Sonoma Water

April 1, 2022

Attn: Mr. Erik Ekdahl
Deputy Director of Water Rights
State Water Resources Control Board
Division of Water Rights
P.O. Box 2000
Sacramento, CA 95812-2000

VIA EMAIL

RE: Reporting Requirements for Term 7 of the State Water Resources Control Board Order 2021-0056-EXEC (June 14, 2021)

Dear Mr. Ekdahl:

In accordance with the requirements of the State Water Resources Control Board Order 2021-0056-EXEC received June 14, 2021 that approved the Temporary Urgency Change Petitions for water-right Permits 12947A, 12949, 12950, and 16596 (Applications 12919A, 15736, 15737, and 19351), please accept the submittal of the following enclosed report by Sonoma Water:

- Term 7 – Water Quality Monitoring Activities Summary Report

If you have any questions about the report, please do not hesitate to contact me at Shiyu.Xin@scwa.ca.gov.

Sincerely,

Shiyu Xin

Shiyu Xin
Water Agency Engineer I

Enclosures

c: S. Boland-Brien, J. Ling - State Water Resources Control Board, Division of Water Rights
G. Davis, J. Jasperse, P. Jeane, D. Seymour, J. Martini-Lamb, D. Manning - Sonoma Water
C. O'Donnell, A. Brand - Sonoma County Counsel
R. Bezerra - Bartkiewicz, Kronick & Shanahan
R. Coey, J. Fuller – National Marine Fisheries Service
M. Kittel - California Department of Fish & Wildlife
M. St. John, B. McFadin – North Coast Regional Water Quality Control Board
E. Salomone – Mendocino County Russian River FCWCID

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Russian River Water Quality Summary for the 2021 Temporary Urgency Change

Sonoma Water

March 2022

American Disabilities Act Compliance

This report for Sonoma Water's Russian River Water Quality Summary for the 2021 Temporary Urgency Change has been prepared to be compliant with requirements under the Americans with Disabilities Act (ADA). The ADA mandates that reasonable accommodations be made to reduce "discrimination on the basis of disability." As such, Sonoma Water is committed to ensuring that documents we make publicly available online are accessible to potential users with disabilities, particularly blind or visually impaired users who make use of screen reading technology.

This disclaimer is provided to advise that portions of the document, including the figures, charts, and graphics included in the document are non-convertible material, and could not reasonably be adjusted to be fully compliant with ADA regulations. For assistance with this data or information, please contact Sonoma Water at (707) 526-5370 and reference the Russian River Water Quality Summary for the 2021 Temporary Urgency Change Project, dated March 2022.

Contents

1.0 Introduction

On 14 May 2021, the Sonoma County Water Agency (Sonoma Water) filed Temporary Urgency Change Petitions (TUCPs) with the State Water Resources Control Board (SWRCB) to approve temporary reductions to minimum instream flows in the Russian River, to address the current dry conditions in the Russian River Watershed and the extreme low storage conditions in Lake Mendocino, and to meet the terms and conditions of the Russian River Biological Opinion (NMFS, 2008).

In summary, the SWRCB approved the following temporary changes to the Decision 1610 (D1610) instream flow requirements from 14 June 2021 through 11 December 2021 to the following:

(1) Minimum instream flow in the Upper Russian River (from its confluence of the East and West Forks of the Russian River to its confluence with Dry Creek) shall remain at or above 25 cubic feet per second (cfs), as measured on a five-day running average of average daily stream flow.

(2) Minimum instream flow in the Lower Russian River (from its confluence with Dry Creek to the Pacific Ocean) shall remain at or above 35 cfs, as measured on a five-day running average of average daily stream flow.

(3) Sonoma Water shall pass through or release sufficient water to maintain a continuous, instantaneous streamflow of no less than 15 cfs in the Upper Russian River and no less than 25 cfs in the Lower Russian River at all times.

Approval of the TUCP will increase storage levels in Lake Mendocino in the fall, which will be used for releases of stored water to benefit returning adult Chinook salmon, and improve the likelihood of carryover storage for use in 2022 in the event 2022 is also a dry year. The SWRCB issued the Order (Order) approving Sonoma Water's TUCP on 14 June 2021.

2.0 2021 Russian River Flow Summary

In early January 2021, following a dry fall and winter in 2020, water storage levels in Lake Mendocino were below 28,500 acre-feet, which is similar to storage levels experienced in 2014, a dry water year. Overall storage in 2021 was the lowest in the last ten years of monitoring. In addition, storage only increased by about 8,000 acre-feet through the months of February and March due to less than normal rainfall, and by April 2020 storage levels were below drought levels observed in 2014 and would remain that way the rest of the year (Figure 2-1). Storage in Lake Mendocino peaked in early May at just under 37,000 acre-feet, and dropped below 25,000 acre-feet by 1 August and below 13,000 acre-feet by late-October. However, with significant rainfall beginning in late October and continuing through the months of November and December, storage levels partially recovered and were approximately 41,000 acre-feet by 31 December (Figure 2-1).

The 2021 average daily flows at the Talmage, Hopland, Cloverdale, Jimtown, Digger Bend, and Hacienda U.S. Geological Survey (USGS) gaging stations are shown in Figure 2-2.

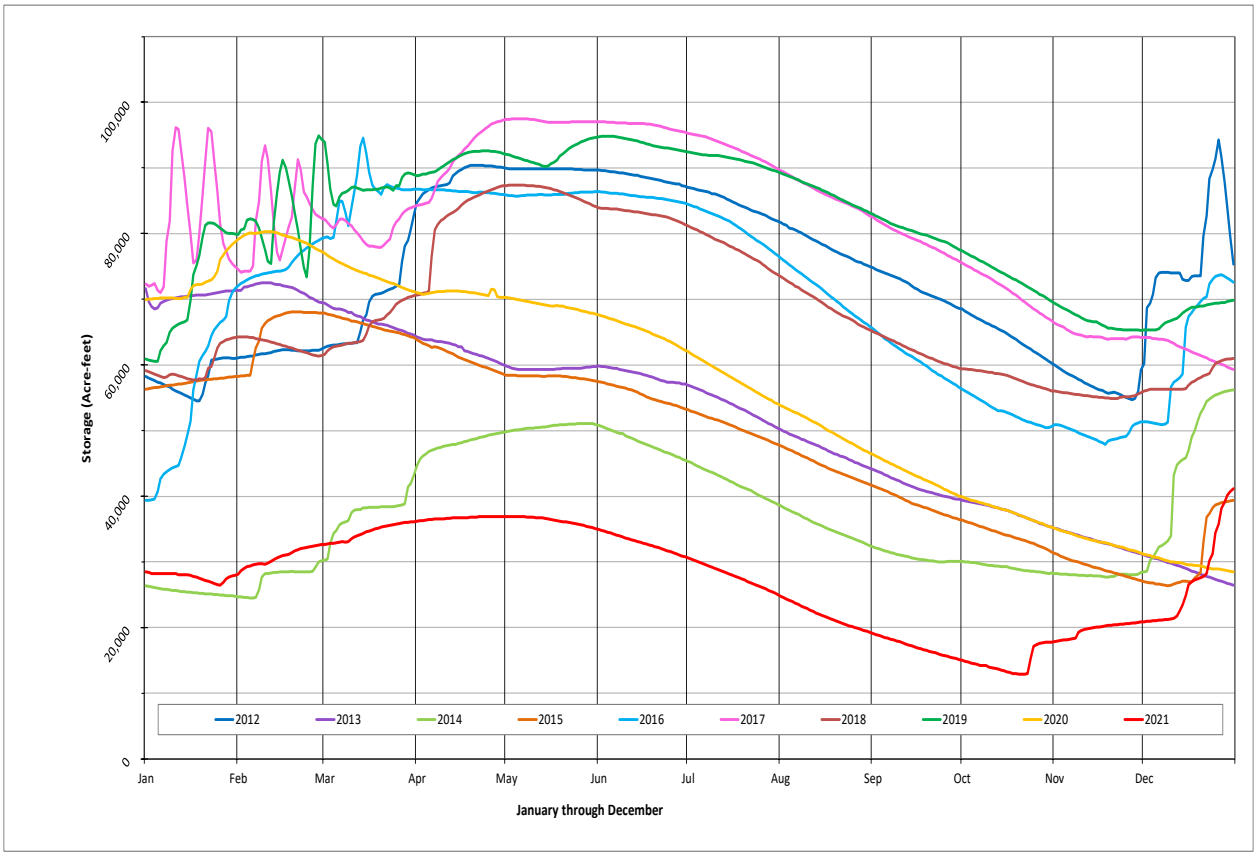

Figure 2-1. Lake Mendocino water storage levels, in acre-feet, from 2012 through 2021.

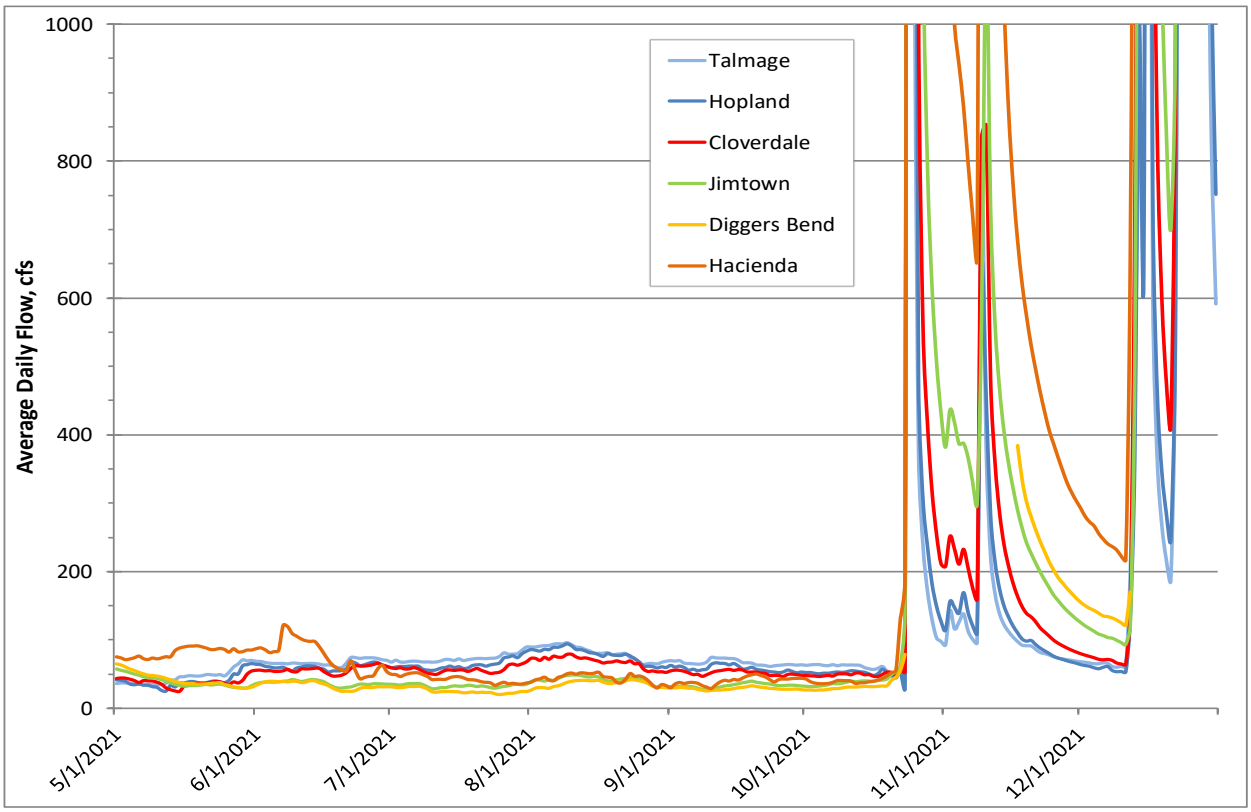

Figure 2-2. 2021 average daily flows in the Russian River as measured at U.S. Geological Survey (USGS) gages in cubic feet per second (cfs). Flow rates are preliminary and subject to final revision by USGS.

The changes in upper Russian River minimum instream flow requirements authorized by the Order allowed flows to decline below D1610 minimum instream flows of 75 cfs for most of the monitoring season (Figure 2-3). Additionally, upper Russian River flows did briefly decline below the TUC minimum daily average flows of 25 cfs at the Diggers Bend station, but did not drop below the instantaneous minimum flow of 15 cfs authorized by the Order (Figure 2-3).

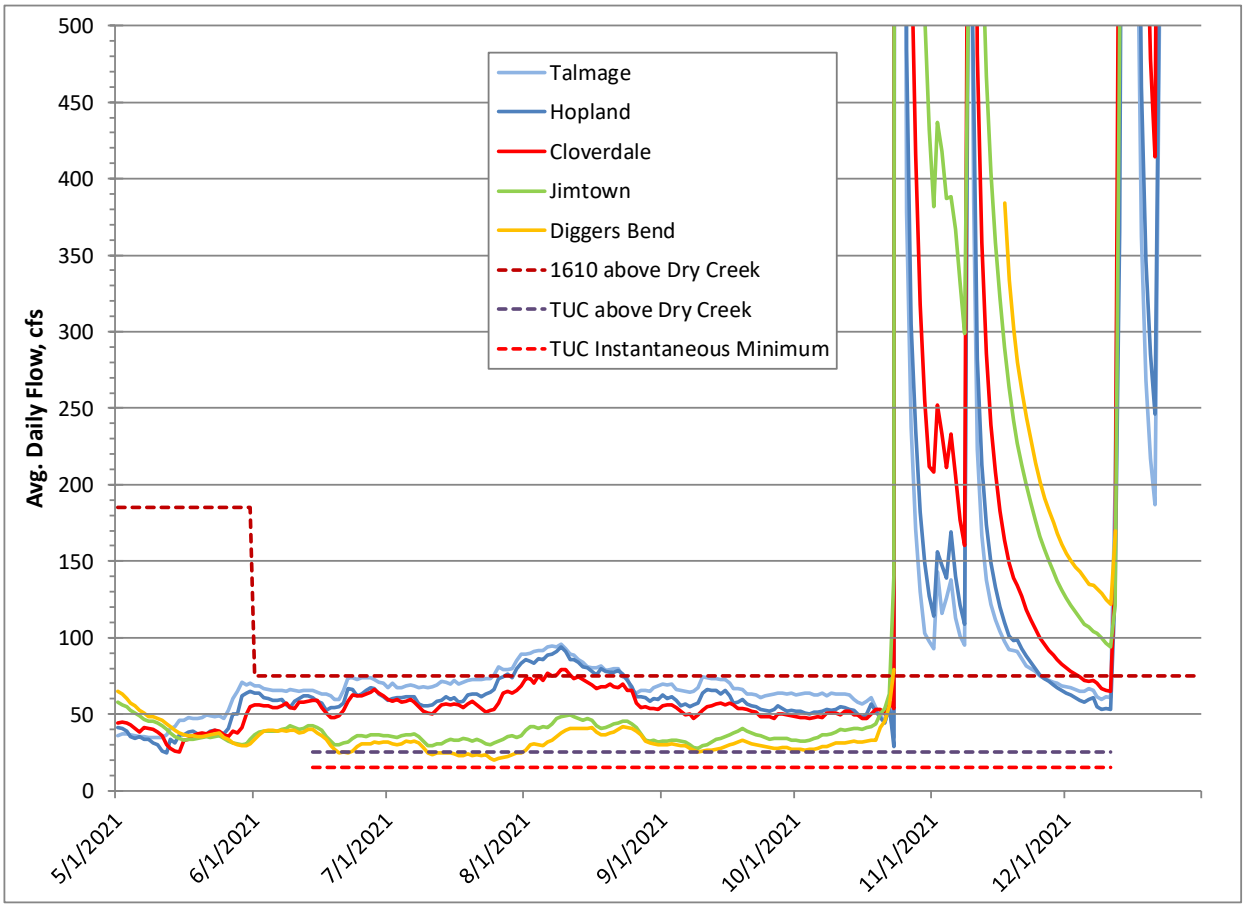

Figure 2-3. 2021 average daily flows in the upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

The changes in lower Russian River minimum instream flow requirements authorized by the Order allowed flows at Hacienda to decline below D1610 minimum instream flows of 85 cfs for most of the monitoring season (Figure 2-4). Additionally, lower Russian River flows did briefly decline below the TUC minimum daily average flows of 35 cfs at Hacienda, but did not drop below the instantaneous minimum flow of 25 cfs authorized by the Order (Figure 2-4).

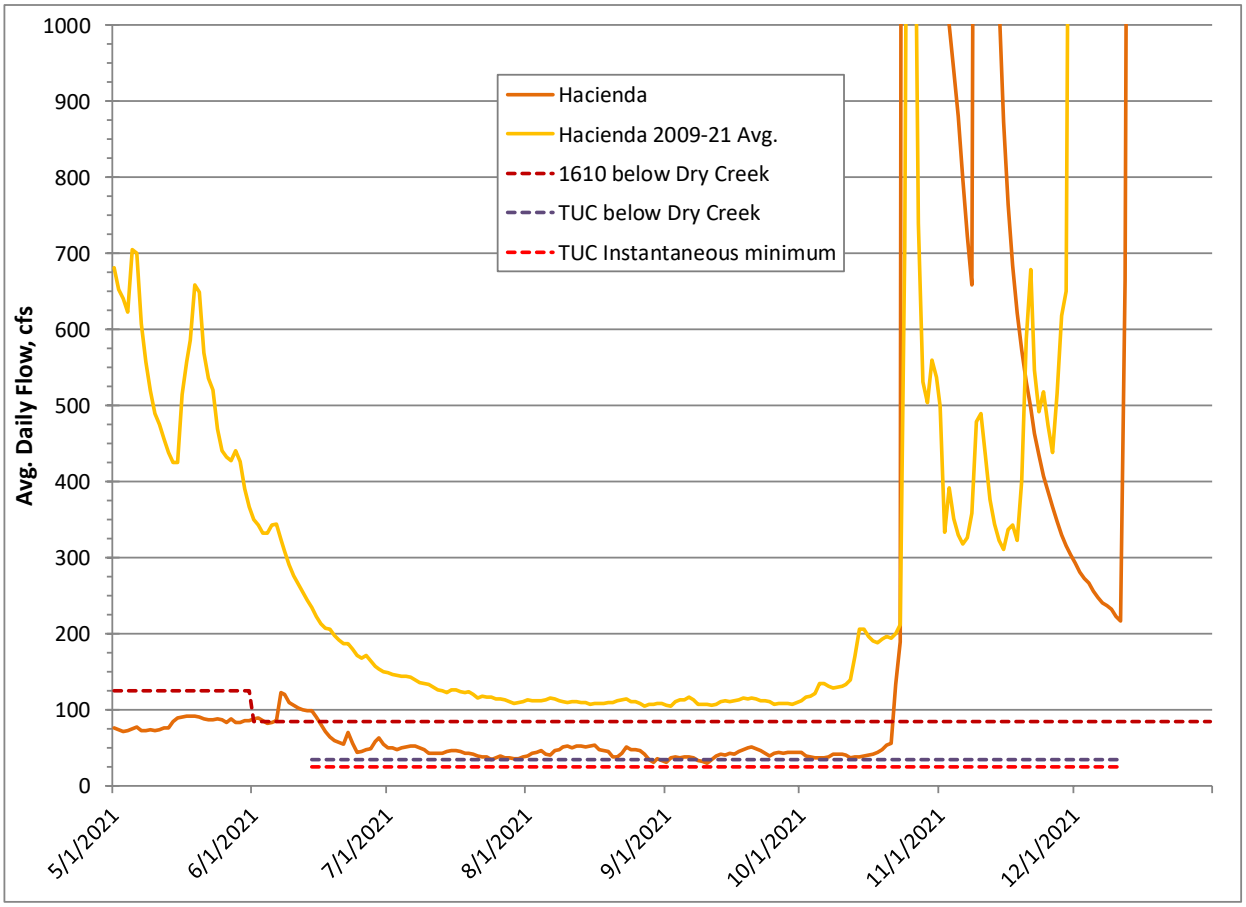

Figure 2-4. 2021 average daily flows in the lower Russian River as measured at USGS gages below the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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.

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 2021, Sonoma Water staff added East Fork Russian River and Lake Mendocino monitoring to their overall TUCP monitoring effort to provide a better understanding of lake limnology and potential effects on water quality in the upper Russian River mainstem.

In 2021, 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 2021 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 17 May and continued until 20 September. 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 several exceedances throughout the season at Cloverdale River Park of the SSM for Total Coliform. There were also three (3) exceedances each of the Total Coliform SSM at the Johnson's Beach and Monte Rio Beach stations. There was one (1) exceedance of the BAV for *E. coli* that occurred at Camp Rose Beach on 20 September. There were three (3) exceedances of the BAV for *E. coli* that occurred at Johnson's Beach that generally corresponded with the timing of the exceedances of the Total Coliform SSM. Finally, there were four (4) exceedances of the BAV for *E. coli* that occurred at Monte Rio Beach that also generally corresponded with the timing of the exceedances of the Total Coliform SSM. 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, 2021a). The 2021 seasonal results are shown in Table 3-1 and in Figures 3-1 and 3-2.

Table 3-1. Sonoma County DHS 2021 Seasonal Mainstem Bacteria Sampling Results (Sonoma County DHS, 2021a).

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
17-May-21	15531*	52	1,414	10	932	20	860	52	457	<10	789	<10	813	31	670	52	2,014	108	1,664	41
18-May-21	>24196	31																		
24-May-21	8,164	10	521	<10	1,071	<10	410	10	420	31	959	<10	798	20	512	<10	906	41	857	20
1-Jun-21	12033*	41	1,374	169	2,480	20	1,211	10	504	20	860	30	1,014	20	2,909	10	2,481	41	1,076	<10
3-Jun-21	11,199	10																		
7-Jun-21	10,462	20	2,500	20	2,481	31	2,014	195	546	31	910	10	1,789	20	1,918	10	703	31	959	<10
14-Jun-21	11,199	52	2,755	63	5,794	41	2,909	63	616	20	820	20	1,500	52	1,455	20	1,607	20	1,430	30
21-Jun-21	14,136	10	1,860	41	3,448	156	1,153	52	934	30	3,448	41	1,515	20	8,664	218	11199*	1782*	1,785	<10
22-Jun-21																	2,909	20		
28-Jun-21	4,884	<10	1,553	10	2,909	20	1,296	75	1,674	20	4,106	31	2,909	52	6,488	110	4,106	763*	1,354	<10
30-Jun-21																	12,997	9,804		
6-Jul-21	7,701	31	2,247	10	2,909	<10	2,359	20	2,046	<10	3,873	10	4,106	41	5,794	30	1,725	20	1,782	10
12-Jul-21	15,531	10	1,842	72	4,611	20	2,613	10	1,785	30	6,131	31	2,613	31	7,701	110	1,314	10	1,850	61
19-Jul-21	7,270*	20	1,597	<10	1,664	<10	882	10	1,250	20	2,755	<10	2,359	20	9,208	<10	2,613	132	2,187	<10
20-Jul-21	4,352	85																		
26-Jul-21	15,531	<10	1,576	10	2,603	<10	1,274	10	1,515	<10	4,106	10	1,722	20	2,247	<10	2,098	31	1,467	<10
2-Aug-21	9,208	62	1,529	10	2,909	<10	886	10	1,246	31	3,255	52	1,616	<10	7,270	364*	1,607	233	1,789	10
3-Aug-21															24,196	388				
9-Aug-21	8,164	<10	1,483	20	2,755	10	1,789	189	1,664	10	3,255	10	2,310	31	2,046	41	1,989	20	1,785	98
16-Aug-21	19,863	52	2,143	<10	2,909	<10	958	<10	2,359	20	3,873	31	4,106	31	3,076	216	1,439	20	908	20
23-Aug-21	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
25-Aug-21	12,997	75	1,989	10	1,850	20	2,098	<10	1,153	10	1,860	<10	1,725	10	1,223	10	1,515	41	1,376	20
7-Sep-21	12,997	52	1,935	10	1,785	10	2,098	31	2,282	20	4,352	199	2,603	20	1,314	<10	1,236	10	2,851	<10
13-Sep-21	9,208	<10	1,414	10	3,873	10	2,282	20	1,539	20	1,872	20	2,755	20	>24,196	265	1,050	<10	1,333	52
20-Sep-21	3,873	20	1,722	31	5,475	1,274	1,565	75	712	20	2,247	20	1,529	10	11,199	110	>24,196	246	1,565	<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

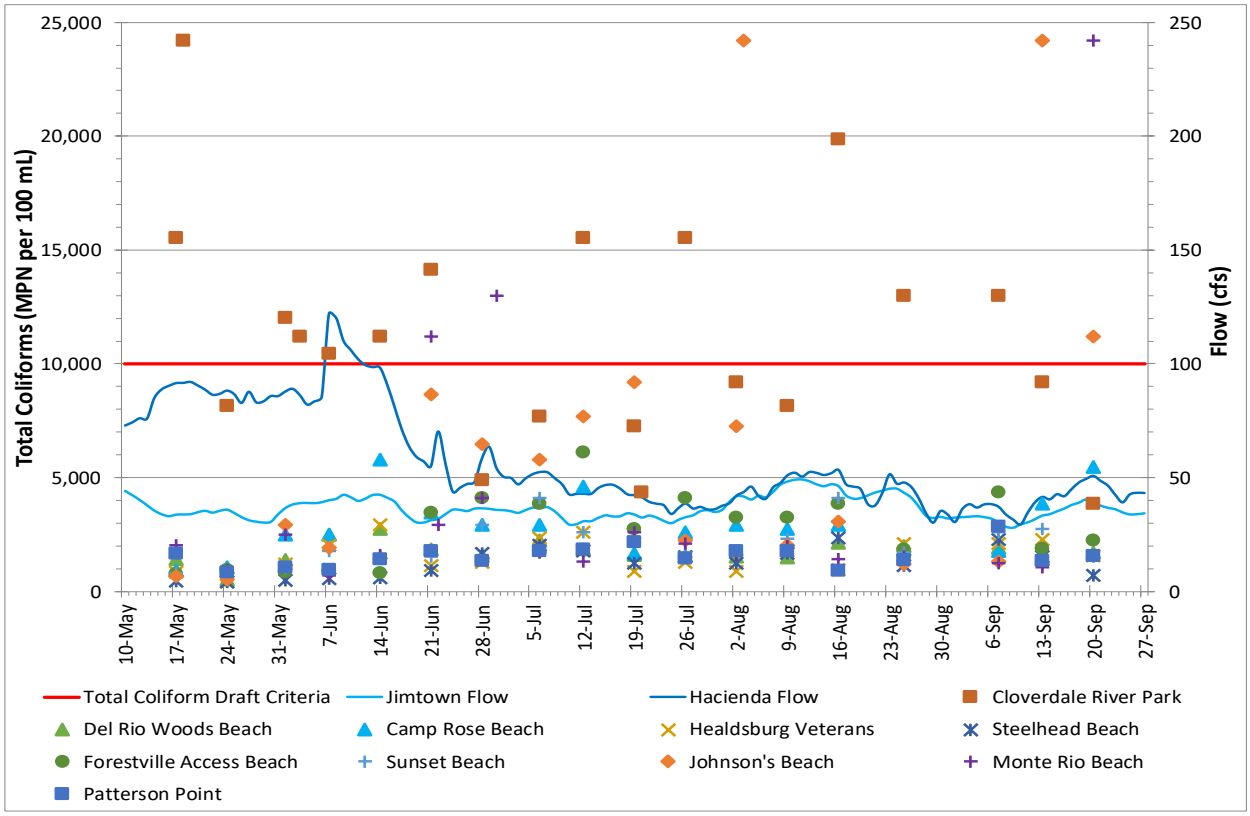

Figure 3-1. Sonoma County DHS 2021 Seasonal Mainstem Russian River Bacteria Sample Results for Total Coliform. Flow rates are preliminary and subject to final revision by USGS.

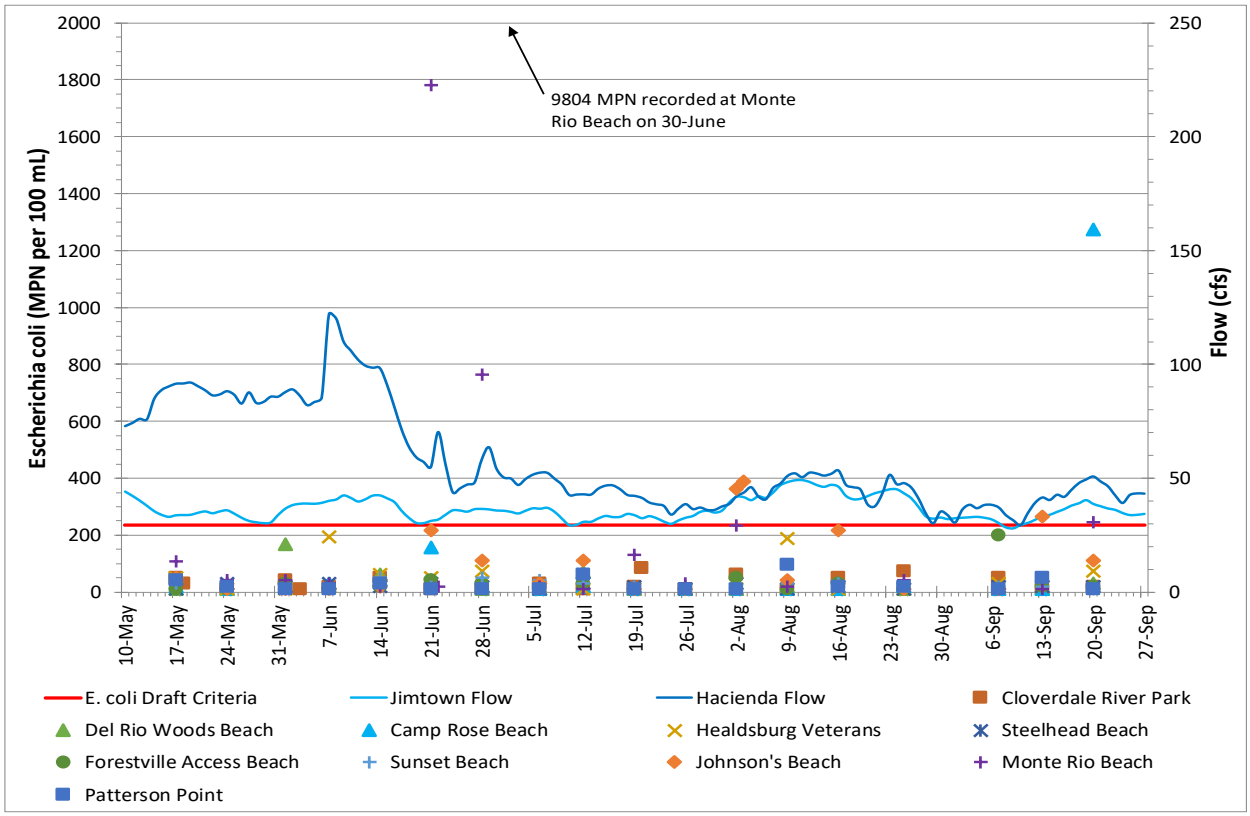

Figure 3-2. Sonoma County DHS 2021 Seasonal Mainstem Russian River Bacteria Sample Results for *E. coli*. Flow rates are preliminary and subject to final revision by USGS.

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

The Sonoma County DHS did not conduct seasonal cyanotoxin sampling in 2021 (Sonoma County DHS, 2021b).

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

Lake Mendocino Vertical Profiles

In 2021, Sonoma Water staff collected vertical profiles at Lake Mendocino near the dam using a datasonde. Vertical profiles were collected for temperature, dissolved oxygen, and turbidity between March and November as weather and access allowed, including biweekly monitoring from April through October. Vertical profiling was conducted in large part to track the timing and strength of stratification of the lake into a three layered system 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 layer in the spring as surface temperatures begin to rise with increasing air temperatures, creating a stratified lake system. 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 to begin in early April and break down into a mixed system in September. Turbidity values were generally observed to be higher in the hypolimnion than in the epilimnion (Figure 3-5).

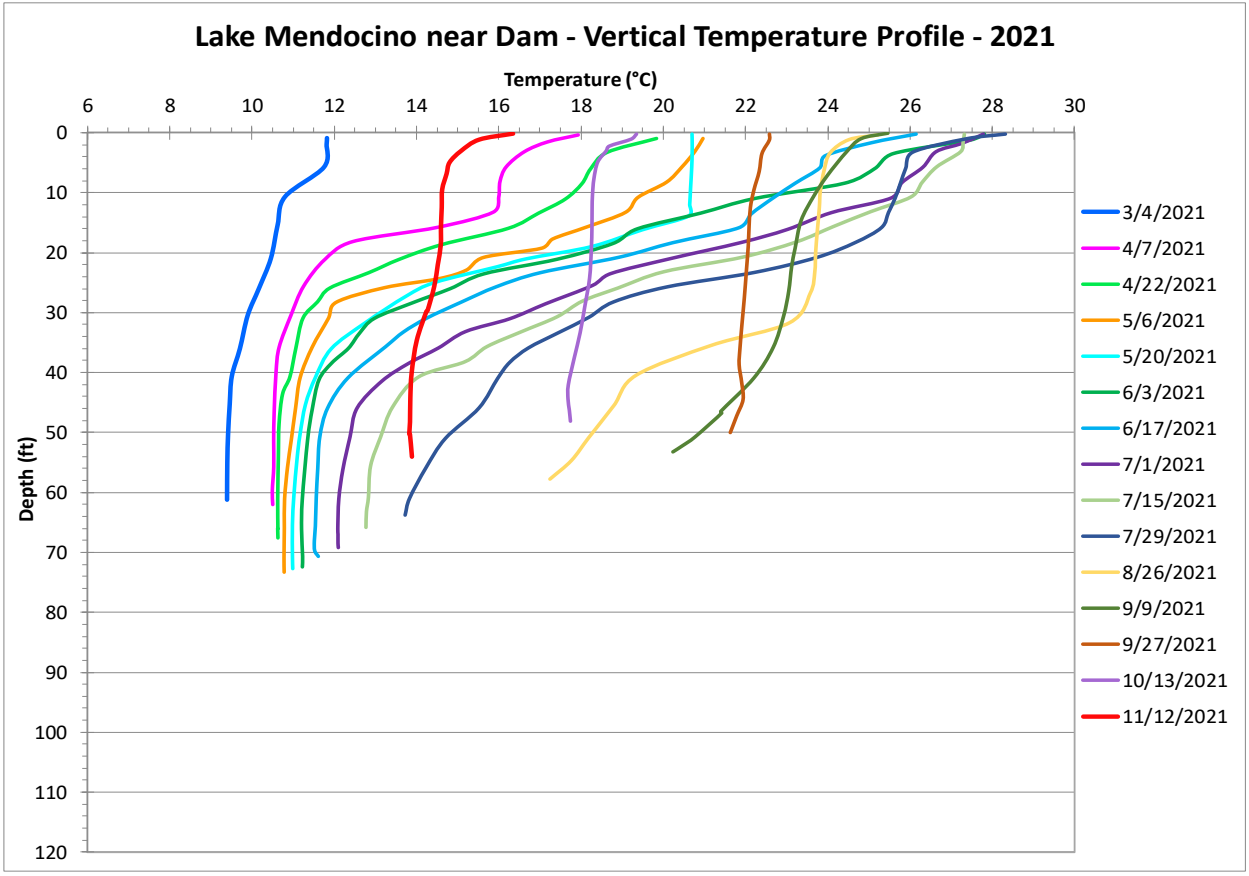

Figure 3-3. Sonoma Water 2021 Vertical Temperature Profiles of Lake Mendocino near the Dam.

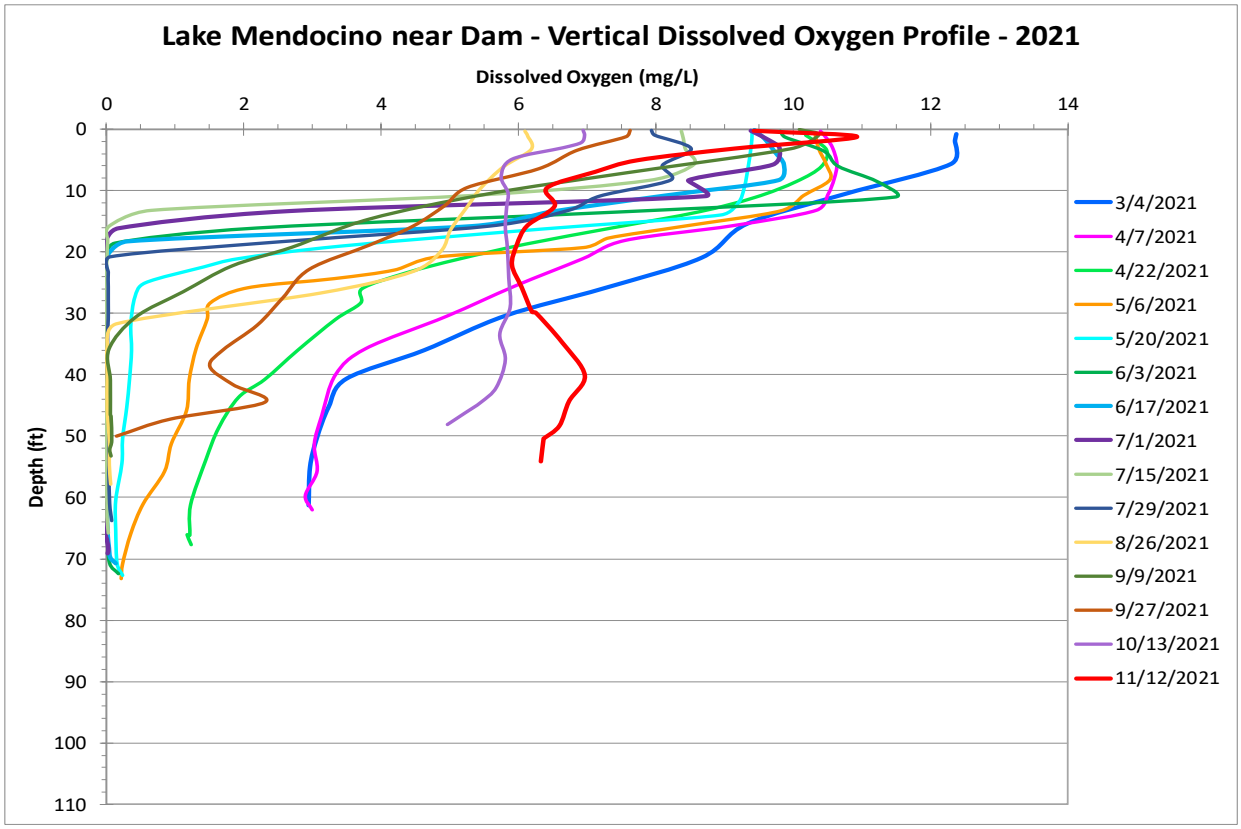

Figure 3-4. Sonoma Water 2021 Vertical Dissolved Oxygen Profiles of Lake Mendocino near the Dam.

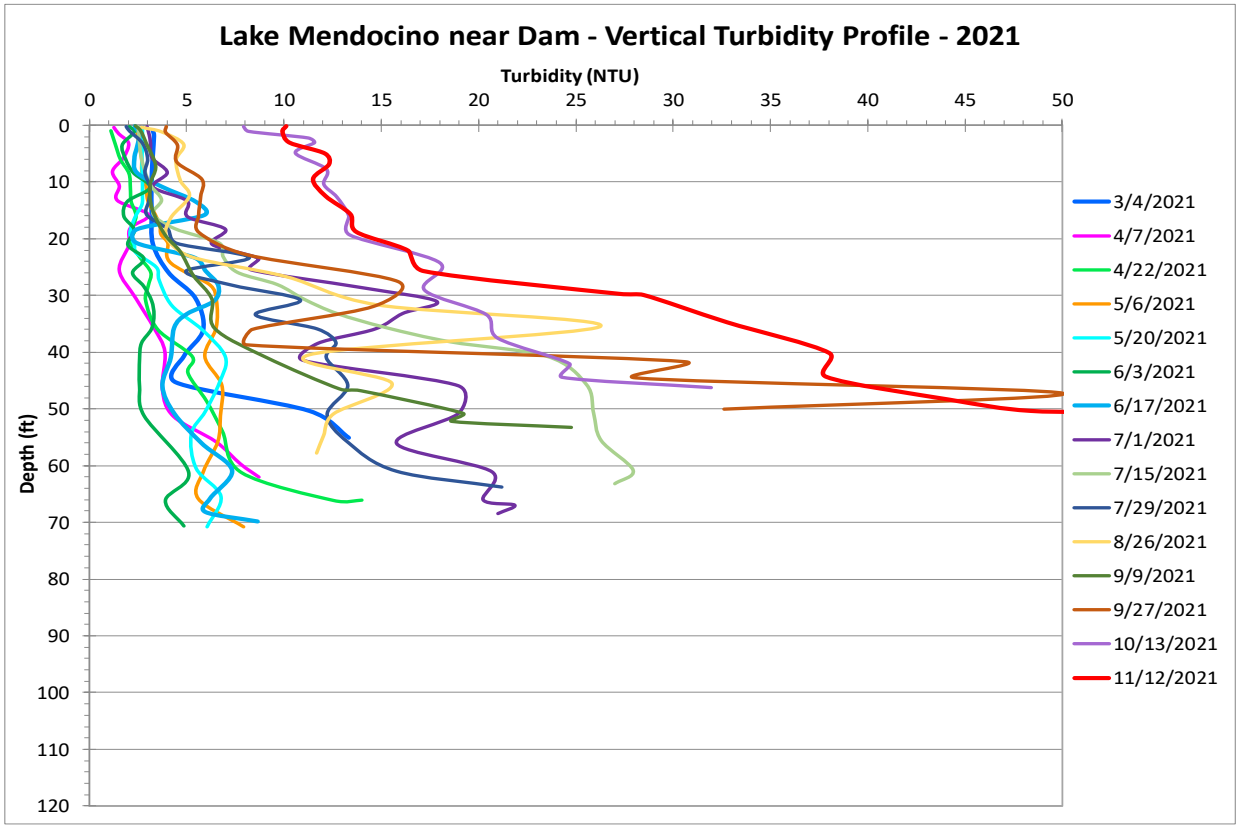

Figure 3-5. Water Vertical 2021 Turbidity Profiles of Lake Mendocino near the Dam.

Lake Mendocino and East Fork Russian River Grab Sampling

Sonoma Water staff generally conducted nutrient grab sampling on a bi-weekly 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. However, sampling frequency at Lake Mendocino was affected by low water levels that restricted access beginning in the late summer through December. Nutrient grab samples were also generally collected bi-weekly 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,* 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.

The sampling results for total nitrogen, total phosphorus, turbidity, and *chlorophyll a* are discussed below and summarized in Tables 3-2 through 3-4 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, 2021).

Highlighted values for 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 2021 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.

Highlighted values for 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 fourteen (14) times, representing 43.8% of the total samples collected (14 out of 32) at the upper and lower East Fork Russian River stations (Tables 3-2 and 3-4, and Figure 3-6). The EPA criteria for lakes and reservoirs was exceeded three (3) times, representing 11.1% of the total samples collected (3 out of 27) in Lake Mendocino during the monitoring effort (Table 3-3).

The East Fork Calpella station had five (5) exceedances of the total nitrogen criteria out of 16 samples collected (31.3%), under flows that ranged from 10.1 cfs to 84.3 cfs (Table 3-2 and Figure 3-6). The maximum concentration measured 0.80 mg/L on 12 November with a flow of 84.3 cfs (Table 3-2). The minimum concentration was 0.05 mg/L, which occurred on 26 August with a flow of 10.9 cfs. Nitrogen values were observed to generally decline in the spring at Calpella then increase through the fall. However, concentrations were also observed to fluctuate during the spring and summer months.

Table 3-2. Sonoma Water 2021 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	0.50	0.010	0.030	0.600	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)
3/4/2021	13:20	9.4	7.8	0.33	ND	ND	0.15	ND	ND	**0.48**	0.018	0.030	1.72	1.99	140	1.2	ND	59.8
4/7/2021	10:50	12.9	7.6	ND	ND	ND	0.085	ND	ND	0.09	0.015	ND	1.48	1.89	120	0.64	ND	55.4
4/22/2021	12:50	14.9	7.6	ND	ND	ND	0.075	ND	ND	0.08	**0.027**	0.053	1.75	2.11	130	1.0	ND	46.0
5/6/2021	14:00	17.7	8.3	0.26	ND	ND	0.14	ND	0.26	**0.40**	**0.047**	0.10	2.48	3.06	150	1.3	ND	28.0
5/20/2021	11:30	15.3	8.1	0.18	ND	ND	0.092	ND	ND	0.27	**0.040**	0.077	2.04	2.58	150	0.94	ND	27.5
6/3/2021	14:10	22.9	8.3	0.18	ND	ND	0.099	ND	ND	0.28	**0.066**	0.15	2.49	2.54	140	0.38	ND	19.5
6/17/2021	13:50	21.9	8.2	ND	ND	ND	0.093	ND	ND	0.09	**0.059**	0.13	1.92	2.33	160	0.97	ND	12.0
7/1/2021	14:00	24.2	8.1	0.18	ND	ND	0.16	ND	ND	0.34	**0.086**	0.21	2.07	2.62	170	0.68	**0.0051**	13.3
7/15/2021	14:10	24.1	8.2	0.26	ND	ND	0.095	ND	0.26	0.36	**0.087**	0.20	2.16	2.67	170	0.34	ND	11.5
7/29/2021	14:00	24.4	8.2	0.18	ND	ND	0.071	ND	ND	0.25	**0.067**	0.16	2.39	2.62	170	0.41	ND	8.84
8/12/2021	12:40	22.2	8.1	ND	ND	ND	0.15	ND	ND	0.33	**0.071**	0.16	2.15	2.70	170	0.94	ND	9.30
8/26/2021	13:50	20.2	8.1	ND	ND	0.0034	0.050	ND	ND	0.05	**0.070**	0.15	1.93	2.36	170	1.3	ND	10.9
9/9/2021	14:00	21.1	8.0	0.26	ND	ND	0.066	ND	0.26	0.33	**0.064**	0.16	2.62	3.44	160	1.5	ND	15.6
9/27/2021	13:10	17.0	7.9	0.26	ND	ND	0.18	ND	0.26	**0.44**	**0.055**	0.12	2.32	2.78	160	1.0	ND	16.3
10/13/2021	13:10	12.4	7.9	0.44	ND	ND	0.083	ND	0.44	**0.52**	**0.043**	0.094	1.78	2.17	170	0.96	**0.0075**	10.1
11/12/2021	14:00	13.1	7.7	0.39	ND	ND	0.41	ND	0.38	**0.80**	**0.049**	0.098	4.15	4.85	140	**5.2**	ND	84.3

* 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 two (2) exceedances of the total nitrogen criteria out of nine (9) samples collected (22.2%) at a depth of 5 feet (Table 3-3). The maximum concentration measured 0.44 mg/L, which occurred twice on 4 March and on 17 June (Table 3-3 and Figure 3-6). The minimum concentration was 0.06 mg/L, which occurred on 1 July at a depth of 5 feet.

Table 3-3. Sonoma Water 2021 Seasonal Grab Sampling Results at Lake Mendocino.

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	0.50	0.010	0.030	0.600	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
3/4/2021	15:30	11.8	8.2	0.44	ND	ND	ND	ND	0.44	**0.44**	**0.030**	ND	2.46	2.63	220	4.8	**0.017**	5
4/7/2021	13:30	16.0	8.6	0.26	ND	ND	0.046	ND	0.26	0.31	**0.029**	ND	2.24	2.54	130	3.2	**0.0056**	5
4/22/2021	14:40	18.2	8.7	0.26	ND	ND	ND	ND	0.26	0.26	**0.031**	ND	2.41	2.86	140	2.9	**0.0037**	5
5/6/2021	13:20	20.5	8.9	0.26	ND	ND	ND	ND	0.26	0.26	**0.027**	ND	2.76	3.53	130	3.2	**0.0051**	5
6/3/2021	12:50	25.2	9.0	0.35	ND	ND	ND	ND	0.35	0.35	**0.025**	ND	2.82	3.47	140	3.3	**0.0040**	5
6/17/2021	12:40	23.8	8.9	0.44	ND	ND	ND	ND	0.44	**0.44**	**0.030**	ND	3.09	3.71	140	4.0	**0.0067**	5
7/1/2021	12:40	26.3	8.9	ND	ND	ND	0.057	ND	ND	0.06	**0.031**	ND	3.00	3.75	150	4.5	**0.011**	5
7/15/2021	13:00	26.7	8.9	0.35	ND	ND	ND	ND	0.35	0.38	**0.034**	ND	2.88	3.33	150	1.9	**0.012**	5
7/29/2021	12:50	25.9	8.6	0.26	ND	ND	ND	ND	0.26	0.26	**0.039**	ND	3.09	3.12	160	4.0	**0.010**	5

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	0.50	0.010	0.030	0.600	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
3/4/2021	15:20	10.2	7.2	0.26	ND	ND	ND	ND	0.26	0.26	**0.026**	ND	2.20	2.52	120	5.5	**0.0083**	25
4/7/2021	13:20	14.5	7.7	0.35	ND	ND	0.045	ND	0.35	0.38	**0.031**	ND	2.19	2.65	120	3.1	**0.0035**	15
4/22/2021	14:30	13.6	7.0	0.26	ND	ND	ND	ND	0.26	0.26	**0.020**	ND	2.00	2.52	130	3.3	**0.0040**	20
5/6/2021	13:10	15.6	7.7	0.26	ND	ND	ND	ND	0.26	0.26	**0.022**	ND	1.95	2.66	130	7.0	**0.0067**	20
6/3/2021	12:40	19.4	7.6	0.35	ND	ND	ND	ND	0.35	0.38	**0.033**	ND	2.40	2.92	1400	3.6	**0.015**	15
6/17/2021	12:30	18.9	7.3	0.26	ND	ND	ND	ND	0.26	0.26	**0.028**	ND	2.54	3.05	150	4.6	**0.0043**	20
7/1/2021	12:30	20.2	7.3	ND	ND	ND	0.058	ND	ND	0.06	**0.033**	ND	2.17	3.18	140	6.2	**0.0096**	20
7/15/2021	12:50	20.0	7.3	0.26	ND	ND	ND	ND	0.26	0.26	**0.040**	ND	2.33	2.95	140	5.6	**0.0069**	22.5
7/29/2021	12:40	20.1	7.2	0.26	ND	ND	ND	ND	0.26	0.26	**0.049**	0.058	2.58	3.00	160	10	**0.0035**	25

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	0.50	0.010	0.030	0.600	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
3/4/2021	15:10	9.4	7.0	0.26	ND	ND	ND	ND	0.26	0.26	**0.023**	ND	2.04	2.49	140	5.5	**0.0061**	50
4/7/2021	13:10	10.5	7.0	0.26	ND	ND	0.063	ND	0.26	0.32	**0.025**	ND	1.95	2.46	130	6.3	0.0032	50
4/22/2021	14:20	10.6	6.9	ND	ND	ND	0.048	ND	ND	0.05	**0.027**	0.033	1.95	2.40	130	7.7	ND	60
5/6/2021	13:00	10.8	7.1	0.18	ND	ND	0.060	ND	ND	0.24	**0.036**	0.051	1.94	2.51	140	8.4	ND	60
6/3/2021	12:30	11.2	6.7	0.26	ND	ND	ND	ND	0.26	0.26	**0.068**	0.12	1.96	2.57	140	4.8	ND	60
6/17/2021	12:20	11.6	6.9	0.26	ND	ND	ND	ND	0.26	0.26	**0.10**	0.13	2.14	2.61	150	8.8	ND	60
7/1/2021	12:20	12.1	7.1	0.44	ND	ND	0.058	ND	0.44	**0.50**	**0.14**	0.20	2.14	2.72	140	26	**0.0040**	60
7/15/2021	12:40	13.1	6.9	0.35	ND	ND	ND	ND	0.35	0.35	**0.15**	0.037	1.86	2.59	140	28	**0.0045**	50
7/29/2021	12:30	14.7	7.2	0.26	ND	ND	ND	ND	0.26	0.26	**0.11**	0.038	2.18	2.57	150	20	0.0032	50

* 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.

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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 did not have any exceedances of the total nitrogen criteria out of 9 samples collected (0%) at depths ranging from 15 to 25 feet (Table 3-3). The maximum seasonal value measured 0.38 mg/L, which occurred twice on 7 April and 3 June at a depth of 15 feet (Table 3-3 and Figure 3-6). The minimum concentration was 0.06 mg/L, which occurred on 1 July at a depth of 20 feet.

The Lake Mendocino hypolimnion had one (1) exceedance of the total nitrogen criteria out of 9 samples collected (11.1%) at depths ranging from 50 to 60 feet (Table 3-3). The maximum seasonal value measured 0.50 mg/L on 1 July at a depth of 60 feet (Table 3-3 and Figure 3-6). The minimum concentration was 0.05 mg/L, which occurred on 22 April at a depth of 60 feet.

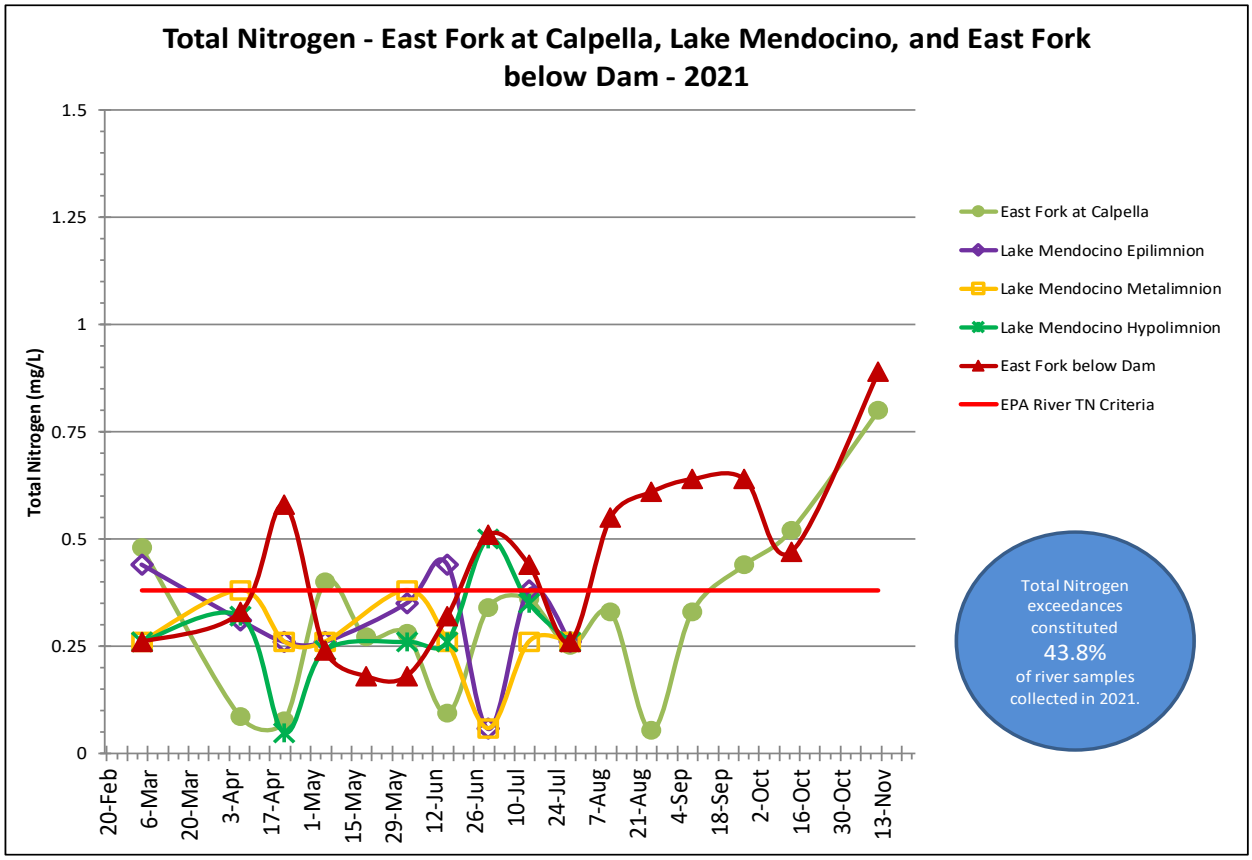


Figure 3-6. Sonoma Water Total Nitrogen results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Dam in 2021. Percent exceedances only apply to samples collected at East Fork stations.

The East Fork below Dam station had nine (9) exceedances of the total nitrogen criteria out of 16 samples collected (31.3%), under flows that ranged from 28 cfs to 109 cfs (Table 3-4 and Figure 3-6). The maximum concentration measured 0.89 mg/L on 12 November with a flow of 28 cfs (Table 3-4). The minimum concentration was 0.18 mg/L, which occurred twice on 20 May and 3 June with flows of 50 and 70 cfs, respectively. Nitrogen values were observed to generally increase during the second half of the monitoring season.

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 thirty (30) times, representing 93.8% of the total samples collected (30 out of 32) in the East Fork Russian River during the monitoring effort (Tables 3-2 and 3-4, and Figure 3-7). The total phosphorus criteria for lakes and reservoirs was exceeded twenty-seven (27) times, representing 100% of the total samples collected (27 out of 27) in Lake Mendocino during the monitoring effort (Table 3-3). The East Fork Calpella station was the only location that did not exceed the criteria in every sample during the 2021 season (Table 3-2).

Table 3-4. Sonoma Water 2021 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	0.50	0.010	0.030	0.600	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)
3/4/2021	16:00	10.0	7.3	0.26	ND	ND	ND	ND	0.26	0.26	**0.023**	ND	2.10	2.40	150	**5.3**	**0.0059**	30
4/7/2021	11:50	11.2	7.6	0.26	ND	ND	0.070	ND	0.26	0.33	**0.032**	ND	2.36	2.43	130	**5.6**	**0.0040**	28
4/22/2021	11:50	12.1	7.2	0.52	ND	ND	0.064	ND	0.52	**0.58**	**0.12**	0.033	1.98	2.62	140	**130**	**0.0053**	28
5/6/2021	11:10	11.8	7.7	0.18	ND	ND	0.062	ND	ND	0.24	**0.044**	0.084	1.94	2.43	110	**6.8**	ND	29
5/20/2021	12:30	12.0	7.6	0.18	ND	ND	ND	ND	ND	0.18	**0.053**	0.11	1.86	2.40	150	**5.4**	ND	50
6/3/2021	13:30	12.4	7.6	0.18	ND	ND	ND	ND	ND	0.18	**0.076**	0.14	1.94	2.53	140	**4.4**	**0.0032**	70
6/17/2021	13:20	12.7	7.4	0.26	ND	ND	0.064	ND	0.26	0.32	**0.085**	0.12	2.11	2.58	140	**6.3**	ND	72
7/1/2021	13:00	13.3	7.6	0.44	ND	ND	0.066	ND	0.44	**0.51**	**0.15**	0.10	2.16	2.77	140	**34**	**0.0040**	82
7/15/2021	13:30	13.8	7.2	0.44	ND	ND	ND	ND	0.44	**0.44**	**0.17**	0.054	1.90	2.61	140	**34**	**0.0035**	91
7/29/2021	13:30	15.0	7.1	0.26	ND	ND	ND	ND	0.26	0.26	**0.15**	0.058	2.16	2.36	170	**20**	ND	107
8/12/2021	11:30	16.7	7.1	0.44	ND	ND	0.11	ND	0.44	**0.55**	**0.17**	0.12	2.12	2.76	170	**14**	**0.0037**	109
8/26/2021	12:50	18.7	7.2	0.61	ND	ND	ND	ND	0.61	**0.61**	**0.23**	0.36	2.18	2.93	160	**17**	**0.0032**	82
9/9/2021	11:10	21.2	7.3	0.61	ND	ND	ND	ND	0.61	**0.64**	**0.24**	0.38	3.06	3.68	160	**15**	ND	83
9/27/2021	12:40	21.9	7.6	0.52	ND	ND	0.12	ND	0.52	**0.64**	**0.073**	0.072	3.42	3.73	230	**13**	**0.0056**	77
10/13/2021	12:50	18.1	7.7	0.44	ND	ND	ND	ND	0.44	**0.47**	**0.090**	0.050	3.09	3.41	190	**35**	**0.0064**	73
11/12/2021	13:40	14.5	7.4	0.49	ND	ND	0.40	ND	0.49	**0.89**	**0.11**	0.049	5.68	6.42	160	**60**	**0.0037**	28

* 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

Calpella exceeded the EPA criteria for a majority of the season, including 14 of 16 samples (87.5%), under flows that ranged from 8.84 cfs to 84.3 cfs (Table 3-2 and Figure 3-7). The maximum concentration measured 0.087 mg/L on 15 July with a flow of approximately 11.5 cfs (Table 3-2 and Figure 3-7). The minimum concentration was 0.015 mg/L, which occurred on 7 April with a flow of approximately 55.4 cfs. Total phosphorus values were observed to generally increase from spring into summer at Calpella then slightly decrease through the fall. Calpella experienced two small spikes in concentration during July including a value of 0.086 mg/L on1 July and 0.087 mg/L on 15 July.

The Lake Mendocino epilimnion exceeded the total phosphorus EPA criteria throughout the season (9 of 9 samples or 100%) at a sampling depth of 5 feet (Table 3-3). The maximum concentration measured 0.039 mg/L on 29 July (Table 3-3 and Figure 3-7). The minimum concentration at the Lake Mendocino epilimnion was 0.025 mg/L, which occurred on 3 June.

The Lake Mendocino metalimnion also exceeded the total phosphorus EPA criteria throughout the season (9 of 9 samples or 100%) at a sampling depth that ranged from 15 to 25 feet (Table 3-3). The maximum concentration measured 0.049 mg/L on 29 July at a depth of 25 feet (Table 3-3 and Figure 3-7). The minimum concentration at the Lake Mendocino epilimnion was 0.020 mg/L, which occurred on 22 April at a depth of 20 feet.

The Lake Mendocino hypolimnion also exceeded the total phosphorus EPA criteria throughout the season (9 of 9 samples or 100%) at a sampling depth that ranged from 50 to 60 feet (Table 3-3). The maximum concentration measured 0.15 mg/L on 15 July at a depth of 50 feet (Table 3-3 and Figure 3-7). The minimum concentration at the Lake Mendocino epilimnion was 0.023 mg/L, which occurred on 4 March at a depth of 50 feet. Total phosphorus values at the hypolimnion were observed to generally increase from spring into summer (Figure 3-7).

The East Fork below Dam exceeded the total phosphorus EPA criteria throughout the season (16 of 16 samples or 100%) at flows that ranged from 28 to 109 cfs (Table 3-4). The East Fork below Dam was observed to have the highest overall concentration with a maximum value of 0.24 mg/L that occurred on 9 September with a flow of 83 cfs (Table 3-4). Total phosphorus values were observed to generally increase from spring into summer then decrease through the fall (Table 3-4 and Figure 3-7). The East Fork below Dam also experienced several spikes in concentration during the monitoring period including the seasonal maximum on 9 September (Figure 3-7).

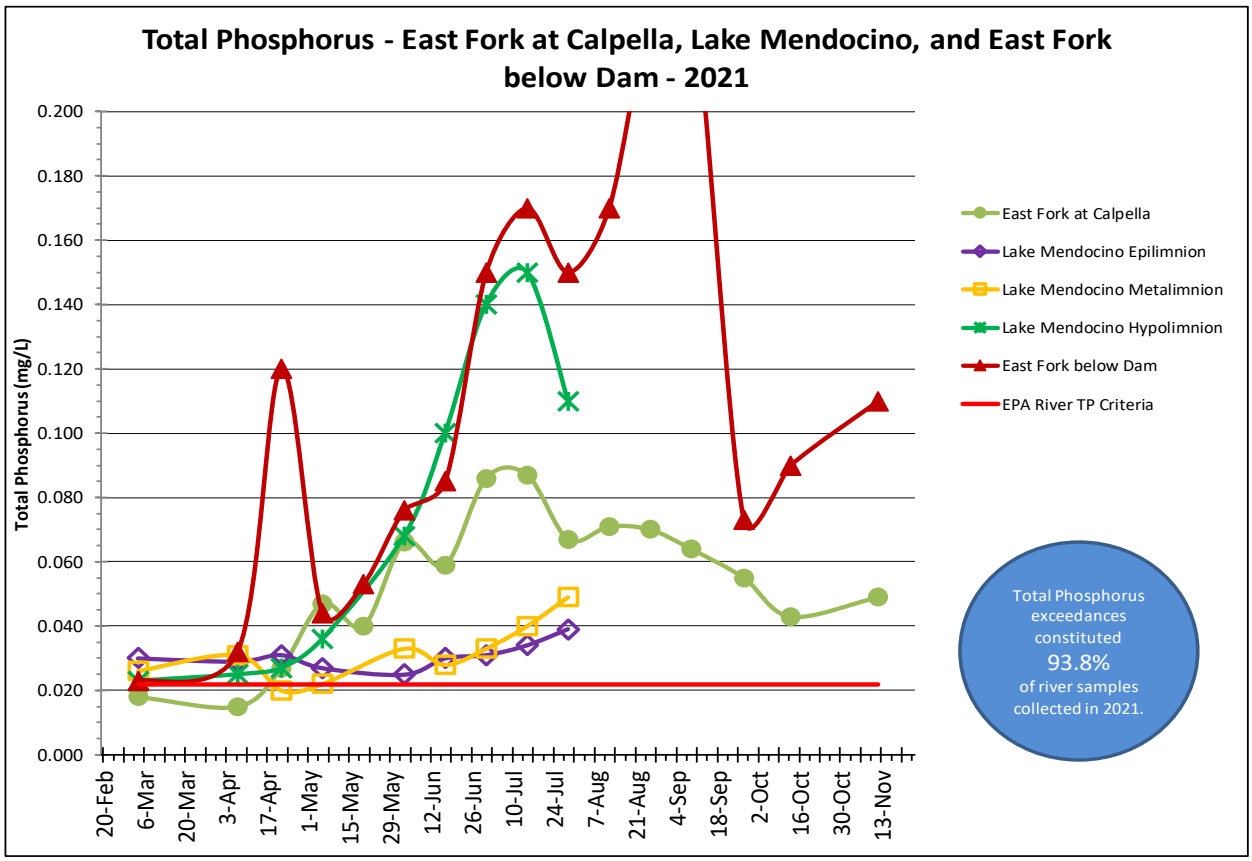


Figure 3-7. Sonoma Water Total Phosphorus results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Dam in 2021. Percent exceedances only apply to samples collected at East Fork stations.

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 seventeen (17) times, representing 53.1% of the total samples collected (17 out of 32) at the upper and lower East Fork Russian River stations (Tables 3-2 and 3-4, and Figure 3-8).

Turbidity values at Calpella were observed to remain consistently low throughout the monitoring season with the exception of the last sample collected on 12 November that had a value of 5.2 NTU with a flow of 84.3 cfs (Table 3-2). This maximum value was the only exceedance of the EPA criteria (1 of 16 samples or 6.3%) at the station in 2021 (Table 3-2 and Figure 3-8).

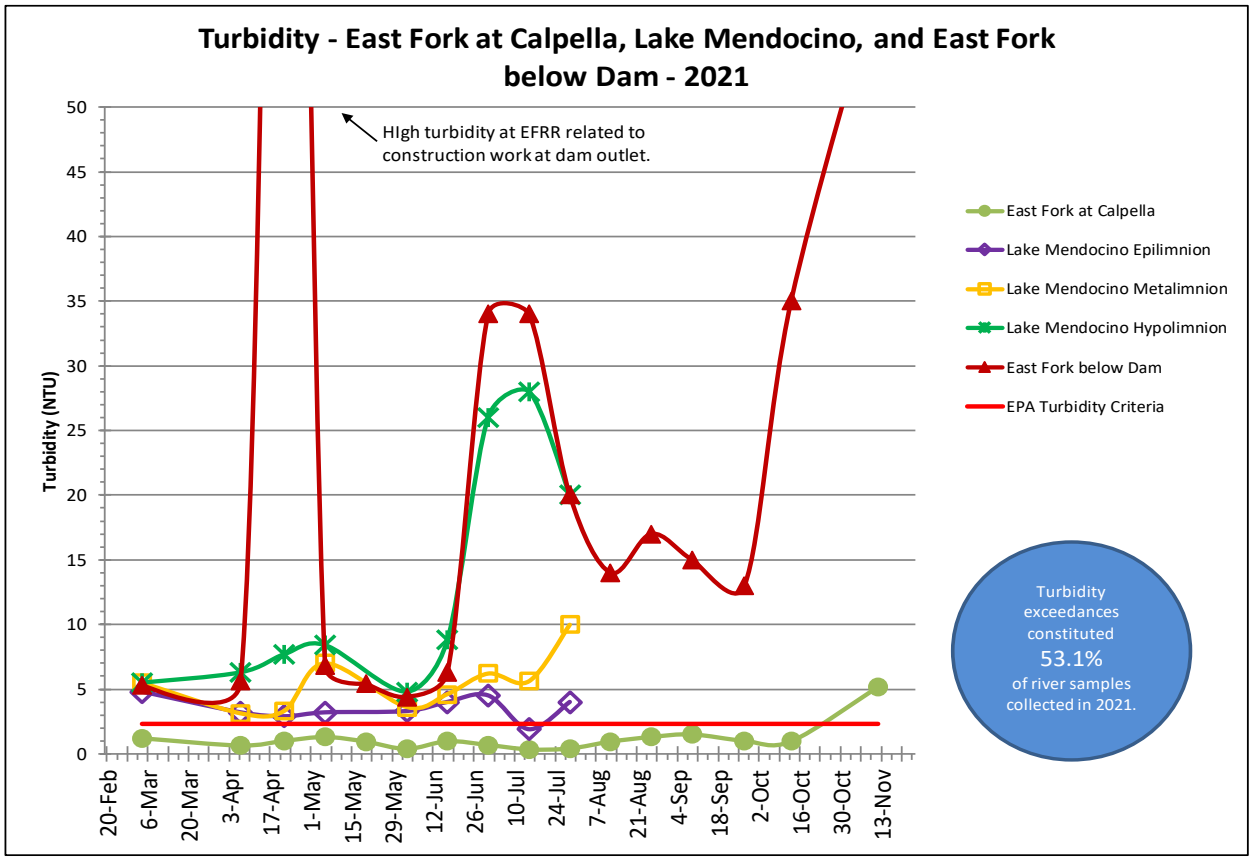


Figure 3-8. Sonoma Water Turbidity results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Dam in 2021. Percent exceedances only apply to samples collected at East Fork stations.

Turbidity levels exceeded the EPA criteria throughout the monitoring season (16 of 16 samples or 100%) at the East Fork below Dam station (Table 3-4). Values were observed to spike several times throughout the season including a maximum value of 130 NTU observed on 22 April with a flow of 28 cfs (Table 3-4 and Figure 3-8). That maximum value was partially a result of construction activity at the dam outlet that contributed to the high turbidity value. Values were also observed to spike in July and again at the

end of the season with a value of 60 NTU occurring on 12 November with a flow of 28 cfs. The minimum turbidity value observed was 4.4 NTU on 3 June with a flow of 70 cfs.

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 2021 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 2021, the *chlorophyll a* criteria for rivers and streams was exceeded thirteen (13) times, representing 40.6% of the total samples collected (13 out of 32) in the East Fork Russian River at Calpella and East Fork Russian River below Dam stations during the monitoring effort (Tables 3-2 and 3-4, 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 twenty-one (21) times, representing 77.8% of the total samples collected (21 out of 27) in Lake Mendocino during the monitoring effort (Table 3-3).

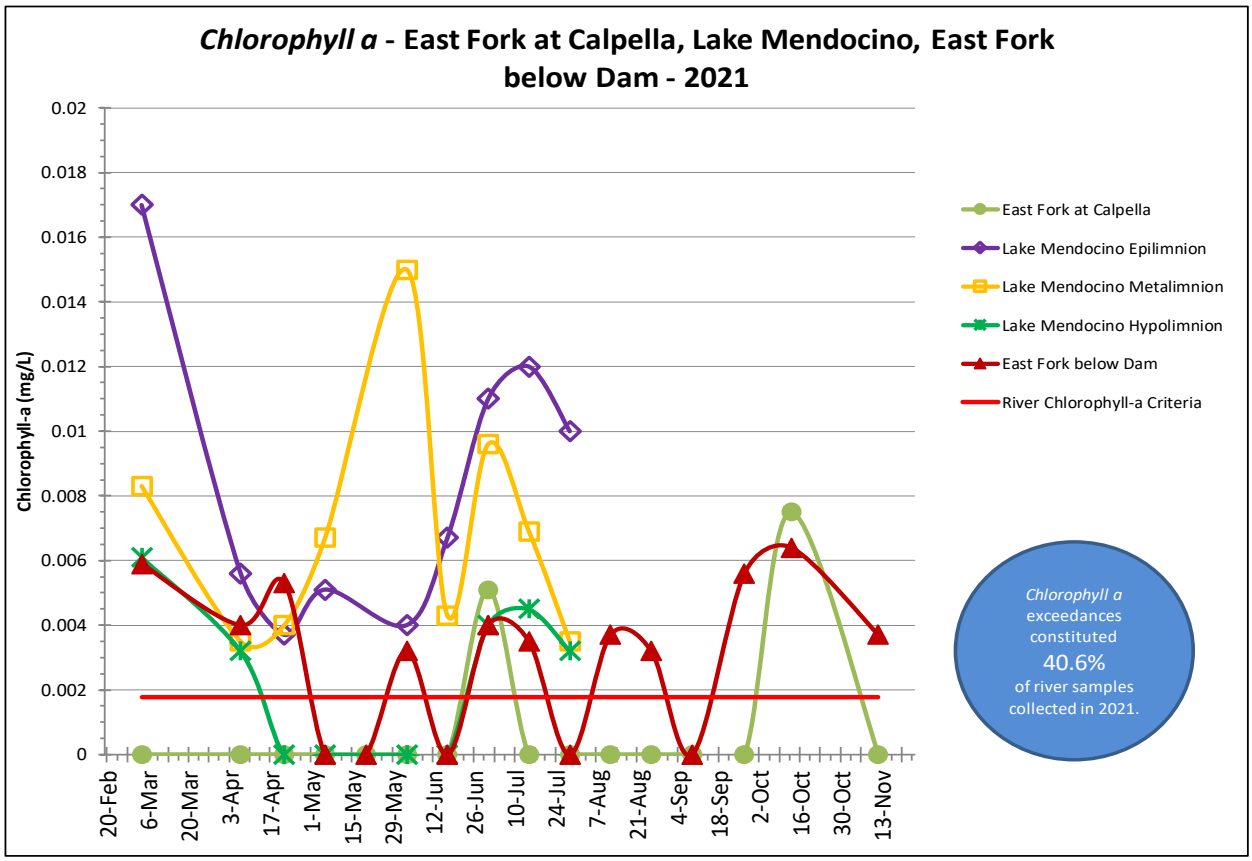


Figure 3-9. Sonoma Water Chlorophyll a results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Dam in 2021. Percent exceedances only apply to samples collected at East Fork stations.

Chlorophyll a exceedances occurred most predominantly at the Lake Mendocino epilimnion and metalimnion stations and least predominantly at Calpella (Tables 3-2 through 3-4 and Figure 3-9).

Calpella had two (2) *chlorophyll a* exceedances (2 of 16 or 12.5%) and fourteen (14) non-detects, including a maximum value of 0.0075 mg/L that occurred on 13 September with a flow of 10.1 cfs (Table 3-2 and Figure 3-9).

The Lake Mendocino epilimnion had nine (9) *chlorophyll a* exceedances (9 of 9 or 100%), including a maximum value of 0.017 mg/L that occurred on 4 March at a depth of 5 feet (Table 3-3 and Figure 3-9).

The Lake Mendocino metalimnion had nine (9) *chlorophyll a* exceedances (9 of 9 or 100%), including a maximum value of 0.015 mg/L that occurred on 3 June at a depth of 15 feet (Table 3-3 and Figure 3-9).

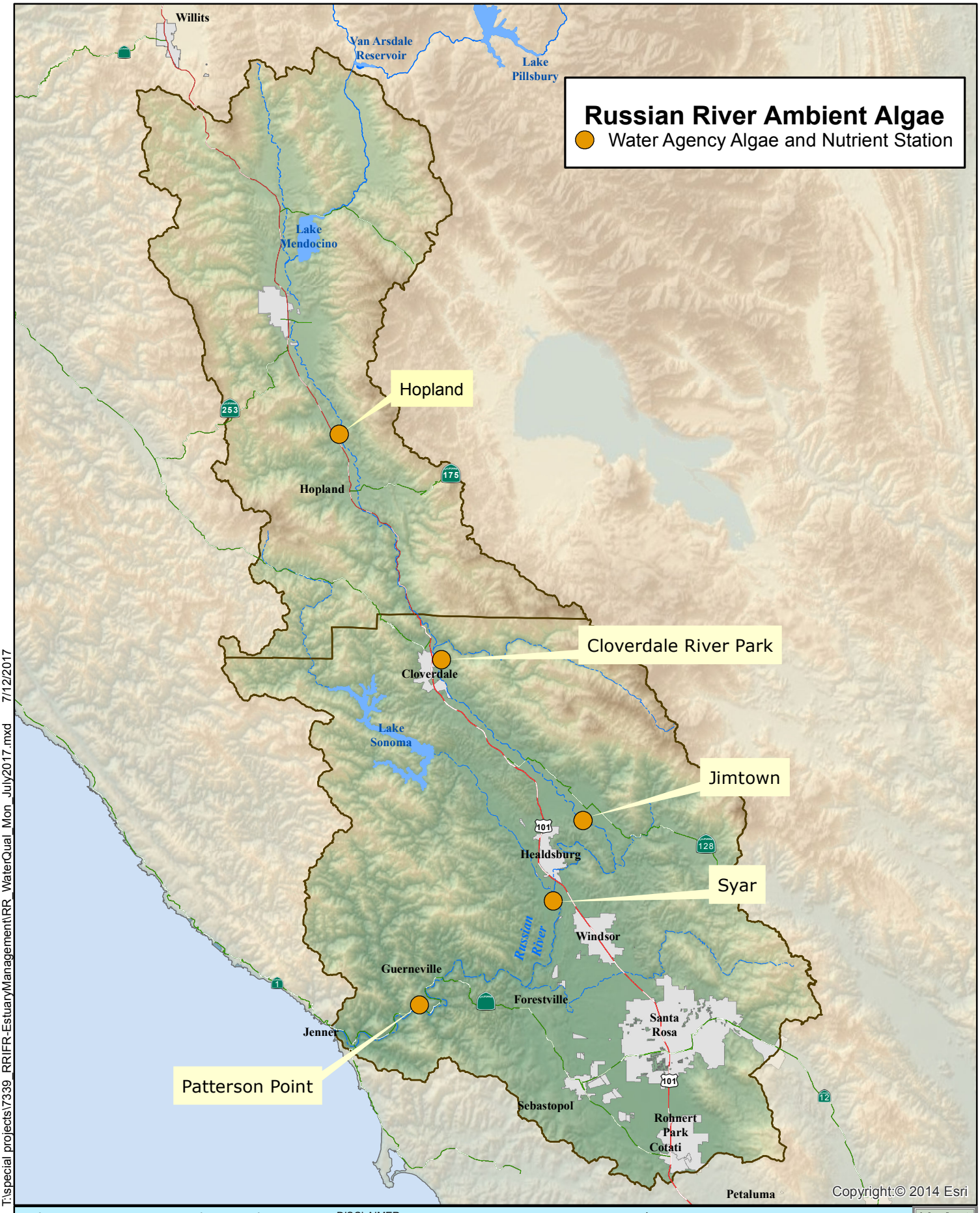
The Lake Mendocino hypolimnion had three (3) *chlorophyll a* exceedances (3 of 9 or 33.3%) and four (4) non-detects, including a maximum value of 0.0061 mg/L that occurred on 4 March at a depth of 50 feet (Table 3-3 and Figure 3-9).

The East Fork below Dam had eleven (11) *chlorophyll a* exceedances (11 of 16 or 68.8%) and five (5) non-detects, including a maximum value of 0.0064 mg/L that occurred on 13 October with a flow of 73 cfs (Table 3-4 and Figure 3-9).

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

Ambient Algae

In 2021, Sonoma Water conducted biweekly ambient algae and cyanobacterial monitoring and sampling during 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). This effort supports the NCRWQCB and Sonoma County DHS cyanotoxin monitoring and assessment for the potential for harmful algal blooms dominated by cyanobacteria (cyanoHABs) in the Russian River. This effort is being conducted to identify algal and cyanobacterial genera and species in the Russian River, as well as to estimate algal cover, frequency, and seasonal growth patterns.



T:\special projects\7339_RRIFR-EstuaryManagement\RR_WaterQual_Mon_July2017.mxd 7/12/2017

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

N

0 3 6 Miles

SONOMA COUNTY WATER AGENCY

Methods

Algal monitoring includes identifying genera present and collecting cover data using a line-intercept method, estimating microalgae (microscopic algae) thickness, and macroalgae (relatively large filamentous algae) length along established transects at the four monitoring and sampling stations. Multi-habitat algae samples (as well as a separate phytoplankton sample) are collected from the range of algae habitats present in the littoral zone (depth light penetrates and supports photosynthesis) up to 100 feet (30 meters) upstream and downstream of the transect. Habitat variations sampled include different substrates (cobble, gravel, sand or mud), flow velocities, depths, shade, and incorporate emergent or floating aquatic vegetation, boulders, woody debris, edge water, and backwater, riffle, run and pool habitats. Genera present are identified by preparing wet slides of algae samples and evaluating taxa under 10X to 400X magnification. For each monitoring event, ten (10) slides were evaluated for each multi-habitat and phytoplankton sample collected to determine the frequency of occurrence of algal genera at each monitoring site.

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

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), *Mouegotia* (green), *Oedogonium* (green), *Zygnema* (green), and *Tribonema* (yellow-green). The “Others” grouping includes the Divisions Rhodophyta (red algae), Chrysophyta (golden brown algae), and Dinophyta (Dinoflagellates).

Results

Over the monitoring period, 746 slides were evaluated from multi-habitat samples collected from the four monitoring stations. Genera present in the samples were detected and identified a total of 10,178 times. Figure 3-11 illustrates the frequency of algal species observed in the mainstem Russian River between 3 March 2021 and 1 December 2021 at the four TUC stations. Figure 3-11 displays which algal genera were detected along the “x” axis while the “y” axis indicates the number of times each genus was detected. The colors indicate the functional group; yellow for Diatoms, green for Green Macrophytes, blue for cyanobacteria, and orange for Others.

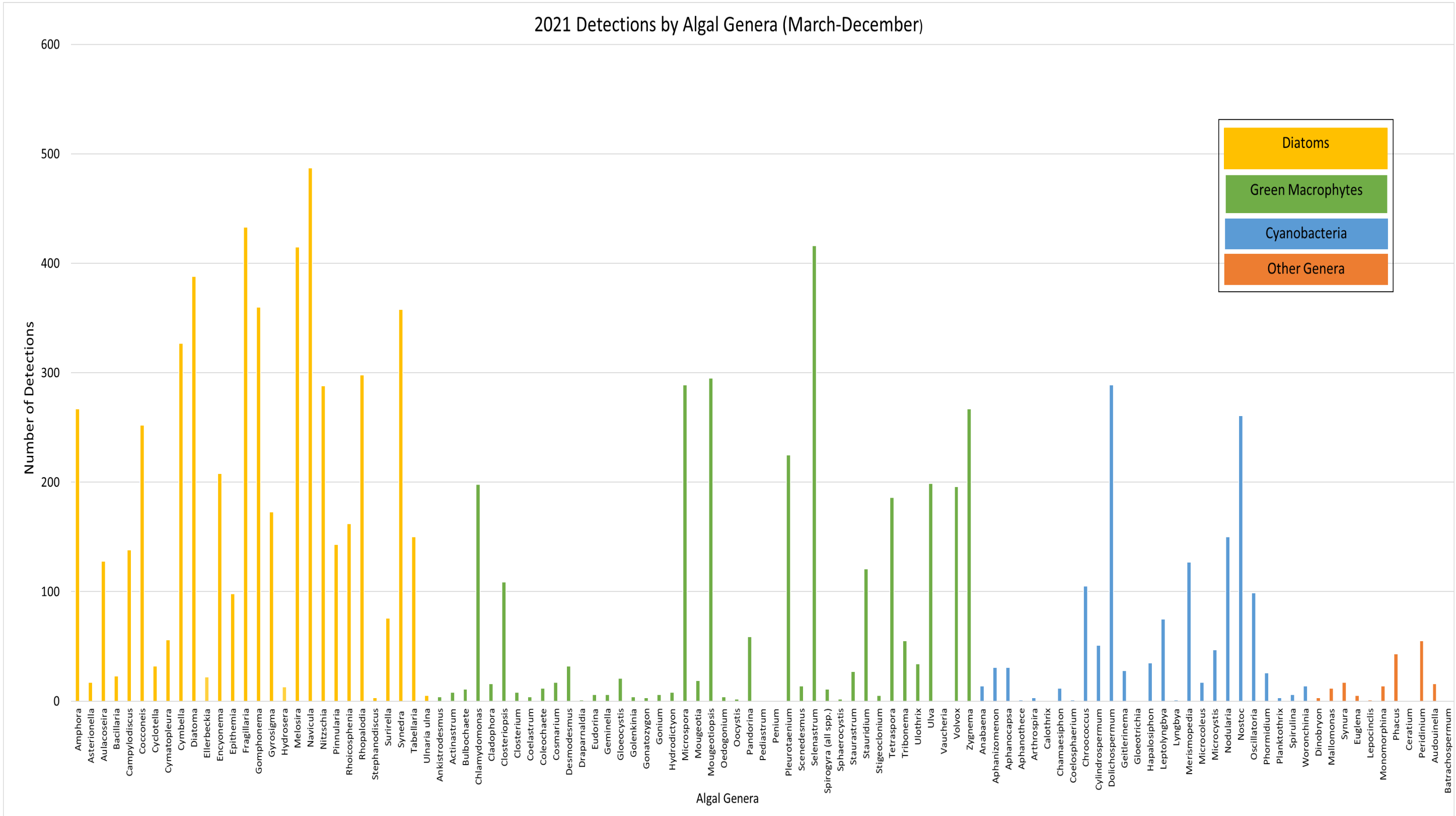


Figure 3-11. Algal Genera by Grouping Detected at the Hopland, Jimtown, Syar, and Patterson Point Ambient Algae Monitoring Stations in the Russian River in 2021.

For cover measurements, the periphyton was divided into two groups that are differentiated depending on their visibility without microscopic evaluation. Microalgae is comprised of microscopic algae genera in the periphyton that is 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 that microalgae often grow on as epiphytes, and often form drifting masses (or metaphyton) that accumulates 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.

Figures 3-12 through 3-15 illustrate the shifts in frequency of the four algal groupings through the monitoring season based on number of detections of algae genera collected from the range of algae habitats present in the littoral zone up to 100 feet (30 meters) upstream and downstream of the transect. The number of detections is determined through microscopic identification of ten (10) slides of algae samples per sampling event. Diatoms were consistently found in the greatest frequency at all stations. Green macrophyte frequency was generally higher during the monitoring season than Cyanobacteria. Diatom frequency stayed higher at all sites than frequency observed to be contributed by Green macrophytes and Cyanobacteria throughout the monitoring season.

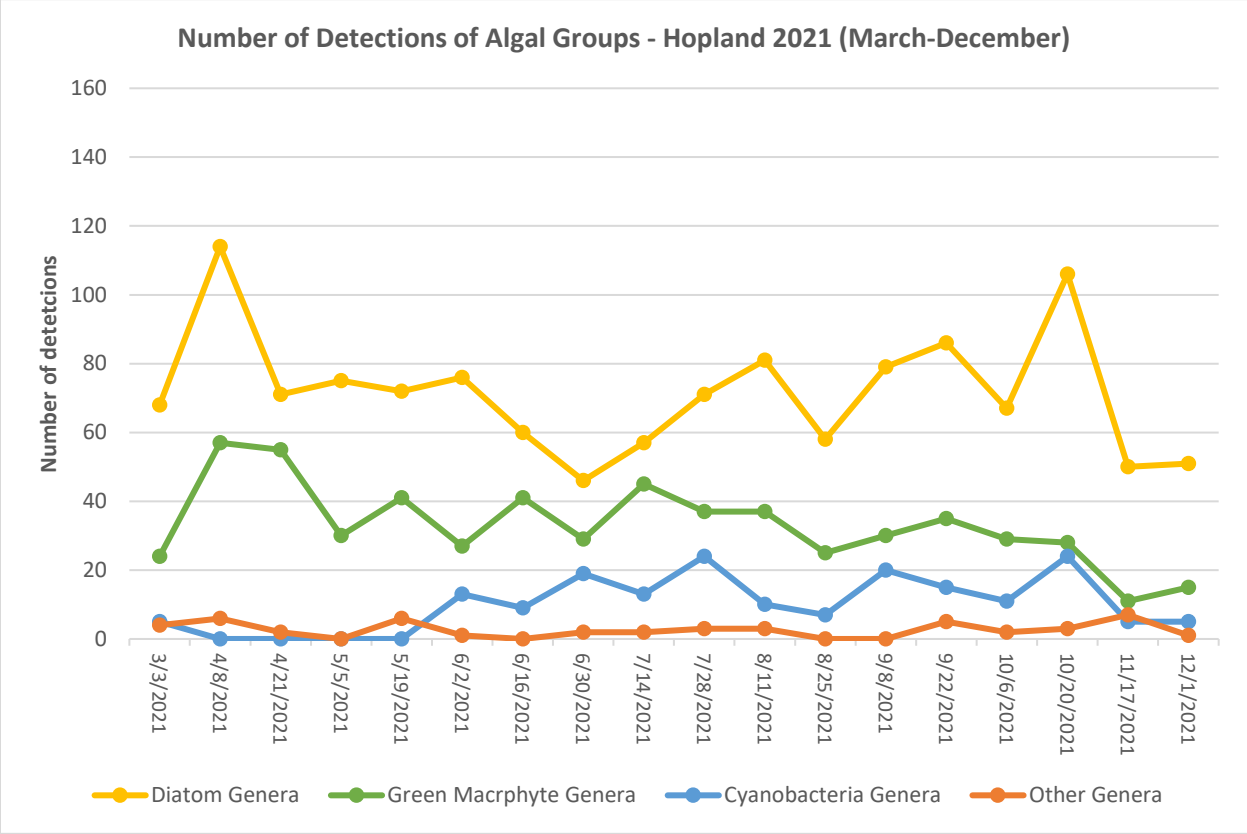


Figure 3-12. Number of Detections of Algal Groups at the Hopland Monitoring Station in 2021.

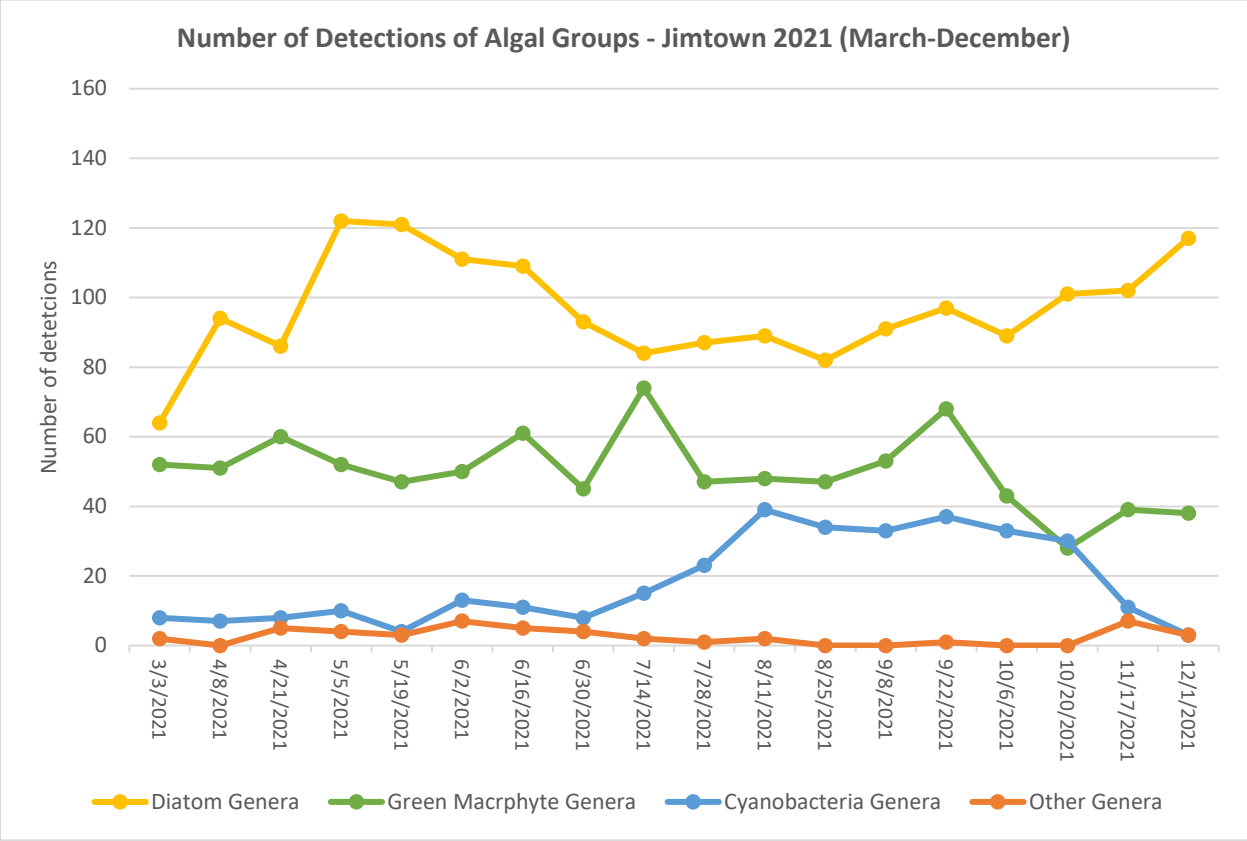


Figure 3-13. Number of Detections of Algal Groups at the Jimtown Monitoring Station in 2021.

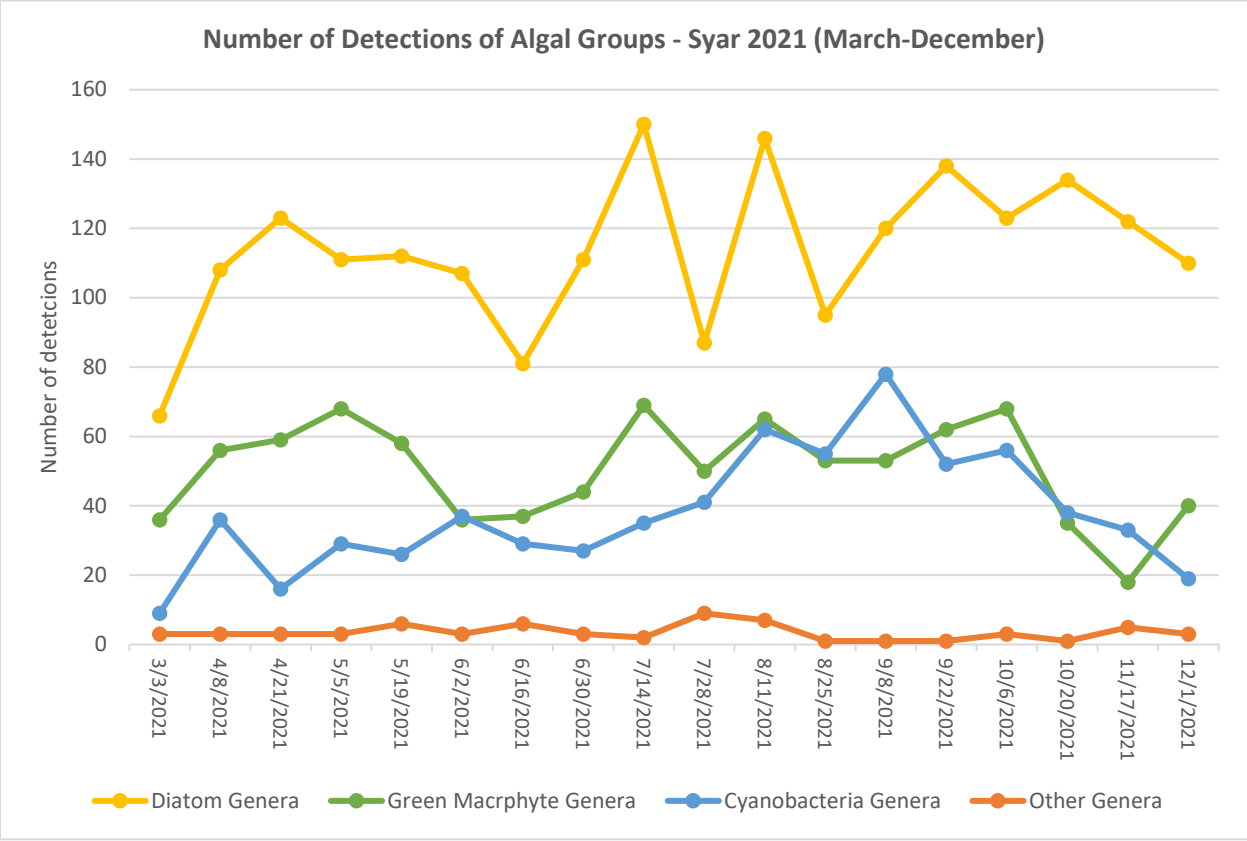


Figure 3-14. Number of Detections of Algal Groups at the Syar Monitoring Station in 2021.

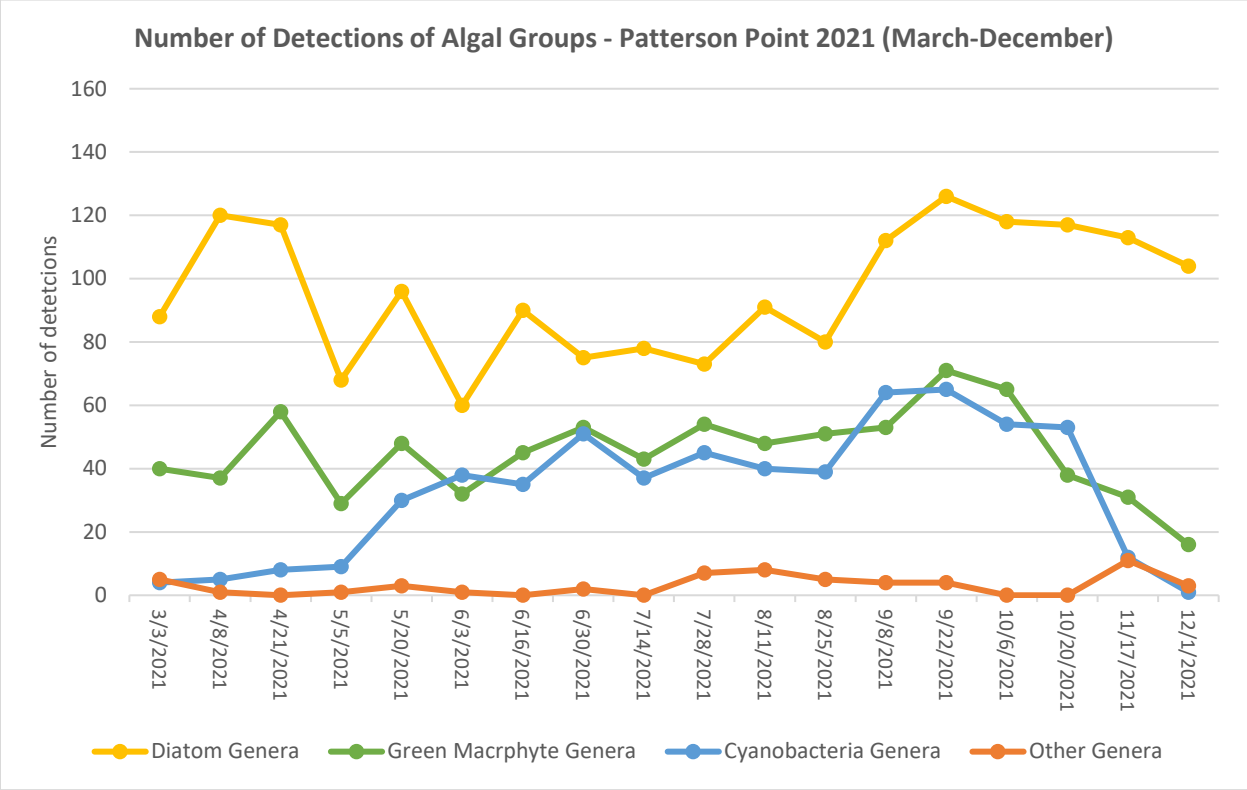


Figure 3-15. Number of Detections of Algal Groups at the Patterson Point Monitoring Station in 2021.

Some direct observations regarding the algal groups are evident. Figure 3-16 illustrates the overall average frequency of detections for the algal groupings as a percentage calculated for all sites between March and December 2021. Diatoms made up 55% of all detections. Green Macrophytes comprised 26% of all detections, Cyanobacteria made up 17%, and the rest of the detections were represented by Others at 2%.

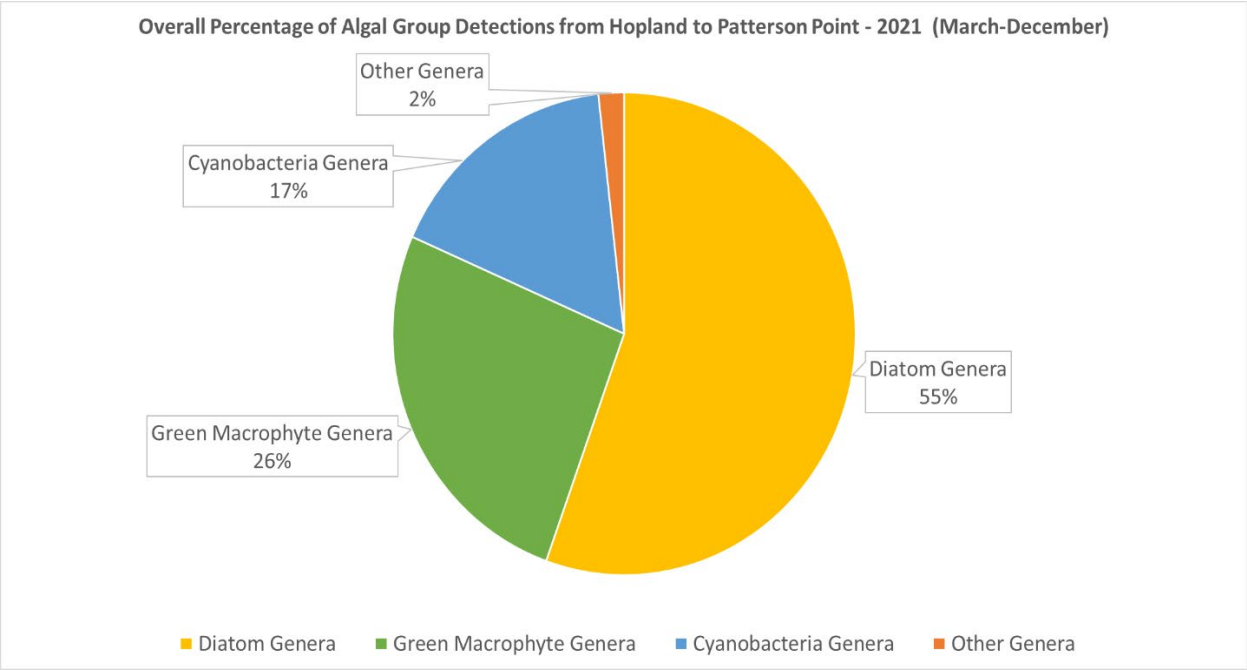


Figure 3-16. Overall Percentage of Algal Group Detections at Hopland, Jimtown, Syar, and Patterson Point in 2021.

Figures 3-17 through 3-20 display estimated cover contributed by microalgae (diatoms and cyanobacteria) versus macroalgae (filamentous green and yellow-green algae) at each sampling site during the monitoring season. Microalgae cover was generally higher at Patterson, Syar and Jimtown sites than Macroalgae cover throughout the monitoring season. Because of increased water clarity and low turbidity at the Hopland monitoring station, cover by Green macrophytes (specifically *Vaucheria*) was unusually high through the end of July when the Macroalgae started breaking off and floating downstream as metaphyton.

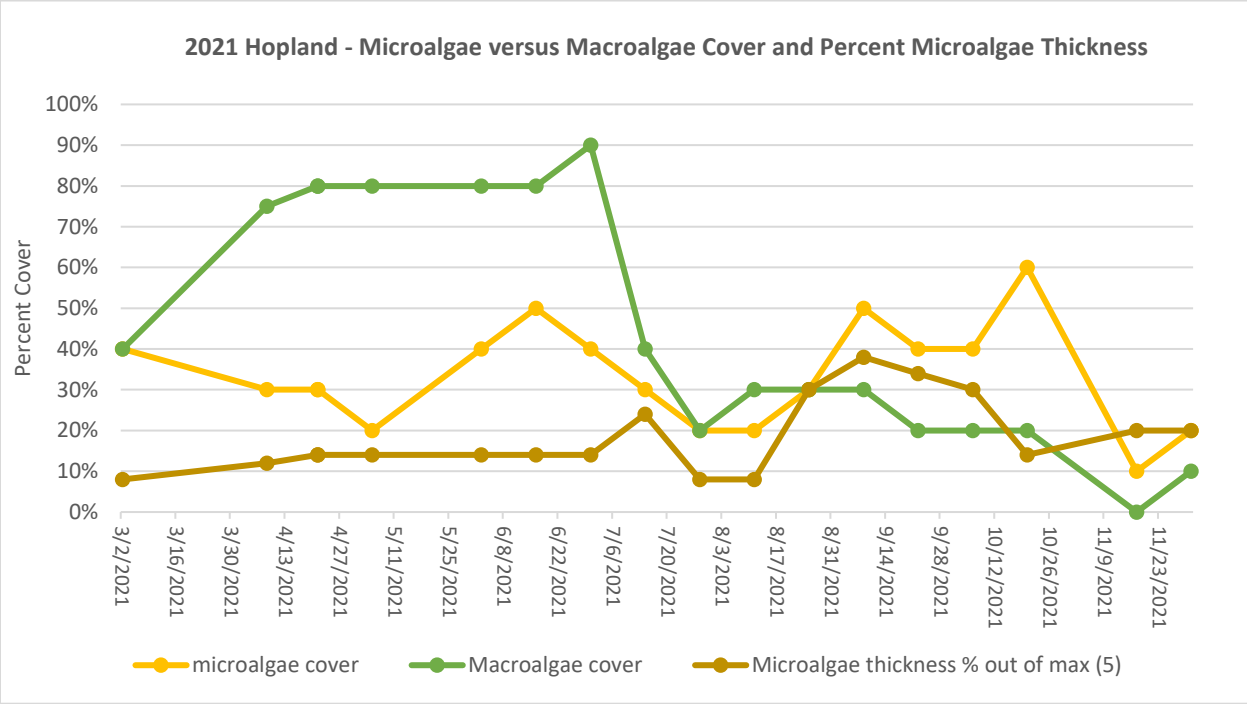


Figure 3-17. Microalgae versus Macroalgae Cover and percent Microalgae Thickness at Hopland in 2021.

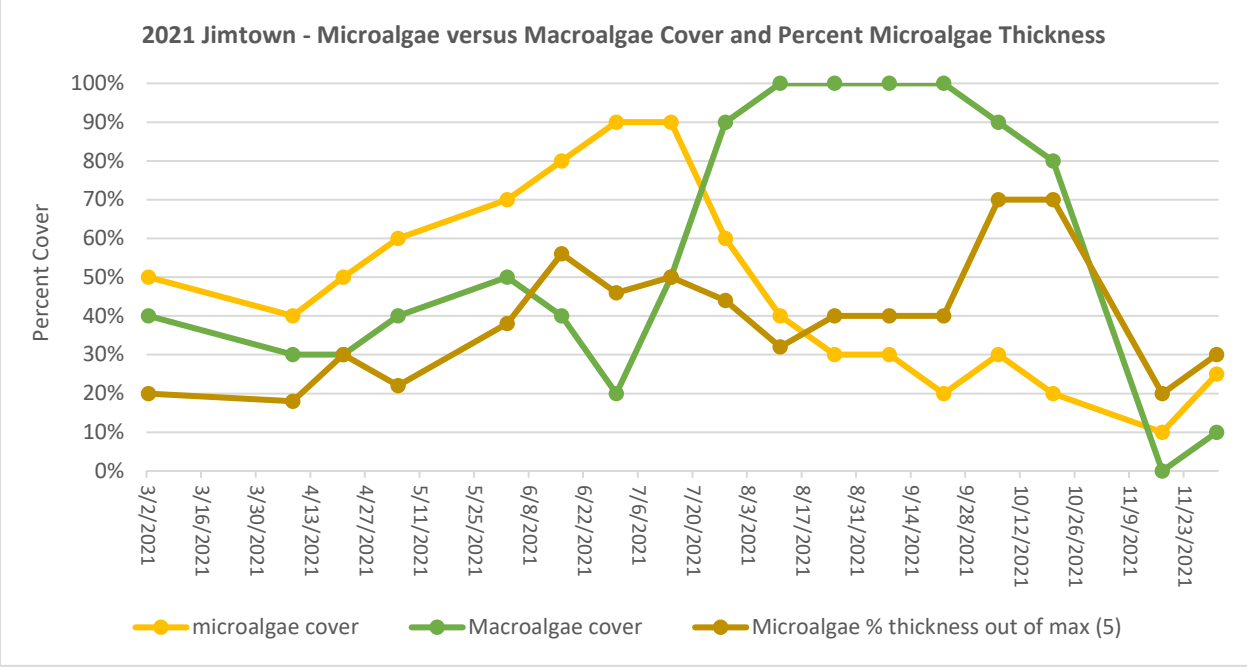


Figure 3-18. Microalgae versus Macroalgae Cover and percent Microalgae Thickness at Jimtown in 2021.

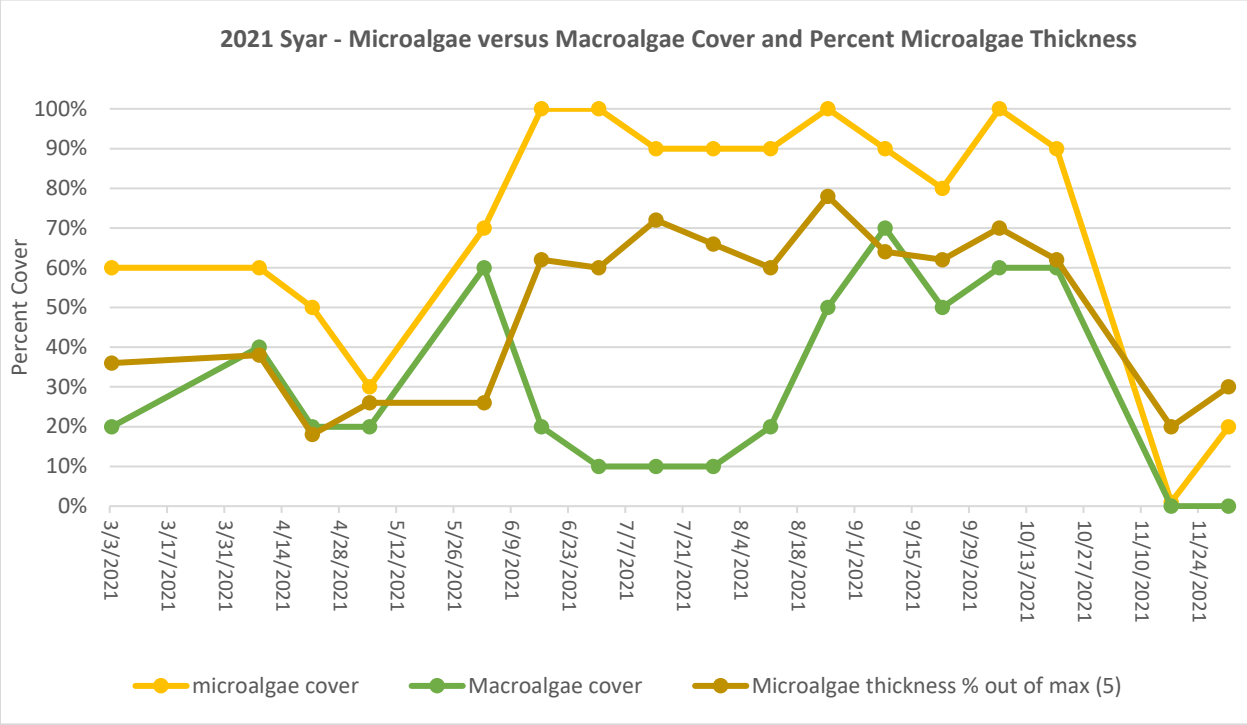


Figure 3-19. Microalgae versus Macroalgae Cover and percent Microalgae Thickness at Syar in 2021.

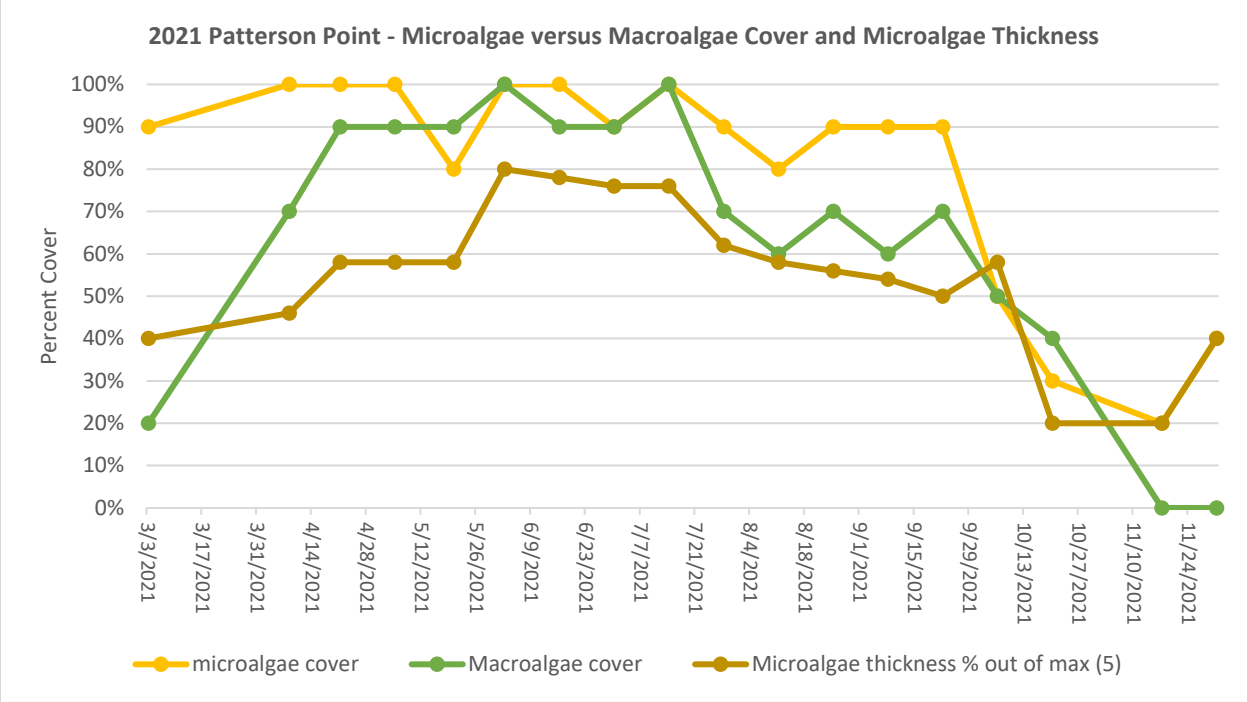


Figure 3-20. Microalgae versus Macroalgae Cover and percent Microalgae Thickness at Patterson Point in 2021.

Summary

Overall, 2021 algae growth in the Russian River was strongly affected by a lack of winter high flows, an abundance of snail grazing, an unusually high cover by Green Macrophytes in the upper river at Hopland, and limited runoff contributions of nutrients, and carbon inputs from the watershed. The river's dry season littoral zone was not scoured by flows in the winter of 2021 and algae growth did not experience a major turnover in algal populations. Significant gravel and bed movement was only

observed at the Patterson Point monitoring station, which is located in the lower Russian River. Substrates were already thickly (rank 2-3) (Fetscher et al., 2009) colonized by microalgae at Patterson, Jimtown, and Syar in May and June of 2021 (Figures 3-18 through 3-20). Generally, the development of filamentous algae in the Russian River in 2021 appeared to be affected by snail grazing which reduced cover by Green Macrophytes typically present by June. High numbers of New Zealand mud snails, an invasive species, were observed in the littoral zone between May and July at all monitoring sites. Likely early growth of green macrophytes was reduced by grazing pressure (Tuchman, N.C., Stevenson, R.C., 1991). Filamentous algae species did not become prevalent until late July at the Jimtown, Syar, and Patterson Point monitoring stations and then remained as the dominant cover until heavy rains in late October.

Dominant filamentous species in the periphyton were observed to be *Vaucheria* during the monitoring period at Hopland while *Spirogyra* was the dominant filamentous species at Jimtown, Syar, and Patterson Point. Mats of *Microcoleus*/*Phormidium* (Oscillatorian Genera) were present associated with layers of mucilaginous diatoms, and widespread by late July. These mats persisted at Patterson, Syar and Jimtown and started being observed in Hopland in late August and September and were present at all sites until high flows in late October. The diatoms *Rhopalodia* and *Amphora* (which are genera known to have cyanobacterial symbionts) were observed to be microscopically associated (imbedded in mucilage) with the cyanobacterial mats. A wide variety of Ocillatorian cyanobacteria were observed associated with cyanobacterial mat development on finer substrates (sand and small gravels). Occilatorian genera that were more prevalent in 2021 included, *Leptolyngba*, *Lyngba*, and several forms of *Phormidium* and *Ocillatoria.* (Figure 3-21).

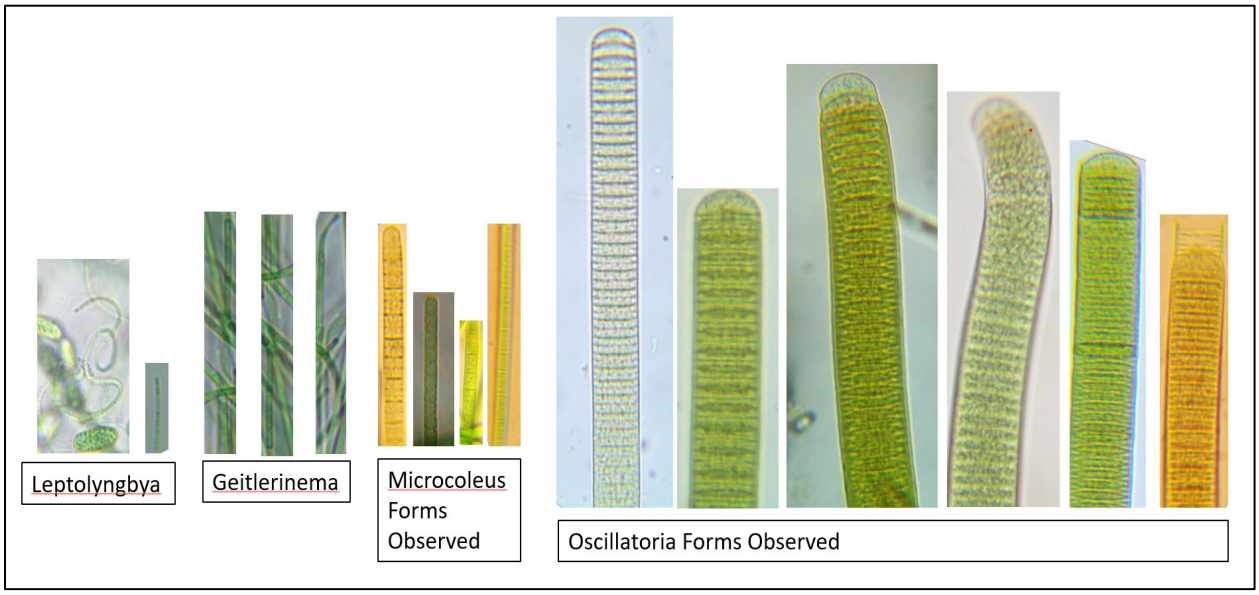


Figure 3-21. Variety of Oscillatorian cyanobacteria genera and forms observed in 2021.

Both Microalgae and Macroalgae support growth of cyanobacteria that contribute to cyanoHABs. Observations since 2016 support the hypothesis that the dominant green macrophyte influences the form and composition of the warm weather cyanoHAB in a given season. When Cladophora is the dominant Green Macrophyte numerous diatom species colonize the cell walls and provide suitable substrate for the growth of cyanobacterial genera dominated by the taxa that form heterocysts

(structure for nitrogen fixation) such as *Anabaena* and *Cylindrospermum*. In 2021, the periphyton was dominated by a variety of diatoms and the Green Macrophyte Spirogyra. Spirogyra has smooth cell walls and does not support the epiphytic growth of other algae. A thick layer of diatoms carried over from 2020 in the littoral zone and various Oscillatorian cyanobacteria (these genera do not form heterocysts) colonized this layer over the season forming complex mats that bubbled to the surface initiating cyanoHABs in late June, July and August. When an epiphytically colonizable macrophyte is present, cyanobacteria biomass has been observed to be contributed primarily by heterocyst forming genera. When a macrophyte is dominant that does not support epiphytic colonization cyanobacterial biomass is contributed by non-heterocyst forming Oscillatorian taxa closely associated with benthic diatom mats.

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 3-5 through 3-7 and Figures 3-22 through 3-25. 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 2021 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.

Ambient algae, cyanobacteria, estuary response, and associated grab sampling data for 2021 is currently being compiled and will be discussed in greater detail in the Russian River Biological Opinion 2021-2022 annual report, which will be posted to Sonoma Water's website when available: https://www.sonomawater.org/biological-opinion-outreach.

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, representing 16.4% of the total samples collected (18 out of 110) during the ambient algae monitoring effort (Tables 3-3 through 3-5, and Figure 3-22).

Hopland had seven (7) exceedances of the total nitrogen criteria out of 19 samples collected (36.8%), under flows that ranged from 47.7 cfs to 363 cfs (Table 3-5 and Figure 3-21). The maximum seasonal value measured 0.91 mg/L on 17 November with a flow of 104 cfs (Table 3-5). The minimum seasonal value was Non-Detect (ND), which occurred on 11 August with a flow of 85.8 cfs. Nitrogen values were observed to generally decline from spring into summer at Hopland then increase through the fall (Figure 3-22).

Cloverdale River Park had two (2) exceedances of the total nitrogen criteria out of 19 samples collected (10.5%), under flows that ranged from 164 to 406 cfs (Table 3-5 and Figure 3-21). The maximum concentration measured 0.52 mg/L on 1 January with a flow of 406 cfs (Table 3-5). The minimum seasonal value was Non-Detect (ND), which occurred six (6) times with flows that ranged from 37.0 to 75.6 cfs. Other than the two exceedances, which occurred during elevated winter and fall flows, total nitrogen values remained relatively low through the monitoring season (Figure 3-22).

Jimtown had two (2) exceedances of the total nitrogen criteria out of 19 samples collected (10.5%), under flows that ranged from 48.4 to 291 cfs (Table 3-6 and Figure 3-21). The maximum seasonal value measured 0.52 mg/L on 17 November with a flow of approximately 291 cfs (Table 3-6 and Figure 3-21). The minimum concentration was 0.10 mg/L, which occurred on 8 September with a flow of approximately 30.3 cfs. Nitrogen values at Jimtown remained relatively low through the monitoring season before increasing in the fall, resulting in the two late season exceedances (Figure 3-22).

Syar also had two (2) exceedances of the total nitrogen criteria out of 19 samples collected (10.5%) that occurred late in the season (Table 3-6 and Figure 3-21). The maximum seasonal value measured 0.45 mg/L on 17 November with an estimated flow of approximately 565 cfs (Table 3-6). The USGS near Windsor gaging station had been removed for the season therefore estimated flow is based on a flow of 434 cfs at USGS RR at Healdsburg combined with a flow of 131 cfs at USGS Dry Creek near Mouth. The minimum seasonal value was Non-Detect (ND), which occurred five (5) times with flows that ranged from 96.8 to 114 cfs. Syar also had nitrogen values that remained relatively low through the monitoring season before increasing in the fall, resulting in the two late season exceedances (Figure 3-22).

Patterson Point had five (5) exceedances of the total nitrogen criteria out of 34 samples collected (14.7%), under flows that ranged from 33.8 cfs to 684 cfs (Table 3-7 and Figure 3-21). The maximum seasonal value measured 4.0 mg/L on 1 December with a flow of 293 cfs (Table 3-7 and Figure 3-22). The minimum seasonal value was Non-Detect (ND), which occurred eight (8) times with flows that ranged from 36.5 to 120 cfs. Aside from the periodic exceedances, including the result on 1 December, total nitrogen values remained relatively low at Patterson Point through the monitoring season.

Table 3-5. Sonoma Water 2021 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	0.50	0.010	0.030	0.600	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)
1/14/2021	13:00	10.9	7.4	0.35	ND	ND	0.21	ND	0.35	**0.56**	**0.062**	0.052	4.18	4.58	110	**16**	**0.0043**	363
3/2/2021	10:00	9.9	6.9	ND	ND	ND	0.42	ND	ND	**0.42**	**0.048**	0.11	1.71	1.73	150	1.4	ND	113
4/5/2021	13:40	14.9	7.9	0.18	ND	ND	0.21	ND	ND	0.30	**0.048**	0.11	1.58	1.85	150	0.82	ND	77.7
4/21/2021	13:10	16.3	7.6	0.21	ND	ND	0.19	ND	0.21	**0.40**	**0.053**	0.12	1.55	1.93	160	1.2	ND	48.7
5/5/2021	15:00	19.1	8.2	0.18	ND	ND	0.17	ND	ND	0.35	**0.050**	0.11	1.67	2.02	190	0.72	ND	34.2
5/19/2021	13:40	16.6	7.7	0.18	ND	ND	0.048	ND	ND	0.228	**0.044**	0.083	1.72	2.13	160	1.0	**0.0035**	37.4
6/2/2021	14:10	18.6	7.8	0.18	ND	ND	0.063	ND	ND	0.243	**0.047**	0.055	2.01	2.44	140	1.1	ND	63.6
6/16/2021	14:50	18.1	7.5	0.18	ND	ND	0.057	ND	ND	0.237	**0.043**	0.082	2.16	2.94	150	1.8	ND	57.0
6/30/2021	14:00	19.5	7.4	0.18	ND	ND	0.060	ND	ND	0.240	**0.045**	0.077	2.23	2.72	140	2.0	**0.0035**	61.2
7/14/2021	14:40	18.8	7.4	0.18	ND	ND	0.044	ND	ND	0.224	**0.050**	0.087	2.20	2.56	140	**3.2**	ND	61.5
7/28/2021	15:20	19.0	8.5	ND	ND	ND	0.13	ND	ND	0.34	**0.057**	0.086	2.39	2.50	140	**5.0**	**0.0056**	76.5
8/11/2021	14:40	20.6	7.7	ND	ND	ND	ND	ND	ND	ND	**0.067**	0.12	2.28	2.86	150	1.8	ND	85.8
8/25/2021	14:20	19.4	7.7	0.18	ND	ND	0.12	ND	ND	0.30	**0.076**	0.14	2.55	2.73	160	**3.0**	**0.0053**	67.9
9/8/2021	15:45	21.3	7.6	0.26	ND	ND	0.076	ND	0.26	0.34	**0.13**	0.29	3.29	3.13	150	1.4	**0.0096**	56.1
9/22/2021	14:00	19.7	7.8	0.18	ND	ND	0.086	ND	ND	0.266	**0.080**	0.20	3.31	3.48	180	1.2	**0.0051**	54.7
10/6/2021	14:40	17.1	8.1	0.44	ND	ND	0.14	ND	0.44	**0.58**	**0.063**	0.12	3.16	3.70	180	2.1	**0.0048**	51.1
10/20/2021	13:30	14.1	7.7	0.35	ND	ND	0.090	ND	0.35	**0.44**	**0.051**	0.091	3.07	3.73	170	**5.0**	**0.0048**	47.7
11/17/2021	14:40	13.7	6.7	0.28	ND	ND	0.63	ND	0.28	**0.91**	**0.054**	0.096	2.64	3.12	180	**7.6**	ND	104
12/1/2021	15:20	11.7	7.5	0.28	ND	ND	0.46	ND	0.28	**0.74**	**0.041**	0.073	2.12	2.57	190	**5.7**	**0.0035**	58.9

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	0.50	0.010	0.030	0.600	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)
1/14/2021	12:10	11.4	7.6	0.35	ND	ND	0.17	ND	0.35	**0.52**	**0.080**	0.056	2.38	2.70	140	**15**	**0.0080**	406
3/2/2021	11:00	10.6	7.7	ND	ND	ND	0.19	ND	ND	0.19	0.014	ND	1.27	1.50	150	0.68	**0.0035**	137
4/5/2021	13:00	16.1	7.9	ND	ND	ND	0.069	ND	ND	0.069	0.018	ND	1.28	1.53	160	0.78	ND	91.5
4/21/2021	12:20	17.9	7.9	0.14	ND	ND	0.077	ND	ND	0.217	**0.029**	0.053	1.23	1.43	170	1.7	ND	52.3
5/5/2021	14:10	21.2	8.1	0.26	ND	ND	0.096	ND	0.26	0.36	**0.030**	0.059	1.14	1.45	220	0.87	ND	40.9
5/19/2021	12:50	19.4	8.1	ND	ND	ND	ND	ND	ND	ND	**0.026**	0.038	1.15	1.41	190	1.1	ND	37.0
6/2/2021	13:20	22.6	7.6	0.18	ND	ND	0.059	ND	ND	0.239	**0.029**	ND	1.65	2.01	160	0.37	ND	56.2
6/16/2021	14:00	22.3	7.4	0.18	ND	ND	0.063	ND	ND	0.243	**0.032**	0.049	1.60	2.17	160	**3.2**	ND	54.3
6/30/2021	13:20	24.7	7.7	0.18	ND	ND	ND	ND	ND	0.18	**0.035**	0.060	1.82	2.42	170	0.78	ND	61.7
7/14/2021	13:40	23.0	7.7	ND	ND	ND	ND	ND	ND	ND	**0.029**	0.054	1.83	2.24	140	0.37	ND	56.6
7/28/2021	14:40	23.3	8.3	ND	ND	ND	0.12	ND	ND	0.12	**0.025**	0.062	1.97	2.18	140	0.99	ND	65.1
8/11/2021	14:00	23.4	7.6	ND	ND	ND	ND	ND	ND	ND	**0.032**	0.059	1.83	2.25	170	0.74	ND	75.6
8/25/2021	13:40	21.3	8.5	0.10	ND	ND	0.12	ND	ND	0.22	**0.032**	0.052	1.84	2.17	190	1.0	ND	65.5
9/8/2021	14:00	23.3	7.0	ND	ND	ND	ND	ND	ND	ND	**0.028**	0.066	2.04	2.21	160	0.42	ND	47.2
9/22/2021	13:20	20.8	7.5	ND	ND	ND	ND	ND	ND	ND	**0.035**	0.086	2.21	2.48	200	0.42	**0.0037**	51.5
10/6/2021	13:50	17.3	8.1	0.18	ND	ND	0.12	ND	ND	0.30	**0.027**	0.050	2.22	2.60	190	0.30	ND	48.5
10/20/2021	11:40	16.4	7.2	0.18	ND	ND	ND	ND	ND	0.18	**0.15**	0.038	2.17	2.68	160	0.70	**0.0035**	53.0
11/17/2021	14:00	14.1	7.3	0.15	ND	ND	0.32	ND	ND	**0.47**	**0.027**	0.052	2.04	2.39	180	1.8	ND	164
12/1/2021	14:30	12.6	8.3	0.18	ND	ND	0.16	ND	ND	0.34	**0.014**	ND	1.63	1.77	200	0.62	**0.0035**	80.2

* 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

Total Nitrogen: 0.38 mg/L

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

Turbidity: 2.34 FTU/NTU

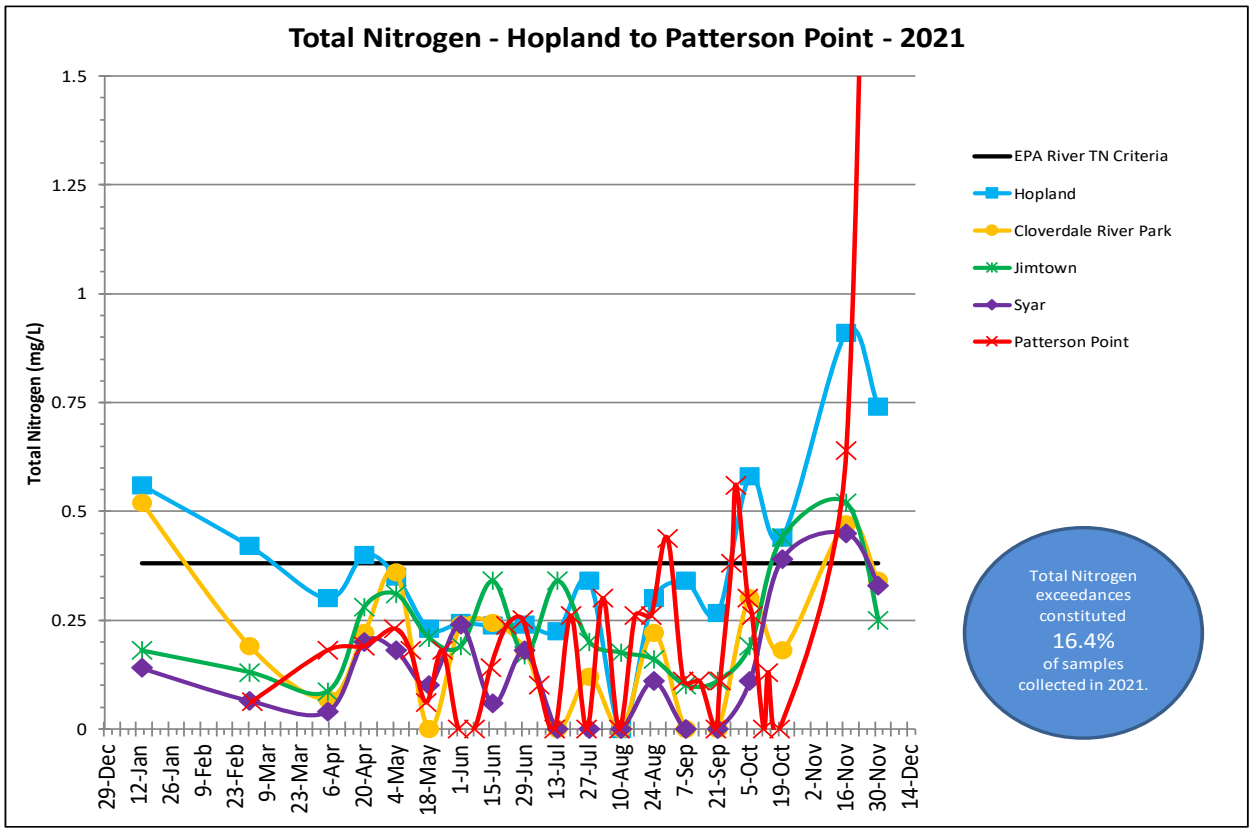


Figure 3-22. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Total Nitrogen Results in 2021.

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 3-5 through 3-7, and Figure 3-23). The EPA criteria was exceeded seventy (70) times out of 110 samples collected at the five stations (63.6%). The Hopland, Cloverdale, and Patterson Point stations predominantly exceeded the total phosphorus criteria during the monitoring season, whereas the Jimtown station had only two (2) exceedances and the Syar station had seven (7) exceedances during the 2021 season.

The station at Hopland generally had higher concentrations than the other stations, with the exception of the Patterson Point station in the spring and early summer (Figure 3-23). Hopland exceeded the EPA criteria throughout the monitoring season (19 of 19 samples or 100%), under flows that ranged from 34.2 cfs to 363 cfs (Table 3-5 and Figure 3-23). The maximum concentration measured 0.13 mg/L on 8 September with a flow of 56.1 cfs (Table 3-5). The minimum concentration was 0.041 mg/L, which occurred on 1 December with a flow of approximately 58.9 cfs. Total phosphorus values at Hopland were observed to slightly decrease from spring into summer before spiking in September and then decreasing through the fall (Figure 3-23).

The Cloverdale River Park station also exceeded the total phosphorus EPA criteria for a majority of the season, including 16 of 19 samples (84.2%) under flows that ranged from 37.0 to 406 cfs. The maximum concentration measured 0.15 mg/L on 20 October with a flow of 53.0 cfs (Table 3-5 and Figure 3-23).

The minimum concentration was 0.014 mg/L, which occurred twice on 2 March and 1 December with flows of approximately 137 and 80.2 cfs, respectively. Total phosphorus values at Cloverdale were observed to decrease from winter into spring, where they remained relatively stable through summer into fall before spiking in October (Figure 3-23).

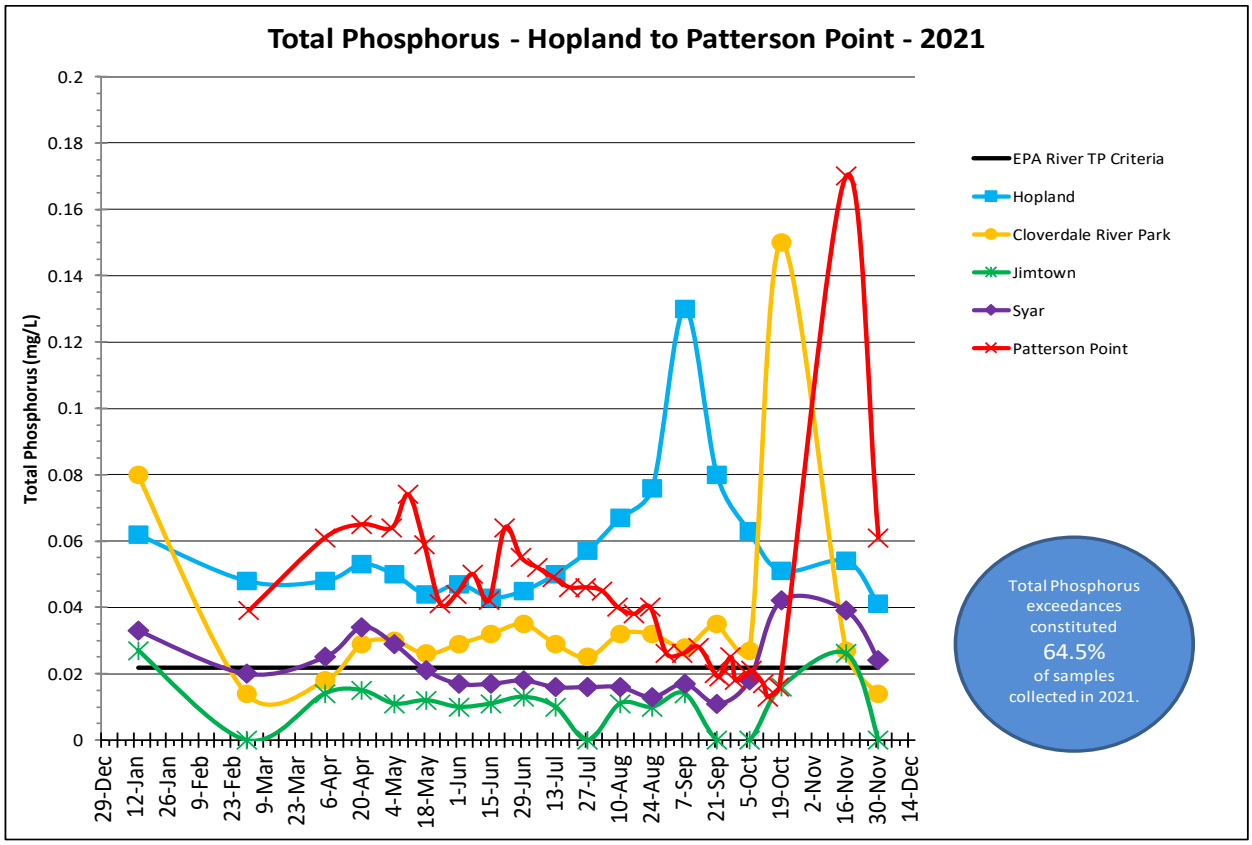


Figure 3-23. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Total Phosphorus Results in 2021.

Concentrations at the Jimtown station were significantly lower compared to the Hopland and Cloverdale stations, with only two (2) exceedances (2 of 19 or 10.5%) of the EPA criteria with flows of 291 and 300 cfs, respectively (Table 3-6 and Figure 3-23). The maximum concentration measured 0.027 mg/L on 14 January with a flow of approximately 300 cfs (Table 3-6). The minimum seasonal value was ND, which occurred five (5) times with flows that ranged from approximately 34.0 to 184 cfs (Table 3-6). Overall, concentrations remained consistently low throughout the monitoring season (Figure 3-23).

Syar Vineyards had seven (7) exceedances (7 of 19 or 36.8%) of the total phosphorus EPA criteria during the season, with a maximum value of 0.042 mg/L that occurred on 20 October with a flow of approximately 115 cfs (Table 3-6 and Figure 3-23). A majority of the exceedances occurred early in winter/spring and again in the fall when the USGS gaging station had been removed for the season (Table 3-6). However, flows were estimated to range from approximately 145 to 565 cfs based on flows at the USGS RR at Healdsburg gage combined with flows at the USGS Dry Creek near Mouth gage. The minimum seasonal value was 0.011 mg/L on 22 September with a flow of approximately 97.8 cfs (Table 3-6). Concentrations remained relatively low throughout the season, similar to Jimtown (Figure 3-23).

Table 3-6. Sonoma Water 2021 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	0.50	0.010	0.030	0.600	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)
1/14/2021	10:50	11.9	7.6	ND	ND	ND	0.18	ND	ND	0.18	**0.027**	0.043	1.58	2.00	130	1.1	ND	300
3/2/2021	12:00	13.0	7.3	ND	ND	ND	0.13	ND	ND	0.13	ND	ND	1.15	1.33	160	0.40	ND	184
4/5/2021	12:20	16.0	7.4	ND	ND	ND	0.086	ND	ND	0.086	0.014	ND	1.01	1.34	170	0.45	ND	134
4/21/2021	11:40	17.8	7.2	0.14	ND	ND	0.14	ND	ND	0.28	0.015	0.033	0.980	1.05	190	0.40	ND	70.6
5/5/2021	12:50	20.5	7.5	0.18	ND	ND	0.13	ND	ND	0.31	0.011	ND	0.881	0.998	220	0.25	ND	50.5
5/19/2021	11:30	17.5	6.9	ND	ND	ND	0.21	ND	ND	0.21	0.012	ND	0.573	0.692	210	0.53	ND	33.9
6/2/2021	11:50	19.8	6.9	ND	ND	ND	0.19	ND	ND	0.19	0.010	ND	0.803	0.968	180	ND	ND	38.2
6/16/2021	12:50	21.1	6.7	0.18	ND	ND	0.16	ND	ND	0.34	0.011	ND	0.817	1.13	200	1.5	**0.0040**	37.4
6/30/2021	12:00	21.5	6.4	ND	ND	ND	0.17	ND	ND	0.17	0.013	ND	0.867	1.17	190	0.89	ND	35.8
7/14/2021	12:40	20.5	7.0	0.18	ND	ND	0.16	ND	ND	0.34	0.010	ND	0.860	0.903	190	0.16	ND	32.3
7/28/2021	13:40	21.8	7.5	ND	ND	ND	0.20	ND	ND	0.20	ND	ND	0.820	0.996	190	ND	**0.0032**	35.2
8/11/2021	13:00	22.2	7.3	0.11	ND	ND	0.065	ND	ND	0.175	0.011	ND	0.976	1.45	190	0.70	**0.0093**	50.4
8/25/2021	12:40	20.3	7.1	ND	ND	ND	0.16	ND	ND	0.16	0.010	ND	0.848	1.18	200	0.58	**0.0048**	44.8
9/8/2021	13:00	21.1	7.2	ND	ND	ND	0.10	ND	ND	0.10	0.014	ND	0.920	1.12	180	0.53	**0.0064**	30.3
9/22/2021	12:20	19.5	7.3	ND	ND	ND	0.11	ND	ND	0.11	ND	ND	0.896	1.21	210	0.43	**0.0048**	35.6
10/6/2021	12:50	18.2	7.3	ND	ND	ND	0.19	ND	ND	0.19	ND	ND	0.905	1.27	290	0.30	ND	34.0
10/20/2021	10:40	13.3	7.3	0.35	ND	ND	0.089	ND	0.35	**0.44**	0.016	ND	1.13	1.67	180	0.88	**0.0075**	48.4
11/17/2021	12:50	15.4	6.7	0.18	ND	ND	0.34	ND	ND	**0.52**	**0.026**	0.048	1.79	2.08	200	1.6	ND	291
12/1/2021	13:20	14.6	7.7	0.10	ND	ND	0.15	ND	ND	0.25	ND	ND	1.26	1.41	210	0.37	ND	128

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	0.50	0.010	0.030	0.600	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)
1/14/2021	9:50	11.8	7.3	ND	ND	ND	0.14	ND	ND	0.14	**0.033**	0.060	1.69	1.71	140	1.1	**0.0035**	out for season
3/3/2021	11:00	11.9	7.8	ND	ND	ND	0.065	ND	ND	0.065	0.020	0.031	1.26	1.45	150	0.47	**0.0056**	out for season
4/5/2021	11:30	14.9	7.5	ND	ND	ND	0.040	ND	ND	0.04	**0.025**	0.048	1.31	1.36	150	0.99	**0.0048**	out for season
4/21/2021	10:50	17.1	7.7	0.14	ND	ND	0.060	ND	ND	0.200	**0.034**	0.10	1.07	1.31	140	0.56	ND	out for season
5/5/2021	11:50	17.5	8.0	0.18	ND	ND	ND	ND	ND	0.18	**0.029**	0.055	1.13	1.41	160	0.50	ND	149
5/19/2021	10:20	14.6	7.2	0.10	ND	ND	ND	ND	ND	0.10	0.021	ND	1.10	1.38	130	1.4	ND	188
6/2/2021	10:10	15.7	7.5	0.18	ND	ND	0.059	ND	ND	0.239	0.017	0.57	1.26	1.48	120	0.54	ND	196
6/16/2021	11:40	19.0	7.2	ND	ND	ND	0.059	ND	ND	0.059	0.017	ND	1.22	1.58	140	1.1	ND	163
6/30/2021	11:00	19.4	8.3	0.18	ND	ND	ND	ND	ND	0.18	0.018	ND	1.24	1.68	130	0.70	ND	108
7/14/2021	11:10	16.2	7.1	ND	ND	ND	ND	ND	ND	ND	0.016	ND	1.20	1.46	120	0.54	ND	104
7/28/2021	12:40	20.0	8.1	ND	ND	ND	ND	ND	ND	ND	0.016	ND	1.24	1.43	130	0.57	ND	99.5
8/11/2021	11:50	18.4	7.4	ND	ND	ND	ND	ND	ND	ND	0.016	ND	1.08	1.70	770	0.58	ND	114
8/25/2021	11:30	16.8	7.5	ND	ND	ND	0.11	ND	ND	0.11	0.013	ND	0.980	1.29	140	0.64	ND	105
9/8/2021	11:50	17.7	7.1	ND	ND	ND	ND	ND	ND	ND	0.017	ND	1.36	1.40	120	0.63	ND	96.8
9/22/2021	10:10	16.3	7.3	ND	ND	ND	ND	ND	ND	ND	0.011	ND	1.40	1.54	150	0.52	**0.0048**	97.8
10/6/2021	11:20	14.7	7.9	ND	ND	ND	0.11	ND	ND	0.11	0.018	ND	1.78	2.14	120	0.57	ND	95.8
10/20/2021	9:20	14.7	7.7	0.35	ND	ND	0.041	ND	0.35	**0.39**	**0.042**	0.047	2.25	3.38	120	**4.0**	**0.0032**	115
11/17/2021	11:50	14.9	7.3	0.14	ND	ND	0.31	ND	ND	**0.45**	**0.039**	0.084	1.93	2.27	180	**3.0**	**0.0032**	out for season
12/1/2021	12:00	13.3	8.0	0.21	ND	ND	0.12	ND	0.21	0.33	**0.024**	0.037	1.50	1.62	180	**2.4**	**0.0048**	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

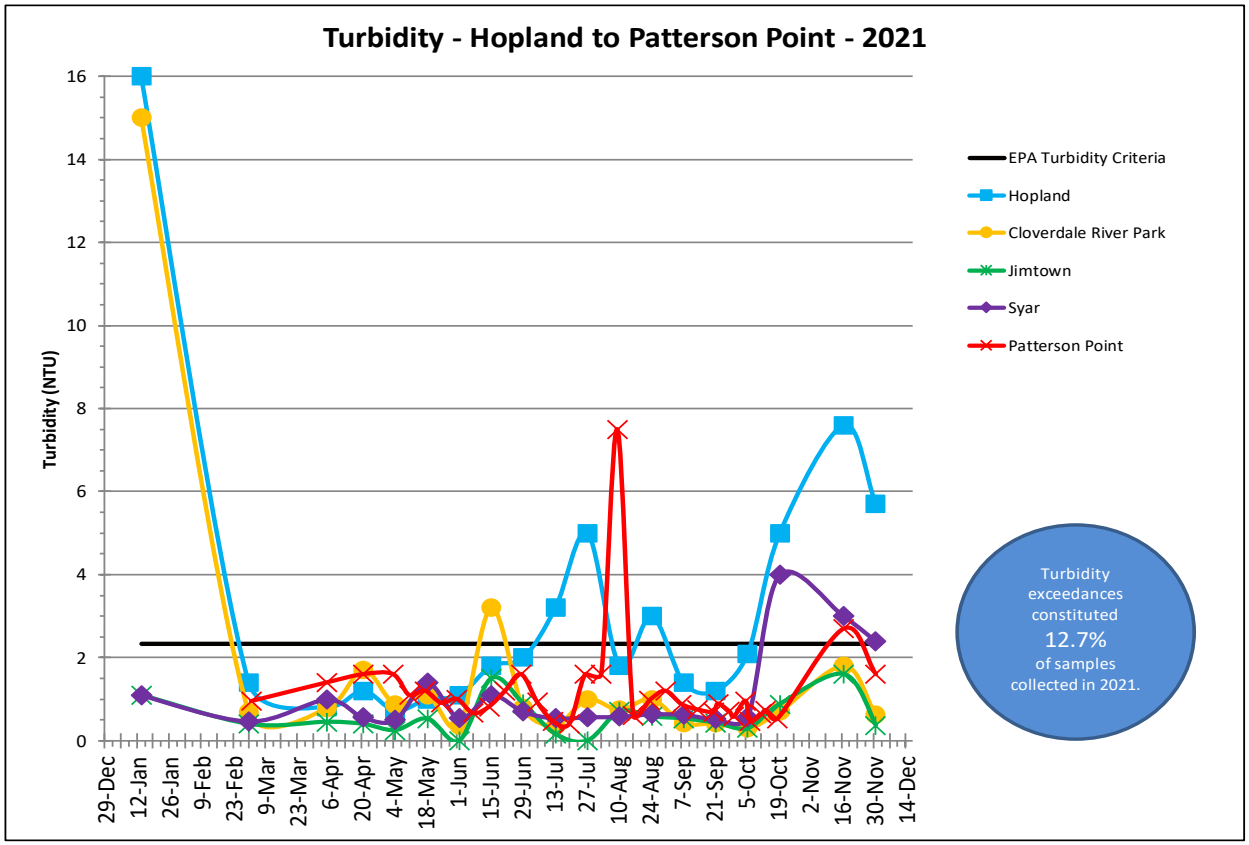
Turbidity: 2.34 FTU/NTU

Patterson Point had twenty-six (26) exceedances of the total phosphorus criteria (26 of 34 or 76.5%) under flows that ranged from 33.8 to 684 cfs (Table 3-7 and Figure 3-23). The maximum concentration measured 0.17 mg/L on 17 November with a flow of 684 cfs (Table 3-7). The minimum seasonal value was 0.013mg/L on 14 October with a flow of approximately 38.1 cfs (Table 3-7). Concentrations were observed to generally decrease from winter through summer and into fall before spiking in November during elevated storm flows (Table 3-7 and Figure 3-23).

Turbidity

The EPA recommended criteria for turbidity is 2.34 NTU (EPA, 2000). Four of the five monitoring stations were observed to have exceedances of the EPA criteria during the monitoring season (Tables 3-5 through 3-7). The Jimtown station did not have any observed exceedances during the 2021 season. Overall, the EPA criteria was exceeded fourteen (14) times out of 110 samples collected (12.7%) at the five stations (Tables 3-5 through 3-7 and Figure 3-24).

Turbidity levels at Hopland exceeded the EPA criteria periodically through the monitoring season (7 of 19 samples or 36.8%) with flows that ranged from 47.7 to 363 cfs (Table 3-5 and Figure 3-24). The maximum seasonal value measured 16 NTU on 14 January with a flow of approximately 363 cfs (Table 3-5). The minimum seasonal value was 0.72 NTU on 5 May with a flow of approximately 34.2 cfs (Table 3-5). Values were observed to remain relatively low through the spring and summer with a few periodic exceedances before increasing in the fall and winter (Figure 3-24).



Figures 3-24. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Turbidity in 2021.

Cloverdale River Park had two (2) exceedances of the EPA criteria out of 19 samples collected (2 of 19 or 10.5%) during flows of approximately 406 and 54.3 cfs, respectively (Table 3-5 and Figure 3-24). Cloverdale River Park was observed to have a maximum value of 15 NTU on 14 January with a flow of 406 cfs (Table 3-5). The minimum seasonal value was 0.30 NTU on 6 October with a flow of approximately 48.5 cfs (Table 3-5). Other than the exceedance during elevated flows in January and a minor spike in June, values were observed to remain consistently low through the monitoring season (Figure 3-24).

Table 3-7. Sonoma Water 2021 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	0.50	0.010	0.030	0.600	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)
3/3/2021	9:50	11.6	7.4	ND	ND	ND	0.062	ND	ND	0.062	**0.039**	0.076	1.92	1.97	160	0.95	ND	276
4/5/2021	10:30	15.8	7.1	0.18	ND	ND	ND	ND	ND	0.18	**0.061**	0.14	1.73	2.06	160	1.4	ND	215
4/21/2021	9:50	18.6	7.5	0.14	ND	ND	0.045	ND	ND	0.185	**0.065**	0.17	1.66	1.91	170	1.6	ND	76.8
5/4/2021	12:00	21.1	8.2	0.18	ND	ND	0.053	ND	ND	0.233	**0.064**	0.14	1.66	1.95	150	1.6	ND	72.8
5/11/2021	11:40	21.2	7.3	0.18	ND	ND	ND	ND	ND	0.18	**0.074**	0.17	1.48	1.84	150	1.1	ND	74.3
5/18/2021	10:20	19.9	7.4	ND	ND	ND	0.060	ND	ND	0.060	**0.059**	0.12	1.32	1.70	140	1.2	**0.0037**	91.6
5/25/2021	10:30	20.1	7.5	0.18	ND	ND	ND	ND	ND	0.18	**0.041**	0.081	1.37	1.90	150	0.91	ND	86.6
6/1/2021	10:20	21.7	7.5	ND	ND	ND	ND	ND	ND	ND	**0.044**	0.10	1.35	1.84	140	1.0	ND	87.8
6/8/2021	9:20	21.5	7.4	ND	ND	ND	ND	ND	ND	ND	**0.050**	0.097	1.31	1.80	130	0.66	ND	120
6/15/2021	9:40	22.1	7.4	0.14	ND	ND	ND	ND	ND	0.14	**0.042**	0.078	1.50	1.79	130	0.82	ND	90.8
6/22/2021	9:30	22.9	7.7	0.18	ND	ND	0.057	ND	ND	0.237	**0.064**	0.14	1.63	1.98	130	1.2	**0.0037**	70.3
6/29/2021	9:10	22.8	7.8	0.18	ND	ND	0.071	ND	ND	0.251	**0.055**	0.11	1.78	1.99	130	1.6	ND	63.6
7/6/2021	9:30	23.1	7.9	0.10	ND	ND	ND	ND	ND	0.10	**0.052**	0.10	1.54	2.13	140	0.93	ND	52.5
7/13/2021	9:40	23.1	7.6	ND	ND	ND	ND	ND	ND	ND	**0.049**	0.095	1.50	1.90	150	0.46	ND	42.9
7/20/2021	10:20	22.8	7.9	0.26	ND	ND	ND	ND	0.26	0.26	**0.046**	0.083	1.48	1.85	160	0.52	**0.0035**	41.4
7/27/2021	9:50	22.1	7.6	ND	ND	ND	ND	ND	ND	ND	**0.046**	0.082	1.62	1.87	140	1.2	ND	36.5
8/3/2021	9:40	22.5	7.8	0.18	ND	ND	0.12	ND	ND	0.30	**0.045**	0.097	1.40	2.08	160	1.1	**0.0040**	43.8
8/10/2021	9:10	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.040**	0.055	1.46	1.80	140	**7.5**	ND	52.2
8/17/2021	9:10	22.8	7.8	0.26	ND	ND	ND	ND	0.26	0.26	**0.038**	0.047	1.46	1.71	170	0.61	ND	47.2
8/24/2021	9:30	20.7	7.6	0.14	ND	ND	0.12	ND	ND	0.26	**0.040**	0.055	1.27	1.62	150	0.97	ND	47.4
8/31/2021	9:40	21.7	7.8	ND	0.32	0.0087	0.11	ND	ND	**0.4387**	**0.026**	0.046	1.22	1.65	160	1.2	ND	33.8
9/7/2021	9:40	21.0	7.5	ND	ND	ND	0.11	ND	ND	0.11	**0.026**	ND	1.75	1.65	160	0.88	ND	37.2
9/14/2021	10:00	20.9	7.7	ND	ND	ND	0.11	ND	ND	0.11	**0.028**	0.032	1.47	1.97	170	0.75	ND	40.5
9/21/2021	9:50	19.8	7.5	ND	ND	ND	ND	ND	ND	ND	0.020	ND	1.42	1.74	140	0.69	ND	48.6
9/23/2021	10:30	19.8	7.7	ND	ND	ND	0.11	ND	ND	0.11	0.019	ND	1.45	1.78	190	0.89	ND	42.5
9/28/2021	9:40	19.1	7.7	0.26	ND	ND	0.12	ND	0.26	**0.38**	**0.025**	ND	1.62	1.66	140	0.70	ND	44.2
9/30/2021	11:10	18.7	7.3	0.44	ND	ND	0.12	ND	0.44	**0.56**	0.018	ND	1.66	1.65	130	0.58	ND	44.4
10/5/2021	9:40	18.4	7.5	0.18	ND	ND	0.12	ND	ND	0.30	0.020	ND	1.45	1.70	150	0.96	**0.0035**	36.6
10/7/2021	9:40	17.8	7.6	0.26	ND	ND	ND	ND	0.26	0.26	0.021	ND	1.56	1.76	140	0.47	ND	38.6
10/12/2021	10:00	15.5	7.6	ND	ND	ND	ND	ND	ND	ND	0.017	ND	1.38	1.50	160	0.64	ND	37.0
10/14/2021	10:10	15.1	7.2	ND	ND	ND	0.13	ND	ND	0.13	0.013	ND	1.17	1.50	150	0.73	ND	38.1
10/19/2021	9:50	14.6	7.3	ND	ND	ND	ND	ND	ND	ND	0.016	ND	1.19	1.64	150	0.53	ND	48.1
11/17/2021	10:10	14.4	7.1	0.35	ND	ND	0.29	ND	0.35	**0.64**	**0.17**	0.43	4.18	4.91	190	**2.7**	ND	684
12/1/2021	10:20	12.3	7.5	3.9	ND	ND	0.12	ND	3.9	**4.0**	**0.061**	0.15	2.73	2.83	190	1.6	ND	293

* 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

Total Nitrogen: 0.38 mg/L

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

Turbidity: 2.34 FTU/NTU

Jimtown did not have any exceedances (0 of 19 or 0%) of the EPA criteria in 2021 (Table 3-6 and Figure 3-24). The maximum seasonal value was 1.6 NTU on 17 November with a flow of approximately 291 cfs (Table 3-6). The minimum seasonal value was ND, which occurred twice on 2 June and 28 July with flows of approximately 38.2 and 35.2 cfs, respectively (Table 3-6). Turbidity values remained consistently low through the monitoring season (Figure 3-24).

Syar Vineyards had three (3) exceedances of the turbidity criteria (3 of 19 or 15.8%) during the monitoring season (Table 3-6 and Figure 3-24). The maximum seasonal value was 4.0 NTU on 20 October with a flow of approximately 115 cfs (Table 3-6 and Figure 3-24). The minimum seasonal value was 0.47 NTU, which occurred 3 March with an estimated flow of approximately 284 cfs (Table 3-6 and Figure 3-24). The USGS near Windsor gaging station had been removed for the season therefore estimated flow is based on a flow of 199 cfs at USGS RR at Healdsburg gage combined with a flow of 85.3 cfs at USGS Dry Creek near Mouth gage. Turbidity values remained low through the monitoring

season before increasing and exceeding the EPA criteria during the last three sampling events in the fall and winter (Figure 3-24).

The Patterson Point station had two (2) exceedances of the turbidity criteria (2 of 34 or 5.9%) during flows of approximately 52.2 and 684 cfs, respectively (Table 3-7 and Figure 3-24). The maximum seasonal value was 7.5 NTU on 10 August with a flow of approximately 52.2 cfs (Table 3-7). The minimum seasonal value was 0.46 NTU on 13 July with a flow of approximately 42.9 cfs (Table 3-7). Other than the August exceedance and a minor spike in November, values were observed to remain consistently low through the monitoring season (Figure 3-24).

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 during the season (34 of 110 samples or 30.9%), most predominantly at Hopland and least predominantly at Patterson Point (Tables 3-5 through 3-7 and Figure 3-25). *Chlorophyll a* values varied through the season with several ND values occurring at all five stations (Figure 3-25).

As mentioned above, lab analysis constraints in 2021 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.

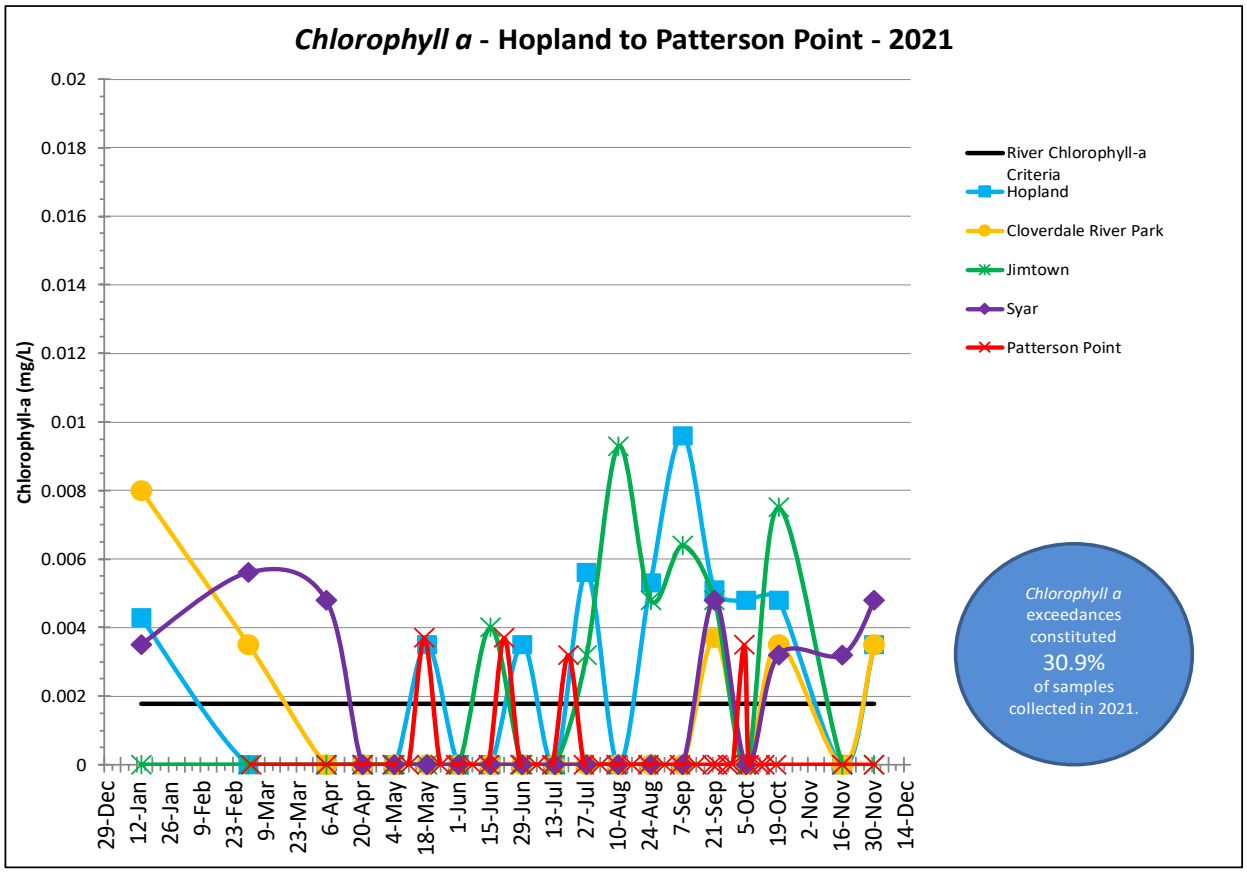
Hopland had ten (10) *chlorophyll a* exceedances (10 of 19 or 52.6%) and nine (9) non-detects, including a maximum value of 0.0096 mg/L that occurred on 8 September with a flow of 56.1 cfs (Table 3-5 and Figure 3-25). Hopland had exceedances periodically throughout the monitoring period, but more predominantly during the summer and fall months.

Cloverdale River Park had five (5) *chlorophyll a* exceedances (5 of 19 or 26.3%) and fourteen (14) non-detects, including a maximum value of 0.0080 mg/L that occurred on 14 January with a flow of 406 cfs (Table 3-5 and Figure 3-25). Exceedances occurred during the early winter monitoring in January and again in the late summer and fall.

Jimtown had seven (7) *chlorophyll a* exceedances (7 of 19 or 36.8%) and twelve (12) non-detects, including a maximum value of 0.0093 mg/L that occurred on 11 August with a flow of 50.4 cfs (Table 3-6 and Figure 3-25). Exceedances at Jimtown primarily occurred during the latter half of the monitoring period in the summer and fall.

Syar Vineyards had seven (7) *chlorophyll a* exceedances (7 of 19 or 36.8%) and twelve (12) non-detects, including a maximum value of 0.056 mg/L that occurred on 3 March with an estimated flow of approximately 284 cfs (Table 3-6 and Figure 3-25). The USGS near Windsor gaging station had been removed for the season, therefore estimated flow is based on a flow of 199 cfs at USGS RR at Healdsburg gage combined with a flow of 85.3 cfs at USGS Dry Creek near Mouth gage. Exceedances at Syar primarily occurred during the early winter and spring months and then in late summer and fall. (Table 3-6 and Figure 3-25)

Patterson Point had five (5) *chlorophyll a* exceedances (5 of 34 or 14.7%) and twenty-nine (29) non-detects, including a maximum value of 0.0040 mg/L that occurred on 3 August with a flow of approximately 43.8 cfs at Hacienda (Table 3-7 and Figure 3-25). Exceedances at Patterson Point occurred periodically throughout the monitoring season (Table 3-7).



Figures 3-25. Sonoma Water Seasonal Mainstem Russian River Grab Sampling *Chlorophyll a* Results in 2021.

3.2 Sonoma Water Russian River Estuary Water Quality Monitoring

The changes in lower Russian River minimum instream flow requirements authorized by the Order allowed flows at Hacienda to decline below D1610 minimum instream flows of 85 cfs for most of the monitoring season (Figure 2-4). Additionally, lower Russian River flows did briefly decline below the TUC minimum flows of 35 cfs, but did not drop below the instantaneous minimum flow of 25 cfs authorized by the Order (Figure 2-4). Long-term water quality monitoring and weekly grab sampling was conducted in the lower, 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.

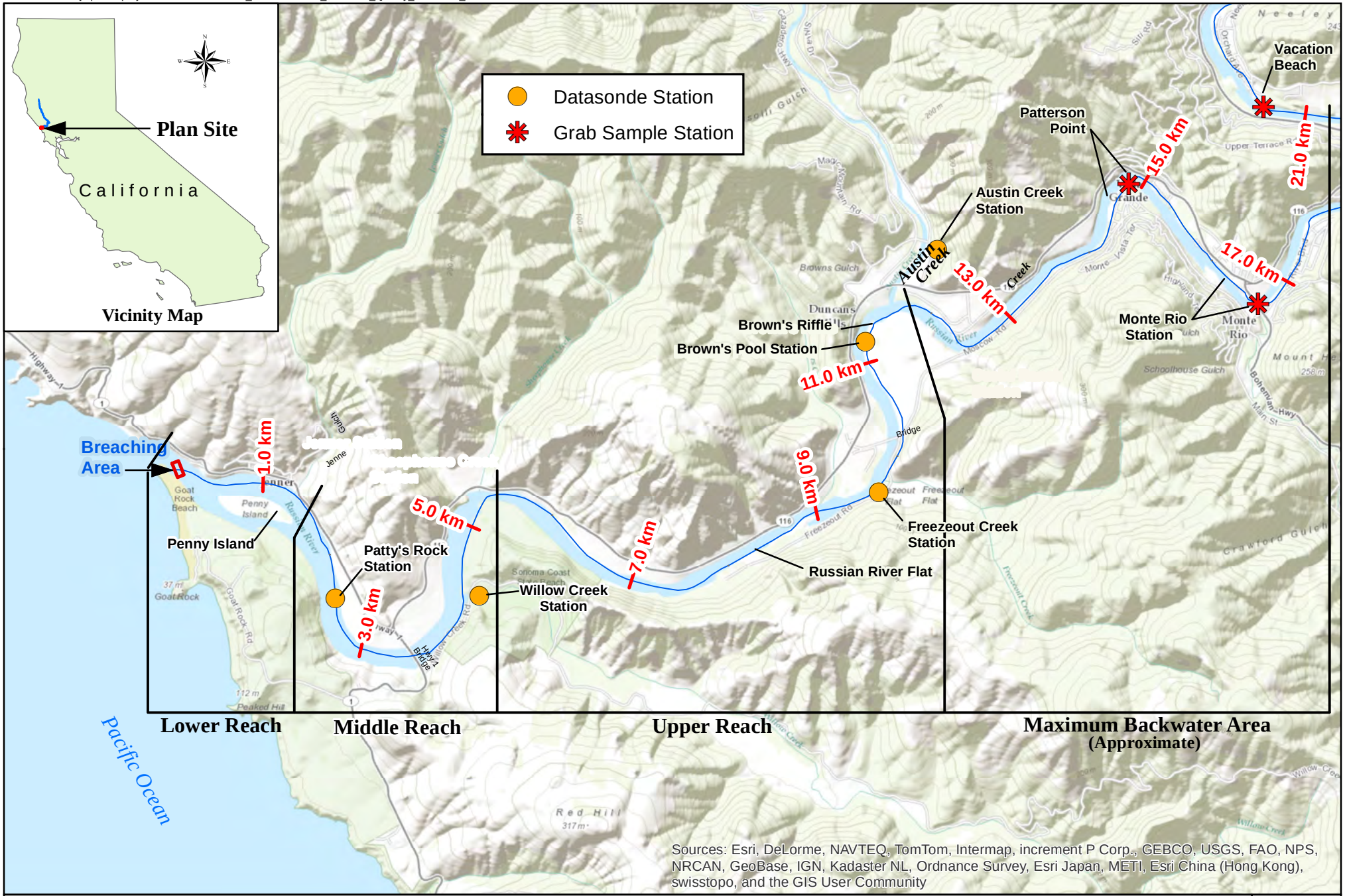
Saline water is denser than freshwater and a salinity "wedge" forms as freshwater outflow passes over the denser tidal inflow. During the lagoon management period (15 May to 15 October), the lower and

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 2021 monitoring season (Figure 3-26). However, drought conditions precluded long-term deployment in Austin Creek as the station went dry in early 2021. 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 2021 is currently being compiled and will be discussed in the Russian River Biological Opinion 2021-2022 annual report, which will be posted to Sonoma Water's website when available: https://www.sonomawater.org/biological-opinion-outreach.

Sonoma Water staff conducted weekly grab sampling from 4 May to 19 October at three stations in the lower mainstem Russian River, including: Vacation Beach, Monte Rio, and Patterson Point (Figure 3-25). Additional grab sampling was conducted at Patterson Point for nutrients, *chlorophyll a*, total and dissolved organic carbon, total dissolved solids, and turbidity in March, April, November, and December. 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.

\\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 3-26

The grab sample sites are shown in Figure 3-26, and the results are summarized in Tables 3-8 through 3-13 and Figures 3-27 through 3-33. 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 2021 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 in 2021 for diluted and undiluted analysis of Total Coliform and *E. coli* for comparative purposes and the results are included in Tables 3-8 through 3-10 and Figures 3-27 and 3-28. Total Coliform and *E. coli* data presented in Figures 3-27 and 3-28 utilize undiluted sample results unless the reporting limit has been exceeded, at which point the diluted results are utilized. Samples collected for *Enterococcus* were undiluted only and results are included in Tables 3-8 through 3-10 and Figure 3-29. 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 87 or 2.3%) of the CDPH guideline for Total Coliform during the 2021 monitoring season at the lower river stations (Tables 3-8 through 3-10 and Figure 3-27). Both exceedances were observed at the Vacation Beach station (2 of 29 or 6.9%), including a maximum value of >24196 MPN/100mL which occurred on 22 June during open estuary conditions and a flow of approximately 70.3 cfs at the Hacienda USGS gage (Table 3-8 and Figure 3-27). The minimum concentration measured 461.1 MPN/100mL on 19 October during closed estuary conditions and a flow of approximately 48.1 cfs at the Hacienda USGS gage (Table 3-8 and Figure 3-27). Aside from the two

exceedances at Vacation Beach, Total Coliform concentrations remained low at all three stations during the monitoring season (Figure 3-27).

Table 3-8. 2021 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)
5/4/2021	13:00	22.4	8.1	816.4	1259	5.2	10	4.1	72.8
5/11/2021	12:20	22.4	7.5	1986.3	2481	8.5	<10	6.3	74.3
5/18/2021	11:10	19.8	7.7	1203.3	1421	13.2	10	24.3	91.6
5/25/2021	11:40	21.1	7.2	980.4	906	12.2	<10	6.3	86.6
6/1/2021	11:20	22.6	7.4	1553.1	1533	9.8	20	7.5	87.8
6/8/2021	10:20	20.6	7.6	1732.9	2064	30.9	52	49.5	120
6/15/2021	10:50	22.7	7.6	2419.6	2187	14.6	10	8.4	90.8
6/22/2021	10:20	23.4	7.9	>2419.6	**>24196**	30.5	31	**190.4**	70.3
6/29/2021	10:10	23.3	7.8	>2419.6	**14136**	21.8	10	31.3	63.6
7/6/2021	10:30	23.1	7.9	>2419.6	5172	48.7	<10	39.9	52.5
7/13/2021	10:40	23.2	7.8	>2419.6	4352	13.2	10	31.8	42.9
7/20/2021	11:40	23.6	8.0	>2419.6	1935	7.5	10	11.0	41.4
7/27/2021	10:50	22.4	7.6	2419.6	2909	9.7	20	13.2	36.5
8/3/2021	10:30	23.0	7.5	>2419.6	2014	67.6	75	22.6	43.8
8/10/2021	10:10	23.3	7.8	2419.6	1616	37.4	31	35.9	52.2
8/17/2021	10:10	23.5	7.7	>2419.6	1860	29.5	52	27.5	47.2
8/24/2021	10:20	21.0	7.7	>2419.6	2098	60.2	31	22.1	47.4
8/31/2021	10:30	22.0	7.7	2419.6	2359	29.5	31	**65.0**	33.8
9/7/2021	10:50	21.4	7.4	1413.6	2046	17.3	31	3.1	37.2
9/14/2021	10:40	21.2	7.6	>2419.6	1281	28.2	20	28.5	40.5
9/21/2021	10:40	19.9	7.3	1986.3	1658	31.8	20	26.9	48.6
9/23/2021	11:20	20.3	7.5	>2419.6	1119	40.8	20	28.5	42.5
9/28/2021	11:00	19.9	8.0	1732.9	1178	6.3	10	9.8	44.2
9/30/2021	12:00	19.9	7.4	1986.3	1500	24.1	10	7.2	44.4
10/5/2021	10:50	18.0	7.7	1413.6	1989	8.5	20	7.5	36.6
10/7/2021	10:40	17.2	7.8	1413.6	1497	31.5	52	8.6	38.6
10/12/2021	10:50	15.5	7.8	629.4	695	34.1	20	19.5	37.0
10/14/2021	10:50	15.5	7.4	727.0	762	24.9	52	22.6	38.1
10/19/2021	10:50	14.3	7.8	461.1	762	30.9	41	22.6	48.1
* 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 Total Coliform concentration observed at Monte Rio was 4611 MPN/100mL, which occurred on 22 June during open estuary conditions and a flow of approximately 70.3 cfs at the Hacienda USGS gage (Table 3-9 and Figure 3-27). The minimum concentration measured 113.6 MPN/100mL on 15 June during open estuary conditions and a flow of approximately 90.8 cfs at the Hacienda USGS gage (Table 3-9 and Figure 3-27).

The maximum Total Coliform concentration observed at Patterson Point was >2419.6 MPN/100mL, which occurred twice on 17 August and 21 September during open estuary conditions and flows of approximately 47.2 and 48.6 cfs, respectively (Table 3-10 and Figure 3-27). The minimum concentration measured 435.2 MPN/100mL on 4 May during closed estuary conditions and a flow of approximately 72.8 cfs at the Hacienda USGS gage (Table 3-10 and Figure 3-27).

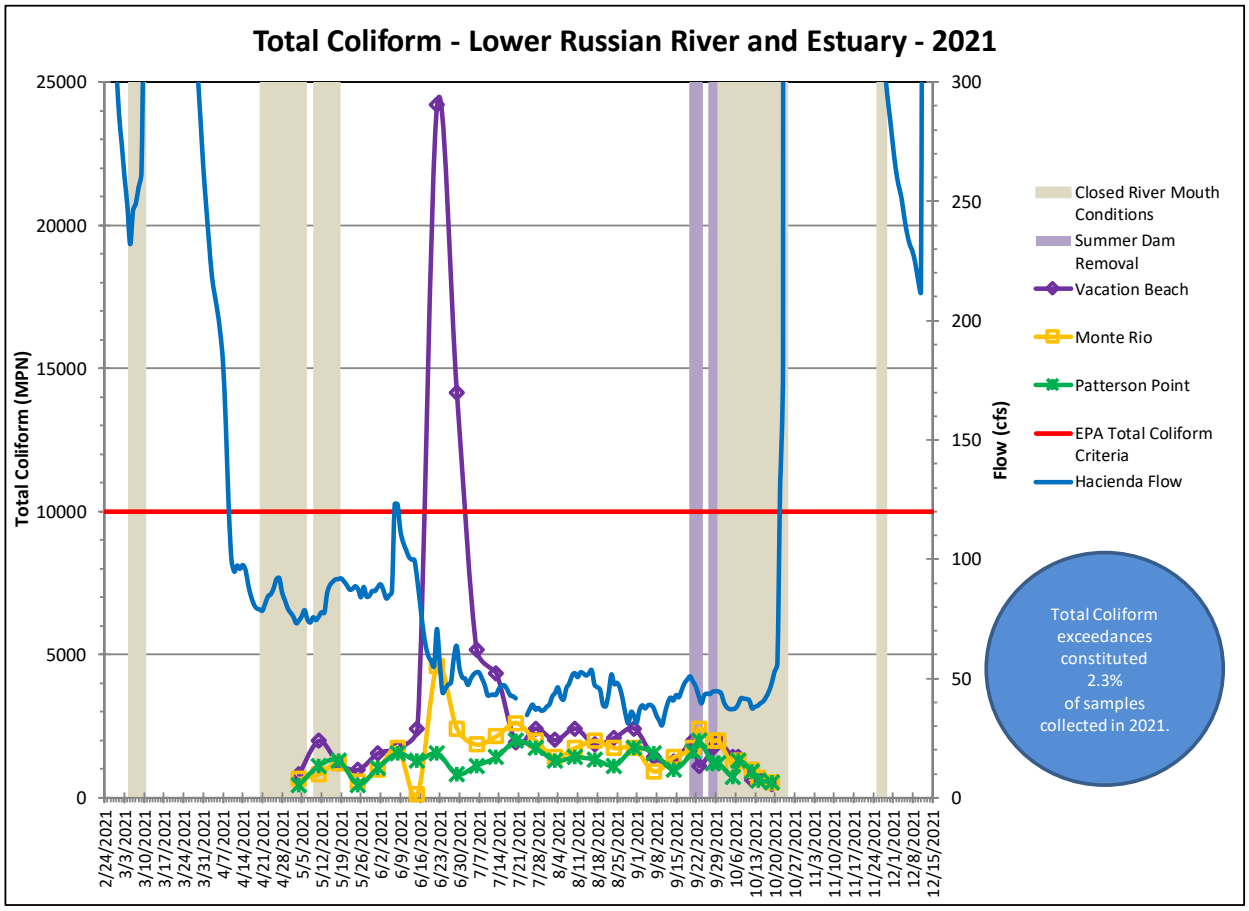


Figure 3-27. Total Coliform results for the Russian River from Vacation Beach to Patterson Point in 2021.

E. coli

There were no exceedances (0 of 87 or 0%) of the EPA criteria for *E. coli* during the 2021 monitoring season at the lower river stations (Tables 3-8 through 3-10 and Figure 3-28).

The maximum *E. coli* concentration observed at Vacation Beach was 67.6 MPN/100mL, which occurred on 3 August during open estuary conditions and a flow of approximately 43.8 cfs at the Hacienda USGS gage (Table 3-8 and Figure 3-28). The minimum concentration measured 5.2 MPN/100mL on 4 May during closed estuary conditions and a flow of approximately 72.8 cfs at the Hacienda USGS gage (Table 3-8 and Figure 3-28).

The maximum *E. coli* concentration observed at Monte Rio was 111.9 MPN/100mL, which occurred on 4 May during closed estuary conditions and a flow of approximately 72.8 cfs at the Hacienda USGS gage (Table 3-9 and Figure 3-28). The minimum concentration measured 2.0 MPN/100mL on 25 May during open estuary conditions and a flow of approximately 86.6 cfs at the Hacienda USGS gage (Table 3-9 and Figure 3-28).

Table 3-9. 2021 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)
5/4/2021	12:30	21.6	8.0	648.8	933	111.9	108	**128.1**	72.8
5/11/2021	12:00	22.0	7.5	816.4	1376	5.2	10	2.0	74.3
5/18/2021	10:50	19.9	7.4	1203.3	1137	14.6	41	4.1	91.6
5/25/2021	11:10	20.6	7.5	579.4	908	2.0	10	4.1	86.6
6/1/2021	10:50	22.5	7.6	980.4	1211	5.2	<10	4.1	87.8
6/8/2021	10:00	21.6	7.6	1732.9	1500	12.1	10	21.3	120
6/15/2021	10:20	22.7	7.5	113.6	1274	17.3	10	18.7	90.8
6/22/2021	10:00	23.2	7.8	>2419.6	4611	73.8	75	**128.1**	70.3
6/29/2021	9:40	23.0	7.6	2419.6	2143	93.2	110	29.5	63.6
7/6/2021	10:10	23.2	7.9	>2419.6	1860	24.9	52	7.5	52.5
7/13/2021	10:10	23.9	7.6	>2419.6	2143	10.7	10	13.4	42.9
7/20/2021	11:10	23.1	7.9	>2419.6	2613	8.4	<10	11.0	41.4
7/27/2021	10:20	21.9	7.5	1986.3	2098	5.2	<10	13.4	36.5
8/3/2021	10:00	22.5	7.7	1413.6	1616	10.9	10	14.5	43.8
8/10/2021	9:50	22.7	7.8	1732.9	1872	22.8	31	26.2	52.2
8/17/2021	9:50	22.9	7.7	1986.3	1935	13.2	10	27.2	47.2
8/24/2021	10:00	20.8	7.7	1732.9	1935	8.4	10	3.1	47.4
8/31/2021	10:00	21.7	7.8	1732.9	1565	10.9	20	20.3	33.8
9/7/2021	10:30	21.1	7.7	920.8	1396	28.8	10	17.5	37.2
9/14/2021	10:20	21.0	7.7	1413.6	1421	4.1	<10	12.1	40.5
9/21/2021	10:20	19.7	7.5	1732.9	1153	30.1	20	53.7	48.6
9/23/2021	10:50	20.0	7.8	2419.6	1664	75.9	75	59.1	42.5
9/28/2021	10:30	19.0	7.7	1986.3	1723	25.3	10	36.4	44.2
9/30/2021	11:40	18.8	7.3	1986.3	1860	67.6	31	53.8	44.4
10/5/2021	10:10	18.2	7.5	1119.9	1354	18.5	20	23.3	36.6
10/7/2021	10:10	17.2	7.6	1299.7	1483	50.4	63	20.3	38.6
10/12/2021	10:30	14.8	7.4	980.4	985	54.6	134	**76.2**	37.0
10/14/2021	10:30	14.8	7.4	686.7	738	42.0	52	21.8	38.1
10/19/2021	10:20	14.1	7.6	547.5	414	33.6	52	39.9	48.1

* 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 72.3 MPN/100mL, which occurred on 21 September during open estuary conditions and a flow of approximately 48.6 cfs at the Hacienda USGS gage (Table 3-10 and Figure 3-28). The minimum concentration measured 1.0 MPN/100mL on 20 July during open estuary conditions and a flow of approximately 41.4 cfs at the Hacienda USGS gage (Table 3-10 and Figure 3-28).

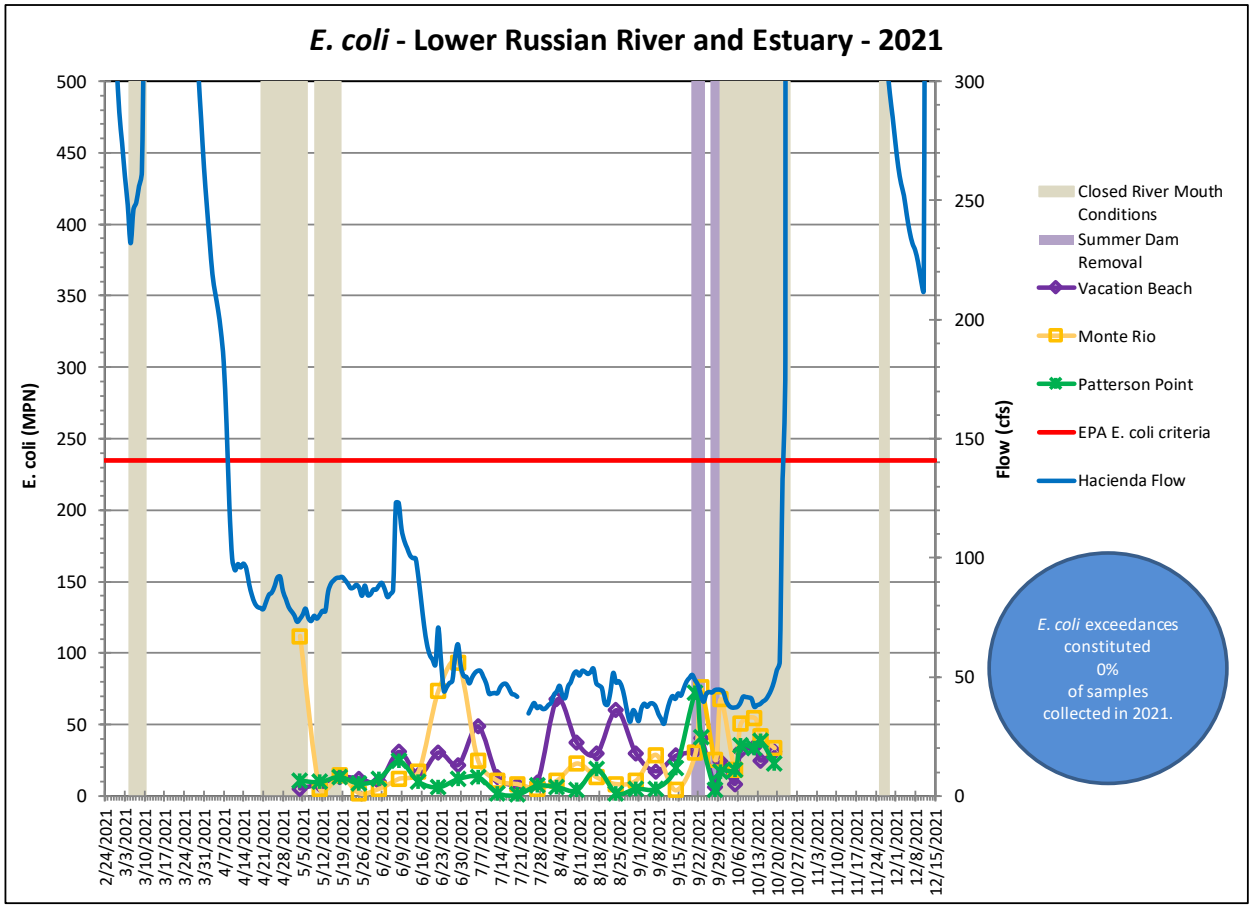


Figure 3-28. *E. coli* results for the Russian River from Vacation Beach to Patterson Point in 2021.

Enterococcus

There were eight (8) exceedances (8 of 87 or 9.2%) of the EPA criteria for *Enterococcus* at the lower river stations in 2021, with flows that ranged from 33.8 to 72.8 cfs at the Hacienda USGS gage (Tables 3-8 through 3-10 and Figure 3-29).

The Vacation Beach station had two (2) exceedances of the EPA criteria for *Enterococcus* (2 of 29 or 6.9%), including a maximum concentration of 190.4 MPN/100mL that occurred on 22 June during open estuary conditions and a flow of approximately 70.3 cfs at the Hacienda USGS gage (Table 3-8 and Figure 3-29). The minimum concentration measured 3.1 MPN/100mL on 7 September during open estuary conditions and a flow of approximately 37.2 cfs at the Hacienda USGS gage (Table 3-8 and Figure 3-29).

The Monte Rio station had three (3) exceedances of the EPA criteria for *Enterococcus* (3 of 29 or 10.4%), including a maximum concentration of 128.1 MPN/100mL that occurred twice, on 4 May and 22 June during closed and open estuary conditions and flows of approximately 72.8 and 70.3 cfs, respectively (Table 3-9 and Figure 3-29). The minimum concentration measured 2.0 MPN/100mL on 11 May during closed estuary conditions and a flow of approximately 74.3 cfs at the Hacienda USGS gage (Table 3-9 and Figure 3-29).

The Patterson Point station had three (3) exceedances of the EPA criteria for *Enterococcus* (3 of 29 or 10.4%), including a maximum concentration of 131.4 MPN/100mL on 31 August during open estuary conditions and a flow of approximately 33.8 cfs at the Hacienda USGS gage (Table 3-10 and Figure 3-29).

The minimum concentration at Patterson Point measured 2.0 MPN/100mL, which occurred twice on 13 July and 27 July during open estuary conditions and flows of approximately 42.9 and 36.5 cfs at the Hacienda USGS gage, respectively (Table 3-10 and Figure 3-29).

External factors including contact recreation, river mouth/estuary closure, and summer dam installation and removal in Guerneville likely had an effect on elevated *Enterococcus* concentrations observed in the Monte Rio to Patterson Point area during the 2021 monitoring season (Figure 3-29).

Table 3-10. 2021 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)
5/4/2021	12:00	21.1	8.2	435.2	650	10.9	10	8.4	72.8
5/11/2021	11:40	21.2	7.3	1119.9	1014	10	10	4.1	74.3
5/18/2021	10:20	19.9	7.4	1299.7	1274	13.5	41	4.1	91.6
5/25/2021	10:30	20.1	7.5	456.9	586	8.6	20	3.0	86.6
6/1/2021	10:20	21.7	7.5	1046.2	906	12.2	30	5.2	87.8
6/8/2021	9:20	21.5	7.4	1553.1	1354	24.6	10	28.8	120
6/15/2021	9:40	22.1	7.4	1299.7	934	10.0	<10	14.8	90.8
6/22/2021	9:30	22.9	7.7	1553.1	1119	6.2	20	8.5	70.3
6/29/2021	9:10	22.8	7.8	816.4	1250	12.0	<10	29.6	63.6
7/6/2021	9:30	23.1	7.9	1119.9	1553	13.4	10	3.0	52.5
7/13/2021	9:40	23.1	7.6	1413.6	248	2.0	<10	2.0	42.9
7/20/2021	10:20	22.8	7.9	1986.3	1935	1.0	<10	5.2	41.4
7/27/2021	9:50	22.1	7.6	1732.9	2143	7.3	20	2.0	36.5
8/3/2021	9:40	22.5	7.8	1299.7	1515	6.3	<10	8.5	43.8
8/10/2021	9:10	22.6	7.8	1413.6	1439	4.1	10	10.7	52.2
8/17/2021	9:10	22.8	7.8	>2419.6	1333	18.9	10	31.8	47.2
8/24/2021	9:30	20.7	7.6	1119.9	1314	2.0	20	5.1	47.4
8/31/2021	9:40	21.7	7.8	1732.9	1720	5.2	<10	**131.4**	33.8
9/7/2021	9:40	21.0	7.5	1553.1	1314	5.2	74	8.6	37.2
9/14/2021	10:00	20.9	7.7	980.4	882	19.3	10	14.5	40.5
9/21/2021	9:50	19.8	7.5	>2419.6	1627	72.3	52	**112.4**	48.6
9/23/2021	10:30	19.8	7.7	1986.3	2481	41.0	75	**73.3**	42.5
9/28/2021	9:40	19.1	7.7	1203.3	1529	4.1	<10	16.8	44.2
9/30/2021	11:10	18.7	7.3	1203.3	1112	17.3	10	17.3	44.4
10/5/2021	9:40	18.4	7.5	727.0	1483	18.5	148	22.6	36.6
10/7/2021	9:40	17.8	7.6	1299.7	1210	35.5	31	23.5	38.6
10/12/2021	10:00	15.5	7.6	920.8	1067	33.6	41	38.8	37.0
10/14/2021	10:10	15.1	7.2	613.1	414	38.8	41	33.6	38.1
10/19/2021	9:50	14.6	7.3	547.5	323	22.6	10	47.1	48.1

* 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

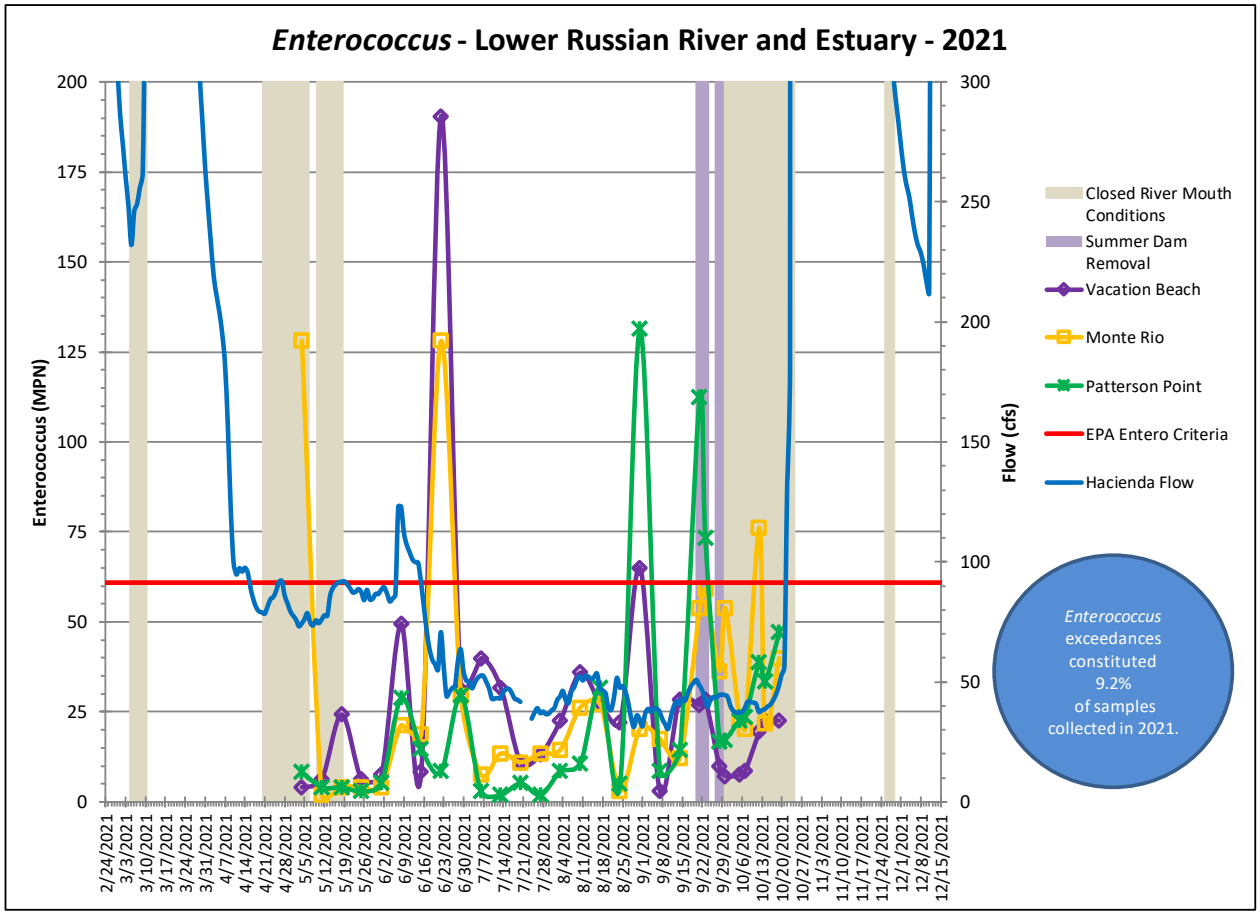


Figure 3-29. *Enterococcus* results for the Russian River from Vacation Beach to Patterson Point in 2021.

Total Nitrogen

There were seven (7) exceedances (7 of 92 or 7.6%) of the EPA criteria for total nitrogen at the lower river stations in 2021, with flows that ranged from 33.8 to 684 cfs at the Hacienda USGS gage (Tables 3-11 through 3-13 and Figure 3-30). Exceedances were observed at Vacation Beach and Patterson Point, but there were no exceedances of the total nitrogen criteria at Monte Rio (Figure 3-29).

The Vacation Beach station had two (2) exceedances of the EPA total nitrogen criteria (2 of 29 or 6.9%), including a maximum concentration of 0.90 mg/L that occurred on 14 October during open estuary conditions and a flow of approximately 38.1 cfs at the Hacienda USGS gage (Table 3-11 and Figure 3-30). The minimum concentration at Vacation Beach was ND, which occurred seven (7) times during open and closed estuary conditions and flows that ranged from approximately 36.5 to 120 cfs (Table 3-11).

There were no exceedances of the total nitrogen criteria at the Monte Rio station in 2021. The maximum total nitrogen concentration observed at Monte Rio was 0.35 mg/L on 20 July during open river mouth/estuary conditions with a flow of approximately 41.4 cfs at the Hacienda USGS gage (Table 3-12 and Figure 3-30). The minimum concentration at Monte Rio was ND, which occurred seven (7) times during open and closed estuary conditions and flows that ranged from approximately 36.5 to 120 cfs (Table 3-12).

The Patterson Point station had five (5) exceedances of the EPA total nitrogen criteria (5 of 34 or 14.7%), including a maximum concentration of 4.0 mg/L that occurred on 1 December during closed estuary

conditions and a flow of approximately 293 cfs at the Hacienda USGS gage (Table 3-13 and Figure 3-30). The minimum concentration at Patterson Point was ND, which occurred eight (8) times during open and closed estuary conditions and flows that ranged from approximately 36.5 to 120 cfs (Table 3-13).

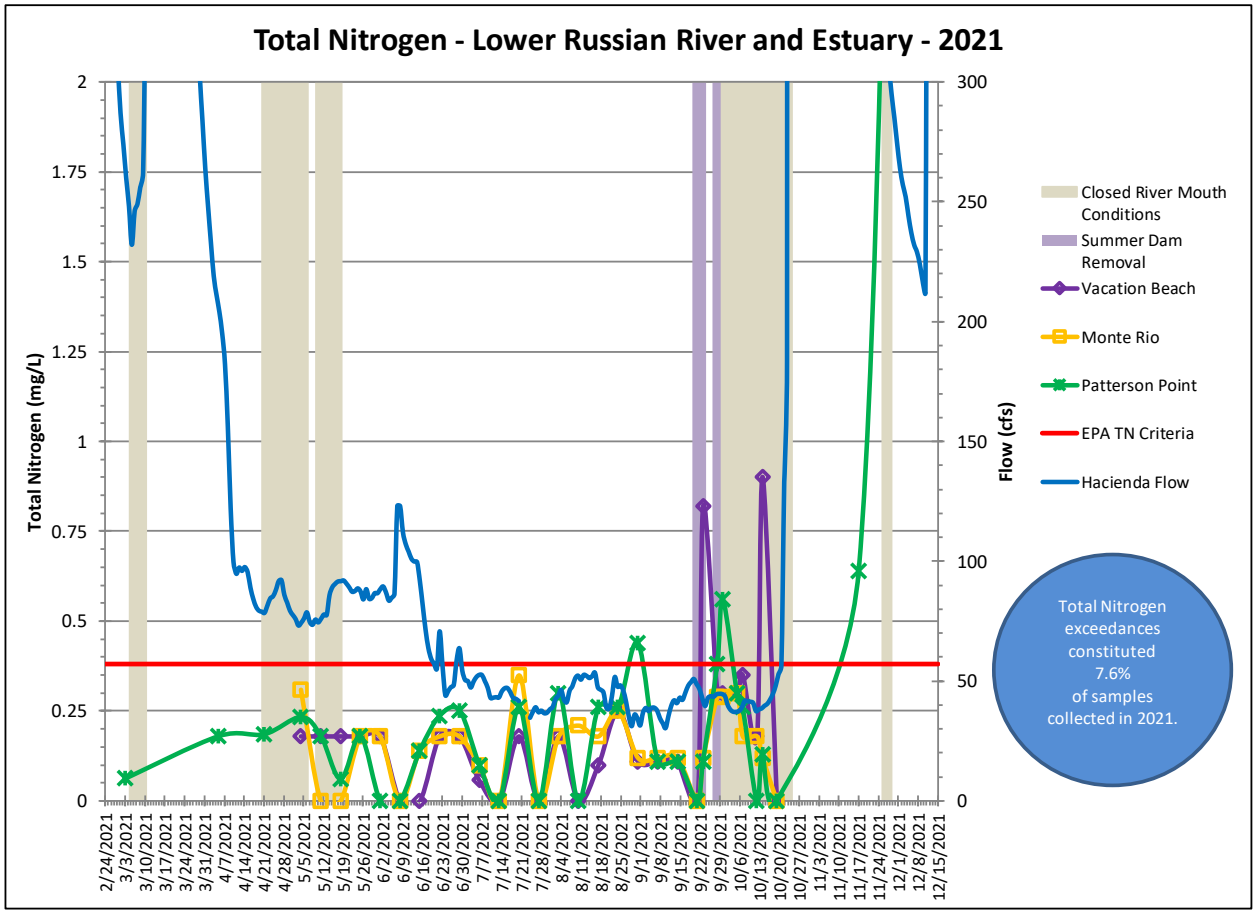


Figure 3-30. Total Nitrogen results for the Russian River from Vacation Beach to Patterson Point in 2021.

Total Phosphorus

All three lower river stations predominantly exceeded the EPA criteria for total phosphorous (66 of 92 or 71.7%) in 2021 with flows that ranged from 33.8 cfs to 684 cfs at the Hacienda USGS gage, continuing a trend of consistent exceedances observed in previous years (Tables 3-11 through 3-13 and Figure 3-31). Exceedances occurred primarily in the spring and summer months, with all three stations experiencing concentrations below the criteria in September and October (Table 3-11 through 3-13). Exceedances occurred during open and closed estuary conditions and generally trended downward through the monitoring season, until increasing with elevated storm flows in November and December as seen at Patterson Point (Figure 3-31).

Vacation Beach had nineteen (19) exceedances of the EPA total phosphorus criteria (19 of 29 or 65.5%), including a maximum concentration of 0.060 mg/L that occurred on 23 September during summer dam removal, open estuary conditions, and a flow of approximately 42.5 cfs at the Hacienda USGS gage (Table 3-11 and Figure 3-31). The minimum concentration at Vacation Beach was 0.013 mg/L, which occurred on 7 September during open estuary conditions and a flow of approximately 37.2 cfs. Finally,

the lowest flow recorded during sampling was approximately 33.8 cfs, which occurred on 31 August during open estuary conditions, with a concentration of 0.017 mg/L (Table 3-11).

Monte Rio had twenty-one (21) exceedances of the EPA total phosphorus criteria (21 of 29 or 72.4%), including a maximum concentration of 0.073 mg/L that occurred on 11 May during closed estuary conditions and a flow of approximately 74.3 cfs at the Hacienda USGS gage (Table 3-12 and Figure 3-31). The minimum concentration at Monte Rio was 0.015 mg/L, which occurred on 12 October during closed estuary conditions and a flow of approximately 37.0 cfs. Finally, the lowest flow recorded during sampling was approximately 33.8 cfs, which occurred on 31 August during open estuary conditions, with a concentration of 0.022 mg/L (Table 3-12).

Patterson Point had twenty-six (26) exceedances of the EPA total phosphorus criteria (26 of 34 or 76.5%), including a maximum concentration of 0.17 mg/L that occurred on 17 November during open estuary conditions and a flow of approximately 684 cfs at the Hacienda USGS gage (Table 3-13 and Figure 3-31). The minimum concentration at Patterson Point was 0.013 mg/L, which occurred on 14 October during closed estuary conditions and a flow of approximately 38.1 cfs (Table 3-13 and Figure 3-31). Finally, the lowest flow recorded during sampling was approximately 33.8 cfs, which occurred on 31 August during open estuary conditions, with a concentration of 0.439 mg/L (Table 3-13).

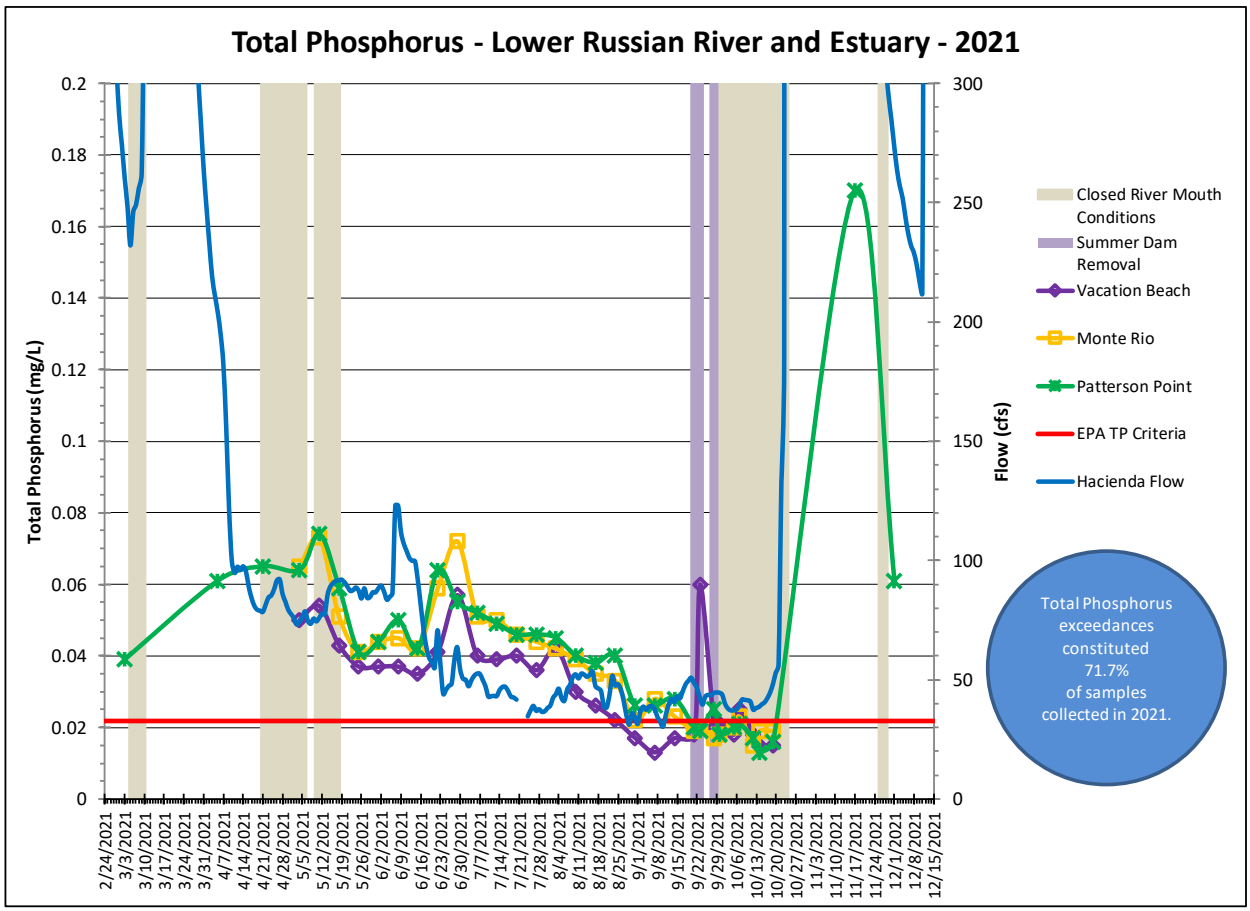


Figure 3-31. Total Phosphorus results for the Russian River from Vacation Beach to Patterson Point in 2021.

Turbidity

The EPA criteria for turbidity was exceeded four times at Vacation Beach and twice each at Monte Rio and Patterson Point (8 of 92 or 8.7%) during the 2021 monitoring season (Tables 3-11 through 3-13). Exceedances were observed to periodically occur throughout the monitoring season with open and closed estuary conditions, summer dam removal, and Hacienda flows ranging from 36.5 cfs to 684 cfs (Figure 3-32). Turbidity values were generally higher at Vacation Beach than at the other stations, and are a result of increased turbulence from streamflow over the Vacation Beach summer dam and through the fish ladder just upstream of the monitoring location.

The maximum turbidity value observed at Vacation Beach was 3.1 NTU on 23 September during open estuary conditions and summer dam removal, with a flow of approximately 42.5 cfs at the Hacienda USGS gage (Table 3-11 and Figure 3-32). The minimum value at Vacation Beach was 0.40 NTU, which occurred on 20 July during open estuary conditions and a flow of approximately 41.4 cfs. Finally, the lowest flow recorded during sampling was approximately 33.8 cfs, which occurred on 31 August, with a value of 0.87 NTU.

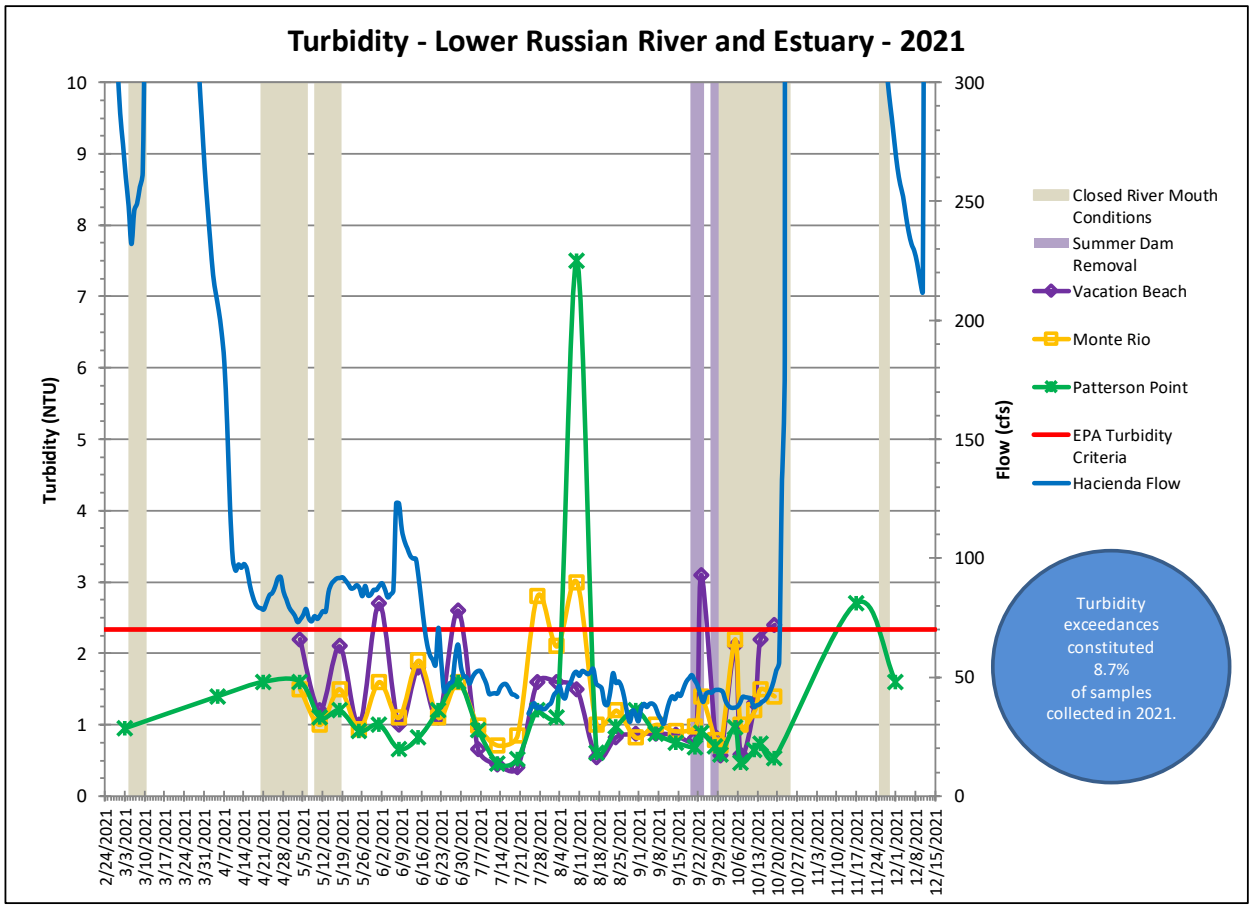


Figure 3-32. Turbidity results for the Russian River from Vacation Beach to Patterson Point in 2021.

The maximum turbidity value observed at Monte Rio was 3.0 NTU on 10 August during open estuary conditions and a Hacienda flow of approximately 52.2 cfs (Table 3-12 and Figure 3-32). The minimum value at Monte Rio was 0.71 NTU, which occurred twice during the monitoring season (Table 3-12). First on 13 July during open estuary conditions and flows of approximately 42.9 cfs and again on 30

September during closed estuary conditions and a flow of approximately 44.4 cfs. Finally, the lowest flow recorded during sampling was approximately 33.8 cfs, which occurred on 31 August, with a value of 0.82 NTU.

The maximum turbidity value observed at Patterson Point was 7.5 NTU on 10 August during open estuary conditions and a flow of approximately 52.2 cfs at the Hacienda USGS gage (Table 3-13 and Figure 3-32). The minimum value at Patterson Point was 0.46 NTU, which occurred on 13 July during open estuary conditions and a flow of approximately 42.9 cfs at the Hacienda USGS gage. Finally, the lowest flow recorded during sampling was approximately 33.8 cfs, which occurred on 31 August, with a value of 1.2 NTU.

Chlorophyll a

Algal (*chlorophyll a*) results exceeded the EPA criteria ten (10) times at Vacation Beach and five (5) times each at Monte Rio and Patterson Point (20 of 92 or 21.7%) under open and closed estuary conditions, summer dam removal, and Hacienda flows that ranged from 36.6 to 91.6 cfs (Tables 3-11 through 3-13 and Figure 3-33). *Chlorophyll a* values varied through the monitoring season with several ND values occurring at all three stations, including during estuary closure in May and October (Figure 3-33).

As mentioned above, lab analysis constraints in 2021 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 was 0.0083 mg/L on 23 September during closed estuary conditions, summer dam removal, and a Hacienda flow of approximately 42.5 cfs (Table 3-11 and Figure 3-33). The minimum value at Vacation Beach was ND, which occurred nineteen (19) times throughout the season during open and closed estuary conditions and flows that ranged from 33.8 to 120 cfs (Table 3-11). *Chlorophyll a* values at Vacation Beach were sporadic throughout the monitoring season before increasing during summer dam removal and estuary closure in October (Figure 3-33).

The maximum *Chlorophyll a* concentration observed at Monte Rio was 0.063 mg/L on 23 September during closed estuary conditions, summer dam removal, and a flow of approximately 42.5 cfs at the Hacienda USGS gage (Table 3-12 and Figure 3-33). *Chlorophyll a* exceedances occurred during the second half of the monitoring season in September and October during open and closed estuary conditions and summer dam removal (Figure 3-33). The minimum value at Monte Rio was ND, which occurred twenty four (24) times through the monitoring season during open and closed estuary conditions with flows that ranged from 33.8 to 120 cfs (Table 3-12).

The maximum *Chlorophyll a* concentration observed at Patterson Point was 0.0040 mg/L on 3 August during open estuary conditions and a flow of approximately 43.8 cfs at the Hacienda USGS gage (Table 3-13 and Figure 3-33). The minimum value at Patterson Point was ND, which occurred twenty nine (29) times through the season, during open and closed estuary conditions, summer dam removal, and flows

that ranged from 33.8 to 684 cfs (Table 3-13). *Chlorophyll a* exceedances were sporadic at Patterson Point through the monitoring season (Figure 3-33).

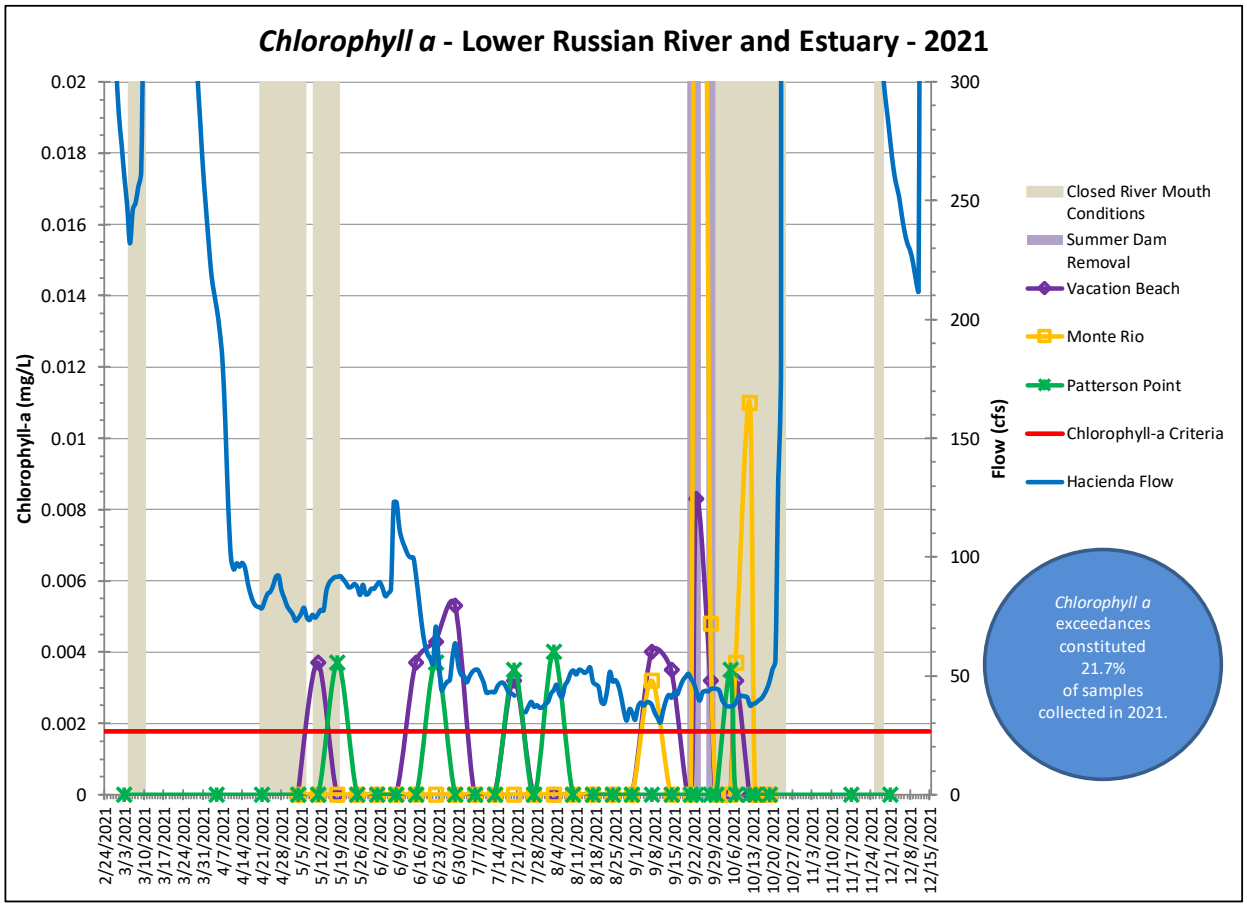


Figure 3-33. *Chlorophyll a* results for the Russian River from Vacation Beach to Patterson Point in 2021.

Table 3-11. 2021 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*				0.20	0.10	0.00010	0.040	0.050	0.20	0.50	0.010	0.030	0.600	0.300	10	0.10	0.0010	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)
5/4/2021	13:00	22.4	8.1	0.18	ND	ND	ND	ND	ND	0.18	**0.050**	0.11	1.44	1.83	140	2.2	ND	72.8
5/11/2021	12:20	22.4	7.5	0.18	ND	ND	ND	ND	ND	0.18	**0.054**	0.12	1.66	1.74	160	1.2	**0.0037**	74.3
5/18/2021	11:10	19.8	7.7	0.18	ND	ND	ND	ND	ND	0.18	**0.043**	0.075	1.53	1.61	80	2.1	ND	91.6
5/25/2021	11:40	21.1	7.2	0.18	ND	ND	ND	ND	ND	0.18	**0.037**	0.069	1.20	1.69	140	1.0	ND	86.6
6/1/2021	11:20	22.6	7.4	0.18	ND	ND	ND	ND	ND	0.18	**0.037**	0.071	1.59	1.84	140	**2.7**	ND	87.8
6/8/2021	10:20	20.6	7.6	ND	ND	ND	ND	ND	ND	ND	**0.037**	0.052	1.30	1.68	120	1.0	ND	120
6/15/2021	10:50	22.7	7.6	ND	ND	ND	ND	ND	ND	ND	**0.035**	0.053	1.39	1.74	140	1.8	**0.0037**	90.8
6/22/2021	10:20	23.4	7.9	0.18	ND	ND	ND	ND	ND	0.18	**0.041**	0.073	1.72	2.16	150	1.1	**0.0043**	70.3
6/29/2021	10:10	23.3	7.8	0.18	ND	ND	ND	ND	ND	0.18	**0.057**	0.10	1.57	2.14	130	**2.6**	**0.0053**	63.6
7/6/2021	10:30	23.1	7.9	ND	ND	ND	0.057	ND	ND	0.057	**0.040**	0.074	1.59	1.96	140	0.66	ND	52.5
7/13/2021	10:40	23.2	7.8	ND	ND	ND	ND	ND	ND	ND	**0.039**	0.066	1.54	1.94	130	0.44	ND	42.9
7/20/2021	11:40	23.6	8.0	0.18	ND	ND	ND	ND	ND	0.18	**0.040**	0.063	1.49	1.77	140	0.40	**0.0032**	41.4
7/27/2021	10:50	22.4	7.6	ND	ND	ND	ND	ND	ND	ND	**0.036**	0.054	1.73	1.83	130	1.6	ND	36.5
8/3/2021	10:30	23.0	7.5	0.18	ND	ND	ND	ND	ND	0.18	**0.042**	0.056	1.33	1.84	140	1.6	ND	43.8
8/10/2021	10:10	23.3	7.8	ND	ND	ND	ND	ND	ND	ND	**0.030**	0.039	1.60	1.66	140	1.5	ND	52.2
8/17/2021	10:10	23.5	7.7	0.10	ND	ND	ND	ND	ND	0.10	**0.026**	0.031	1.56	1.60	140	0.54	ND	47.2
8/24/2021	10:20	21.0	7.7	0.14	ND	ND	0.11	ND	ND	0.25	**0.022**	0.031	1.21	1.51	150	0.83	ND	47.4
8/31/2021	10:30	22.0	7.7	ND	ND	ND	0.11	ND	ND	0.11	0.017	0.038	1.12	1.66	160	0.87	ND	33.8
9/7/2021	10:50	21.4	7.4	ND	ND	ND	0.11	ND	ND	0.11	0.013	ND	1.49	1.65	160	0.88	**0.0040**	37.2
9/14/2021	10:40	21.2	7.6	ND	ND	ND	0.11	ND	ND	0.11	0.017	ND	1.52	1.90	140	0.86	**0.0035**	40.5
9/21/2021	10:40	19.9	7.3	ND	ND	ND	ND	ND	ND	ND	0.018	ND	1.43	1.78	130	0.81	ND	48.6
9/23/2021	11:20	20.3	7.5	0.70	ND	ND	0.12	ND	0.70	**0.82**	**0.060**	0.038	1.30	1.76	130	**3.1**	**0.0083**	42.5
9/28/2021	11:00	19.9	8.0	0.18	ND	ND	0.12	ND	ND	0.30	0.020	0.039	1.24	1.62	140	0.84	**0.0032**	44.2
9/30/2021	12:00	19.9	7.4	0.18	ND	ND	0.12	ND	ND	0.30	0.021	0.031	1.37	1.55	150	0.57	ND	44.4
10/5/2021	10:50	18.0	7.7	0.18	ND	ND	0.12	ND	ND	0.30	0.018	ND	1.57	1.54	140	2.1	ND	36.6
10/7/2021	10:40	17.2	7.8	0.35	ND	ND	ND	ND	0.35	0.35	**0.025**	ND	1.25	1.60	150	0.58	**0.0032**	38.6
10/12/2021	10:50	15.5	7.8	0.18	ND	ND	ND	ND	ND	0.18	0.018	ND	1.13	1.45	140	1.3	ND	37.0
10/14/2021	10:50	15.5	7.4	0.79	ND	ND	0.11	ND	0.79	**0.90**	0.015	0.031	1.09	1.34	140	2.2	ND	38.1
10/19/2021	10:50	14.3	7.8	ND	ND	ND	ND	ND	ND	ND	0.015	0.12	1.14	1.46	140	**2.4**	ND	48.1

* 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 3-12. 2021 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*				0.20	0.10	0.00010	0.040	0.050	0.20	0.50	0.010	0.030	0.600	0.300	10	0.10	0.0010	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)
5/4/2021	12:30	21.6	8.0	0.26	ND	ND	0.053	ND	0.26	0.31	**0.065**	0.15	1.54	1.87	170	1.5	ND	72.8
5/11/2021	12:00	22.0	7.5	ND	ND	ND	ND	ND	ND	ND	**0.073**	0.18	1.40	1.85	150	1.0	ND	74.3
5/18/2021	10:50	19.9	7.4	ND	ND	ND	ND	ND	ND	ND	**0.051**	0.13	1.19	1.60	1100	1.5	ND	91.6
5/25/2021	11:10	20.6	7.5	0.18	ND	ND	ND	ND	ND	0.18	**0.041**	0.081	1.25	1.78	140	0.94	ND	86.6
6/1/2021	10:50	22.5	7.6	0.18	ND	ND	ND	ND	ND	0.18	**0.044**	0.088	1.31	1.86	140	1.6	ND	87.8
6/8/2021	10:00	21.6	7.6	ND	ND	ND	ND	ND	ND	ND	**0.045**	0.089	1.65	1.75	130	1.1	ND	120
6/15/2021	10:20	22.7	7.5	0.14	ND	ND	ND	ND	ND	0.14	**0.042**	0.078	1.42	1.85	140	1.9	ND	90.8
6/22/2021	10:00	23.2	7.8	0.18	ND	ND	ND	ND	ND	0.18	**0.059**	0.12	1.59	2.11	130	1.10	ND	70.3
6/29/2021	9:40	23.0	7.6	0.18	ND	ND	ND	ND	ND	0.18	**0.072**	0.077	1.58	2.40	130	1.6	ND	63.6
7/6/2021	10:10	23.2	7.9	0.10	ND	ND	ND	ND	ND	0.10	**0.051**	0.090	1.58	2.03	160	0.99	ND	52.5
7/13/2021	10:10	23.9	7.6	ND	ND	ND	ND	ND	ND	ND	**0.050**	0.083	1.59	1.90	140	0.71	ND	42.9
7/20/2021	11:10	23.1	7.9	0.35	ND	ND	ND	ND	0.35	0.35	**0.046**	0.083	1.45	1.85	150	0.85	ND	41.4
7/27/2021	10:20	21.9	7.5	ND	ND	ND	ND	ND	ND	ND	**0.044**	0.070	1.58	1.90	140	**2.8**	ND	36.5
8/3/2021	10:00	22.5	7.7	0.18	ND	ND	ND	ND	ND	0.18	**0.042**	0.064	1.36	2.03	150	2.1	ND	43.8
8/10/2021	9:50	22.7	7.8	0.21	ND	ND	ND	ND	0.21	0.21	**0.039**	0.051	1.36	1.73	140	**3.0**	ND	52.2
8/17/2021	9:50	22.9	7.7	0.18	ND	ND	ND	ND	ND	0.18	**0.035**	0.039	1.35	1.65	150	1.0	ND	47.2
8/24/2021	10:00	20.8	7.7	0.14	ND	ND	0.11	ND	ND	0.25	**0.033**	0.039	1.20	1.59	140	1.2	ND	47.4
8/31/2021	10:00	21.7	7.8	ND	ND	ND	0.12	ND	ND	0.12	**0.022**	0.038	1.23	1.72	160	0.82	ND	33.8
9/7/2021	10:30	21.1	7.7	ND	ND	ND	0.12	ND	ND	0.12	**0.028**	ND	1.47	1.67	170	1.0	**0.0032**	37.2
9/14/2021	10:20	21.0	7.7	ND	ND	ND	0.12	ND	ND	0.12	**0.023**	ND	1.51	1.89	130	0.91	ND	40.5
9/21/2021	10:20	19.7	7.5	ND	ND	ND	ND	ND	ND	ND	0.019	ND	1.40	1.76	150	0.98	ND	48.6
9/23/2021	10:50	20.0	7.8	ND	ND	ND	0.12	ND	ND	0.12	0.020	ND	1.44	1.74	170	1.4	**0.063**	42.5
9/28/2021	10:30	19.0	7.7	0.18	ND	ND	0.11	ND	ND	0.29	0.017	ND	1.34	1.65	150	0.79	**0.0048**	44.2
9/30/2021	11:40	18.8	7.3	0.18	ND	ND	0.11	ND	ND	0.29	0.018	ND	1.40	1.62	140	0.71	ND	44.4
10/5/2021	10:10	18.2	7.5	0.18	ND	ND	0.12	ND	ND	0.30	0.020	ND	1.43	1.66	150	2.2	ND	36.6
10/7/2021	10:10	17.2	7.6	0.18	ND	ND	ND	ND	ND	0.18	**0.023**	ND	1.23	1.63	140	1.0	**0.0037**	38.6
10/12/2021	10:30	14.8	7.4	0.18	ND	ND	ND	ND	ND	0.18	0.015	ND	1.16	1.46	140	1.2	**0.011**	37.0
10/14/2021	10:30	14.8	7.4	ND	ND	ND	0.12	ND	ND	0.12	0.019	0.039	1.12	1.41	150	1.5	ND	38.1
10/19/2021	10:20	14.1	7.6	ND	ND	ND	ND	ND	ND	ND	0.019	0.030	1.10	1.53	130	1.4	ND	48.1

* 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 3-13. 2021 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*				0.20	0.10	0.00010	0.040	0.050	0.20	0.50	0.010	0.030	0.600	0.300	10	0.10	0.0010	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)
3/3/2021	9:50	11.6	7.4	ND	ND	ND	0.062	ND	ND	0.062	**0.039**	0.076	1.92	1.97	160	0.95	ND	276
4/5/2021	10:30	15.8	7.1	0.18	ND	ND	ND	ND	ND	0.18	**0.061**	0.14	1.73	2.06	160	1.4	ND	215
4/21/2021	9:50	18.6	7.5	0.14	ND	ND	0.045	ND	ND	0.185	**0.065**	0.17	1.66	1.91	170	1.6	ND	76.8
5/4/2021	12:00	21.1	8.2	0.18	ND	ND	0.053	ND	ND	0.233	**0.064**	0.14	1.66	1.95	150	1.6	ND	72.8
5/11/2021	11:40	21.2	7.3	0.18	ND	ND	ND	ND	ND	0.18	**0.074**	0.17	1.48	1.84	150	1.1	ND	74.3
5/18/2021	10:20	19.9	7.4	ND	ND	ND	0.060	ND	ND	0.060	**0.059**	0.12	1.32	1.70	140	1.2	**0.0037**	91.6
5/25/2021	10:30	20.1	7.5	0.18	ND	ND	ND	ND	ND	0.18	**0.041**	0.081	1.37	1.90	150	0.91	ND	86.6
6/1/2021	10:20	21.7	7.5	ND	ND	ND	ND	ND	ND	ND	**0.044**	0.10	1.35	1.84	140	1.0	ND	87.8
6/8/2021	9:20	21.5	7.4	ND	ND	ND	ND	ND	ND	ND	**0.050**	0.097	1.31	1.80	130	0.66	ND	120
6/15/2021	9:40	22.1	7.4	0.14	ND	ND	ND	ND	ND	0.14	**0.042**	0.078	1.50	1.79	130	0.82	ND	90.8
6/22/2021	9:30	22.9	7.7	0.18	ND	ND	0.057	ND	ND	0.237	**0.064**	0.14	1.63	1.98	130	1.2	**0.0037**	70.3
6/29/2021	9:10	22.8	7.8	0.18	ND	ND	0.071	ND	ND	0.251	**0.055**	0.11	1.78	1.99	130	1.6	ND	63.6
7/6/2021	9:30	23.1	7.9	0.10	ND	ND	ND	ND	ND	0.10	**0.052**	0.10	1.54	2.13	140	0.93	ND	52.5
7/13/2021	9:40	23.1	7.6	ND	ND	ND	ND	ND	ND	ND	**0.049**	0.095	1.50	1.90	150	0.46	ND	42.9
7/20/2021	10:20	22.8	7.9	0.26	ND	ND	ND	ND	0.26	0.26	**0.046**	0.083	1.48	1.85	160	0.52	**0.0035**	41.4
7/27/2021	9:50	22.1	7.6	ND	ND	ND	ND	ND	ND	ND	**0.046**	0.082	1.62	1.87	140	1.2	ND	36.5
8/3/2021	9:40	22.5	7.8	0.18	ND	ND	0.12	ND	ND	0.30	**0.045**	0.097	1.40	2.08	160	1.1	**0.0040**	43.8
8/10/2021	9:10	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.040**	0.055	1.46	1.80	140	**7.5**	ND	52.2
8/17/2021	9:10	22.8	7.8	0.26	ND	ND	ND	ND	0.26	0.26	**0.038**	0.047	1.46	1.71	170	0.61	ND	47.2
8/24/2021	9:30	20.7	7.6	0.14	ND	ND	0.12	ND	ND	0.26	**0.040**	0.055	1.27	1.62	150	0.97	ND	47.4
8/31/2021	9:40	21.7	7.8	ND	0.32	0.0087	0.11	ND	ND	**0.439**	**0.026**	0.046	1.22	1.65	160	1.2	ND	33.8
9/7/2021	9:40	21.0	7.5	ND	ND	ND	0.11	ND	ND	0.11	**0.026**	ND	1.75	1.65	160	0.88	ND	37.2
9/14/2021	10:00	20.9	7.7	ND	ND	ND	0.11	ND	ND	0.11	**0.028**	0.032	1.47	1.97	170	0.75	ND	40.5
9/21/2021	9:50	19.8	7.5	ND	ND	ND	ND	ND	ND	ND	0.020	ND	1.42	1.74	140	0.69	ND	48.6
9/23/2021	10:30	19.8	7.7	ND	ND	ND	0.11	ND	ND	0.11	0.019	ND	1.45	1.78	190	0.89	ND	42.5
9/28/2021	9:40	19.1	7.7	0.26	ND	ND	0.12	ND	0.26	**0.38**	**0.025**	ND	1.62	1.66	140	0.70	ND	44.2
9/30/2021	11:10	18.7	7.3	0.44	ND	ND	0.12	ND	0.44	**0.56**	0.018	ND	1.66	1.65	130	0.58	ND	44.4
10/5/2021	9:40	18.4	7.5	0.18	ND	ND	0.12	ND	ND	0.30	0.020	ND	1.45	1.70	150	0.96	**0.0035**	36.6
10/7/2021	9:40	17.8	7.6	0.26	ND	ND	ND	ND	0.26	0.26	0.021	ND	1.56	1.76	140	0.47	ND	38.6
10/12/2021	10:00	15.5	7.6	ND	ND	ND	ND	ND	ND	ND	0.017	ND	1.38	1.50	160	0.64	ND	37.0
10/14/2021	10:10	15.1	7.2	ND	ND	ND	0.13	ND	ND	0.13	0.013	ND	1.17	1.50	150	0.73	ND	38.1
10/19/2021	9:50	14.6	7.3	ND	ND	ND	ND	ND	ND	ND	0.016	ND	1.19	1.64	150	0.53	ND	48.1
11/17/2021	10:10	14.4	7.1	0.35	ND	ND	0.29	ND	0.35	**0.64**	**0.17**	0.43	4.18	4.91	190	**2.7**	ND	684
12/1/2021	10:20	12.3	7.5	3.9	ND	ND	0.12	ND	3.9	**4.0**	**0.061**	0.15	2.73	2.83	190	1.6	ND	293

* 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

The mainstem Russian River experienced less rainfall and lower flows in 2021 compared to Normal Water Year flow rates. These lower flows from a dry winter and spring resulted in a Dry Water Year designation that allowed D1610 flows to be reduced to the Dry Water Year minimum flow rates. This Dry Water Year condition, coupled with significantly low levels of water supply storage in Lake Mendocino, precipitated the request and issuing of a TUC Order to reduce minimum instream flow requirements below D1610 Dry Water Year requirements to preserve water storage in Lake Mendocino.

Monitoring conducted for the TUC Order was similar (methods, locations) to monitoring conducted in past years when TUC Orders have been issued in response to dry watershed conditions and low reservoir storage levels, as well as to comply with Biological Opinion proposed mainstem flows.

Based on the assemblage of data collected by Sonoma County DHS, USACE, CDFW, USGS, and Sonoma Water, it does not appear that lower flows observed in 2021 negatively affected water quality or the availability of aquatic habitat, or provided a significant contribution to biostimulatory conditions when compared to data collected during years with Normal Water Year flow rates, such as 2019.

A brief comparison of several streamflow data points from 2019; a Normal Water Year under D1610, and 2021; a dry to critically dry water year, is provided for context. The 2019 data is available in the Russian River Water Quality Summary for the 2019 Temporary Urgency Change (Sonoma Water, 2020).

The 2019 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 3-34).

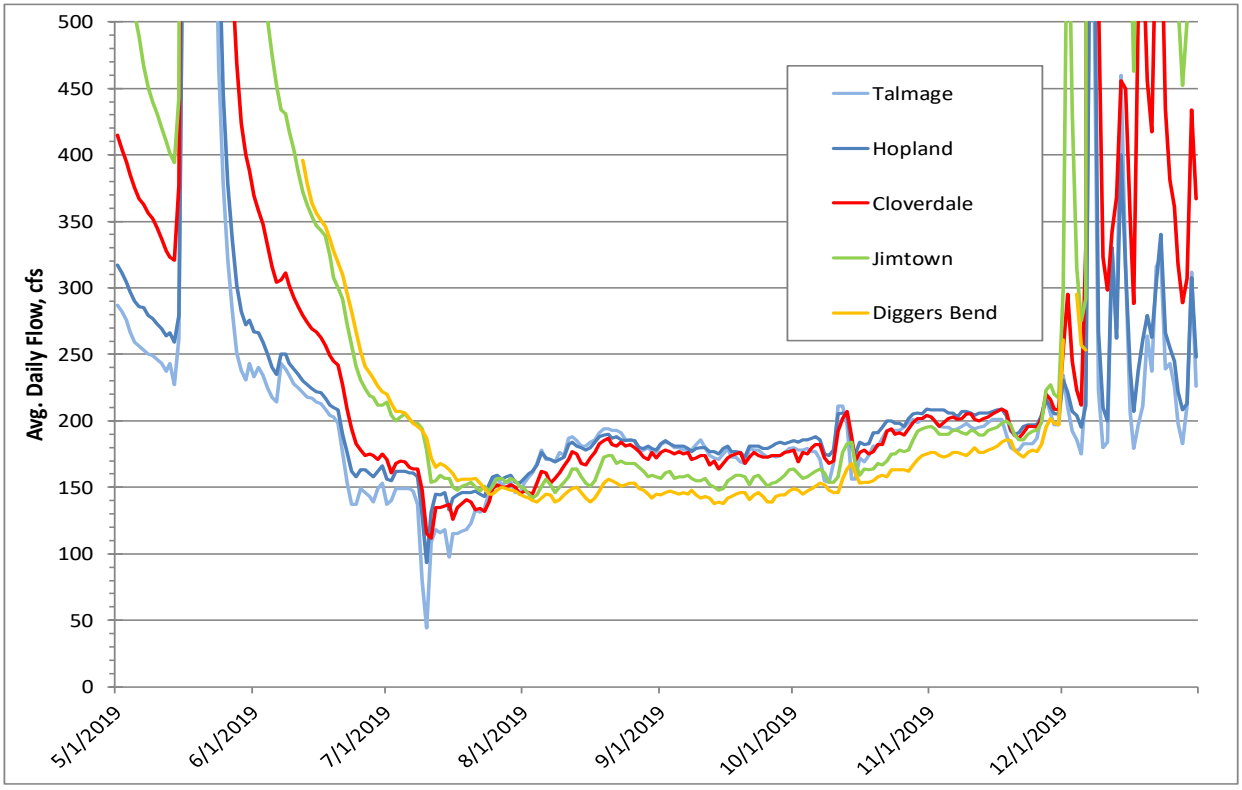


Figure 3-34. 2019 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Whereas, 2021 daily average flows in the upper river between Talmage and Diggers Bend generally ranged between 25 and 75 cfs during the months of June through October until storms increased flows significantly in late October (Figure 3-35).

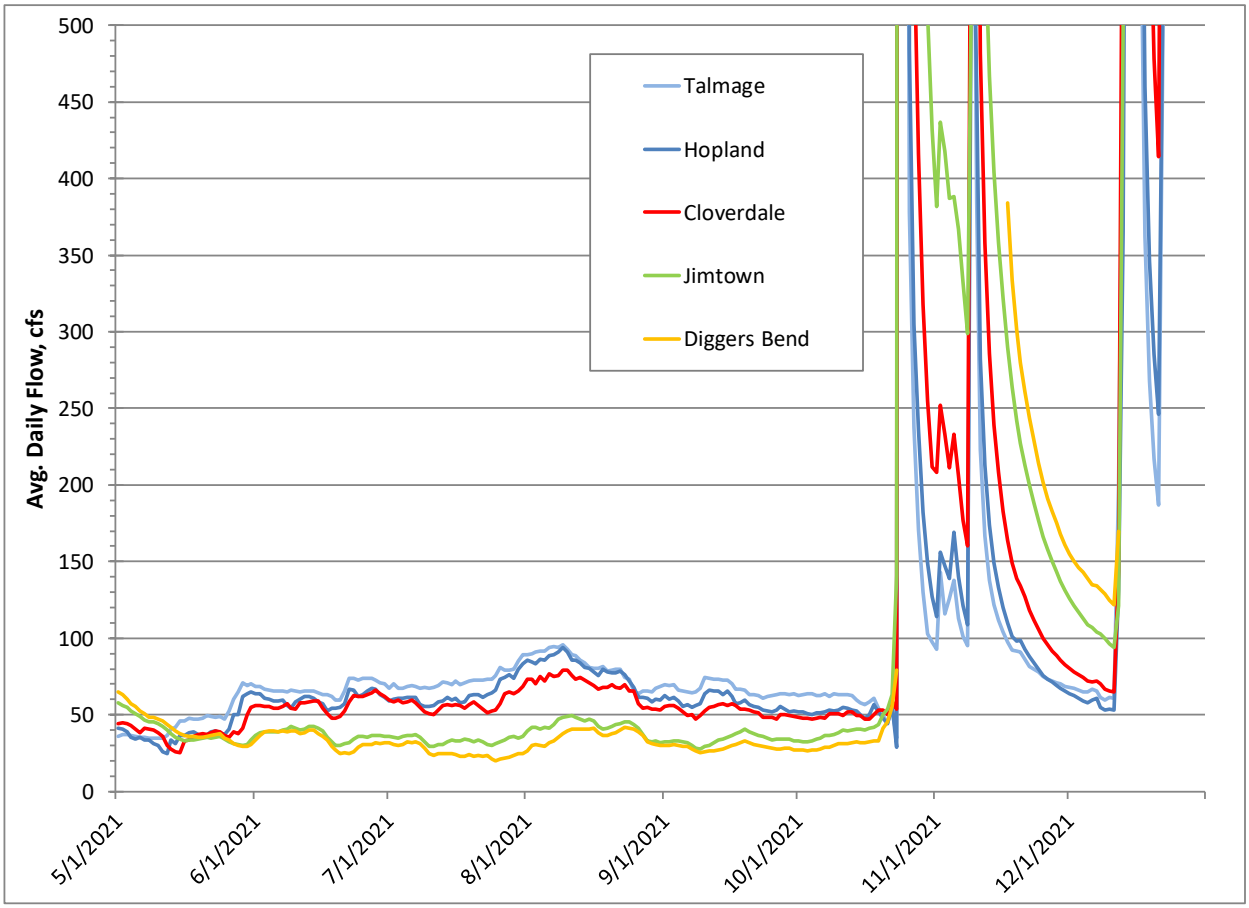


Figure 3-35. 2021 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

In the lower river, a late season storm in 2019 significantly elevated flows from approximately 600 cfs to over 3000 cfs at Hacienda in mid-May. Flows remained above 500 cfs into early June, resulting in mainstem flows decreasing to base summertime flows later in the dry season compared to previous years, including 2021 (Figure 3-36).

In contrast, a dry winter and spring in 2021 resulted in flows at Hacienda decreasing to about 75 cfs in early May. Flows continued to decrease through the season to between 30 and 50 cfs by late June, where they remained until late October storms significantly increased flows (Figure 3-36).

Summertime base flows in the lower river at Hacienda remained above 150 cfs in 2019, whereas summertime base flows in 2021 were generally below 50 cfs (Figure 3-36).

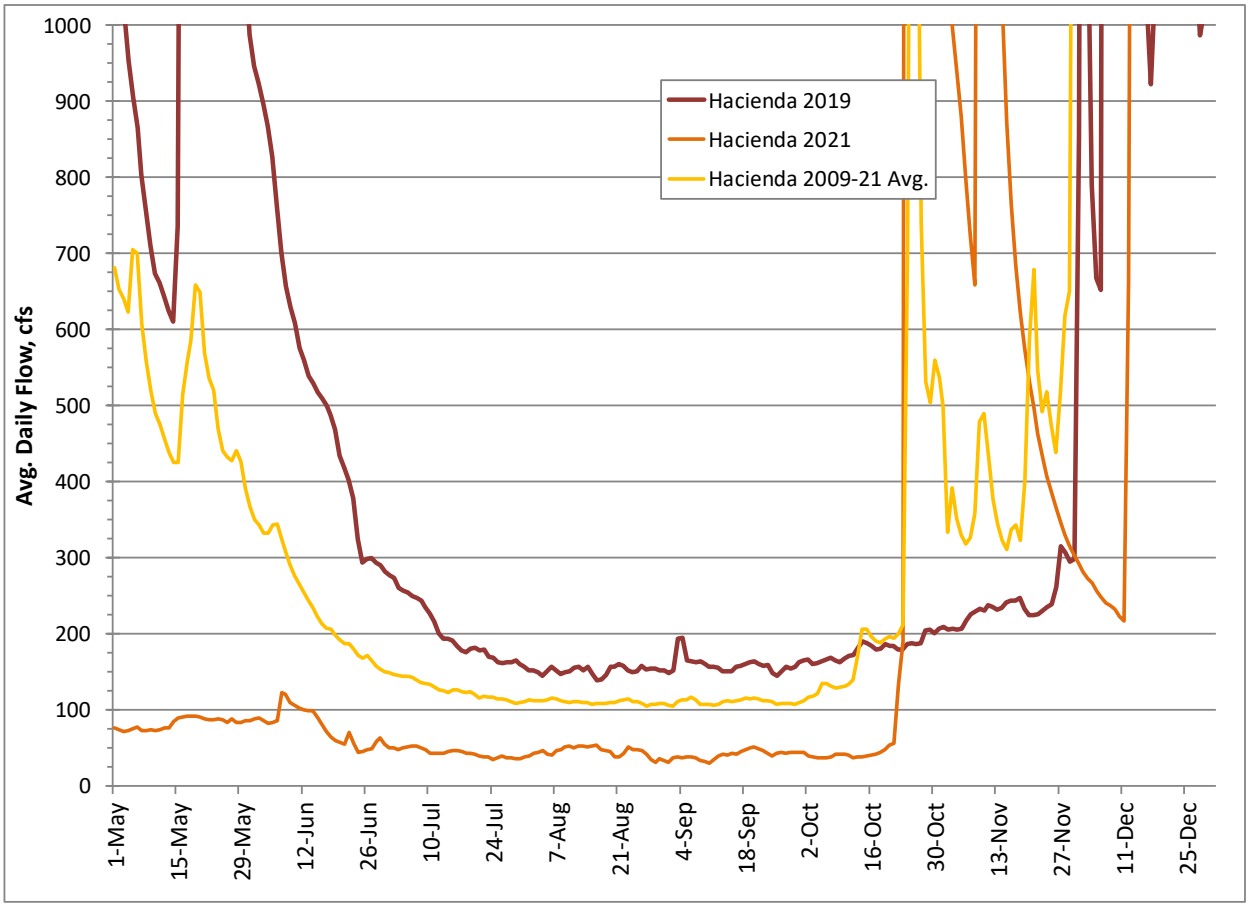


Figure 3-36. Comparison of 2019, 2021 and 2009-2021 average daily flows in the Lower Russian River as measured at USGS Hacienda gage in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Overall, observed exceedances of EPA and CDPH criteria in the upper and lower river were less frequent, and concentrations were generally lower in 2021 compared with 2019. Included below is a brief discussion and comparison of some of the data collected in 2019 and 2021 that demonstrate that lower flows in 2021 did not negatively affect water quality or the availability of aquatic habitat, or significantly contribute to biostimulatory conditions compared to Normal Water Years, including 2019.

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 2021 with the exception of the Cloverdale River Park station, which experienced twelve (12) exceedances of the total coliform criteria out of 21 samples collected (57.1%). The other nine stations had six (6) total coliform exceedances out of 165 total samples collected (3.6%). Even with the inclusion of Cloverdale River Park, total exceedances reported by Sonoma County DHS were only 18 out of 186 total samples collected (9.7%) at the ten beach monitoring stations. Similarly, in 2021 Sonoma County DHS reported eight (8) *E. coli* exceedance out of 186 total samples collected (4.3%) at the ten 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 2021, Sonoma Water reported two (2) total coliforms exceedances out

of 87 total samples collected (2.3%) and zero (0) *E. coli* exceedances out of 87 total samples collected (0%) at the three lower river stations.

DHS did not conduct cyanotoxin monitoring at the ten beach monitoring stations in 2019 or 2021 so there are no comparative values.

The TUC Order required recommendations for minimizing cyanoHAB outbreaks during the current and future water years under similar flow conditions to those experienced under the Order. 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 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. Staff would also support US Army Corps of Engineers (USACE) efforts to address elevated turbidity issues associated with Lake Mendocino releases and improve water clarity in the upper Russian River.

Total nitrogen exceedances and concentrations at the upper river stations were fairly consistent from 2019 to 2021, with 2019 having ten (10) exceedances of 49 total samples (20.4%) and 2021 having thirteen (13) exceedances of 76 total samples (17.1%). Hopland was also observed to have the most total nitrogen exceedances of the four upper river stations in 2019 and in 2021.

Total nitrogen exceedances in 2019 and 2021 were also consistent at the lower river stations of Vacation Beach, Monte Rio, and Patterson Point, with 2019 experiencing eight (8) exceedances of 75 total samples (10.6%) and 2021 experiencing seven (7) exceedances of 92 samples (7.6%). However, total nitrogen concentrations were observed to be slightly higher in 2021 than in 2019, especially during summer dam removal and closed estuary conditions in late September.

Total phosphorus concentrations and numbers of exceedances were fairly consistent from 2019 to 2021 in Hopland, Cloverdale, and Syar but were significantly lower in Jimtown and to a lesser degree at Syar in 2021. In 2019, Jimtown had six (6) exceedances of 12 samples collected (50%) and Syar had 11 exceedances of 18 samples collected (61.1%). Whereas in 2021, Jimtown had two (2) exceedances out of 19 samples collected (10.5%) and Syar had seven (7) exceedances out of 19 samples collected

(36.8%). Total phosphorus exceedances and concentrations at the three lower river stations were consistently high in 2019 and 2021, with values typically declining in September and October during both years. These exceedances in both 2019 and 2021 continue a pattern of chronic elevated total phosphorus in the lower river area.

Turbidity values in the upper river were significantly lower in 2021 than in 2019, especially at Hopland and Cloverdale. Turbidity values at Hopland 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 2021, Hopland only had seven (7) exceedances of 19 samples (36.8%), with most values below 5 NTU and a maximum of 16 NTU. Cloverdale also exceeded the criteria through the entire 2019 season (7 of 7 or 100%) with a maximum value of 15 NTU. Although Cloverdale had a maximum value of 15 NTU in 2021 as well, it occurred during elevated early winter flows in January. Additionally, Cloverdale only experienced two (2) exceedances out of 19 samples collected (10.5%) in 2021. Jimtown had six (6) exceedances of 12 samples collected (50%) and a maximum value of 6.6 NTU in 2019, but zero (0) exceedances of 19 samples collected (0%) and a maximum value of 1.6 NTU in 2021. Syar had 14 exceedances of 18 samples collected (77.8%) with a maximum value of 30 NTU in 2019, but only had three (3) exceedances of 19 samples collected (15.8%) and a maximum value of 4.0 NTU in 2021.

Turbidity values were significantly lower at Vacation Beach, Monte Rio and Patterson Point in 2021 compared to 2019, especially during the first half of the monitoring season. Vacation Beach had 20 exceedances out of 25 samples collected (80%) in 2019 compared with four (4) exceedances of 29 samples collected (13.8%) in 2021. Monte Rio had nine (9) exceedances of 25 samples collected (36%) in 2019 compared with two (2) exceedances of 29 samples collected (6.9%) in 2021. Patterson Point had eleven (11) exceedances of 25 samples collected (44%) in 2019 compared with two (2) exceedances of 34 samples collected (5.9%) in 2021. The majority of exceedances at Monte Rio and Patterson Point in 2019 occurred during the first half of the season when flows were still elevated from late season storms in May. Whereas exceedances in 2021 occurred periodically through the season with flows ranging from 36.5 to 684 cfs.

A comparison of *chlorophyll a* exceedances between 2019 and 2021 is not possible due to the higher lab MDL for *chlorophyll a* concentrations in 2021 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 2021 (10 of 19 or 52.6%) than in 2019 (2 of 12 or 16.7%) and concentrations were generally higher in 2021. *Chlorophyll a* concentrations that were quantifiable in 2021 were also slightly higher in the upper river compared to 2019. This may have been influenced by the increased clarity of the water and lower turbidity in 2021 allowing for greater light penetration into the water column.

Again, a comparison of *chlorophyll a* exceedances between 2019 and 2021 is not possible due to the higher lab MDL for *chlorophyll a* concentrations in 2021. However, maximum *chlorophyll a* concentrations were somewhat similar in the lower river in 2021 compared to 2019, even with improved water clarity. In 2019, the maximum value at Vacation Beach was 0.0069 mg/L, compared with a maximum value of 0.0083 mg/L in 2021. In 2019, the maximum value at Monte Rio was 0.11 mg/L, compared with a maximum value of 0.063 mg/L in 2021. Finally, the maximum value at Patterson Point in 2019 was 0.0064 mg/L, compared with a maximum value of 0.0040 mg/L in 2021.

Chlorophyll a exceedances in the lower river in 2019 occurred predominantly during the first half of the season while flows were still elevated from late season storms. Whereas, *chlorophyll a* exceedances were periodic at Patterson Point and Vacation Beach in 2021, and occurred more predominantly during summer dam removal and estuary closure at Monte Rio in September and October.

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. In addition, Sonoma Water 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 2021 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 Sonoma Water and USGS Russian River Permanent and Seasonal Datasonde Monitoring Stations

NORTH

0 1.25 2.5 5 Miles

Sonoma Water

4.2 Aquatic Habitat for Salmonids

4.2.1 Introduction

In Term 7 of the Temporary Urgency Change Order (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 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, temperature, and dissolved oxygen (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 follow 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

Wild 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 the 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 are mainstem spawners and deposit their eggs into the stream bed of the mainstem Russian River and in Dry Creek during the fall (Chase et al. 2005 and 2007, Cook 2003, Martini-Lamb and Manning 2011). 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 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, CA) and in the east fork Russian River 0.5 km downstream of Coyote Valley Dam, near Ukiah, CA. These sondes were operated by Sonoma Water. 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).

For the east fork downstream of Coyote Valley Dam, 12 days of data were missing in late August. Water temperature and dissolved oxygen was interpolated for these missing dates in order to calculate the 7-day running averages for these two parameters. Water temperature and dissolved oxygen were not reported for dates where the 7-day running average contained more than 3 days of interpolated data.

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) thresholds 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.

4.2.4 Results

Flow

The Spring 2021 TUCO went into effect on June 14 and expired on December 11, 2021. During that period, flow at Hacienda ranged from a high of 19,300 cfs on October 25, to a low of 30 cfs on August 29. Flow during the Order was typically between 41 cfs and 239 cfs (25th and 75th percentiles of the daily average flow at Hacienda). During the Order, the Russian River was generally controlled by reservoir releases and not strongly influenced by tributary in-flow until late October. After late October flow in the Russian River was mainly comprised of tributary inflow.

Temperature

Adult Salmonid Migration

The underwater video camera at the Mirabel dam was installed on September 1, 2021. However, a large storm occurred on October 24, 2021 (Figure 4-1). At approximately 2,000 cfs flow in the river becomes too high to operate the inflatable dam as well as the underwater video equipment used to count returning adult salmonids. Flow at the Hacienda gage approached 20,000 cfs following the rain event in late October and became much too high to operate the video equipment. Because this event occurred during the very early stages of the typical adult migration season, few adults were observed and will therefore not be reported.

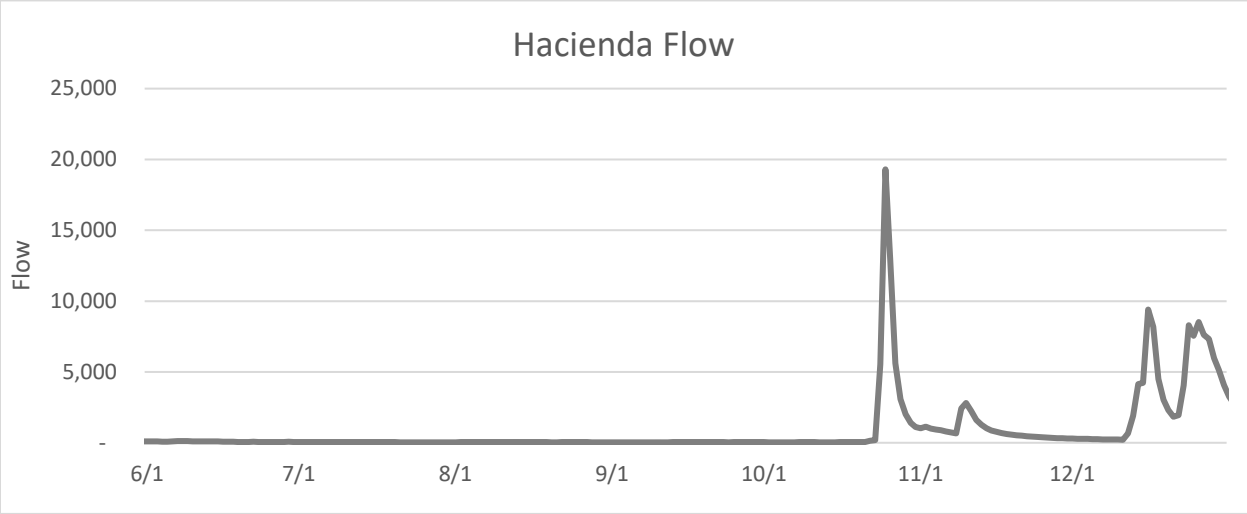


Figure 4-1. Flow in the Russian River at the USGS Hacienda stream gage (11467000).

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 optimal 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 Jimtown (Figures 4-2 through 4-5).

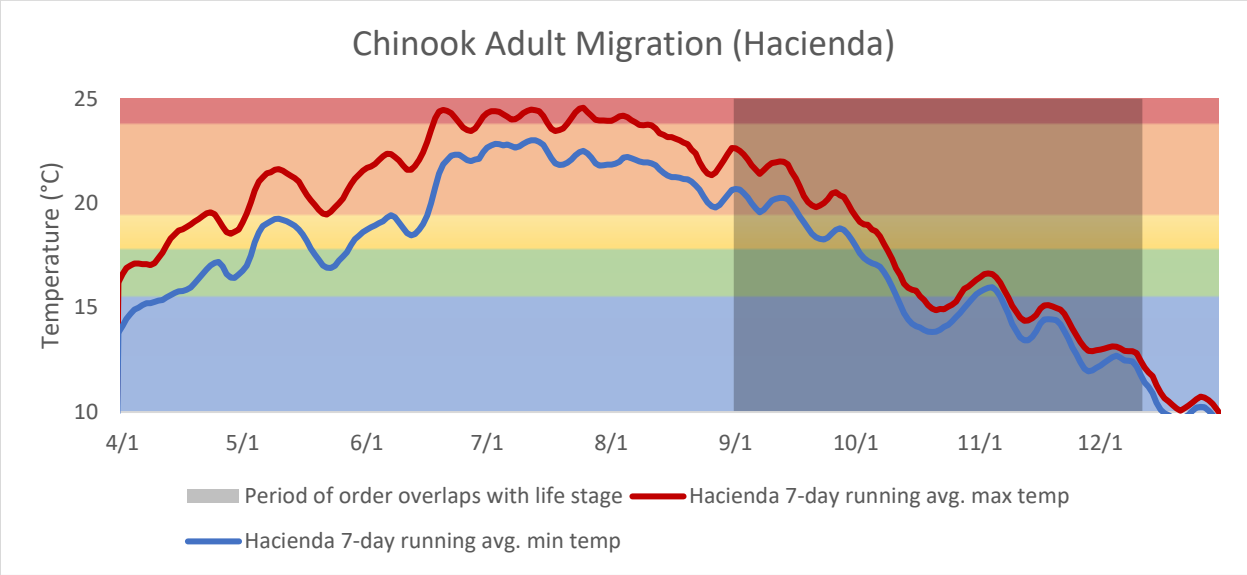


Figure 4-2. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult Chinook based on Table 4-1.

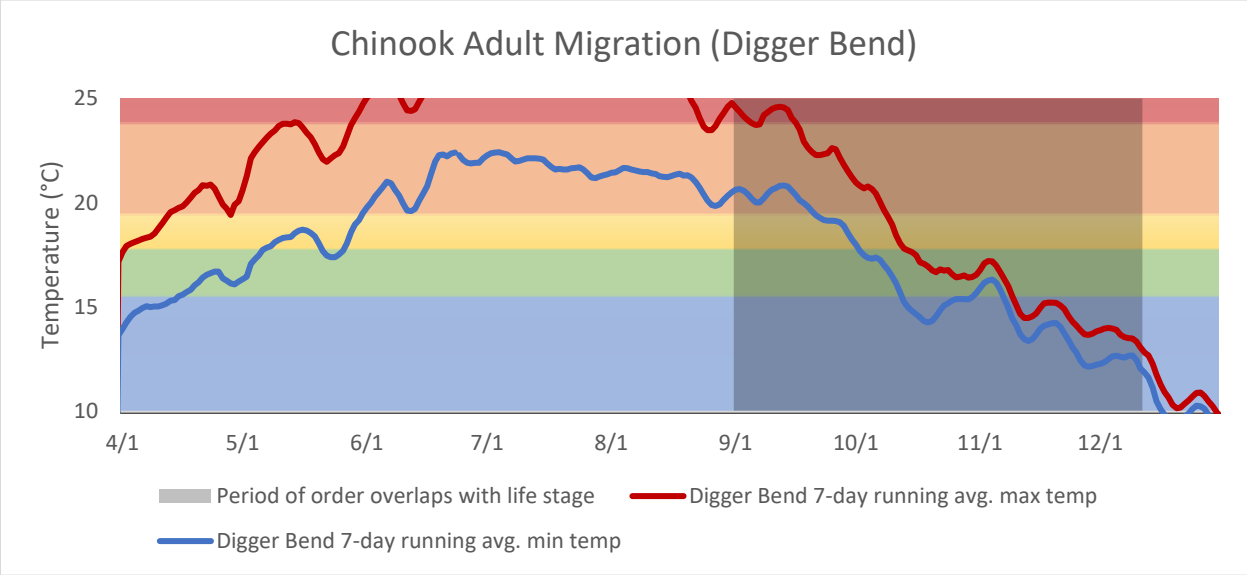


Figure 4-3. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

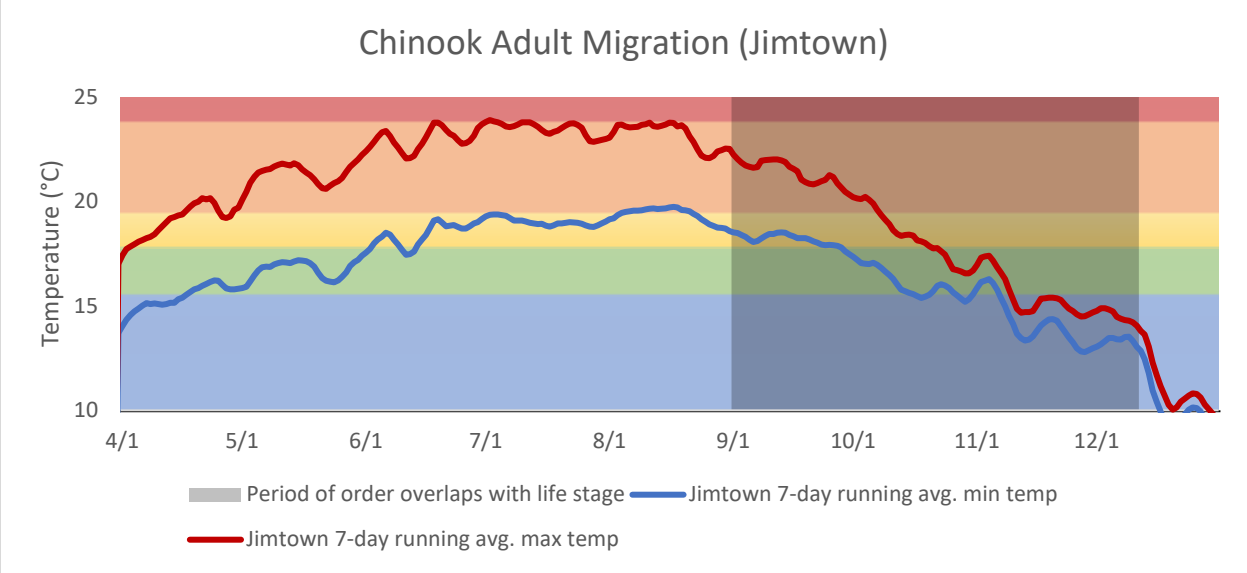


Figure 4-4. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

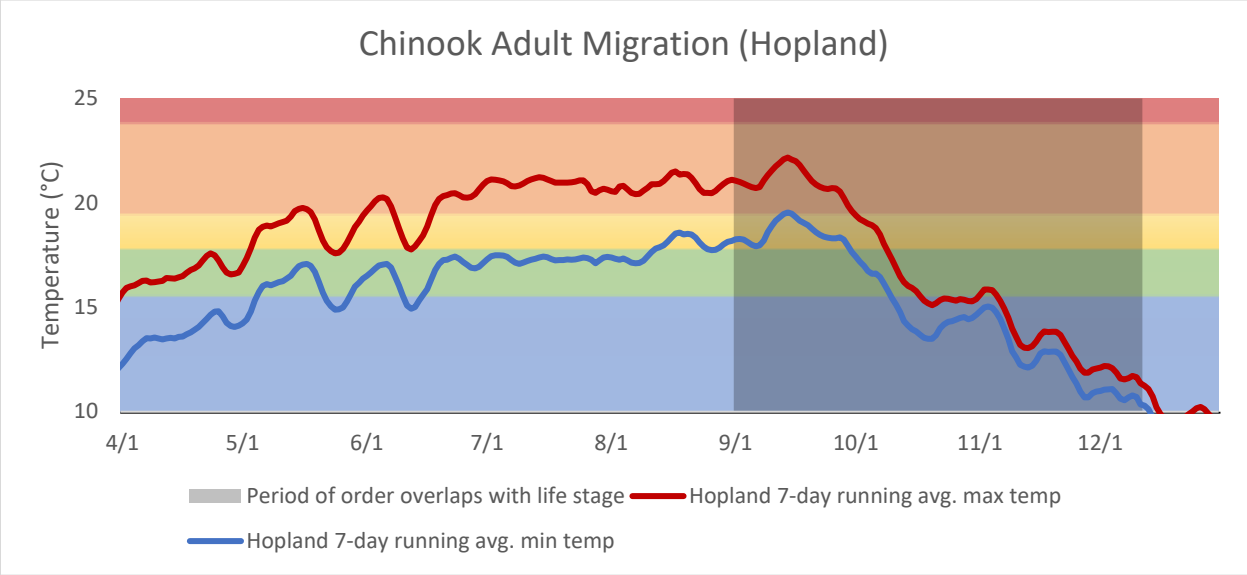


Figure 4-5. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

Water temperature data at in the mainstem near the confluence with Pieta Creek was not collected during the adult migration period. Water temperature in the east fork Russian River downstream of Coyote Valley Dam was acutely stressful when data was available during the Chinook migration period (Figure 4-6). The warmer water temperature in the east fork Russian River is related to releases from Coyote Valley Dam and conditions in Lake Mendocino.

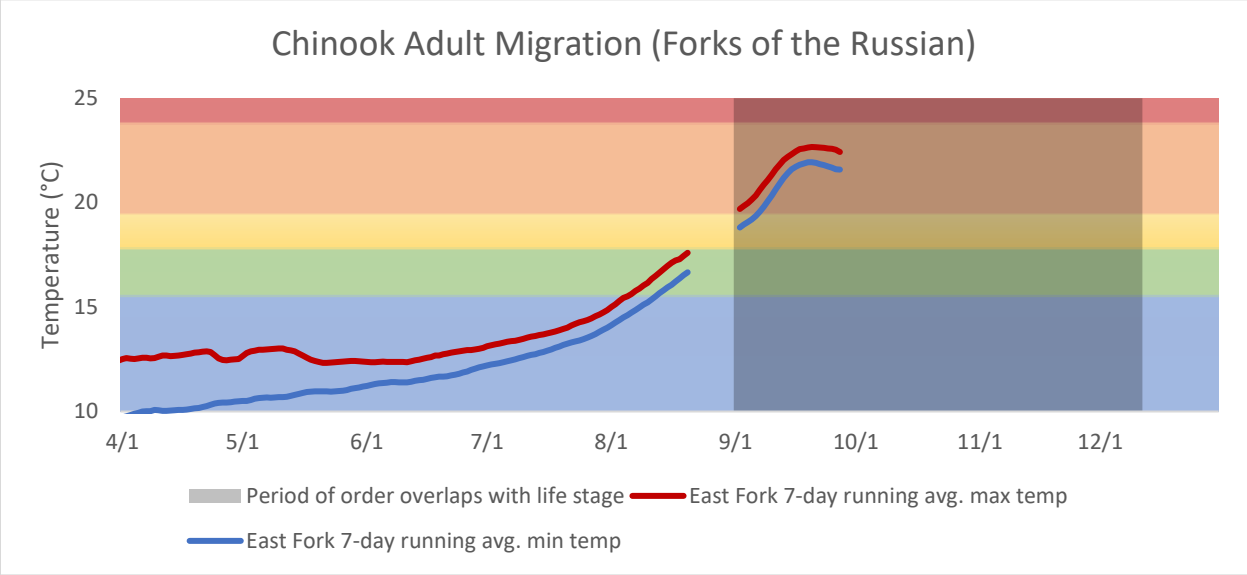


Figure 4-6. The 7-day running average of the minimum and maximum water temperatures collected in the East fork of the Russian River 0.5 km downstream of Coyote Valley Dam. Shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

Coho

Water temperatures for coho were generally favorable during the portion of the Order that overlaps with coho adult migration (November through December). At the Hacienda gage the temperature was

mainly in the suitable range for adult coho (based on the criteria in Table 4-1 and Figure 4-7). Moving upstream from Hacienda to Digger Bend, coho would have experienced water temperatures similar to Hacienda (Figure 4-8).

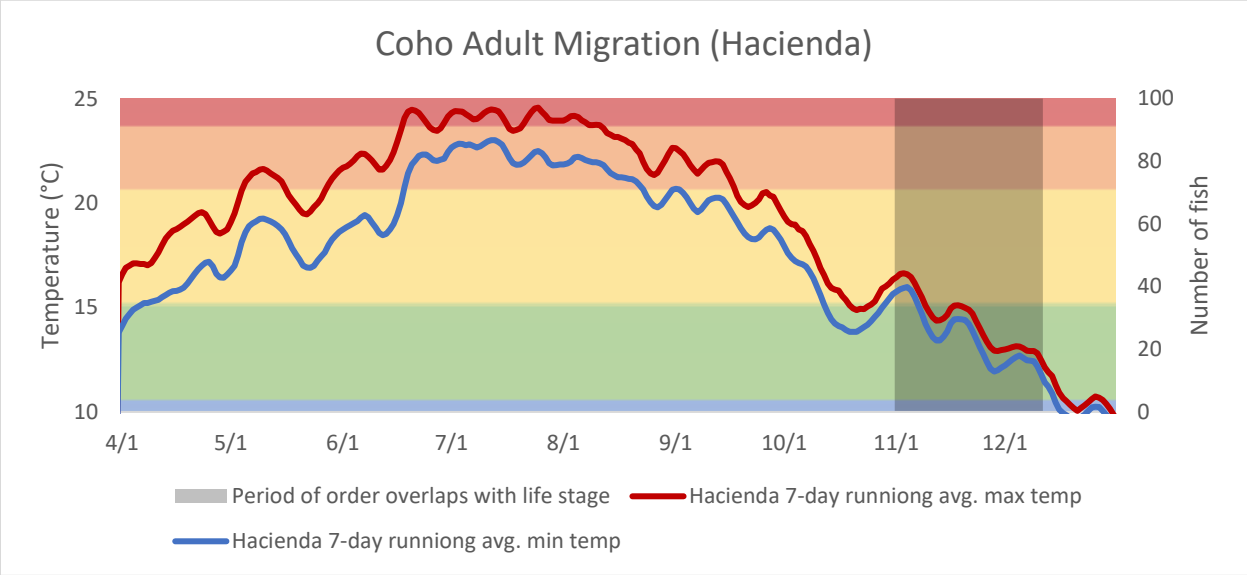


Figure 4-7. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000). Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult coho based on Table 4-1.

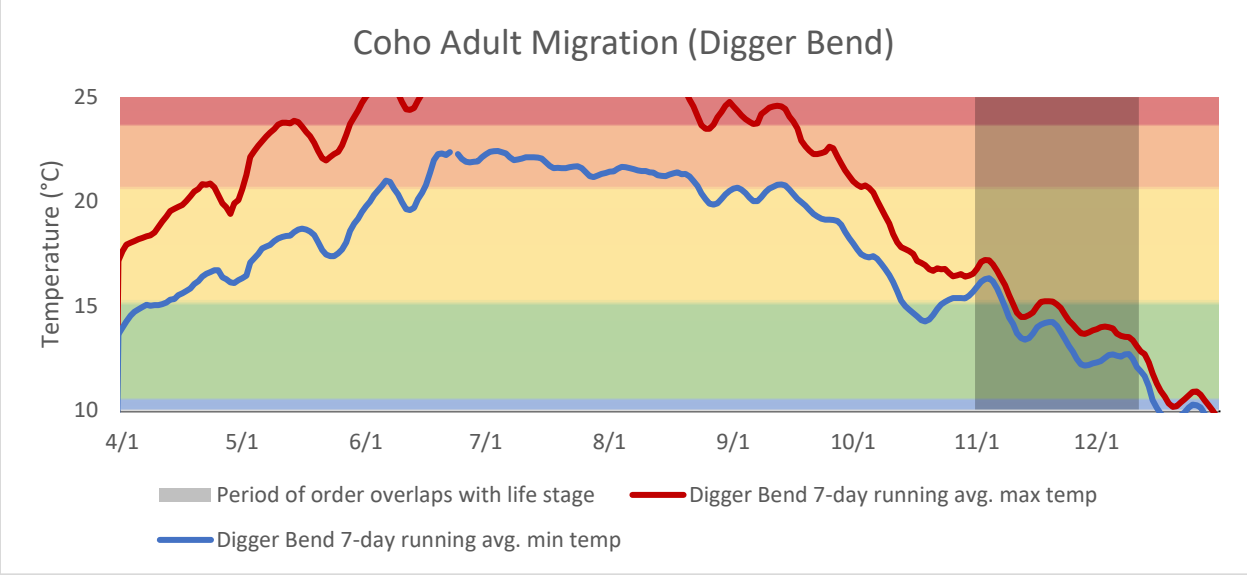


Figure 4-8. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for coho adult migration based on Table 4-1.

Steelhead

Water temperatures for steelhead were favorable during the portion of the Order that overlaps with the steelhead adult migration (December). At the Hacienda gage the temperature was suitable for adult steelhead based on our criteria (Table 4-1 and Figure 4-9). Moving upstream from Hacienda, steelhead

would have experienced water temperatures similar to Hacienda (Figures 4-9 through 4-12). Due to high stream flows, the data sonde in the east fork Russian River and in the mainstem Russian River at the confluence with Pieta Creek near Hopland, CA were removed prior to the adult steelhead migration period. Therefore, temperature data from these two locations are unavailable for the adult steelhead migration period.

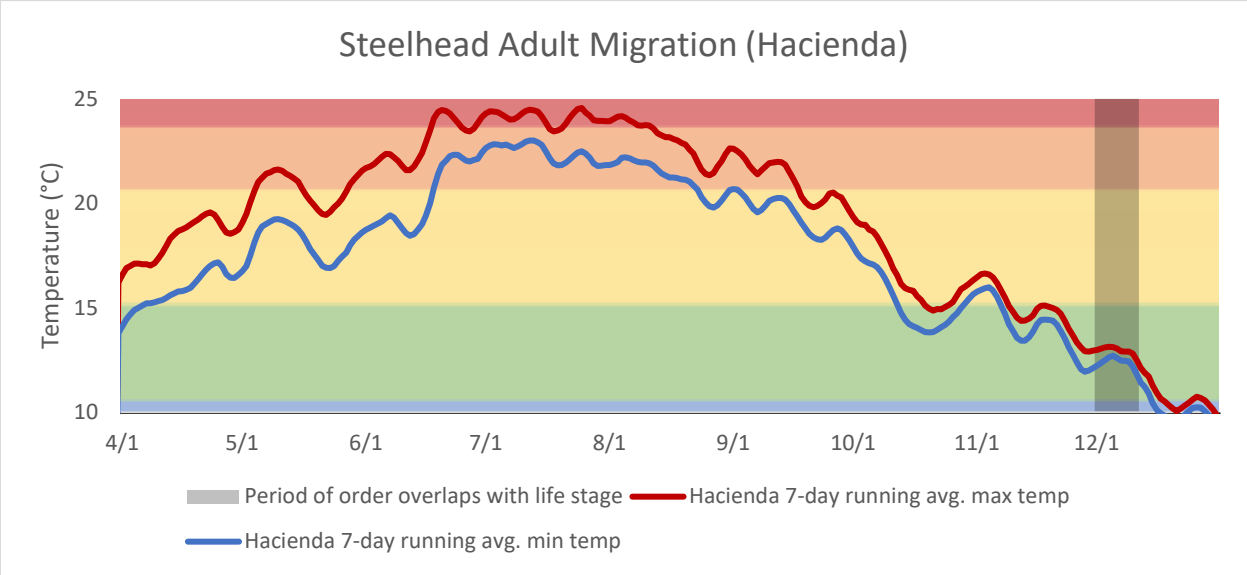


Figure 4-9. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000). Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult steelhead based on Table 4-1.

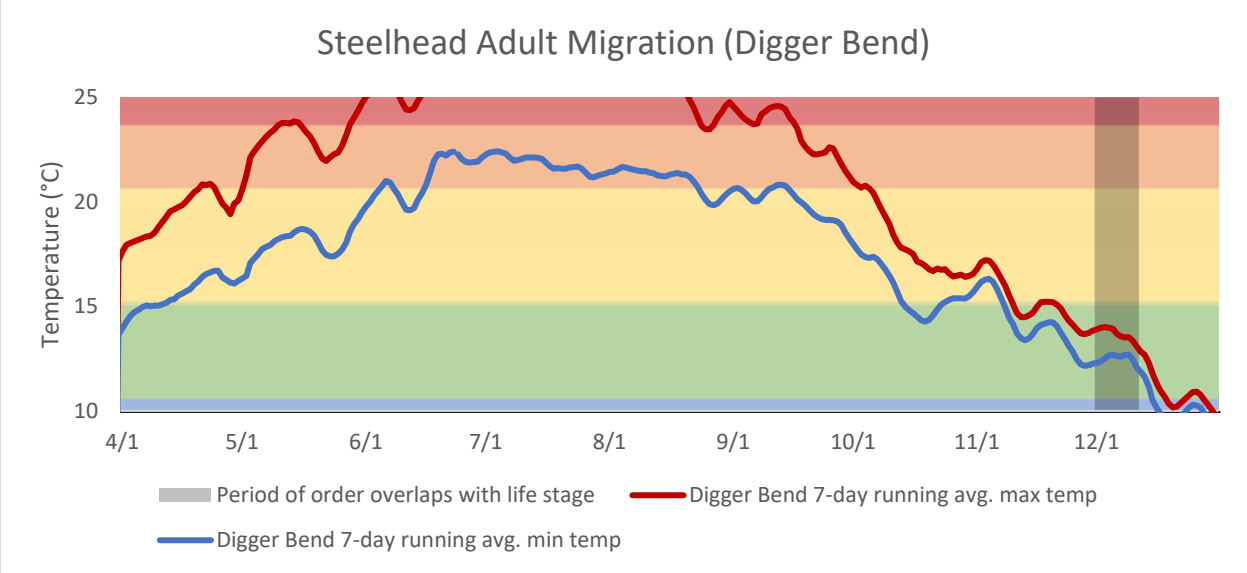


Figure 4-10. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

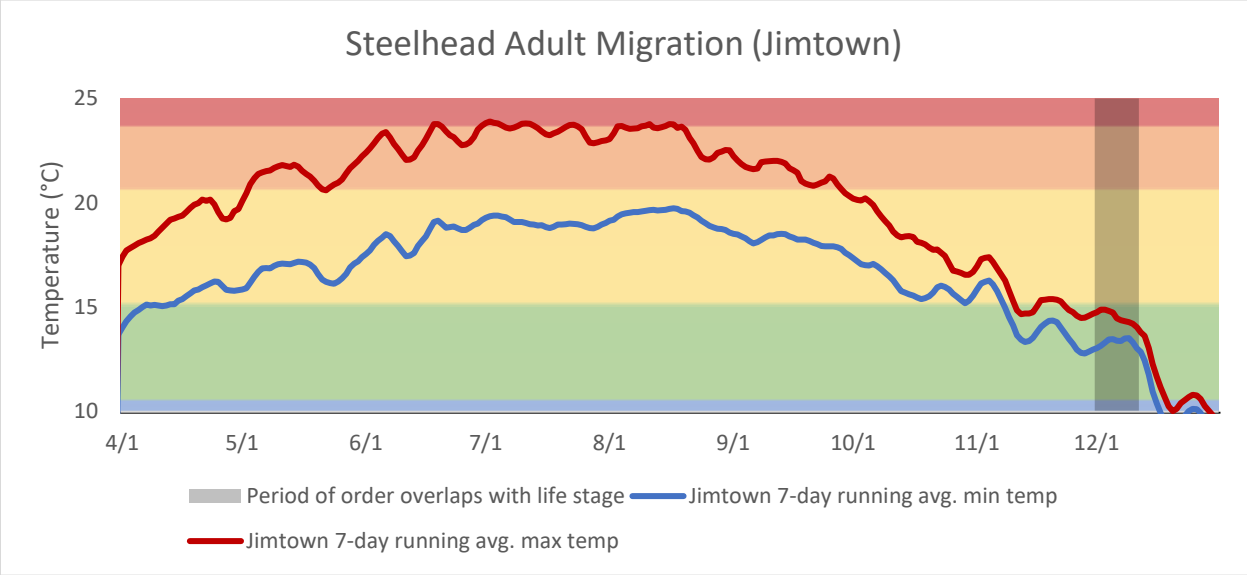


Figure 4-11. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

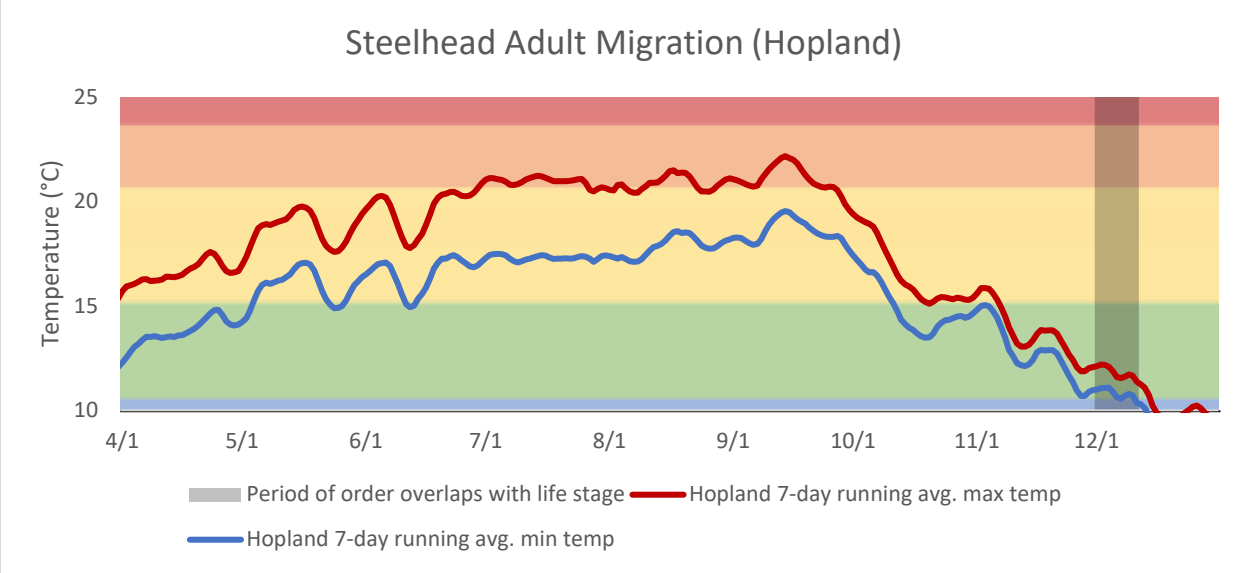


Figure 4-12. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

Salmonid Rearing

Salmonids must cope with water temperatures found at their rearing sites. 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, CA) 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 2021, water temperatures for rearing Chinook ranged from optimal to lethal depending on the site and time period within the Chinook rearing season. Although stressful and eventually acutely stressful conditions did occur at those sites in late spring and summer, water temperatures were generally in the optimal or suitable range for Chinook salmon rearing in the east fork Russian River downstream of Coyote Valley Dam, near the USGS stream gage at Hopland (gauge number 11462500), and near the confluence with Pieta Creek earlier in the spring (Figure 4-13 through 4-15). At Jimtown, Digger Bend, and Hacienda water temperatures became stressful and eventually acutely stressful or even potentially lethal by mid-June (Figures 4-16 through 4-18). However, It is important to note that Chinook in the Russian migrate downstream and out to sea in the spring thus avoiding high temperatures and by June the majority of Chinook smolts have emigrated from the Russian River (see Salmonid Smolt Outmigration).

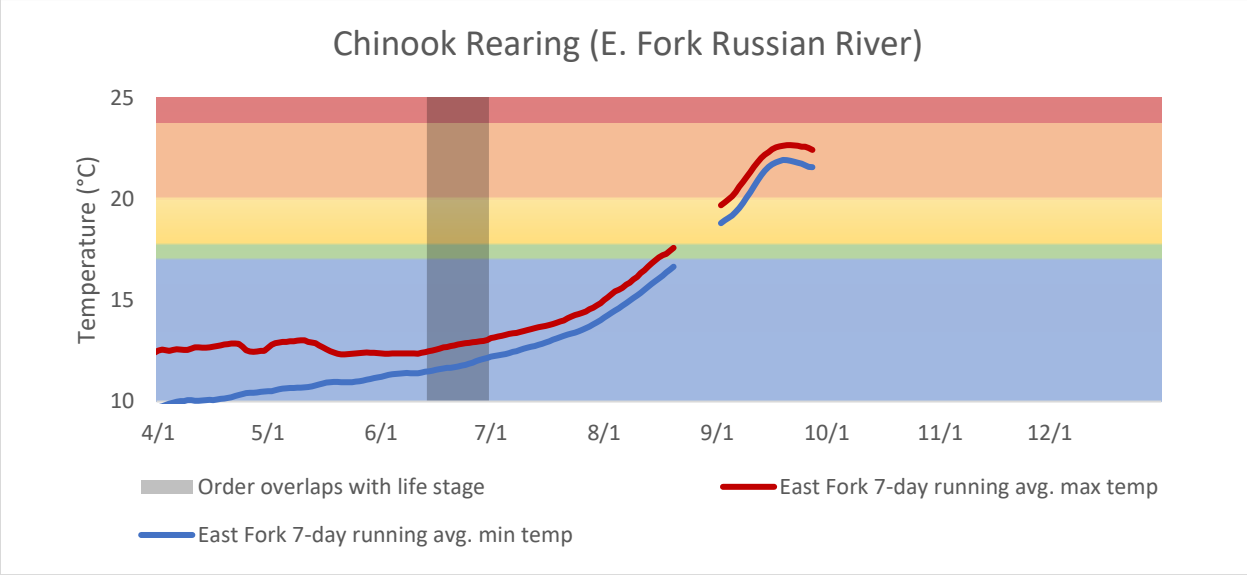


Figure 4-13. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water in the east fork Russian River 0.5 km downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

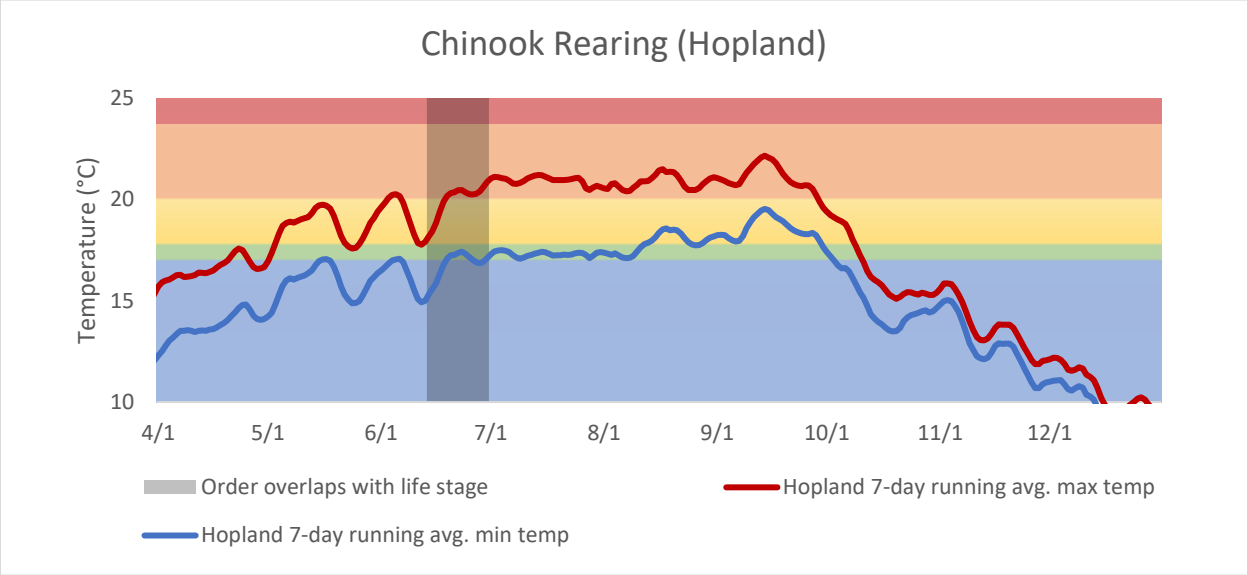


Figure 4-14. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

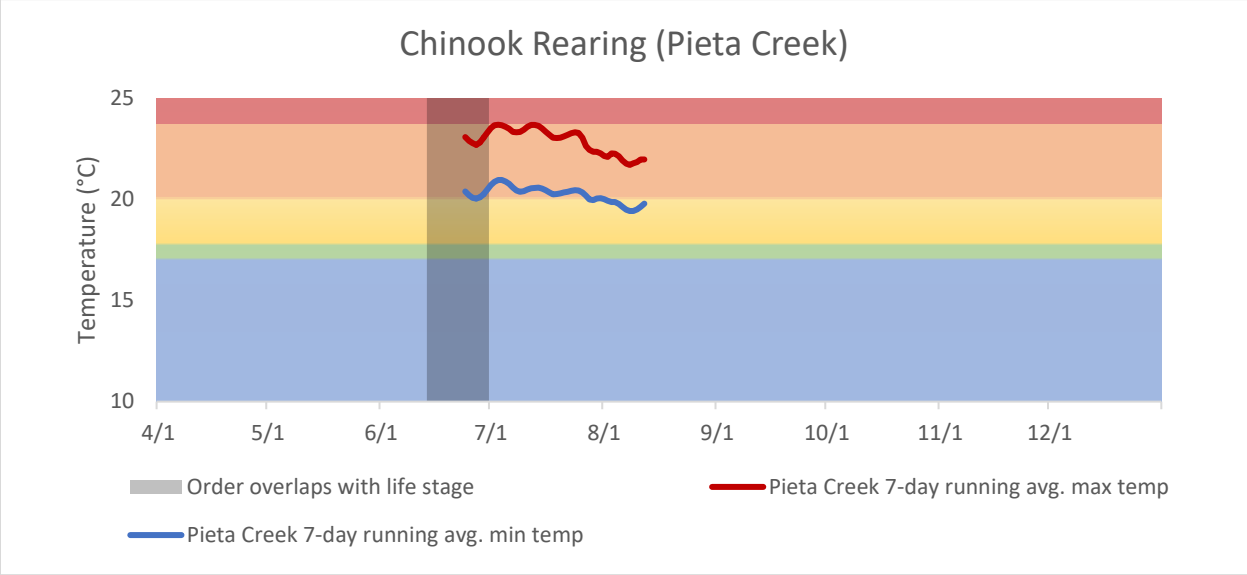


Figure 4-15. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

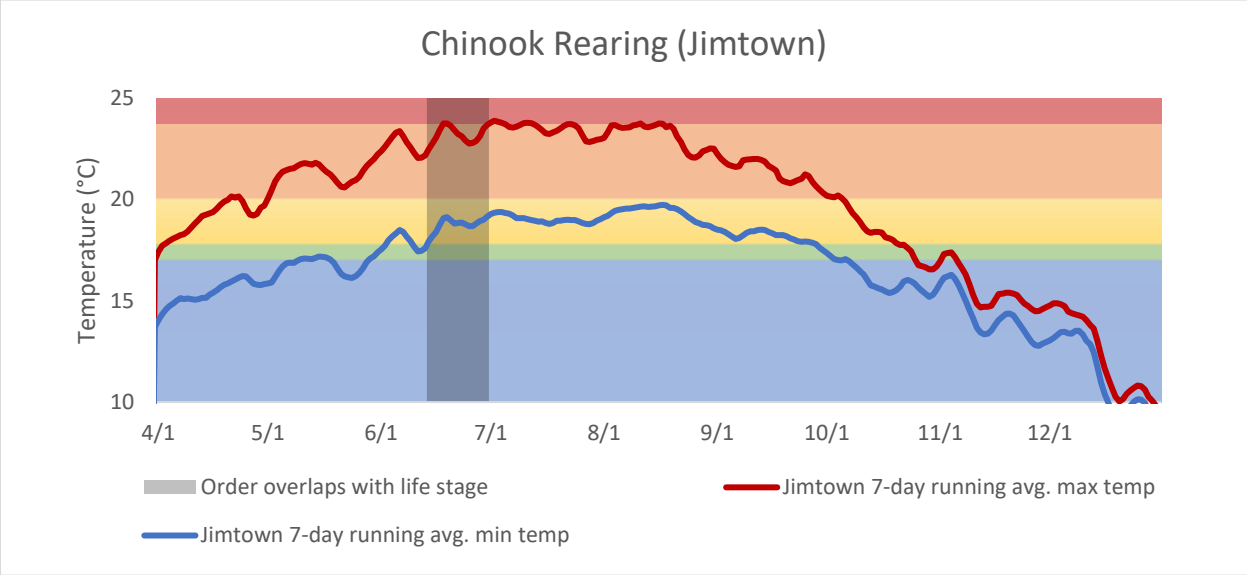


Figure 4-16. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

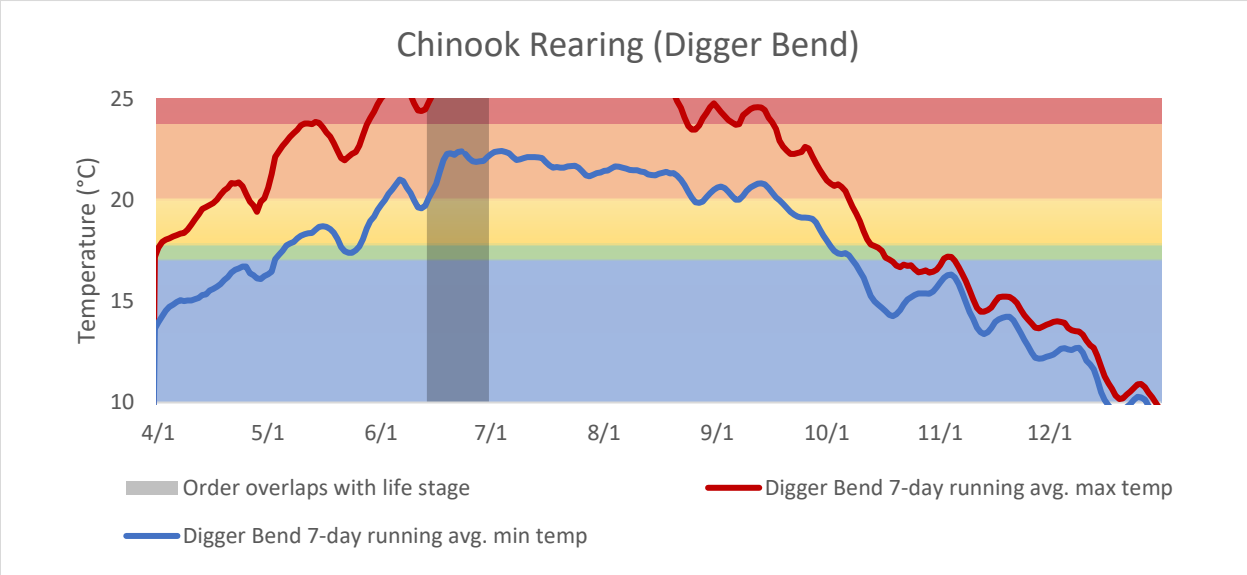


Figure 4-17. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

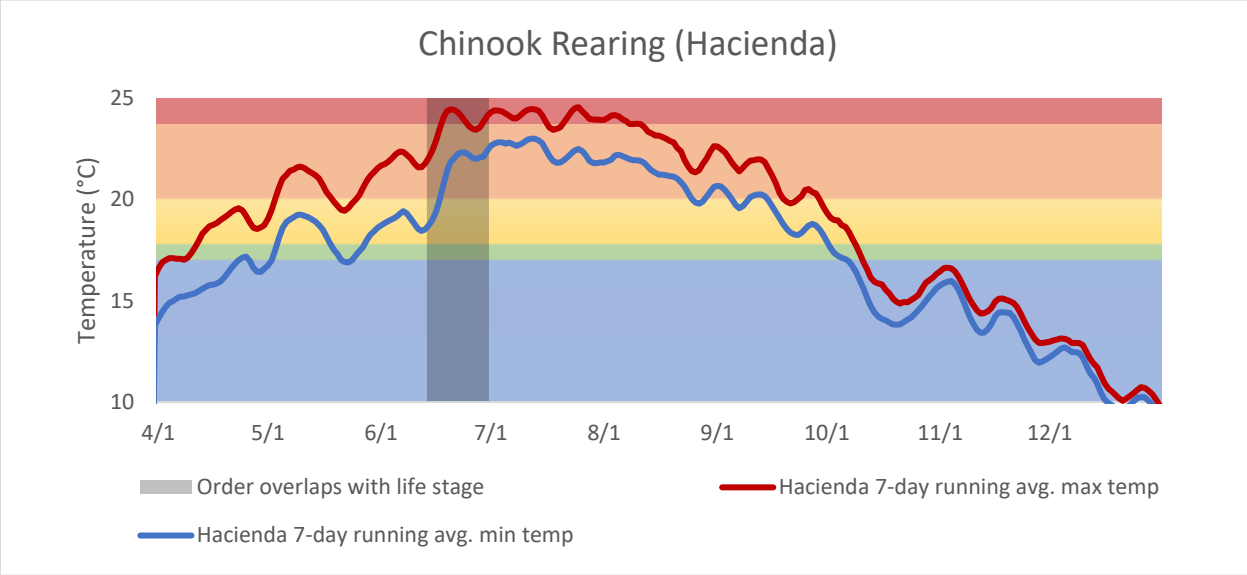


Figure 4-18. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hacienda (gage number 11467000) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

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 until September, then water temperatures gradually increased becoming acutely stressful by mid-September. By late September, water temperatures began to level off and were likely to begin cooling at about the time the data sonde was removed for the season. At the USGS stream gage at Hopland, water temperature was generally suitable to stressful for steelhead rearing (Figure 4-19 and 4-20).

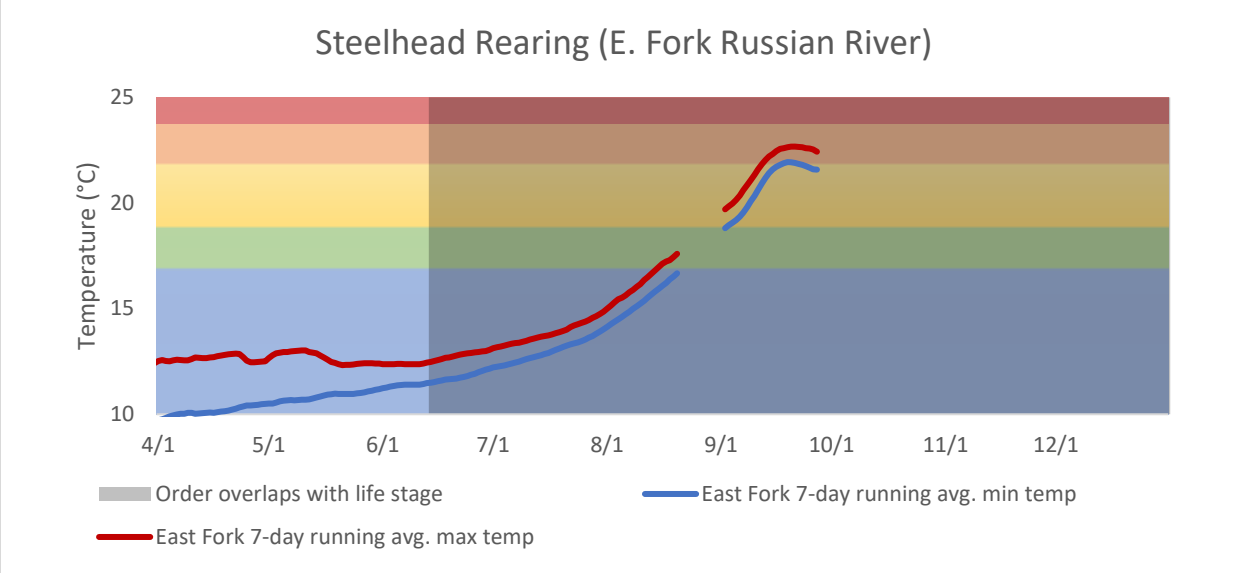


Figure 4-19. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water at the east fork Russian River downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead parr based on Table 4-2.

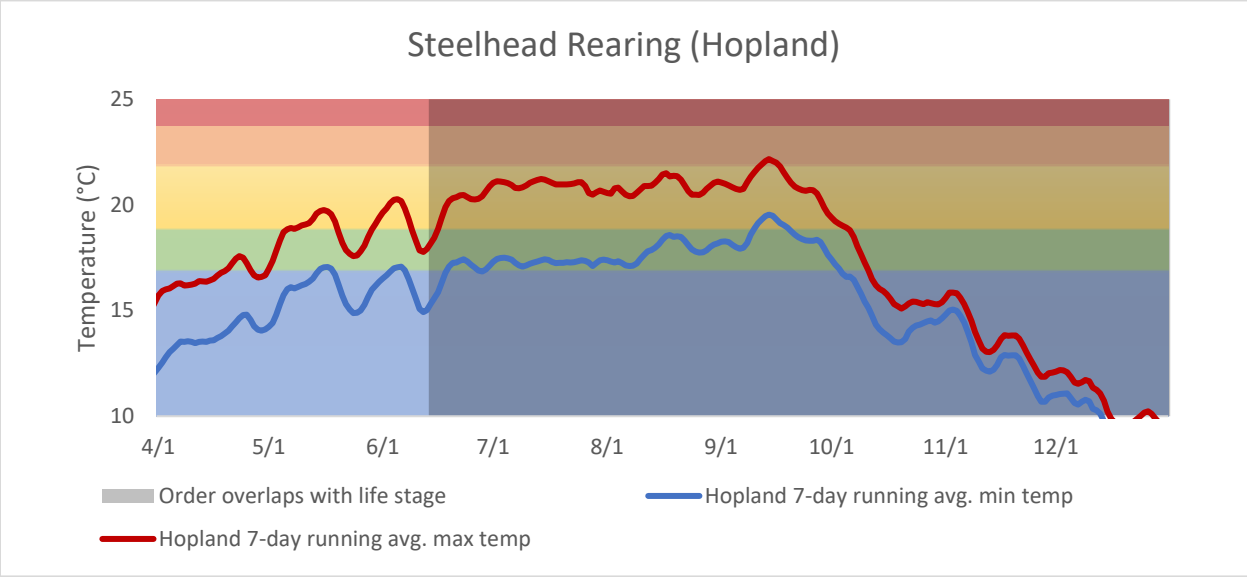


Figure 4-20. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead parr based on Table 4-2.

In the Russian River near Pieta Creek water temperature was stressful to acutely stressful for most of the period temperature data were collected at that location (Figure 4-21).

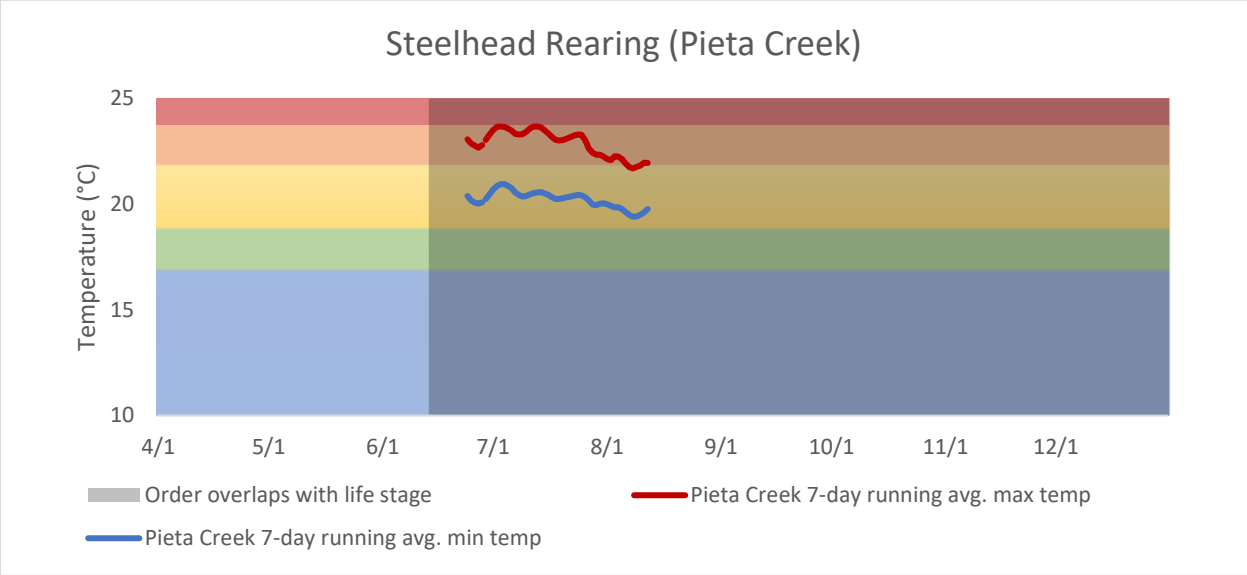


Figure 4-21. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead parr based on Table 4-2.

Salmonid Smolt Outmigration

For smolts produced in the upper portion of the watershed, we summarized 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 and show these temperatures with water temperature criteria for Chinook smolts. Typically, we relate Chinook smolt catches at Mirabel to water temperature collected at the Hacienda gage. However, in 2021, we ended fish trapping operations at Mirabel before the Order went into effect. It is noteworthy that many Chinook smolts (over 10,000 captured in the trap) emigrated from the Russian River before the order went into effect. 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 4-22). However, water temperature became stressful to potentially lethal at some sites located downstream of Hopland (Figure 4-23 through Figure 4-27). It is important to note that Chinook have evolved to emigrate during the spring before water temperatures become lethal and that many Chinook were captured at the Mirabel fish trap emigrated before the Order went in effect in June (Figure 4-27).

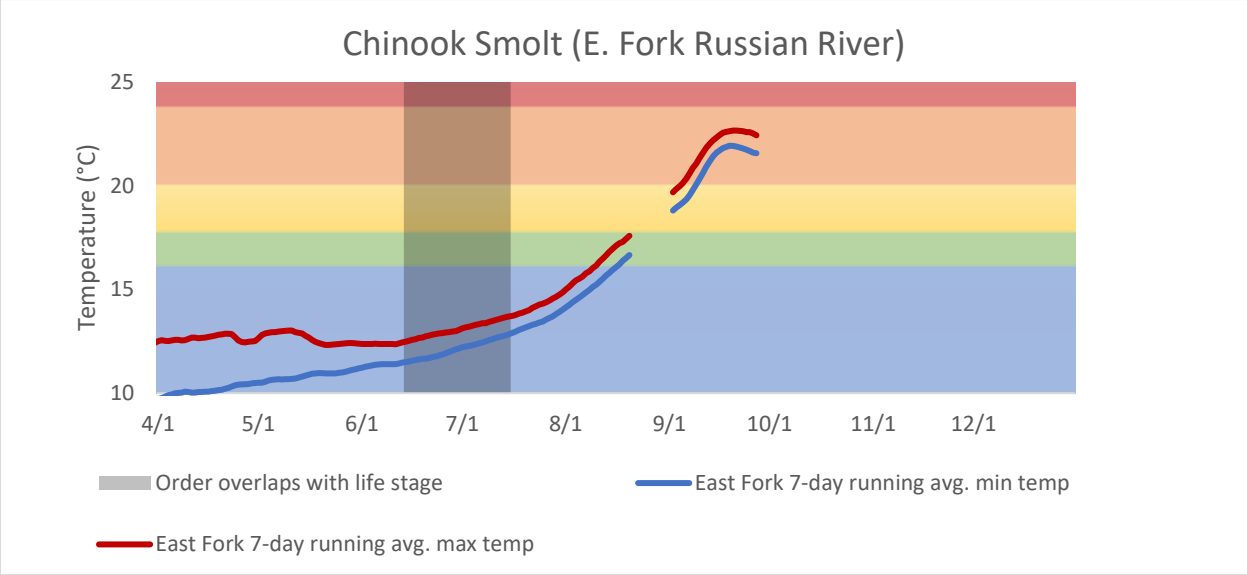


Figure 4-22. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water at the east fork of the Russian River downstream of the Coyote Valley Dam. Shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

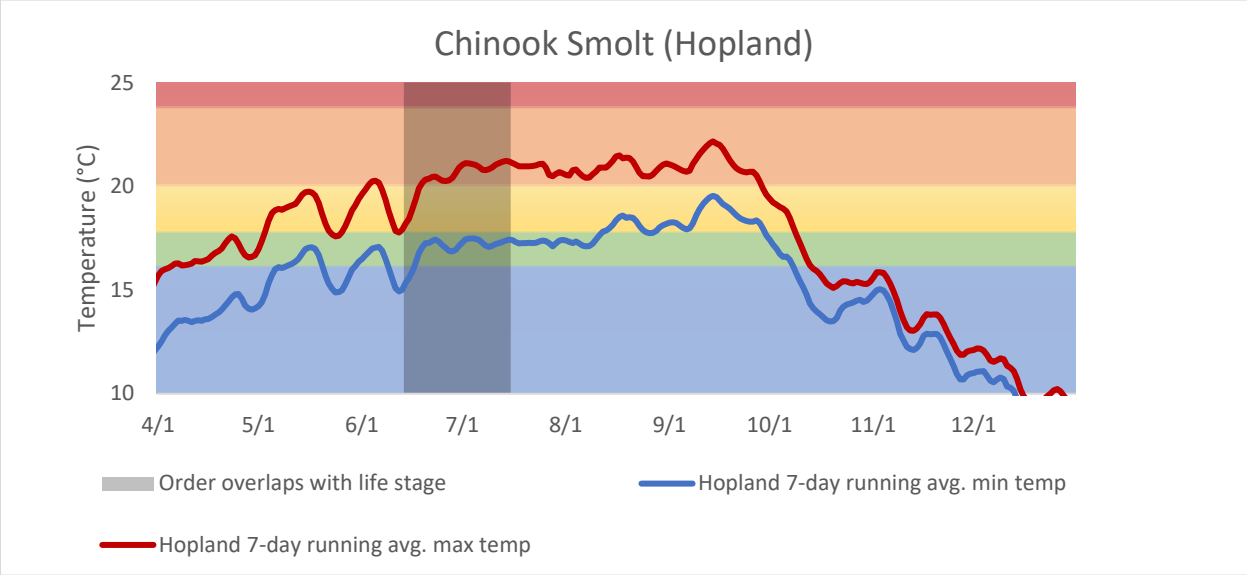


Figure 4-23. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). Shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

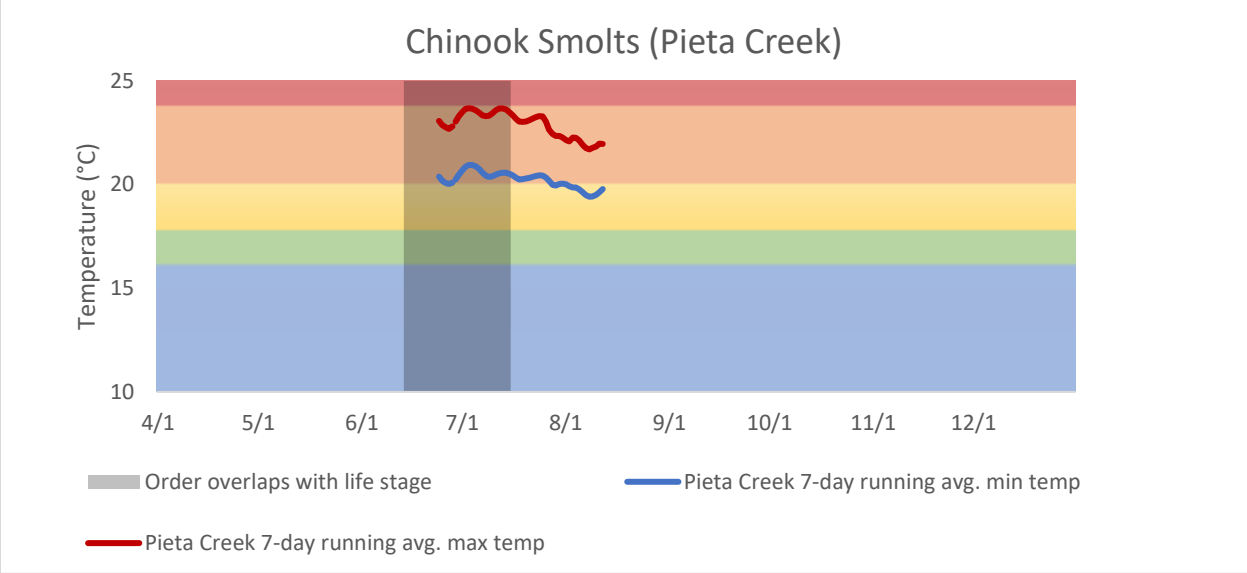


Figure 4-24. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

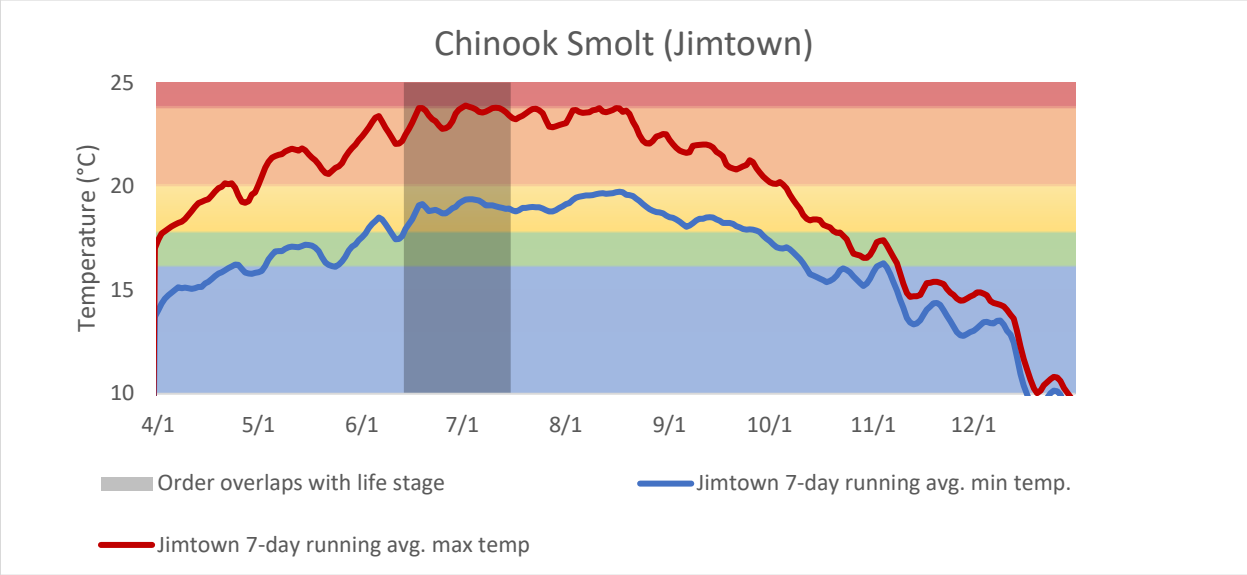


Figure 4-25. The 7-day running average of the minimum and maximum water temperatures collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

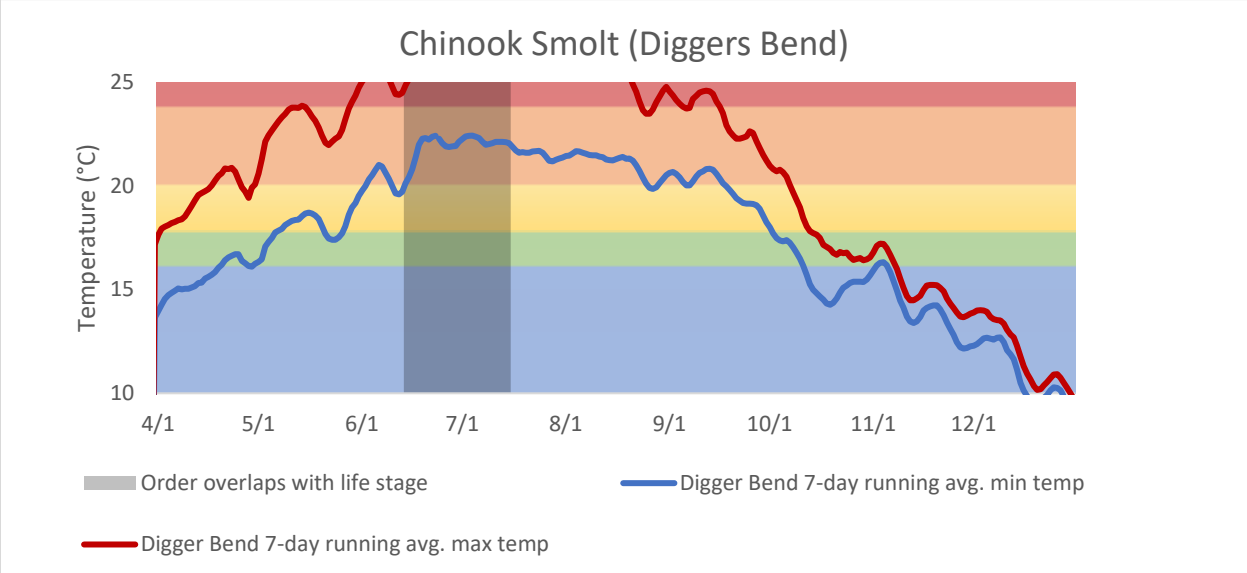


Figure 4-26. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

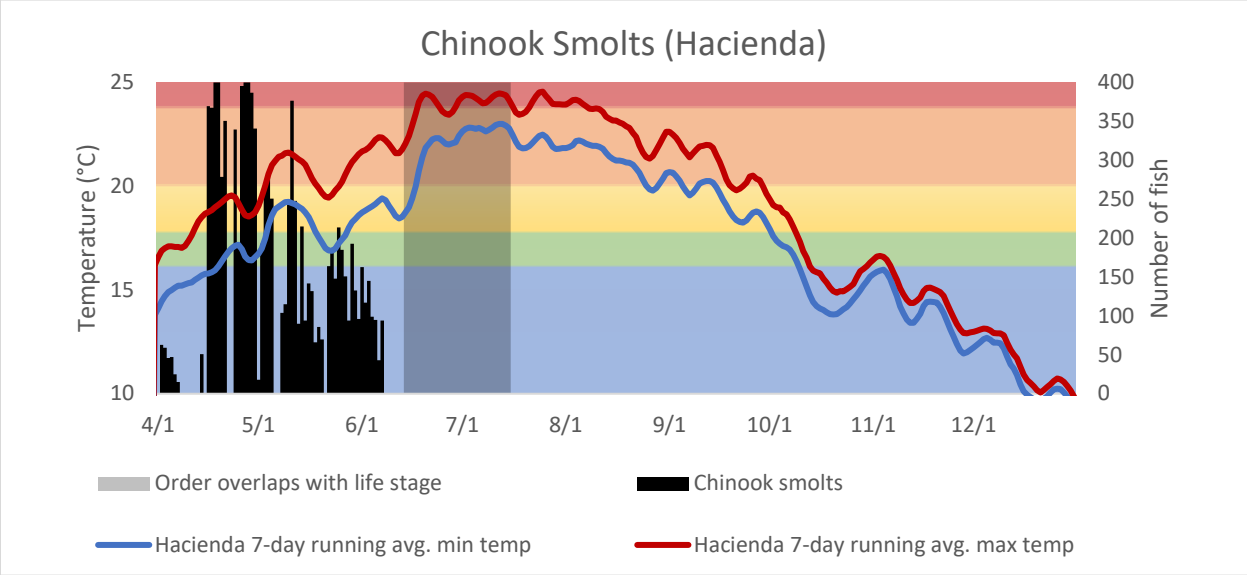


Figure 4-27. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook smolt catch from the Mainstem Russian River near Mirabel and optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

Dissolved Oxygen

At most sites, dissolved oxygen generally ranged from suitable to stressful for salmonids in the Russian River throughout the Order. However, dissolved oxygen was potentially lethal in the east fork Russian River downstream of Coyote Valley Dam (Figure 4-28). It is worth noting that dissolved oxygen in summer and early fall is typically poor immediately downstream of Coyote Valley Dam and that dissolved oxygen generally recovers fairly quickly downstream of the dam.

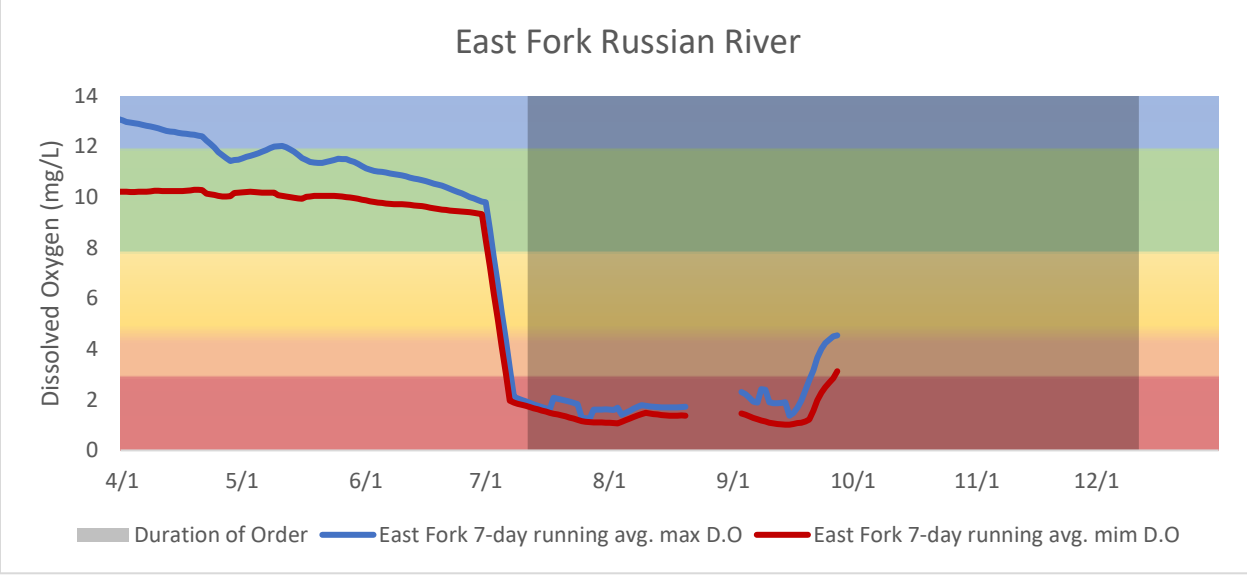


Figure 4-28. The 7-day running average of the minimum and maximum dissolved oxygen collected by Sonoma Water in the east fork of the Russian River downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

At Hopland, the Russian River near the confluence of Pieta Creek, Jimtown, Digger Bend, and Hacienda, maximum daily average dissolved oxygen levels were generally suitable whereas the minimum daily dissolved oxygen levels were often stressful (Figures 4-29 through 4-33).

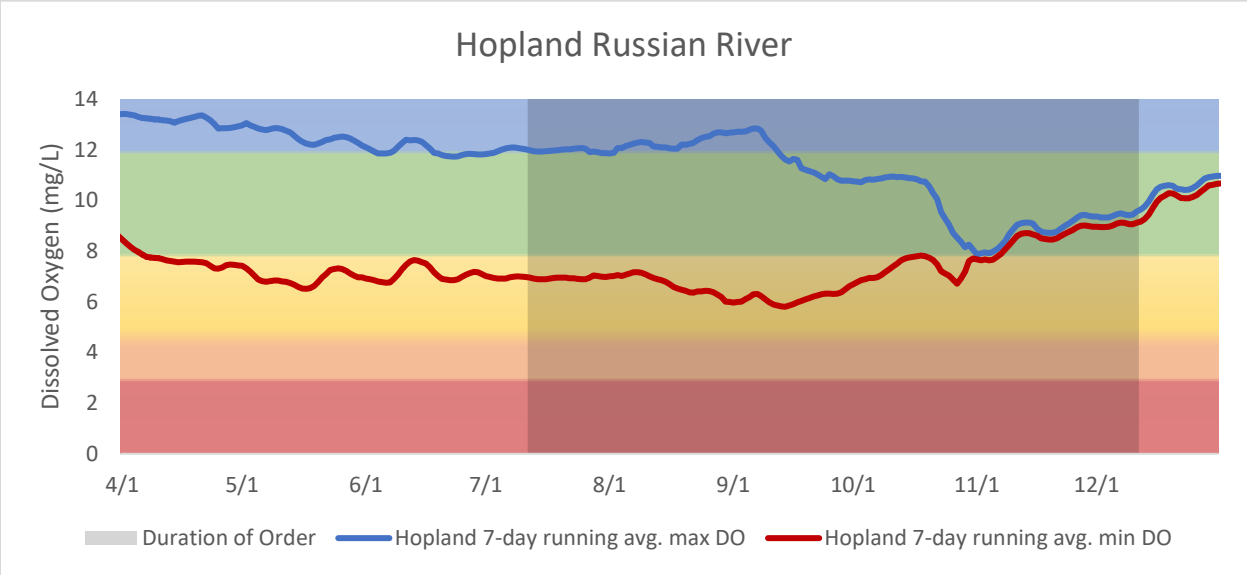


Figure 4-29. The 7-day running average of the minimum and maximum dissolved oxygen collected at Hopland (USGS stream gage number 11462500) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

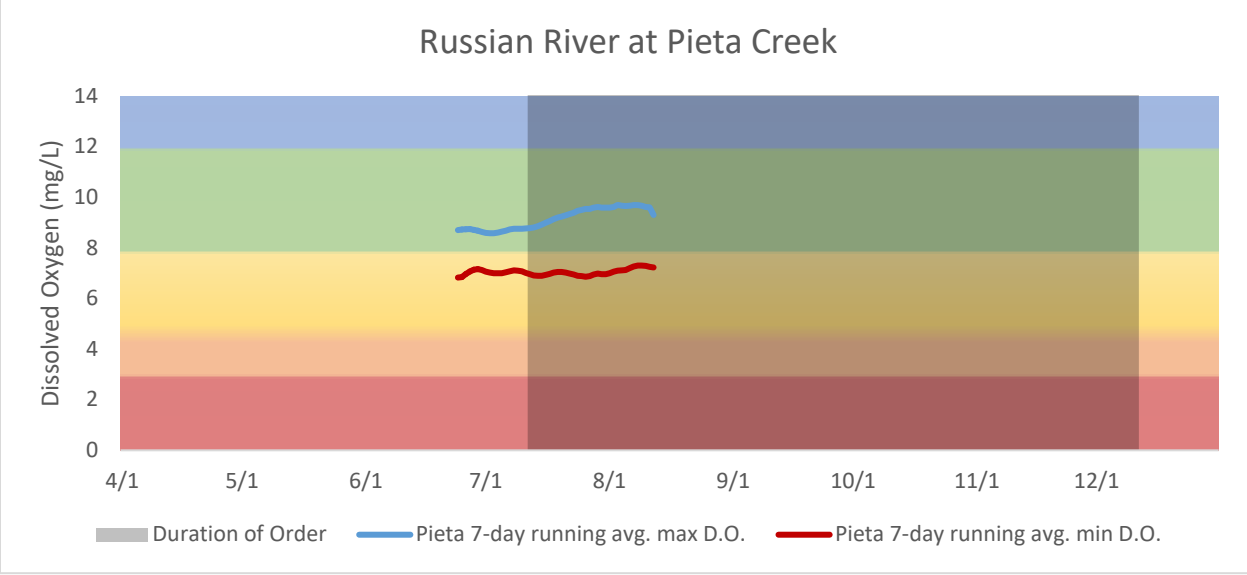


Figure 4-30. The 7-day running average of the minimum and maximum dissolved oxygen collected in in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

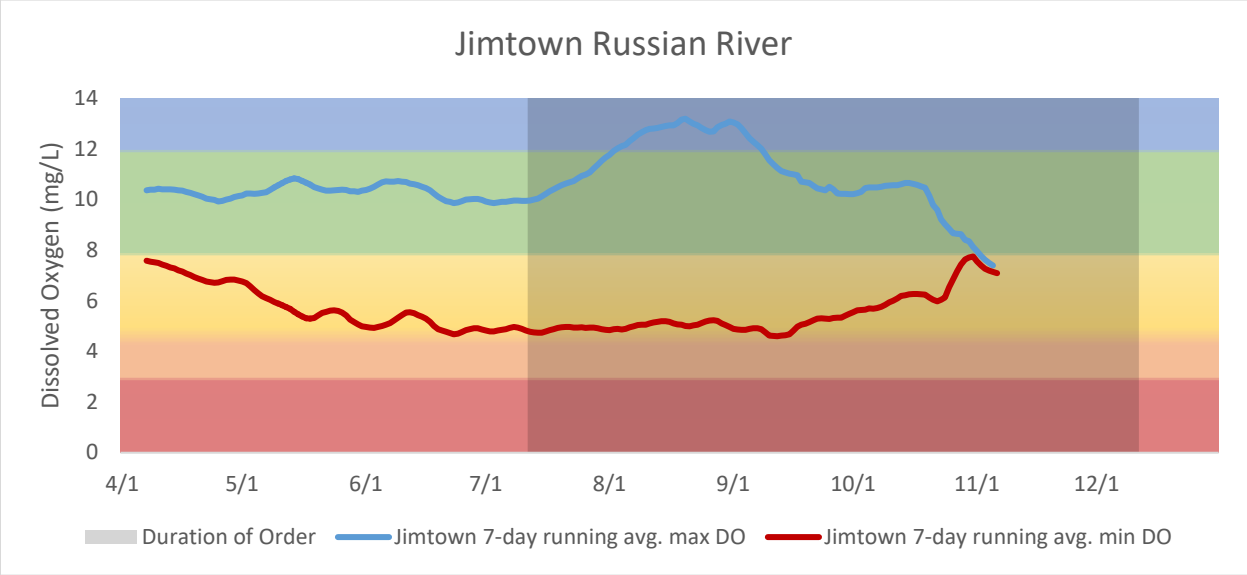


Figure 4-31. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

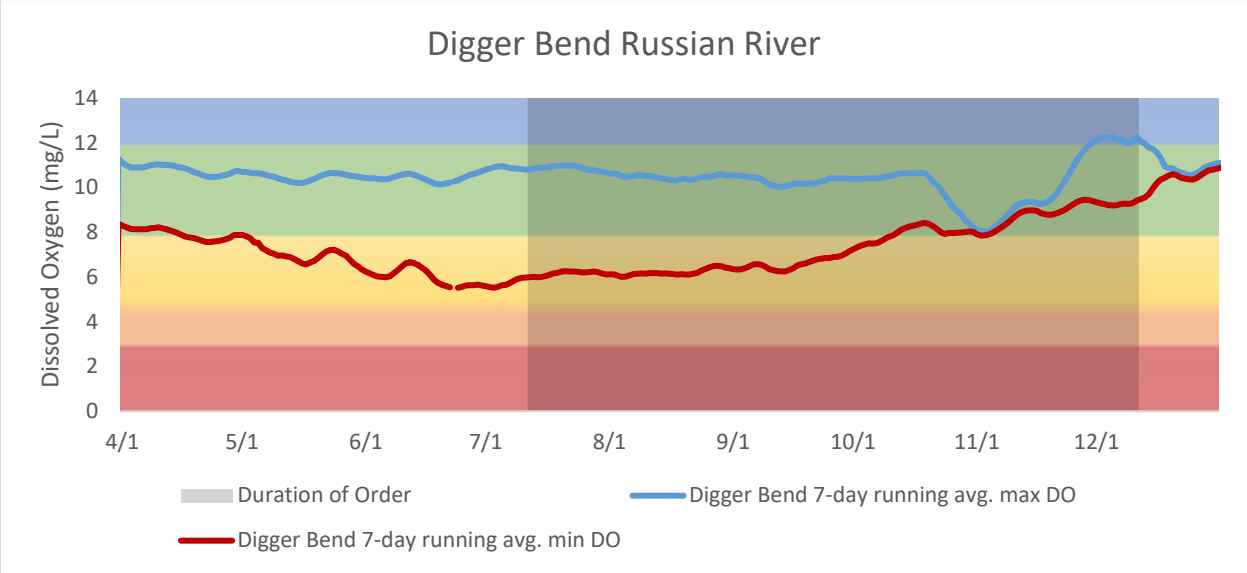


Figure 4-32. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

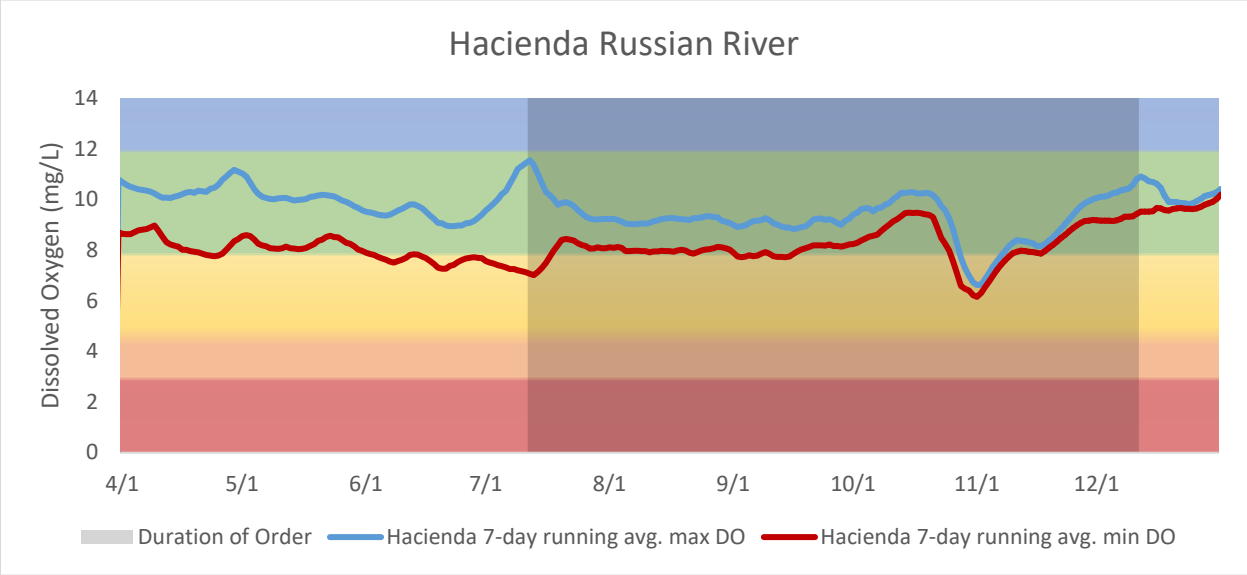


Figure 4-33. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Hacienda USGS stream gage (1146700) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

4.2.5 Summary

When Chinook were expected to begin migrating upstream in 2021, 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 potentially lethal, acutely stressful, or stressful early in the migration period then temperature conditions improved as air temperatures decreased with the onset of fall. In addition to atmospheric cooling, a large rain event in late October increased flow in the Russian River well above the minimum instream flow requirements set by the Order and likely contributed to the decrease in water temperature. The increase in flow was primarily due to tributary inflow meaning that water temperature in the river became less influenced by reservoir releases and more influenced by tributary input. Flow remained above the minimum instream flow requirements at Hacienda for the remainder of the order. November water temperatures were suitable to optimal for adult Chinook at all sites. By mid-November water temperatures were suitable or optimal for adult coho and adult steelhead at all sites. While temperatures were occasionally unfavorable for adult salmonids it is important to note that (1) these fish have evolved to cope with seasonally warm water temperatures by returning to the river in the fall when water temperatures are beginning to cool and (2) the vast majority of adult salmonids return to the Russian River after water temperatures in the river have become favorable.

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 Chinook have

likely adapted to warm temperatures in the Russian River and have adjusted their run timing to further cope with seasonally warmer water temperatures by emigrating earlier in the year.

For steelhead rearing, water temperatures in the east fork Russian River ranged from optimal to acutely stressful. The increase in water temperature at this site was likely due to depletion of the cold water pool in the reservoir. At Hopland, water temperature for steelhead rearing ranged from optimal to stressful with a brief period where the average maximum daily temperature was acutely stressful. In the Russian River near the confluence with Pieta Creek, water temperature was typically stressful to acutely stressful for rearing steelhead; however, water quality data was unavailable after mid-August. Water temperatures at Pieta likely followed a similar trend as water temperatures at Hopland and likely fell to optimal levels by mid-October due to cooling air temperatures.

Chinook salmon experienced suitable to acutely stressful water temperatures for smolt migration at Hopland. Water temperatures became acutely stressful and even potentially lethal after mid-June at the downstream monitoring sites; however, the bulk of Chinook smolts emigrate from the Russian River prior to mid-June when water temperatures are more favorable. In 2021, over 10,000 Chinook smolts were captured at the Mirabel downstream migrant trap (not adjusted for trap efficiency) before the downstream migrant trap was removed in early June.

Dissolved oxygen 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. Dissolved oxygen usually recovers near the confluence with the west fork of the Russian River (based on limited data collected in the past by Sonoma Water) so the length of stream that was impacted by low dissolved oxygen was likely relatively short. The 7-day running average of the minimum dissolved oxygen was stressful for salmonids at Hopland, in the Russian river near the confluence with Pieta Creek, Jimtown, and Digger bend. At Hacienda, the 7-day running average of the minimum dissolved oxygen was generally suitable for salmonids.

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