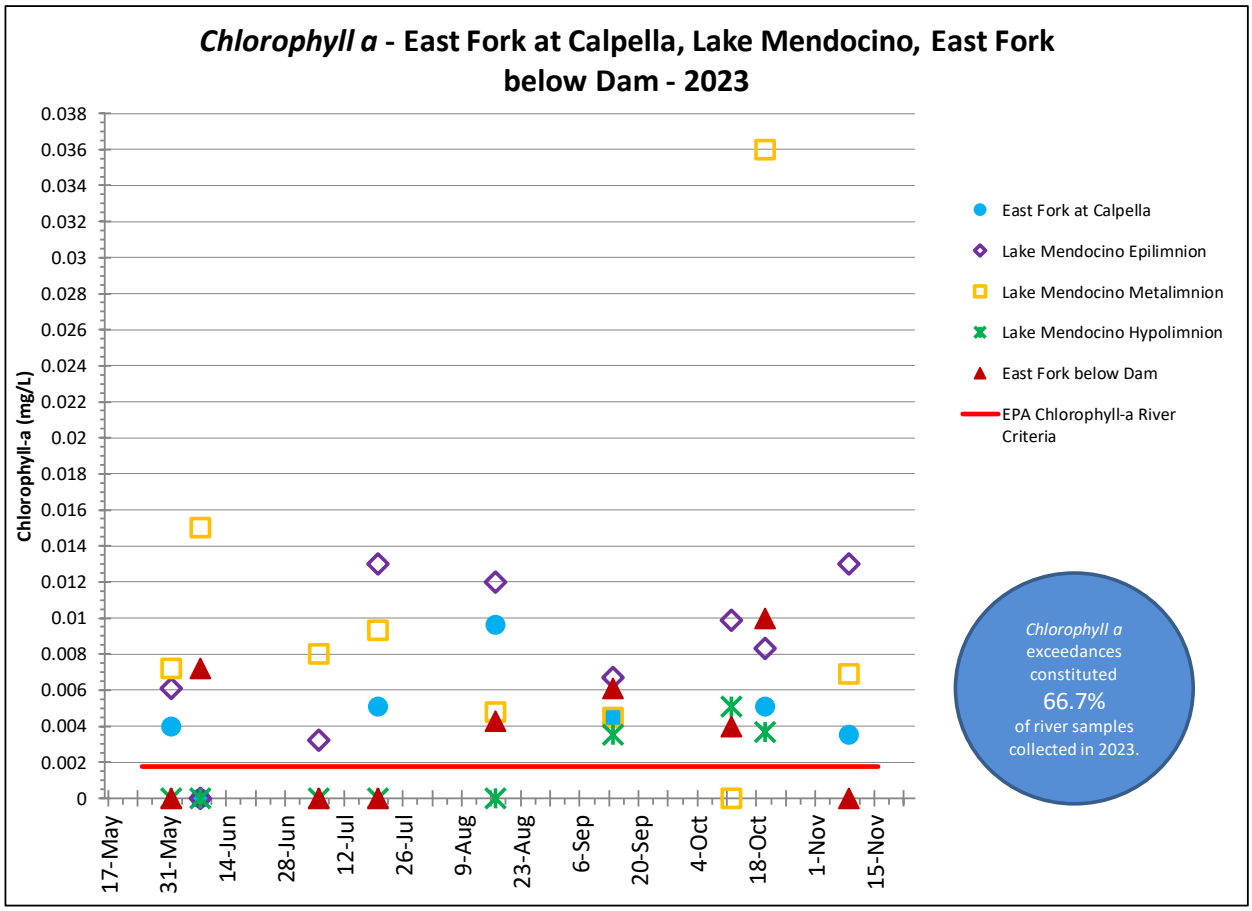


Figure 3-9. Sonoma Water Chlorophyll a results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Dam in 2023. Percent exceedances only apply to samples collected at East Fork river stations.

The Lake Mendocino metalimnion had eight (8) *chlorophyll a* exceedances (8 of 9 or 88.9%) and one (1) non-detect, including a maximum value of 0.036 mg/L that occurred following the terms of the Order on 20 October at a depth of 50 feet (Table 3-4 and Figure 3-9). The maximum concentration during the terms of the Order measured 0.015 mg/L on 8 June at a depth of 20 feet (Table 3-4). The ND occurred during the terms of the Order on 12 October at a depth of 50 feet (Table 3-4).

The Lake Mendocino hypolimnion had three (3) *chlorophyll a* exceedances (3 of 8 or 37.5%) and five (5) non-detects, including a maximum value of 0.0051 mg/L that occurred during the terms of the Order on 12 October at a depth of 70 feet (Table 3-5 and Figure 3-9). The NDs occurred during the terms of the Order between 1 June and 17 August (Table 3-5).

The East Fork below Dam had five (5) *chlorophyll a* exceedances (5 of 9 or 55.6%) and four (4) non-detects, including a maximum value of 0.010 mg/L that occurred following the terms of the Order on 20 October with a flow of 219 cfs (Table 3-6 and Figure 3-9). The maximum concentration during the terms of the Order measured 0.0072 mg/L on 8 June with a flow of 110 cfs (Table 3-6). The NDs occurred during and following the terms of the Order with flows that ranged from 110 to 179 cfs (Table 3-6).

3.1.4 Sonoma Water Seasonal Mainstem Russian River Ambient Algae and Nutrient Grab Sampling

Ambient Algae

In 2023, Sonoma Water conducted biweekly ambient algae and cyanobacterial monitoring and sampling prior to, during, and following the terms of the Order at four (4) stations including: the Hopland USGS gaging station north of Hopland; the Jimtown USGS gaging station in Alexander Valley; Syar Vineyards downstream of the confluence with Dry Creek; and Patterson Point in Villa Grande (Figure 3-10). Nutrient grab sampling was conducted at these four stations and at Cloverdale River Park as part of this monitoring effort (Figure 3-10). This effort supports the NCRWQCB and Sonoma County DHS cyanotoxin monitoring and assessment for the potential for harmful algal blooms (HABs) dominated by cyanobacteria (cyanoHABs) in the Russian River. This effort is being conducted to identify algal and cyanobacterial genera in the Russian River, as well as to estimate algal cover, frequency, and seasonal growth patterns.

Methods

Seasonal ambient algal monitoring consisted of identification of genera present, assessment of detection frequency in microscope slides, collection of algal cover data using line-intercept methodology, and the estimation of microalgae (microscopic algae including diatoms and cyanobacteria) thickness and macroalgae (relatively large filamentous algae) length along established transects at the four monitoring and sampling stations. Additionally, periphyton growth was monitored at specific locations where cyanoHABs had been observed being generated in previous years. These areas were inspected over time in order to evaluate the relationship between potential cyanoHAB generating areas and actual cyanoHAB generation.

To inform the set-up of periphyton conditions and support data collected between May and December (coinciding with the term of the TUC Order) some analysis of the late Fall, Winter and Early Spring conditions is required to understand how the previous Winter affected instream conditions. These observations are generally collected outside of the term of the TUC. These observations include an analysis of how long high flows occurred, what stage the flows reached, and how long flows were above bankfull. Flows above bankfull scour the thalweg and move sediment bedload, which reduces invertebrate grazers and algal propagules, strongly affecting periphyton development.

Figure 3-10. Russian River Ambient Algae and Nutrient Grab Sampling Stations

Multi-habitat algae samples (including a separate phytoplankton sample) were collected from the range of algae habitats in the littoral zone up to 100 feet (30 meters) upstream and downstream of the transect line. Multi-habitat samples were collected from a range of habitat and substrate types including boulders, cobble, gravel, sand, mud, woody debris, incorporated emergent or floating vegetation, metaphyton drift, edge water, riffles, pools, and backwaters. A phytoplankton sample was collected at each sampling event using a plankton net with 55µm mesh size deployed horizontally into the flow of the river. Genera observed on wet slides were identified using light microscopy. Taxa were evaluated under 10X to 400X magnification. For each monitoring event, ten (10) total slides were evaluated for each multi-habitat and phytoplankton sample to determine the frequency of occurrence of algal genera at each monitoring station. Of the ten (10) total slides evaluated, three (3) slides were made using the collected phytoplankton sample, three (3) multi-habitat slides were made using multi-habitat samples collected directly along each station's transect line, and the remaining four (4) slides were made using a multi-habitat sample collected within 100 feet of the transect line. Frequency of occurrence equals the number of times a given taxa is detected divided by the total number of detections for the whole study period or specific to a given location and sampling event. Frequency is a metric for abundance and can be calculated for each monitoring event or across the period of study.

For the convenience of analysis, algal groupings of genera are classified as: "Diatoms"; "Green Macrophytes" (filamentous and colonial green algae, desmids and the yellow-green species of *Vaucheria* and *Tribonema*); "Cyanobacteria"; and "Others" (including red algae, dinoflagellates, euglenoids, and golden-brown algae). These groupings are convenient for separating algal types based on photosynthetic pigment (chlorophyll a, c, and phycobilins), morphology (filamentous, colonial or single celled), and at microscopic and macroscopic scales.

These algal groupings follow formal taxonomy for "Diatoms" (members of the Division Bacillariophyta) and "Cyanobacteria" (members of the Division Cyanophyta or photosynthetic bacteria), which are both considered microalgae for the purposes of monitoring cover and thickness. The Genera incorporated in "Green Macrophytes" are considered macroalgae and include both filamentous and single celled members of the Division Chlorophyta (green algae) and filamentous members of Xanthophyta (yellow-green algae). Specifically, "Green Macrophytes" described here include both green and yellow green macroscopic genera dominant in the periphyton such as *Vaucheria* (yellow-green), *Cladophora* (green), *Spirogyra* (green), *Mougeotia* (green), *Oedogonium* (green), *Zygnema* (green), and *Tribonema* (yellow-green). The "Others" grouping includes the Divisions Rhodophyta (red algae), Chrysophyta and Synurophyta (together referred to as the golden-brown algae), Euglenophyta (Euglenoids), and Dinophyta (Dinoflagellates). The Others are generally a small proportion of the genera present and non-filamentous forms represent a minor component of overall diversity, not contributing to cover estimates.

For estimating cover, the periphyton was divided into two groups differentiated by their visibility without microscopic evaluation. Periphyton refers to the collection of organisms, including but not limited to algae and detritus, attached on the surface of unspecified substratum type and includes both macroalgae and microalgae. Microalgae forms a film or a coating on substrate and other algae. It is comprised of the microscopic algae genera in the periphyton dominated by diatoms and cyanobacteria, but also includes other benthic green, red, and yellow-green microscopic algal genera. Macroalgae are

the larger filamentous members of the periphyton frequently colonized by microalgae, which often breaks off and forms drifting masses (or metaphyton) during phases of its lifecycle that can accumulate in backwater areas and shallow shorelines.

Percent cover is estimated by determining the presence of microalgae and/or macroalgae at a given point location across a linear transect in the littoral zone. The number of points microalgae and/or macroalgae is present along the transect, divided by the total number of points sampled, represents the percent cover. As a metric to quantify biomass, or density of algae in the littoral zone, the thickness of the microalgae is measured and the length of the macroalgae is measured to quantify the relative contributions of microalgae and macroalgae to the overall periphyton.

Cyanobacteria in CyanoHAB Generator Zones

In 2023 as part of ambient algae monitoring along the mainstem Russian River, shallow cyanoHAB generating zones were monitored for condition, composition and cover shifts to correlate site conditions with the timing of observable cyanoHABs. CyanoHAB generating areas were identified at each monitoring site and are evaluated for development of cyanoHABs. At Patterson the HAB generating areas are associated with shallow slow water areas around the in-channel island. At Syar the cyanoHAB generating areas are the off-stream pool and shallow shelf areas along the edge and at the top of the gravel bar. At Jimtown the uniform shallow exposed area under Jimtown Bridge and along the water's edge are tracked as cyanoHAB generating areas. At Hopland shallow shelf areas associated with gravel bars are similarly evaluated.

Results

The 2023 sampling season was a year defined by a marked change in the primary boundary conditions that drive seasonal variability in summer periphyton conditions as compared to previous monitoring years. These changes included the intensity and duration of high and moderate flows in the winter and spring. The high rainfall events scoured out the thalweg, reset bed topography and supported higher than normal flows in April, May, and June. Figure 2-4 indicates average flows measured at the USGS Hacienda stream gage between 2009 and 2023, and shows that the average timing of the end of the spring drawdown was in late June to early July. In 2023 this didn't occur until late July (Figure 2-4). In addition, looking back at previous seasons of USGS gaging data at Johnson's Beach indicate that summertime stage equilibrated to 5.62 feet by 7 June in 2019, 9 February in 2020, 7 February in 2021, 30 January in 2022, but not until 14 May in 2023. To evaluate the effect this had on algal growth in the watershed, monitoring was started in early May just prior to the TUC Order taking effect on 19 May and lasted through 30 November 2023. Results are presented based on visual observations of periphyton conditions and predicted drivers, an evaluation of genera diversity and frequency, and an analysis of cover and thickness.

Visual Observations of Periphyton Conditions and Drivers

The goal of ambient algae monitoring is to understand the ecology of periphyton in the Russian River and the abiotic drivers that directly affect the conditions present during the monitoring period. These observations are included here to help define the boundary conditions both inside and outside of the monitoring period or field season, which generally runs from May to November, that shape each year's periphyton development and succession. These observations occur both during the term of the order and outside of the term of the order. These are largely abiotic drivers though each affect the biological response of the periphyton. Primary observations of periphyton condition and drivers for the 2023 field season include the following:

- *Intensity of flows* - at least two storm events occurred prior to terms of the order that reset channel conditions for the 2023 season.
- *Duration of flows* - high flows sustained close to bank full volumes for approximately 7 weeks also prior to the terms of the Order.
- *Velocity of flows* - high velocities precluding algae colonization were observed in channel through the end of June.
- *Turbidity* - high turbidity levels were sustained through the season and affected every monitoring station.
- *Level of scour* (degree of bed-load movement) - the observed level of scour was complete, completely removing the layer of periphyton in the thalweg and also removing the majority of algae grazers (snails and other herbivorous invertebrates) creating fresh unoccupied surfaces for colonization.
- *Fate of spring metaphyton bloom* - the late spring-early summer macrophyte bloom in 2023 was largely retained in the thalweg following the seasonal drawdown in the mainstem and a return to typical summertime water levels. This is as opposed to being caught out of the water on gravel bars if the bloom had occurred during elevated flows.

Diversity and Frequency Analysis

Between 3 May and 20 November 2023, 559 slides were prepared and evaluated from multi-habitat and phytoplankton tow samples collected from the four monitoring stations. Genera present in the samples were detected and identified a total of 14,847 times. Table 3-7 illustrates the frequency of algal genera observed in the mainstem Russian River between 3 May 2023, and 20 November 2023, at the four algal monitoring stations. Table 3-7 displays which algal genera were detected, their taxonomic division, the number of detections for each station, total detections across all stations, and the relative percent (by group and overall) they were detected during the 2023 sampling period. The top ten genera in the diatom group represents 56% of the diatom observations; top ten in the green macrophytes represents 80% of the observations; and top ten in the cyanobacteria represent 89% of the observations. There are only 12 representatives of "others" so the top ten represent more than 99% of the observations for that group. The red alga *Audouinella* makes up 58% of the observations in the "others" functional grouping.

Table 3-7. Algal Genera by Funtional Group Detected at Ambient Algae Monitoring Stations in the Russian River in 2023. Yellow background indicates Diatom genera, green background represents green macrophyte genera, blue background indicates cyanobacterial genera, and purple background indicates all other genera identified. Overall frequency was calculated by dividing Total Detections for each genus by the total number of detected genera. Group frequency was calculated by dividing the Total Detections for each genus by the Total Detections of each functional group.

Genus	Patterson	Syar	Jimtown	Hopland	Total Detections	Overall Frequency %	Group Frequency %
Ulnaria	127	139	137	137	540	3.64%	6.34%
Navicula	127	132	137	136	532	3.58%	6.24%
Melosira	122	134	131	139	526	3.54%	6.17%
Cocconeis	116	127	138	132	513	3.46%	6.02%
Diatoma	119	127	124	124	494	3.33%	5.80%
Amphora	121	124	133	99	477	3.21%	5.60%
Gomphonema	91	126	131	128	476	3.21%	5.59%
Nitzschia	96	101	94	128	419	2.82%	4.92%
Cymbella	74	114	119	92	399	2.69%	4.68%
Fragillaria	112	109	96	77	394	2.65%	4.62%
Synedra	106	95	94	79	374	2.52%	4.39%
Gyrosigma	102	68	88	91	349	2.35%	4.10%
Rhoicosphenia	73	100	72	102	347	2.34%	4.07%
Encyonema	58	105	89	74	326	2.20%	3.83%
Ellerbeckia	32	97	70	124	323	2.18%	3.79%
Surirella	73	72	39	94	278	1.87%	3.26%
Epithemia	88	68	50	43	249	1.68%	2.92%
Aulacoseira	84	54	45	49	232	1.56%	2.72%
Cymatopleura	96	34	25	58	213	1.43%	2.50%
Rhopalodia	83	59	14	23	179	1.21%	2.10%
Frustulia	42	39	19	58	158	1.06%	1.85%
Campylodiscus	27	40	33	47	147	0.99%	1.73%
Aneumastus	40	35	31	34	140	0.94%	1.64%
Pinnularia	58	25	21	31	135	0.91%	1.58%
Bacillaria	62	30	26	5	123	0.83%	1.44%
Cyclotella	10	18	14	45	87	0.59%	1.02%
Asterionella	28	15	5	13	61	0.41%	0.72%
Hydrosera	3	4	4	18	29	0.20%	0.34%
Total Diatom Detections	**2170**	**2191**	**1979**	**2180**	**8520**	**57.39%**	**100.00%**
Closterium	91	105	124	105	425	2.86%	11.50%
Oedogonium	102	78	101	107	388	2.61%	10.50%
Spirogyra	123	83	101	68	375	2.53%	10.15%
Cladophora	76	102	102	93	373	2.51%	10.09%
Stigeoclonium	58	86	81	74	299	2.01%	8.09%
Tribonema	79	64	50	97	290	1.95%	7.85%

Table 3-7. Continued. Algal Genera by Grouping Detected at Ambient Algae Monitoring Stations in the Russian River in 2023.

Genus	Patterson	Syar	Jimtown	Hopland	Total Detections	Overall Frequency %	Group Frequency %
Desmodesmus/ Scenedesmus	38	74	93	57	262	1.76%	7.09%
Mougeotia	104	73	45	29	251	1.69%	6.79%
Ankistrodesmus/ Selenastrum	35	43	60	24	162	1.09%	4.38%
Pediastrum/ Stauridium	28	32	56	31	147	0.99%	3.98%
Vaucheria	13	18	23	63	117	0.79%	3.17%
Tetraspora	10	13	19	35	77	0.52%	2.08%
Ulothrix	7	24	11	22	64	0.43%	1.73%
Cosmarium	2	15	21	19	57	0.38%	1.54%
Ulva	0	24	8	25	57	0.38%	1.54%
Zygnema	42	0	1	9	52	0.35%	1.41%
Chlamydomonas	14	14	7	15	50	0.34%	1.35%
Hydrodictyon	36	4	1	1	42	0.28%	1.14%
Aphanochaete	15	8	6	1	30	0.20%	0.81%
Microspora	0	6	6	15	27	0.18%	0.73%
Pandorina/ Eudorina	11	6	1	4	22	0.15%	0.60%
Rhizoclonium	5	2	11	1	19	0.13%	0.51%
Coelastrum	2	5	7	3	17	0.11%	0.46%
Gloeocystis	5	6	4	2	17	0.11%	0.46%
Sphaerocystis	6	4	1	5	16	0.11%	0.43%
Draparnaldia	1	4	3	7	15	0.10%	0.41%
Gonatozygon	11	2	0	0	13	0.09%	0.35%
Oocystis	3	4	4	1	12	0.08%	0.32%
Geminella	0	5	3	3	11	0.07%	0.30%
Gonium	1	1	1	0	3	0.02%	0.08%
Staurastrum	1	0	1	1	3	0.02%	0.08%
Dictyosphaerium	2	0	0	0	2	0.01%	0.05%
Volvox	1	0	0	0	1	0.01%	0.03%
Total Greens	**922**	**905**	**952**	**917**	**3696**	**24.89%**	**100.00%**
Leptolyngbya	103	112	113	113	441	2.97%	19.43%
Geitlerinema	100	100	104	100	404	2.72%	17.80%
Microcoleus	46	100	70	95	311	2.09%	13.70%
Oscillatoria	82	52	36	20	190	1.28%	8.37%
Anabaena	81	53	26	26	186	1.25%	8.19%
Planktothrix	50	36	36	34	156	1.05%	6.87%
Nostoc	44	16	9	40	109	0.73%	4.80%
Cylindrospermum	72	16	6	8	102	0.69%	4.49%

Table 3-7. Continued. Algal Genera by Grouping Detected at Ambient Algae Monitoring Stations in the Russian River in 2023.

Genus	Patterson	Syar	Jimtown	Hopland	Total Detections	Overall Frequency %	Group Frequency %
Lyngbya	57	4	2	2	65	0.44%	2.86%
Dolichospermum	30	18	2	4	54	0.36%	2.38%
Chamaesiphon	16	10	8	17	51	0.34%	2.25%
Phormidium	3	17	8	21	49	0.33%	2.16%
Gloeotrichia	30	11	1	4	46	0.31%	2.03%
Nodularia	27	3	1	0	31	0.21%	1.37%
Aphanothece	9	6	9	1	25	0.17%	1.10%
Merismopedia	0	3	12	1	16	0.11%	0.70%
Aphanocapsa	3	9	2	1	15	0.10%	0.66%
Calothrix	3	2	0	0	5	0.03%	0.22%
Aphanizomenon	3	1	0	0	4	0.03%	0.18%
Hapalosiphon	3	1	0	0	4	0.03%	0.18%
Arthrospira/ Spirulina	1	1	1	0	3	0.02%	0.13%
Chroococcus	0	1	0	1	2	0.01%	0.09%
Microcystis	0	0	0	1	1	0.01%	0.04%
Coelosphaerium	0	0	0	0	0	0.00%	0.00%
Woronchinia	0	0	0	0	0	0.00%	0.00%
Cyanobacteria Totals	**763**	**572**	**446**	**489**	**2270**	**15.29%**	**100.00%**
Audouinella	13	27	72	97	209	1.41%	57.89%
Euglena	11	12	7	8	38	0.26%	10.53%
Mallomonas	9	8	12	2	31	0.21%	8.59%
Synura	10	8	4	3	25	0.17%	6.93%
Lepocinclis	12	7	1	1	21	0.14%	5.82%
Phacus	2	2	1	6	11	0.07%	3.05%
Ceratium	3	3	2	3	11	0.07%	3.05%
Dinobryon	7	2	0	0	9	0.06%	2.49%
Compsopogon	3	1	0	0	4	0.03%	1.11%
Peridinium	0	0	1	0	1	0.01%	0.28%
Monomorphina	1	0	0	0	1	0.01%	0.28%
Batrachospermum	0	0	0	0	0	0.00%	0.00%
Other Genera Totals	**71**	**70**	**100**	**120**	**361**	**2.43%**	**100.00%**
Total Genera Totals	**3926**	**3738**	**3477**	**3706**	**14847**		

Diatoms were consistently found in the highest frequency across all monitoring stations, followed by green macrophytes, cyanobacteria, and the "other" genera category respectively. Figure 3-11 illustrates the overall frequency of detections for algal groupings as a percentage calculated for all stations within the monitoring season. Diatoms accounted for the majority of all detections (approximately 57%). Green macrophytes comprised 25% of detections, cyanobacteria comprised 15%, while the "others" consisted of 2% of total detections.

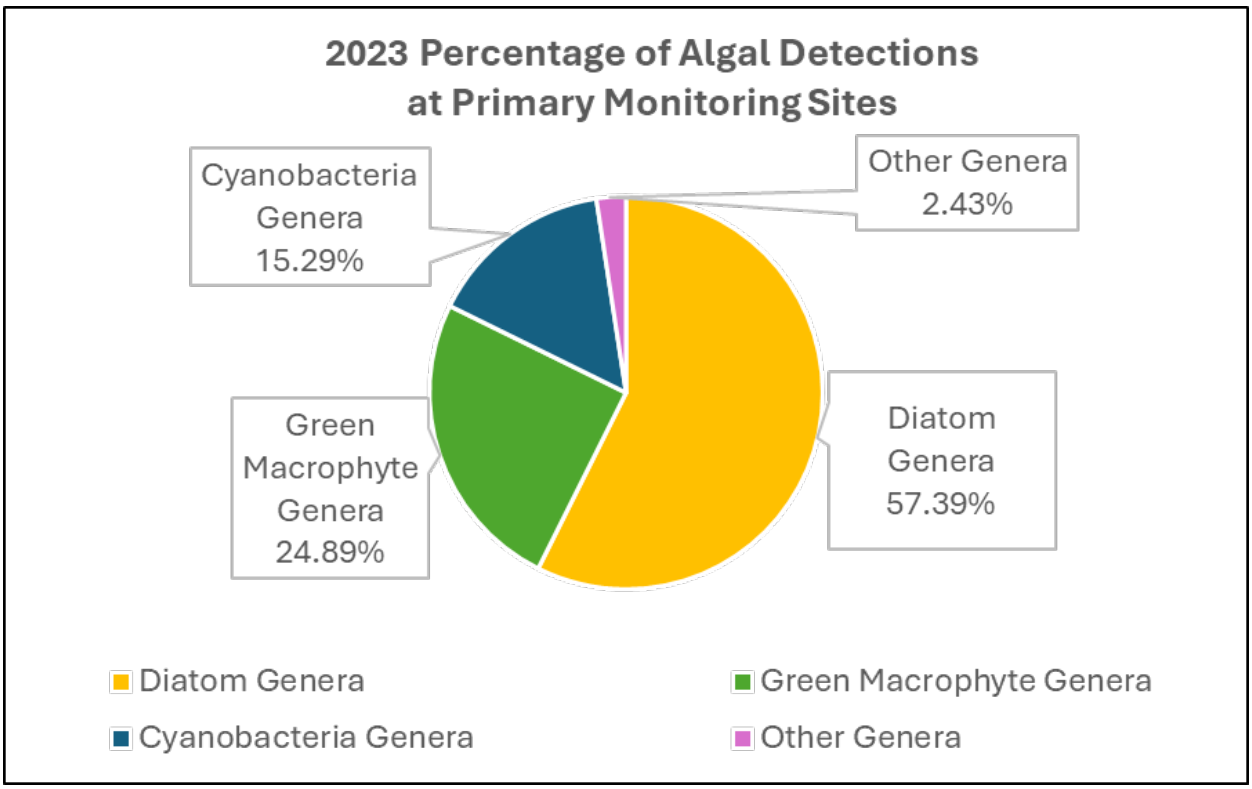


Figure 3-11. Overall Percentage of Algal Group Detections at Hopland, Jimtown, Syar, and Patterson Point in 2023.

Figures 3-12 through 3-15 illustrate the shifts in frequency of the four algal groups through the monitoring season based on the number of detections of algae genera collected from the range of algae habitats. Relative abundance can be expressed as the number of times a taxon was identified out of the number of slides evaluated or as the number of times the genus was detected out of all detections. Figure 3-16 illustrates the seasonal changes in functional groups across all stations for the 2023 season. Figure 3-17 shows the seasonality of biodiversity of genera observed at each station. Patterson Point and Syar had the greatest levels of algal diversity with Jimtown having the least amount of diversity.

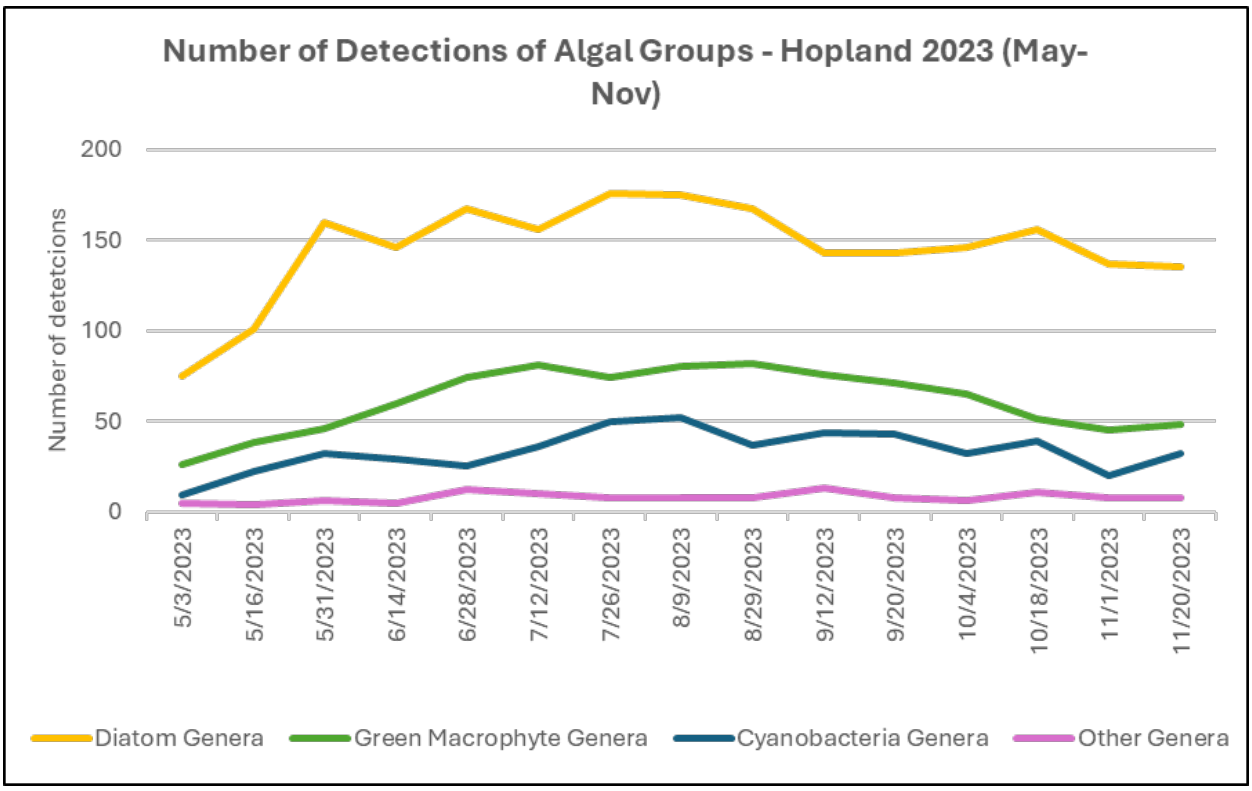


Figure 3-12. Number of Detections of Algal Groups at the Hopland Monitoring Station in 2023.

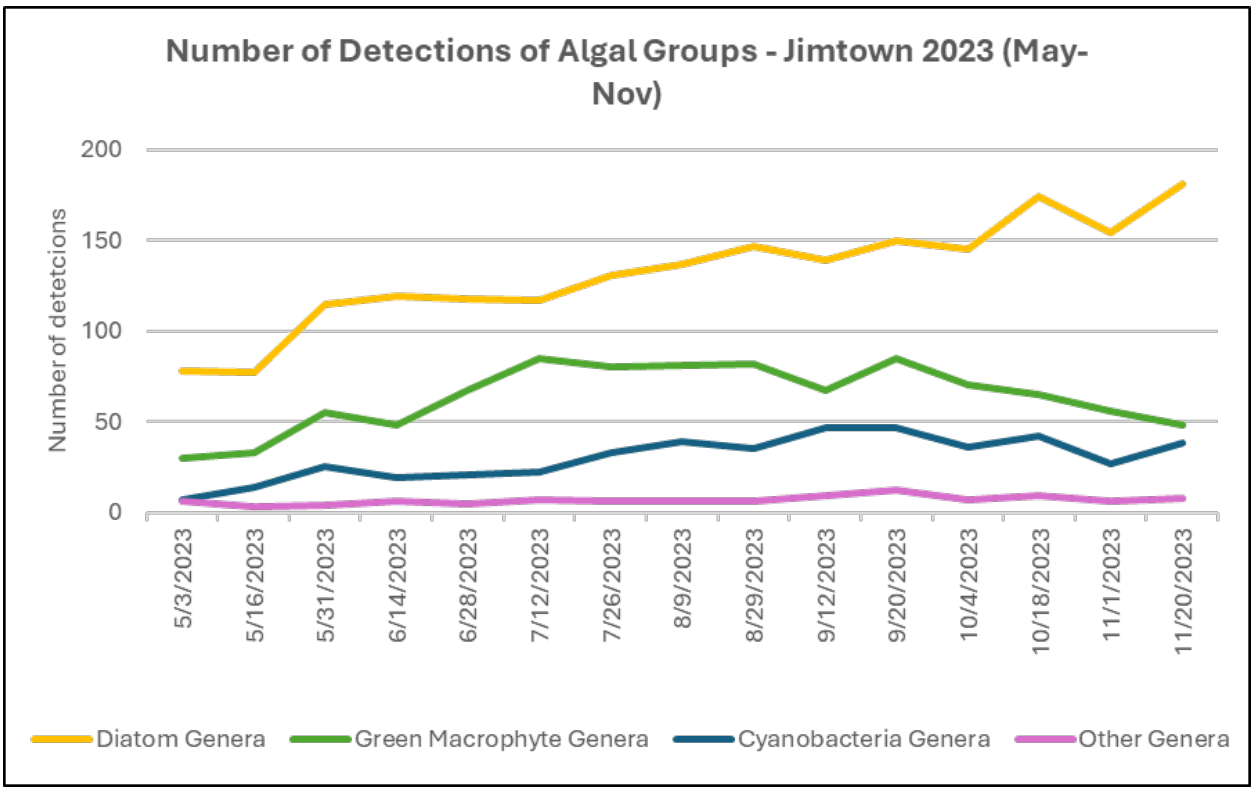


Figure 3-13. Number of Detections of Algal Groups at the Jimtown Monitoring Station in 2023.

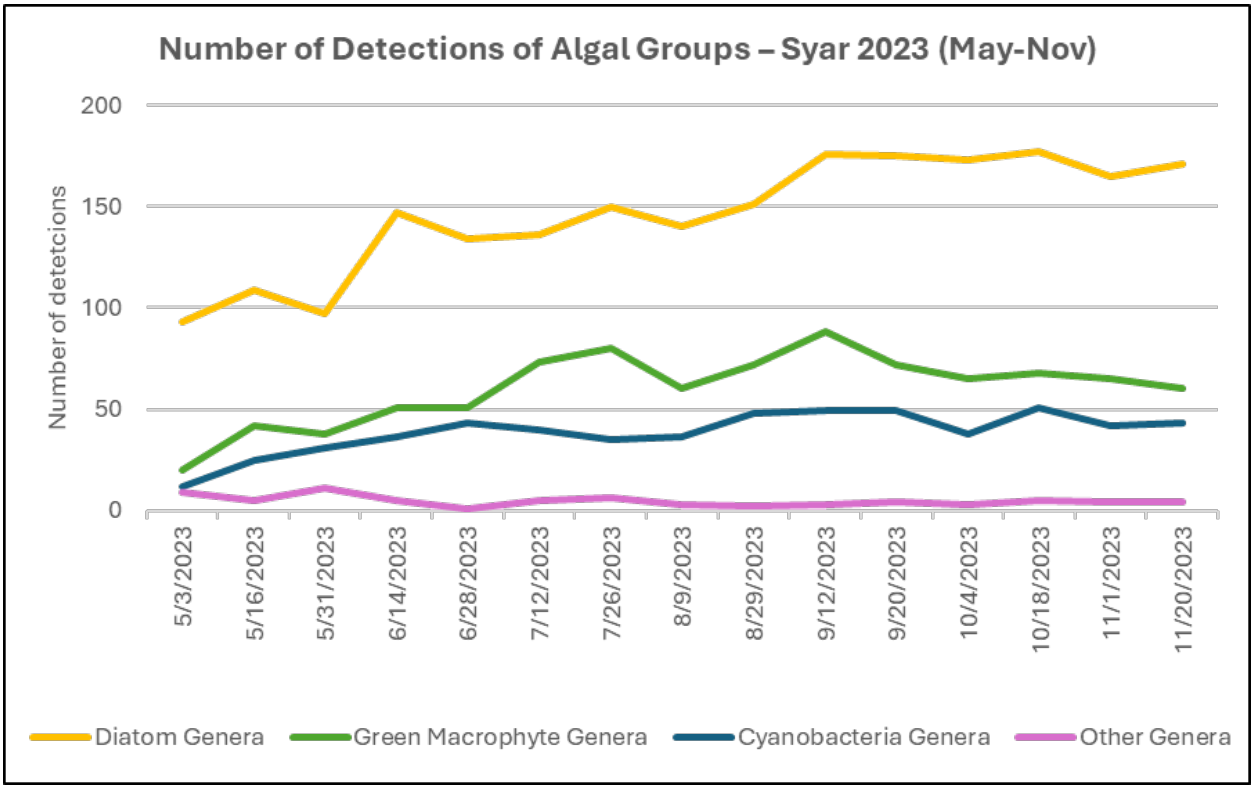


Figure 3-14. Number of Detections of Algal Groups at the Syar Monitoring Station in 2023.

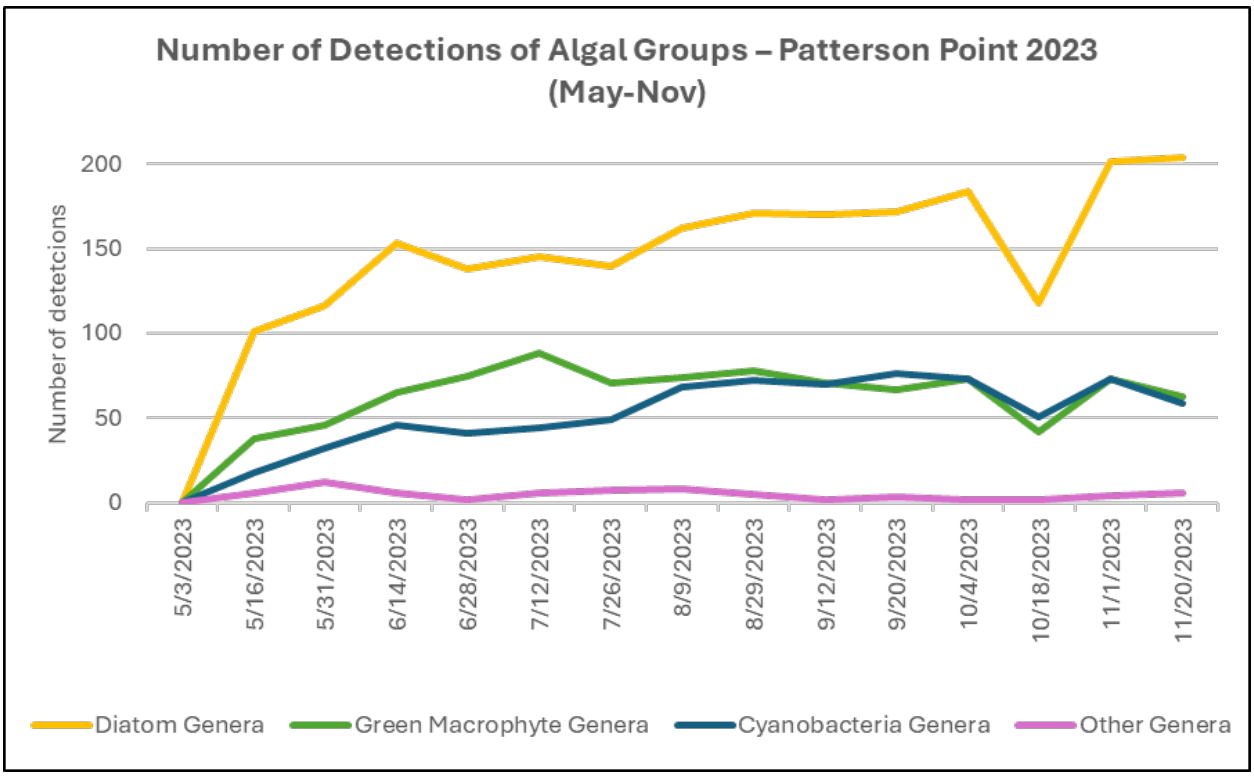


Figure 3-15. Number of Detections of Algal Groups at the Patterson Point Monitoring Station in 2023. Sampling at Patterson began almost 2 weeks later (5/16/23) than at other stations (5/3/23) due to high flows making the sample area inaccessible. An estuary closure event occurred during the 18 October sampling event. Field conditions were not wadable, so only 7 of 10 slides were evaluated.

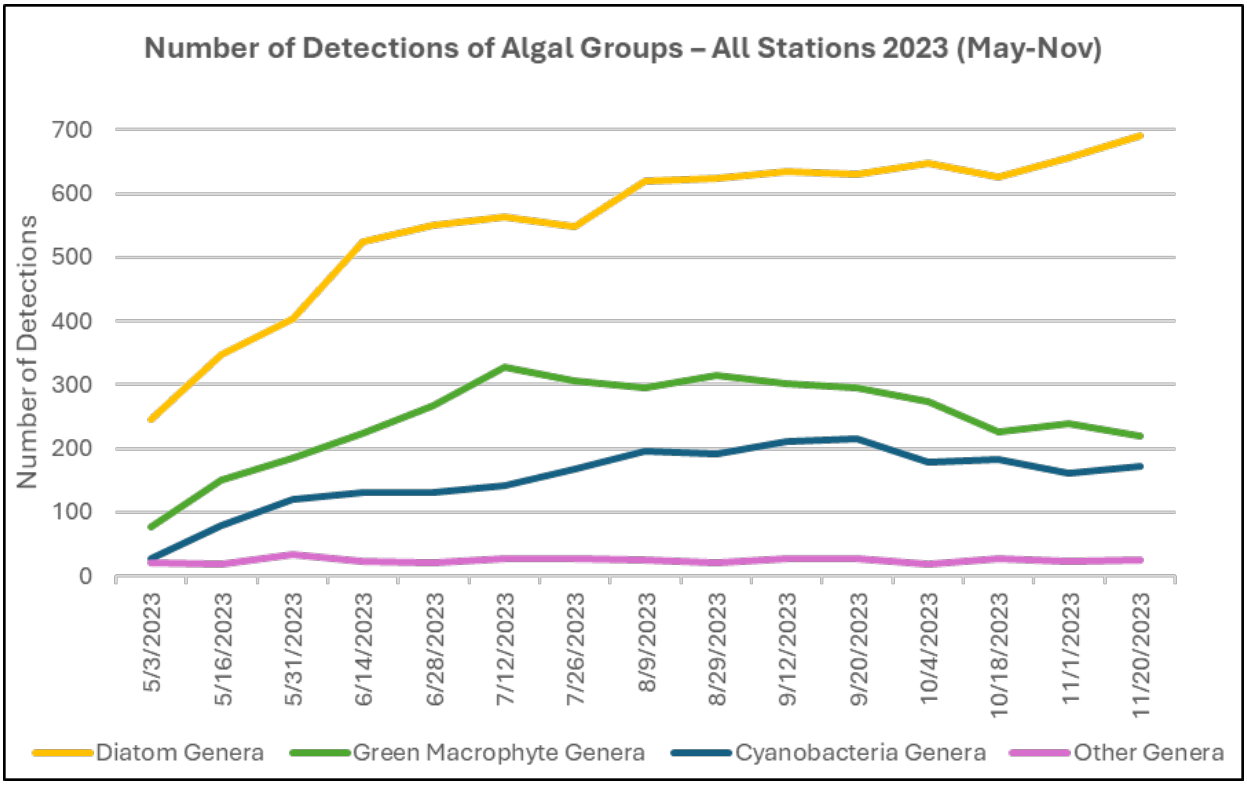


Figure 3-16. Overall Percentage of Algal Group Detections at Hopland, Jimtown, Syar, and Patterson Point in 2023.

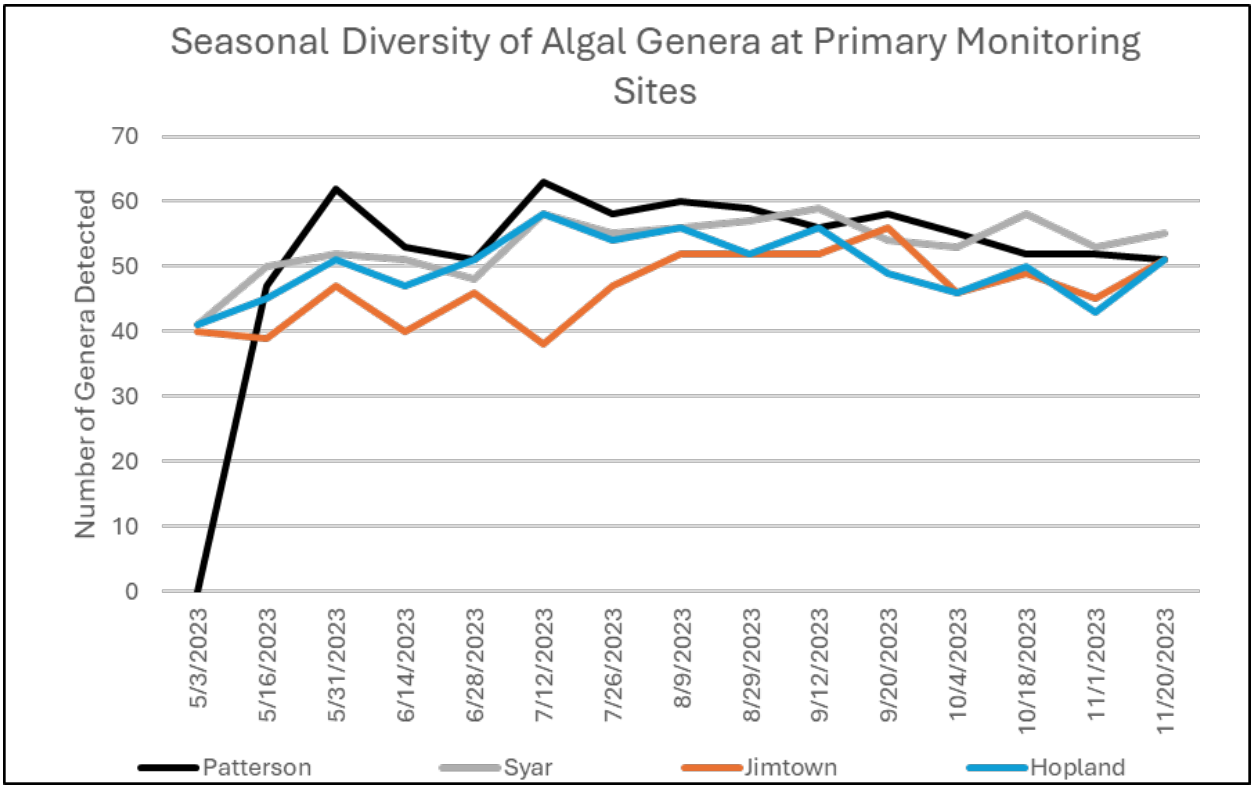


Figure 3-17. Number of Genera detected at each monitoring station in 2023. Note that Patterson was non surveyable on 5/3/23.

Cover and Thickness Analysis

Figures 3-18 through 3-21 display estimated cover contributed by microalgae (diatoms and cyanobacteria) versus macroalgae (filamentous green and yellow-green algae) at each sampling station during the monitoring season.

Microalgae clearly dominated measured cover at Hopland, Jimtown and Syar monitoring locations over the 2023 season reaching the greatest extent in October. Patterson supported the greatest cover by macroalgae, reaching 90% by late July -August, then dropping off as cyanobacteria and diatoms continued to proliferate. Hopland never developed macrophytes in water deeper than about a foot because of the turbidity and lack of light penetration. The accumulated silt at all locations also encouraged cover by both diatoms and cyanobacteria as the season progressed.

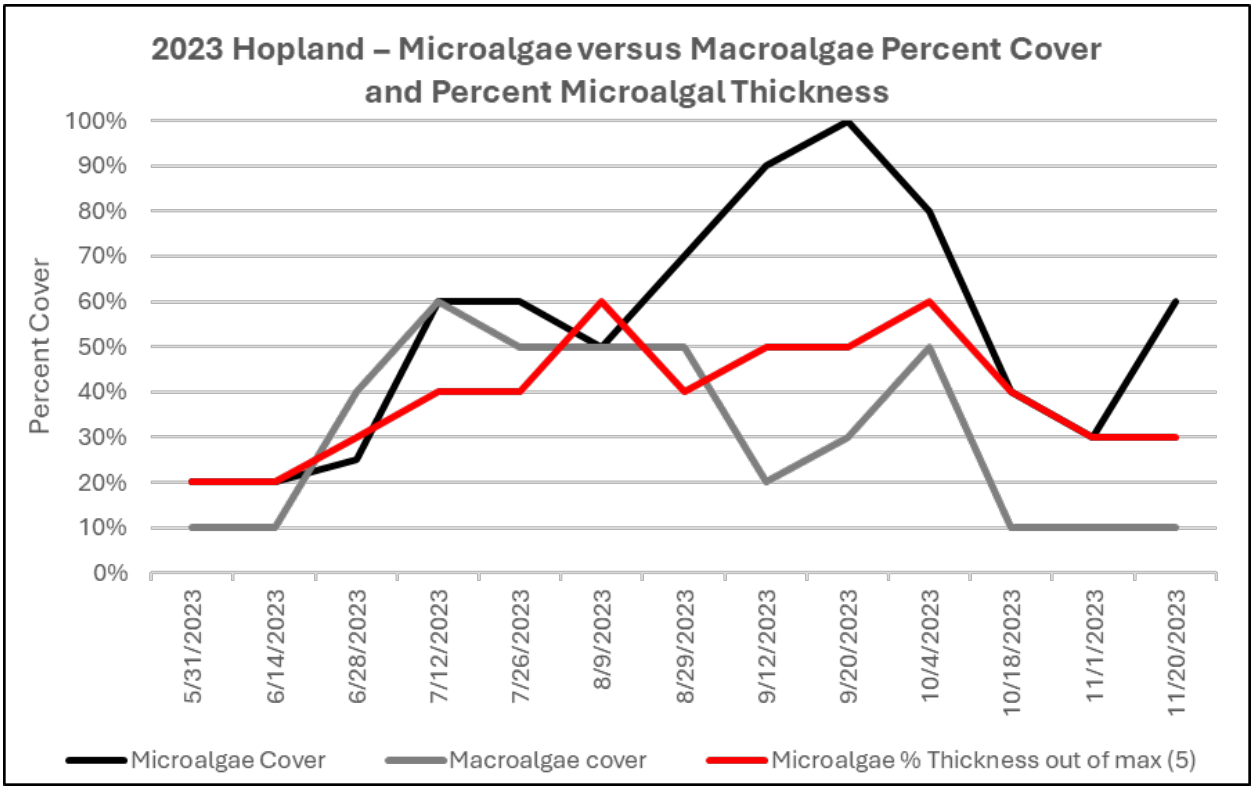


Figure 3-18. Microalgae versus Macroalgae Percent Cover and Percent Microalgae Thickness at Hopland in 2023.

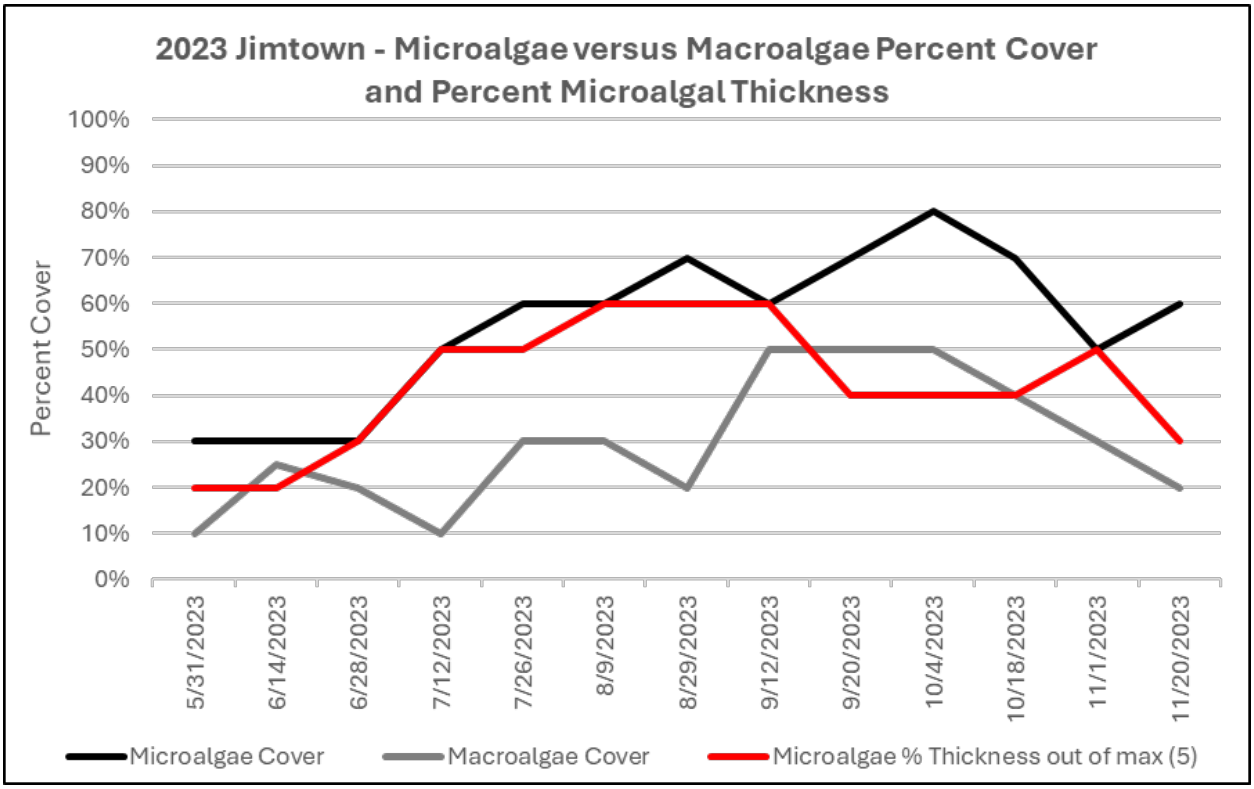


Figure 3-19. Microalgae versus Macroalgae Percent Cover and Percent Microalgae Thickness at Jimtown in 2023.

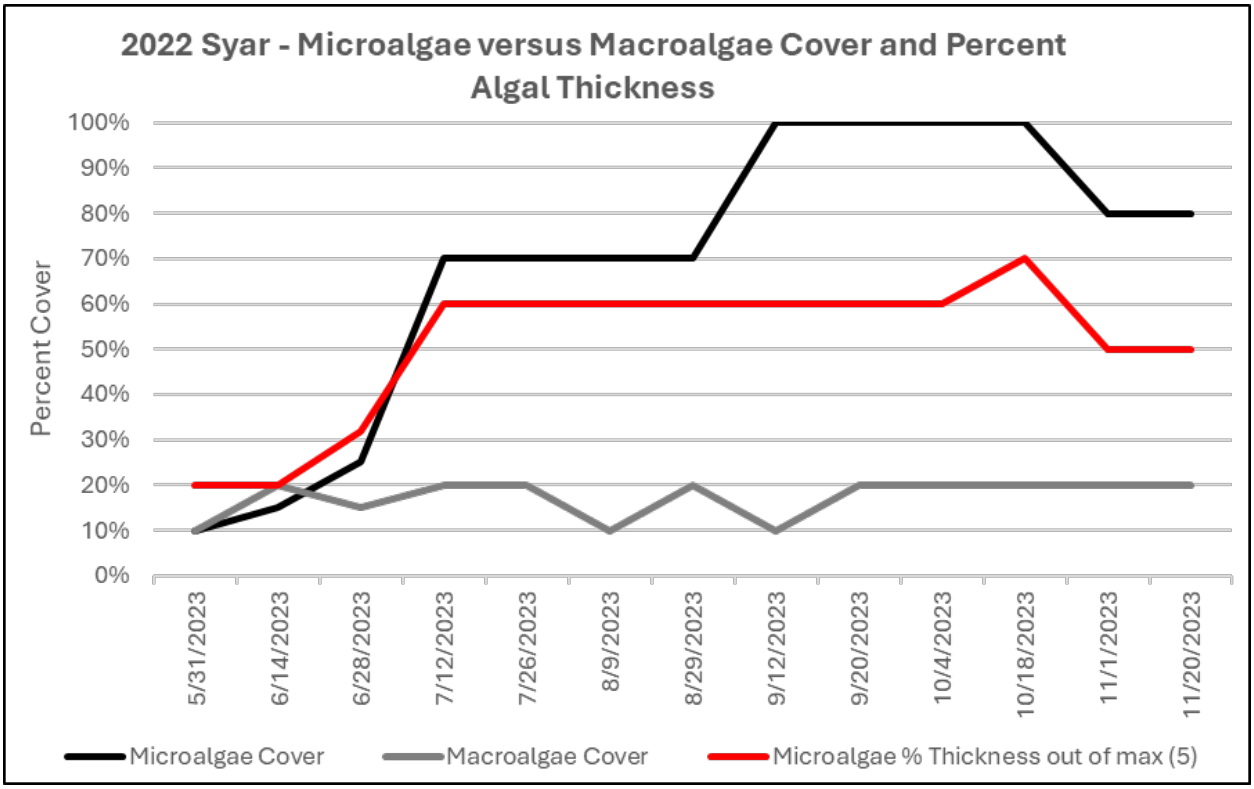


Figure 3-20. Microalgae versus Macroalgae Percent Cover and Percent Microalgae Thickness at Syar in 2023.

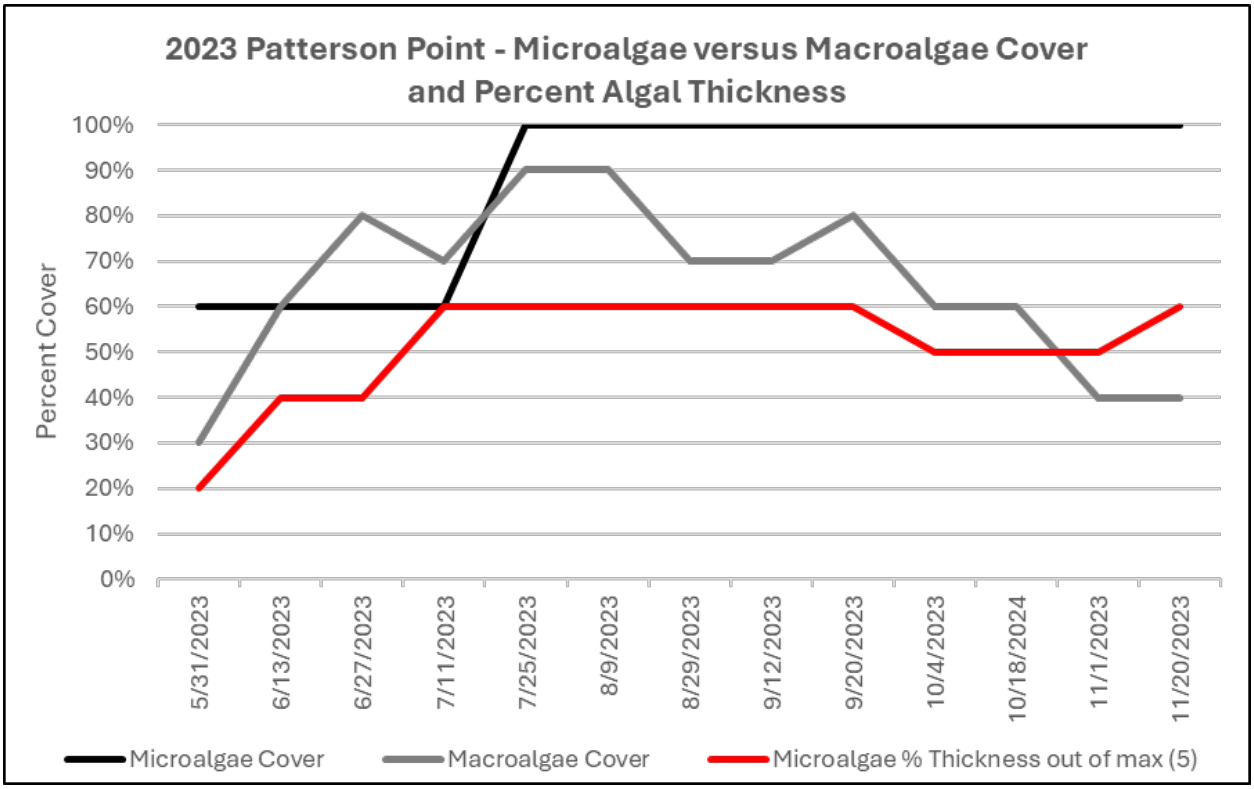


Figure 3-21. Microalgae versus Macroalgae Percent Cover and Percent Microalgae Thickness at Patterson Point in 2023.

Cyanobacteria in HAB Generator Zones

In 2023 as part of ambient algae monitoring along the mainstem Russian River, shallow cyanoHAB generating zones were monitored for condition, composition and cover shifts to correlate site conditions with the timing of observable cyanoHABs. The 2023 monitoring season did not reveal a large quantity of floating cyanoHABs compared to other years. At Patterson Point, the maximum area generating cyanoHABs never exceeded 50% of the potential area. Syar only produced cyanoHABs in an isolated off stream pool for the majority of the monitoring period but in late September *Microcoleus* mats developed on cobble and continued establishing through the end of the monitoring period. Monitoring did not occur long enough to determine if these Microcoleus mats evolved into cyanoHABs. Jimtown also was delayed, where the imported fines provided habitat for cyanoHAB development under the Jimtown Bridge on river right very unlike other seasons. Hopland never generated discrete cyanoHABs at the monitoring site.

Patterson Point cyanoHAB generating areas associated with shallow slow water areas around the in-channel island and toward the left bank generated typical heterocyst forming (with *Anabaena*, *Nostoc* and *Cylindrospermum*) cyanoHABs over approximately 30% of the available area by Late July. In September and later, *Microcoleus* cyanoHABs were generating from the accumulation of fines that had deposited over the season and areas around the in-channel island are actively producing floating cyanoHABs over approximately 50% of the available production areas.

At Syar, the off-stream pools are generating floating mixed cyanoHABs mostly disconnected from the mainstem. The off-stream pools formed cyanobacterial mat/tower morphologies composed of both *Anabaena* and *Microcoleus* though *Anabaena* dominated in terms of observed biomass. *Microcoleus*

mats were observed at Syar colonizing the sides of medium to large cobble in late August which continued into November when sampling was completed.

At Jimtown, the area under the bridge accumulated enough fine sediment to support the production of *Microcoleus/Oscillatoria* cyanoHABs by late September. Oscillatorian mats previously observed in willow roots were not observed in 2023.

Similarly, at Hopland, none of the potential areas developed clear areas that were generating cyanoHABs. The shoreline at Hopland was colonized more thickly by dark Nostoc and at a greater distance from the water's edge then we have observed in previous years of sampling.

Summary

The 2023 monitoring season was unlike the previous drought defined seasons, with heavy basin filling rain events stemming from a series of atmospheric rivers that inundated the watershed. Large amounts of precipitation led to very high flows that scoured out the established periphyton communities, displaced grazers, and flushed out propagules that would normally have developed.

In the 2022 season, algae sampling events occurred as early as February to better understand conditions for the season. In 2023, surveys could not start until the beginning of May due to high flows and even then Patterson Point was not surveyable until mid-May with much of the mainstem inaccessible to wading until mid-June because of bed load changes and sustained heavy flows.

The late 2022 to early 2023 rainy season brought scouring events that caused major bed load movement and served to reset the cover and composition of the periphyton assemblage that for the last three years had only partially been displaced by new growth. Water levels in the mainstem river were slow to drop to base summer flows, but once they had, instream shelves were quick to be colonized by pioneering species, mostly comprised of diatoms, that establish a biofilm layer on the substrate which supports colonization of periphyton. These shelves remained the main area of periphyton growth as flows were still too fast in the main channel at most sites for colonization of the thalweg. These conditions persisted for some weeks where algae growth was slowed due to turbid waters limiting light availability and flows that precluded colonization. The algae that could grow was mostly limited to submerged gravel shelves that were one or two feet deep. Some of this new growth was stranded on the shoreline as the spring drawdown led to receding water levels.

As the water receded, a large bloom of green macrophytes was observed in the lower river in June. The drawdown stimulated reproductive cycles in some macrophytes that had established in March, April, and May and led to the accumulation of metaphyton in slow moving areas of the river, particularly lower in the system. Metaphyton drift leads to the establishment of allochthonous algal communities downstream which eventually are inhabited by colonies of cyanobacteria. Metaphyton stranded on the shoreline has been observed to lead directly to cyanobacterial Harmful Algal Blooms (cyanoHABs). The bed movement from high flows and the spring drawdown also exposed backwater pools in some areas, providing refuge from high flows for organisms like heterocystous cyanobacteria to start growing almost immediately in June. By late June, flows had mostly attenuated to a summer low flow condition.

Following the late June flow attenuation, the remainder of the spring bloom was mostly stranded on shorelines and gravel bars. Around this time, diatoms usually associated with cyanobacterial growth,

Epithemia and *Rhopalodia* specifically, were being detected in samples. Water temperatures were lower for this season than in previous years due to sustained flows but were beginning to rise. By late July the lower river was actively developing cyanoHABs that oscillated between heterocystous and Oscillatorian dominant throughout the late summer. At this point in the season Syar and Jimtown were beginning to develop cyanoHABs with Syar developing mixed cyanoHABs in backwater pools and Oscillatorian mats appearing in the mainstem, meanwhile Jimtown was beginning to develop Oscillatorian mats in the shallow mainstem area underneath the Jimtown bridge. Turbidity stemming from releases at the Coyote Valley Dam and flows in the West Fork appeared to hamper macrophyte growth at Hopland and this lack of filamentous growth could explain why this site was later than the rest if at all to develop cyanoHABs. Turbid conditions move fine sediment down the system and this transport mechanism led to a late summer season defined by fine particulates blanketing the mainstem. These fine sediments appear to have provided the basis for increased rates of Oscillatorian cyanobacteria colonization as well as motile diatom colonization. By late summer metaphyton drift was less prevalent, Oscillatorian mats were growing in abundance, and motile diatoms were increasing in frequency.

By fall, periphyton conditions in the Russian River appeared to be beginning a cycle of release with cyanobacterial colonies detaching from the developed crust and going planktonic to re-colonize new areas or form akinetes. Syar and Jimtown were at their macrophyte maximum at this time with Patterson and Hopland having already peaked. *Microcoleus* was present at all sites with two forms apparent, the first being the more common brown form that seems to prefer habitats with cobble and heavier flow while the less frequently observed green form seemed to favor silt dominated edge water or submerged wood habitats. Future observations will be important to define seasonal habitat characteristics of *Microcoleus*. In early October an estuary closure had an impact on the lower river. Increased water levels had the effect of metaphyton drift accumulating in the lower river, spurring reproductive activity. When the estuary opened, the drop in water level stranded much of the drift on the shoreline. This was when the active growth period began to end for the season and overall biomass and diversity began to taper. In past seasons, the lower river has mostly been dominated by heterocystous cyanobacteria colonies, but after the estuary reopened, an explosion of Microcoleus occurred. Currently, we attribute this to the seasonal prevalence of fine materials accumulating in the lower river.

Visual Observations of Periphyton and Drivers

As described in RESULTS, winter flows had the greatest effect on the development of periphyton and algae succession. Algal and periphyton growth in the Russian River is largely predicated on the seasonal flow transition from high winter flows to lower summer flows. The periphyton is strongly affected by both the frequency and the duration of high scouring flows which typically occur in the winter season. The type of flow transition dictates and drives the season's algal community succession. Specifically, when there is little transition from winter flows to summer flows, like transitions occurring in drought years, the existing periphyton can propagate into the next season to quickly jump start community growth and not leave habitat available for different taxa. Grazers also persist without large scale disruption and can quickly rebound in densities that can drastically reduce the abundance of certain periphyton dominants (like *Cladophora*).

Similarly, how quickly the periphyton develops in the following low flow season is tied to the degree of scour occurring in the channel during the winter and spring high flows, the degree of bed movement in the littoral zone, the survival of grazing organisms, and where deposits of early spring blooms accumulate, decay and provide resources for microalgae, including cyanobacteria. This regime is typified by the late 2019 to early 2020 rainy season, the late 2020 to early 2021 rainy season, and late 2021 to early 2022 rainy season which had few storms and provided little scour with the macrophytes present in the summer and fall and persisting into the following season. When the periphyton persists it continues to cycle through growth and reproductive phases throughout the winter and spring.

Figure 3-22 below illustrates the stage height at the Johnson's Beach Guerneville gage between 31 August 2018 and 29 February 2024. Flows between late 2018 and early 2019 supported a series of higher flows that reset the periphyton cycle for the 2019 monitoring season. However, the winters between the fall of 2019 and the spring of 2022 were drought years (2020 and 2021 ambient algal monitoring periods) and there was little to no reset. In the winter and spring of 2022-2023 flows were over 30 feet in stage height during two large atmospheric river events. Sustained flows over 10 feet occurred between 27 December 2022 and 21 January 2023, and between 28 February 2023 and 3 April 2023. Flows had not equilibrated down to the summer elevation (approximately 5.62 feet) until 14 May 2023. Comparing these flows to previous years illustrates how different the winter of 2022-2023 was compared to previous monitoring years and disruption of the periphyton cycle.

Sustained flows at or near 15 feet are channel forming flows that cause bed-load movement and based on observations since 2018, the magnitude and duration of the channel forming flows were sufficient in the late 2018 to early 2019 rainy season and the late 2022 to early 2023 rainy season to reset the periphyton cycle. In the late 2018 to early 2019 rainy season, flows exceeded the bankfull dimension briefly several times over the season but aggregated lasted approximately 6 and a half weeks. The late 2022 to early 2023 rainy season exceeded bankfull for approximately seven weeks. One conclusion possible based on observations and the duration of flows during the high flow years is that six to seven weeks above bankfull capacity is enough to reset instream conditions for a complete renewal of periphyton. Further analysis is needed to determine more precisely what frequency, intensity and duration of winter flows causes what range of conditions that can effect periphyton succession in the Summer. When flows are sustained into May it allows the periphyton to cycle through a pattern of colonizing, growing, and detaching that result in an early summer bloom of predominantly green filamentous algae that accumulates in various locations. The organic carbon provided by the decaying metaphyton supports the continued growth of diatoms and cyanobacteria. Clearly 2023 and what is shaping up for 2024, demonstrates very different winter conditions than what has been monitored since the drought years. The intensity and duration of winter and spring flows can delay or speed periphyton development following the drawdown depending on degree of scour, propagule availability, water velocity, and presence of grazers.

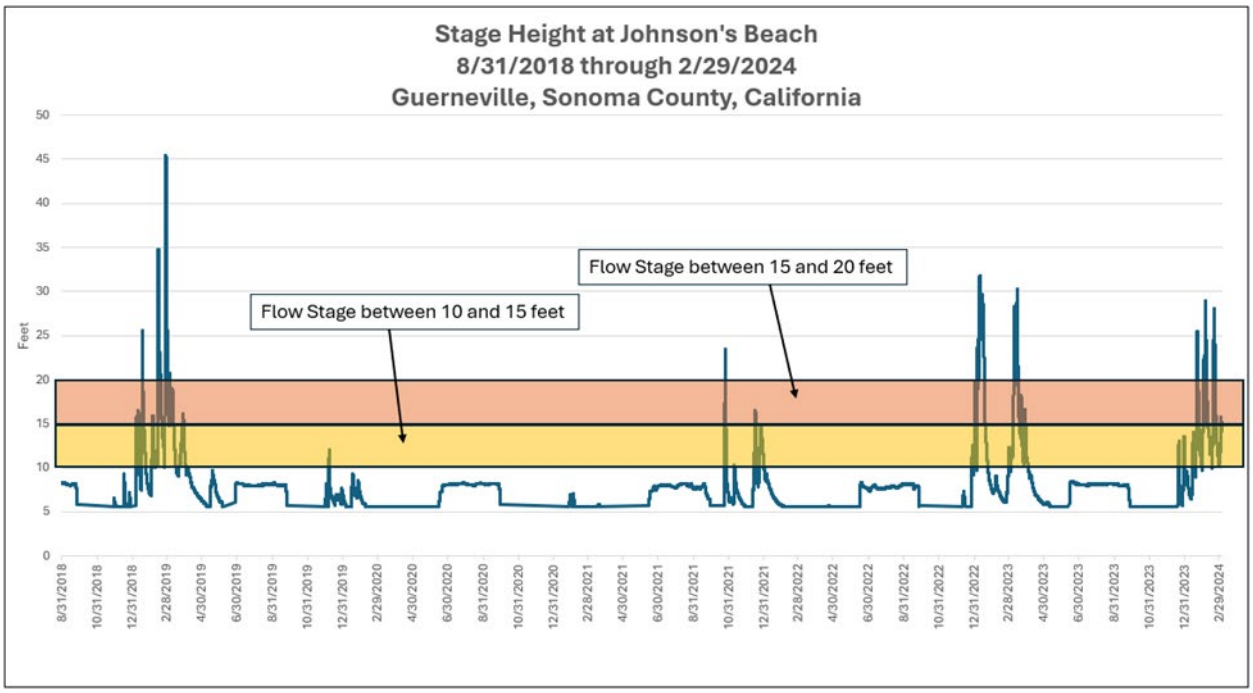


Figure 3-22. Stage Height at Johnson's Beach from 31 August 2018 to 29 February 2024.

Diversity and Frequency Analysis

All the monitoring stations were affected by transported fines accumulating throughout the system, directly blocking colonization, smothering portions of the periphyton, and creating an accumulation of fine substrate areas that favored Oscillatorian cyanobacteria colonization and growth. The silt also seemed to promote an observed increase in motile diatoms and an increase in the abundance of red algae and cyanobacteria adapted to low light levels, and interestingly an increase in the green alga Closterium (a desmid).

The difference in diversity and previous seasons observed from 2023 could also be due to habitat complexities presented this season between Patterson Point and Syar stations in relation to Jimtown and Hopland as affected by the much higher winter flows. Patterson Point is lower in the system where flows are often slower, the water deeper, and receives runoff or point sources that create a higher nutrient load that accumulates in the lower river. Syar is located about one mile downstream of the Dry Creek confluence and is affected by inputs from Lake Sonoma. Jimtown is located at the bottom of the Alexander Valley and is affected by this broad valley and suspected interactions with the hyporheic zone (likely affecting bio-stimulatory conditions). The Hopland station's diversity was affected by the high levels of turbidity stemming from Lake Mendocino water releases from the Coyote Valley Dam.

The abundance of cyanobacterial detections follows the same gradient as overall generic diversity of the monitoring stations with the highest level of cyanobacterial detections occurring at Patterson Point, which also boasted the highest frequency of heterocyst forming cyanobacteria. The balance of heterocyst forming versus non-heterocyst forming cyanobacteria is often used as an indicator of the lack of nitrogen availability. This metric can be similarly assigned to the presence and abundance of Epithemiod diatoms (*Epithemia* and *Rhopalodia*) which are known to have cyanobacterial symbionts that fix atmospheric nitrogen.

At most stations, macrophytes tended to either hold or drop in frequency when cyanobacteria detections began to rise. In a similar trend observed at most stations, diatom frequency tended to drop when green algae detections rose. Direct comparisons to last year are difficult to make due to this season being defined by early heavy rains followed by dry periods instead of the sustained drought of the previous three years. In general, periphyton condition trends this year were almost a month later to reach the same level of development. This is largely due to the increased amount of water in the system, increased velocities, and lack of propagules leading to a delayed reaction from the periphyton community.

Cover and Thickness Analysis

In 2022, there was more cover and abundance of green macrophytes early in the season. This was not the case for the 2023 sampling season as high flows scoured out almost all the established growth in the river. Turbidity in the system led to a delayed establishment of green macrophytes overall which affects community composition and succession. Abundant grazers were not observed in the system. Since the absence of grazers in a system is used to understand why green macrophytes colonize quickly after scouring flows, this reaction of the periphyton was not reflected in observations for 2023. At Hopland, a trend that persisted through the season was that of increased turbidity. Macroalgae initially outpaced microalgae, but were quickly taken over by diatoms, cyanobacteria, and other shade-tolerant taxa. The microalgae layer remained thick for the season at Hopland. In previous years, the Jimtown monitoring station was abundant with green macrophytes for most of the season, whereas this year there was a long delay in growth which never met the same levels of abundance as last year. Microalgae and macroalgae were not all that present in the thalweg at this station but the river's edge, initially coated in microalgae, was then colonized by green macrophytes. The Syar monitoring station also did not meet the same levels of green macrophyte abundance experienced in previous drought-defined seasons. Microalgae made up of mostly diatoms dominated in the early season with cyanobacteria becoming much more prevalent by late August. At the Patterson Point monitoring station, the macroalgae became so abundant that microalgae cover was initially difficult to ascertain, but by late July the microalgae began to colonize the macrophytes and this back and forth continued into the end of October with microalgae mostly in the form of diatoms and Oscillatorian cyanobacteria overtaking or densely covering the macroalgae.

Nutrients

Sonoma Water staff conducted biweekly nutrient grab sampling monitoring at five (5) stations in the mainstem Russian River including: the Hopland USGS gaging station, Cloverdale River Park in Cloverdale, the Jimtown USGS gaging station, Syar Vineyards, and Patterson Point (Figure 3-10).

All grab samples were analyzed for nutrients including: total organic nitrogen, ammonia, unionized ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus, and total orthophosphate. Samples were also analyzed for total dissolved solids, total and dissolved organic carbon, turbidity, and *chlorophyll a,* which is a measurable parameter of algal growth that can be tied to excessive nutrient concentrations and reflect a biostimulatory response. Grab samples were submitted to Alpha Analytical Labs in Ukiah for analysis. Grab sample data was collected during Sonoma Water's ambient algae and cyanobacteria monitoring effort.

The sampling results for total nitrogen, total phosphorus, turbidity, and *chlorophyll a* are discussed below and summarized in Tables 3-8 through 3-10 and Figures 3-23 through 3-26. Highlighted values indicate those values exceeding EPA recommended ambient water quality criteria for "Rivers and Streams in Nutrient Ecoregion III" (EPA, 2000).

Lab analysis constraints in 2023 resulted in a method detection limit (MDL) for *chlorophyll a*, which is the level of accuracy for a given lab analysis to provide a valid concentration of a given constituent, that was higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Put simply, the EPA exceedance criteria for *chlorophyll a* in rivers and streams is approximately 0.0018 mg/L, whereas the lab analysis MDL for *chlorophyll a* was 0.0030 mg/L. Therefore, some lab results for *chlorophyll a* that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL, which in turn could result in an under representation of the actual number of exceedances observed. However, for reporting purposes, only those exceedances that are quantified will be included in the summation. Additionally, it must be emphasized that the EPA criteria are not adopted standards and are therefore both subject to change (if it is determined that the guidelines or criteria are not accurate indicators) and are not currently enforceable.

Sampling results for other nutrient components, dissolved and total organic carbon, and total dissolved solids are included in the tables; however, a discussion of these constituents is not included in this report.

Total Nitrogen

The EPA desired goal for total nitrogen in Aggregate Ecoregion III is 0.38 mg/L for rivers and streams (EPA, 2000).

Calculating total nitrogen values requires the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (referred to as Total Kjeldahl Nitrogen or TKN), and nitrate/nitrite nitrogen. The EPA criteria for Total Nitrogen was exceeded eighteen (18) times prior to, during, and following the terms of the Order, representing 21.7% of the total samples collected (18 out of 83) during the ambient algae monitoring effort (Tables 3-8 through 3-10, and Figure 3-23).

Hopland had four (4) exceedances of the total nitrogen criteria prior to, during, and following the terms of the Order out of 14 samples collected (28.6%), under flows that ranged from 143 cfs to 254 cfs (Table 3-8 and Figure 3-23). The maximum seasonal value measured 1.0 mg/L during the terms of the Order on 14 June with a flow of 143 cfs (Table 3-8). The minimum seasonal value was 0.14 mg/L, which occurred following the terms of the Order, on 20 November with a flow of 183 cfs (Table 3-8). The minimum seasonal value during the terms of the Order was 0.18 mg/L on 12 September with a flow of 160 cfs. Nitrogen values were observed to generally decline from spring into summer, with values remaining relatively low through the monitoring season (Figure 3-23).

Cloverdale River Park had five (5) exceedances of the total nitrogen criteria prior to, during, and following the terms of the Order out of 14 samples collected (35.7%), under flows that ranged from 132 to 293 cfs (Table 3-8 and Figure 3-23). The maximum concentration measured 0.73 mg/L during the terms of the Order on 14 June with a flow of 162 cfs (Table 3-8). The minimum seasonal value was 0.11 mg/L, which occurred during the terms of the Order on 9 August with a flow of 140 cfs. Nitrogen values

were observed to generally decline from spring into summer, with values remaining relatively low through the monitoring season (Figure 3-23).

Table 3-8. Sonoma Water 2023 Seasonal Mainstem Russian River Grab Sampling Results at Hopland and Cloverdale.

Hopland	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11462500 RR near Hopland***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2023	13:00	14.0	7.2	0.42	ND	ND	0.56	ND	0.42	**0.98**	**0.065**	0.12	1.65	2.72	130	**12**	ND	254
5/31/2023	14:20	16.6	7.2	ND	ND	ND	0.57	ND	ND	**0.57**	**0.074**	0.13	1.71	2.44	140	**14**	ND	157
6/14/2023	14:00	15.3	7.5	0.58	ND	ND	0.45	ND	0.58	**1.0**	**0.11**	0.11	1.88	2.72	30	**21**	ND	143
6/28/2023	13:20	15.3	7.3	ND	0.14	0.00024	0.36	ND	ND	0.36	**0.063**	0.098	2.83	2.83	110	**18**	**0.0040**	138
7/12/2023	12:30	14.7	7.5	ND	ND	ND	0.26	ND	ND	0.26	**0.063**	ND	2.78	2.73	120	**21**	ND	134
7/26/2023	12:30	14.2	7.6	ND	ND	ND	0.28	ND	ND	0.28	**0.068**	ND	2.74	3.06	110	**22**	ND	149
8/9/2023	13:40	14.0	7.6	ND	ND	ND	0.24	ND	ND	0.24	**0.056**	ND	3.17	2.92	110	**16**	**0.0040**	155
8/29/2023	14:30	13.9	7.8	ND	ND	ND	0.21	ND	ND	0.21	**0.061**	ND	2.75	3.66	110	**13**	ND	165
9/12/2023	14:00	14.0	7.6	ND	ND	ND	0.18	ND	ND	0.18	**0.089**	0.13	2.83	3.12	120	**27**	**0.014**	160
9/20/2023	12:50	13.2	7.5	ND	ND	ND	0.22	ND	ND	0.22	**0.089**	0.093	2.90	2.90	100	**24**	ND	165
10/4/2023	12:40	14.0	7.6	ND	ND	ND	0.20	ND	ND	0.20	**0.090**	ND	2.74	3.05	120	**29**	ND	147
10/18/2023	14:10	13.8	7.4	0.45	ND	ND	0.17	0.049	0.45	**0.67**	**0.12**	0.077	2.67	2.83	100	**40**	ND	182
11/1/2023	14:00	13.1	7.5	ND	ND	ND	0.15	0.056	ND	0.206	**0.14**	0.076	2.69	3.08	110	**30**	**0.012**	188
11/20/2023	12:40	13.5	7.5	ND	ND	ND	0.14	ND	ND	0.14	**0.050**	ND	2.44	2.71	110	**7.4**	**0.013**	183

Cloverdale River Park	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11463000 RR near Cloverdale***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2023	12:10	17.2	7.7	ND	ND	ND	0.43	ND	ND	**0.43**	**0.045**	0.083	1.48	2.06	160	**7.6**	**0.0064**	293
5/31/2023	13:40	18.3	7.8	ND	ND	ND	0.38	ND	ND	**0.38**	**0.048**	ND	1.46	1.85	170	**6.4**	**0.0045**	192
6/14/2023	13:10	19.4	7.9	0.45	ND	ND	0.28	ND	0.45	**0.73**	**0.042**	ND	1.59	1.92	68	**6.5**	ND	162
6/28/2023	12:30	19.1	8.2	ND	0.18	0.011	0.17	ND	ND	0.361	**0.032**	ND	2.29	2.16	140	**7.0**	**0.0040**	142
7/12/2023	11:15	19.1	7.9	0.63	ND	ND	ND	ND	0.63	**0.63**	**0.045**	ND	2.34	2.26	140	**7.7**	**0.0051**	132
7/26/2023	11:50	18.7	7.9	ND	ND	ND	0.19	ND	ND	0.19	**0.045**	ND	2.48	2.56	100	**11**	ND	139
8/9/2023	13:00	18.6	8.0	ND	ND	ND	0.11	ND	ND	0.11	**0.045**	ND	2.81	2.74	120	**7.9**	ND	140
8/29/2023	13:50	17.3	8.0	ND	ND	ND	0.13	ND	ND	0.13	**0.053**	ND	3.08	2.54	120	**7.5**	**0.0048**	149
9/12/2023	13:20	16.8	7.9	ND	ND	ND	0.14	ND	ND	0.14	**0.054**	0.11	2.52	2.61	120	**10**	ND	146
9/20/2023	12:10	16.1	7.7	ND	ND	ND	0.19	ND	ND	0.19	**0.053**	0.068	2.64	2.64	120	**11**	**0.0059**	155
10/4/2023	11:50	15.0	7.7	ND	ND	ND	0.19	ND	ND	0.19	**0.057**	ND	2.50	2.65	120	**16**	ND	143
10/18/2023	13:20	15.4	7.7	0.40	ND	ND	0.17	ND	0.40	**0.57**	**0.071**	0.068	2.45	2.76	110	**20**	ND	175
11/1/2023	13:10	12.2	7.7	ND	ND	ND	0.15	ND	ND	0.15	**0.067**	0.068	2.37	2.66	120	**17**	**0.0051**	176
11/20/2023	12:00	12.7	7.7	ND	ND	ND	0.13	ND	ND	0.13	**0.042**	ND	2.38	2.65	140	**5.2**	**0.0053**	183

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station.

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

Jimtown had three (3) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 14 samples collected (21.4%), under flows that ranged from 211 to 416 cfs (Table 3-9 and Figure 3-23). The maximum seasonal value measured 0.73 mg/L during the terms of the Order on 14 June with a flow of approximately 211 cfs (Table 3-9). The minimum concentration was 0.091 mg/L, which occurred during the terms of the Order on 29 August with a flow of approximately 146 cfs.

Nitrogen values at Jimtown were also observed to generally decline from spring into summer, with values remaining relatively low through the monitoring season (Figure 3-23). Syar had two (2) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 14 samples collected (14.3%), under flows that ranged from 370 cfs to 571 cfs (Table 3-9 and Figure 3-23). The maximum seasonal value measured 0.81 mg/L during the terms of the Order on 14 June with a flow of approximately 370 cfs (Table 3-9). The minimum seasonal value of 0.061 mg/L occurred during the terms of the Order on 29 August with a flow of 254 cfs. Syar also had nitrogen values that generally declined from spring into summer, with overall values remaining relatively low through the monitoring season (Figure 3-23).

Patterson Point had four (4) exceedances of the total nitrogen criteria during and following the terms of the Order out of 27 samples collected (14.8%), under flows that ranged from 154 cfs to 198 cfs (Table 3-10 and Figure 3-23). The maximum seasonal value of 3.9 mg/L occurred during the terms of the Order on 1 August with a flow of 154 cfs (Table 3-10 and Figure 3-23). The minimum seasonal value was ND, which occurred twelve (12) times during the terms of the Order with flows that ranged from 151 cfs to 206 cfs. With the exception of the seasonal maximum concentration of 3.9 mg/L, total nitrogen values remained relatively low at Patterson Point through the monitoring season.

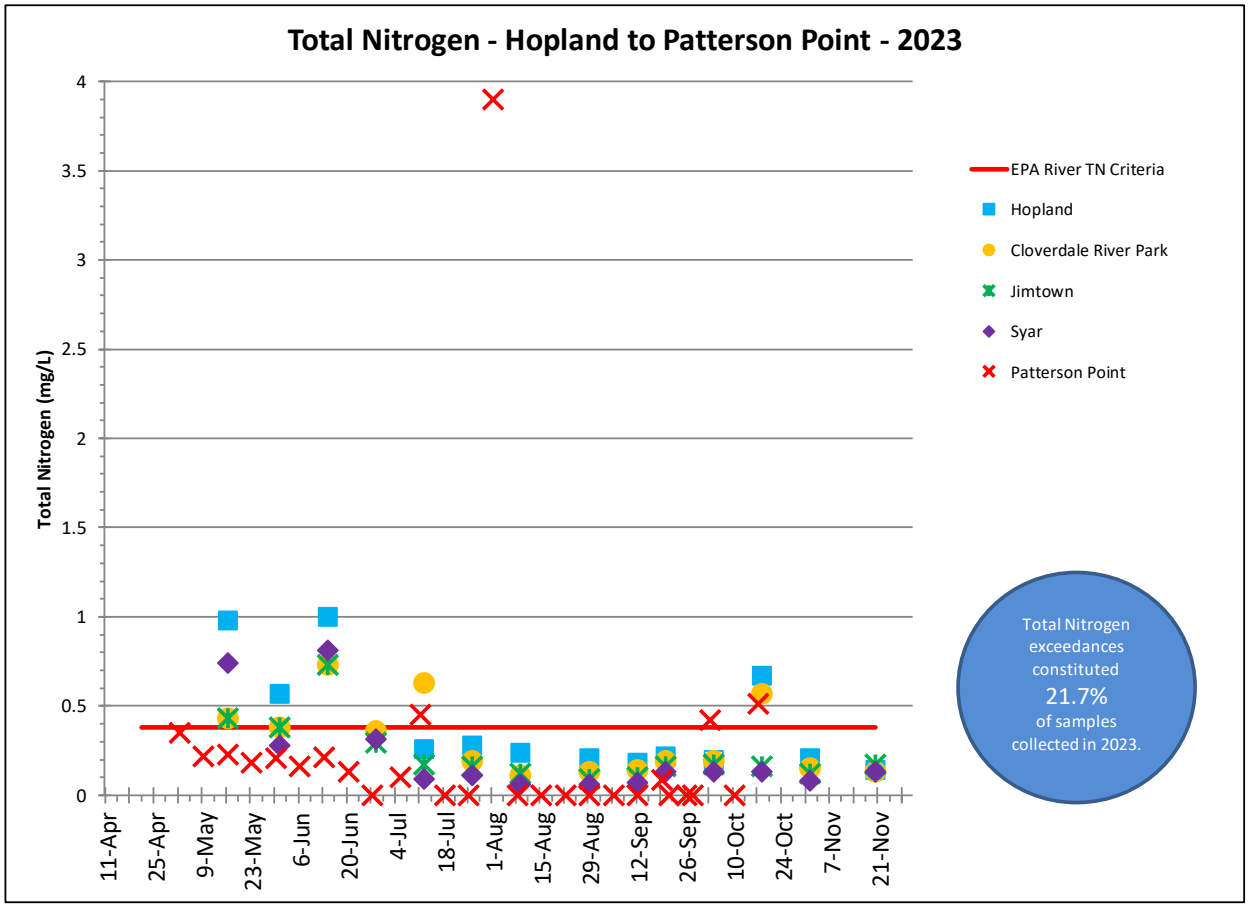


Figure 3-23. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Total Nitrogen Results in 2023.

Total Phosphorus

The EPA's desired goal for total phosphates as phosphorus in Aggregate Ecoregion III has been established as 21.88 micrograms per liter (µg/L), or approximately 0.022 mg/L, for rivers and streams (EPA, 2000). All five monitoring stations were observed to have exceedances of the EPA criteria for total phosphorous during the monitoring season (Tables 3-8 through 3-10, and Figure 3-24). The EPA criteria was exceeded seventy-five (75) times prior to, during, and following the terms of the Order out of 83 samples collected at the five stations (90.4%).

The station at Hopland generally had higher concentrations than the other stations (Figure 3-24). Hopland exceeded the EPA criteria fourteen (14) times out of 14 samples collected (100%), under flows that ranged from 134 cfs to 254 cfs (Table 3-8 and Figure 3-24). The maximum concentration measured 0.14 mg/L, which occurred following the terms of the Order on 1 November with a flow of 188 cfs (Table 3-8). The maximum concentration during the terms of the Order was 0.11 mg/L on 14 June with a flow of 143 cfs (Table 3-8). The minimum concentration was 0.050 mg/L, which occurred following the terms of the Order on 20 November with a flow of 183 cfs. The minimum concentration during the terms of the Order was 0.056 mg/L, which occurred on 9 August with a flow of 155 cfs (Table 3-8). Total phosphorus values at Hopland were observed to generally increase from summer into the fall (Figure 3-24).

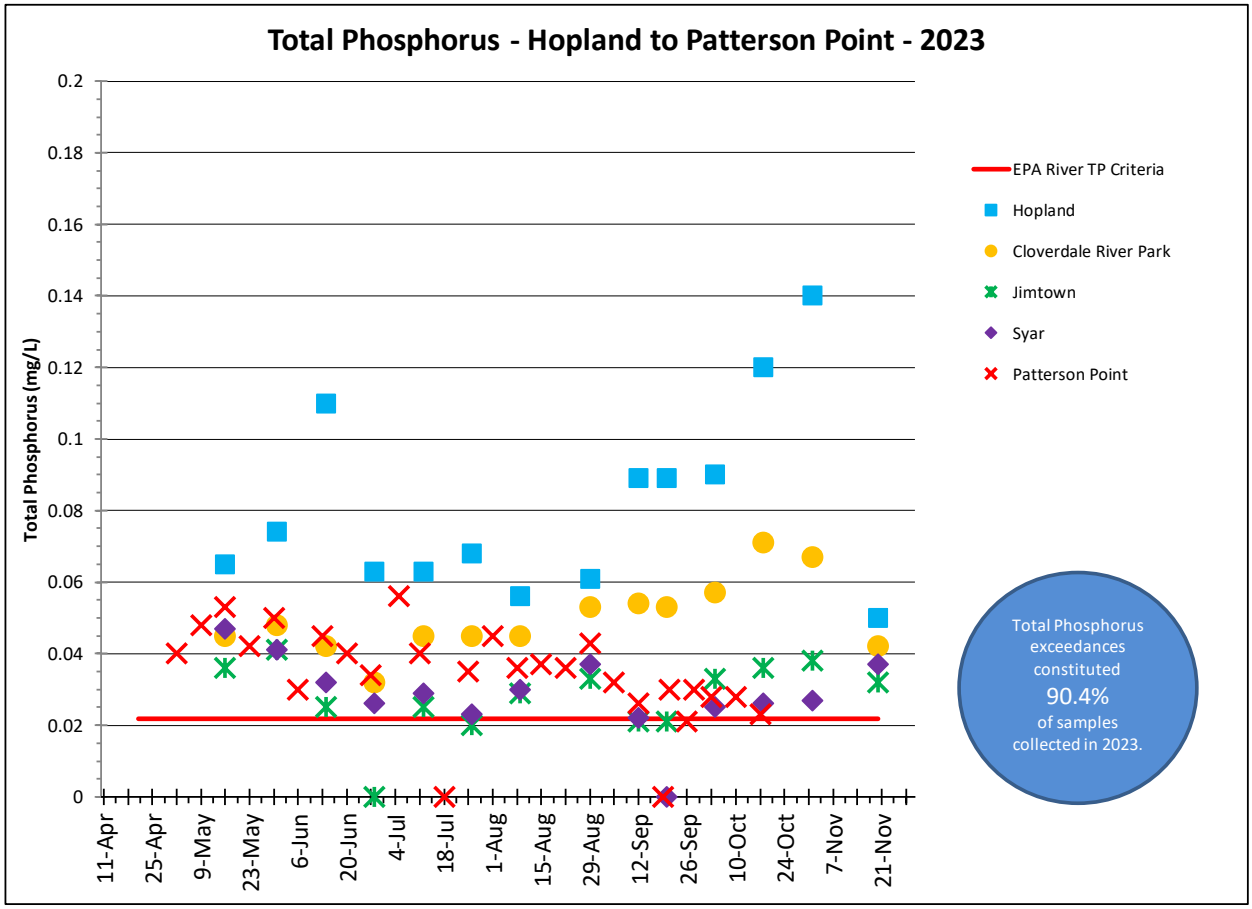


Figure 3-24. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Total Phosphorus Results in 2023.

The Cloverdale River Park station also exceeded the total phosphorus EPA criteria for the entire monitoring season (14 of 14 samples or 100%) under flows that ranged from 132 cfs to 293 cfs (Table 3-8 and Figure 3-24). The maximum concentration of 0.071 mg/L occurred following the terms of the Order on 18 October with a flow of 175 cfs (Table 3-8). The maximum concentration during the terms of the Order was 0.057 mg/L on 4 October with a flow of 143 cfs (Table 3-8). The minimum concentration was 0.032 mg/L, which occurred during the terms of the Order on 28 June with a flow of 142 cfs. Total phosphorus values at Cloverdale remained elevated through the monitoring season (Figure 3-24).

Although concentrations at the Jimtown station were lower compared to the Hopland and Cloverdale stations, the Jimtown station did experience ten (10) exceedances (10 of 14 or 71.4%) of the EPA criteria that occurred prior to, during, and following the terms of the Order with flows ranging from 136 cfs to 416 cfs (Table 3-9 and Figure 3-24). The maximum concentration measured 0.041 mg/L during the terms of the Order on 31 May with a flow of approximately 271 cfs (Table 3-9). The minimum seasonal value was ND, which occurred during the terms of the Order on 28 June with a flow of approximately 174 cfs (Table 3-9).

Similar to Jimtown, concentrations at Syar Vineyards were lower compared to Hopland and Cloverdale, but the station still experienced thirteen (13) exceedances (13 of 14 or 92.9%) of the total phosphorus EPA criteria that occurred prior to, during, and following the terms of the Order with flows ranging from 245 cfs to 571 cfs (Table 3-9 and Figure 3-24). The maximum concentration of 0.047 mg/L occurred prior to the terms of the Order on 16 May with a flow of 571 cfs (Table 3-9). The maximum concentration during the terms of the Order measured 0.041 mg/L on 31 May with a flow of approximately 430 cfs (Table 3-9). The minimum seasonal value was ND, which occurred during the terms of the Order on 20 September with a flow of 252 cfs (Table 3-9).

Patterson Point had twenty-four (24) exceedances prior to, during, and following the terms of the Order of the total phosphorus criteria (24 of 27 or 88.9%) under flows that ranged from 143 cfs to 898 cfs (Table 3-10 and Figure 3-24). The maximum concentration occurred during the terms of the Order and measured 0.056 mg/L on 5 July with a flow of 200 cfs (Table 3-10). The minimum seasonal value was ND, which occurred twice during the terms of the Order, on 18 July with a flow of approximately 154 cfs and on 19 September with a flow of 166 cfs (Table 3-10).

Turbidity

The EPA recommended criteria for turbidity is 2.34 NTU (EPA, 2000). All five of the monitoring stations were observed to have exceedances of the EPA criteria (Tables 3-8 through 3-10). Overall, the EPA criteria was exceeded sixty-four (64) times prior to, during, and following the terms of the Order out of 83 samples collected (77.1%) at the five stations (Tables 3-8 through 3-10 and Figure 3-25).

Turbidity levels at Hopland exceeded the EPA criteria throughout the monitoring season, including prior to, during, and following the terms of the Order (14 of 14 samples or 100%) with flows that ranged from 134 cfs to 254 cfs (Table 3-8 and Figure 3-25). The maximum seasonal value measured 40 NTU on 18 October with a flow of 182 cfs (Table 3-8). The maximum value during the terms of the Order measured 29 NTU on 4 October with a flow of 147 cfs (Table 3-8). The minimum seasonal value was 7.4 NTU on 20 November with a flow of 183 cfs (Table 3-8). The minimum value during the terms of the Order was 13 NTU on 29 August with a flow of 165 cfs (Table 3-8). Values were observed to remain elevated

throughout the monitoring season and generally increasing from spring through summer and into fall (Figure 3-25).

Table 3-9. Sonoma Water 2023 Seasonal Mainstem Russian River Grab Sampling Results at Jimtown and Syar.

Jimtown	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11463682 RR at Jimtown***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2023	11:20	17.9	7.6	ND	ND	ND	0.43	ND	ND	**0.43**	**0.036**	0.074	1.24	1.79	180	**3.5**	**0.0048**	416
5/31/2023	12:20	18.0	7.6	ND	ND	ND	0.38	ND	ND	**0.38**	**0.041**	ND	1.23	1.68	170	**2.8**	**0.0032**	271
6/14/2023	11:40	19.7	7.6	0.54	ND	ND	0.19	ND	0.54	**0.73**	**0.025**	ND	1.22	1.52	120	1.5	**0.0035**	211
6/28/2023	11:30	19.9	7.5	ND	0.18	0.0020	0.11	ND	ND	0.292	ND	ND	1.95	1.95	170	1.3	**0.0099**	174
7/12/2023	11:00	20.0	7.4	ND	ND	ND	0.17	ND	ND	0.17	**0.025**	ND	1.78	1.82	180	1.4	**0.0032**	146
7/26/2023	10:50	20.8	7.4	ND	ND	ND	0.16	ND	ND	0.16	0.020	ND	1.87	1.89	120	2.3	ND	144
8/9/2023	11:40	20.1	7.4	ND	ND	ND	0.12	ND	ND	0.12	**0.029**	ND	2.15	1.91	150	1.4	ND	136
8/29/2023	13:00	20.3	7.5	ND	ND	ND	0.091	ND	ND	0.091	**0.033**	ND	1.89	1.89	140	1.9	**0.0080**	146
9/12/2023	12:20	19.6	7.5	ND	ND	ND	0.10	ND	ND	0.10	0.021	ND	1.98	2.00	150	1.8	**0.0064**	140
9/20/2023	11:10	18.2	7.2	ND	ND	ND	0.16	ND	ND	0.16	0.021	0.035	2.06	2.06	130	**2.4**	**0.0040**	149
10/4/2023	10:20	16.9	7.3	ND	ND	ND	0.17	ND	ND	0.17	**0.033**	ND	1.97	2.08	150	**3.0**	ND	149
10/18/2023	12:30	16.9	7.4	ND	ND	ND	0.16	ND	ND	0.16	**0.036**	0.043	1.97	1.97	130	**4.3**	**0.0064**	166
11/1/2023	12:30	13.3	7.3	ND	ND	ND	0.12	ND	ND	0.12	**0.038**	0.040	1.87	2.07	140	**5.6**	**0.0045**	182
11/20/2023	11:20	13.5	7.3	ND	ND	ND	0.17	ND	ND	0.17	**0.032**	ND	2.29	2.36	160	2.3	**0.0043**	242

Syar	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11465390 RR near Windsor***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2023	10:10	17.5	7.7	0.42	ND	ND	0.32	ND	0.42	**0.74**	**0.047**	0.067	1.29	1.74	160	**4.3**	**0.0053**	571
5/31/2023	10:50	16.4	7.8	ND	ND	ND	0.28	ND	ND	0.28	**0.041**	ND	1.18	1.57	160	**5.4**	ND	430
6/14/2023	10:00	17.3	7.7	0.63	ND	ND	0.18	ND	0.63	**0.81**	**0.032**	ND	1.25	1.44	140	**4.2**	ND	370
6/28/2023	10:10	18.6	7.8	ND	0.20	0.0041	0.11	ND	ND	0.314	**0.026**	ND	1.80	1.80	150	**3.8**	**0.0051**	284
7/12/2023	9:40	18.7	7.7	ND	ND	ND	0.091	ND	ND	0.091	**0.029**	ND	1.72	1.65	150	**3.9**	ND	268
7/26/2023	9:00	19.2	7.7	ND	ND	ND	0.11	ND	ND	0.11	**0.023**	ND	1.84	1.82	130	**4.6**	**0.012**	260
8/9/2023	10:40	18.6	7.7	ND	ND	ND	0.062	ND	ND	0.062	**0.030**	ND	1.93	2.05	200	**3.9**	ND	245
8/29/2023	11:40	18.8	7.8	ND	ND	ND	0.061	ND	ND	0.061	**0.037**	ND	1.77	1.72	130	**3.9**	**0.0040**	254
9/12/2023	11:30	17.5	7.7	ND	ND	ND	0.069	ND	ND	0.069	**0.022**	ND	1.76	1.86	120	**3.8**	**0.0037**	245
9/20/2023	9:30	16.6	7.5	ND	ND	ND	0.13	ND	ND	0.13	ND	ND	1.93	1.93	120	**4.1**	ND	252
10/4/2023	8:40	15.4	7.5	ND	ND	ND	0.13	ND	ND	0.13	**0.025**	ND	1.85	1.96	130	**4.2**	**0.0048**	254
10/18/2023	11:20	15.3	7.6	ND	ND	ND	0.13	ND	ND	0.13	**0.026**	0.031	1.74	2.01	120	**3.3**	ND	277
11/1/2023	11:20	12.1	7.6	ND	ND	ND	0.083	ND	ND	0.083	**0.027**	ND	1.83	1.89	110	**3.2**	ND	out for season
11/20/2023	10:10	12.3	7.4	ND	ND	ND	0.13	ND	ND	0.13	**0.037**	ND	1.97	2.28	140	**3.3**	**0.0088**	out for season

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station.

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

Cloverdale River Park had fourteen (14) exceedances of the EPA criteria that occurred prior to, during, and following the terms of the Order out of 14 samples collected (14 of 14 or 100%), with a maximum value of 20 NTU measured on 18 October during a flow of 175 cfs (Table 3-8 and Figure 3-25). The maximum value during the terms of the Order was 16 NTU on 4 October with a flow of 143 cfs (Table 3-8). The minimum seasonal value was 5.2 NTU on 20 November with a flow of 183 cfs (Table 3-8). The

minimum value during the terms of the Order was 6.4 NTU on 31 May with a flow of 192 cfs (Table 3-8). Values were observed to remain elevated throughout the monitoring season and generally increasing from spring through summer and into fall (Figure 3-25).

Turbidity levels at the Jimtown station were lower compared to the Hopland and Cloverdale stations, with six exceedances (6 of 14 or 42.9%) of the EPA criteria in 2023 (Table 3-9 and Figure 3-25), with a maximum seasonal value of 5.6 NTU that occurred following the terms of the Order on 1 November with a flow of approximately 182 cfs (Table 3-9). The maximum value during the terms of the Order was 3.0 NTU on 4 October with a flow of 149 cfs (Table 3-9). The minimum seasonal value was 1.3 NTU, which occurred during the terms of the Order on 28 June with a flow of approximately 174 cfs (Table 3-9). Turbidity values remained consistently low through the monitoring season, with slightly higher values in the spring and fall contributing to the exceedances (Figure 3-25).

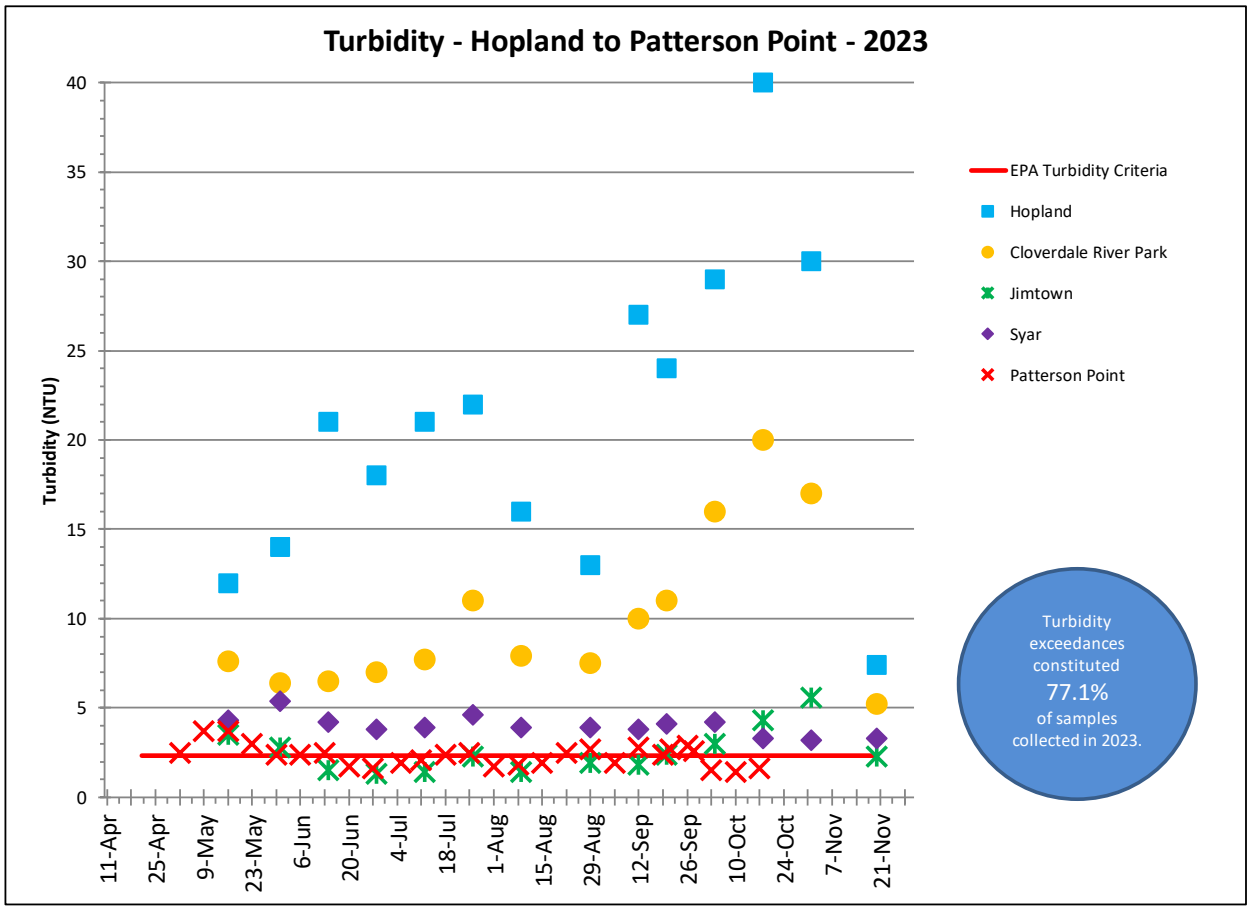


Figure 3-25. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Turbidity in 2023.

Turbidity levels at Syar Vineyards were also lower compared to Hopland and Cloverdale. However, Syar exceeded the EPA criteria throughout the monitoring season, including prior to, during, and following the terms of the Order (14 of 14 samples or 100%) with flows that ranged from 245 cfs to 571 cfs (Table 3-9 and Figure 3-25). The maximum value of 5.4 NTU occurred during the terms of the Order on 31 May with a flow of 430 cfs (Table 3-9). The minimum seasonal value was 3.2 NTU, which occurred following the terms of the Order on 1 November with an estimated flow of 280 cfs (Table 3-9). Estimated flows are based on flow at the USGS RR at Healdsburg gage combined with flow at the USGS Dry Creek near

Mouth gage. The minimum value during the terms of the Order was 3.8 NTU, which occurred twice, on 28 June and 12 September with flows of 284 and 245 cfs, respectively (Table 3-8). Turbidity values were observed to remain fairly consistent through the monitoring season (Figure 3-25).

The Patterson Point station had sixteen (16) exceedances of the turbidity criteria (16 of 27 or 59.3%) prior to and during the terms of the Order with flows ranging from 143 cfs to 898 cfs (Table 3-10 and Figure 3-25). The maximum seasonal value was 3.7 NTU, which occurred twice before the terms of the Order, on 9 May and 16 May with flows of 898 cfs and 668 cfs, respectively (Table 3-10). The maximum value during the terms of the Order was 3.0 NTU on 23 May with a flow of 521 cfs (Table 3-10). The minimum seasonal value was 1.4 NTU, which occurred during the terms of the Order on 10 October with a flow of 186 cfs (Table 3-10). Turbidity values were observed to remain fairly consistent through the monitoring season (Figure 3-25).

Table 3-10. Sonoma Water 2023 Seasonal Mainstem Russian River Grab Sampling Results at Patterson Point.

Patterson Point	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/2/2023	11:00	15.3	7.3	ND	0.14	0.0080	0.20	ND	ND	0.35	**0.040**	ND	1.45	1.84	160	**2.5**	**0.0037**	890
5/9/2023	10:10	15.5	7.5	ND	ND	ND	0.22	ND	ND	0.22	**0.048**	0.1	1.5	2.15	160	**3.7**	ND	898
5/16/2023	8:10	18.4	7.8	ND	ND	ND	0.23	ND	ND	0.23	**0.053**	0.12	1.61	2.18	160	**3.7**	**0.0037**	668
5/23/2023	9:10	19.9	7.8	ND	ND	ND	0.18	ND	ND	0.18	**0.042**	0.077	1.47	2.81	170	**3.0**	**0.0085**	521
5/30/2023	9:20	17.3	7.7	ND	ND	ND	0.21	ND	ND	0.21	**0.050**	0.11	1.40	1.83	170	**2.4**	**0.0064**	455
6/6/2023	8:50	20.1	8.1	ND	0.11	ND	0.054	ND	ND	0.164	**0.030**	ND	1.58	1.94	140	**2.4**	**0.0064**	364
6/13/2023	9:40	19.3	7.9	ND	0.11	0.0031	0.1	ND	ND	0.2131	**0.045**	ND	1.53	1.69	70	**2.5**	**0.0059**	298
6/20/2023	9:10	20.4	7.8	ND	0.13	ND	ND	ND	ND	0.13	**0.040**	0.13	1.74	1.88	160	1.7	**0.0088**	267
6/27/2023	10:00	20.0	7.8	ND	ND	ND	ND	ND	ND	ND	**0.034**	ND	1.80	6.26	160	1.6	**0.0035**	214
7/5/2023	9:20	22.4	7.7	ND	0.1	0.0022	ND	ND	ND	0.1022	**0.056**	ND	1.71	2.00	140	1.9	**0.0040**	200
7/11/2023	9:20	22.0	7.7	ND	0.33	0.0080	ND	ND	0.45	**0.45**	**0.040**	ND	1.88	1.83	160	2.1	ND	189
7/18/2023	8:50	23.7	7.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.97	2.35	140	**2.4**	**0.0037**	154
7/25/2023	9:30	23.7	7.6	ND	ND	ND	ND	ND	ND	ND	**0.035**	ND	1.83	1.91	110	**2.5**	**0.0077**	165
8/1/2023	10:10	22.9	7.7	3.9	ND	ND	ND	ND	3.9	**3.9**	**0.045**	ND	1.89	2.03	100	1.7	**0.0048**	154
8/8/2023	9:10	23.4	7.5	ND	ND	0.0014	ND	ND	ND	0.0014	**0.036**	ND	2.00	2.02	140	1.8	**0.0051**	143
8/15/2023	9:00	21.5	7.5	ND	ND	ND	ND	ND	ND	ND	**0.037**	0.092	1.86	2.04	140	1.9	ND	151
8/22/2023	9:00	21.6	7.4	ND	ND	ND	ND	ND	ND	ND	**0.036**	ND	1.98	1.92	130	**2.5**	ND	166
8/29/2023	9:20	21.8	7.5	ND	ND	ND	ND	ND	ND	ND	**0.043**	ND	1.79	1.69	120	**2.7**	**0.0056**	166
9/5/2023	9:40	21.3	7.5	ND	ND	ND	ND	ND	ND	ND	**0.032**	ND	1.78	1.82	98	1.9	**0.0088**	206
9/12/2023	9:10	20.6	7.6	ND	ND	ND	ND	ND	ND	ND	**0.026**	ND	1.84	1.91	120	**2.8**	ND	152
9/19/2023	10:10	19.9	7.5	ND	ND	ND	0.086	ND	ND	0.086	ND	ND	1.84	1.84	120	**2.4**	**0.0059**	166
9/21/2023	8:30	18.8	7.5	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	1.83	1.89	120	**2.7**	ND	173
9/26/2023	9:10	18.5	7.5	ND	ND	ND	ND	ND	ND	ND	0.021	ND	1.80	1.85	90	**2.9**	**0.0043**	195
9/28/2023	9:00	18.4	7.5	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	1.78	1.92	130	**2.6**	ND	188
10/3/2023	9:40	17.6	7.6	0.42	ND	ND	ND	ND	ND	**0.42**	**0.028**	ND	1.91	1.83	140	1.5	ND	181
10/10/2023	8:40	17.7	7.6	ND	ND	ND	ND	ND	ND	ND	**0.028**	ND	2.22	2.19	130	1.4	ND	186
10/17/2023	10:20	16.6	7.6	0.51	ND	ND	ND	ND	0.51	**0.51**	**0.023**	0.037	1.78	1.79	120	1.6	ND	198

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station.

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L — Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Total Nitrogen: 0.38 mg/L — Turbidity: 2.34 FTU/NTU

Chlorophyll a

The EPA criteria for *chlorophyll a* in Aggregate Ecoregion III is 1.78 µg/L, or approximately 0.0018 mg/L for rivers and streams (EPA, 2000). *Chlorophyll a* results were observed to periodically exceed the EPA

criteria at all five stations prior to, during, and following the terms of the Order (48 of 83 samples or 57.8%), most predominantly at Jimtown and Patterson Point and least predominantly at Hopland (Tables 3-8 through 3-10 and Figure 3-26). *Chlorophyll a* values varied through the season with several ND values occurring at all five stations (Figure 3-26).

As mentioned above, lab analysis constraints in 2023 resulted in the MDL for *chlorophyll a* being higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Therefore, some lab results for *chlorophyll a* that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL. However, for reporting purposes, only those exceedances that are quantified will be included in the summation.

Hopland had five (5) *chlorophyll a* exceedances (5 of 14 or 35.7%) and nine (9) non-detects prior to, during, and following the terms of the Order, including a maximum value of 0.014 mg/L that occurred during the terms of the Order on 12 September with a flow of 160 cfs (Table 3-8 and Figure 3-26). Hopland had exceedances periodically throughout the monitoring period, but more predominantly during the latter half of the monitoring period and following the terms of the Order (Table 3-8 and Figure 3-26).

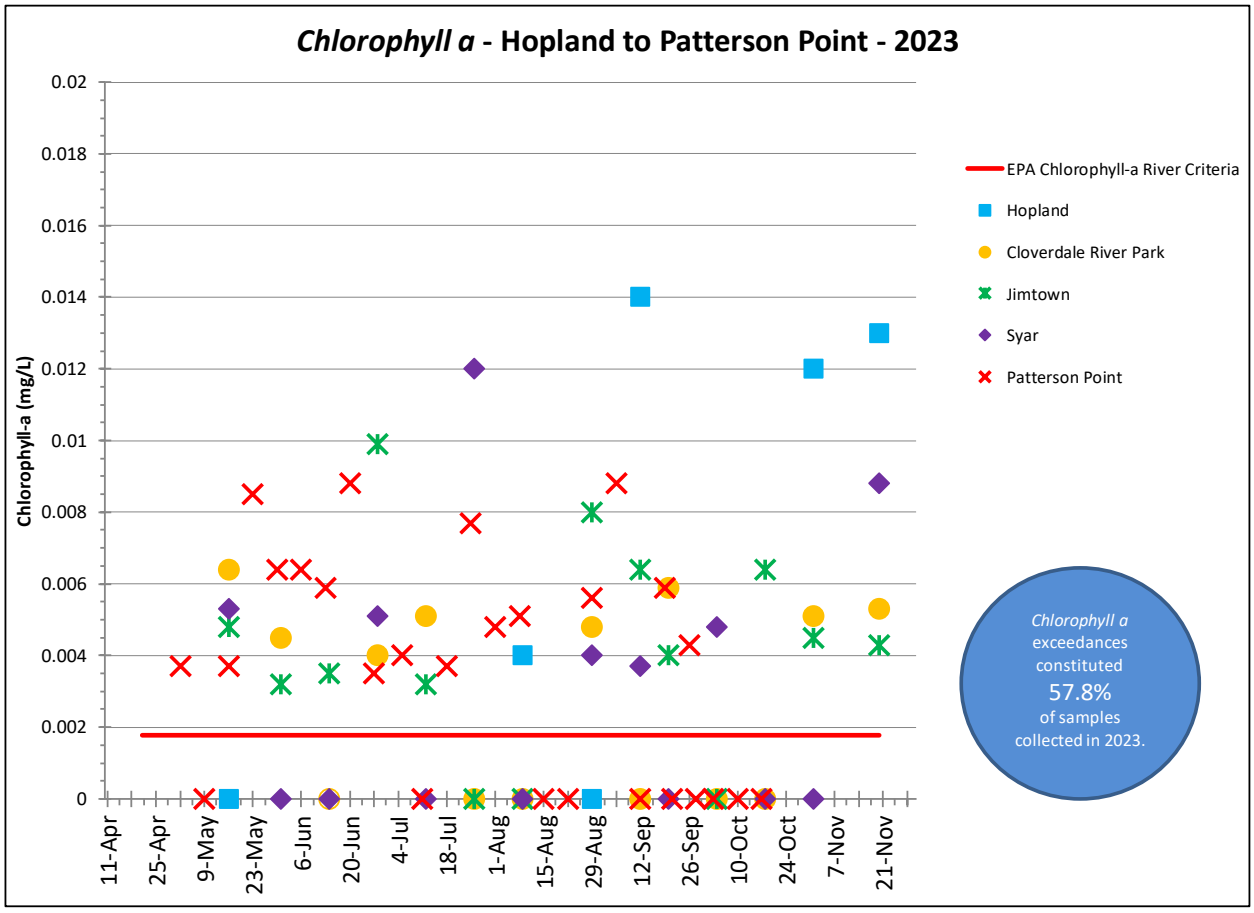


Figure 3-26. Sonoma Water Seasonal Mainstem Russian River Grab Sampling *Chlorophyll a* Results in 2023.

Cloverdale River Park had eight (8) *chlorophyll a* exceedances (8 of 14 or 57.1%) and six (6) non-detects prior to, during, and following the terms of the Order, including a maximum value of 0.0064 mg/L that occurred prior to the terms of the Order on 16 May with a flow of 293 cfs (Table 3-8 and Figure 3-26).

The maximum value during the terms of the Order was 0.0059 mg/L on 20 September with a flow of 155 cfs (Table 3-8). Exceedances were periodic through the monitoring period (Table 3-8).

Jimtown had eleven (11) *chlorophyll a* exceedances (11 of 14 or 78.6%) and three (3) non-detects prior to, during, and following the terms of the Order, including a maximum value of 0.0099 mg/L that occurred during the terms of the Order on 28 June with a flow of 174 cfs (Table 3-9 and Figure 3-26). Exceedances at Jimtown occurred predominantly throughout the monitoring period (Table 3-9).

Syar Vineyards had seven (7) *chlorophyll a* exceedances (7 of 14 or 50%) and seven (7) non-detects prior to, during, and following the terms of the Order, including a maximum value of 0.012 mg/L that occurred during the terms of the Order on 26 July with a flow of 260 cfs (Table 3-9 and Figure 3-26). Exceedances at Syar occurred periodically throughout the monitoring period (Table 3-9).

Patterson Point had seventeen (17) *chlorophyll a* exceedances (17 of 27 or 63%) and ten (10) non-detects prior to, during, and following the terms of the Order, including a maximum value of 0.0088 mg/L that occurred twice during the terms of the Order, on 20 June and 5 September, with flows of 267 cfs and 206 cfs, respectively (Table 3-10 and Figure 3-26). Exceedances at Patterson Point occurred more predominantly through the spring and summer, with several non-detects occurring during and following the terms of the Order at the end of the monitoring period (Table 3-10).

3.2 Sonoma Water Russian River Estuary Water Quality Monitoring

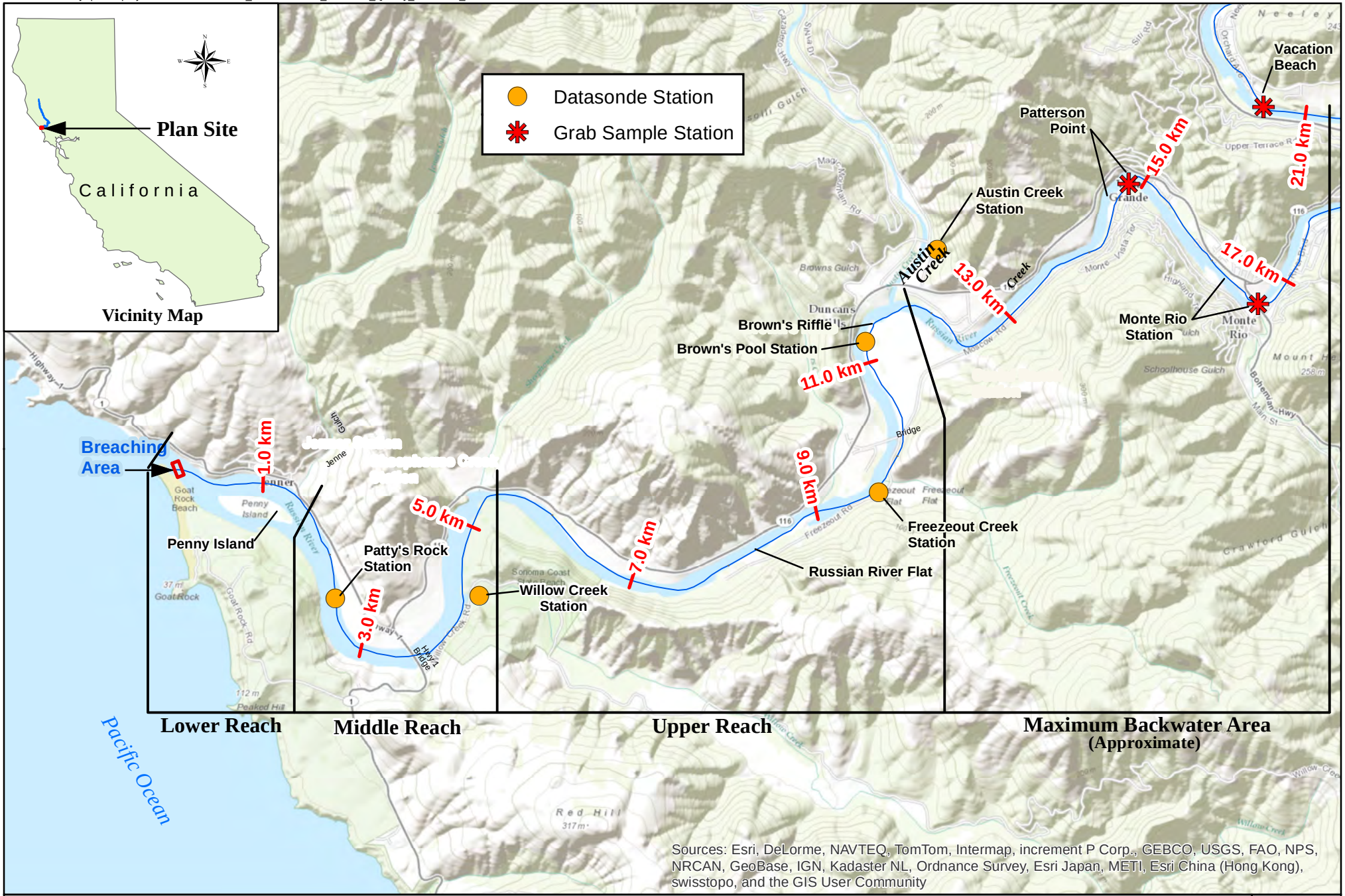
With a normal water year and elevated spring flows, Russian River flows at Hacienda (downstream of the confluence with Dry Creek) did not drop below the D1610 minimum flows of 125 cfs or the TUC minimum daily average flows of 70 cfs authorized by the Order during the monitoring season (Figure 2-4). Long-term water quality monitoring and weekly grab sampling was conducted prior to, during, and following the terms of the Order in the middle and upper reaches of the Russian River Estuary and the upper extent of inundation and backwatering during lagoon formation, referred to as the maximum backwater area (MBA). The three reaches of the estuary experience saline water conditions of various degrees with the upper reach extending up to the Duncans Mills area near the confluence with Austin Creek. The MBA does not experience any saline water migration and is located in the mainstem from Austin Creek to Vacation Beach in Guerneville. Long-term monitoring stations and grab sampling sites were located between Patty's Rock at Jenner and Vacation Beach in Guerneville, including in two tributaries.

Saline water is denser than freshwater and a salinity "wedge" forms as freshwater outflow passes over the denser tidal inflow. During the lagoon management period (15 May to 15 October), the lower and middle reaches of the Estuary up to Sheephouse Creek are predominantly saline environments with a thin freshwater layer that flows over the denser saltwater. The upper reach of the Estuary transitions to a predominantly freshwater environment, which is periodically underlain by a denser, saltwater layer that migrates upstream to Duncans Mills during low flow conditions and barrier beach closure.

Sonoma Water staff continued to collect long-term monitoring data to: establish baseline information on water quality in the Estuary and assess the availability of aquatic habitat in the Estuary; gain a better understanding of the longitudinal and vertical water quality profile during the ebb and flow of the tide; and track changes to the water quality profile that may occur during periods of low flow conditions,

barrier beach closure, lagoon outlet channel implementation, and reopening. Long-term monitoring datasondes were deployed at five (5) stations in the Russian River estuary, including two tributary stations during the 2023 monitoring season (Figure 3-27). Sonoma Water submits an annual report to the National Marine Fisheries Service (NMFS) and California Department of Fish and Wildlife (CDFW) documenting the status updates of Sonoma Water's efforts in implementing the Biological Opinion. The water quality monitoring data for 2023 is currently being compiled and will be discussed in the Russian River Biological Opinion 2023-2024 annual report, which will be posted to Sonoma Water's website when available: https://www.sonomawater.org/biological-opinion-outreach.

\\SD-DATA\Proj\special projects\russian river\7339_Activities\7339_01\Water_Quality_MultiYear_2014.mxd 7/30/2015



0 0.45 0.9 1.8 Kilometers

0 0.375 0.75 1.5 Miles

Russian River Estuary
Water Quality Monitoring Stations

This Map is for general reference only.

Figure 3-27

Sonoma Water staff conducted weekly grab sampling from 2 May to 17 October at three stations in the lower mainstem Russian River, including: Vacation Beach, Monte Rio, and Patterson Point (Figure 3-27). All samples were analyzed for bacterial indicators (Total Coliform, *E. coli*, and *Enterococcus*), nutrients, *chlorophyll a*, total and dissolved organic carbon, total dissolved solids, and turbidity. Sonoma Water submitted samples to the Sonoma County DHS Public Health Division Lab in Santa Rosa for bacteria analysis. Samples for all other constituents were submitted to Alpha Analytical Labs in Ukiah for analysis.

The grab sample sites are shown in Figure 3-27, and the results are summarized in Tables 3-11 through 3-16 and Figures 3-28 through 3-34. Highlighted values indicate those values exceeding California Department of Public Health Draft Guidance (CDPH guidelines) for Fresh Water Beaches for Indicator Bacteria (CDPH, 2011), EPA Recreational Water Quality Criteria (EPA, 2012), and EPA Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion III (EPA, 2000).

Lab analysis constraints in 2023 resulted in a method detection limit (MDL) for *chlorophyll a*, which is the level of accuracy for a given lab analysis to provide a valid concentration of a given constituent, that was higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Put simply, the EPA exceedance criteria for *chlorophyll a* in rivers and streams is approximately 0.0018 mg/L, whereas the lab analysis MDL for *chlorophyll a* was 0.0030 mg/L. Therefore, some lab results for *chlorophyll a* that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL, which in turn could result in an under representation of the actual number of exceedances observed. However, for reporting purposes, only those exceedances that are quantified will be included in the summation.

Additionally, it must be emphasized that the draft CDPH guidelines and EPA criteria are not adopted standards, and are therefore subject to change (if it is determined that the guidelines or criteria are not accurate indicators) and are not currently enforceable.

Bacteria

Samples were collected in the lower river prior to, during, and following the terms of the Order in 2023 for diluted and undiluted analysis of Total Coliform and *E. coli* for comparative purposes and the results are included in Tables 3-11 through 3-13 and Figures 3-28 and 3-29. Total Coliform and *E. coli* data presented in Figures 3-28 and 3-29 utilize undiluted sample results unless the reporting limit has been exceeded, at which point the diluted results are utilized. Samples collected for *Enterococcus* prior to, during, and following the terms of the Order were undiluted only and results are included in Tables 3-11 through 3-13 and Figure 3-30. The CDPH guideline for Total Coliform is 10,000 MPN per 100 mL, and the EPA BAV is 235 MPN per 100 mL for *E. coli* and 61 MPN per 100 mL for *Enterococcus*.

NCRWQCB staff indicated in 2014 that *Enterococcus* was not being utilized as a fecal indicator bacteria for beach posting purposes in freshwater environments of the Russian River due to evidence that *Enterococcus* colonies can be persistent in the water column and therefore its presence at a given freshwater site may not always be associated with a fecal source. Sonoma Water staff will continue to collect *Enterococcus* samples and record and report the data however, *Enterococcus* results will not be relied upon when coordinating with the NCRWQCB and Sonoma County DHS about potentially posting warning signs at freshwater beach sites or to discuss potential adaptive management actions.

Total Coliform

There were two exceedances (2 of 81 or 2.5%) of the CDPH guideline for Total Coliform during the 2023 monitoring season at the lower river stations (Tables 3-11 through 3-13 and Figure 3-28).

The Vacation Beach station did not exceed the Total Coliform guideline during the terms of the Order (0 of 27 or 0%), with a maximum value of 4,106 MPN/100mL occurring on 25 July during open estuary conditions and a flow of 165 cfs (Table 3-11 and Figure 3-28). The minimum concentration at Vacation Beach measured 517.2 MPN/100mL following the terms of the Order on 17 October during open estuary conditions and a flow of 198 cfs (Table 3-11 and Figure 3-28). The minimum concentration at Vacation Beach during the terms of the Order was 920.8 MPN/100mL on 10 October during open estuary conditions and a flow of 186 cfs (Table 3-11 and Figure 3-28). Total Coliform concentrations remained low at the Vacation Beach station during the monitoring season (Figure 3-28).

Table 3-11. 2023 Vacation Beach bacteria concentrations for samples collected by Sonoma Water. This site experiences freshwater conditions.

Vacation Beach	Time	Temperature	pH	Total Coliforms (Colilert)	Total Coliforms Diluted 1:10 (Colilert)	E. coli (Colilert)	E. coli Diluted 1:10 (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				<1	<10	<1	<10	<1	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/2/2023	11:50	15.1	7.6	1986.3	1789	12.1	31	7.2	890
5/9/2023	11:00	16.0	7.7	>2419.6	2359	19.5	20	5.2	898
5/16/2023	9:10	18.7	7.9	>2419.6	2909	18.5	52	12.1	668
5/23/2023	10:10	19.8	7.9	2419.6	2098	12.1	10	3.0	521
5/30/2023	10:10	16.8	7.8	1203.3	1112	11.0	10	5.1	455
6/6/2023	9:40	19.1	7.7	1553.1	1616	15.8	41	3.0	364
6/13/2023	8:50	18.8	7.7	1413.6	1539	13.4	<10	7.5	298
6/20/2023	10:10	20.0	7.8	2419.6	2909	40.4	41	26.9	267
6/27/2023	9:20	20.1	7.9	1986.3	2046	36.9	74	**69.7**	214
7/5/2023	10:20	22.3	7.9	1732.9	2359	16.0	20	25.9	200
7/11/2023	8:20	22.1	7.8	>2419.6	2613	2.0	<10	18.9	189
7/18/2023	9:50	24.1	7.8	>2419.6	3448	11.0	10	6.3	154
7/25/2023	8:40	23.9	7.8	>2419.6	4106	16.1	10	21.3	165
8/1/2023	11:20	23.1	7.9	>2419.6	3654	8.5	20	7.5	154
8/8/2023	10:30	23.7	7.7	>2419.6	3448	7.4	30	8.6	143
8/15/2023	9:40	22.5	7.6	>2419.6	1421	6.2	<10	40.5	151
8/22/2023	10:00	21.3	7.4	1732.9	2282	8.5	<10	21.6	166
8/29/2023	8:40	21.7	7.6	1553.1	1789	20.3	20	9.8	166
9/5/2023	10:30	21.0	7.5	1732.9	1607	13.5	10	8.4	206
9/12/2023	9:50	20.6	7.5	1046.2	1046	14.5	<10	20.3	152
9/19/2023	9:20	19.4	7.5	1203.3	1374	26.5	<10	14.6	166
9/21/2023	9:20	18.4	7.5	1413.6	909	29.2	41	19.9	173
9/26/2023	10:00	18.0	7.4	1732.9	1211	35.5	31	27.5	195
9/28/2023	9:50	18.1	7.5	1986.3	906	19.9	31	13.5	188
10/3/2023	8:50	17.1	7.5	1119.9	789	20.1	10	41.4	181
10/10/2023	9:40	17.4	7.5	920.8	836	11.0	20	27.2	186
10/17/2023	11:10	16.9	7.6	517.2	495	11.0	10	14.6	198

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** United States Geological Survey (USGS) Continuous-Record Gaging Station

*** Flow rates are preliminary and subject to final revision by USGS.

Recommended California Department of Public Health (CDPH) Draft Guidance - Single Sample Maximum (SSM):

Total Coliform (SSM): 10,000 per 100ml

Environmental Protection Agency (EPA) Recreational Water Quality Criteria - Beach Action Value (BAV):

E. coli (BAV): 235 per 100 ml *Enterococcus* (BAV): 61 per 100 ml

(Beach notification is recommended when indicator organisms exceed the SSM for Total Coliform or the BAV for *E. coli*) - Indicated by red text

Monte Rio had one exceedance of the Total Coliform guideline (1 of 27 or 3.7%) with a maximum concentration of 11,199 MPN/100mL, which occurred during the terms of the Order on 18 July during open estuary conditions and a flow of 154 cfs (Table 3-12 and Figure 3-28). The minimum concentration occurred during the terms of the order and measured 613.1 MPN/100mL on 3 October during open estuary conditions and a flow of 181 cfs (Table 3-12 and Figure 3-28).

Patterson Point had one exceedance of the Total Coliform guideline (1 of 27 or 3.7%) with a maximum concentration of 12,997 MPN/100mL, which occurred during the terms of the Order on 1 August during open estuary conditions and a flow of 154 cfs (Table 3-13 and Figure 3-28). The minimum concentration at Patterson Point measured 547.5 MPN/100mL following the terms of the Order on 17 October during open estuary conditions and a flow of 198 cfs (Table 3-13 and Figure 3-28). The minimum concentration during the terms of the Order measured 613.1 MPN/100mL on 30 May during open estuary conditions and a flow of 455 cfs (Table 3-13 and Figure 3-28).

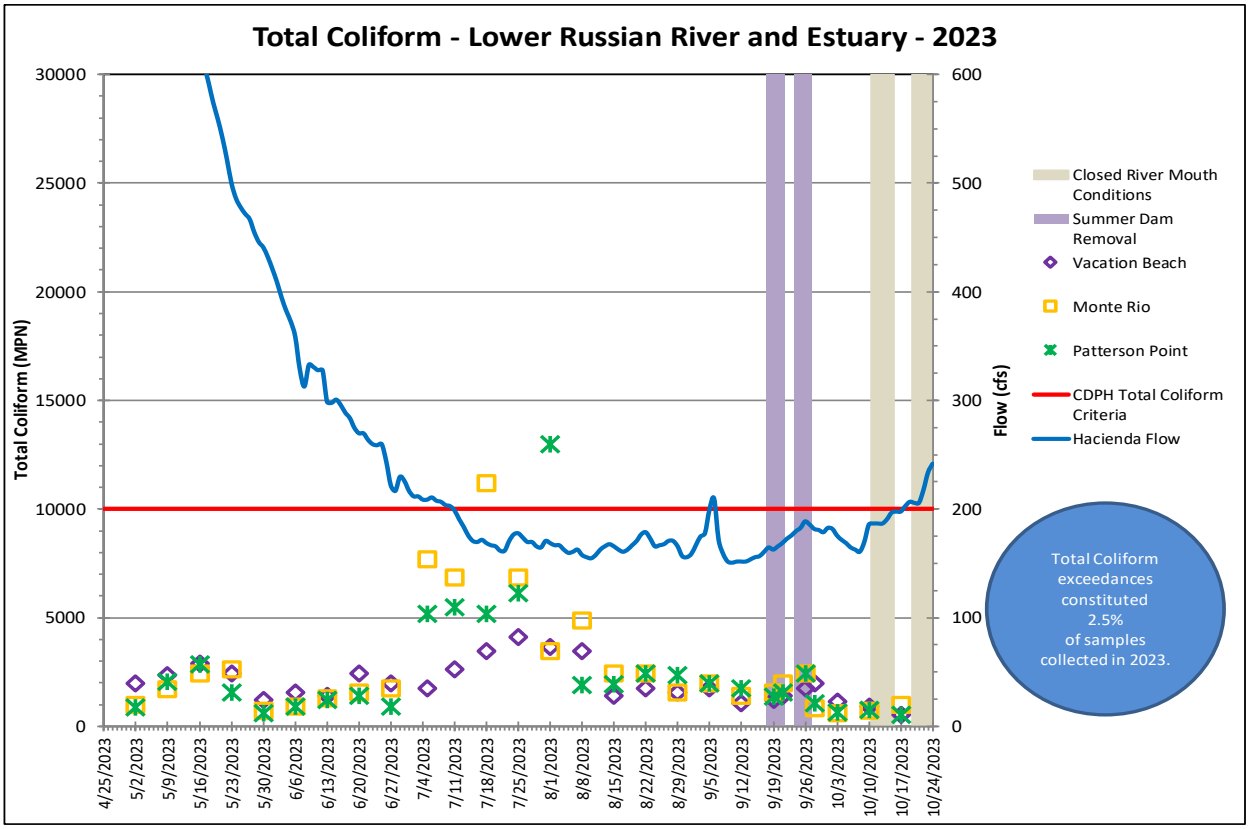


Figure 3-28. Total Coliform results for the Russian River from Vacation Beach to Patterson Point in 2023.

E. coli

There were no exceedances (0 of 81 or 0%) of the EPA criteria for *E. coli* during the 2023 monitoring season at the lower river stations (Tables 3-11 through 3-13 and Figure 3-29).

The maximum *E. coli* concentration observed at the Vacation Beach station was 40.4 MPN/100mL, which occurred during the terms of the Order on 20 June during open estuary conditions and a flow of 267 cfs (Table 3-11 and Figure 3-29). The minimum concentration measured 2.0 MPN/100mL during the terms

of the Order on 11 July during open estuary conditions and a flow of 189 cfs (Table 3-11 and Figure 3-29).

The maximum *E. coli* concentration observed at Monte Rio was 113.7 MPN/100mL, which occurred following the terms of the Order on 17 October during open estuary conditions and a flow of 198 cfs (Table 3-12 and Figure 3-29). The maximum concentration during the terms of the Order measured 86.0 MPN/100mL on 19 September during open estuary conditions and a flow of 166 cfs (Table 3-12 and Figure 3-29). The minimum concentration occurred during the terms of the Order and measured 4.1 MPN/100mL on 25 July during open estuary conditions and a flow of 165 cfs (Table 3-12 and Figure 3-29).

Table 3-12. 2023 Monte Rio bacteria concentrations for samples collected by Sonoma Water. This site experiences freshwater conditions.

Monte Rio	Time	Temperature	pH	Total Coliforms (Colilert)	Total Coliforms Diluted 1:10 (Colilert)	E. coli (Colilert)	E. coli Diluted 1:10 (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				<1	<10	<1	<10	<1	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/2/2023	11:30	15.3	7.5	980.4	1201	7.5	20	35.4	890
5/9/2023	10:40	15.8	7.8	>2419.6	1720	32.7	20	7.5	898
5/16/2023	8:40	18.4	7.8	2419.6	2282	9.6	20	2.0	668
5/23/2023	9:50	19.7	7.8	>2419.6	2613	12.0	10	5.2	521
5/30/2023	9:50	17.2	7.7	727.0	880	12.2	10	27.5	455
6/6/2023	9:20	19.8	7.8	920.8	1201	14.6	20	16	364
6/13/2023	9:10	19.1	7.8	1299.7	1274	41.0	31	10.9	298
6/20/2023	9:50	20.5	7.9	1553.1	1354	24.1	63	6.3	267
6/27/2023	9:40	19.8	7.8	1732.9	1421	39.9	20	56.3	214
7/5/2023	9:50	22.2	7.6	>2419.6	7701	27.2	20	15.5	200
7/11/2023	8:50	21.8	7.7	>2419.6	6867	10.8	20	13.5	189
7/18/2023	9:20	24.0	7.7	>2419.6	**11199**	7.2	10	4.1	154
7/25/2023	9:00	23.9	7.6	>2419.6	6867	4.1	20	7.4	165
8/1/2023	11:00	23.1	7.7	>2419.6	3448	5.2	52	14.6	154
8/8/2023	10:10	23.6	7.6	>2419.6	4884	9.8	10	8.6	143
8/15/2023	9:20	22.4	7.5	2419.6	1918	6.3	<10	8.6	151
8/22/2023	9:30	21.7	7.4	2419.6	2382	17.5	31	22.8	166
8/29/2023	9:00	21.6	7.7	1553.1	1842	20.1	30	18.7	166
9/5/2023	10:10	21.1	7.4	1986.3	2359	47.3	41	23.3	206
9/12/2023	9:30	20.7	7.6	1413.6	2143	29.9	41	18.5	152
9/19/2023	9:40	19.6	7.6	1553.1	1785	86.0	119	58.3	166
9/21/2023	9:00	18.5	7.5	1986.3	1333	72.3	52	59.1	173
9/26/2023	9:30	18.4	7.5	2419.6	1789	66.3	52	**66.3**	195
9/28/2023	9:30	18.2	7.5	816.4	820	27.5	<10	17.3	188
10/3/2023	9:10	17.4	7.6	613.1	1019	18.7	52	**228.2**	181
10/10/2023	9:20	17.6	7.6	727	1043	11.0	10	42.6	186
10/17/2023	10:50	16.8	7.6	980.4	749	113.7	110	**86.0**	198
* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.									
** United States Geological Survey (USGS) Continuous-Record Gaging Station									
*** Flow rates are preliminary and subject to final revision by USGS.									
Recommended California Department of Public Health (CDPH) Draft Guidance - Single Sample Maximum (SSM):									
Total Coliform (SSM): 10,000 per 100ml									
Environmental Protection Agency (EPA) Recreational Water Quality Criteria - Beach Action Value (BAV):									
E. coli (BAV): 235 per 100 ml				*Enterococcus* (BAV): 61 per 100 ml					
(Beach notification is recommended when indicator organisms exceed the SSM for Total Coliform or the BAV for *E. coli*) - Indicated by red text									

The maximum *E. coli* concentration observed at Patterson Point was 118.7 MPN/100mL, which occurred during the terms of the Order on 26 September during open estuary conditions and a flow of 195 cfs

(Table 3-13 and Figure 3-29). The minimum concentration measured 5.2 MPN/100mL, which occurred during the terms of the Order on 25 July during open estuary conditions and a flow of 165 cfs (Table 3-13 and Figure 3-29).

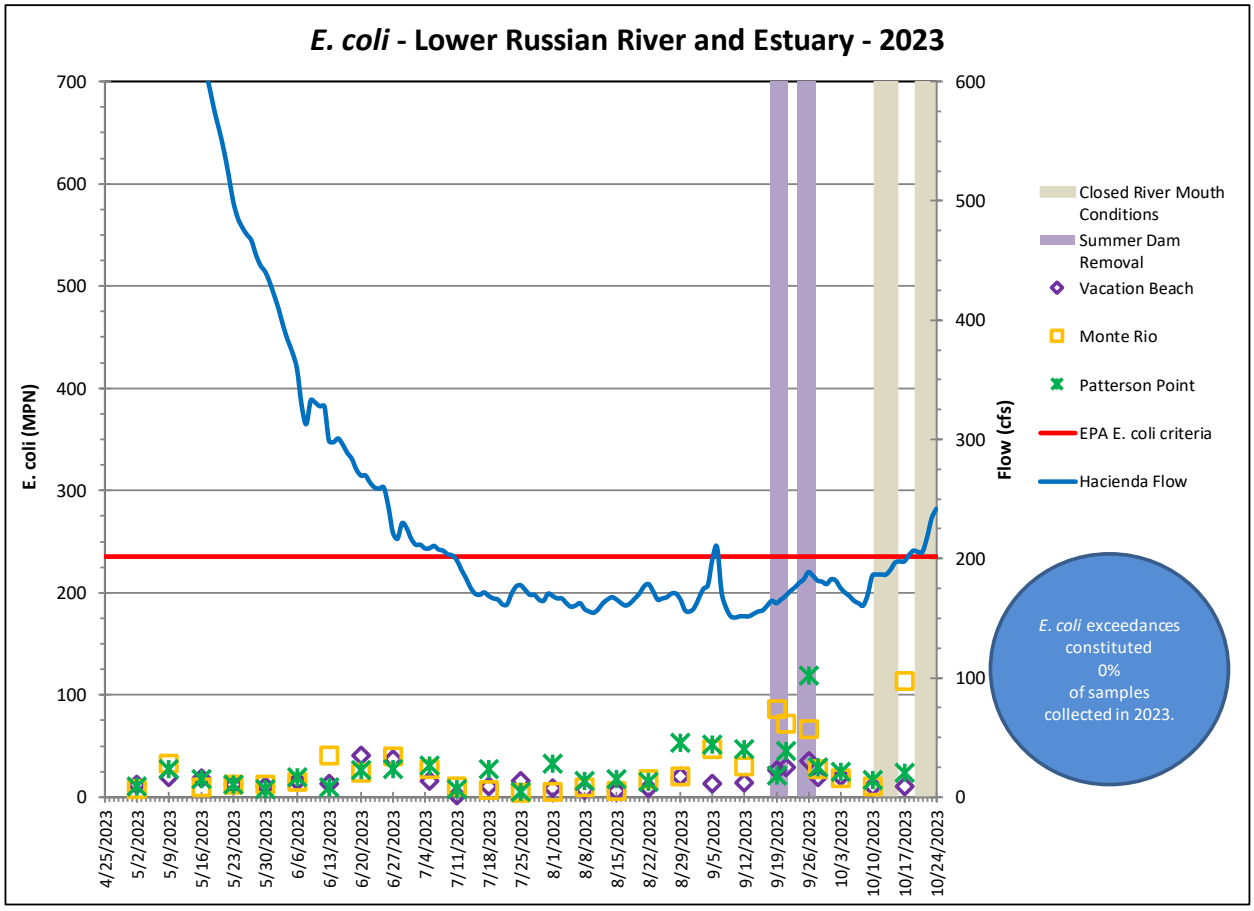


Figure 3-29. *E. coli* results for the Russian River from Vacation Beach to Patterson Point in 2023.

Enterococcus

There were six (6) exceedances (6 of 81 or 7.4%) of the EPA criteria for *Enterococcus* at the lower river stations during and following the terms of the Order, with flows that ranged from 166 cfs to 214 cfs at the Hacienda USGS gage (Tables 3-11 through 3-13 and Figure 3-30).

The Vacation Beach station had one (1) exceedance of the EPA criteria for *Enterococcus* during the terms of the Order (1 of 27 or 3.7%), including a maximum concentration of 69.7 MPN/100mL that occurred on 27 June during open estuary conditions and a flow of 214 cfs (Table 3-11 and Figure 3-30). The minimum seasonal concentration measured 3.0 MPN/100mL, which occurred twice during the terms of the Order on 23 May and 6 June during open estuary conditions and flows of 521 cfs and 364 cfs, respectively (Table 3-11 and Figure 3-30).

The Monte Rio station had three (3) exceedances of the EPA criteria for *Enterococcus* that occurred during and following the terms of the Order (3 of 27 or 11.1%). The maximum concentration of 228.2 MPN/100mL occurred during the terms of the Order on 3 October during open estuary conditions and a flow of 181 cfs (Table 3-12 and Figure 3-30). The minimum concentration measured 2.0 MPN/100mL prior to the terms of the Order on 16 May during open estuary conditions and a flow of approximately

668 cfs at the Hacienda USGS gage (Table 3-12 and Figure 3-30). The minimum concentration during the terms of the Order measured 4.1 MPN/100mL on 18 July during open estuary conditions and a flow of 154 cfs (Table 3-12 and Figure 3-30).

Table 3-13. 2023 Patterson Point bacteria concentrations for samples collected by Sonoma Water. This site experiences freshwater conditions.

Patterson Point	Time	Temperature	pH	Total Coliforms (Colilert)	Total Coliforms Diluted 1:10 (Colilert)	E. coli (Colilert)	E. coli Diluted 1:10 (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				<1	<10	<1	<10	<1	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/2/2023	11:00	15.3	7.3	866.4	820	10.9	<10	5.2	890
5/9/2023	10:10	15.5	7.5	>2419.6	2046	27.8	31	3.1	898
5/16/2023	8:10	18.4	7.8	>2419.6	2851	17.5	10	4.1	668
5/23/2023	9:10	19.9	7.8	1553.1	1396	12.0	20	7.5	521
5/30/2023	9:20	17.3	7.7	613.1	813	7.5	10	5.2	455
6/6/2023	8:50	20.1	8.1	920.8	842	19.9	<10	14.5	364
6/13/2023	9:40	19.3	7.9	1203.3	563	9.7	10	5.2	298
6/20/2023	9:10	20.4	7.8	1413.6	1725	26.5	31	11	267
6/27/2023	10:00	20.0	7.8	920.8	1274	27.5	41	24.1	214
7/5/2023	9:20	22.4	7.7	>2419.6	5172	31.3	41	51.2	200
7/11/2023	9:20	22.0	7.7	>2419.6	5475	7.5	52	25.6	189
7/18/2023	8:50	23.7	7.7	>2419.6	5172	27.5	31	16.8	154
7/25/2023	9:30	23.7	7.6	>2419.6	6131	5.2	<10	6.3	165
8/1/2023	10:10	22.9	7.7	>2419.6	**12997**	32.7	20	36.8	154
8/8/2023	9:10	23.4	7.5	>2419.6	1918	16.1	30	12.1	143
8/15/2023	9:00	21.5	7.5	>2419.6	1935	17.5	<10	24.6	151
8/22/2023	9:00	21.6	7.4	2419.6	2481	14.6	52	16.9	166
8/29/2023	9:20	21.8	7.5	>2419.6	2359	52.9	30	**64.5**	166
9/5/2023	9:40	21.3	7.5	1986.3	2247	51.2	10	29.8	206
9/12/2023	9:10	20.6	7.6	1732.9	1483	47.1	30	25.9	152
9/19/2023	10:10	19.9	7.5	>2419.6	1354	21.3	41	24.9	166
9/21/2023	8:30	18.8	7.5	1553.1	1860	44.8	41	26.6	173
9/26/2023	9:10	18.5	7.5	2419.6	1956	118.7	110	**83.3**	195
9/28/2023	9:00	18.4	7.5	1046.2	1201	29.2	52	17.1	188
10/3/2023	9:40	17.6	7.6	648.8	1401	24.6	31	21.3	181
10/10/2023	8:40	17.7	7.6	770.1	609	16.9	20	27.5	186
10/17/2023	10:20	16.6	7.6	547.5	650	24.3	20	38.9	198

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** United States Geological Survey (USGS) Continuous-Record Gaging Station

*** Flow rates are preliminary and subject to final revision by USGS.

Recommended California Department of Public Health (CDPH) Draft Guidance - Single Sample Maximum (SSM):

Total Coliform (SSM): 10,000 per 100ml

Environmental Protection Agency (EPA) Recreational Water Quality Criteria - Beach Action Value (BAV):

E. coli (BAV): 235 per 100 ml *Enterococcus* (BAV): 61 per 100 ml

(Beach notification is recommended when indicator organisms exceed the SSM for Total Coliform or the BAV for *E. coli*) - Indicated by red text

The Patterson Point station had two (2) exceedances of the EPA criteria for *Enterococcus* (2 of 27 or 7.4%) that occurred during the terms of the Order, including a maximum concentration of 83.3 MPN/100mL on 26 September during open estuary conditions and a flow of 195 cfs (Table 3-13 and Figure 3-30). The minimum concentration at Patterson Point measured 3.1 MPN/100mL, which occurred prior to the terms of the Order on 9 May during open estuary conditions and a flow of 898 cfs (Table 3-13 and Figure 3-30). The minimum concentration during the terms of the Order measured 5.2 MPN/100mL, which occurred twice on 30 May and 13 June during open estuary conditions and flows of 455 cfs and 298 cfs, respectively (Table 3-13 and Figure 3-30).

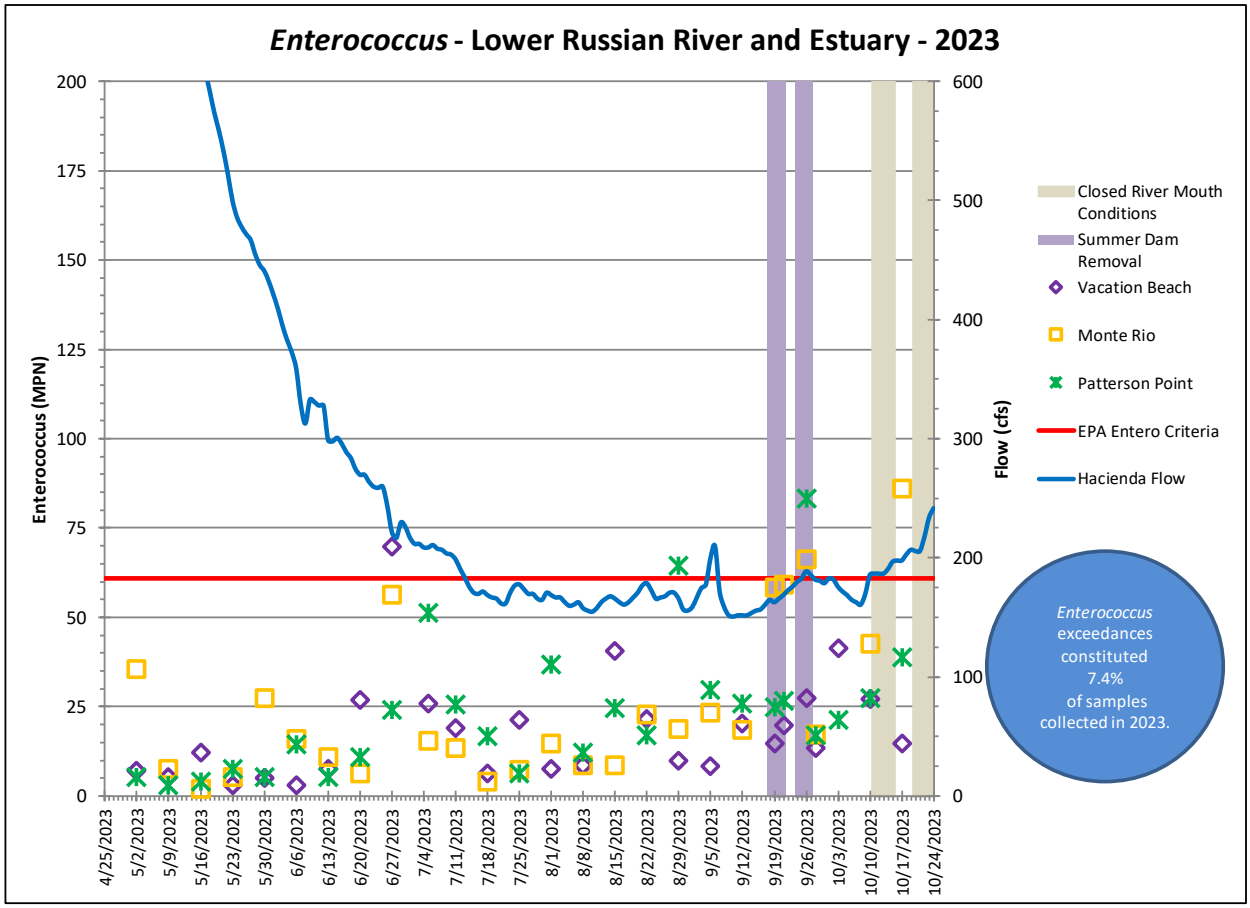


Figure 3-30. *Enterococcus* results for the Russian River from Vacation Beach to Patterson Point in 2023.

Total Nitrogen

There were eight (8) exceedances (8 of 81 or 9.9%) of the EPA criteria for total nitrogen that occurred prior to and during the terms of the Order at the lower river stations, with flows that ranged from 154 to 267 cfs (Tables 3-14 through 3-16 and Figure 3-31). Exceedances were observed at Monte Rio and Patterson Point, but there were no exceedances at Vacation Beach (Figure 3-31).

There were no exceedances of the total nitrogen criteria (0 of 27 or 0%) at the Vacation Beach station in 2023 (Table 3-14). The maximum total nitrogen concentration observed at Vacation Beach was 0.24 mg/L, which occurred prior to the terms of the Order on 16 May during open estuary conditions with a flow of 668 cfs (Table 3-14 and Figure 3-31). The maximum concentration during the terms of the Order was 0.22 mg/L on 30 May during open conditions and a flow of 455 cfs (Table 3-14 and Figure 3-31). The minimum concentration at Vacation Beach was ND, which occurred thirteen (13) times during and following the terms of the Order during open estuary conditions and flows that ranged from 151 to 206 cfs (Table 3-14).

The Monte Rio station had four (4) exceedances of the EPA total nitrogen criteria (4 of 27 or 14.8%) that occurred during and following the terms of the Order with flows that ranged from 154 to 267 cfs (Table 3-15 and Figure 3-31). The maximum total nitrogen concentration observed at Monte Rio was 0.52 mg/L, which occurred following the terms of the Order on 17 October during open estuary conditions with a flow of 198 cfs (Table 3-15 and Figure 3-31). The maximum concentration during the terms of the

Order was 0.49 mg/L on 20 June during open conditions and a flow of 267 cfs (Table 3-15 and Figure 3-31). The minimum concentration at Monte Rio was ND, which occurred twelve (12) times during the terms of the Order during open estuary conditions and flows that ranged from 151 to 214 cfs (Table 3-15).

The Patterson Point station had four (4) exceedances of the EPA total nitrogen criteria (4 of 27 or 14.8%) during and following the terms of the Order, with flows that ranged from 154 to 198 cfs (Table 3-16 and Figure 3-31). The maximum concentration of 3.9 mg/L occurred during the terms of the Order on 1 August during open conditions and a flow of 154 cfs (Table 3-16 and Figure 3-31). The minimum concentration at Patterson Point was ND, which occurred twelve (12) times during the terms of the Order during open estuary conditions and flows that ranged from 151 to 214 cfs (Table 3-16). Other than the one anomalous exceedance that occurred on 1 August, total nitrogen concentrations remained relatively low through the monitoring season (Table 3-16 and Figure 3-31).

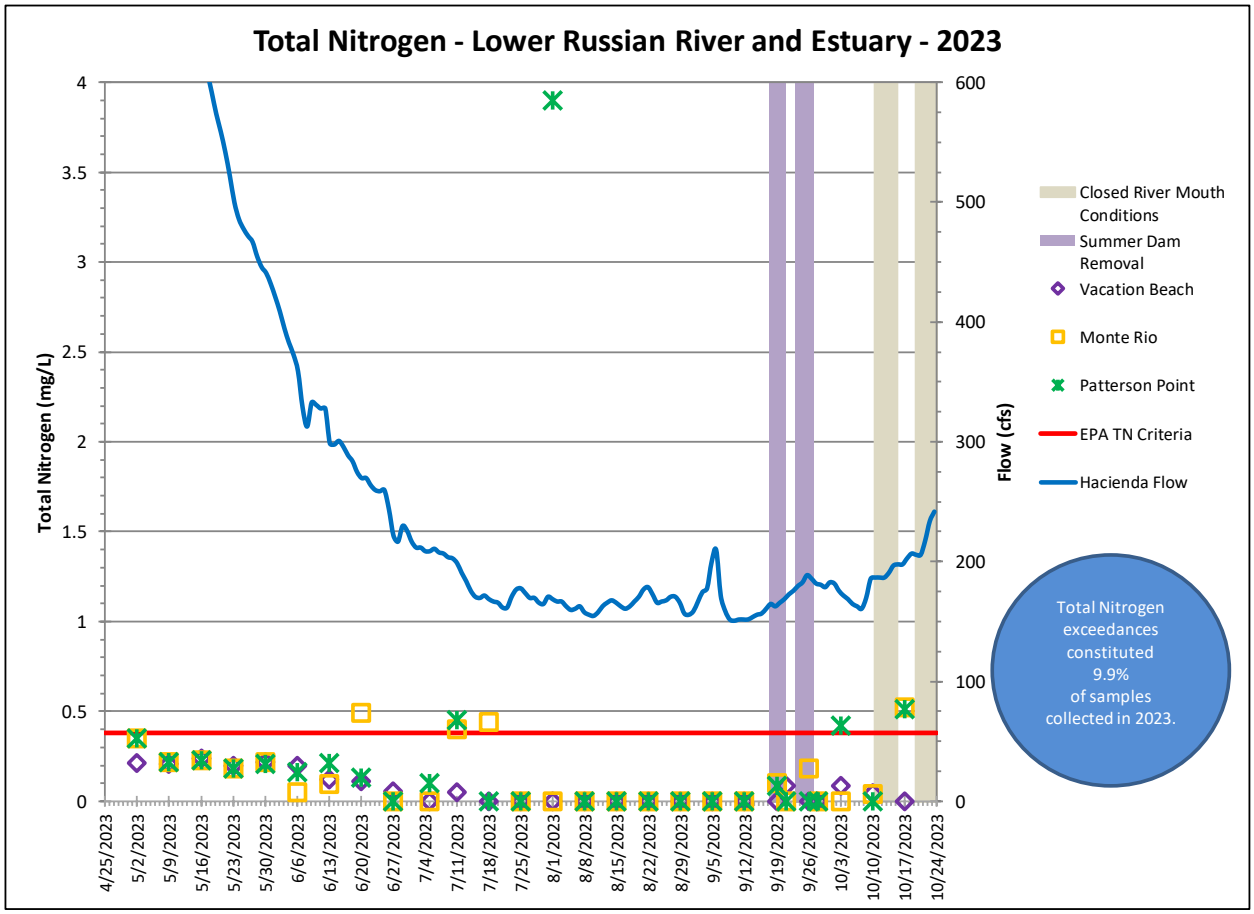


Figure 3-31. Total Nitrogen results for the Russian River from Vacation Beach to Patterson Point in 2023.

Total Phosphorus

All three lower river stations predominantly exceeded the EPA criteria for total phosphorous (74 of 81 or 91.4%) prior to, during, and following the terms of the Order with flows that ranged from 143 cfs to 898 cfs, continuing a trend of consistent exceedances observed in previous years (Tables 3-14 through 3-16 and Figure 3-32). Exceedances occurred during open estuary conditions and generally trended downward through the monitoring season (Figure 3-32).

Vacation Beach had twenty-four (24) exceedances of the EPA total phosphorus criteria (24 of 27 or 88.9%) that occurred prior to, during, and following the terms of the Order, including a maximum concentration of 0.061 mg/L that occurred twice prior to the terms of the Order on 9 May and 16 May during open estuary conditions and flows of 898 and 668 cfs, respectively (Table 3-14 and Figure 3-32). The maximum concentration during the terms of the Order was 0.057 mg/L on 30 May during open estuary conditions and a flow of 455 cfs (Table 3-14 and Figure 3-32). The minimum concentration at Vacation Beach was ND, which occurred twice during the terms of the Order on 18 July and 19 September during open estuary conditions and flows of 154 and 166 cfs, respectively (Table 3-14). Finally, the lowest flow recorded during sampling was approximately 143 cfs, which occurred during the terms of the Order on 8 August during open estuary conditions with a concentration of 0.029 mg/L (Table 3-14).

Monte Rio had twenty-six (26) exceedances of the EPA total phosphorus criteria (26 of 27 or 96.3%) that occurred prior to, during, and following the terms of the Order, including a maximum concentration of 0.074 mg/L that occurred during the terms of the Order on 20 June during open estuary conditions and a flow of 267 cfs (Table 3-15 and Figure 3-32). The minimum concentration at Monte Rio was ND, which occurred during the terms of the Order on 19 September during open estuary conditions and a flow of 166 cfs. Finally, the lowest flow recorded during sampling was approximately 143 cfs, which occurred during the terms of the Order on 8 August during open estuary conditions with a concentration of 0.034 mg/L (Table 3-15).

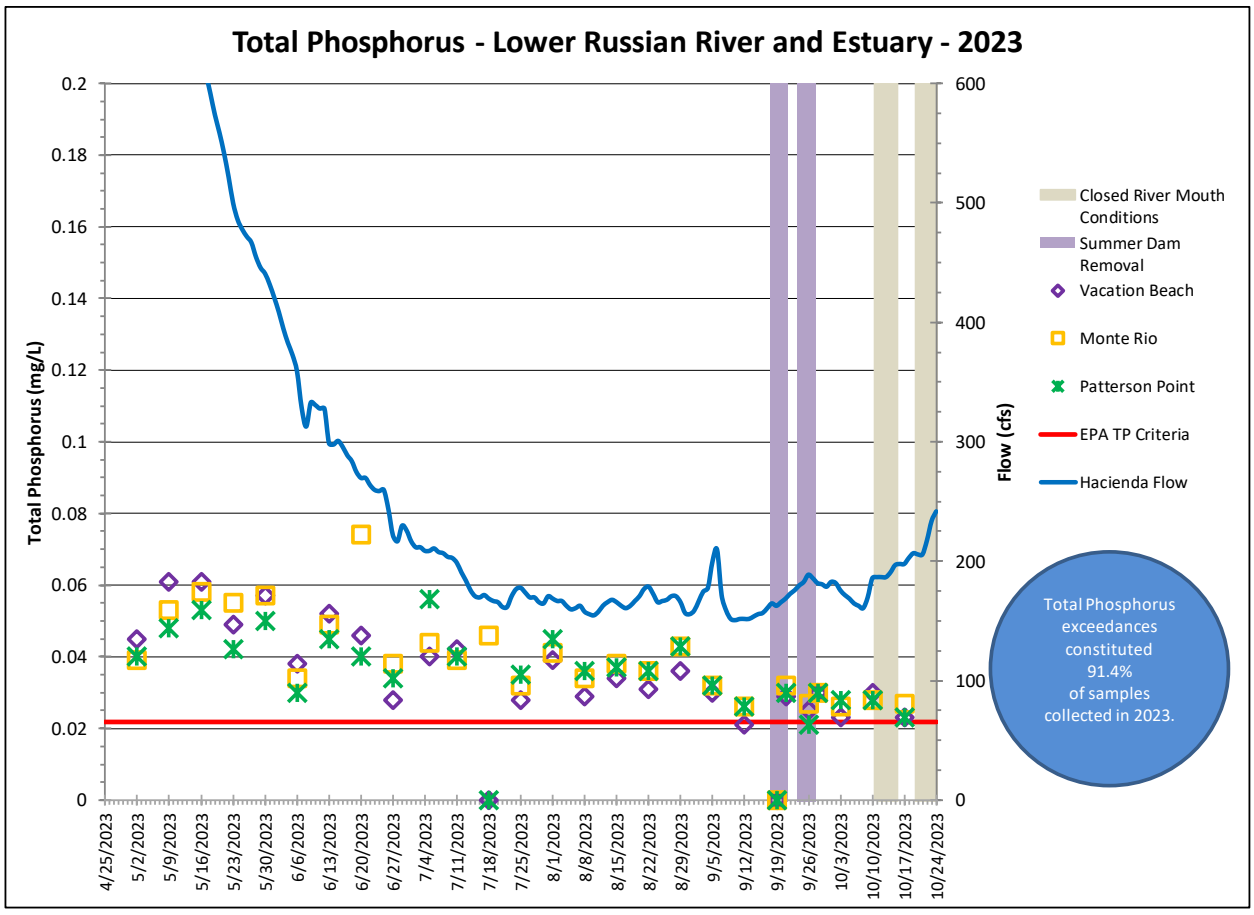


Figure 3-32. Total Phosphorus results for the Russian River from Vacation Beach to Patterson Point in 2023.

Patterson Point had twenty-four (24) exceedances of the EPA total phosphorus criteria (24 of 27 or 88.9%) that occurred prior to, during, and following the terms of the Order, including a maximum concentration of 0.056 mg/L that occurred during the terms of the Order on 5 July during open estuary conditions and a flow of 200 cfs (Table 3-16 and Figure 3-32). The minimum concentration at Patterson Point was ND, which occurred twice during the terms of the Order on 18 July and 19 September during open estuary conditions and flows of 154 and166 cfs, respectively (Table 3-16 and Figure 3-32). Finally, the lowest flow recorded during sampling was approximately 143 cfs, which occurred during the terms of the Order on 8 August during open estuary conditions with a concentration of 0.036 mg/L (Table 3-16).

Turbidity

The EPA criteria for turbidity was exceeded forty-one (41) times at the lower river stations (41 of 81 or 50.6%) prior to and during the terms of the Order (Tables 3-14 through 3-16). Exceedances were observed to periodically occur throughout the monitoring season with open estuary conditions, summer dam removal, and Hacienda flows ranging from 152 cfs to 898 cfs (Figure 3-33).

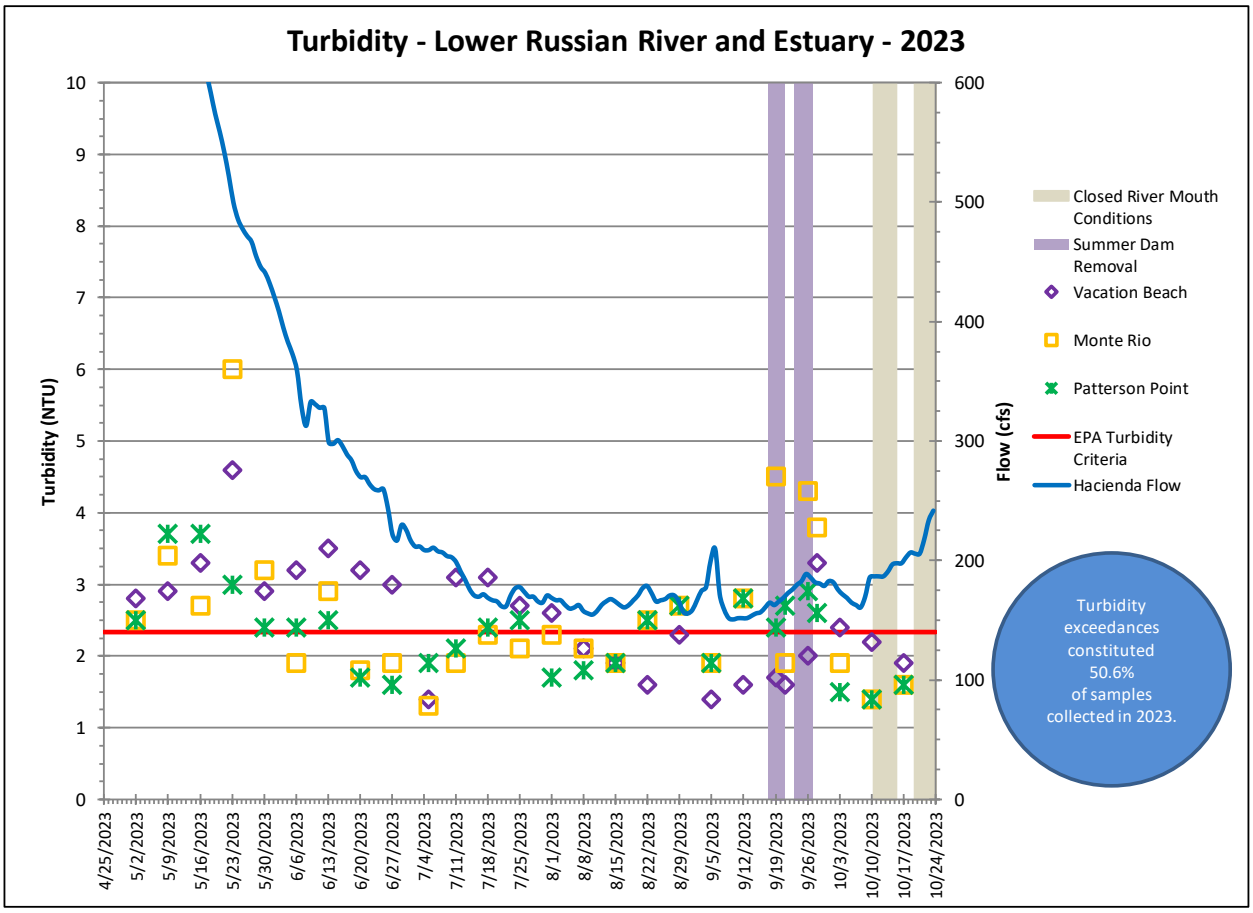


Figure 3-33. Turbidity results for the Russian River from Vacation Beach to Patterson Point in 2023.

Vacation Beach had fifteen (15) exceedances of the EPA turbidity criteria (15 of 27 or 55.6%) that occurred prior to and during the terms of the Order, including a maximum value of 4.6 NTU that occurred during the terms of the Order on 23 May during open estuary conditions and a flow of 521 cfs (Table 3-14 and Figure 3-33). The minimum value at Vacation Beach was 1.4 NTU, which occurred twice

during the terms of the Order on 5 July and 5 September during open estuary conditions and flows of 200 cfs and 206 cfs, respectively (Table 3-14). Finally, the lowest flow recorded during sampling was approximately 143 cfs, which occurred during the terms of the Order on 8 August during open estuary conditions with a value of 2.1 NTU (Table 3-14).

Monte Rio had ten (10) exceedances of the EPA turbidity criteria (10 of 27 or 37.0%) that occurred prior to and during the terms of the Order, including a maximum value of 6.0 NTU that occurred during the terms of the Order on 23 May during open estuary conditions and a flow of 521 cfs (Table 3-15 and Figure 3-33). The minimum value at Monte Rio was 1.3 NTU, which occurred twice during the terms of the Order, on 5 July and 5 September during open estuary conditions and flows of 200 cfs and 206 cfs, respectively (Table 3-15). Finally, the lowest flow recorded during sampling was approximately 143 cfs, which occurred during the terms of the Order on 8 August during open estuary conditions with a value of 2.1 NTU (Table 3-15).

Patterson Point had sixteen (16) exceedances of the EPA turbidity criteria (16 of 27 or 59.3%) that occurred prior to and during the terms of the Order, including a maximum value of 3.7 NTU that occurred twice prior to the terms of the Order on 9 May and 16 May during open estuary conditions and flows of 898 and 668 cfs, respectively (Table 3-16 and Figure 3-33). The maximum turbidity value observed during the terms of the Order and was 3.0 NTU on 23 May during open estuary conditions and a flow of 521 cfs (Table 3-16 and Figure 3-33). The minimum value at Patterson Point was 1.4 NTU, which occurred during the terms of the Order on 10 October during open estuary conditions and a flow of 186 cfs (Table 3-16). Finally, the lowest flow recorded during sampling was approximately 143 cfs, which occurred during the terms of the Order on 8 August during open estuary conditions with a value of 1.8 NTU (Table 3-16).

Chlorophyll a

Algal (*chlorophyll a*) results exceeded the EPA criteria nineteen (19) times each at Vacation Beach and Monte Rio, and seventeen (17) times at Patterson Point (55 of 81 or 67.9%) prior to, during, and following the terms of the Order under open estuary conditions and flows that ranged from 143 to 898 cfs (Tables 3-14 through 3-16 and Figure 3-34). *Chlorophyll a* values varied through the monitoring season with several ND values occurring at all three stations prior to, during, and following the terms of the Order, including during summer dam removal in September (Figure 3-34).

As mentioned above, lab analysis constraints in 2023 resulted in the MDL for *chlorophyll a* being higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Therefore, some lab results for *chlorophyll a* that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL. However, for reporting purposes, only those exceedances that are quantified will be included in the summation.

The maximum *chlorophyll a* concentration observed at Vacation Beach occurred during the terms of the Order and was 0.013 mg/L on 6 June during open estuary conditions and a flow of 364 cfs (Table 3-14 and Figure 3-34). The minimum value at Vacation Beach was ND, which occurred eight (8) times during the terms of the Order during open estuary conditions, summer dam removal, and flows that ranged from 143 to 455 cfs (Table 3-14).

The maximum *chlorophyll a* concentration observed at Monte Rio occurred during the terms of the Order and was 0.024 mg/L on 23 May during open estuary conditions and a flow of 521 cfs (Table 3-15 and Figure 3-34). The minimum value at Monte Rio was ND, which occurred eight (8) times during the terms of the Order during open estuary conditions, summer dam removal, and flows that ranged from 151 to 206 cfs (Table 3-15).

The maximum *chlorophyll a* concentration observed at Patterson Point occurred twice during the terms of the Order and was 0.0088 mg/L on 20 June and 5 September during open estuary conditions and flows of 267 cfs and 206 cfs, respectively (Table 3-16 and Figure 3-34). The minimum value at Patterson Point was ND, which occurred ten (10) times prior to, during, and following the terms of the Order during open estuary conditions, summer dam removal, and flows that ranged from 151 to 898 cfs (Table 3-16).

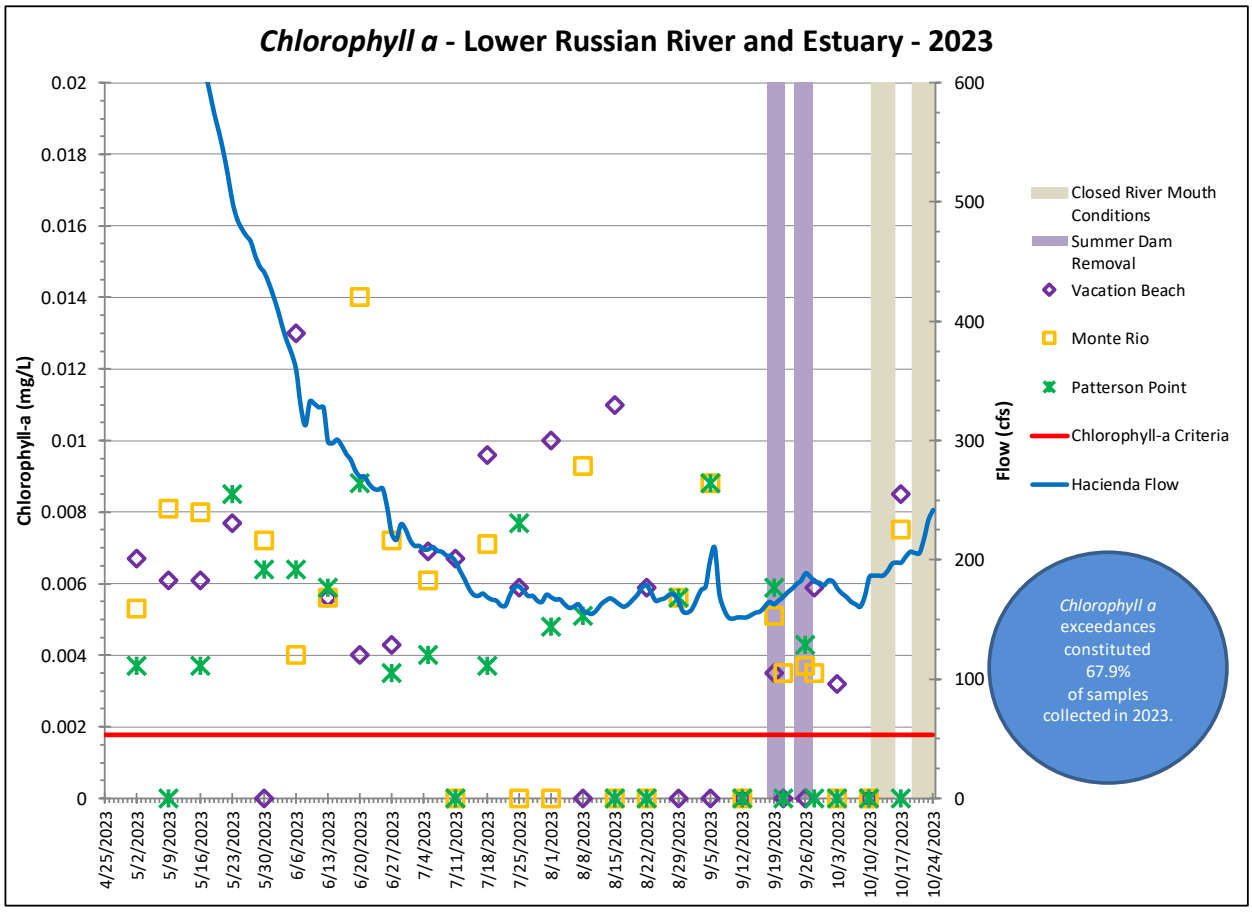


Figure 3-34. ***Chlorophyll a*** **results for the Russian River from Vacation Beach to Patterson Point in 2023.**

Table 3-14. 2023 Vacation Beach nutrient grab sample results. This site experiences freshwater conditions.

Vacation Beach	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.10	0.10	0.00010	0.040	0.050	0.20	0.30	0.010	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/2/2023	11:50	15.1	7.6	ND	ND	0.00050	0.21	ND	ND	0.2105	**0.045**	ND	1.47	1.84	160	**2.8**	**0.0067**	890
5/9/2023	11:00	16.0	7.7	ND	ND	ND	0.21	ND	ND	0.21	**0.061**	0.11	1.55	2.07	160	**2.9**	**0.0061**	898
5/16/2023	9:10	18.7	7.9	ND	ND	ND	0.24	ND	ND	0.24	**0.061**	0.11	1.62	2.12	170	**3.3**	**0.0061**	668
5/23/2023	10:10	19.8	7.9	ND	ND	ND	0.20	ND	ND	0.20	**0.049**	0.070	1.63	2.10	160	**4.6**	**0.0077**	521
5/30/2023	10:10	16.8	7.8	ND	ND	ND	0.22	ND	ND	0.22	**0.057**	0.11	1.40	1.80	150	**2.9**	ND	455
6/6/2023	9:40	19.1	7.7	ND	0.11	ND	0.086	ND	ND	0.196	**0.038**	ND	1.39	1.82	160	**3.2**	**0.013**	364
6/13/2023	8:50	18.8	7.7	ND	ND	ND	0.12	ND	ND	0.12	**0.052**	ND	1.43	1.61	150	**3.5**	**0.0056**	298
6/20/2023	10:10	20.0	7.8	ND	0.11	ND	ND	ND	ND	0.11	**0.046**	ND	1.44	1.96	160	**3.2**	**0.0040**	267
6/27/2023	9:20	20.1	7.9	ND	ND	ND	0.053	ND	ND	0.053	**0.028**	ND	1.57	1.93	220	**3.0**	**0.0043**	214
7/5/2023	10:20	22.3	7.9	ND	ND	ND	ND	ND	ND	ND	**0.040**	ND	1.61	1.91	130	1.4	**0.0069**	200
7/11/2023	8:20	22.1	7.8	ND	ND	ND	0.051	ND	ND	0.051	**0.042**	ND	1.84	1.78	150	**3.1**	**0.0067**	189
7/18/2023	9:50	24.1	7.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.89	1.90	160	**3.1**	**0.0096**	154
7/25/2023	8:40	23.9	7.8	ND	ND	ND	ND	ND	ND	ND	**0.028**	ND	1.78	1.87	140	**2.7**	**0.0059**	165
8/1/2023	11:20	23.1	7.9	ND	ND	ND	ND	ND	ND	ND	**0.039**	ND	1.84	1.88	98	**2.6**	**0.010**	154
8/8/2023	10:30	23.7	7.7	ND	ND	0.0020	ND	ND	ND	0.0020	**0.029**	ND	1.87	1.91	130	2.1	ND	143
8/15/2023	9:40	22.5	7.6	ND	ND	ND	ND	ND	ND	ND	**0.034**	ND	1.87	1.84	130	1.9	**0.011**	151
8/22/2023	10:00	21.3	7.4	ND	ND	ND	ND	ND	ND	ND	**0.031**	ND	2.09	1.97	130	1.6	**0.0059**	166
8/29/2023	8:40	21.7	7.6	ND	ND	ND	ND	ND	ND	ND	**0.036**	ND	1.85	1.71	120	2.3	ND	166
9/5/2023	10:30	21.0	7.5	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	1.75	1.81	100	1.4	ND	206
9/12/2023	9:50	20.6	7.5	ND	ND	ND	ND	ND	ND	ND	0.021	ND	1.75	1.81	130	1.6	ND	152
9/19/2023	9:20	19.4	7.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.85	1.85	130	1.7	**0.0035**	166
9/21/2023	9:20	18.4	7.5	ND	ND	ND	0.087	ND	ND	0.087	**0.029**	ND	1.82	1.83	110	1.6	ND	173
9/26/2023	10:00	18.0	7.4	ND	ND	ND	ND	ND	ND	ND	**0.025**	ND	1.82	1.89	120	2.0	ND	195
9/28/2023	9:50	18.1	7.5	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	1.90	1.88	130	**3.3**	**0.0059**	188
10/3/2023	8:50	17.1	7.5	ND	ND	ND	0.088	ND	ND	0.088	**0.023**	ND	1.95	1.85	120	**2.4**	**0.0032**	181
10/10/2023	9:40	17.4	7.5	ND	ND	ND	0.044	ND	ND	0.044	**0.030**	ND	1.78	1.81	140	2.2	ND	186
10/17/2023	11:10	16.9	7.6	ND	ND	ND	ND	ND	ND	ND	**0.023**	ND	1.75	1.75	120	1.9	**0.0085**	198

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Chlorophyll *a* : 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-15. 2023 Monte Rio nutrient grab sample results. This site experiences freshwater conditions.

Monte Rio	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.10	0.10	0.00010	0.040	0.050	0.20	0.30	0.010	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/2/2023	11:30	15.3	7.5	ND	0.16	0.0014	0.19	ND	ND	0.3514	**0.039**	ND	1.45	1.83	170	**2.5**	**0.0053**	890
5/9/2023	10:40	15.8	7.8	ND	ND	ND	0.22	ND	ND	0.22	**0.053**	0.11	1.52	2.02	170	**3.4**	**0.0081**	898
5/16/2023	8:40	18.4	7.8	ND	ND	ND	0.23	ND	ND	0.23	**0.058**	0.12	1.61	2.19	170	**2.7**	**0.0080**	668
5/23/2023	9:50	19.7	7.8	ND	ND	ND	0.18	ND	ND	0.18	**0.055**	0.070	1.49	2.26	170	**6.0**	**0.024**	521
5/30/2023	9:50	17.2	7.7	ND	ND	ND	0.22	ND	ND	0.22	**0.057**	0.11	1.36	1.85	150	**3.2**	**0.0072**	455
6/6/2023	9:20	19.8	7.8	ND	ND	ND	0.052	ND	ND	0.052	**0.034**	ND	1.49	1.86	160	1.9	**0.0040**	364
6/13/2023	9:10	19.1	7.8	ND	ND	ND	0.095	ND	ND	0.095	**0.049**	ND	1.43	1.78	140	**2.9**	**0.0056**	298
6/20/2023	9:50	20.5	7.9	0.33	0.20	ND	ND	ND	0.49	**0.49**	**0.074**	0.15	1.44	2.22	140	1.8	**0.014**	267
6/27/2023	9:40	19.8	7.8	ND	ND	ND	ND	ND	ND	ND	**0.038**	ND	1.67	2.25	160	1.9	**0.0072**	214
7/5/2023	9:50	22.2	7.6	ND	ND	ND	ND	ND	ND	ND	**0.044**	ND	1.91	2.02	140	1.3	**0.0061**	200
7/11/2023	8:50	21.8	7.7	ND	0.39	0.0081	ND	ND	ND	**0.398**	**0.039**	ND	2.02	1.86	160	1.9	ND	189
7/18/2023	9:20	24.0	7.7	0.44	ND	ND	ND	ND	0.44	**0.44**	**0.046**	ND	1.99	2.02	150	2.3	**0.0071**	154
7/25/2023	9:00	23.9	7.6	ND	ND	ND	ND	ND	ND	ND	**0.032**	ND	1.80	1.94	100	2.1	ND	165
8/1/2023	11:00	23.1	7.7	ND	ND	ND	ND	ND	ND	ND	**0.041**	ND	1.90	1.94	110	2.3	ND	154
8/8/2023	10:10	23.6	7.6	ND	ND	0.0011	ND	ND	ND	0.0011	**0.034**	ND	1.93	2.08	140	2.1	**0.0093**	143
8/15/2023	9:20	22.4	7.5	ND	ND	ND	ND	ND	ND	ND	**0.038**	ND	1.86	1.90	130	1.9	ND	151
8/22/2023	9:30	21.7	7.4	ND	ND	ND	ND	ND	ND	ND	**0.036**	ND	1.88	1.88	120	2.2	ND	166
8/29/2023	9:00	21.6	7.7	ND	ND	ND	ND	ND	ND	ND	**0.043**	ND	1.81	1.69	140	**2.9**	**0.0075**	166
9/5/2023	10:10	21.1	7.4	ND	ND	ND	ND	ND	ND	ND	**0.031**	ND	1.79	1.85	100	1.3	ND	206
9/12/2023	9:30	20.7	7.6	ND	ND	ND	ND	ND	ND	ND	**0.032**	ND	1.80	1.83	140	1.7	**0.0051**	152
9/19/2023	9:40	19.6	7.6	ND	0.1	0.0014	ND	ND	ND	0.1014	ND	0.033	1.84	1.84	130	**4.5**	**0.0051**	166
9/21/2023	9:00	18.5	7.5	ND	ND	ND	ND	ND	ND	ND	**0.032**	ND	1.98	1.98	120	1.9	**0.0035**	173
9/26/2023	9:30	18.4	7.5	ND	0.18	ND	ND	ND	ND	0.18	**0.027**	ND	1.88	1.88	110	**4.3**	**0.0037**	195
9/28/2023	9:30	18.2	7.5	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	1.84	1.88	120	**3.8**	**0.0035**	188
10/3/2023	9:10	17.4	7.6	ND	ND	ND	ND	ND	ND	ND	**0.026**	ND	1.92	1.83	130	1.9	ND	181
10/10/2023	9:20	17.6	7.6	ND	ND	ND	0.040	ND	ND	0.040	**0.028**	ND	1.84	1.73	130	1.4	ND	186
10/17/2023	10:50	16.8	7.6	0.52	ND	ND	ND	ND	0.52	**0.52**	**0.027**	ND	1.74	1.80	120	1.6	**0.0075**	198

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-16. 2023 Patterson Point nutrient grab sample results. This site experiences freshwater conditions.

Patterson Point	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.10	0.10	0.00010	0.040	0.050	0.20	0.30	0.010	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/2/2023	11:00	15.3	7.3	ND	0.14	0.0080	0.20	ND	ND	0.35	**0.040**	ND	1.45	1.84	160	**2.5**	**0.0037**	890
5/9/2023	10:10	15.5	7.5	ND	ND	ND	0.22	ND	ND	0.22	**0.048**	0.10	1.50	2.15	160	**3.7**	ND	898
5/16/2023	8:10	18.4	7.8	ND	ND	ND	0.23	ND	ND	0.23	**0.053**	0.12	1.61	2.18	160	**3.7**	**0.0037**	668
5/23/2023	9:10	19.9	7.8	ND	ND	ND	0.18	ND	ND	0.18	**0.042**	0.077	1.47	2.81	170	**3.0**	**0.0085**	521
5/30/2023	9:20	17.3	7.7	ND	ND	ND	0.21	ND	ND	0.21	**0.050**	0.11	1.40	1.83	170	**2.4**	**0.0064**	455
6/6/2023	8:50	20.1	8.1	ND	0.11	ND	0.054	ND	ND	0.164	**0.030**	ND	1.58	1.94	140	**2.4**	**0.0064**	364
6/13/2023	9:40	19.3	7.9	ND	0.11	0.0031	0.10	ND	ND	0.2131	**0.045**	ND	1.53	1.69	70	**2.5**	**0.0059**	298
6/20/2023	9:10	20.4	7.8	ND	0.13	ND	ND	ND	ND	0.13	**0.040**	0.13	1.74	1.88	160	1.7	**0.0088**	267
6/27/2023	10:00	20.0	7.8	ND	ND	ND	ND	ND	ND	ND	**0.034**	ND	1.80	6.26	160	1.6	**0.0035**	214
7/5/2023	9:20	22.4	7.7	ND	0.10	0.0022	ND	ND	ND	0.1022	**0.056**	ND	1.71	2.00	140	1.9	**0.0040**	200
7/11/2023	9:20	22.0	7.7	ND	0.33	0.0080	ND	ND	0.45	**0.45**	**0.040**	ND	1.88	1.83	160	2.1	ND	189
7/18/2023	8:50	23.7	7.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.97	2.35	140	**2.4**	**0.0037**	154
7/25/2023	9:30	23.7	7.6	ND	ND	ND	ND	ND	ND	ND	**0.035**	ND	1.83	1.91	110	**2.5**	**0.0077**	165
8/1/2023	10:10	22.9	7.7	3.9	ND	ND	ND	ND	3.9	**3.9**	**0.045**	ND	1.89	2.03	100	1.7	**0.0048**	154
8/8/2023	9:10	23.4	7.5	ND	ND	0.0014	ND	ND	ND	0.0014	**0.036**	ND	2.00	2.02	140	1.8	**0.0051**	143
8/15/2023	9:00	21.5	7.5	ND	ND	ND	ND	ND	ND	ND	**0.037**	0.092	1.86	2.04	140	1.9	ND	151
8/22/2023	9:00	21.6	7.4	ND	ND	ND	ND	ND	ND	ND	**0.036**	ND	1.98	1.92	130	**2.5**	ND	166
8/29/2023	9:20	21.8	7.5	ND	ND	ND	ND	ND	ND	ND	**0.043**	ND	1.79	1.69	120	**2.7**	**0.0056**	166
9/5/2023	9:40	21.3	7.5	ND	ND	ND	ND	ND	ND	ND	**0.032**	ND	1.78	1.82	98	1.9	**0.0088**	206
9/12/2023	9:10	20.6	7.6	ND	ND	ND	ND	ND	ND	ND	**0.026**	ND	1.84	1.91	120	**2.8**	ND	152
9/19/2023	10:10	19.9	7.5	ND	ND	ND	0.086	ND	ND	0.086	ND	ND	1.84	1.84	120	**2.4**	**0.0059**	166
9/21/2023	8:30	18.8	7.5	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	1.83	1.89	120	**2.7**	ND	173
9/26/2023	9:10	18.5	7.5	ND	ND	ND	ND	ND	ND	ND	0.021	ND	1.80	1.85	90	**2.9**	**0.0043**	195
9/28/2023	9:00	18.4	7.5	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	1.78	1.92	130	**2.6**	ND	188
10/3/2023	9:40	17.6	7.6	0.42	ND	ND	ND	ND	ND	**0.42**	**0.028**	ND	1.91	1.83	140	1.5	ND	181
10/10/2023	8:40	17.7	7.6	ND	ND	ND	ND	ND	ND	ND	**0.028**	ND	2.22	2.19	130	1.4	ND	186
10/17/2023	10:20	16.6	7.6	0.51	ND	ND	ND	ND	0.51	**0.51**	**0.023**	0.037	1.78	1.79	120	1.6	ND	198

* Method Detection Limit - limits can vary for individual samples depending on matrix interference and dilution factors, all results are preliminary and subject to final revision.

** Total nitrogen is calculated through the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (together referred to as Total Kjeldahl Nitrogen or TKN) and nitrate/nitrite nitrogen.

*** United States Geological Survey (USGS) Continuous-Record Gaging Station

**** Flow rates are preliminary and subject to final revision by USGS.

Recommended EPA Criteria based on Aggregate Ecoregion III

Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Chlorophyll *a* : 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

3.3 Discussion and Observations

Although the mainstem Russian River experienced a Normal Water Year in 2023, Sonoma Water requested a temporary urgency change to reduce minimum instream flow requirements pursuant to the 2008 Biological Opinion as described in Section 1.0, Introduction.

The changes in upper Russian River minimum instream flow requirements authorized by the Order allowed flows to decline below D1610 minimum instream flows of 185 cfs in late May at the Talmage and Hopland gages, at the beginning of June at the Cloverdale gage, and in late June at the Jimtown and Diggers Bend gages (Figure 2-3). Flows were also periodically below the D1610 minimum instream flows of 150 cfs that were in effect on 1 September. Additionally, upper Russian River flows did briefly decline below the TUC minimum daily average flows of 125 cfs at the Talmage station, but did not drop below the instantaneous minimum flow of 110 cfs authorized by the Order (Figure 2-3).

While the Order was in effect, lower Russian River flows at Hacienda (downstream of the confluence with Dry Creek) did not drop below the D1610 minimum flows of 125 cfs or the TUC minimum daily average flows of 70 cfs authorized by the Order (Figure 2-4).

Monitoring conducted for the TUC Order was similar (methods, locations) to monitoring conducted prior years when TUC Orders were issued in response to dry watershed conditions and low reservoir storage levels, as well as to comply with Biological Opinion proposed mainstem flows. Additional monitoring was conducted prior to and/or following the terms of the TUC Order, which was active from 19 May to 15 October, to provide additional context on conditions in the watershed leading up to the period in which the Order was active and following.

Overall, observed exceedances of EPA and CDPH criteria in the upper and lower river in 2023 were generally consistent with other Normal Water Years such as 2019, as well as Dry Water Years such as 2022. However, turbidity values and exceedances in 2023 were observed to be more frequent in the upper and lower river compared to the Dry Water Year of 2022. Likewise, total phosphorus exceedances were more frequent in the upper river during the Normal Water year of 2023 compared to the Dry Water Year of 2022.

A brief comparison of several streamflow data points from 2023; a Normal Water Year under D1610, and 2022; a Dry Water Year, is provided for context. The 2022 data is available in the Russian River Water Quality Summary for the 2022 Temporary Urgency Change (Sonoma Water, 2022).

The 2023 daily average flows in the Upper Russian River between Talmage and Diggers Bend generally ranged between 125 and 175 cfs during the months of July through October (Figure 3-35).

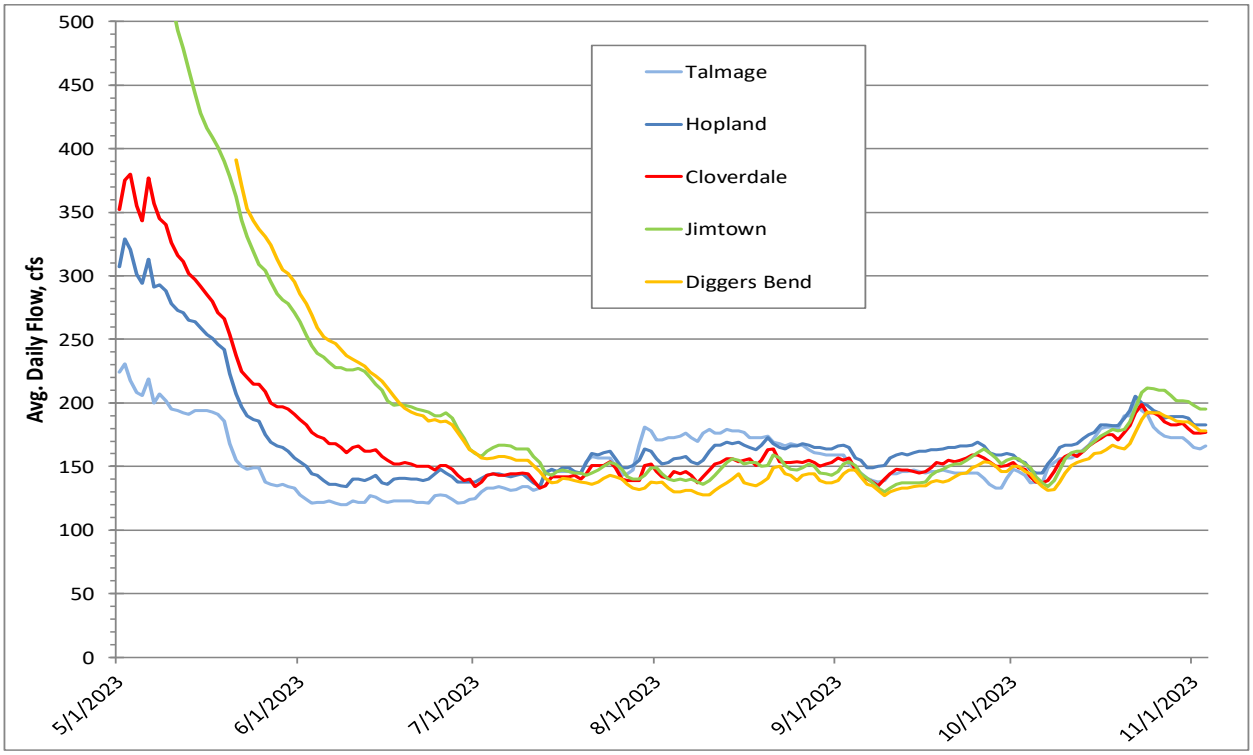


Figure 3-35. 2023 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Whereas, 2022 daily average flows in the upper river between Talmage and Diggers Bend generally ranged between 25 and 75 cfs during the months of July through October (Figure 3-36).

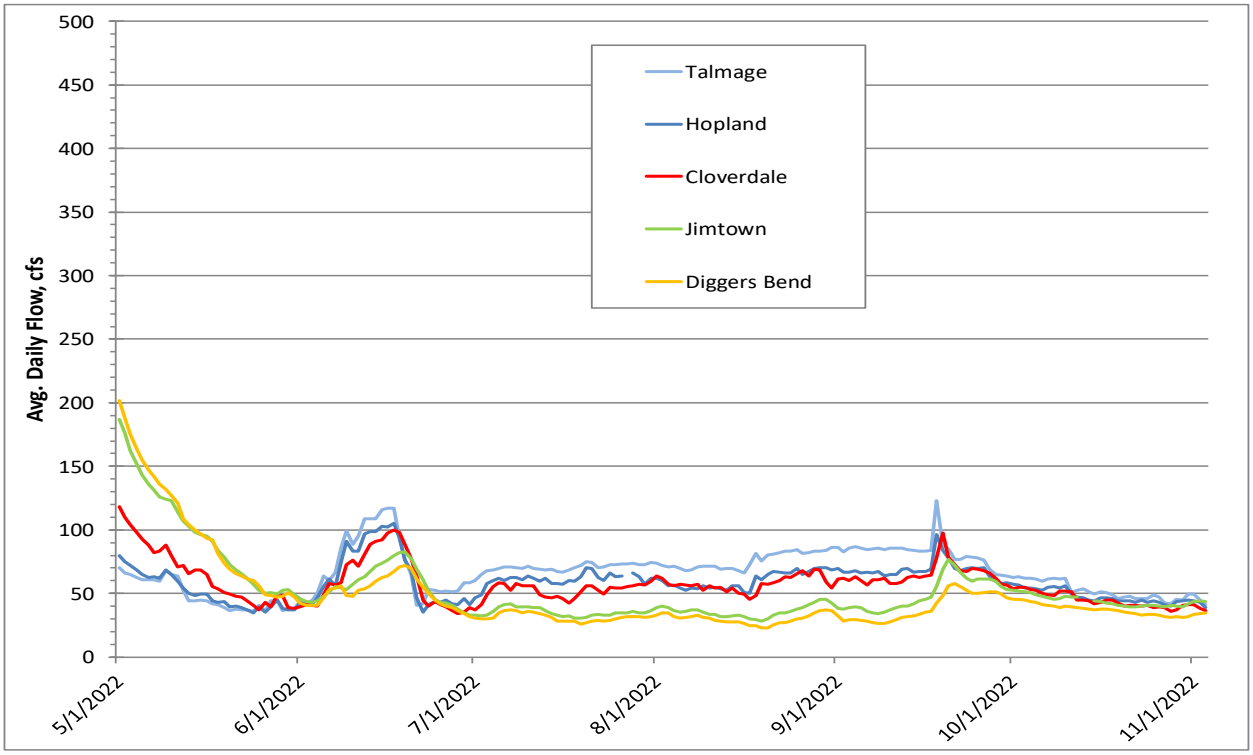


Figure 3-36. 2022 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Streamflow conditions in 2023 represented a Normal Water Year with higher than average dry season base flows compared to average flows as measured at Hacienda from 2009 through 2023 (Figure 3-37). Spring storms in 2023 resulted in lower Russian River flows remaining above 800 cfs into early May and 500 cfs through late-May at Hacienda. Flows remained above 300 cfs into mid-June, resulting in mainstem flows decreasing to base summertime flows later in the dry season compared to previous years, including 2022 (Figure 3-37).

In contrast, a dry winter and spring in 2022 resulted in flows at Hacienda decreasing to under 100 cfs in mid-May. Flows increased briefly from mid to late June to just under 150 cfs, before decreasing and remaining between 35 and 95 cfs through October (Figure 3-37).

Summertime base flows in the lower river at Hacienda remained above 150 cfs in 2023, whereas summertime base flows in 2022 were generally below 75 cfs (Figure 3-37).

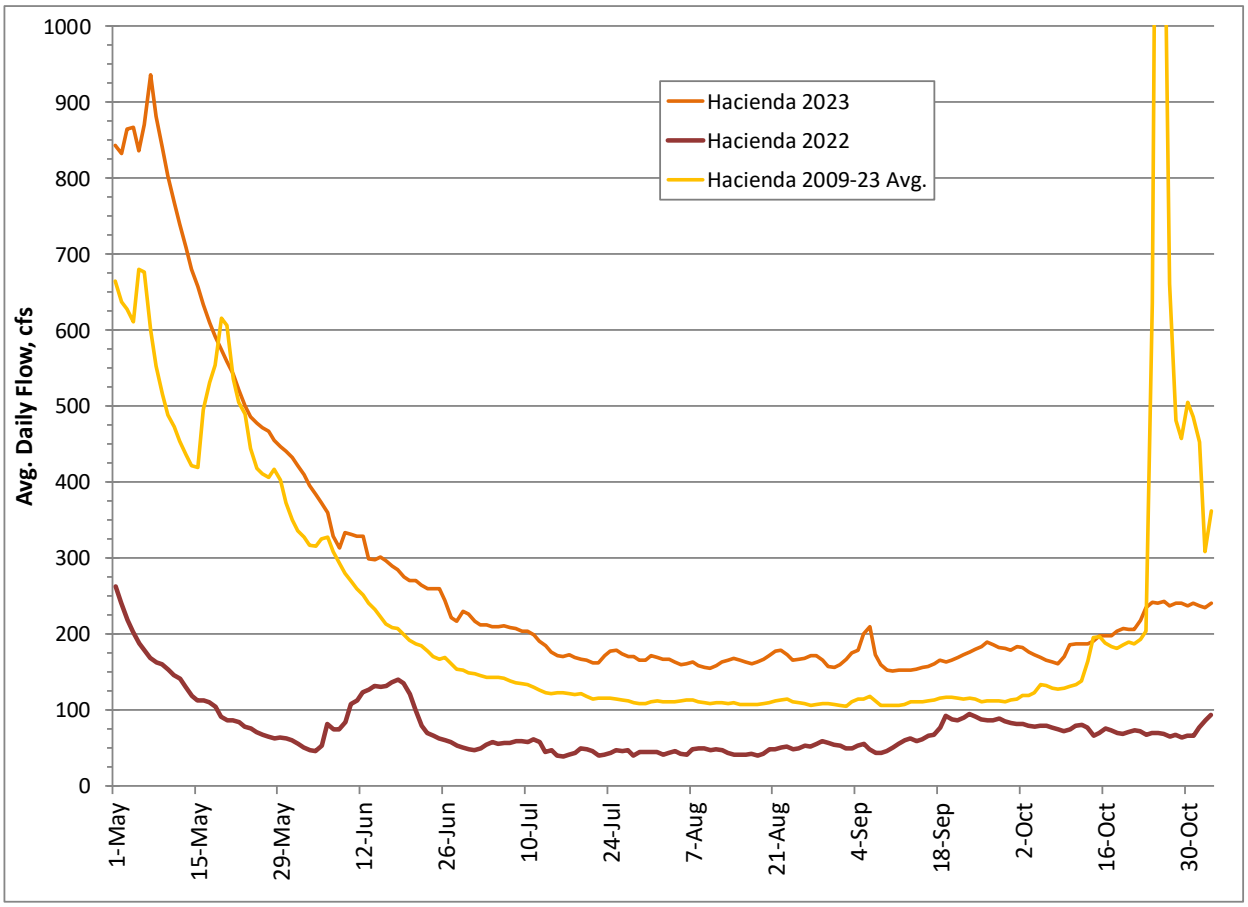


Figure 3-37. Comparison of 2023, 2022 and 2009-2023 average daily flows in the Lower Russian River as measured at USGS Hacienda gage in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Based on the assemblage of data collected by Sonoma County DHS, USACE, CDFW, USGS, and Sonoma Water, it does not appear that flows observed in 2023 negatively affected water quality or the availability of aquatic habitat, or provided a significant contribution to biostimulatory conditions when compared to data collected during other years with Normal Water Year flow rates, such as 2019. The

2019 data is available in the Russian River Water Quality Summary for the 2019 Temporary Urgency Change (Sonoma Water, 2020).

Total coliform, E. coli, and total nitrogen concentrations in 2023 were fairly consistent with past years, including the Normal Water Year of 2019 and the Dry Water Year of 2022. The 2022 data is available in the Russian River Water Quality Summary for the 2022 Temporary Urgency Change (Sonoma Water, 2022). However, a comparison of turbidity and total phosphorus data collected in 2019 and 2023 indicate that higher flows, including elevated spring flows during the Normal Water Years of 2019 and 2023, may have contributed to more frequent exceedances of total phosphorus and turbidity, as well as higher turbidity values in the upper river compared to the Dry Water Year of 2022.

In 2023, Sonoma County DHS reported zero (0) total coliforms exceedances out of 153 total samples collected (0%) and three (3) *E. coli* exceedances out of 153 total samples collected (2.0%) at the ten beach monitoring stations. In 2019, Sonoma County DHS reported three (3) total coliforms exceedances out of 153 total samples collected (2.0%) and two (2) *E. coli* exceedances out of 153 total samples collected (1.3%) at the ten beach monitoring stations. Conditions for total coliforms were similar in 2022 with eight (8) total coliform exceedances out of 152 total samples collected (5.3%) and eight (8) *E. coli* exceedances out of 152 total samples collected (5.3%) at the ten stations.

In 2023, Sonoma Water reported two (2) total coliforms exceedances out of 81 total samples collected (2.5%) and zero (0) *E. coli* exceedances out of 81 total samples collected (0%) at the three lower river monitoring stations. In 2019, Sonoma Water reported two (2) total coliforms exceedances out of 75 total samples collected (2.7%) and three (3) *E. coli* exceedances out of 75 total samples collected (4.0%) at the three lower river monitoring stations. Similarly in 2022, Sonoma Water reported one (1) total coliforms exceedance out of 75 total samples collected (1.3%) and one (1) *E. coli* exceedance out of 75 total samples collected (1.3%) at the three lower river stations.

DHS did not conduct cyanotoxin monitoring at the ten beach monitoring stations in 2019, 2022, or 2023 so there are no comparative values.

Algae monitoring conducted in the Russian River since 2016 indicates that cyanoHABs will occur annually at some level regardless of changes to summertime reservoir releases. Nutrient monitoring indicates that during drought conditions and periods of low river flow sustained only by reservoir releases, the input of biostimulating nutrients is typically less than during periods of abundant rainfall and higher river flows. CyanoHAB formation is inevitable in the Russian River if there is water present in the system in the dry summer months. To minimize cyanoHAB outbreaks, efforts to reduce point source and over land addition of nutrients to the Russian River in general would be the most effective. Additionally, the presence of invertebrate grazers as well as rearrangement of the littoral zone during high storm flows have been observed to affect the timing and composition of cyanoHABs.

As such, Sonoma Water staff would recommend continued coordination and comprehensive monitoring across agencies (including the North Coast Regional Water Quality Control Board and DHS) to assess river conditions and specifically those conditions that may contribute to an elevated potential for cyanoHAB outbreaks. These conditions include but are not limited to nutrient availability, invertebrate grazing, water clarity, temperature, the timing and intensity of storm events, streamflow, and the

potential for changing hydrology and bed scour to influence development of algal biomass. Sonoma Water staff would continue to promote the preservation of the cold water pool in Lake Mendocino through responsible reservoir management and river flow operations.

Total nitrogen exceedances and concentrations at the four upper river stations at Hopland, Cloverdale, Jimtown, and Syar were fairly consistent in 2023, 2019, and 2022 with 2023 having fourteen (14) exceedances of 56 total samples (25.0%), 2019 having ten (10) exceedances of 49 total samples (20.4%), and 2022 having nineteen (19) exceedances of 64 total samples (29.7%). Hopland was observed to have the highest percentage of total nitrogen exceedances of the four upper river stations in 2019 and in 2022, but Cloverdale had the highest percentage in 2023.

Total nitrogen exceedances in 2023, 2019, and 2022 were also fairly consistent at the lower river stations of Vacation Beach, Monte Rio, and Patterson Point, with 2023 experiencing eight (8) exceedances of 81 total samples (9.9%), 2019 experiencing eight (8) exceedances of 75 total samples (10.7%), and 2022 experiencing three (3) exceedances of 76 samples (4.0%).

Total phosphorus concentrations and numbers of exceedances were fairly consistent in 2023, 2019, and 2022 in Hopland, but were significantly lower in Cloverdale and Syar and to a lesser degree at Jimtown in 2022. In 2023, Cloverdale had fourteen (14) exceedances of 14 samples collected (100%), Jimtown had ten (10) exceedances of 14 samples collected (71.4%) and Syar had thirteen (13) exceedances of 14 samples collected (92.9%). In 2019, Cloverdale had six (6) exceedances of 6 samples collected (100%), Jimtown had six (6) exceedances of 12 samples collected (50%) and Syar had 11 exceedances of 18 samples collected (61.1%). Whereas in 2022, Cloverdale had nine (9) exceedances of 16 samples collected (56.3%), Jimtown had five (5) exceedances out of 16 samples collected (31.3%) and Syar had four (4) exceedances out of 16 samples collected (25%).

Total phosphorus exceedances and concentrations at the three lower river stations were consistently high in 2023 (74 of 81 or 91.4%), 2019 (64 of 75 or 85.3%), and 2022 (75 of 76 or 98.7%) with values slightly declining in September and October. These exceedances in 2023, 2019, and 2022 continue a pattern of chronic elevated total phosphorus in the lower river area.

Turbidity values in the upper river were significantly lower in 2022 than in 2023 or 2019, especially at Hopland and Cloverdale. Turbidity values at Hopland exceeded the criteria through the entire 2023 season (14 of 14 or 100%), with most values being above 10 NTU including a maximum value of 40 NTU. Hopland also exceeded the criteria through the entire 2019 season (12 of 12 or 100%), with most values being above 10 NTU including a maximum value of 29 NTU. Whereas in 2022, Hopland only had six (6) exceedances of 16 samples (37.5%), with most values below 3 NTU and a maximum of 9.5 NTU.

Cloverdale exceeded the criteria through the entire 2023 season (14 of 14 or 100%) with all values above 5 NTU and a maximum value of 20 NTU. Cloverdale also exceeded the criteria through the entire 2019 season (7 of 7 or 100%) with most values above 5 NTU and a maximum value of 15 NTU. Whereas, Cloverdale only experienced one (1) exceedance out of 16 samples collected (6.3%) in 2022, with most values below 2 NTU and a maximum value of 3.6 NTU.

Jimtown had six (6) exceedances of 14 samples collected (42.9%) and a maximum value of 5.6 NTU in 2023, and six (6) exceedances of 12 samples collected (50%) and a maximum value of 6.6 NTU in 2019, but only one (1) exceedance of 16 samples collected (6.3%) and a maximum value of 2.5 NTU in 2022.

Syar had fourteen (14) exceedances of 14 samples collected (100%) with a maximum value of 5.4 NTU in 2023, and 14 exceedances of 18 samples collected (77.8%) with a maximum value of 30 NTU (during high storm flows) in 2019, but only one (1) exceedance of 16 samples collected (6.3%) and a maximum value of 2.8 NTU in 2022.

Turbidity exceedances were less frequent at Vacation Beach, Monte Rio and Patterson Point in 2022 compared to 2023 and 2019, especially during the first half of the monitoring season when flows were significantly higher in 2023 and 2019 compared to 2022. Vacation Beach had fifteen (15) exceedances of 27 samples collected (55.6%) in 2023 and 20 exceedances out of 25 samples collected (80%) in 2019, compared with five (5) exceedances of 25 samples collected (20%) in 2022. Monte Rio had ten (10) exceedances of 27 samples collected (37%) in 2023 and nine (9) exceedances of 25 samples collected (36%) in 2019, compared with five (5) exceedances of 25 samples collected (20%) in 2022. Patterson Point had sixteen (16) exceedances of 27 samples collected (59.3%) in 2023 and eleven (11) exceedances of 25 samples collected (44%) in 2019, compared with four (4) exceedances of 26 samples collected (15.4%) in 2022.

The majority of turbidity exceedances in the lower river in 2023 and 2019 occurred during the first half of the season when flows were still elevated from spring storms. Similarly, exceedances in 2022 occurred at all three stations at the beginning of the monitoring season during elevated storm flows, as well as periodically through the season with flows ranging from 43.7 to 141 cfs.

A comparison of *chlorophyll a* exceedances between 2023, 2019, and 2022 is not possible due to the higher lab MDL for *chlorophyll a* concentrations in 2022 and 2023 that did not allow a quantification of values that may fall between the EPA criteria of approximately 0.0018 mg/L and the MDL of 0.0030 mg/L. Even so, there were more exceedances at Hopland in 2022 (9 of 16 or 56.3%) than in 2023 (5 of 14 or 35.7%) or 2019 (2 of 12 or 16.7%). This may have been influenced by the increased clarity of the water and lower turbidity in 2022 allowing for greater light penetration into the water column.

C*hlorophyll a* exceedances varied from year to year in the lower river, even with improved water clarity in 2022 compared to 2019 and 2023. Vacation Beach had the most exceedances in 2023 (19 of 27 or 70.4%), followed by 2022 (16 of 25 or 64%), and the least in 2019 (12 of 25 or 48%). Monte Rio had the most exceedances in 2023 (19 of 27 or 70.4%), followed by 2019 (13 of 25 or 52%), and the least in 2022 (8 of 25 or 32%). Finally, Patterson Point had the most exceedances in 2023 (17 of 27 or 63.0%), followed by 2022 (12 of 26 or 46.2%), and the least in 2019 (11 of 25 or 44%).

Chlorophyll a exceedances in the lower river in 2023 and 2019 occurred predominantly during the first half of the season while flows were still elevated from late season storms. Whereas, *chlorophyll a* exceedances were more periodic in 2022.

Improved conditions relating to water clarity (turbidity) and total phosphorus during the Dry Water Year of 2022 followed two years of drought. During this time watershed wide sediment inputs were significantly reduced, likely contributing to the improved turbidity and total phosphorus conditions

observed in 2022, the last of three years of consecutive drought conditions. Lower spring and summer flows in 2022 compared to 2023 and 2019 also likely contributed to the improved conditions in 2022 relating to turbidity and total phosphorus.

Year to year variability in the percentage of exceedances, and concentrations and values, for the constituents discussed above can be attributed in large part to: the frequency, timing, and severity of storm events; fluctuating stream flow rates; atmospheric conditions; and contact recreation. Additionally, in the lower river the frequency and timing of barrier beach closures, the strength of tidal cycles, and summer dam removal also contribute to the year to year variability in exceedances, concentrations, and values.

4.0 Additional Monitoring

4.1 Sonoma Water and USGS Permanent and Seasonal Datasondes

In coordination with the USGS, Sonoma Water maintains three, multi-parameter water quality sondes on the Russian River located at Russian River near Hopland, Russian River at Digger Bend near Healdsburg, and Russian River near Guerneville (aka Hacienda). These three sondes are referred to as "permanent" because Sonoma Water contracts with the USGS to maintain them as part of Sonoma Water's early warning detection system for use year-round (Figure 4.1). The sondes take real time readings of water temperature, pH, dissolved oxygen content (DO), specific conductivity, turbidity, and depth, every 15 minutes. Sonoma Water also maintains a permanent sonde on the East Fork of the Russian River approximately one-third of a mile (1/3 mi.) downstream of Lake Mendocino. However, this station is not a real-time station or part of the early warning detection system.

In addition to the permanent sondes, Sonoma Water, in cooperation with the USGS, installed four seasonal sondes with real-time telemetry at the USGS river gage stations at East Fork near Calpella (upstream of Lake Mendocino), Russian River near Cloverdale (north of Cloverdale at Comminsky Station Road), Russian River at Jimtown (Alexander Valley Road Bridge), and at Johnson's Beach in Guerneville (Figure 4.1). The three seasonal sondes at Calpella, Cloverdale, and Jimtown are included by the USGS on its "Real-time Data for California" website: https://waterdata.usgs.gov/ca/nwis/rt.

The data collected by the sondes described above are evaluated in Section 4.2 in response to the terms of the SWRCB TUC Order to evaluate whether and to what extent the reduced flows authorized by the Order caused any impacts to water quality or availability of aquatic habitat for salmonids. In addition, the 2023 data will help provide information to evaluate potential changes to water quality and availability of habitat for aquatic resources resulting from the proposed permanent changes to D1610 minimum instream flows that are mandated by the Biological Opinion and will be included in the Biological Opinion Annual Monitoring Report. The annual report will be available on Sonoma Water's website: https://www.sonomawater.org/biological-opinion-outreach.

Figure 4-1. 2023 Sonoma Water and USGS Russian River permanent and seasonal datasonde monitoring stations.

4.2 Aquatic Habitat for Salmonids

4.2.1 Introduction

In Term 7 of the Temporary Urgency Change Order covering the period May 19, 2023 to October 15, 2023 (Order), the State Water Resource Control Board (SWRCB) tasked Sonoma Water with evaluating impacts associated with reductions in minimum instream flows authorized by the Order to water quality and the availability of aquatic habitat for Russian River salmonids. This section of the report summarizes temperature and dissolved oxygen (DO) conditions in the Russian River during the period covered by the Order and relates these conditions to fisheries monitoring data collected by Sonoma Water.

4.2.2 Russian River Salmonid Life Stages

Salmonids in the Russian River can be affected by flow, high temperature, and low DO changes at multiple life stages. The Russian River supports three species of salmonids: coho salmon, steelhead, and Chinook salmon. These species follow similar life history patterns with adults migrating from the ocean to the river and moving upstream to spawn in the fall and winter. Females dig nests called redds in the stream substrate and deposit eggs simultaneously with fertilization by one or more males. Eggs then remain in the redd for several weeks before hatching. After hatching, the larval fish remain in the gravel for several more weeks before emerging. After emerging from the gravel these young salmonids are identified first as fry and then later as parr once they have undergone freshwater growth. Parr rear for a few months (Chinook) to approximately 2 years (steelhead) in freshwater before undergoing a physiological change identified as smoltification. At this stage, fish are identified as smolts and are physiologically tolerant of saltwater, and therefore ready for ocean entry (Quinn 2005). In the Russian River, smolts move downstream to the ocean in the spring (Chase et al. 2005 and 2007, Obedzinski et al. 2006). Salmonids spend several months to a few years at sea before returning to the river to spawn as adults. Because all three species of Russian River anadromous salmonids spend a period of time freshwater, individuals must cope with the freshwater conditions they encounter including flow, temperature, and DO. While all three species have a similar life history, each species tends to spawn and rear in different locations and are present in the Russian River watershed at slightly different times. These subtle but important differences may expose each species to a different set of freshwater conditions.

Coho Timing and Distribution

Natural-origin coho salmon populations in the Russian River are at alarmingly low levels and recovery measures rely mainly on fish released from Don Clausen Warm Springs Hatchery as part of the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP). Data collected at Sonoma Water's Mirabel inflatable dam on an underwater video camera system from 2011 through 2013 indicate that adult coho salmon begin migrating past the dam in late October and continue through at least January and that the bulk of adult coho migrate through that portion of the river from November through February (in 2013, 97% of coho were observed after November 20 (Martini-Lamb and Manning 2014)). Spawning and rearing occurs in certain tributaries to the Russian River (NMFS 2008) and data from downstream migrant trapping in some of those tributaries indicate that coho smolt emigration starts before April and continues through mid-June (Obedzinski et al. 2006). Although coho smolts have been captured as late as mid-July in downstream migrant traps operated by Sonoma Water on the mainstem Russian River at

the Mirabel dam (Martini-Lamb and Manning 2011), most emigrate from the Russian River from March through May. Only the Russian River coho adult life stage is present in the mainstem during the Order; therefore, only temperature and DO data relating to this life stage will be analyzed for this report. There is limited coho spawning habitat upstream of Healdsburg; therefore only the Hacienda and Digger bend sites will be summarized for coho.

Steelhead Timing and Distribution

Based on video monitoring at Sonoma Water's Mirabel inflatable dam and returns to Warm Springs Hatchery, adult steelhead return to the Russian River later than Chinook. Deflation of the inflatable dam and removal of the underwater video camera system preclude a precise measure of adult return timing or numbers. However, continuous video monitoring at the inflatable dam during late fall through spring in 2006-2007, timing of returns to the hatchery, and data gathered from steelhead angler report cards (SCWA unpublished data, Jackson 2007) suggests that steelhead return to the Russian River from December through March with the majority returning in January and February.

Many steelhead spawn and rear year-round in tributaries of the Russian River and in the upper mainstem Russian River (NMFS 2008, Cook 2003). Cook (2003) found that summer rearing of steelhead in the mainstem Russian River were distributed in the highest concentrations between Hopland and Cloverdale (Canyon Reach). Steelhead were also found in relatively high numbers (when compared to habitats downstream of Cloverdale) in the section of river between the Coyote Valley Dam and Hopland. The Canyon Reach is the highest gradient section of the mainstem Russian River and contains high velocity habitats that include riffles and cascades (Cook 2003). Due to flow releases from Lake Mendocino, both the Canyon and Ukiah reaches generally have cooler water temperatures when compared to other mainstem reaches.

The steelhead smolt migration in the Russian River begins at least as early as March and continues through June, with most steelhead emigrating from March through May (SCWA unpublished data, Martini-Lamb and Manning 2011). The Russian River steelhead juvenile and adult life stages are present in the mainstem during the Order while most smolts emigrate before the Order; therefore, only temperature and DO data relating to the juvenile and adult life stages will be analyzed for this report.

Chinook Timing and Distribution

Based on video monitoring at Sonoma Water's Mirabel inflatable dam, adult Chinook are typically observed in the Russian River before coho and steelhead. Chinook enter the Russian River as early as September and the migration is complete by early February. Generally, the bulk of Chinook pass the Mirabel dam from October through December. Chinook spawn in the mainstem Russian River and in Dry Creek during the fall (Chase et al. 2005 and 2007, Cook 2003, Martini-Lamb and Manning 2011), with occasional spawning occurring in larger tributaries (e.g., Austin, Santa Rosa, Maacama, Sulphur) depending on accessibility due to low tributary flow as it relates to run-timing. Chinook offspring rear for approximately two to four months before emigrating to sea in the spring. The bulk of Chinook smolt emigration occurs from April through mid-July. Russian River Chinook smolt and adult life stages are present in the mainstem during the Order; therefore, only temperature and DO data relating to these two life stages will be analyzed for this report.

4.2.3 Methods

Sonoma Water uses underwater video, downstream migrant traps, and water quality data collected in the Russian River to depict water quality conditions when salmonids where present. To estimate the number of adult Chinook that return to the Russian River upstream of the Mirabel inflatable dam, Sonoma Water typically operates an underwater video camera in the fish ladder located at the dam. Sonoma Water also operates downstream migrant traps to enumerate salmonid smolts. USGS stream gages and a Sonoma Water operated data sonde were used to provide water quality data in the mainstem Russian River.

Physical and water quality conditions (flow, water temperature, and DO) were collected at multiple sites in the Russian River. USGS stream gages located on the Russian River at Hacienda, Digger Bend, Jimtown, and Hopland provided flow, water temperature, and DO data. Data sondes operated by Sonoma Water that collected temperature and DO data in the mainstem Russian River were located near the confluence with Pieta Creek (approximately 5 miles downstream of Hopland) and in the east fork Russian River 0.5 km downstream of Coyote Valley Dam, near Ukiah. Water quality conditions at these sites were compared to literature-based thresholds then used to construct temperature and DO criteria for Russian River salmonids (Tables 4-1 through Table 4-4).

Table 4-1. Adult salmonid water temperature (°C) thresholds used for migration when describing water quality conditions during the term of the Temporary Urgency Change Order. Criteria are from SCWA (2016).

Description	Chinook	Coho	Steelhead
optimal upper limit	15.6	11.1	11.1
suitable upper limit	17.8	15.0	15.0
stressful upper limit	19.4	21.1	21.1
acutely stressful upper limit	23.8	23.8	23.8
potentially lethal lower limit	23.9	23.9	23.9

Table 4-2. Juvenile salmonid rearing temperature (°C) thresholds used for describing water quality conditions during the term of the Temporary Urgency Change Order. Criteria are from SCWA (2016).

Description	Chinook	Coho	Steelhead
optimal upper limit	16.9	13.9	16.9
suitable upper limit	17.8	16.9	18.9
stressful upper limit	20.0	17.8	21.9
acutely stressful upper limit	23.8	23.8	23.8
potentially lethal lower limit	23.9	23.9	23.9

Table 4-3. Salmonid smolting temperature (°C) thresholds used for describing water quality conditions during the term of the Temporary Urgency Change Order. Criteria are from SCWA (2016).

Description	Chinook	Coho	Steelhead
optimal upper limit	16.9	10.0	11.1
suitable upper limit	17.8	13.9	12.8
stressful upper limit	20.0	16.9	15.0
acutely stressful upper limit	23.8	23.8	23.8
potentially lethal lower limit	23.9	23.9	23.9

Table 4-4. Dissolved oxygen (mg/L) ranges for all salmonid life stages used for describing water quality conditions during the term of the Temporary Urgency Change Order. Criteria are from SCWA (2016).

Description	Dissolved Oxygen (mg/L)
optimal upper limit	>12
suitable	8.0-11.9
stressful	5.0-7.9
acutely stressful	3.0-4.9
potentially lethal upper limit	<3

To evaluate temperature- and DO-related impacts from flow changes to the timing and magnitude of adult and smolt salmonid counts from counting stations, we compared count data (when available) to water quality information only where fish would either pass a water quality station before being detected at a particular counting station. For instance, because most steelhead rearing habitat in the mainstem Russian River occurs upstream of Hopland, this report presents the water quality data from the USGS Hopland gaging station when analyzing temperature- and DO-related impacts to juvenile steelhead. Salmonid smolts of all three species moving downstream out of Dry Creek and the upper Russian River pass our downstream migrant trap on the Russian River at Mirabel then pass the Hacienda USGS stream gage before entering the ocean. Therefore, we paired salmonid smolt data from the Russian River downstream migrant trap to Hacienda water quality data to describe the conditions these fish likely experienced as they moved downstream through the lower Russian River. This report summarizes data for the period covered by the Order (May 19, 2023 to October 15, 2023). Because their migration occurs after the order expired, water temperature data is not summarized for coho and steelhead adults.

4.2.4 Results

Flow

During the Order, the Russian River was generally controlled by reservoir releases and not strongly influenced by tributary in-flow. Average daily flow at the USGS stream gage at Hacienda (gage number 11467000) ranged from a low of 151 cfs to a high of 559 cfs (Figure 4-1).

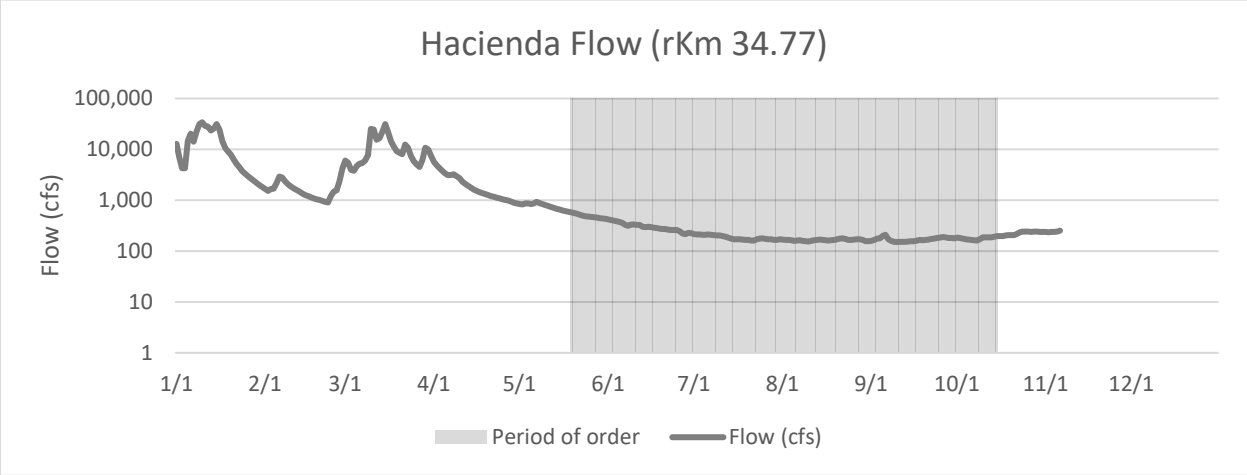


Figure 4-1. Flow in the Russian River at the USGS Hacienda stream gage (11467000). Gray indicates the period included in the TUC Order.

Temperature

Adult Salmonid Migration

The underwater video camera at the Mirabel dam was installed on September 1, 2023. Video was reviewed and daily counts of adult salmonids were summarized. In total 379 adult Chinook, 2 adult steelhead, and no adult coho were observed on the Mirabel video camera between September 1 and October 15, 2023. These counts are preliminary and subject to change.

Chinook

Water temperatures for Chinook salmon were favorable after mid-October when most Chinook are typically observed in the Russian River. At the Hacienda gage the temperature ranged from suitable to acutely stressful for adult salmonids (based on the criteria in Table 4-1 and Figure 4-2). However, temperatures at Hacienda were generally suitable to optimal when the majority of Chinook are typically observed at Mirabel (mid-October to mid-December). Moving upstream from Hacienda, Chinook would have experienced water temperatures similar to Hacienda at Digger Bend, and at Jimtown (Figures 4-2 through 4-4). At Cloverdale and at the confluence with Pieta creek water temperatures ranged from suitable to optimal (Figure 4-5 and 4-6). Water temperature in the east fork Russian River downstream of Coyote Valley Dam were optimal during the Chinook migration period (Figure 4-7 and 4-8).

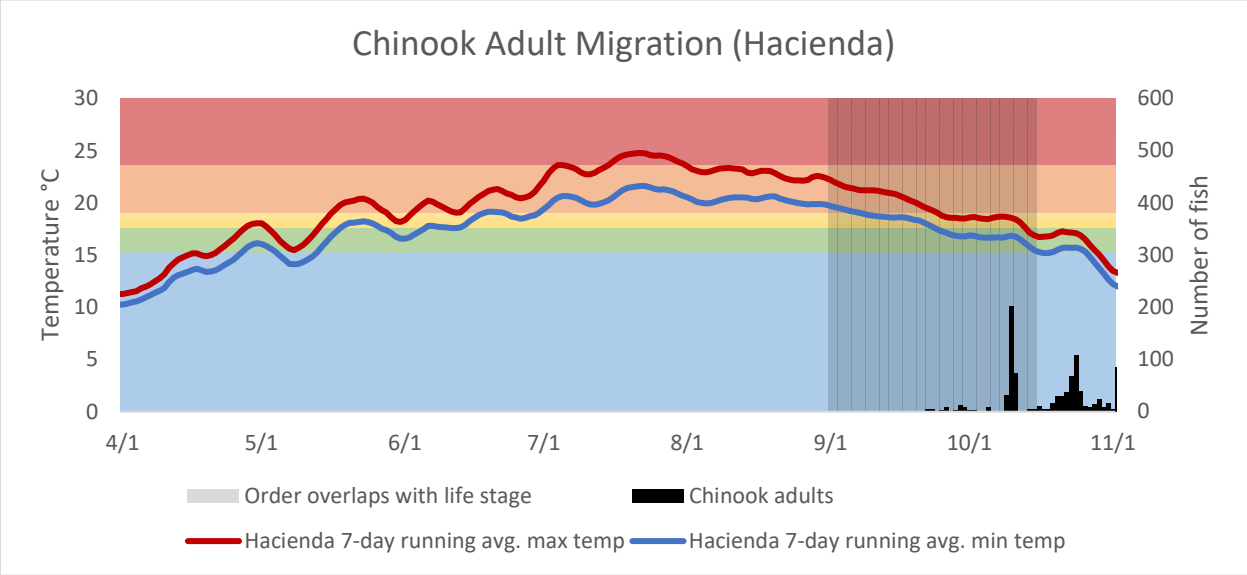


Figure 4-2. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) and number of adult Chinook observed on the Mirabel video camera. Also show are optimal, suitable, stressful, acutely stressful, and potentially lethal water temperature zones for adult Chinook based on Table 4-1.

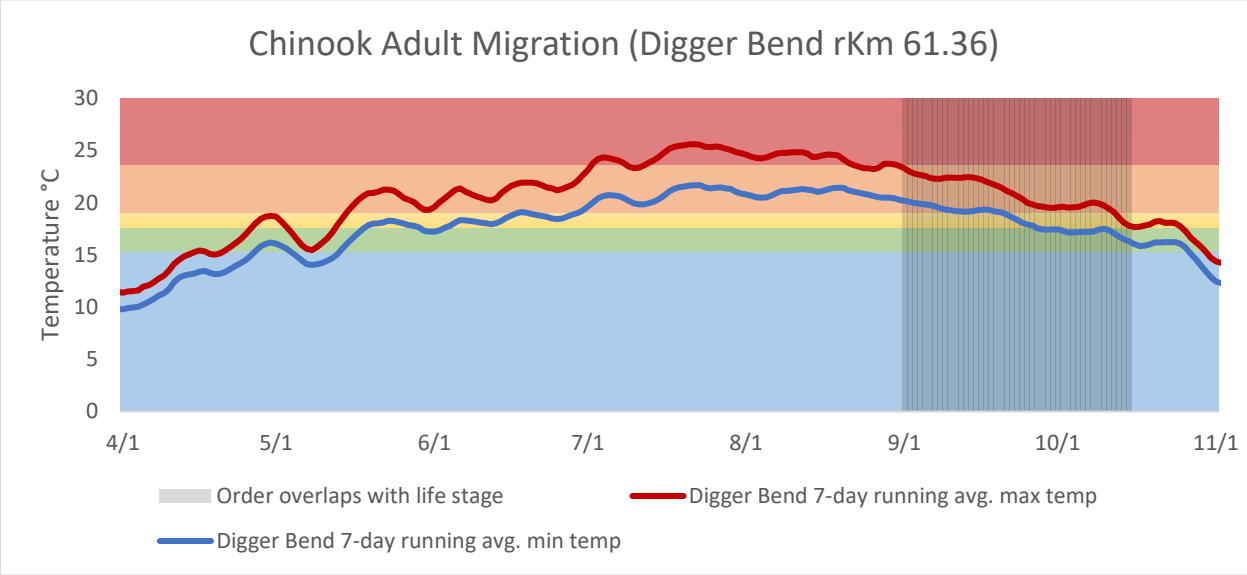


Figure 4-3. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook adult migration based on Table 4-1.

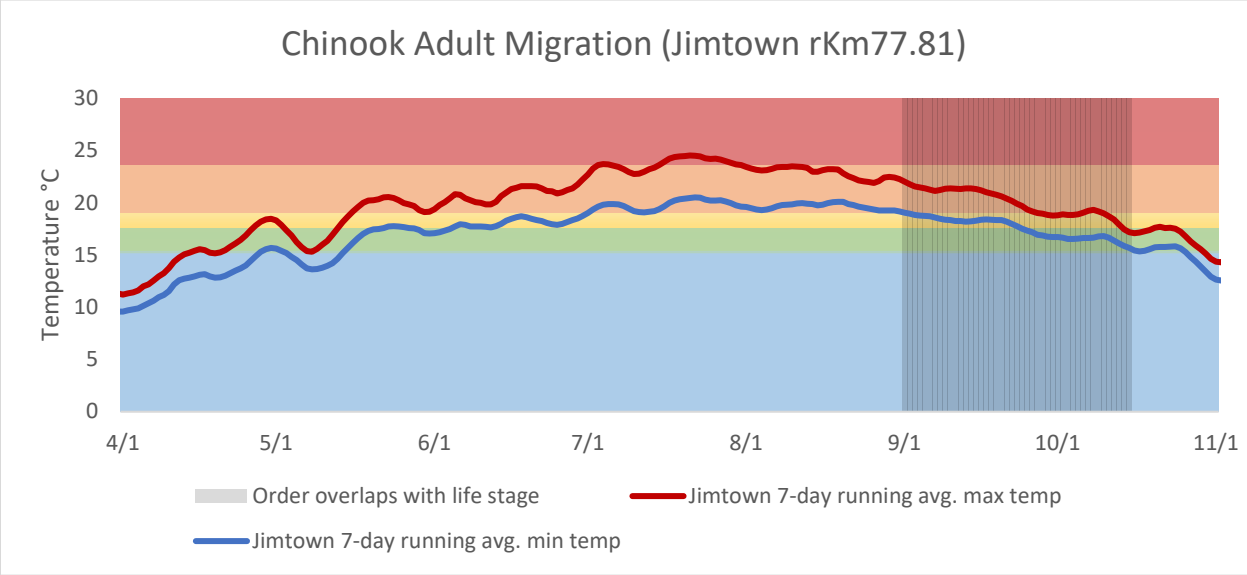


Figure 4-4. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook adult migration based on Table 4-1.

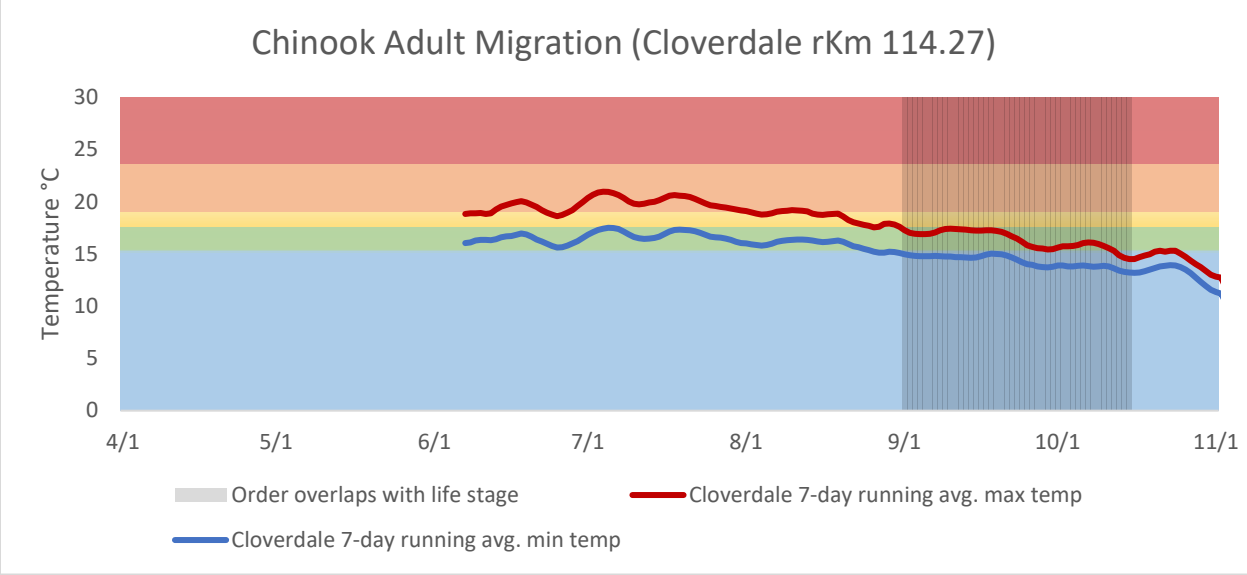


Figure 4-5. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Cloverdale (USGS gage number 11463000) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook adult migration based on Table 4-1.

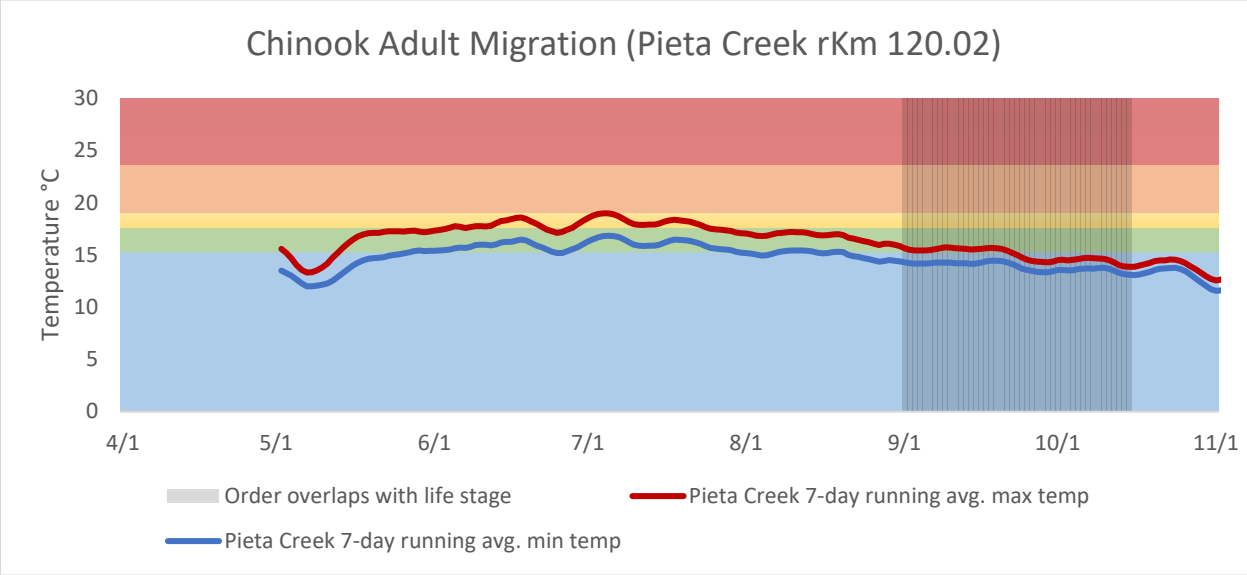


Figure 4-6. The 7-day running average of the minimum and maximum water temperatures collected in the mainstem Russian River at the confluence with Pieta Creek shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook adult migration based on Table 4-1.

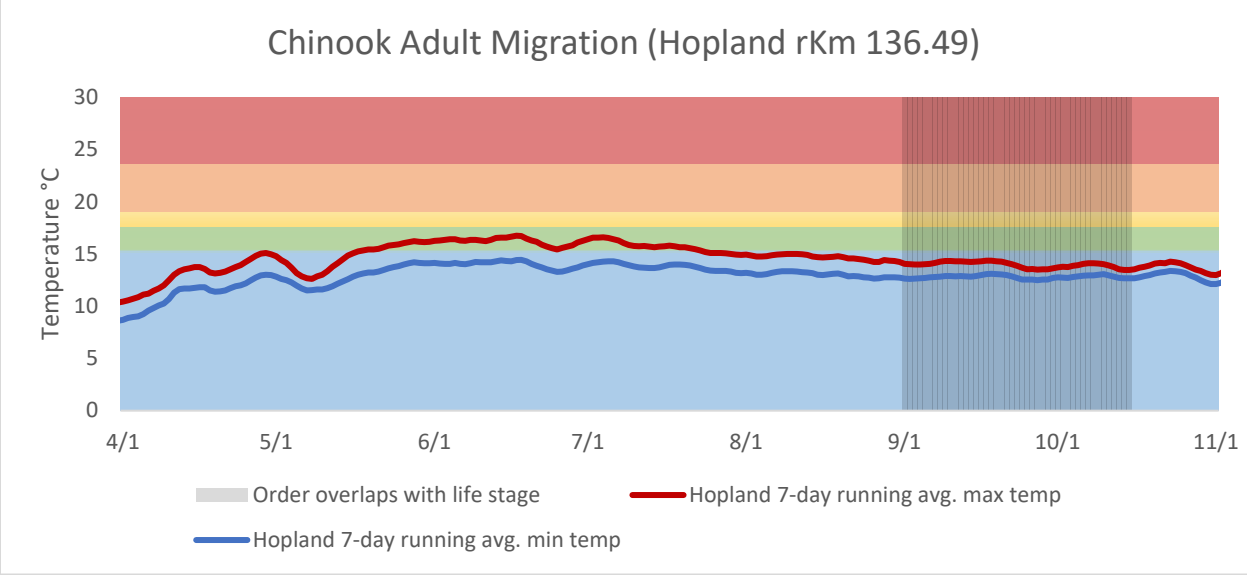


Figure 4-7. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook adult migration based on Table 4-1.

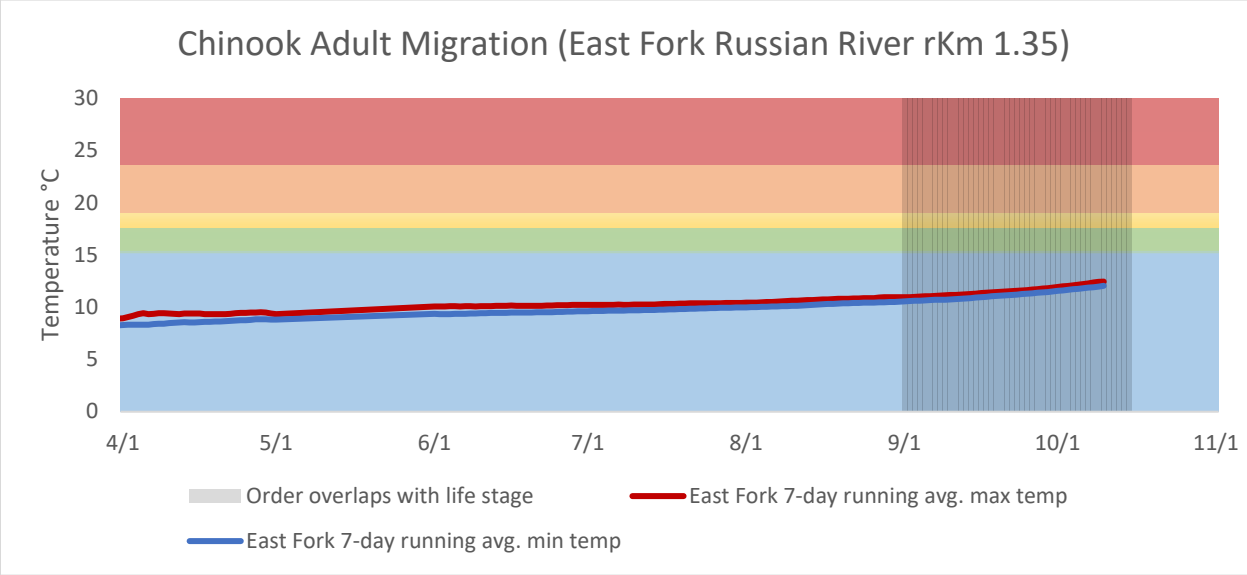


Figure 4-8. The 7-day running average of the minimum and maximum water temperatures collected in the east fork of the Russian River 0.5 km downstream of Coyote Valley Dam. Shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook adult migration based on Table 4-1.

Salmonid Rearing

In the Russian River basin much of the salmonid rearing habitat is in tributaries to the Russian River including Dry Creek, but Chinook and steelhead rear in the mainstem Russian River as well. Chinook emerge from redds constructed in the upper Russian River in the early spring and begin rearing in the shallow portions of the stream margins. In the mainstem Russian River, Chinook finish rearing in the early spring when water temperatures are still relatively cool. As a result, Chinook rear at more locations in the mainstem, but for a shorter time than steelhead. Therefore, we relate water temperature at several mainstem Russian River sites to Chinook water temperature criteria. Steelhead rear in freshwater for one or more years and are primarily restricted to the tributaries of the Russian River and to the portion of Russian River where water released from the cold-water pool (the bottom portion of the lake) in Lake Mendocino has the greatest cooling effect on mainstem rearing habitat near Coyote Valley Dam. This cooling effect has largely diminished by the time water reaches Cloverdale approximately 50 km downstream. We relate steelhead water temperature criteria to water temperature collected in the east fork of Russian River downstream of Coyote Valley Dam, at Hopland, and in the Russian river near the confluence of Pieta Creek (approximately 5 miles downstream of Hopland) as these sites are within the section of the Russian River that can provide year-round rearing opportunities for juvenile steelhead. Juvenile coho salmon do not rear in the mainstem of the Russian River.

Chinook

During 2023, water temperatures for rearing Chinook ranged from optimal to acutely stressful depending on the site and time period within the Chinook rearing season. Although stressful and eventually acutely stressful conditions did occur at some sites in late spring and summer, water temperatures were optimal for Chinook salmon rearing in the east fork Russian River downstream of Coyote Valley Dam (Figure 4-9. Water temperature near the USGS stream gage at Hopland (gauge number 11462500) ranged from optimal to suitable (Figure 4-10). At Pieta Creek water temperature was optimal to stressful during the period of Chinook rearing season when data was available (Figure 4-11).

Depending on the site and time, water temperature at Cloverdale, Jimtown, Digger Bend, and Hacienda ranged from suitable to acutely stressful (Figures 4-12 through 4-15); however, the majority of Chinook smolts in the Russian River migrate downstream and out to sea by mid-June thus avoiding potentially lethal temperatures (see Salmonid Smolt Outmigration).

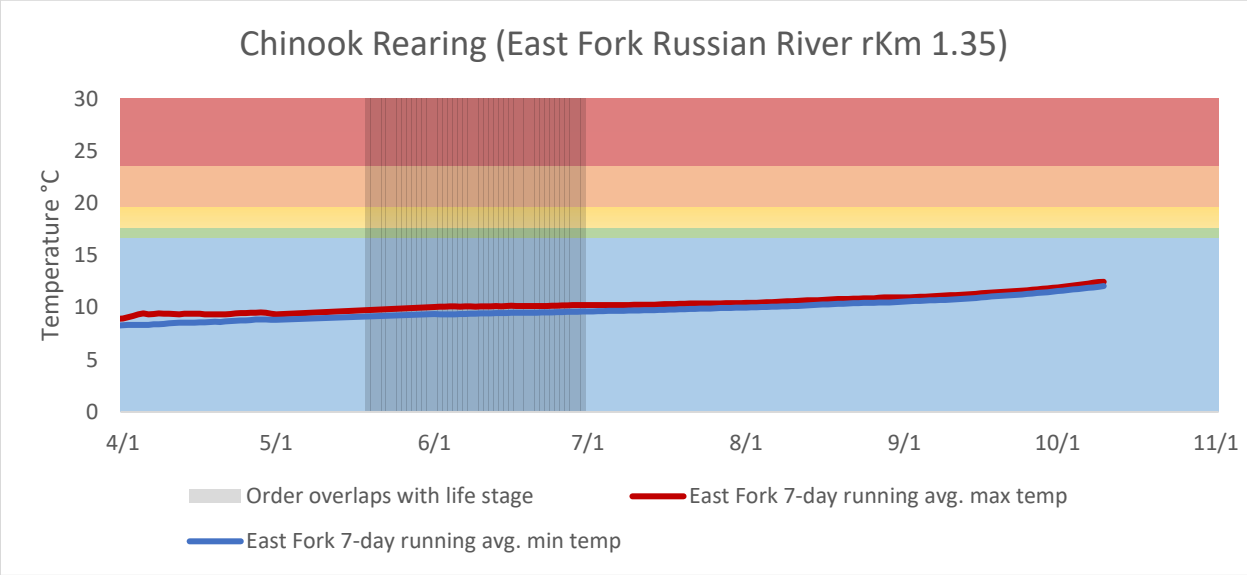


Figure 4-9. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water in the east fork Russian River 0.5 km downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook rearing based on Table 4-2.

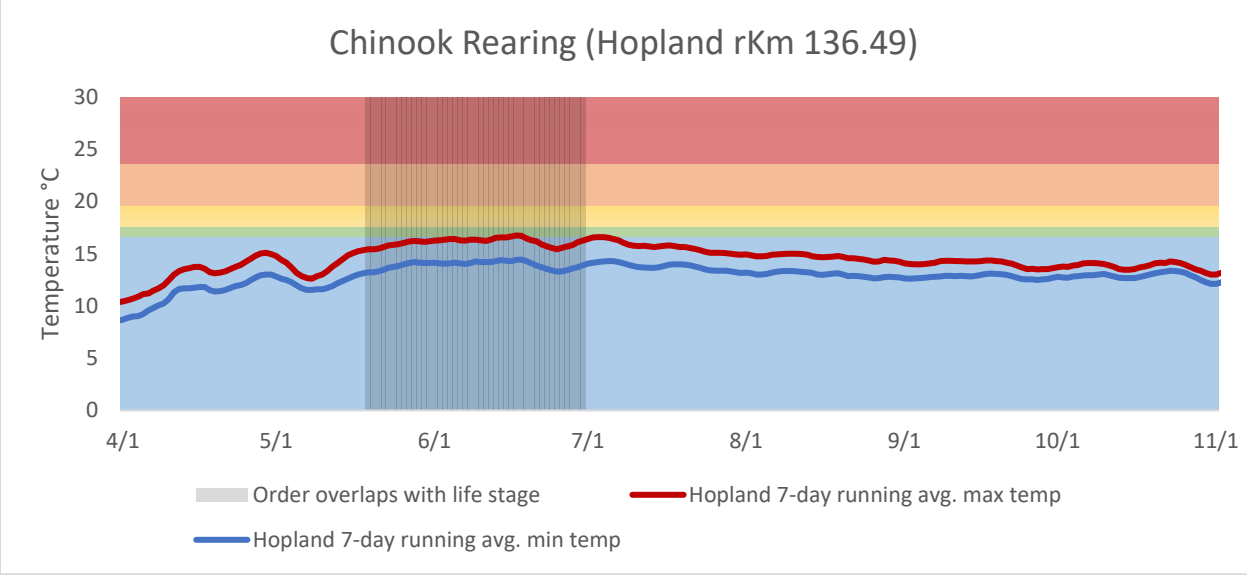


Figure 4-10. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook rearing based on Table 4-2.

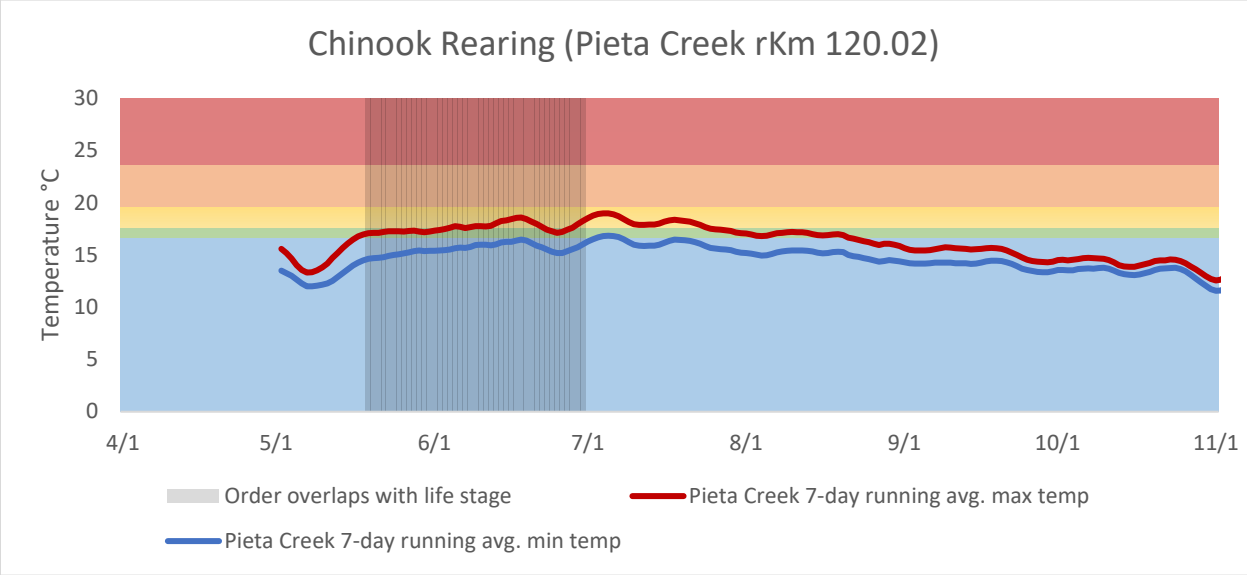


Figure 4-11. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland shown with the optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook rearing based on Table 4-2.

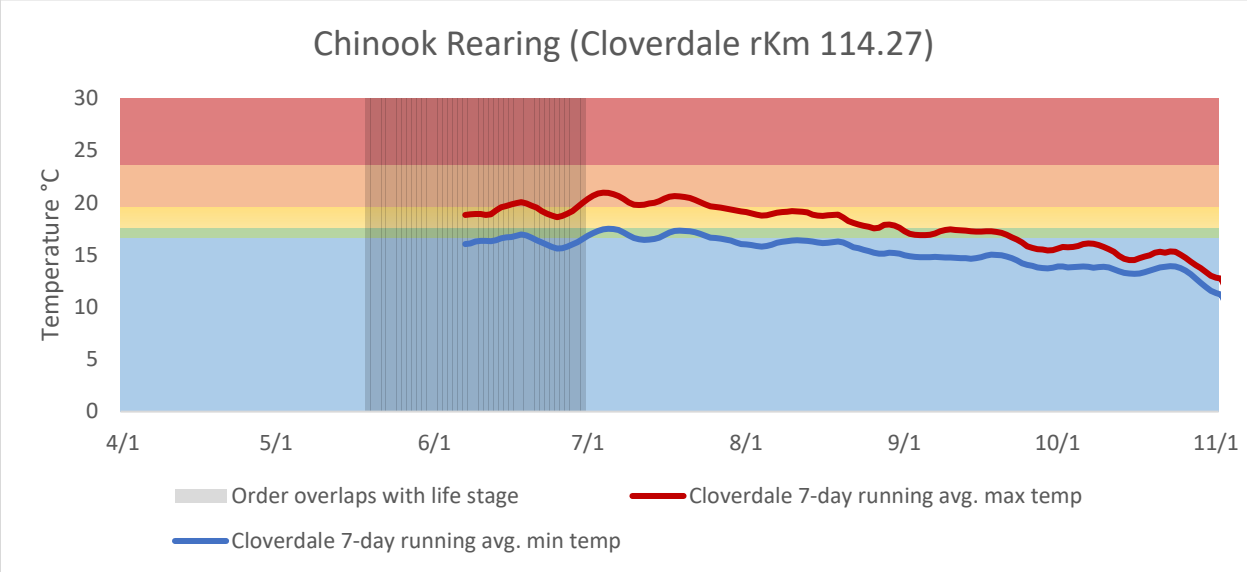


Figure 4-12. The 7-day running average of the minimum and maximum water temperatures at the USGS stream gage at Cloverdale (USGS gage number 11463000) shown with the optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook rearing based on Table 4-2.

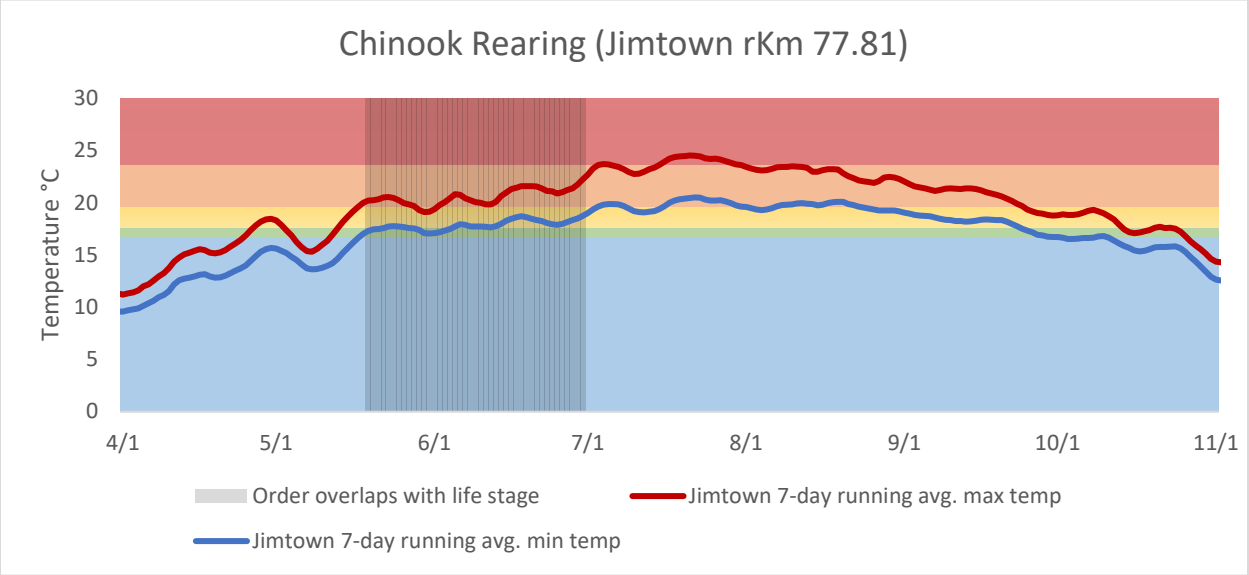


Figure 4-13. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook rearing based on Table 4-2.

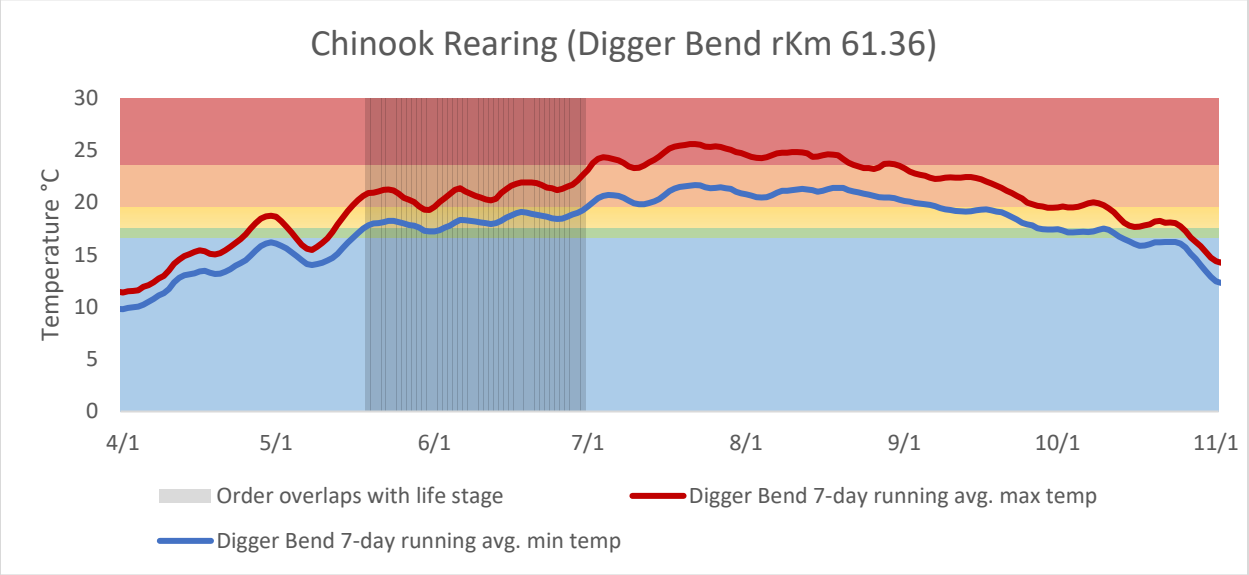


Figure 4-14. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook rearing based on Table 4-2.

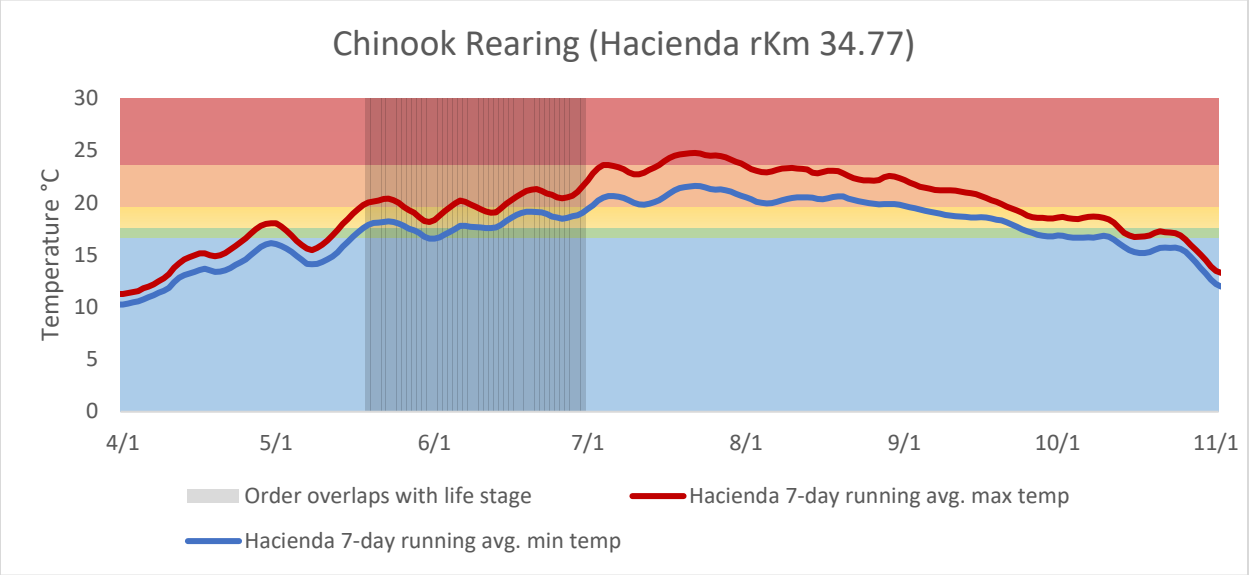


Figure 4-15. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hacienda (gage number 11467000) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook rearing based on Table 4-2.

Steelhead

Steelhead parr rear year-round in the upper Russian River. During the Order water temperature in the east fork of the Russian River downstream of Coyote Valley Dam was optimal (Figure 4-16). At the USGS stream gage at Hopland, water temperature was optimal to suitable for steelhead rearing (Figure 4-17). In the Russian River near Pieta Creek water temperature was generally optimal to suitable, but the 7-day maximum temperature was occasionally stressful (Figure 4-18). Water temperature at Cloverdale ranged from optimal to stressful (Figure 4-19).

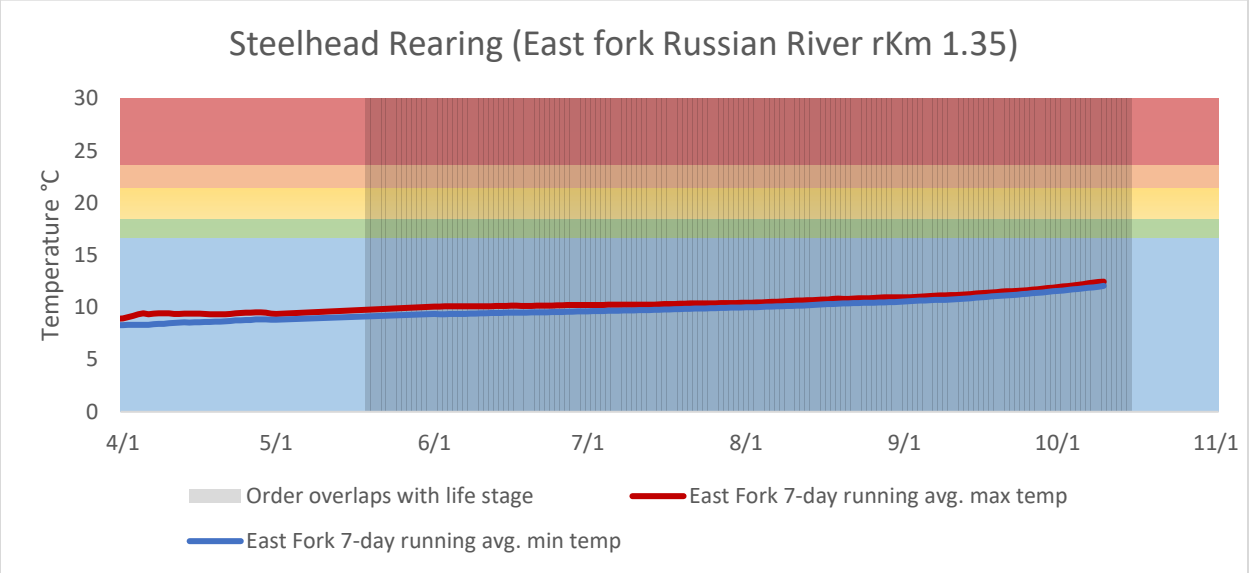


Figure 4-16. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water at the east fork Russian River downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for steelhead parr based on Table 4-2.

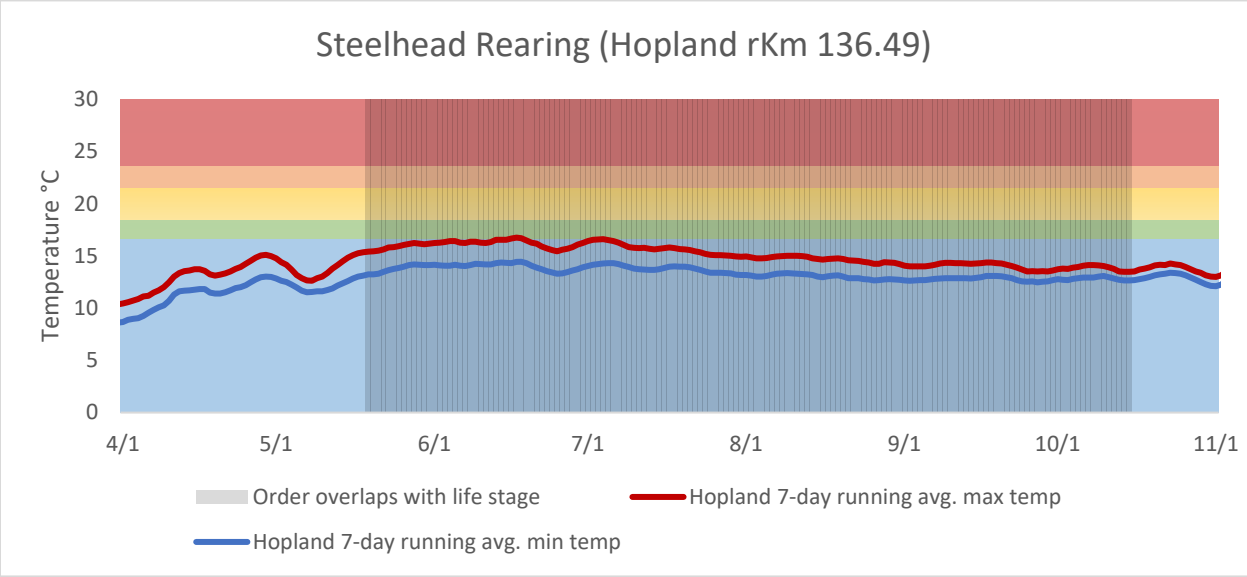


Figure 4-17. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for steelhead parr based on Table 4-2.

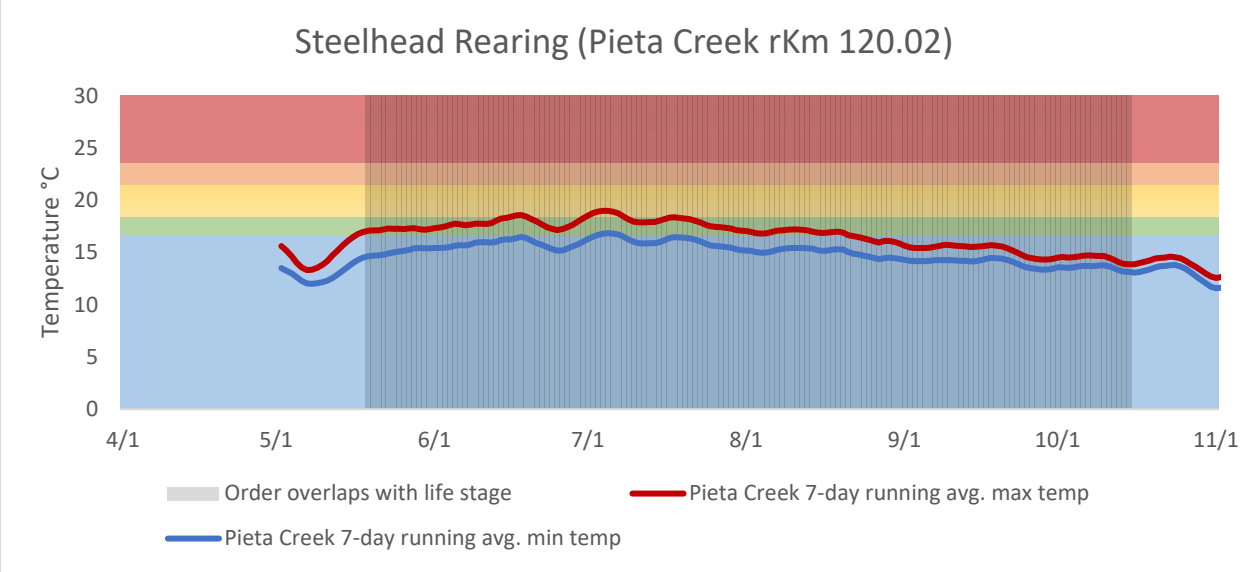


Figure 4-18. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for steelhead parr based on Table 4-2.

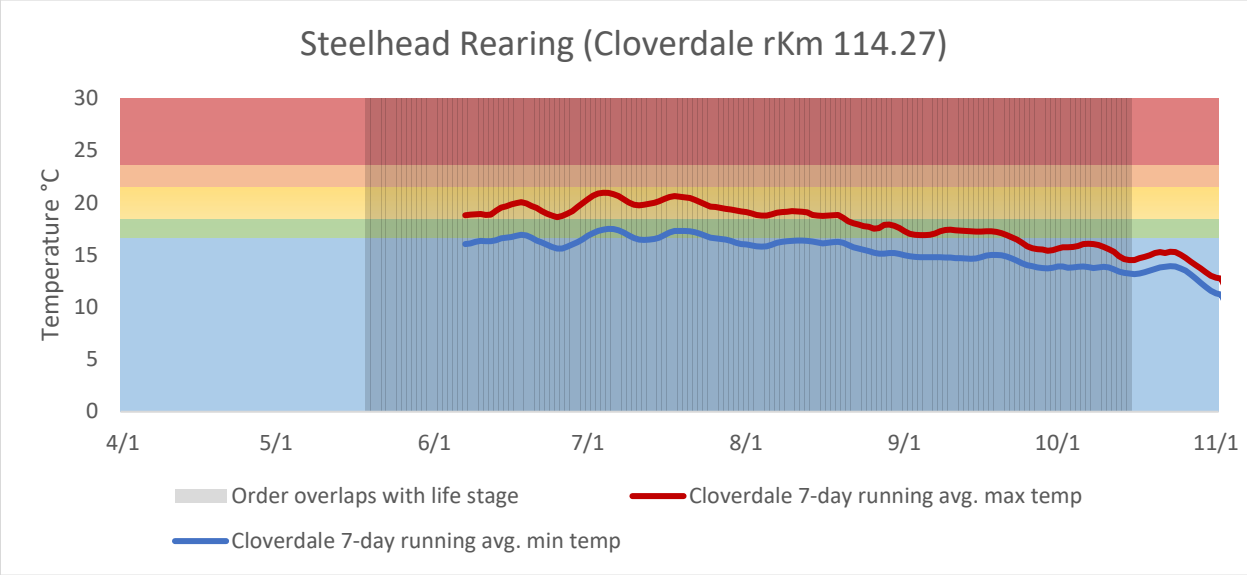


Figure 4-19. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Cloverdale (USGS gage number 11463000) shown with the optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook rearing based on Table 4-2.

Salmonid Smolt Outmigration

For smolts produced in the upper portion of the watershed, Russian River water temperatures for the east fork Russian River downstream of Coyote Valley Dam, Hopland, confluence with Pieta Creek, Jimtown, and Digger Bend gages is summarized and shown with water temperature criteria for Chinook smolts. Chinook smolt catches at Mirabel are also shown for water temperature collected at the Hacienda gage since this trap site is located near the Hacienda stream gage. Because so few coho and steelhead smolts apparently emigrated through the lower river during the period of time that the Order was in effect (based on the historical Mirabel trap catch), we did not evaluate lower river temperature effects on smolts of these two species and instead restricted our analysis to Chinook smolts

Chinook

Water temperature in the upper Russian River near the Coyote Valley Dam was generally favorable for Chinook smolts during the period that Chinook are expected to emigrate from that potion of the Russian river (April through June, Figure 4-20). However, water temperature became stressful to acutely stressful at some sites located downstream of Hopland (Figure 4-21 through Figure 4-26); however, the vast majority of Chinook smolts emigrate by mid-June before water temperatures become potentially lethal.

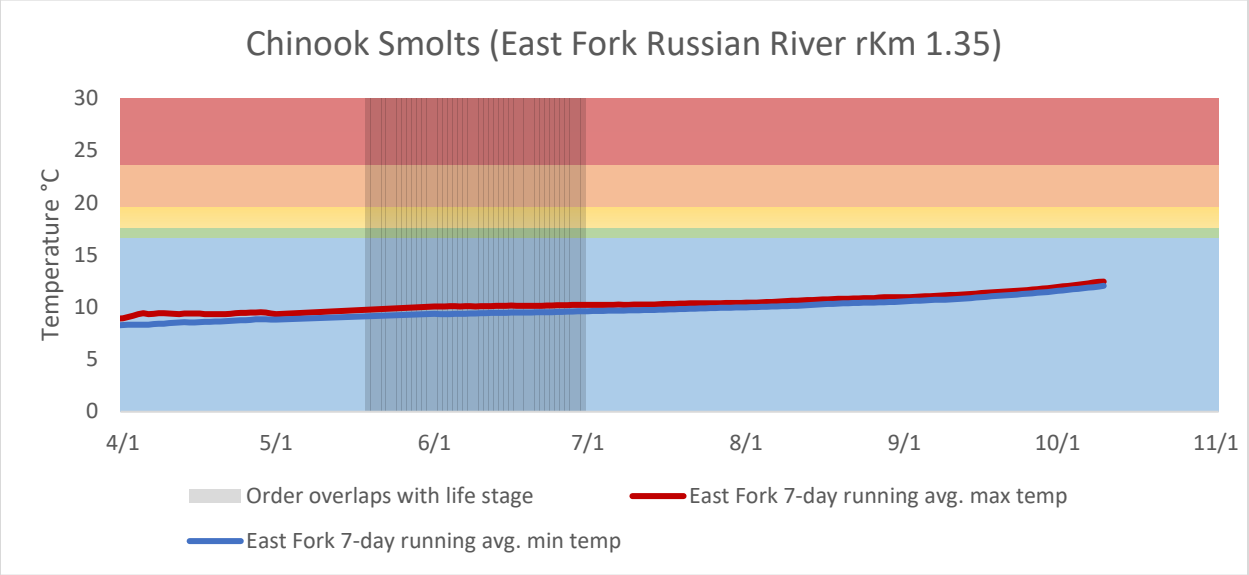


Figure 4-20. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water at the east fork of the Russian River downstream of the Coyote Valley Dam. Shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook smolts based on Table 4-3.

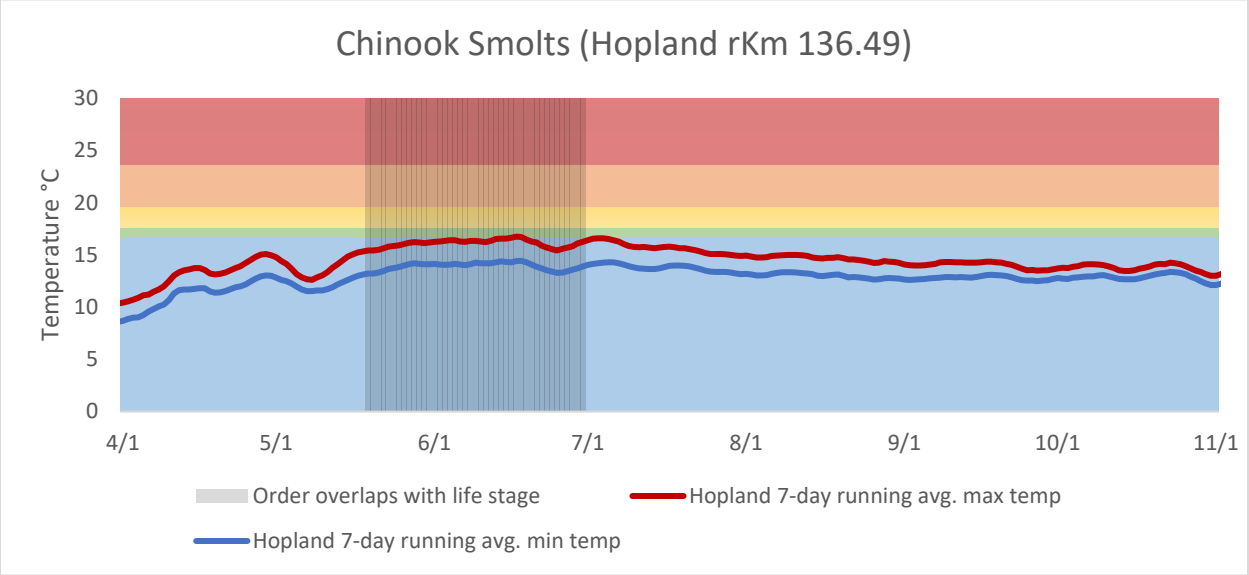


Figure 4-21. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). Shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook smolts based on Table 4-3.

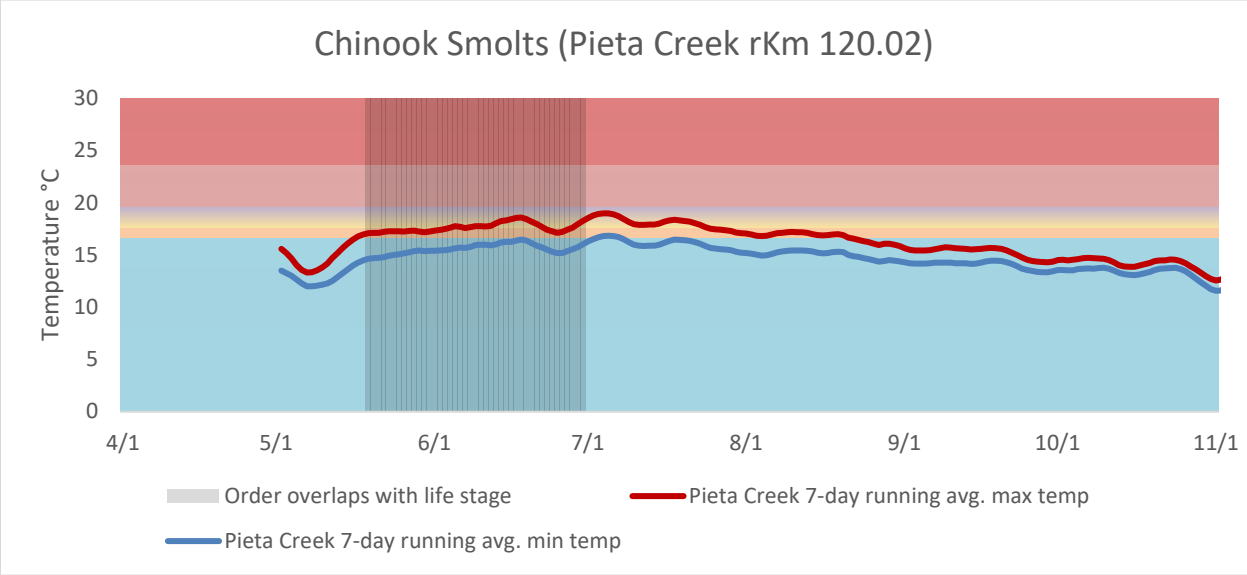


Figure 4-22. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook smolts based on Table 4-3.

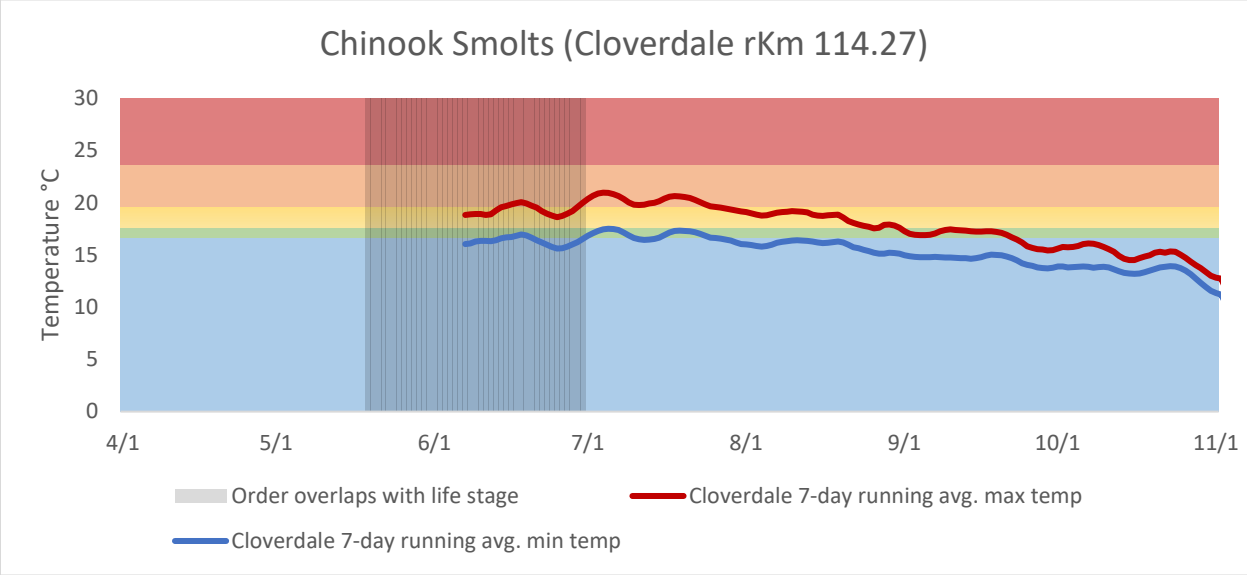


Figure 4-23. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Cloverdale (USGS gage number 11463000) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook smolts based on Table 4-3.

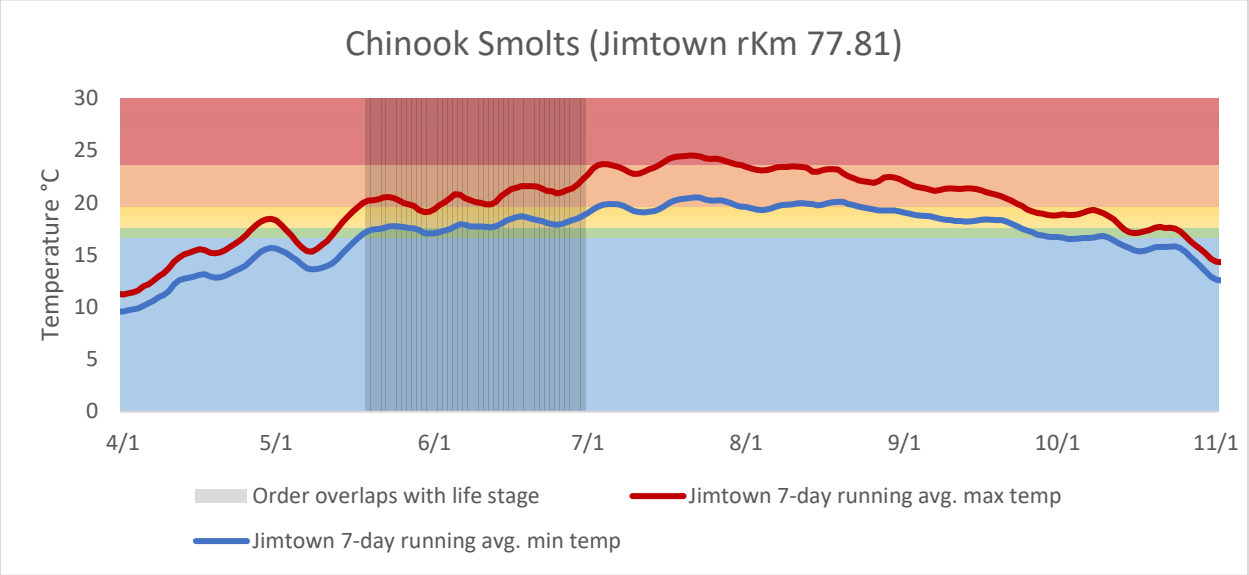


Figure 4-24. The 7-day running average of the minimum and maximum water temperatures collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook smolts based on Table 4-3.

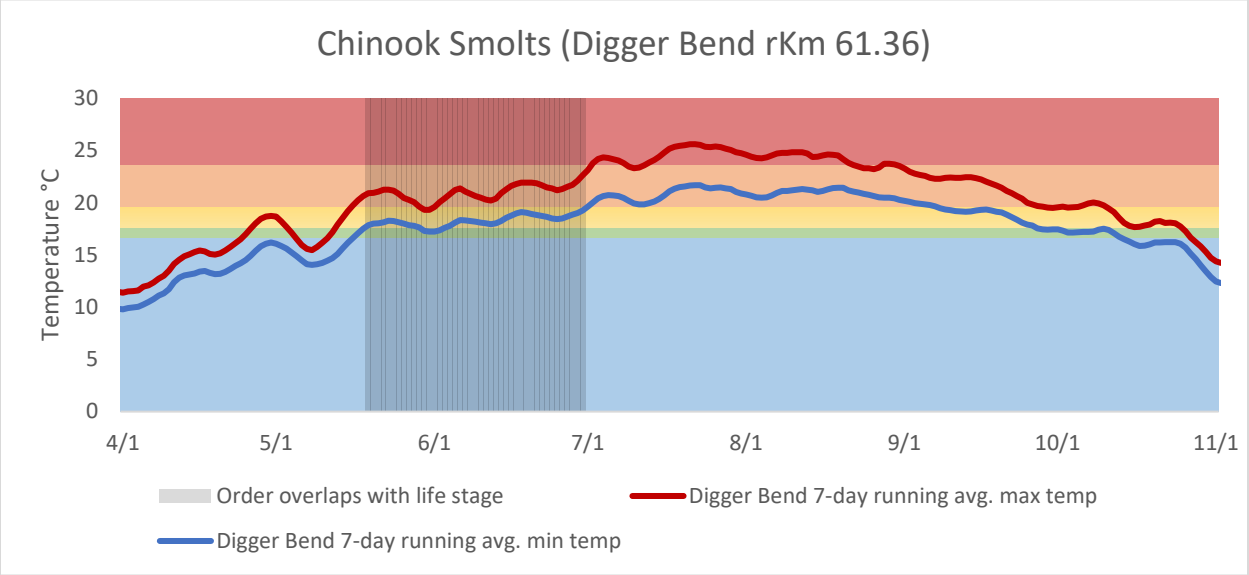


Figure 4-25. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook smolts based on Table 4-3.

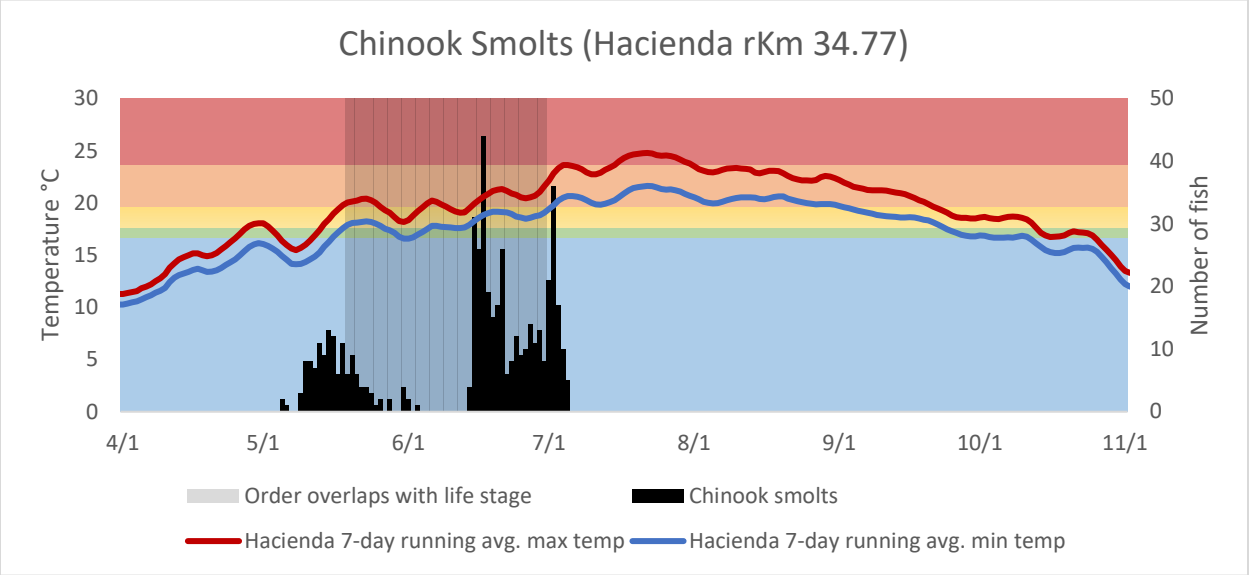


Figure 4-26. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook smolt catch from the Mainstem Russian River near Mirabel and optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for Chinook smolts based on Table 4-3.

Dissolved Oxygen

At most sites, DO was generally suitable to stressful for salmonids in the Russian River throughout the Order. However, by mid-August DO was potentially lethal in the east fork Russian River downstream of Coyote Valley Dam (Figure 4-27). At Hopland, Pieta Creek, and Cloverdale DO was suitable (Figures 4-28 and 4-30), but at Jimtown, Digger Bend, and Hacienda DO was suitable to stressful (Figures 4-31 through 4-33). It is worth noting that DO in summer and early fall is typically poor immediately downstream of Coyote Valley Dam but that it generally recovers fairly quickly downstream of the dam.

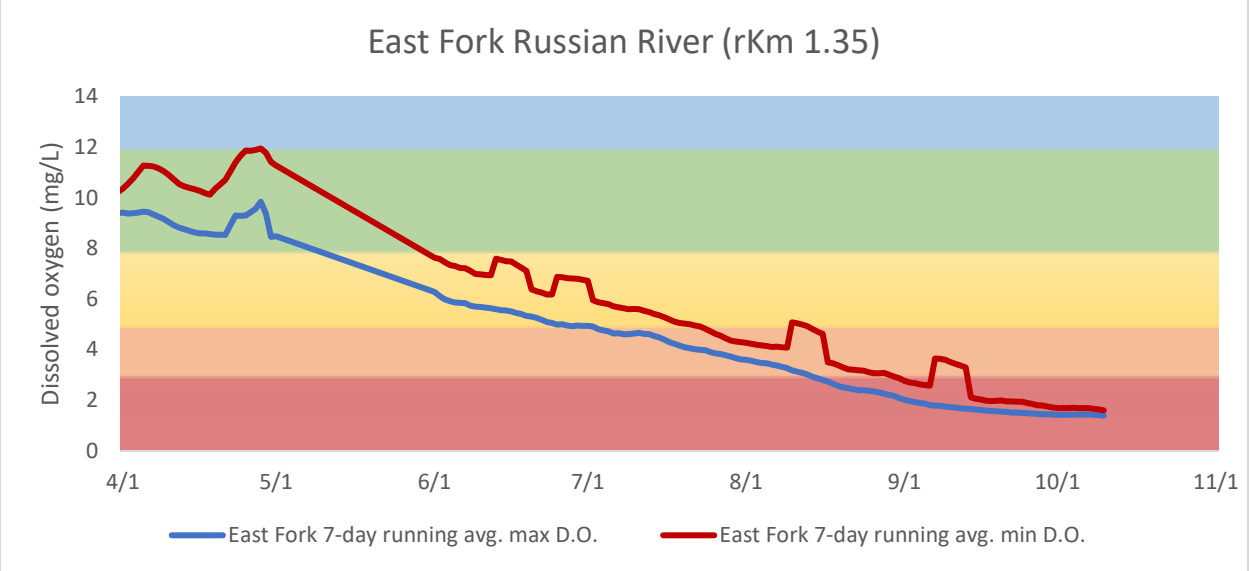


Figure 4-27. The 7-day running average of the minimum and maximum dissolved oxygen collected by Sonoma Water in the east fork of the Russian River downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

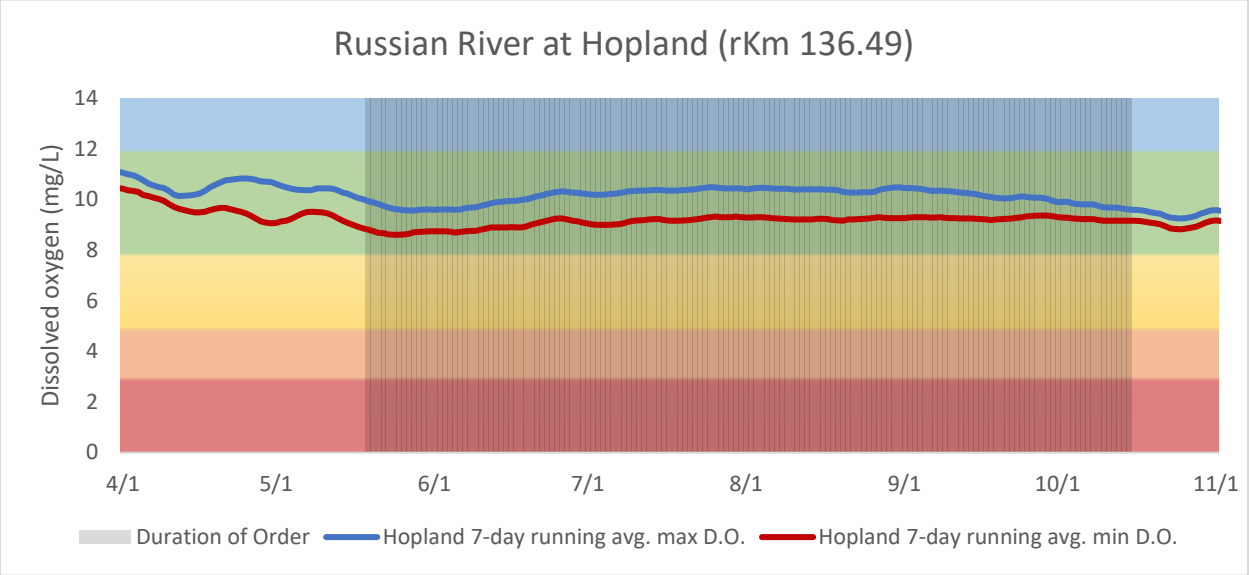


Figure 4-28. The 7-day running average of the minimum and maximum dissolved oxygen collected at Hopland (USGS stream gage number 11462500) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

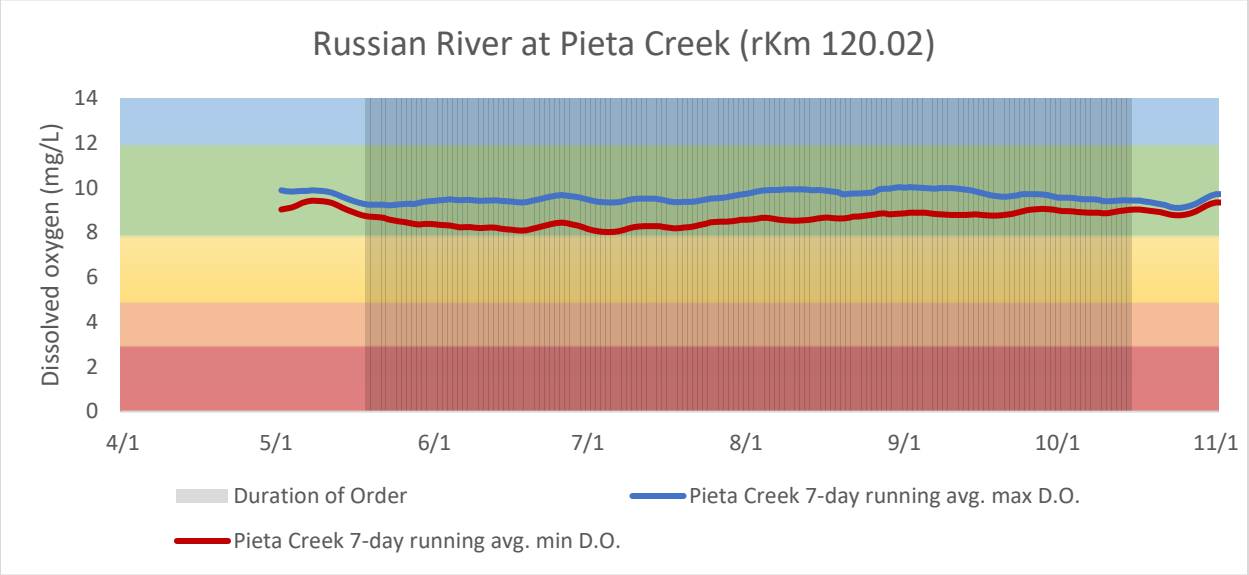


Figure 4-29. The 7-day running average of the minimum and maximum dissolved oxygen collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

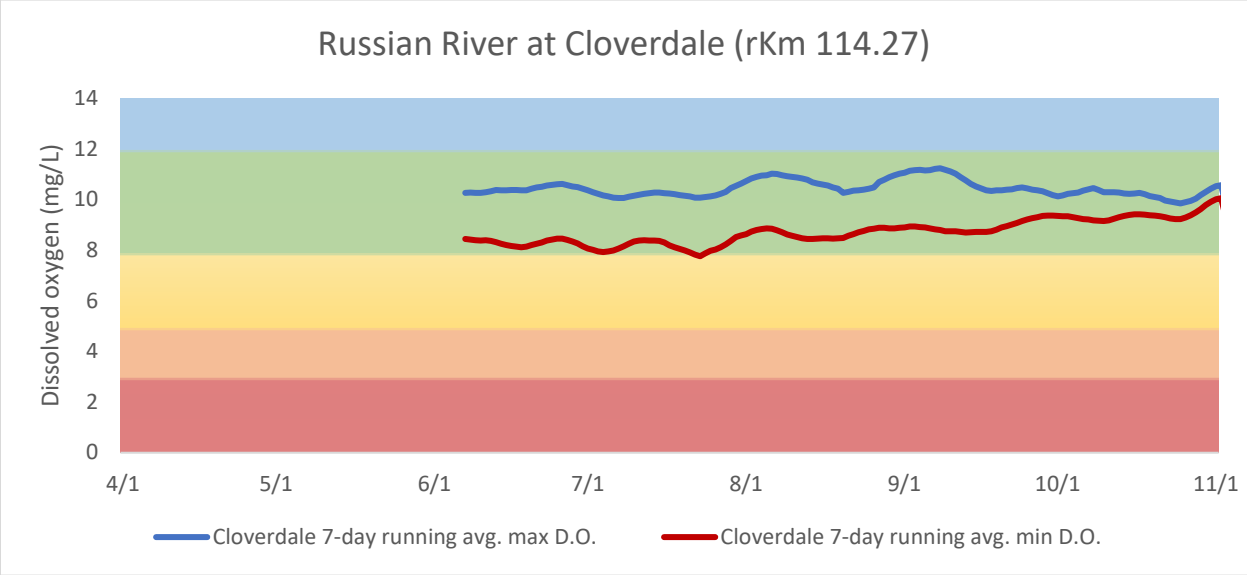


Figure 4-30. The 7-day running average of the minimum and maximum dissolved oxygen collected at the USGS stream gage at Cloverdale (USGS gage number 11463000) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

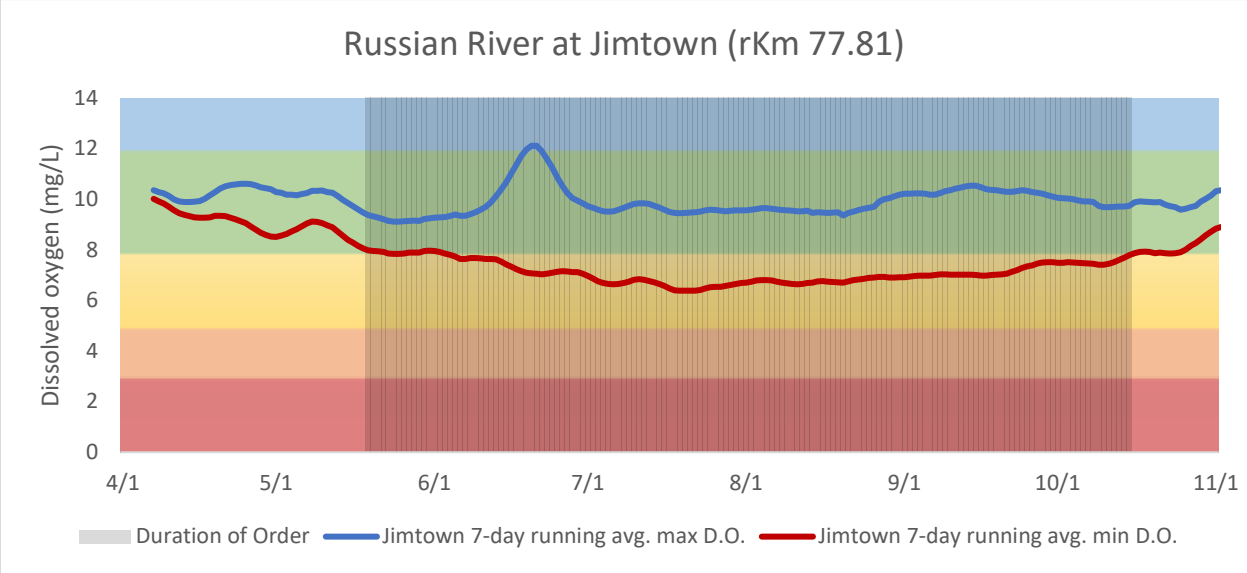


Figure 4-31. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

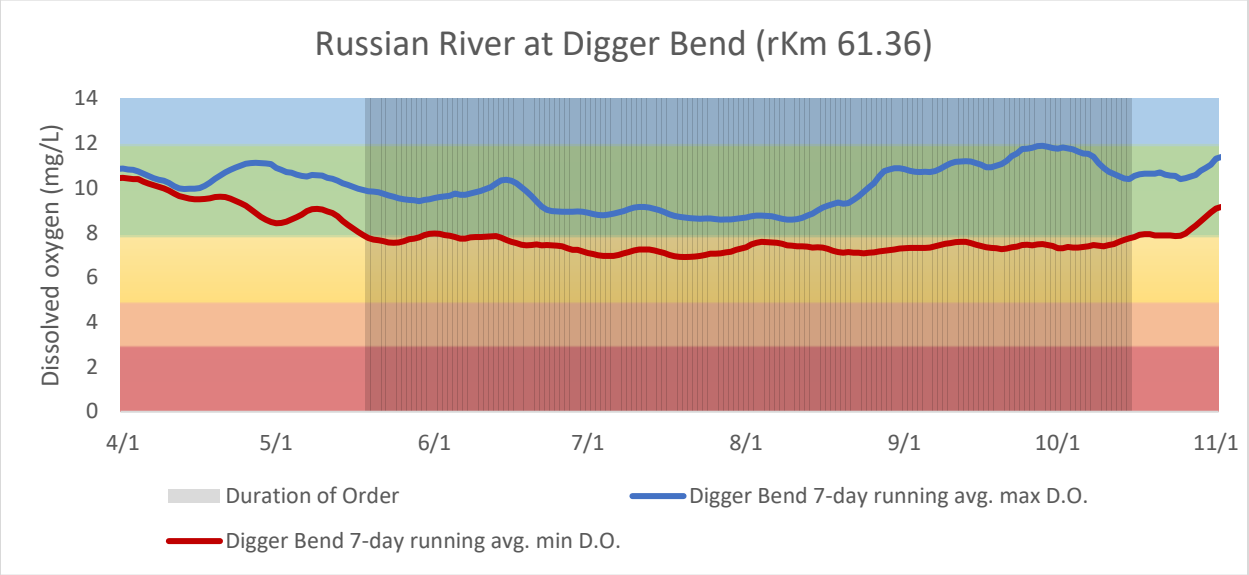


Figure 4-32. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

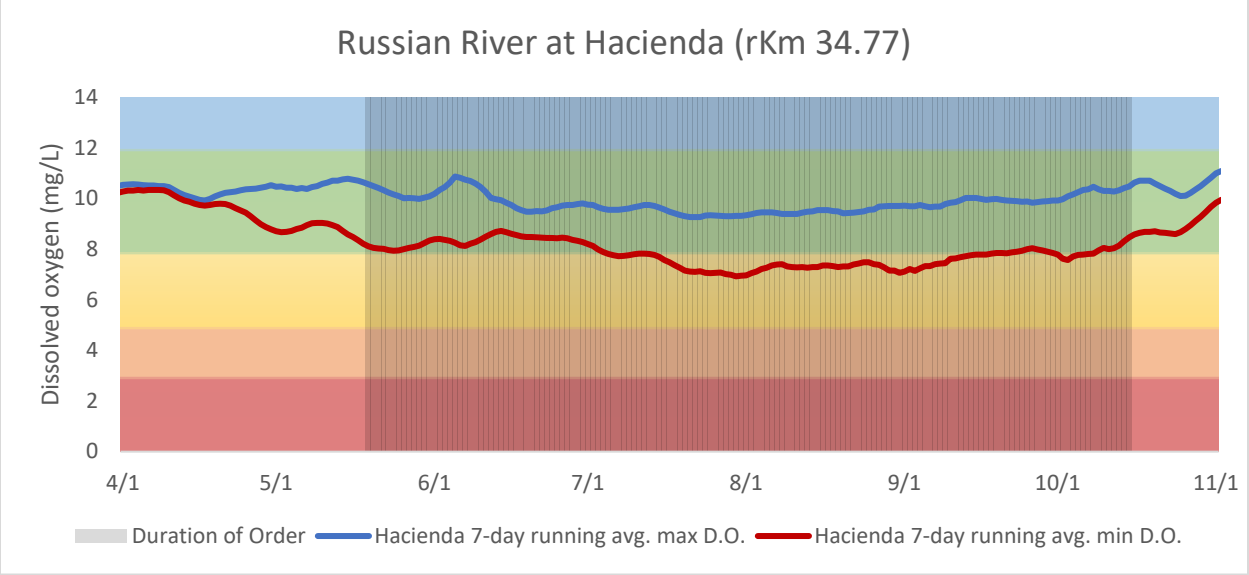


Figure 4-33. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Hacienda USGS stream gage (1146700) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

4.2.5 Summary

When Chinook were expected to begin migrating upstream in 2023, water temperature at Hacienda was acutely stressful, but temperature changed to suitable and optimal by mid-October when the bulk of adult Chinook typically enter the river. Water temperatures at sites upstream of Hacienda followed a similar trend where temperatures were acutely stressful, or stressful early in the migration period as water temperature dropped as air temperatures decreased. While temperatures were occasionally unfavorable for adult salmonids it is important to note that Chinook adults in the Russian River do not begin upstream migration until water temperatures begin to cool in the fall.

For juvenile Chinook, water temperatures were favorable for rearing in the early spring at most sites before the Order went into effect but became unfavorable by the end of the rearing season. Fish that remained in the river and emigrated as smolts late in the rearing season encountered unfavorable water temperatures as they moved downstream and out to sea. It is important to note that the vast majority of Chinook smolts have emigrated by mid-June before water temperatures begin to rise to stressful levels.

For steelhead rearing, water temperatures in the east fork Russian River were optimal. Water temperature in the east fork Russian River was cooler in 2023 when compared to 2021 (Figure 4-34). This is due to significantly improved water quality conditions in Lake Mendocino in 2023 when compared to 2021 when the watershed was experiencing a significant drought. The maximum weekly maximum temperature (MWMT) from the months of June through October appears to be related to storage in Lake Mendocino (Figure 4-35). At Hopland and Pieta, water temperatures for steelhead rearing were generally optimal to suitable.

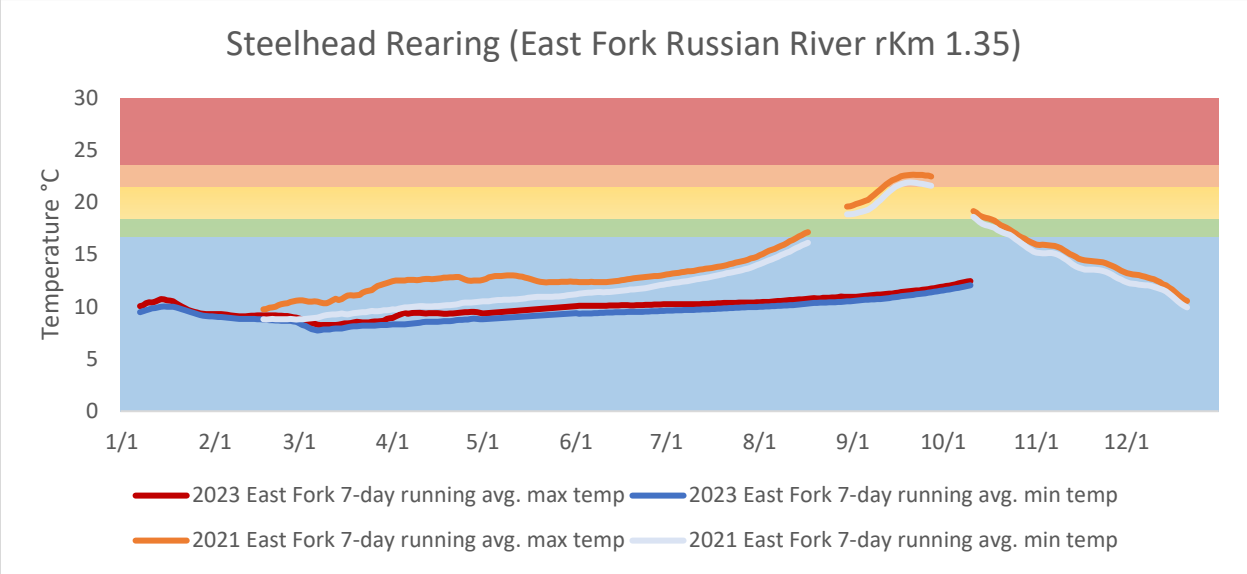


Figure 4-34. The 7-day running average of the minimum and maximum water temperatures collected in the East fork of the Russian River 0.5 km downstream of Coyote Valley Dam in 2021 and 2022. Shown with optimal, suitable, stressful, acutely stressful and potentially lethal water temperature zones for steelhead rearing based on Table 4-2.

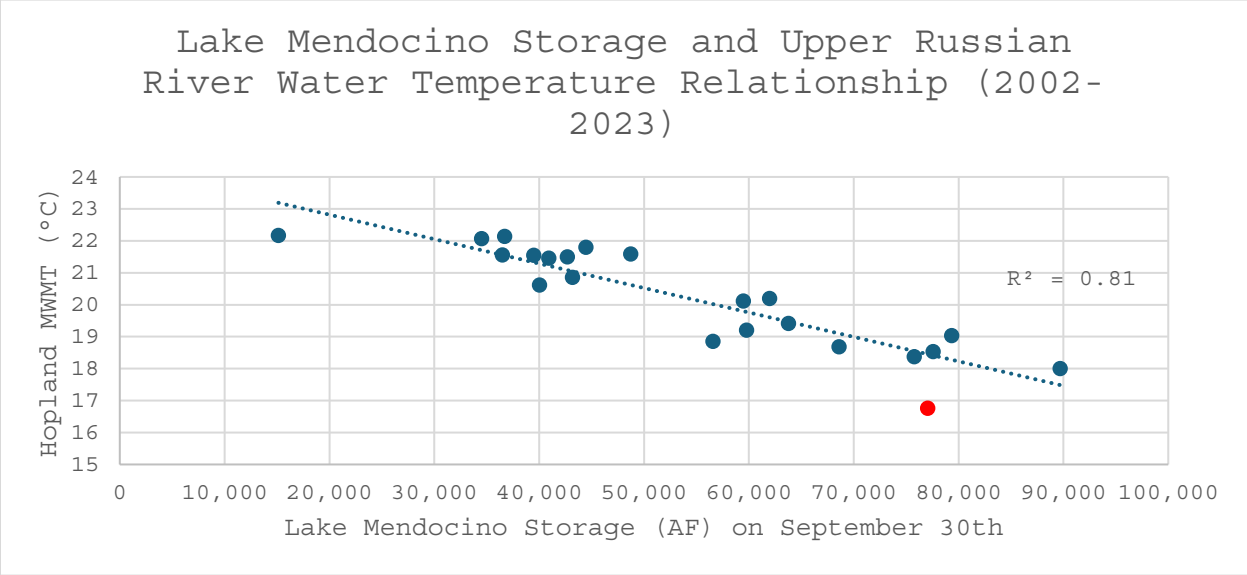


Figure 4-35. The maximum weekly maximum temperature (MWMT) at Hopland (USGS stream gage number 11462500) for the months of September through October and Lake Mendocino storage in acer feet (AF) on September 30th. For the years 2002 through 2023. Year 2023 is shown in red.

Chinook salmon experienced suitable to acutely stressful water temperatures for smolt migration at Hopland and at the confluence with Pieta Creek. Water temperatures became acutely stressful mid-June at the downstream monitoring sites; however, many Chinook smolts emigrate from the Russian River prior to mid-June when water temperatures are more favorable.

DO was poor during the Order in the east fork of the Russian River. The east fork data sonde is located 0.5 km downstream from the outlet of Coyote Valley Dam. DO usually recovers near the confluence with the west fork of the Russian River (based on limited data collected in the past by Sonoma Water). The 7-day running average of the minimum DO was suitable for salmonids at Hopland and in the Russian river near the confluence with Pieta Creek. At Jimtown, and Digger bend the 7-day running average of the minimum DO was often stressful. At Hacienda, the 7-day running average of the minimum DO was generally suitable for salmonids.

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