Russian River Water Quality Summary for the 2022 Temporary Urgency Change

Sonoma Water

December 2022

American Disabilities Act Compliance

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1.0 Introduction

On 26 May 2022, the Sonoma County Water Agency (Sonoma Water) filed Temporary Urgency Change Petitions (TUCPs) with the State Water Resources Control Board (SWRCB) due to severe drought conditions, historically low storage levels in Lake Mendocino and Lake Sonoma, and a flawed hydrologic index that establishes minimum instream flow requirements that do not align with the current watershed conditions.

In summary, the terms of the SWRCB Order approved the following temporary changes to the Decision 1610 (D1610) instream flow requirements from 17 June 2022 through 14 December 2022 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 preserve reservoir storage levels in Lake Mendocino in the fall, which will preserve storage for water supplies to meet human health and safety needs, will be used for releases of stored water to benefit returning adult Chinook salmon, and improve the likelihood of carryover storage for use in 2023 in the event 2023 is also a dry year. The SWRCB issued the Order (Order) approving Sonoma Water's TUCP on 17 June 2022.

2.0 2022 Russian River Flow Summary

In early January 2022, following a relatively dry winter in 2021 and water storage levels as low as 13,000 acre-feet in October 2021, water storage levels in Lake Mendocino were just above 41,000 acre-feet, which is similar to storage levels experienced in 2016, a normal water year. Overall storage in 2022 was lower than most years in the last eleven years of monitoring. In addition, storage only increased by about 1,000 acre-feet through January before remaining relatively flat through February and March due to less than normal rainfall, and by April 2022 storage levels were below drought levels observed in 2014 and remained that way through May (Figure 2-1). However, storage levels continued to increase through May and into early June due to higher inflows from Potter Valley, as measured at the U.S. Geological Survey (USGS) near Calpella gaging station, compared to outflows through the lake. Storage in Lake Mendocino peaked in June and July at approximately 50,500 acre-feet, remained above 50,000 acre-feet through July, and above 40,000 acre-feet by 1 October. However, with no significant rainfall in October, storage levels continued to decline and were just below 38,000 acre-feet by 1 November (Figure 2-1).

The 2022 average daily flows at the Talmage, Hopland, Cloverdale, Jimtown, Digger Bend, and Hacienda USGS gaging stations are shown in Figure 2-2.

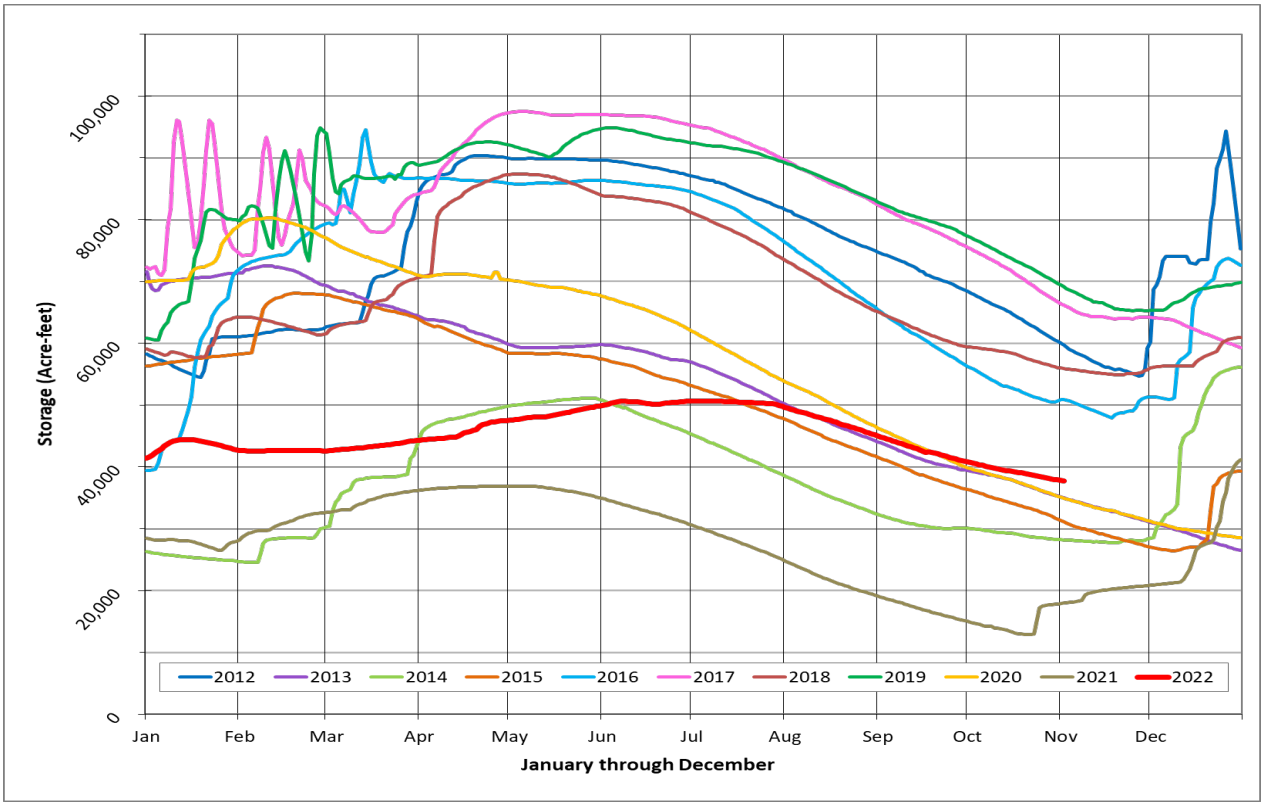

Figure 2-1. Lake Mendocino water storage levels, in acre-feet, from 2012 through 2022.

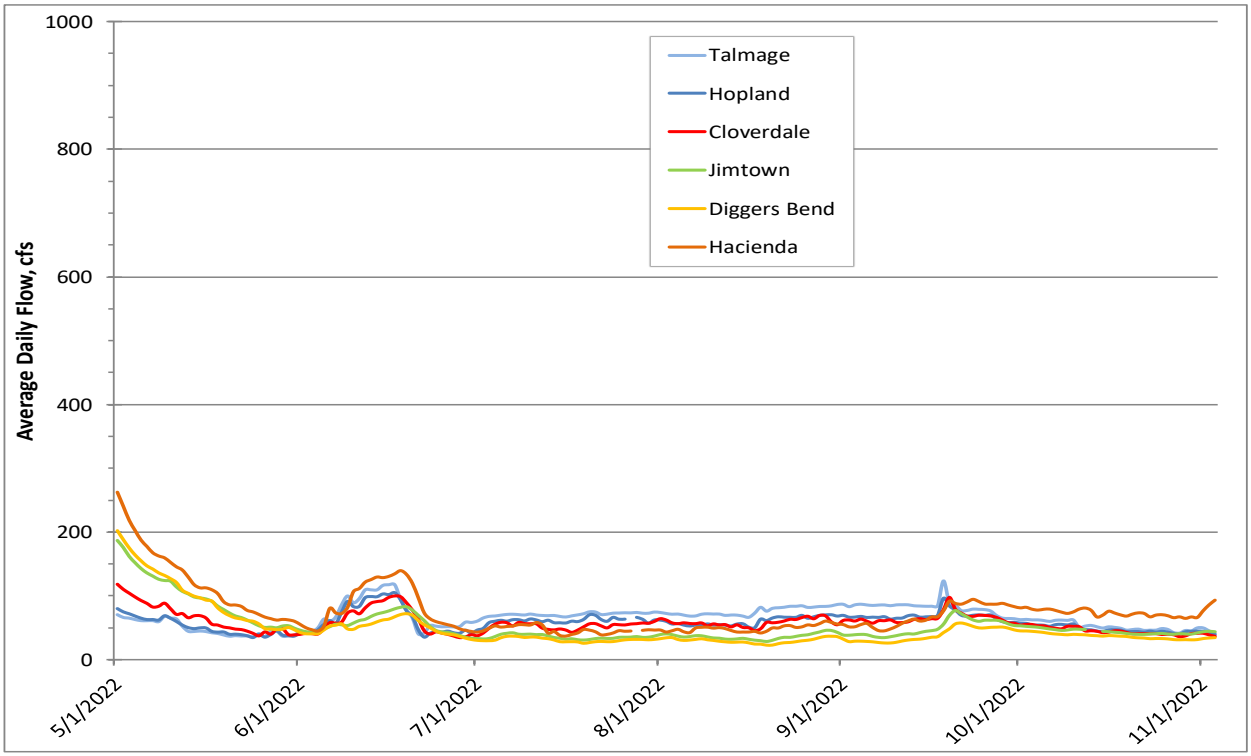

Figure 2-2. 2022 average daily flows in the Russian River as measured at U.S. Geological Survey (USGS) gages in cubic feet per second (cfs). Flow rates are preliminary and subject to final revision by USGS.

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).

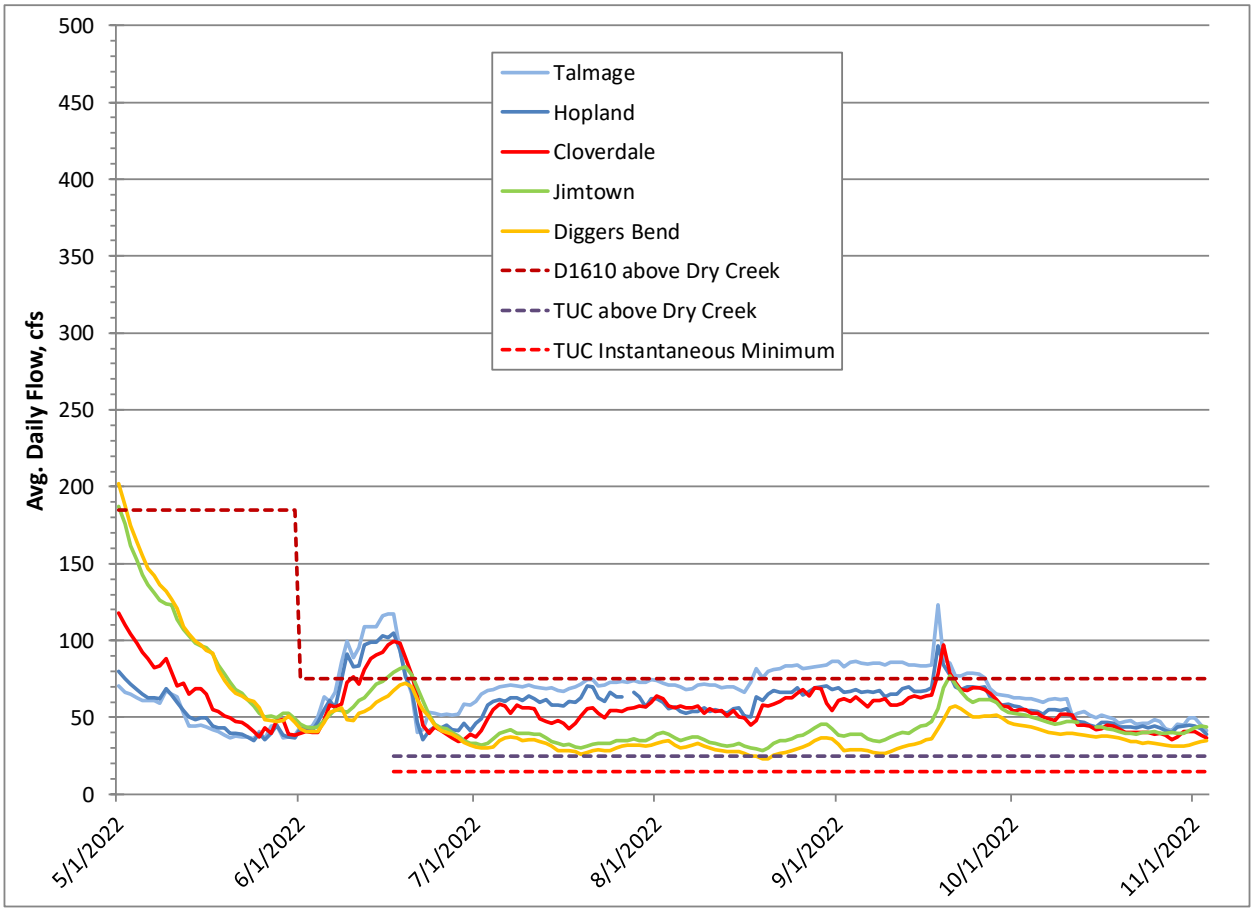

Figure 2-3. 2022 average daily flows in the upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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). However, lower Russian River flows did not decline below the TUC minimum daily average flows of 35 cfs or the instantaneous minimum flow of 25 cfs at Hacienda authorized by the Order (Figure 2-4).

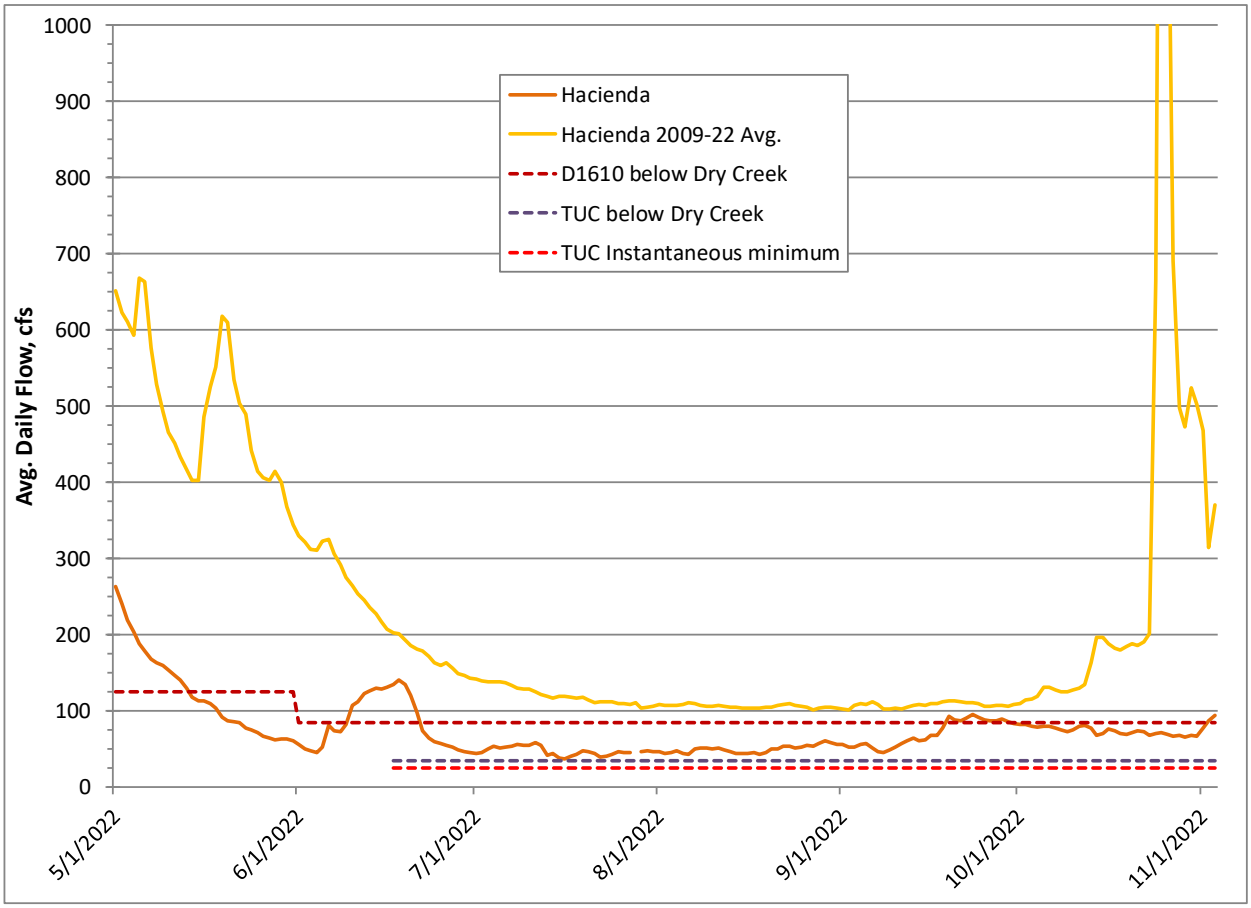

Figure 2-4. 2022 average daily flows in the lower Russian River as measured at USGS gages below the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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. Given that 2022 was a dry year beginning in January, monitoring was conducted prior to the terms of the TUC Order taking effect in June. This was done to provide additional context on conditions in the watershed leading up to the period in which the Order was active. The results discussed below include the data collected from that period prior to the Order taking effect. In addition, the Order requires submittal of this report by December 1, 2022, before the expiration of the Order; therefore, results included here do not reflect all data collected through the December 14, 2022, Order expiration.

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 2022, Sonoma Water staff continued monitoring the East Fork Russian River above and below Lake Mendocino, as well as in Lake Mendocino itself, as part of their overall TUCP monitoring effort to provide a better understanding of lake limnology and potential effects on water quality in the upper Russian River mainstem.

In 2022, 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 2022 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 31 May and continued until 29 August. 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 three exceedances of the SSM for Total Coliform during the season at the Cloverdale River Park station. There were also two (2) exceedances each of the Total Coliform SSM at the Sunset Beach and Johnson's Beach stations, and one (1) exceedance at the Monte Rio Beach station. There was one (1) exceedance each of the BAV for *E. coli* that occurred at Cloverdale River Park and Healdsburg Veterans Memorial Beach stations. Finally, there were two (2) exceedances each of the BAV for *E. coli* that occurred at Steelhead Beach, Johnson's Beach, and Monte Rio Beach. Results from the sampling program were reported by the Sonoma County DHS at their website and on the Sonoma County DHS Beach Sampling Hotline (Sonoma County DHS, 2022a). The 2022 seasonal results are shown in Table 3-1 and in Figures 3-1 and 3-2.

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

Date Sampled	Cloverdale River Park		Del Rio Woods Beach		Camp Rose Beach		Healdsburg Veterans		Steelhead Beach		Forestville Access Beach		Sunset Beach		Johnson's Beach		Monte Rio Beach		Patterson Point	
	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC	TC	EC
5/31/2022	5,127	20	529	10	631	20	776	63	908	243*	1,439	<10	1,259	10	2,282	160	2,755	31	4,352	20
6/1/2022									530	10										
6/6/2022	9,208	74	1,935	63	2,098	135	1,529	266*	3,654	441*	2,382	86	1,467	106	2,014	41	7,270	63	839	31
6/7/2022							1,119	10	1,314	121										
6/13/2022	4,611	20	2,481	10	1,515	<10	1,664	10	1,162	10	3,076	63	11,199*	52	4,106	173	12,997*	345*	2,143	52
6/14/2022													860	10			1,720	259		
6/20/2022	3,488	146	4,611	10	2,987	63	3,130	20	988	20	813	20	860	20	5,172	292*	4,611	31	1,674	20
6/21/2022															24,196	75				
6/27/2022	8,864	20	2,359	41	3,255	10	2,489	<10	1,145	20	6,867	31	>24196	52	10,462	41	4,884	512*	1,281	31
6/28/2022													2,489	<10			1,793	86		
7/5/2022	11,199*	259*	1,956	<10	2,014	20	1,250	10	1,250	10	1,153	10	1,162	20	3,873	175	1,529	86	1,187	31
7/6/2022	5,475	31																		
7/11/2022	>24196	31	1,989	<10	2,613	31	1,674	10	1,106	<10	1,607	<10	1,664	10	2,909	63	2,909	63	1,658	20
7/12/2022	5,475	10																		
7/18/2022	8,664	20	3,873	52	2,909	31	1,616	<10	1,314	52	2,603	75	1,664	<10	4,106	<10	2,613	<10	1,500	20
7/25/2022	6,488	20	272	<10	4,611	52	3,255	31	1,354	<10	1,860	20	1,455	20	2,909	31	884	31	1,092	10
8/1/2022	8,664	41	2,489	41	2,247	31	2,613	31	1,112	<10	2,851	31	1,989	<10	3,654	31	1,314	20	1,162	10
8/8/2022	9,208	10	1,664	41	2,481	10	1,789	<10	888	10	3,448	10	2,098	10	1,850	31	127	10	1,333	30
8/15/2022	7,701	31	1,500	31	2,755	<10	1,467	<10	1,314	<10	2,755	<10	1,935	<10	2,359	241*	985	<10	988	10
8/16/2022															1,935	10				
8/22/2022	11199*	31	2,046	31	2,909	<10	1,236	<10	1,081	<10	2,359	10	3,255	31	1,439	63	1,421	20	1,153	10
8/23/2022	8,164	<10																		
8/29/2022	7,270	20	1,918	<10	1,872	20	1,607	20	789	10	2,187	10	1,904	10	1,259	31	1,439	41	689	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

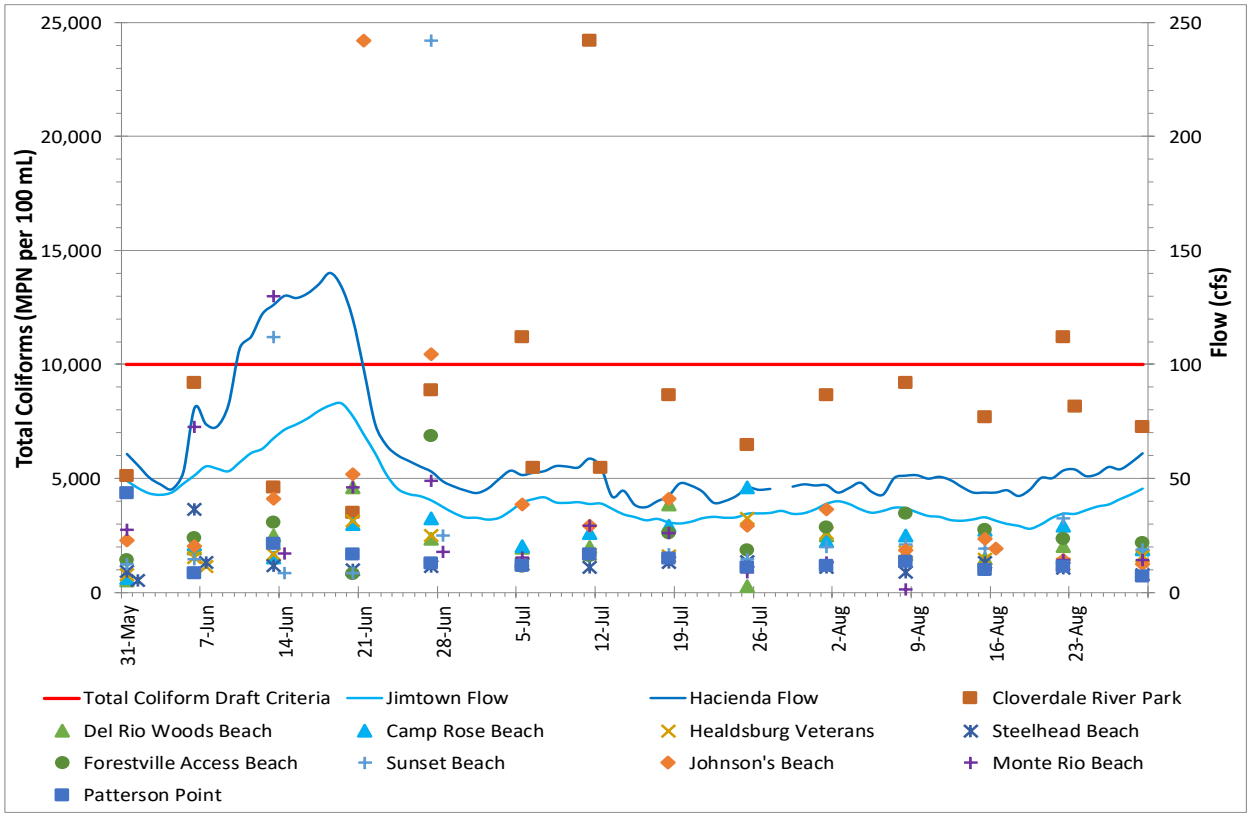

Figure 3-1. Sonoma County DHS 2022 Seasonal Mainstem Russian River Bacteria Sample Results for Total Coliform. Flow rates are preliminary and subject to final revision by USGS.

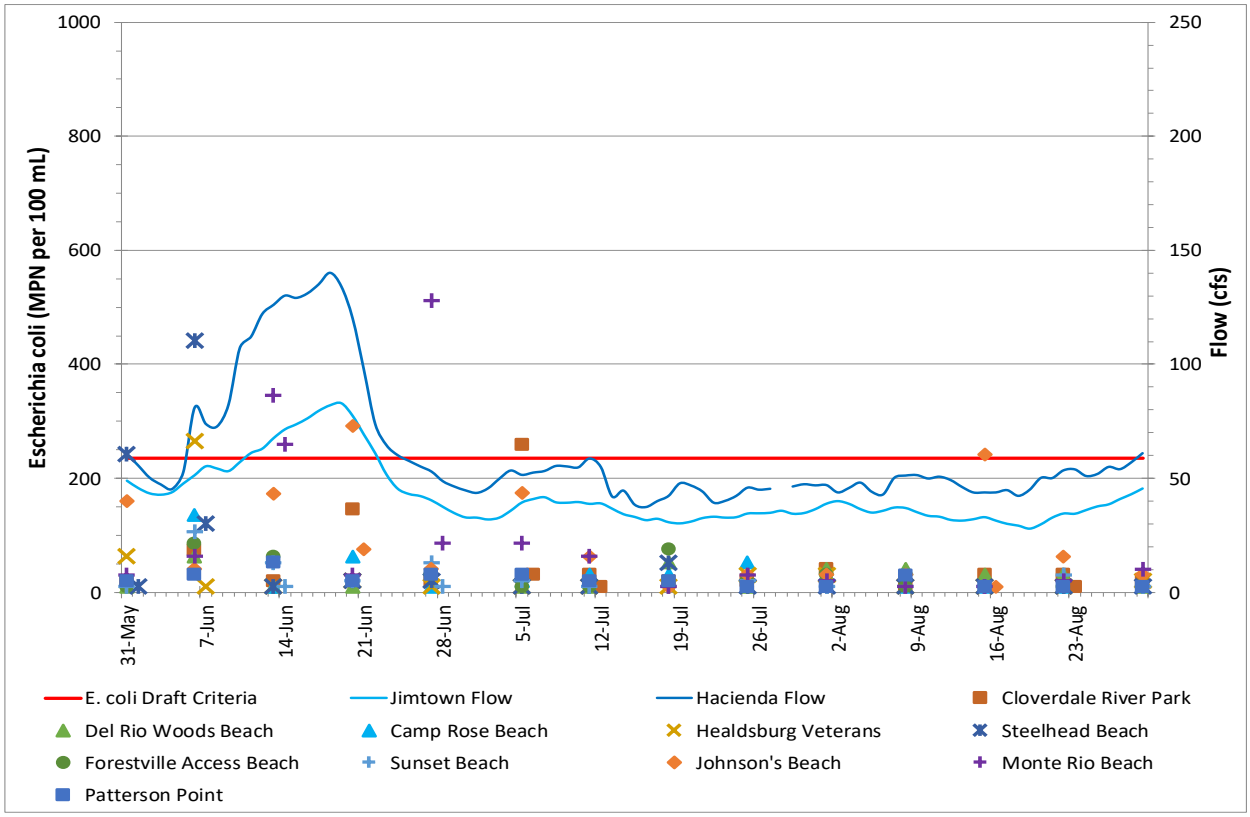

Figure 3-2. Sonoma County DHS 2022 Seasonal Mainstem Russian River Bacteria Sample Results for *E. coli*. Flow rates are preliminary and subject to final revision by USGS.

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

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

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

Lake Mendocino Vertical Profiles

In 2022, 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 from February to November as weather and access allowed, including biweekly monitoring from April through October (Figure 3-3). Vertical profiling was conducted in large part to track the timing and strength of stratification of the lake into a three-layered profile including: a colder, generally anoxic bottom layer known as the hypolimnion; a transitional middle layer known as the metalimnion where temperatures and dissolved oxygen rapidly increase; and a warm oxygenated layer on the surface known as the epilimnion (Figures 3-3 and 3-4). Water temperature and density differences typically form between the bottom and top layers in the spring as surface temperatures begin to rise with increasing air temperatures, creating a stratified lake profile. Stratification of the lake typically begins to break down in the fall as surface temperatures decrease, diminishing the density gradient between layers, and wind driven events contribute to the mixing of the lake. Stratification of the lake was observed to begin in March and did not break down into a mixed system until the end of October. Turbidity values were generally observed to be higher in the hypolimnion than in the epilimnion (Figure 3-5).

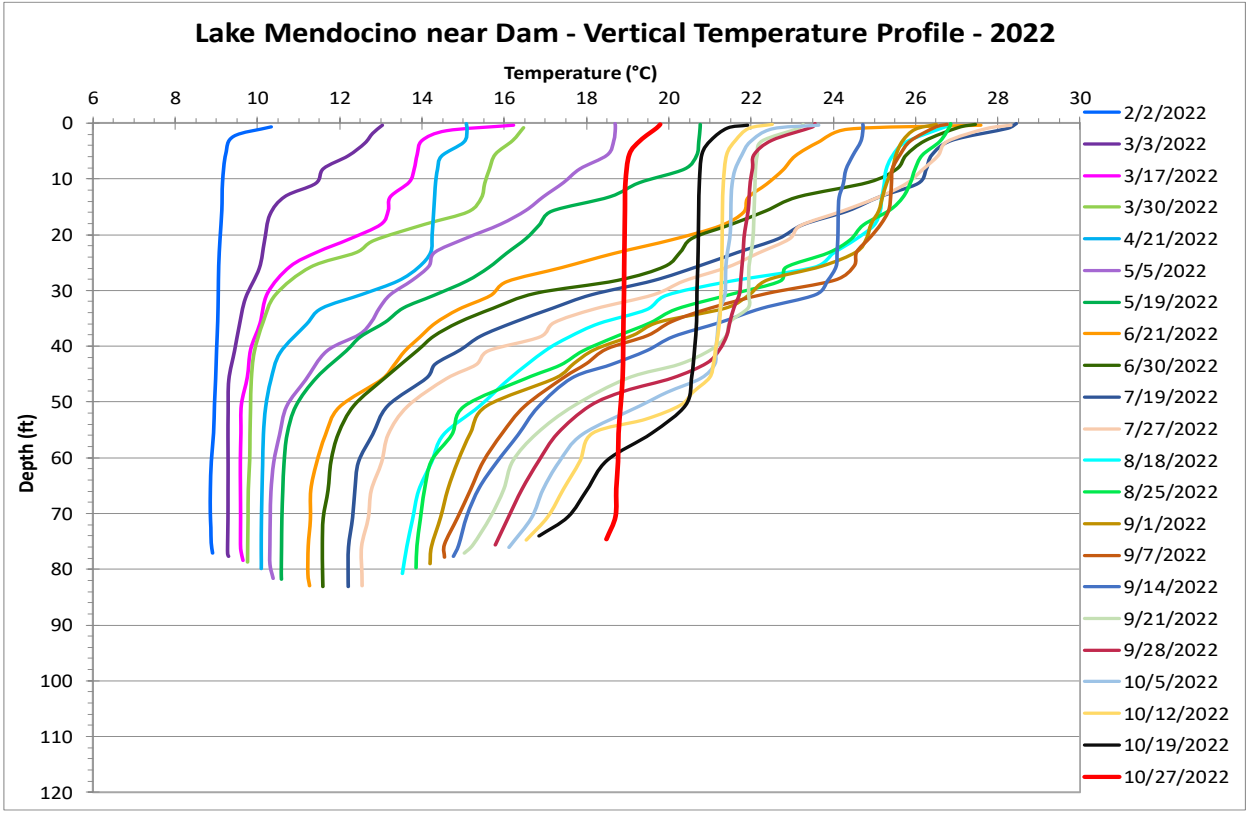

Figure 3-3. Sonoma Water 2022 Vertical Temperature Profiles in Lake Mendocino near Coyote Valley Dam.

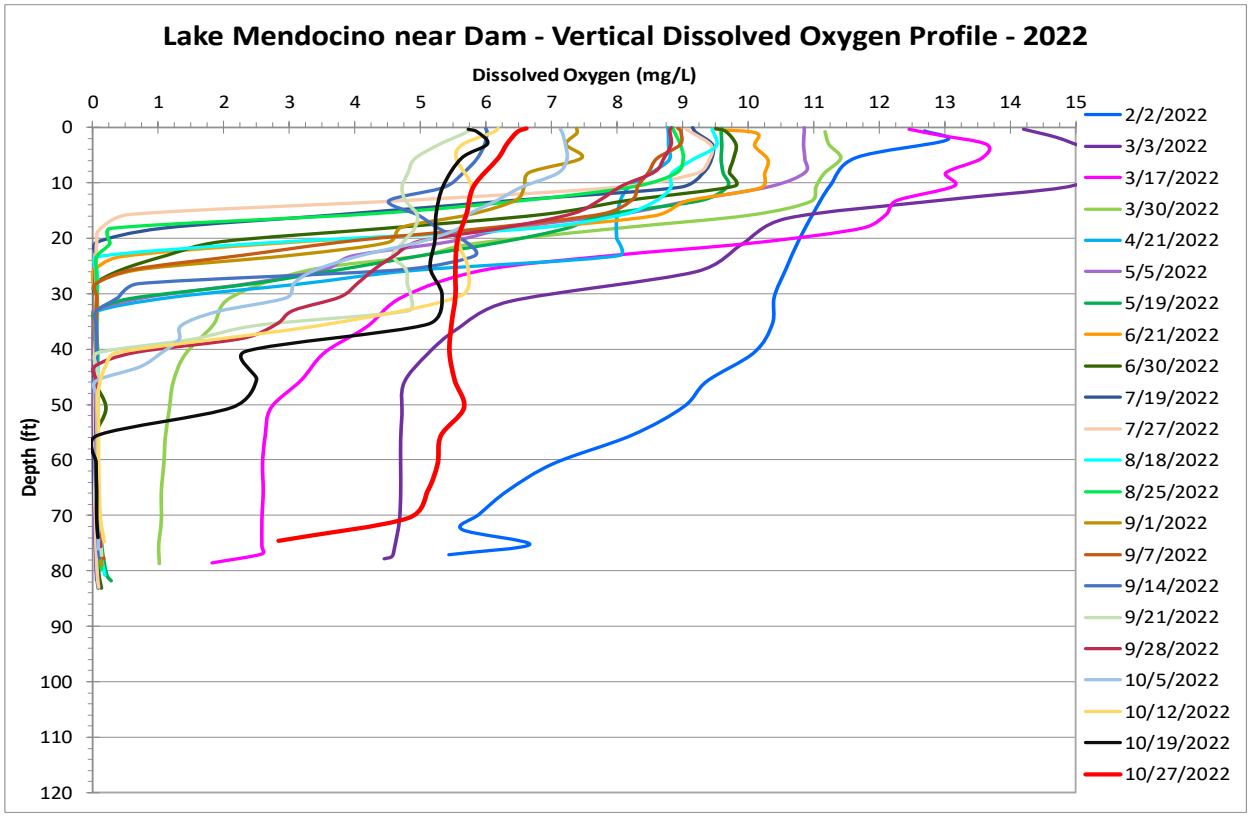

Figure 3-4. Sonoma Water 2022 Vertical Dissolved Oxygen Profiles in Lake Mendocino near Coyote Valley Dam.

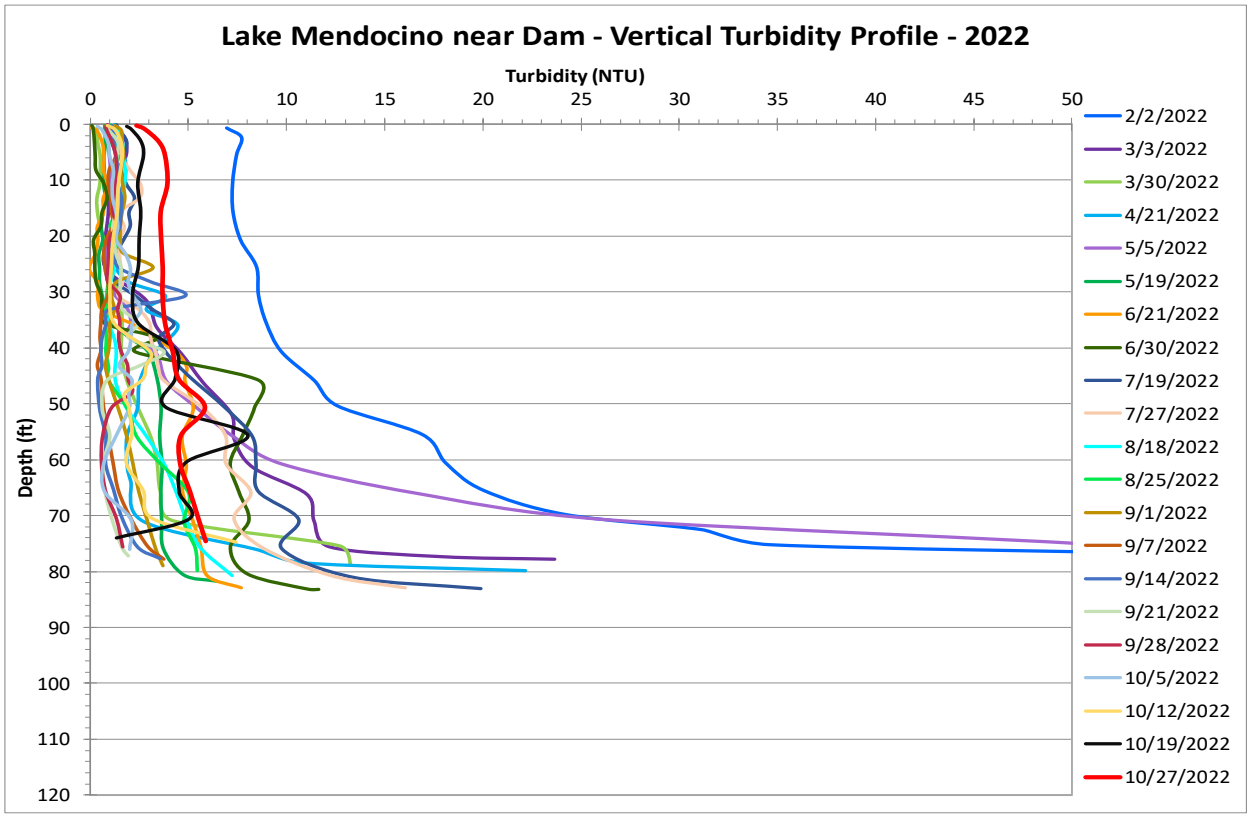

Figure 3-5. Water Vertical 2022 Turbidity Profiles in Lake Mendocino near Coyote Valley Dam.

Lake Mendocino and East Fork Russian River Grab Sampling

Sonoma Water staff generally conducted nutrient grab sampling on a bi-weekly basis during the terms of the Order at three depths in Lake Mendocino including the bottom (hypolimnion) layer, the middle transitional (metalimnion) layer, and the surface (Epilimnion) layer. Nutrient grab samples were also generally collected bi-weekly 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. Sampling results are only included up to 5 October due to the timing of this report and delay associated with receiving sample results.

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

The sampling results for total nitrogen, total phosphorus, turbidity, and *chlorophyll a* are discussed below and summarized in Tables 3-2 through 3-4 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, 2022).

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 2022 resulted in a method detection limit (MDL) for *chlorophyll a*, which is the level of accuracy for a given lab analysis to provide a valid concentration of a given constituent, that was higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Put simply, the EPA exceedance criteria for *chlorophyll a* in rivers and streams is approximately 0.0018 mg/L, whereas the lab analysis MDL for *chlorophyll a* was 0.0030 mg/L. Therefore, some lab results for *chlorophyll a* that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL, which in turn could result in an under representation of the actual number of exceedances observed. However, for reporting purposes, only those exceedances that are quantified are included in the summation.

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

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

Total Nitrogen

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

Calculating total nitrogen values requires the summation of the different components of total nitrogen: organic and ammoniacal nitrogen (referred to as Total Kjeldahl Nitrogen or TKN), and nitrate/nitrite nitrogen. The EPA criteria for total nitrogen for rivers and streams was exceeded twenty-three (23) times prior to and during the terms of the Order, representing 63.9% of the total samples collected (23 out of 36) at the upper and lower East Fork Russian River stations (Tables 3-2 and 3-6, and Figure 3-6). The EPA criteria for lakes and reservoirs was exceeded twenty-six (26) times prior to and during the terms of the Order, representing 51% of the total samples collected (26 out of 51) in Lake Mendocino during the monitoring effort (Tables 3-3 through 3-5).

The East Fork Calpella station had seven (7) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 18 samples collected (38.9%), under flows that ranged from 13.5 cfs to 299 cfs (Table 3-2 and Figure 3-6). The maximum concentration measured 0.99 mg/L on 21 April with a flow of 299 cfs (Table 3-2). The maximum concentration measured during the terms of the Order was 0.67 mg/L on 1 September with a flow of 25.2 cfs (Table 3-2). The minimum concentration was 0.052 mg/L, which occurred on 27 July with a flow of 86.5 cfs. Nitrogen values were observed to fluctuate at Calpella prior to and during the terms of the Order.

Table 3-2. Sonoma Water 2022 Seasonal Grab Sampling Results at East Fork Russian River near Calpella.

East Fork Russian River near Calpella	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11461500 RR Near Calpella***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
2/2/2022	15:00	7.9	8.1	ND	ND	ND	0.29	ND	ND	0.29	**0.024**	0.035	1.41	1.82	130	2.2	ND	66.6
3/17/2022	11:40	11.7	7.6	ND	ND	ND	0.14	ND	ND	0.14	**0.023**	ND	1.44	1.67	130	1.5	ND	54.5
3/30/2022	14:50	14.0	8.1	ND	ND	ND	0.10	ND	ND	0.10	0.020	0.052	1.76	2.10	120	1.6	ND	68.1
4/21/2022	10:50	10.9	7.4	0.64	ND	ND	0.35	ND	0.64	**0.99**	**0.22**	0.16	5.32	7.72	180	**83**	**0.0067**	299
5/5/2022	10:50	15.7	7.9	0.24	ND	ND	0.14	ND	0.24	**0.38**	**0.033**	0.049	1.58	1.97	130	**2.4**	ND	63.7
5/19/2022	10:40	17.0	7.9	0.30	ND	ND	0.12	ND	0.30	**0.42**	**0.032**	0.051	1.79	2.25	140	**2.5**	ND	87.8
6/21/2022	14:20	19.8	8.0	0.26	ND	ND	0.055	ND	0.26	0.32	**0.039**	0.061	1.85	2.19	130	2.1	**0.0032**	91.5
6/30/2022	11:20	19.6	8.0	ND	ND	ND	0.079	ND	ND	0.079	**0.056**	0.076	1.91	2.37	120	**3.3**	**0.0059**	92.8
7/19/2022	10:50	20.3	7.9	0.20	0.13	0.0040	0.094	ND	0.33	**0.42**	**0.067**	0.11	2.72	3.30	120	**5.1**	**0.0085**	87.9
7/27/2022	14:20	22.5	8.1	ND	ND	0.00045	0.052	ND	ND	0.052	**0.068**	0.12	2.52	3.01	110	**4.8**	**0.0059**	86.5
8/18/2022	14:00	22.7	8.1	ND	ND	ND	0.13	ND	ND	0.13	**0.086**	0.18	3.38	3.83	140	1.2	ND	21.6
8/25/2022	14:20	22.6	8.0	ND	ND	0.0019	0.13	ND	ND	0.132	**0.090**	0.21	4.17	5.22	150	1.4	ND	18.7
9/1/2022	13:30	20.5	8.0	0.55	ND	0.0024	0.12	ND	0.55	**0.67**	**0.11**	0.24	2.94	3.32	130	1.7	ND	25.2
9/7/2022	12:50	21.8	7.9	ND	ND	ND	0.098	ND	ND	0.098	**0.097**	0.22	3.09	3.63	130	1.1	ND	16.8
9/14/2022	14:20	18.8	8.1	ND	ND	0.0027	0.11	ND	ND	0.113	**0.10**	0.24	2.73	2.82	160	1.9	**0.0040**	21.7
9/21/2022	14:30	17.7	7.9	0.29	ND	0.0011	0.16	ND	0.29	**0.45**	**0.11**	0.25	4.11	4.61	150	1.6	ND	16.4
9/28/2022	14:50	17.8	8.0	0.52	ND	0.0029	0.11	ND	0.52	**0.63**	**0.075**	0.17	2.12	2.55	160	1.5	ND	13.5
10/5/2022	14:40	17.5	8.0	ND	ND	0.00057	0.15	ND	ND	0.151	**0.067**	0.17	2.11	2.44	140	1.3	ND	14.2

* 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

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 seven (7) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of seventeen (17) samples collected (41.2%) at a depth of 5 feet (Table 3-3 and Figure 3-6). The maximum concentration measured 0.69 mg/L, which occurred on 2 February (Table 3-3). The maximum concentration measured during the terms of the Order was 0.49 mg/L, which occurred on 19 July (Table 3-3). The minimum concentration was ND, which occurred on 7 September at a depth of 5 feet.

The Lake Mendocino metalimnion had five (5) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of seventeen (17) samples collected (29.4%) at depths ranging from 20 to 50 feet (Table 3-4 and Figure 3-6). The maximum seasonal value measured 0.53 mg/L, which occurred on 2 February at a depth of 25 feet (Table 3-4). The maximum seasonal value measured during the terms of the Order was 0.46 mg/L, which occurred on 21 June at a depth of 20 feet (Table 3-4). The minimum concentration was ND, which occurred twice, on 19 May at a depth of 25 feet, and on 7 September at a depth of 30 feet.

The Lake Mendocino hypolimnion had fourteen (14) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 17 samples collected (82.4%) at a depth of 70 feet (Table 3-5 and Figure 3-6). The maximum seasonal value occurred during the terms of the Order and measured 0.75 mg/L on 21 September at a depth of 70 feet (Table 3-5). The minimum concentration was 0.22 mg/L, which occurred on 21 April at a depth of 70 feet (Table 3-5). The minimum concentration during the terms of the Order was 0.32 mg/L, which occurred on 27 July at a depth of 70 feet.

Table 3-3. Sonoma Water 2022 Seasonal Grab Sampling Results in Lake Mendocino Epilimnion.

Lake Mendocino Epilimnion	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	Depth of Sample
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	feet
2/2/2022	14:40	9.2	8.0	0.50	ND	ND	0.19	ND	0.50	**0.69**	**0.054**	ND	4.17	4.50	140	7.9	**0.034**	5
3/17/2022	13:50	13.9	8.8	0.45	ND	ND	0.062	ND	0.45	**0.51**	**0.029**	ND	3.89	4.00	120	2.2	**0.029**	5
4/21/2022	13:30	14.5	8.1	0.26	ND	ND	ND	ND	0.26	0.26	**0.032**	ND	3.60	4.15	120	1.8	**0.0077**	5
5/5/2022	13:20	18.5	8.6	0.54	ND	ND	ND	ND	0.54	**0.54**	**0.030**	ND	3.67	4.09	120	1.9	**0.0093**	5
5/19/2022	12:20	20.7	8.6	0.51	ND	ND	ND	ND	0.51	**0.51**	**0.029**	ND	3.85	4.28	130	2.2	**0.0051**	5
6/21/2022	13:20	23.6	8.8	0.38	ND	ND	ND	ND	0.38	**0.41**	**0.027**	ND	3.87	4.27	140	2.1	**0.0085**	5
6/30/2022	13:30	25.8	8.9	0.33	ND	ND	0.054	ND	0.33	0.38	**0.032**	ND	3.95	4.51	160	1.6	**0.0051**	5
7/19/2022	13:00	26.4	8.9	0.28	0.15	0.049	0.063	ND	0.43	**0.49**	**0.026**	ND	4.35	5.10	130	3.0	**0.0045**	5
7/27/2022	13:00	26.5	8.9	0.20	ND	0.032	ND	ND	0.30	0.30	**0.023**	ND	4.39	5.00	130	3.0	**0.0077**	5
8/18/2022	12:30	25.4	8.8	0.32	ND	ND	0.071	ND	0.32	0.39	**0.036**	ND	4.07	4.61	130	2.9	**0.0096**	5
8/25/2022	12:50	26.2	8.8	0.20	ND	0.010	ND	ND	0.20	0.20	**0.021**	ND	4.26	4.74	140	2.6	**0.0067**	5
9/1/2022	12:10	25.5	8.6	0.32	0.10	0.020	ND	ND	0.42	**0.42**	**0.030**	ND	3.45	3.92	130	2.4	**0.0069**	5
9/7/2022	11:30	25.6	8.7	ND	ND	ND	ND	ND	ND	ND	**0.030**	ND	3.46	4.14	130	2.0	**0.0080**	5
9/14/2022	12:40	24.5	8.3	0.27	ND	0.0094	ND	ND	0.27	0.27	**0.029**	ND	3.16	3.89	150	2.2	**0.0056**	5
9/21/2022	13:00	22.1	7.7	0.35	ND	0.0013	ND	ND	0.35	0.35	**0.027**	ND	2.95	3.74	150	2.4	**0.0096**	5
9/28/2022	13:20	22.1	8.4	0.33	ND	0.0090	ND	ND	0.33	0.33	**0.024**	ND	3.17	3.61	150	1.6	**0.0077**	5
10/5/2022	13:20	21.8	8.1	ND	ND	0.0045	0.062	ND	ND	0.067	**0.024**	ND	3.08	3.57	120	2.1	**0.013**	5

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

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

Recommended EPA Criteria based on Aggregate Ecoregion III

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

Total Nitrogen: 0.40 mg/L

Table 3-4. Sonoma Water 2022 Seasonal Grab Sampling Results in Lake Mendocino Metalimnion.

Lake Mendocino Metalimnion	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	Depth of Sample
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	feet
2/2/2022	14:30	9.1	7.6	0.32	ND	ND	0.21	ND	0.32	**0.53**	**0.042**	ND	4.24	4.62	120	7.6	**0.014**	25
3/17/2022	13:40	12.2	8.1	0.40	ND	ND	0.067	ND	0.40	**0.47**	**0.024**	ND	4.06	3.94	120	1.7	**0.018**	20
4/21/2022	13:20	12.5	7.1	ND	ND	ND	0.069	ND	ND	0.069	**0.023**	ND	3.40	4.05	130	2.2	ND	30
5/5/2022	13:10	15.1	7.5	0.46	ND	ND	ND	ND	0.46	**0.46**	**0.025**	ND	3.39	3.92	130	2.7	**0.0093**	20
5/19/2022	12:30	15.6	7.3	ND	ND	ND	ND	ND	ND	ND	**0.022**	ND	3.27	3.95	130	1.3	ND	25
6/21/2022	13:30	20.1	7.3	0.43	ND	ND	ND	ND	0.43	**0.46**	**0.022**	ND	3.09	3.89	130	2.0	**0.014**	20
6/30/2022	13:40	20.6	7.3	0.36	ND	ND	ND	ND	0.36	0.36	**0.033**	ND	3.06	3.56	130	1.5	**0.0091**	20
7/19/2022	13:10	22.7	7.2	0.36	ND	0.00063	0.064	ND	0.36	**0.42**	**0.028**	0.21	3.20	4.23	130	2.6	**0.011**	20
7/27/2022	13:10	21.4	7.1	ND	ND	0.00037	ND	ND	ND	0.0004	**0.023**	ND	3.03	3.74	130	2.7	**0.0059**	25
8/18/2022	12:40	20.0	7.0	ND	ND	ND	0.068	ND	ND	0.068	**0.032**	ND	3.15	3.87	130	1.9	**0.0056**	30
8/25/2022	13:00	22.9	7.1	ND	ND	0.00012	ND	ND	ND	0.0001	**0.025**	ND	3.70	4.72	140	2.7	**0.0056**	25
9/1/2022	12:20	22.0	7.0	0.37	ND	0.0003	ND	ND	0.37	0.37	**0.031**	ND	2.88	3.46	130	2.6	**0.0040**	30
9/7/2022	11:40	22.4	7.1	ND	ND	ND	ND	ND	ND	ND	**0.029**	ND	2.93	3.56	130	2.3	**0.011**	30
9/14/2022	12:50	21.3	7.0	0.22	ND	0.00040	ND	ND	0.22	0.22	**0.040**	ND	2.97	3.56	170	3.5	**0.0061**	35
9/21/2022	13:10	19.0	7.0	0.31	ND	0.00026	0.063	ND	0.31	0.37	**0.077**	0.076	2.80	3.45	130	7.5	ND	45
9/28/2022	13:30	20.1	7.1	0.26	ND	0.00045	ND	ND	0.26	0.26	**0.045**	0.040	2.80	3.32	130	2.9	**0.0067**	45
10/5/2022	13:30	19.3	7.0	ND	0.15	0.00056	ND	ND	ND	0.151	**0.070**	0.12	2.90	3.42	140	5.0	**0.0037**	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.

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

Table 3-5. Sonoma Water 2022 Seasonal Grab Sampling Results in Lake Mendocino Hypolimnion.

Lake Mendocino Hypolimnion	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	Depth of Sample
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	feet
2/2/2022	14:20	8.9	7.0	0.21	ND	ND	0.39	ND	0.21	**0.60**	**0.066**	0.031	4.16	4.91	120	21	ND	70
3/17/2022	13:30	9.6	7.1	ND	ND	ND	0.30	ND	ND	0.30	**0.025**	ND	3.65	4.19	130	3.7	**0.0037**	70
4/21/2022	13:10	10.1	6.8	ND	ND	ND	0.22	ND	ND	0.22	**0.054**	0.11	3.68	4.31	130	2.3	ND	70
5/5/2022	13:00	10.3	6.7	0.40	ND	ND	0.15	ND	0.40	**0.55**	**0.063**	0.093	3.57	4.15	130	4.1	ND	70
5/19/2022	12:40	10.6	6.9	0.53	ND	ND	0.11	ND	0.53	**0.64**	**0.081**	0.13	3.58	4.24	140	4.4	ND	70
6/21/2022	13:40	11.3	7.0	0.55	ND	ND	ND	ND	0.55	**0.55**	**0.14**	0.23	3.52	4.26	140	8.6	ND	70
6/30/2022	13:50	11.6	7.0	0.28	0.32	ND	0.053	ND	0.60	**0.65**	**0.13**	0.19	3.42	4.15	77	9.5	ND	70
7/19/2022	13:20	12.3	7.0	0.30	0.34	0.00076	0.063	ND	0.64	**0.70**	**0.16**	0.21	3.57	4.79	130	14	**0.0075**	70
7/27/2022	13:20	12.7	6.8	ND	0.33	0.00048	ND	ND	0.32	0.32	**0.15**	0.20	3.53	4.53	120	13	ND	70
8/18/2022	12:50	13.8	7.0	ND	0.28	0.00069	0.071	ND	0.44	**0.51**	**0.17**	0.20	3.47	4.45	130	12	0.0032	70
8/25/2022	13:10	14.0	7.0	ND	0.38	0.00098	ND	ND	0.50	**0.50**	**0.20**	0.28	3.62	5.03	130	17	**0.0045**	70
9/1/2022	12:30	14.5	6.9	0.24	0.30	0.0006	ND	ND	0.54	**0.54**	**0.14**	0.24	3.15	3.89	120	8.9	0.0032	70
9/7/2022	11:50	14.9	6.9	0.24	0.22	0.014	ND	ND	0.46	**0.46**	**0.15**	0.24	3.17	3.97	120	8.3	ND	70
9/14/2022	13:00	15.1	6.9	ND	0.45	0.001	ND	ND	0.64	**0.64**	**0.18**	0.37	3.14	3.95	150	14	**0.0037**	70
9/21/2022	13:20	15.7	6.9	0.27	0.48	0.0011	ND	ND	0.75	**0.75**	**0.20**	0.39	3.06	3.97	130	13	**0.0048**	70
9/28/2022	13:40	16.1	6.9	ND	0.55	0.0013	ND	ND	0.73	**0.73**	**0.20**	0.35	3.08	3.86	140	12	ND	70
10/5/2022	13:40	16.7	6.8	ND	0.49	0.00096	0.064	ND	0.52	**0.58**	**0.19**	0.52	3.00	3.80	120	14	ND	70

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

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

Recommended EPA Criteria based on Aggregate Ecoregion III

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

Total Nitrogen: 0.40 mg/L

The East Fork below Dam station had sixteen (16) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 18 samples collected (88.9%), under flows that ranged from 28 cfs to 219 cfs (Table 3-6 and Figure 3-6). The maximum concentration occurred during the terms of the Order and measured 0.99 mg/L on 28 September with a flow of 66 cfs (Table 3-6). The minimum concentration was 0.22 mg/L, which occurred on 21 April with a flow of 28 cfs (Table 3-6). The minimum concentration during the terms of the Order was 0.26 mg/L, which occurred on 7 September with a flow of 89 cfs (Table 3-6). Nitrogen values were observed to generally remain elevated throughout the monitoring season.

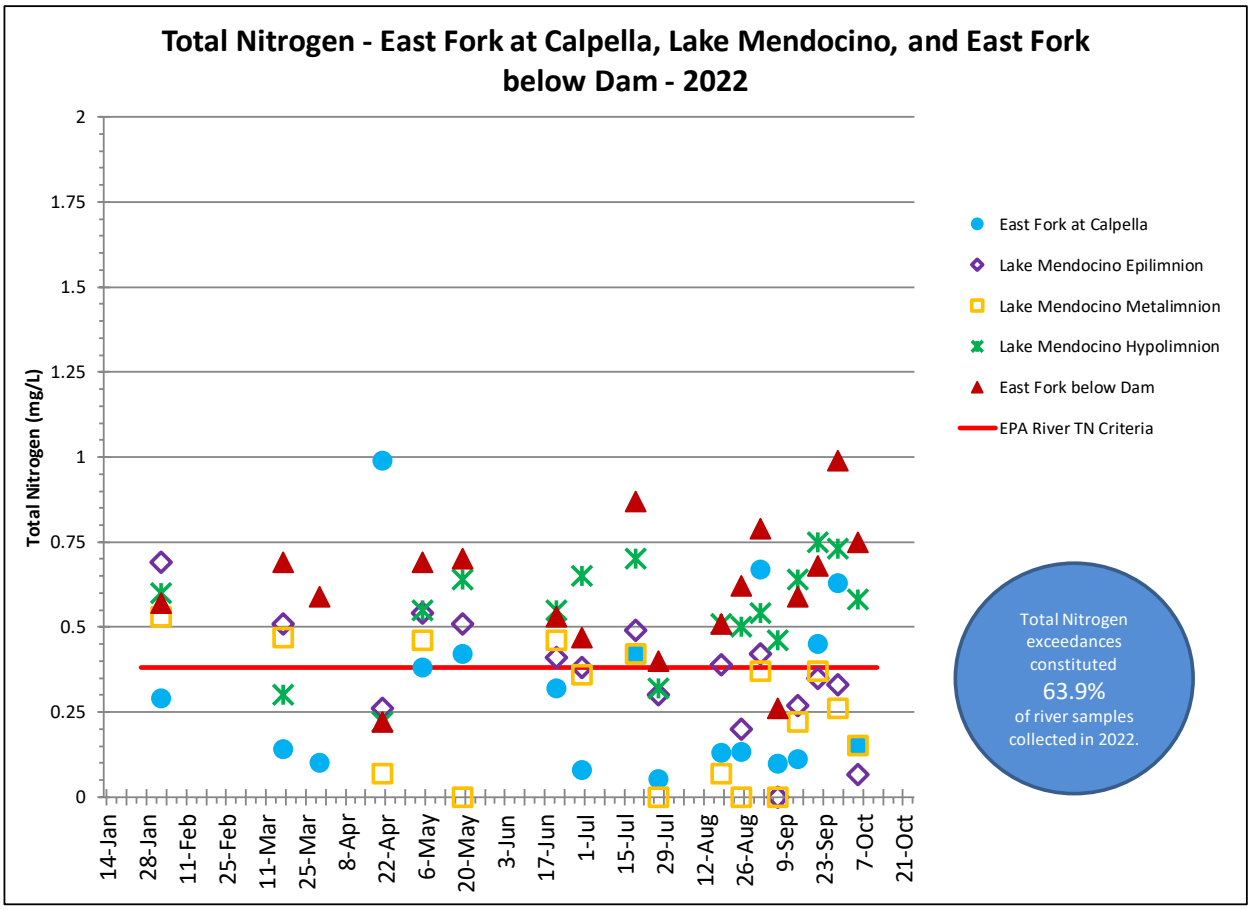

Figure 3-6. Sonoma Water Total Nitrogen results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Coyote Valley Dam in 2022. Percent exceedances only apply to samples collected at East Fork river stations.

Total Phosphorus

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

The total phosphorus criteria for rivers and streams was exceeded thirty (34) times prior to and during the terms of the Order, representing 94.4% of the total samples collected (34 out of 36) at the East Fork Russian River stations located above and below Lake Mendocino (Tables 3-2 and 3-6, and Figure 3-7).

The total phosphorus criteria for lakes and reservoirs was exceeded fifty-one (51) times prior to and during the terms of the Order, representing 100% of the total samples collected (51 out of 51) in Lake Mendocino during the monitoring effort (Tables 3-3 through 3-5).

Calpella exceeded the EPA criteria for a majority of the season prior to and during the terms of the Order, including 17 of 18 samples (94.4%), under flows that ranged from13.5 cfs to 299 cfs (Table 3-2 and Figure 3-7). The maximum concentration measured 0.22 mg/L on 21 April with a flow of approximately 299 cfs (Table 3-2 and Figure 3-7). The maximum concentration during the terms of the Order measured 0.11 mg/L, which occurred twice on 1 September and 21 September with flows of 25.2 cfs and 16.4 cfs, respectively (Table 3-2 and Figure 3-7). The minimum concentration was 0.020 mg/L, which occurred on 30 March with a flow of approximately 68.1 cfs (Table 3-2). The minimum concentration during the terms of the Order was 0.039 mg/L, which occurred on 21 June with a flow of approximately 91.5 cfs. Other than the spike in concentration during the April storm event, total phosphorus values were observed to generally increase from spring into summer at Calpella then decrease through the fall.

Table 3-6. Sonoma Water 2022 Seasonal Grab Sampling Results at East Fork Russian River below Dam.

East Fork Russian River below Dam	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USACE COY (Lake Mendocino)***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Outflow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
2/2/2022	12:20	9.2	7.5	0.26	ND	ND	0.31	ND	0.26	**0.57**	**0.044**	ND	4.12	4.77	120	**16**	**0.0059**	80
3/17/2022	12:20	10.3	7.3	0.38	ND	ND	0.31	ND	0.38	**0.69**	**0.025**	ND	3.72	4.17	110	**3.5**	**0.0053**	29
3/30/2022	12:50	10.5	7.4	0.30	ND	ND	0.29	ND	0.30	**0.59**	0.0091	ND	3.70	3.99	130	**2.6**	**0.0040**	29
4/21/2022	11:30	10.7	7.4	ND	ND	ND	0.22	ND	ND	0.22	**0.046**	0.084	3.73	4.45	130	**3.7**	**0.0032**	28
5/5/2022	14:10	11.0	7.5	0.54	ND	ND	0.15	ND	0.54	**0.69**	**0.064**	0.10	3.62	4.50	130	**3.2**	**0.0048**	29
5/19/2022	13:30	12.6	7.8	0.58	ND	ND	0.12	ND	0.58	**0.70**	**0.076**	0.13	3.70	4.22	120	**4.0**	ND	28
6/21/2022	11:10	12.1	7.1	0.49	ND	ND	0.040	ND	0.49	**0.53**	**0.11**	0.19	3.83	4.14	120	**5.6**	ND	48
6/30/2022	14:30	12.7	7.1	ND	0.23	0.00067	0.060	ND	0.41	**0.47**	**0.12**	0.17	3.34	4.12	130	**8.3**	ND	70
7/19/2022	14:00	13.2	7.1	0.53	0.34	0.0010	ND	ND	0.87	**0.87**	**0.15**	0.19	3.72	4.73	120	**11**	ND	219
7/27/2022	13:50	13.5	7.1	ND	0.37	0.0011	ND	ND	0.40	**0.40**	**0.16**	0.19	3.59	4.92	130	**11**	ND	82
8/18/2022	13:30	14.5	7.1	0.23	0.21	0.00070	0.069	ND	0.44	**0.51**	**0.17**	0.22	3.56	4.44	130	**8.1**	ND	90
8/25/2022	14:00	14.7	7.1	ND	0.38	0.0013	0.084	ND	0.54	**0.62**	**0.20**	0.20	3.58	6.21	140	**9.7**	**0.0032**	89
9/1/2022	13:00	15.1	7.0	0.38	0.35	0.00060	0.063	ND	0.73	**0.79**	**0.18**	0.20	3.18	4.00	130	**4.8**	ND	89
9/7/2022	12:20	15.5	7.1	ND	0.27	0.0048	ND	ND	0.26	0.26	**0.18**	0.22	3.15	3.96	120	**4.1**	ND	89
9/14/2022	13:40	15.8	7.1	ND	0.44	0.0016	ND	ND	0.59	**0.59**	**0.20**	0.31	3.11	4.02	160	**5.5**	**0.0037**	92
9/21/2022	14:00	16.3	7.0	0.23	0.39	0.0012	0.064	ND	0.62	**0.68**	**0.22**	0.33	3.11	3.90	110	**5.1**	**0.0035**	74
9/28/2022	14:20	17.0	7.1	0.39	0.60	0.0024	ND	ND	0.99	**0.99**	**0.23**	0.34	3.10	3.86	160	**3.9**	ND	66
10/5/2022	14:10	17.4	7.1	ND	0.60	0.0011	0.069	ND	0.68	**0.75**	**0.23**	0.530	3.16	3.81	120	**7.2**	ND	61

* 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

The Lake Mendocino epilimnion exceeded the total phosphorus EPA criteria throughout the season prior to and during the terms of the Order (17 of 17 samples or 100%) at a sampling depth of 5 feet (Table 3-3 and Figure 3-7). The maximum concentration measured 0.054 mg/L on 2 February (Table 3-3). The

maximum concentration during the terms of the Order measured 0.036 mg/L on 18 August (Table 3-3). The minimum concentration at the Lake Mendocino epilimnion occurred during the terms of the Order and was 0.021 mg/L, which occurred on 25 August (Table 3-3).

The Lake Mendocino metalimnion also exceeded the total phosphorus EPA criteria throughout the season prior to and during the terms of the Order (17of 17 samples or 100%) at a sampling depth that ranged from 25 to 50 feet (Table 3-4 and Figure 3-7). The maximum concentration occurred during the terms of the Order and measured 0.077 mg/L on 21 September at a depth of 45 feet (Table 3-4). The minimum concentration at the Lake Mendocino epilimnion was 0.022 mg/L, which occurred twice, on 19 May at a depth of 25 feet and on 21 June at a depth of 20 feet.

The Lake Mendocino hypolimnion also exceeded the total phosphorus EPA criteria throughout the season prior to and during the terms of the Order (17of 17 samples or 100%) at a sampling depth of 70 feet (Table 3-5 and Figure 3-7). The maximum concentration occurred during the terms of the Order and measured 0.20 mg/L, which occurred three times, on 25 August, 21 September, and 28 September (Table 3-5). The minimum concentration at the Lake Mendocino epilimnion was 0.025 mg/L, which occurred on 17 March (Table 3-5). The minimum concentration at the Lake Mendocino epilimnion during the terms of the Order was 0.14 mg/L, which occurred on 1 September (Table 3-5). Total phosphorus values at the hypolimnion were observed to generally increase from spring into fall.

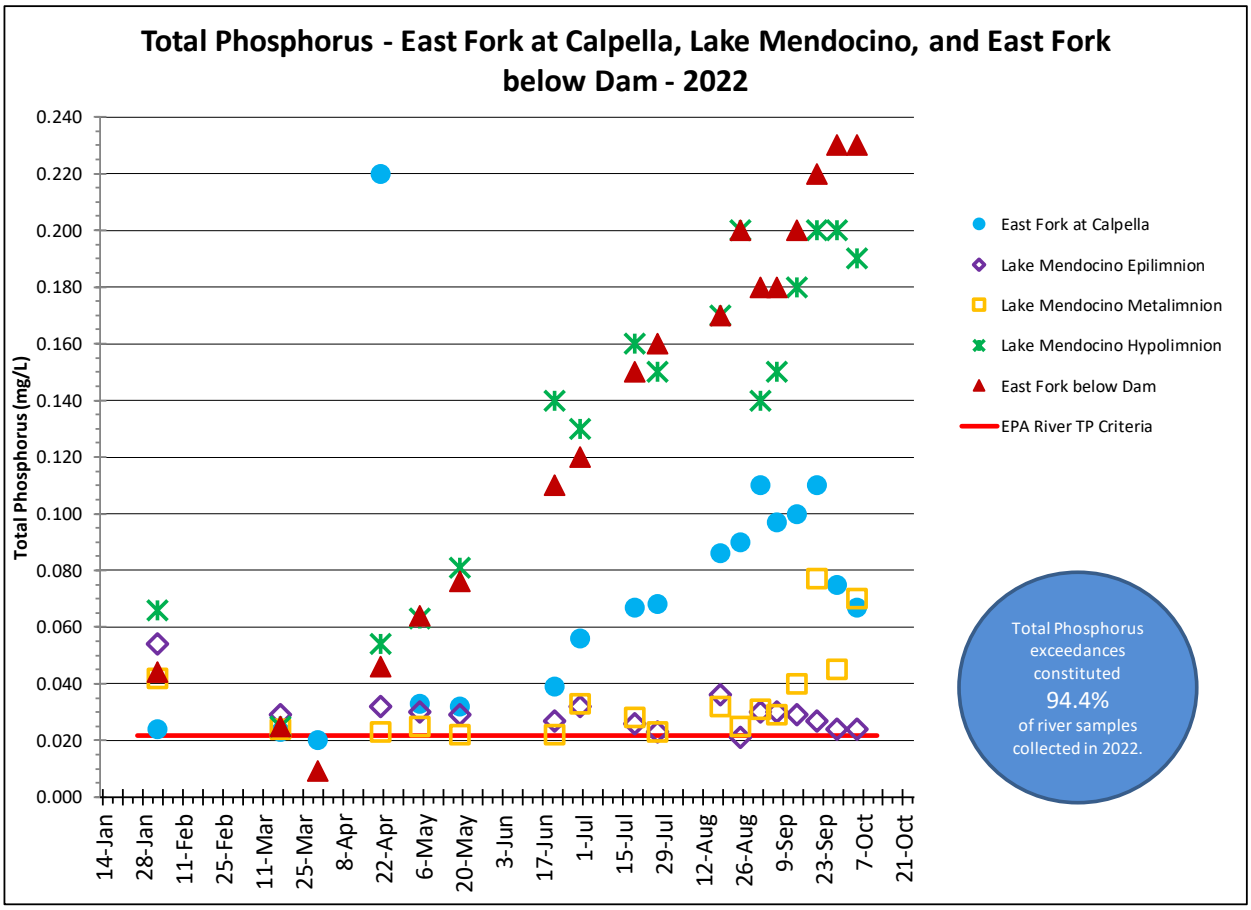

Figure 3-7. Sonoma Water Total Phosphorus results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Dam in 2022. Percent exceedances only apply to samples collected at East Fork river stations.

The East Fork below Coyote Valley Dam exceeded the total phosphorus EPA criteria for a majority of the season prior to and during the terms of the Order, including 17 of 18 samples (94.4%) at flows that ranged from 28 to 219 cfs (Table 3-6). The East Fork below Coyote Valley Dam was observed to have the highest overall concentration with a maximum value of 0.23 mg/L which occurred twice during the terms of the Order, on 28 September with a flow of 66 cfs, and on 5 October with a flow of 61 cfs (Table 3-6). Total phosphorus values were observed to generally increase from spring into fall (Table 3-6 and Figure 3-7).

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 twenty-four (24) times prior to and during the terms of the Order, representing 66.7% of the total samples collected (24 out of 36) at the upper and lower East Fork Russian River stations (Tables 3-2 and 3-6, and Figure 3-8).

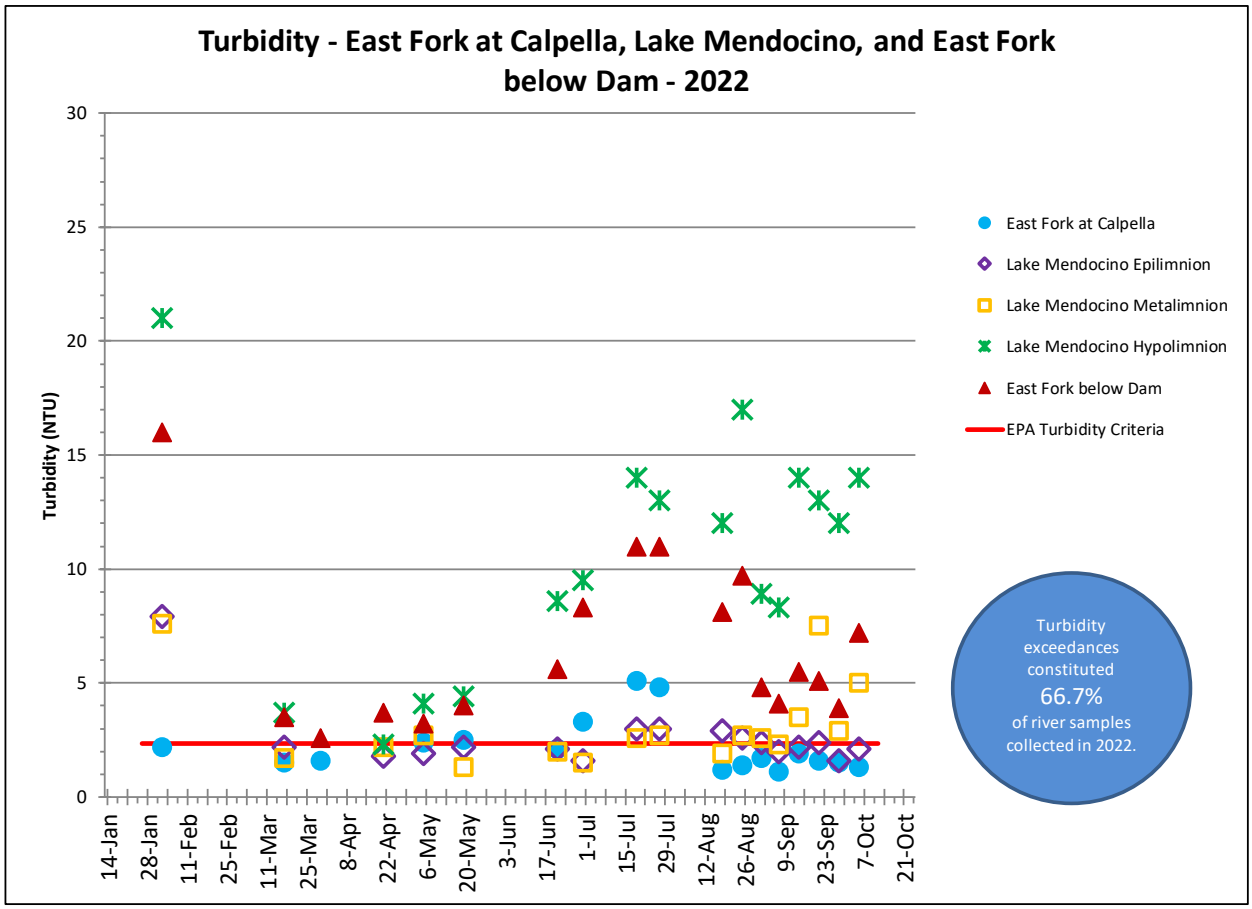

Figure 3-8. Sonoma Water Turbidity results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Coyote Valley Dam in 2022. Percent exceedances only apply to samples collected at river stations.

Turbidity values at Calpella were observed to remain relatively low through the monitoring season prior to and during the terms of the Order, with the exception of the sample collected on 21 April during a storm event that had a value of 83 NTU with a flow of 299 cfs (Table 3-2). The next highest value was 5.1 NTU, which occurred during the terms of the Order on 19 July with a flow of 87.9 cfs (Table 3-2). The EPA criteria was exceeded six (6) times out of eighteen (18) samples collected (33.3%) prior to and during the terms of the Order. The minimum value was 1.1 NTU, which occurred during the terms of the Order on 7 September with a flow of 16.8 cfs (Table 3-2 and Figure 3-8).

Turbidity levels exceeded the EPA criteria throughout the monitoring season prior to and during the terms of the Order (18 of 18 samples or 100%) at the East Fork below Coyote Valley Dam station (Table 3-6 and Figure 3-8). A maximum value of 16 NTU was observed on 2 February with a flow of 80 cfs (Table 3-6). The maximum value observed during the terms of the Order was 11 NTU, which occurred twice on 19 July and 27 July with flows of 291 cfs and 82 cfs, respectively (Table 3-6). Values were also observed to increase through the spring and summer before declining in September (Figure 3-8). The minimum turbidity value observed was 3.9 NTU on 28 September during the terms of the Order with a flow of 66 cfs (Table 3-6).

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 2022 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 2022, the *chlorophyll a* criteria for rivers and streams was exceeded fourteen (14) times prior to and during the terms of the Order, representing 38.9% of the total samples collected (14 out of 36) in the East Fork Russian River at Calpella and East Fork Russian River below Coyote Valley Dam stations during the monitoring effort (Tables 3-2 and 3-6, and Figure 3-9).

The EPA criteria for *chlorophyll a* for lakes and reservoirs in Aggregate Ecoregion III is 3.40 µg/L, or approximately 0.0034 mg/L (EPA, 2001). The *chlorophyll a* criteria for lakes and reservoirs was exceeded thirty-six (36) times prior to and during the terms of the Order, representing 70.6% of the total samples collected (36 out of 51) in Lake Mendocino during the monitoring effort (Tables 3-3 through 3-5).

Chlorophyll a exceedances occurred most predominantly at the Lake Mendocino epilimnion and metalimnion stations and least predominantly at Calpella (Tables 3-2 through 3-6 and Figure 3-9).

Calpella had six (6) *chlorophyll a* exceedances (6 of 18 or 33.3%) and twelve (12) non-detects, including a maximum value of 0.0085 mg/L that occurred during the terms of the Order on 19 July with a flow of 87.9 cfs (Table 3-2 and Figure 3-9).

The Lake Mendocino epilimnion had seventeen (17) *chlorophyll a* exceedances (17 of 17 or 100%), including a maximum value of 0.034 mg/L that occurred on 2 February at a depth of 5 feet (Table 3-3 and Figure 3-9). The maximum concentration during the terms of the Order measured 0.013 mg/L on 5 October (Table 3-3).

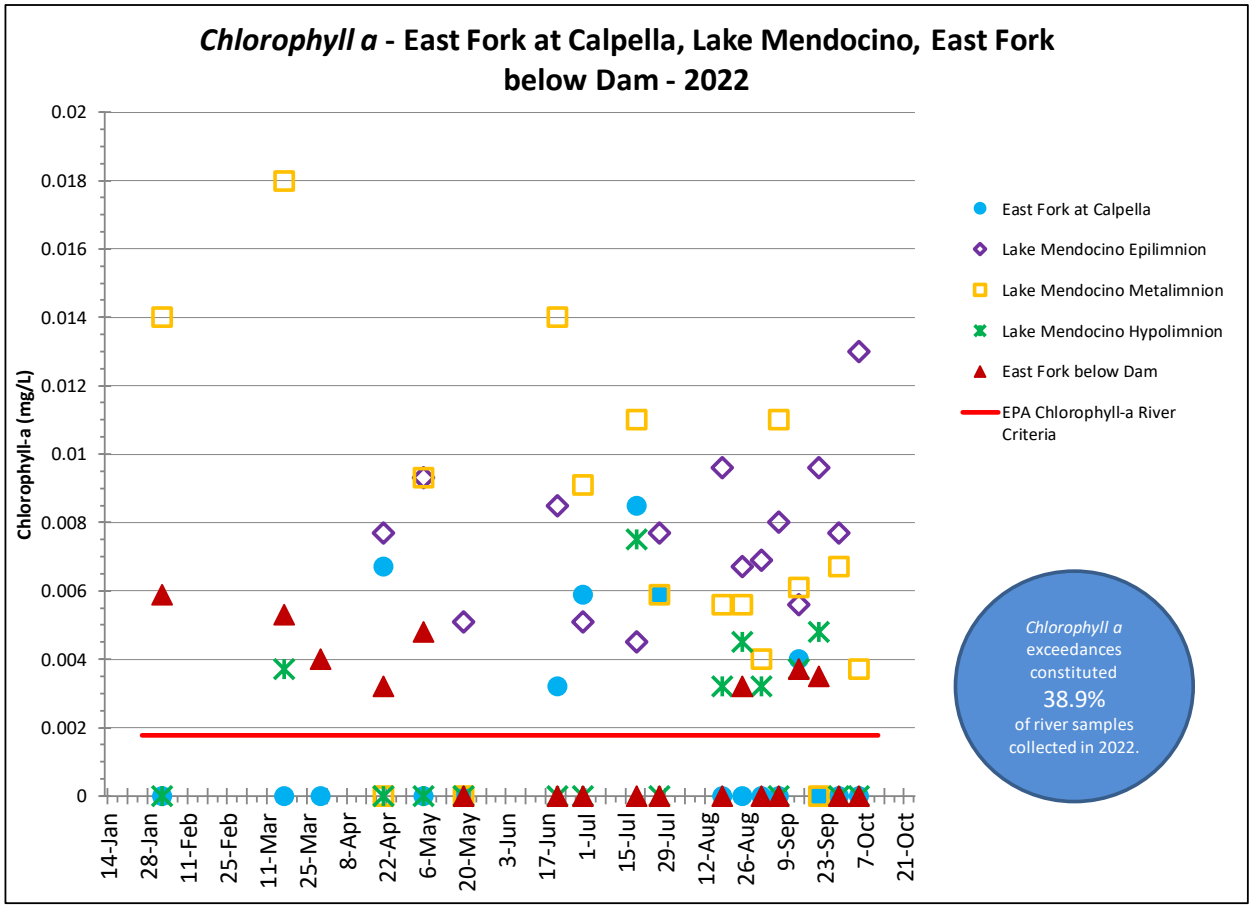

Figure 3-9. Sonoma Water Chlorophyll a results for the East Fork Russian River at Calpella, Lake Mendocino, and East Fork Russian River below Dam in 2022. Percent exceedances only apply to samples collected at East Fork river stations.

The Lake Mendocino metalimnion had fourteen (14) *chlorophyll a* exceedances (14 of 17 or 82.4%) and three (3) non-detects, including a maximum value of 0.018 mg/L that occurred on 17 March at a depth of 20 feet (Table 3-4 and Figure 3-9). The maximum concentration during the terms of the Order measured 0.014 mg/L on 21 June at a depth of 20 feet (Table 3-4).

The Lake Mendocino hypolimnion had five (5) *chlorophyll a* exceedances (5 of 17 or 29.4%) and ten (10) non-detects, including a maximum value of 0.0075 mg/L that occurred during the terms of the Order on 19 July at a depth of 70 feet (Table 3-5 and Figure 3-9).

The East Fork below Dam had eight (8) *chlorophyll a* exceedances (8 of 18 or 44.4%) and ten (10) non-detects, including a maximum value of 0.0059 mg/L that occurred on 2 February with a flow of 80 cfs (Table 3-6 and Figure 3-9). The maximum concentration during the terms of the Order measured 0.0037 mg/L on 14 September with a flow of 92 cfs (Table 3-6).

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

Ambient Algae

In 2022, Sonoma Water conducted biweekly ambient algae and cyanobacterial monitoring and sampling prior to and 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 (HABs) dominated by cyanobacteria (cyanoHABs) in the Russian River. This effort is being conducted to identify algal and cyanobacterial genera in the Russian River, as well as to estimate algal cover, frequency, and seasonal growth patterns.

Figure 3-10. Sonoma Water 2022 Seasonal Mainstem Russian River Ambient Algae and Nutrient Grab Sampling Stations.

Methods

Algal monitoring includes identifying genera present, assessing frequency of detections in microscope slides, collecting cover data using a line-intercept method, and 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 at which 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 incorporated emergent or floating aquatic vegetation, boulders, woody debris, edge water, and backwater, riffle, run and pool habitats. Genera present were 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. Frequency of occurrence equals the number of times a given taxa is detected divided by the total number of detections. Frequency can be calculated for each monitoring event or across the period of study.

For the convenience of analysis, algal groupings of genera are classified as: “Diatoms”; “Green Macrophytes” (filamentous and colonial green algae, desmids and *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). Periphyton refers to the collection of organisms, including but not limited to algae and detritus, attached on the surface of unspecified substratum type.

Results

Given that 2022 was a dry year beginning in January, monitoring was conducted prior to the TUC Order taking effect in June to evaluate watershed conditions affecting algae growth leading up to the period in which the Order was active from 17 June through 14 December. Results are presented based on a diversity and frequency analysis and a cover and thickness evaluation.

Diversity and Frequency Analysis

Between 9 March and 16 November 2022, 815 slides were prepared and evaluated from multi-habitat and phytoplankton tow samples collected from the four monitoring stations. Genera present in the samples were detected and identified a total of 17,788 times. Table 3-7 illustrates the frequency of algal genera observed in the mainstem Russian River between 9 March 2022 and 16 November 2022 at the four algal monitoring stations. Table 3-7 displays which algal genera were detected, their taxonomic division, the number of detections, and the relative percent they were detected during sampling.

Figures 3-11 through 3-14 illustrate the shifts in frequency of the four algal groups through the monitoring season based on the number of detections of algae genera collected from the range of algae habitats. Relative abundance can be expressed as the number of times a taxa was identified out of the number of slides evaluated or as the number of times the genus was detected out of all detections.

Some direct observations are evident based upon seasonal collection of algal frequency. Diatoms were consistently found in the greatest frequency at all stations, with green macrophyte frequency surpassing the frequency of cyanobacteria at all sites. Diatom frequency was higher at all sites than the frequency of Green macrophytes and Cyanobacteria observations throughout the monitoring season. Figures 3-11 through 3-14 illustrate the seasonal changes in functional groups over time. In 2022 Cyanobacteria did not become prevalent until the middle of June at most sampling sites. Also at most sampling sites Green macrophytes tend to either hold steady or drop slightly in detections during the period of increasing cyanobacteria detections. This could be related to formation of bubble towers and loss of periphyton through cyanobacteria harmful algal bloom formation and release (cyanoHABs), or simply illustrate increasing contributions by cyanobacteria as the season progresses. At all sites detections of cyanobacteria follow a gradient that increases downstream. The abundance of heterocyst forming cyanobacteria (Nostocales) follows a similar downstream gradient. The balance of heterocyst forming versus non-heterocyst forming cyanobacteria is often used as an indicator of the lack of nitrogen availability. Figure 3-15 illustrates overall frequency of detections for algal groupings as a percentage calculated for all sites within the monitoring season. Diatoms accounted for the majority of all detections (approximately 61%). Green macrophytes comprised 24% of detections, cyanobacteria comprised 13%, while the Others only consisted of 2% of total detections.

Table 3-7. Algal Genera by Funtional Group Detected at Ambient Algae Monitoring Stations in the Russian River in 2022.

Division	Genus	Total Detections	Percentage Frequency
Diatoms	*Amphora*	673	3.78%
Diatoms	*Asterionella*	21	0.12%
Diatoms	*Aulacoseira*	387	2.18%
Diatoms	*Bacillaria*	40	0.22%
Diatoms	*Campylodiscus*	259	1.46%
Diatoms	*Cocconeis*	665	3.74%
Diatoms	*Cyclotella*	46	0.26%
Diatoms	*Cymatopleura*	256	1.44%
Diatoms	*Cymbella*	544	3.06%
Diatoms	*Diatoma*	676	3.80%
Diatoms	*Ellerbeckia*	321	1.80%
Diatoms	*Encyonema*	360	2.02%
Diatoms	*Epithemia*	343	1.93%
Diatoms	*Fragillaria*	563	3.17%
Diatoms	*Gomphonema*	562	3.16%
Diatoms	*Gyrosigma*	326	1.83%
Diatoms	*Hydrosera*	76	0.43%
Diatoms	*Melosira*	730	4.10%
Diatoms	*Navicula*	764	4.30%
Diatoms	*Nitzschia*	440	2.47%
Diatoms	*Pinnularia*	239	1.34%
Diatoms	*Rhoicosphenia*	401	2.25%
Diatoms	*Rhopalodia*	309	1.74%
Diatoms	*Surirella*	203	1.14%
Diatoms	*Synedra*	797	4.48%
Diatoms	*Ulnaria ulna*	797	4.48%
Total Diatoms Detections		**10,798**	**60.70%**
Green Macrophytes	*Actinastrum*	84	0.47%
Green Macrophytes	*Aphanochaete*	59	0.33%
Green Macrophytes	*Chlamydomonas*	154	0.87%
Green Macrophytes	*Cladophora*	453	2.55%
Green Macrophytes	*Closterium*	321	1.80%
Green Macrophytes	*Coelastrum*	45	0.25%
Green Macrophytes	*Cosmarium*	15	0.08%
Green Macrophytes	*Draparnaldia*	35	0.20%
Green Macrophytes	*Pandorina/Eudorina*	20	0.11%
Green Macrophytes	*Geminella*	16	0.09%
Green Macrophytes	*Gloeocystis*	51	0.29%
Green Macrophytes	*Golenkinia*	55	0.31%

Table 3-7. Continued. Algal Genera by Grouping Detected at Ambient Algae Monitoring Stations in the Russian River in 2022.

Division	Genus	Total Detections	Percentage Frequency
Green Macrophytes	*Gonatozygon*	6	0.03%
Green Macrophytes	*Gonium*	4	0.02%
Green Macrophytes	*Hydrodictyon*	57	0.32%
Green Macrophytes	*Microspora*	29	0.16%
Green Macrophytes	*Mougeotia*	363	2.04%
Green Macrophytes	*Oedogonium*	527	2.96%
Green Macrophytes	*Oocystis*	6	0.03%
Green Macrophytes	*Pediastrum/Stauridium*	77	0.43%
Green Macrophytes	*Penium*	2	0.01%
Green Macrophytes	*Rhizoclonium*	55	0.31%
Green Macrophytes	*Scenedesmus*	353	1.98%
Green Macrophytes	*Spirogyra (all spp.)*	499	2.81%
Green Macrophytes	*Sphaerocystis*	21	0.12%
Green Macrophytes	*Staurastrum*	11	0.06%
Green Macrophytes	*Stigeoclonium*	156	0.88%
Green Macrophytes	*Tetraspora*	14	0.08%
Green Macrophytes	*Tribonema*	334	1.88%
Green Macrophytes	*Ulothrix*	79	0.44%
Green Macrophytes	*Ulva*	150	0.84%
Green Macrophytes	*Vaucheria*	224	1.26%
Green Macrophytes	*Volvox*	1	0.01%
Green Macrophytes	*Zygnema*	84	0.47%
Total Green Macrophyte Detections		**4,360**	**24.51%**
Cyanobacteria	*Anabaena*	189	1.06%
Cyanobacteria	*Aphanizomenon*	2	0.01%
Cyanobacteria	*Aphanocapsa*	110	0.62%
Cyanobacteria	*Aphanothece*	138	0.78%
Cyanobacteria	*Arthrospira/Spirulina*	11	0.06%
Cyanobacteria	*Calothrix*	29	0.16%
Cyanobacteria	*Chamaesiphon*	23	0.13%
Cyanobacteria	*Coelosphaerium*	10	0.06%
Cyanobacteria	*Chroococcus*	18	0.10%
Cyanobacteria	*Cylindrospermum*	164	0.92%
Cyanobacteria	*Dolichospermum*	28	0.16%
Cyanobacteria	*Dolichospermum*	28	0.16%
Cyanobacteria	*Geitlerinema*	304	1.71%
Cyanobacteria	*Gloeotrichia*	57	0.32%
Cyanobacteria	*Hapalosiphon*	3	0.02%
Cyanobacteria	*Leptolyngbya*	361	2.03%

Table 3-7. Continued. Algal Genera by Grouping Detected at Ambient Algae Monitoring Stations in the Russian River in 2022.

Division	Genus	Total Detections	Percentage Frequency
Cyanobacteria	*Lyngbya*	60	0.34%
Cyanobacteria	*Merismopedia*	5	0.03%
Cyanobacteria	*Microcoleus*	221	1.24%
Cyanobacteria	*Microcystis*	6	0.03%
Cyanobacteria	*Nodularia*	26	0.15%
Cyanobacteria	*Nostoc*	168	0.94%
Cyanobacteria	*Oscillatoria*	171	0.96%
Cyanobacteria	*Phormidium*	129	0.73%
Cyanobacteria	*Planktothrix/Limnothrix*	52	0.29%
Total Cyanobacteria Detections		**2,285**	**12.85%**
Golden Brown	*Dinobryon*	39	0.22%
Golden Brown	*Mallomonas*	17	0.10%
Golden Brown	*Synura*	19	0.11%
Euglenoid	*Euglena*	41	0.23%
Euglenoid	*Lepocinclis*	27	0.15%
Euglenoid	*Monomorphina*	4	0.02%
Euglenoid	*Phacus*	6	0.03%
Dinoflagellate	*Ceratium*	26	0.15%
Dinoflagellate	*Peridinium*	2	0.01%
Red Algae	*Audouinella*	158	0.89%
Red Algae	*Batrachospermum*	5	0.03%
Red Algae	*Compsopogon*	1	0.01%
Total Other Algae Detections		**345**	**1.94%**
Grand Total Algae Detections		**17,788**	

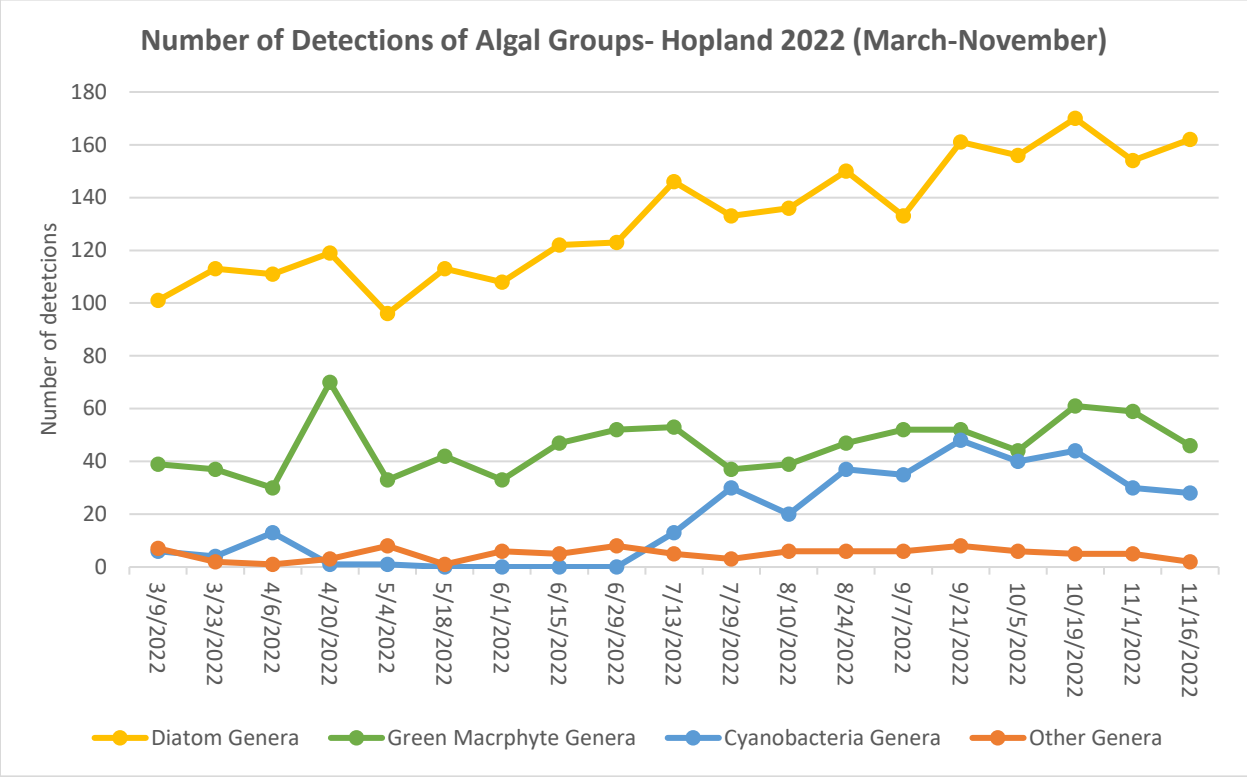

Figure 3-11. Number of Detections of Algal Groups at the Hopland Monitoring Station in 2022.

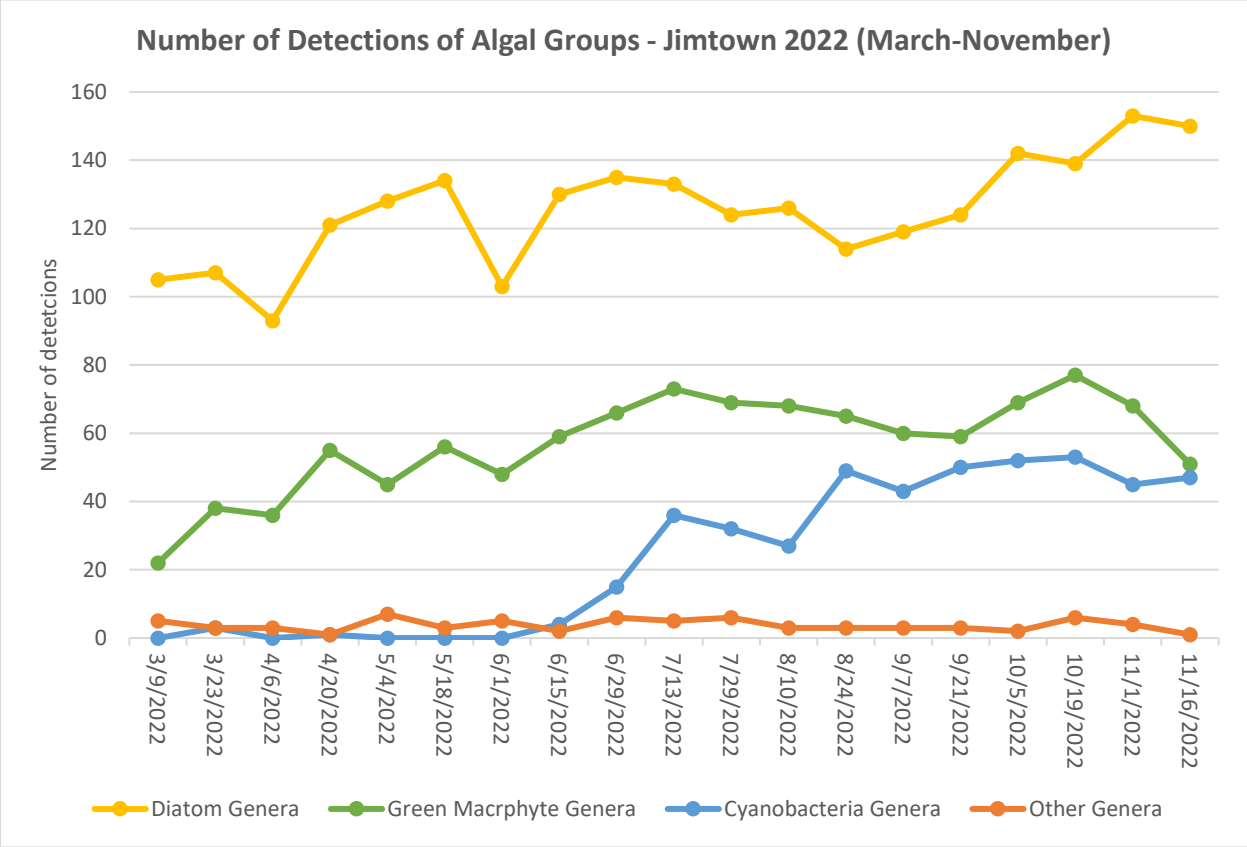

Figure 3-12. Number of Detections of Algal Groups at the Jimtown Monitoring Station in 2022.

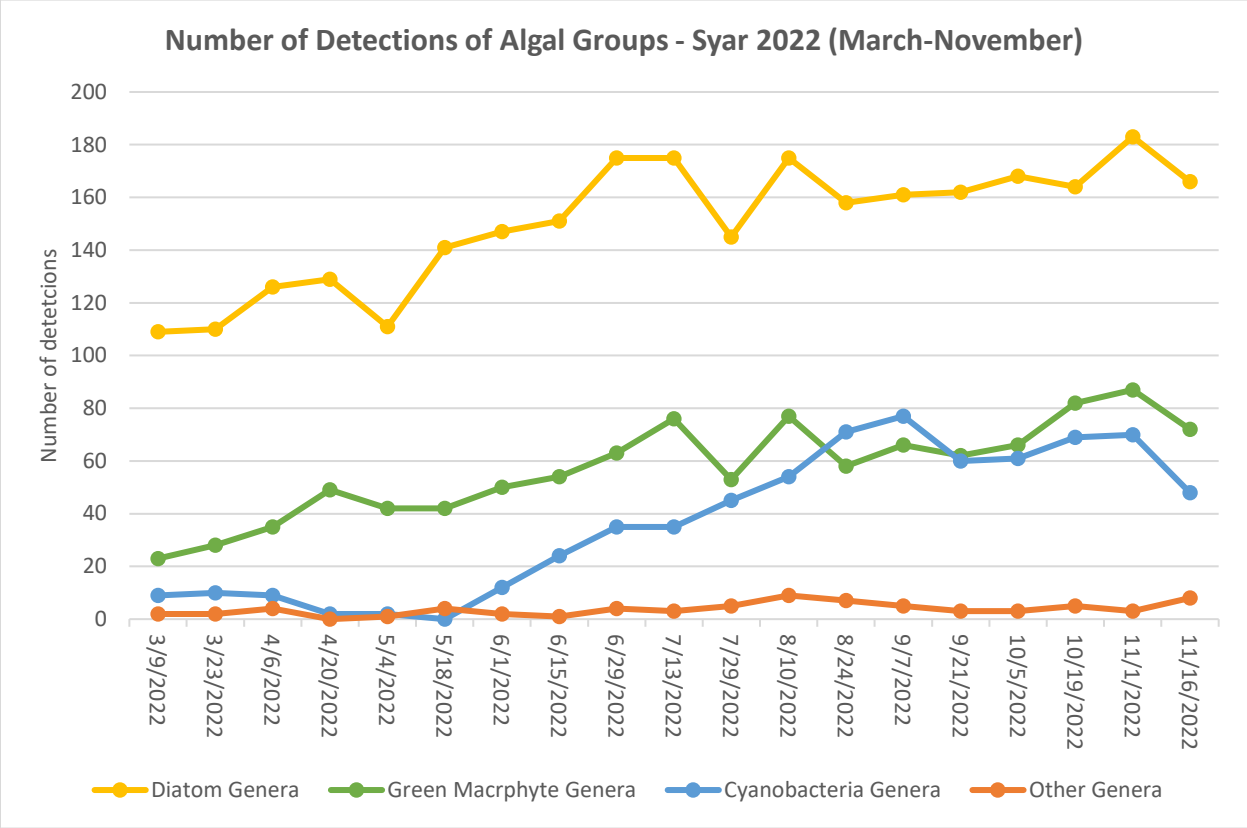

Figure 3-13. Number of Detections of Algal Groups at the Syar Monitoring Station in 2022.

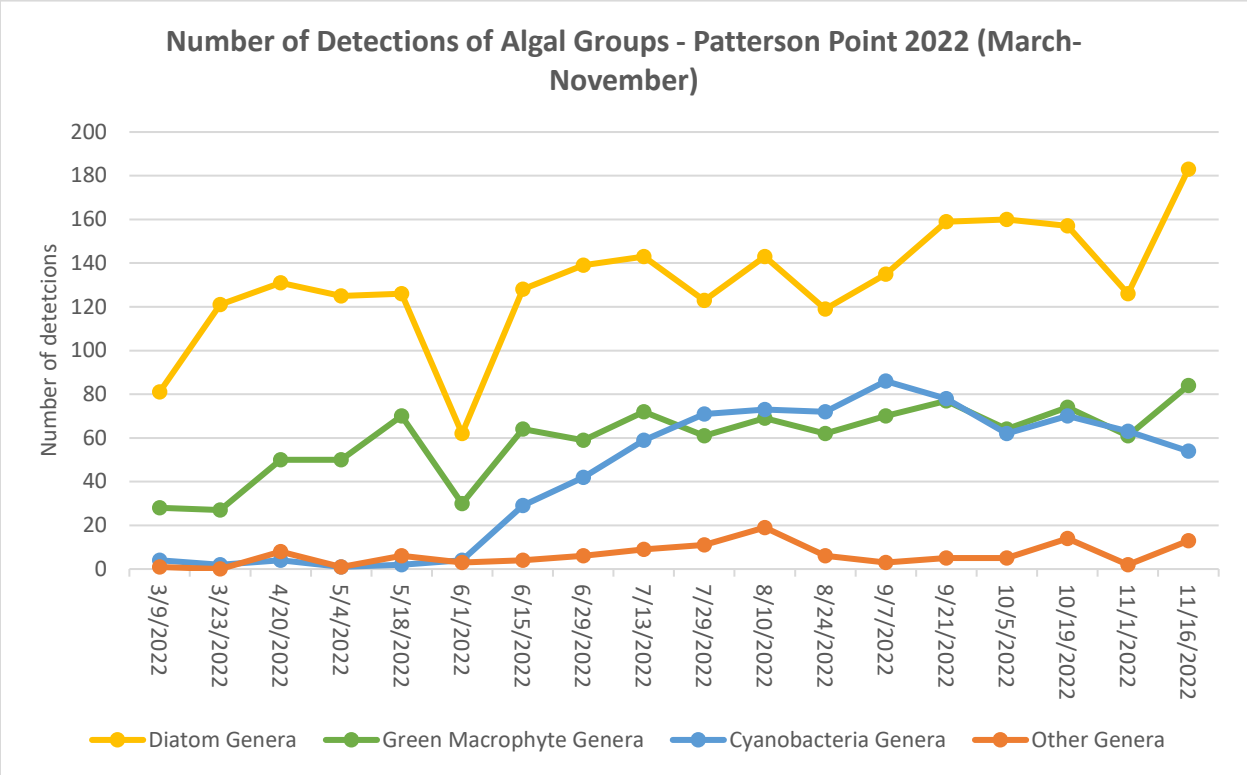

Figure 3-14. Number of Detections of Algal Groups at the Patterson Point Monitoring Station in 2022.

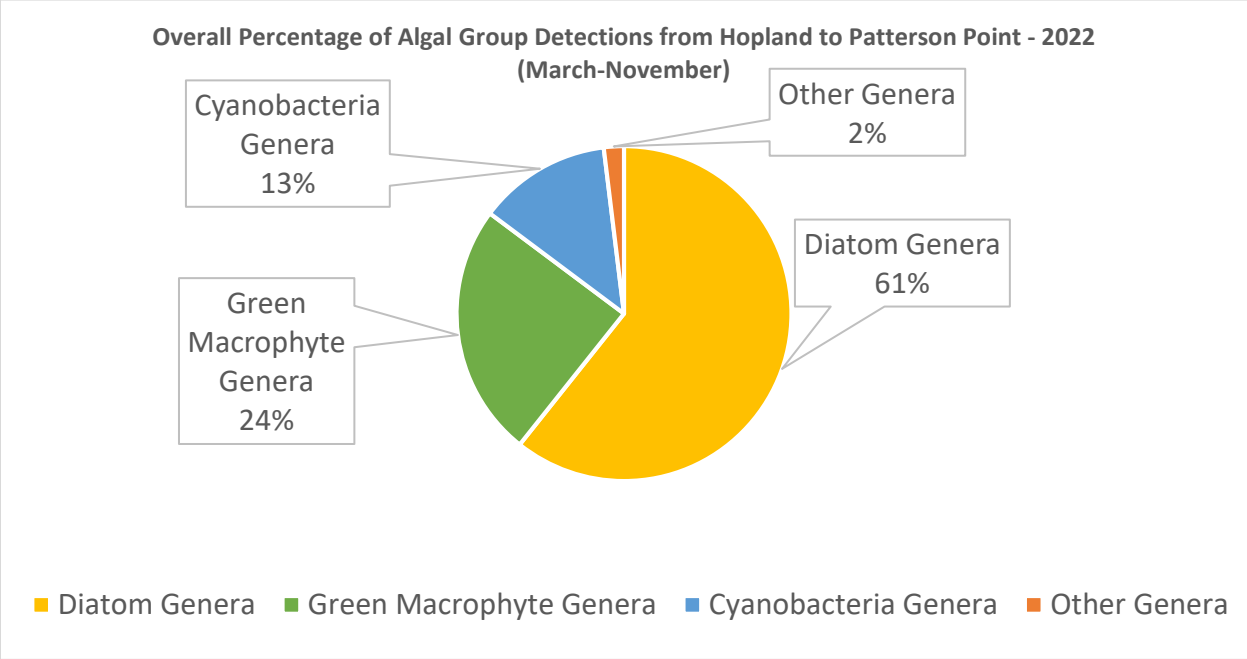

Figure 3-15. Overall Percentage of Algal Group Detections at Hopland, Jimtown, Syar, and Patterson Point in 2022.

Cover and Thickness Analysis

For estimating cover, the periphyton was divided into two groups differentiated by their visibility without microscopic evaluation. Microalgae forms a film or a coating on substrate and other algae. It is comprised of the microscopic algae genera in the periphyton dominated by diatoms and cyanobacteria, but also includes other benthic green, red, and yellow-green microscopic algal genera. Macroalgae are the larger filamentous members of the periphyton frequently colonized by microalgae, which often breaks off and forms drifting masses (or metaphyton) during phases of its lifecycle that can accumulate in backwater areas and shallow shorelines.

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

Figures 3-16 through 3-19 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 and stayed higher at Patterson, Syar, and Hopland sites than macroalgae cover throughout monitoring season. At Jimtown, with macroalgae cover so high, microalgal thickness was difficult to consistently evaluate. Diatoms and cyanobacteria dominate microalgae in the river. Uneven growth of these taxa on green macrophytes or shading of substrate affects the visual assessment of thickness across the river bottom. At Patterson and Jimtown cover by all groups generally increased over the season through September. At Hopland, there was an initial loss of cover by green macrophytes, which began to recover by November 2022. At Syar, initially high cover by diatoms largely remained at high levels during the monitoring season.

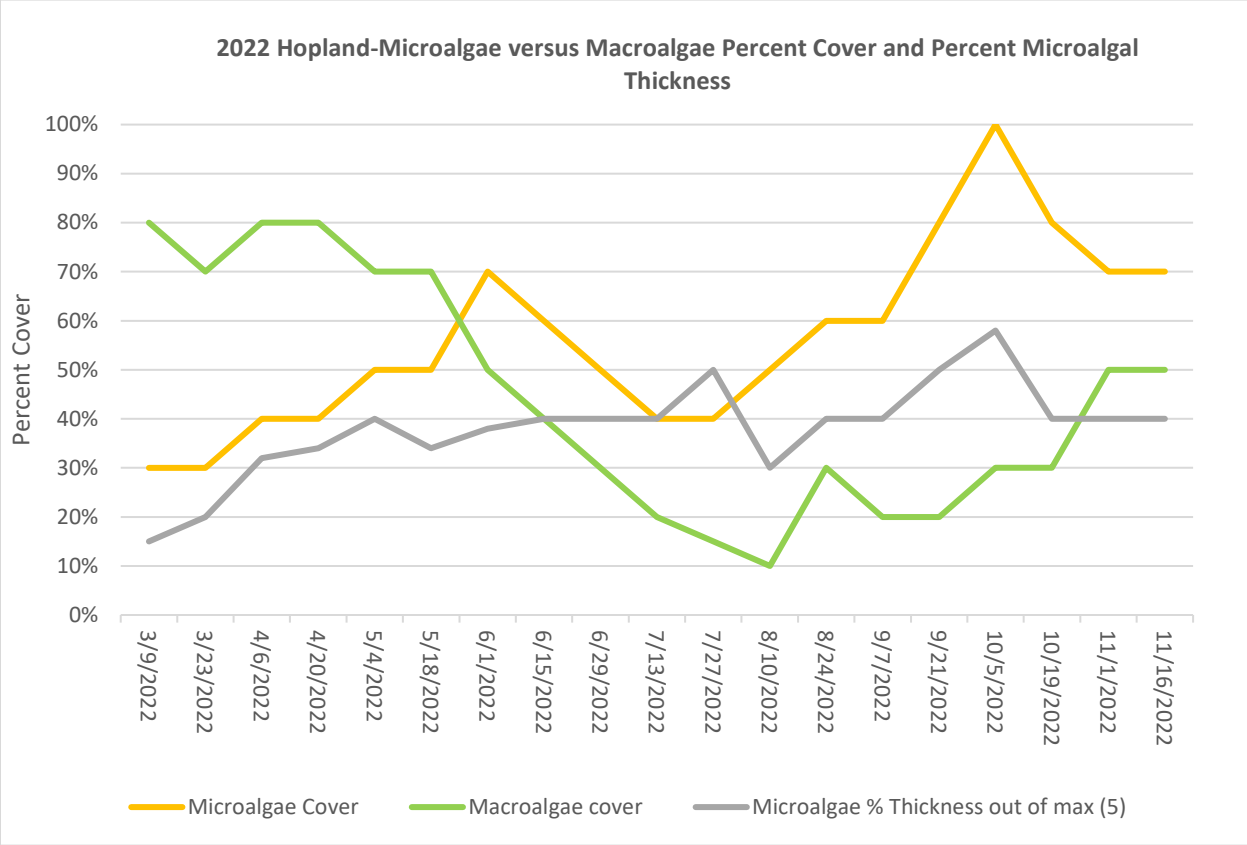

Figure 3-16. Microalgae versus Macroalgae Percent Cover and Percent Microalgae Thickness at Hopland in 2022.

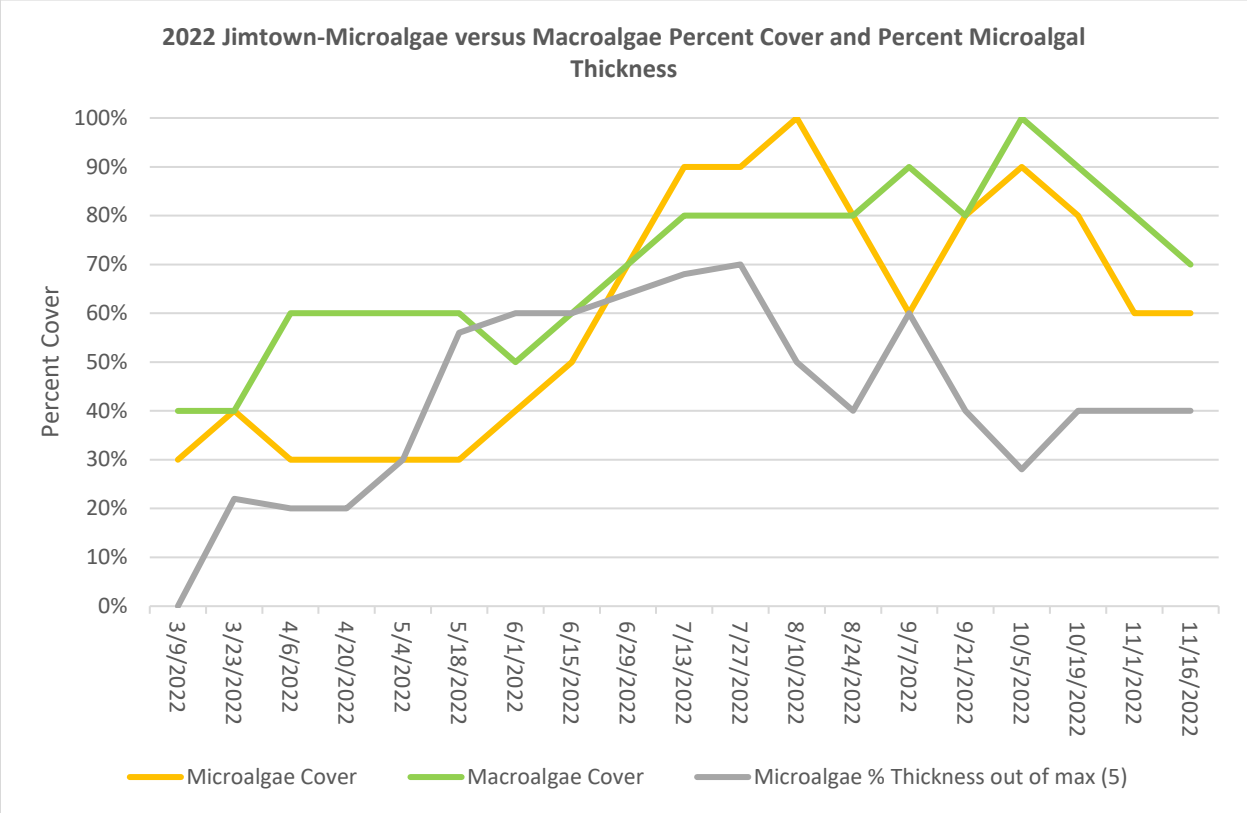

Figure 3-17. Microalgae versus Macroalgae Percent Cover and Percent Microalgae Thickness at Jimtown in 2022.

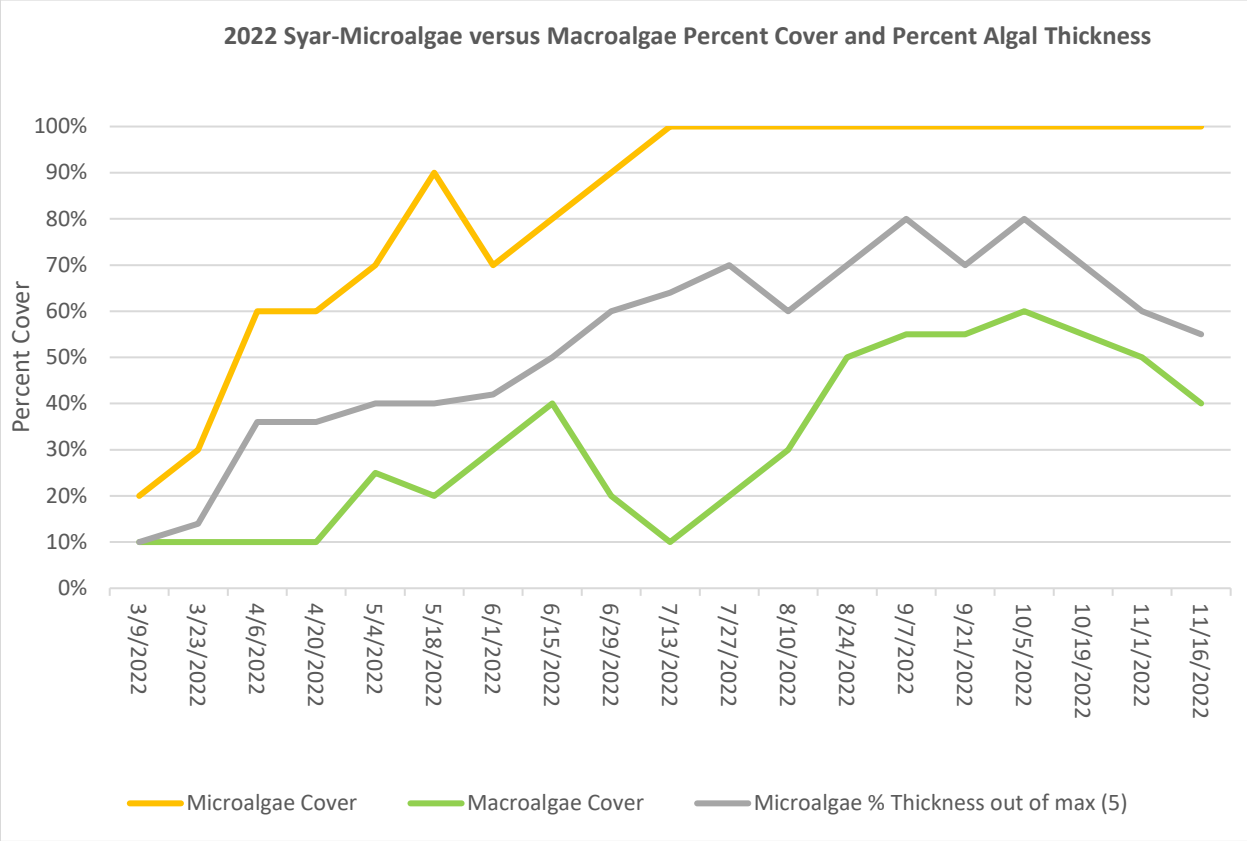

Figure 3-18. Microalgae versus Macroalgae Percent Cover and Percent Microalgae Thickness at Syar in 2022.

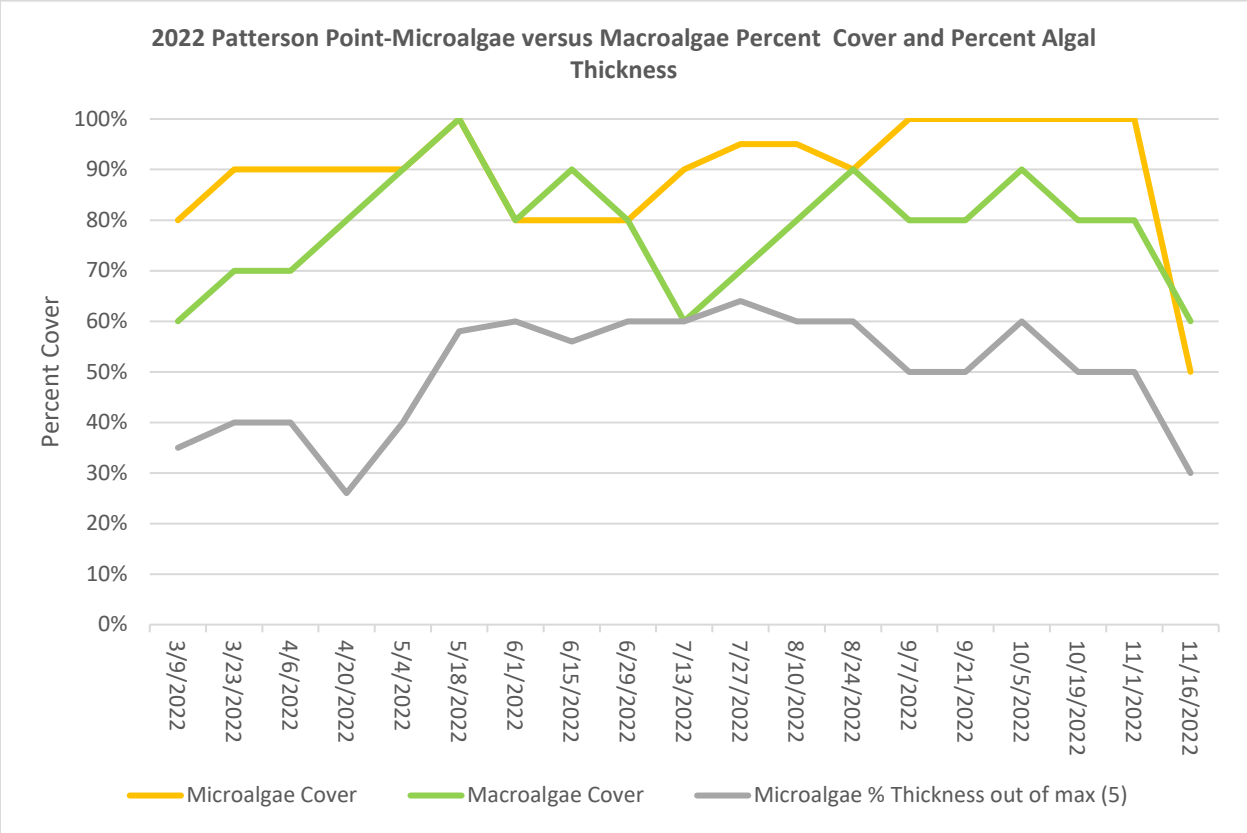

Figure 3-19. Microalgae versus Macroalgae Percent Cover and Percent Microalgae Thickness at Patterson Point in 2022.

Summary

Periphyton growth in the Russian River is strongly affected by the frequency and duration of high scouring flows during the winter and by the type of transition that occurs in a given year between high flow and low flow periods. Specifically, algal growth dynamics appear to be driven by what kind of transition takes place from high scouring winter and early spring flows to reservoir sustained low flows during the late spring, summer and fall. During drought conditions there are limited high flow periods through the late fall, winter and early spring. When high scouring flows do not occur, periphyton cover present in the summer through late fall is still present as flows switch from tributary and watershed augmented to reservoir released sustained flows. How quickly the periphyton develops in the following low flow season is tied to the degree of scour occurring in the channel during the winter and spring high flows, the degree of bed movement in the littoral zone, the survival of grazing organisms, and where deposits of early spring blooms accumulate, decay and provide resources for microalgae, including cyanobacteria. How quickly periphyton recolonizes the littoral zone is strongly influenced by invertebrate grazing and nutrient availability. As soon as tributary flows reduce to summer levels, nutrients are essentially recycled inside the periphyton community, or contributed from metaphyton drift, and shoreline accumulations. Generally, a few high scour events will clear out grazers and re-distribute gravels, and in the next low flow season green macrophytes quickly recolonize. If there are not scouring events, the algae present at the end of the Fall can persist through the Winter, unless environmental signals stimulate a reproductive event and the green macrophytes become planktonic.

Overall, 2022 algae growth in the Russian River was affected by high flows from rain events in late October 2021, late December 2021 and in April of 2022. However, none of these events cleared out the invertebrate grazers or substantially re-arranged the substrate. Algae present in Fall 2021 and Winter 2022 was also present in Spring 2022. This was similar to observations in 2020-21.

Macrophytes with outer cell walls conducive to epiphyte growth (including *Cladophora*, *Oedogonium*, and *Vaucheria*) established dominance after the December 2021 high flow event. As flows receded, an abundance of snails and herbivorous invertebrate larvae (including New Zealand mud snails) were still present and began to graze at all sites. In late April, the shoreline zone was lightly scoured in a high flow event, removing established green macrophytes by around half. Significant gravel and bed movement was only observed at Patterson Point (located in the lower Russian River). With decreasing flows in May, metaphyton drift began accumulating on shorelines providing nutrients and substrate for cyanobacterial growth. In May, after some moderate April flows, the dense diatom coverage and continued invertebrate grazing led to a shift in the composition of dominant filamentous macrophytes. Macrophytes with cell walls that are not conducive to colonization by epiphytes (*Spirogyra*, *Mougeotia*, and *Zygnema*) were dominating the composition and cover of the periphyton. This shift in green macrophyte dominance may have affected the development and type of cyanobacterial HAB generating zones. Based on observation collected during monitoring in the Russian River, cyanoHAB zones are either formed by cyanobacteria (usually heterocystous) in conjunction with green macrophytes, or by mixed periphyton dominated by mucilage forming diatoms and cyanobacteria, or are relatively pure mats of cyanobacteria that release from the substrate during their life cycles. All of these tend to form in shallow exposed areas. CyanoHAB generating zones were not observed in abundance until July 2022. Generally, these were observed developing by June in previous sampling years.

At Hopland, the *Vaucheria* cover, which was high at the end of 2021, was present in May but was mostly gone by June 2022 and stayed below 20% until late August. Despite loss in cover by last year's crop of *Vaucheria* in June, dominant filamentous genera at Hopland were still observed to be predominately *Vaucheria* but joined by *Oedogonium*. At Syar, the dominant filamentous genera were *Cladophora* and *Oedogonium*. *Oedogonium* is a fast-growing filamentous alga with a hard outer cell wall that allows for colonization by epiphytes in a similar way as *Cladophora*. Patterson Point and Jimtown were both characterized by *Spirogyra* as the dominant filamentous macrophyte, which does not allow for colonization by microalgae and so is not a genus often associated with cyanoHABs. Mats of *Microcoleus/Phormidium* (Oscillatorian genera) were present associated with layers of mucilaginous diatoms, and widespread by the end of August. This is at least a month later in the season than *Microcoleus/Phormidium* mat observations in 2021. Patterson and the off-stream pond at Syar supported abundant colonies of the heterocyst forming cyanobacteria Gloeotrichia, which forms floating amorphous gelatinous clumps, and is often entrained in patches of *Ludwigia*.

By mid-September Russian River monitoring sites at Hopland, Jimtown, and Syar started supporting widespread *Microcoleus/Phormidium* mat coverage in riffles on cobble, fine substrate within riparian vegetation in low flow, and on concrete boulders into November. Overall, based on observations of cover, abundance and density, the seasonal peak of periphyton occurred in mid/late September in 2022. The diatoms *Rhopalodia* and *Epithemia* (which are genera known to have cyanobacterial symbionts) were observed to be microscopically associated (imbedded in mucilage) with the cyanobacterial mats. Since these diatoms are associated with cyanobacteria, their occurrence is a sign that cyanobacteria are present. Other diatoms regularly observed associated with cyanobacteria colonies include stalked versions of *Gomphonema* and *Amphora*, and *Cymbella*. A wide variety of Oscillatorian cyanobacteria were observed associated with cyanobacterial mat development on finer substrates (sand and small gravels). Oscillatorian genera that were prevalent in 2022 included *Leptolyngba*, *Geitlerinema*, and several forms of *Phormidium* and *Oscillatoria* (Figure 3-21). Periphyton communities began to decline at the beginning of October as day length, light penetration in the water column, and water temperatures decreased into November.

Figure 3-20. Variety of Oscillatorian cyanobacteria genera and forms observed in 2022.

CyanoHABs

Factors that drive periphytic algal growth in rivers are primarily water temperature, light, available nutrients, available habitat, competition, allelopathy, grazing, epiphytic growth, and the presence and velocity of water. All that is driven by large-scale factors like climate, geology, and land use that affect the resources, biotic factors, and abiotic stressors that directly affect the function and structure of benthic algal assemblages. Every year conditions that support development of cyanoHABs occur in the Russian River regardless of minor differences in the low-flow condition. Development of cyanoHABs has been observed to be largely independent of low flow conditions and have been observed developing under very low nutrient conditions. Years with high and extended flows developed cyanoHABs in similar abundance and distribution as in drought years. Nutrient levels, while certainly a factor to consider for algal growth, are not the sole driver of cyanoHABs in the Russian River because most cyanobacteria are able to fix the nitrogen they need for metabolism and phosphorus is abundant and not a limiting nutrient. CyanoHABs have continued to occur during the last two drought years despite no runoff from land or change in water source.

The pattern of ecological factors that affect benthic algal abundance depends on if the factor has a direct effect and at what landscape habitat or cellular scale the factor operates. Direct actions that could reduce the influence of these factors are difficult to identify or rectify as several key factors that appear to drive cyanoHAB development operate at the climate and landscape level. Three forms of cyanoHAB have been observed in the Russian River. These include bubble towers (mostly formed with green macrophyte that allow colonization), mixed cyanobacterial diatom mats (gelatinous diatoms mixed with various smaller green macrophytes (that do not allow colonization), and relatively uniform cyanobacteria mats (*Oscillatoria, Phormidium* and *Microcoleus*).

Based on years of algae monitoring since 2017, a hypothesis has developed regarding factors that have been observed affecting development of cyanoHABs including:

- Scouring flows the previous Winter and Spring (landscape factor- Climate)
- Extended Spring flows that deposit metaphyton on the flood plain and not in the thalweg (landscape factor- Climate)
- Location in the river and position in the thalweg (habitat factor)
- Type of cyanobacteria making up the bloom (species level factor)
- Dominant type of algae-green macrophyte or diatom (species level factor)
- Extent of habitat along the river (wetted area) (flow related factor)

Each of these factors is discussed briefly below.

Scour- Heavy scour occurring in the winter at high flows at the habitat level reduces available propagules for re-establishment but also provides for space to grow, introduces fresh substrate that provides new nutrients into the system, and flushes out invertebrate grazers. Heavy scour will result in a faster establishing and growing periphyton because of the lack of grazing. Heavy scour appears to favor establishment of *Cladophora*, a green algae that favors cyanobacteria colonization. More *Cladophora* supports bubble tower HABs. Light or no scour appears to favor establishment of *Spirogyra* (which does not favor cyanobacteria colonization) and thick diatom layers. Light scour appears to favor mixed diatom mat HABs.

Extended spring flows- Extended spring flows can result in either the isolation of spring metaphyton on the flood plain, or spring metaphyton can be drawn down into the thalweg. Without the spring metaphyton in the thalweg there is less substrate to decay, provide habitat and nutrients for cyanobacteria growth. Cyanobacteria colonization and subsequent CyanoHABs usually develop first in the unattached drift decaying along the shoreline. Extended spring flows that trap algae out of the thalweg reduce available substrate, nutrients and carbon that would otherwise support cyanoHAB development.

Location in the river- Location can be tied to specific types of habitats and the tendency of certain cyanobacteria to favor different parts (upper, middle, and lower) of the river that generate cyanoHABs. Wide shallow areas in the middle and lower river support the most obvious HAB generating zones. The more wide shallow zones there are along a river the greater cyanoHAB development. The lower river supports more heterocystous forms of cyanobacteria. CyanoHABs develop a few weeks earlier in the lower river than the middle and upper river. CyanoHABs developing in the lower river are primarily bubble tower types initially and transition to a mix of bubble tower mixed cyanobacterial diatom mat, and cyanobacterial mat as the season progresses. The upper river supports more non-heterocystous forming cyanobacteria (specifically the Ocillatoriales group). While these taxa do not have heterocysts, they are known to fix atmospheric nitrogen. Many of these taxa are mobile and capable of moving themselves to the most desirable locations in the periphyton. These taxa mix with diatoms to form mixed cyanobacteria diatom mats or form near single species uniform mats.

Type of cyanobacteria- Different cyanobacteria genera produce different toxins, interact with green macrophytes and diatoms differently, and develop into different forms of cyanoHAB. There is an assumption of cyanobacteria interaction and that genera may have allelopathic effects on other algae as well including other cyanobacteria.

Dominant algae- The green macrophytes establishing that allow for epiphytic colonization versus the genera that do not support colonization affects the form of the cyanoHAB. If diatom cover on the

substrate include abundant gelatinous matrix forming genera, the cyanoHAB will be in the form of a mixed cyanobacterial diatom mat. If green macrophytes are present that allow for cyanobacteria colonization, the cyanoHAB will form as a bubble tower.

Extent of habitat-River algae only grow where there is water to support them. During higher flows more wetted habitat is available for colonization. With lower flows less wetted area is available for colonization. Partially submerged gravel bars and other shallow areas support the best habitat for most algae to proliferate (particularly cyanobacteria) because of available light, warmer temperatures, and nutrient availability through metaphyton recycling. Shallow backwater areas also provide supportive habitat for cyanoHAB development.

These observations will continue to be evaluated during future algae monitoring. Other factors to consider include invertebrate analyses to relate the effect of algal composition on preferred grazing targets and invertebrate diversity, investigating temperature tolerances of Microcoleus/Phormidium mats, evaluating effect of different wetland vegetation at the gravel bar shoreline interface, and correlating cyanobacteria diversity and composition with toxin release (working with North Coast Regional Water Quality Control Board and Sonoma County Environmental Health Department).

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. However, sampling results are only included up to 5 October due to the timing of this report and delay associated with receiving sample results.

The sampling results for total nitrogen, total phosphorus, turbidity, and *chlorophyll a* are discussed below and summarized in Tables 3-8 through 3-10 and Figures 3-21 through 3-24. 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 2022 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.

Estuary response and associated grab sampling data for 2022 is currently being compiled and will be discussed in greater detail in the Russian River Biological Opinion 2022-2023 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 twenty-one (21) times prior to and during the terms of the Order, representing 23.3% of the total samples collected (21 out of 90) during the ambient algae monitoring effort (Tables 3-8 through 3-10, and Figure 3-21).

Hopland had ten (10) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 16 samples collected (62.5%), under flows that ranged from 46.2 cfs to 115 cfs (Table 3-8 and Figure 3-21). The maximum seasonal value measured 1.0 mg/L on 9 February with a flow of 115 cfs (Table 3-8). The maximum seasonal value during the terms of the Order measured 0.57 mg/L on 13 July with a flow of 61.8 cfs (Table 3-8). The minimum seasonal value was 0.12 mg/L, which occurred during the terms of the Order on 10 August with a flow of 54.1 cfs. Nitrogen values were observed to generally decline from spring into summer, then periodically increase through summer and into the fall (Figure 3-21).

Cloverdale River Park had three (3) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 16 samples collected (18.8%), under flows that ranged from 47.2 to 171 cfs (Table 3-8 and Figure 3-21). The maximum concentration measured 0.80 mg/L on 9 February with a flow of 171 cfs (Table 3-8). The maximum concentration during the terms of the Order measured 0.38 mg/L on 13 July with a flow of 47.2 cfs (Table 3-8).The minimum seasonal value was Non-Detect (ND), which occurred during the terms of the Order on 10 August with a flow of 57.0 cfs. Other than the three exceedances, nitrogen values were observed to generally decline from spring into summer, with values remaining relatively low through the monitoring season (Figure 3-21).

Jimtown had three (3) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 16 samples collected (18.8%), under flows that ranged from 36.8 to 250 cfs (Table 3-9 and Figure 3-21). The maximum seasonal value measured 0.69 mg/L on 9 February with a flow of approximately 250 cfs (Table 3-9). The maximum seasonal value during the terms of the Order measured 0.43 mg/L on 13 July with a flow of approximately 36.8 cfs (Table 3-9).The minimum concentration was 0.077 mg/L, which occurred during the terms of the Order on 21 September with a

flow of approximately 71.8 cfs. Nitrogen values at Jimtown were also observed to generally decline from spring into summer, with values remaining relatively low through the monitoring season (Figure 3-21).

Table 3-8. Sonoma Water 2022 Seasonal Mainstem Russian River Grab Sampling Results at Hopland and Cloverdale.

Hopland	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11462500 RR near Hopland***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
2/9/2022	13:50	11.1	8.2	0.38	ND	ND	0.66	ND	0.38	**1.0**	**0.041**	0.10	2.07	2.56	170	0.86	ND	115
3/9/2022	13:50	12.9	7.7	0.23	ND	ND	0.53	ND	0.23	**0.76**	**0.022**	0.054	1.94	2.36	160	1.4	**0.0040**	59.7
3/23/2022	14:00	15.8	7.6	0.34	ND	ND	0.38	ND	0.34	**0.72**	**0.025**	0.036	2.18	2.19	150	1.3	ND	44.1
4/6/2022	14:30	14.8	7.9	ND	ND	ND	0.28	ND	ND	0.28	0.018	ND	1.92	2.46	180	1.2	**0.0059**	41.5
4/20/2022	15:00	12.1	7.4	ND	ND	ND	0.24	ND	ND	0.24	**0.034**	0.057	2.53	3.19	130	**9.5**	ND	142
5/4/2022	13:30	16.3	8.1	ND	ND	ND	0.44	ND	ND	**0.44**	**0.038**	0.078	1.71	2.10	160	**2.8**	ND	68.3
5/18/2022	13:45	17.8	8.2	ND	ND	ND	0.15	ND	ND	0.15	**0.030**	ND	1.78	2.39	160	1.6	ND	43.1
6/15/2022	14:30	17.3	8.0	0.30	ND	ND	0.12	ND	0.30	**0.42**	**0.063**	0.11	3.32	3.87	130	**2.5**	**0.0045**	103
6/29/2022	14:30	19.7	8.1	0.34	ND	ND	0.21	ND	0.34	**0.55**	**0.073**	0.14	2.82	3.45	140	1.8	**0.0040**	46.2
7/13/2022	14:20	19.1	8.3	0.26	0.12	0.0084	0.19	ND	0.38	**0.57**	**0.067**	0.11	3.41	3.89	150	**2.4**	**0.0043**	61.8
7/27/2022	14:40	19.2	8.1	ND	ND	0.0035	0.16	ND	ND	0.164	**0.066**	0.11	3.45	4.16	130	**2.4**	ND	
8/10/2022	14:00	17.9	8.2	ND	ND	ND	0.12	ND	ND	0.12	**0.075**	0.12	3.44	4.27	120	2.3	**0.0048**	54.1
8/24/2022	14:00	18.8	8.5	0.30	ND	ND	0.20	ND	0.30	**0.50**	**0.093**	0.16	3.46	4.50	140	**2.8**	**0.0077**	66.3
9/7/2022	13:20	18.9	8.3	0.25	ND	ND	0.24	ND	0.25	**0.49**	**0.10**	0.18	3.05	3.75	130	1.6	**0.0043**	66.2
9/21/2022	14:10	17.0	8.3	0.23	ND	0.0024	0.27	0.050	0.23	**0.55**	**0.11**	0.26	2.87	3.57	140	1.2	ND	69.6
10/5/2022	13:50	16.8	7.6	ND	0.13	0.0018	0.36	ND	ND	0.36	**0.11**	0.28	2.75	3.23	160	1.6	**0.0061**	53.9

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	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
2/9/2022	13:00	10.9	7.9	0.35	ND	ND	0.45	ND	0.35	**0.80**	0.015	ND	1.62	1.94	180	0.88	**0.0048**	171
3/9/2022	13:10	13.4	8.1	ND	ND	ND	0.33	ND	ND	0.33	0.0051	ND	1.34	1.60	190	0.67	ND	84.0
3/23/2022	13:20	17.0	8.0	0.37	ND	ND	0.20	ND	0.37	**0.57**	**0.024**	ND	1.29	1.43	210	0.71	ND	61.9
4/6/2022	13:40	16.7	8.0	ND	ND	ND	0.13	ND	ND	0.13	0.012	ND	1.31	1.64	240	1.3	ND	52.2
4/20/2022	14:20	12.8	7.4	ND	ND	ND	0.22	ND	ND	0.22	ND	ND	2.34	2.65	170	**3.6**	ND	197
5/4/2022	12:50	17.8	8.8	ND	ND	ND	0.14	ND	ND	0.14	ND	ND	1.50	1.73	180	1.6	ND	98.0
5/18/2022	12:10	19.1	8.4	ND	ND	ND	0.046	ND	ND	0.046	ND	ND	1.68	1.90	220	1.3	**0.0032**	54.0
6/15/2022	13:50	21.0	8.3	0.24	ND	ND	0.053	ND	0.24	0.293	ND	ND	2.46	2.98	150	1.2	**0.0043**	92.2
6/29/2022	13:40	23.9	8.5	0.21	ND	ND	ND	ND	0.21	0.21	**0.031**	ND	1.94	2.28	180	1.0	ND	35.4
7/13/2022	13:40	23.6	8.6	ND	0.12	0.019	0.065	ND	0.31	**0.38**	**0.033**	ND	2.68	3.02	160	0.71	**0.0040**	47.2
7/27/2022	14:10	23.5	8.5	ND	ND	0.011	0.065	ND	ND	0.076	**0.028**	ND	2.96	3.20	140	1.2	**0.0040**	55.6
8/10/2022	13:00	23.0	8.4	ND	ND	ND	ND	ND	ND	ND	**0.035**	0.030	3.24	3.27	150	0.96	**0.0048**	57.0
8/24/2022	13:20	23.6	8.4	ND	ND	ND	0.066	ND	ND	0.066	**0.037**	0.045	2.85	3.73	150	2.2	ND	62.7
9/7/2022	12:40	23.2	8.4	0.20	ND	ND	0.063	ND	0.20	0.263	**0.032**	0.044	2.49	2.96	150	0.70	ND	60.8
9/21/2022	13:30	19.0	9.0	0.23	ND	0.0055	0.058	ND	0.23	0.288	**0.053**	0.098	3.21	3.89	130	0.60	ND	72.8
10/5/2022	13:10	19.0	8.2	ND	0.13	0.0066	0.084	ND	ND	0.221	**0.035**	0.070	2.23	2.48	150	0.45	ND	52.7

* 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

Syar also had three (3) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 16 samples collected (18.8%) that occurred early in the season before the USGS 11465390 near Windsor gaging station was installed for the season, as well as during a flow of 121 cfs (Table 3-9 and Figure 3-21). The maximum seasonal value measured 0.55 mg/L on 9 February with an estimated flow of approximately 365 cfs (Table 3-9). The USGS near Windsor gaging station had not been installed for the season therefore estimated flow is based on a flow of 265 cfs at USGS RR near Healdsburg combined with a flow of 100 cfs at USGS Dry Creek near Mouth. The maximum seasonal value during the terms of the Order measured 0.43 mg/L on 24 August with a flow of 121 cfs (Table 3-9). The minimum seasonal value was 0.045 mg/L which occurred during the terms of the Order on 27 July with a flow of 123 cfs. Syar also had nitrogen values that generally declined from spring into summer, with overall values remaining relatively low through the monitoring season (Figure 3-21).

Patterson Point had two (2) exceedances of the total nitrogen criteria prior to and during the terms of the Order out of 26 samples collected (7.7%), under flows that ranged from 87.4 cfs to 439 cfs (Table 3-10 and Figure 3-21). The maximum seasonal value measured 0.46 mg/L on 9 February with a flow of 439 cfs (Table 3-10). The maximum seasonal value during the terms of the Order measured 0.460 mg/L on 27 September with a flow of 87.4 cfs (Table 3-10 and Figure 3-21). The minimum seasonal value was Non-Detect (ND), which occurred five (5) times prior to and during the terms of the Order with flows that ranged from 44.9to 219 cfs. Aside from the two exceedances, total nitrogen values remained relatively low at Patterson Point through the monitoring season.

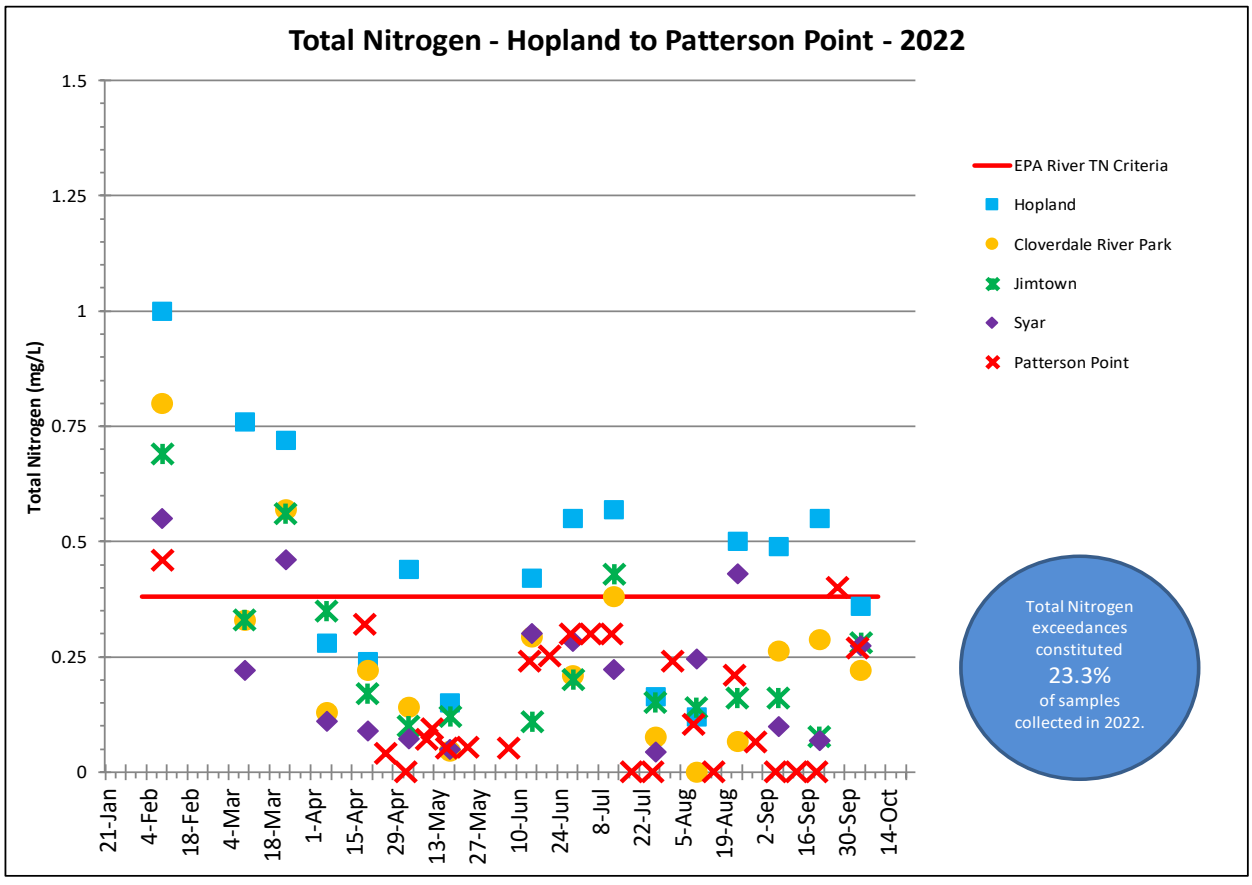

Figure 3-21. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Total Nitrogen Results in 2022.

Total Phosphorus

The EPA's desired goal for total phosphates as phosphorus in Aggregate Ecoregion III has been established as 21.88 micrograms per liter (µg/L), or approximately 0.022 mg/L, for rivers and streams (EPA, 2000). All five monitoring stations were observed to have exceedances of the EPA criteria for total phosphorous during the monitoring season (Tables 3-8 through 3-10, and Figure 3-22). The EPA criteria was exceeded fifty-eight (58) times prior to and during the terms of the Order out of 90 samples collected at the five stations (64.4%). The Hopland and Patterson Point stations predominantly exceeded the total phosphorus criteria prior to and during the terms of the Order. Whereas the Cloverdale and Jimtown stations had only one exceedance each prior to the terms of the Order, and the Syar station only had exceedances that occurred during the terms of the Order.

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 fifteen (15) times prior to and during the terms of the Order out of 16 samples collected (93.8%), under flows that ranged from 43.1 cfs to 142 cfs (Table 3-8 and Figure 3-22). The maximum concentration measured 0.11 mg/L, which occurred twice during the terms of the Order on 21 September and 5 October with flows of 69.6 cfs and 53.9 cfs, respectively (Table 3-8). The minimum concentration was 0.018 mg/L, which occurred on 6 April with a flow of approximately 41.5 cfs. The minimum concentration during the terms of the Order was 0.066 mg/L, which occurred on 27 July (Table 3-8). Total phosphorus values at Hopland were observed to generally increase from spring through summer and into the fall (Figure 3-22).

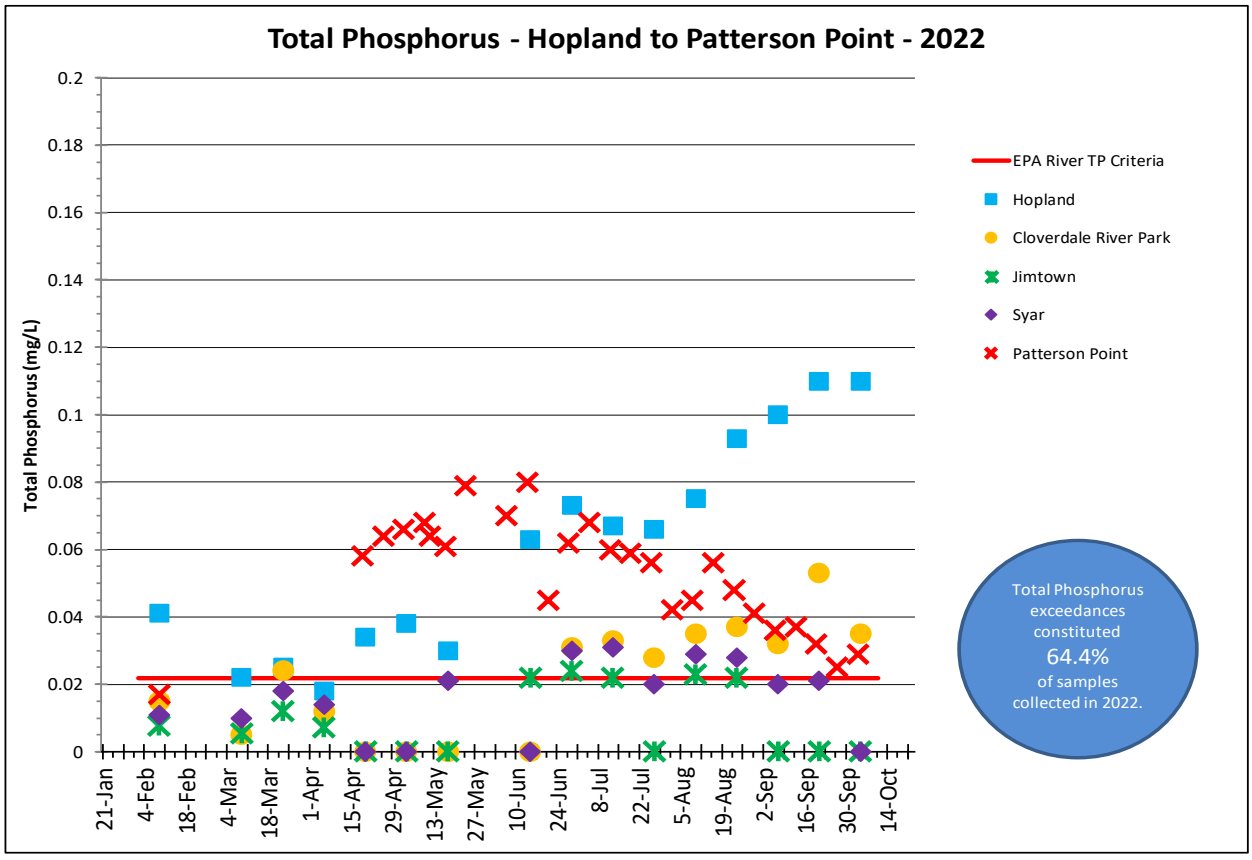

Figure 3-22. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Total Phosphorus Results in 2022.

The Cloverdale River Park station also exceeded the total phosphorus EPA criteria for a majority of the season prior to and during the terms of the Order, including 9 of 16 samples (56.3%) under flows that ranged from 35.4 cfs to 72.8 cfs (Table 3-8 and Figure 3-22). The maximum concentration of 0.053 mg/L occurred during the terms of the Order on 21 September with a flow of 72.8 cfs (Table 3-8). The minimum concentration was ND, which occurred four times prior to the terms of the Order with flows ranging from 54.0 to 197 cfs. The minimum concentration during the terms of the Order was 0.028 mg/L, which occurred with a flow of 55.6 cfs (Table 3-8). Total phosphorus values at Cloverdale were observed to increase from spring into summer, where they remained relatively stable into fall (Figure 3-22).

Concentrations at the Jimtown station were significantly lower compared to the Hopland station, with five (5) exceedances (5 of 16 or 31.3%) of the EPA criteria that occurred prior to and during the terms of the Order with flows ranging from 33.7 cfs to 73.6 cfs (Table 3-9 and Figure 3-22). The maximum concentration measured 0.024 mg/L during the terms of the Order on 29 June with a flow of approximately 35.2 cfs (Table 3-9). The minimum seasonal value was ND, which occurred seven (7) times prior to and during the terms of the Order with flows that ranged from approximately 34.6 to 263 cfs (Table 3-9). Overall, concentrations were observed to increase slightly from spring into summer before declining as fall approached (Figure 3-22).

Syar Vineyards had four (4) exceedances (4 of 16 or 25%) of the total phosphorus EPA criteria that only occurred during the terms of the Order, with a maximum value of 0.031 mg/L that occurred on 13 July with a flow of 133 cfs (Table 3-9 and Figure 3-22). All four exceedances occurred in the summer (Table 3-9). The minimum seasonal value was ND, which occurred four times prior to and during the terms of the Order with flows that ranged from an estimated 133 cfs to 340 cfs (Table 3-9). Concentrations were observed to increase slightly from spring into summer before declining as fall approached, similar to Jimtown (Figure 3-22).

Patterson Point had twenty-five (25) exceedances prior to and during the terms of the Order of the total phosphorus criteria (25 of 26 or 96.2%) under flows that ranged from 43.7 cfs to 463 cfs (Table 3-10 and Figure 3-22). The maximum concentration measured 0.080 mg/L on 14 June with a flow of 130 cfs (Table 3-10). The maximum concentration during the terms of the Order measured 0.068 mg/L on 5 July with a flow of 51.1 cfs (Table 3-10). The minimum seasonal value was 0.017mg/L on 9 February with a flow of approximately 439 cfs (Table 3-10). The minimum value during the terms of the Order was 0.025mg/L on 27 September with a flow of 87.4cfs (Table 3-10). Concentrations were observed to generally increase through spring before declining slightly through summer and into fall (Figure 3-22).

Turbidity

The EPA recommended criteria for turbidity is 2.34 NTU (EPA, 2000). All five of the monitoring stations were observed to have exceedances of the EPA criteria, however three of the stations had only one exceedance each (Tables 3-8 through 3-10). Overall, the EPA criteria was exceeded thirteen (13) times prior to and during the terms of the Order out of 90 samples collected (14.4%) at the five stations (Tables 3-8 through 3-10 and Figure 3-23).

Turbidity levels at Hopland exceeded the EPA criteria periodically through the monitoring season, including prior to and during the terms of the Order (6 of 16 samples or 37.5%) with flows that ranged

from 61.8 cfs to 142 cfs (Table 3-8 and Figure 3-23). The maximum seasonal value measured 9.5 NTU on 20 April with a flow of 142 cfs (Table 3-8). The maximum value during the terms of the Order measured 2.8 NTU on 24 August with a flow of 66.3 cfs (Table 3-8). The minimum seasonal value was 0.86 NTU on 29 February with a flow of 115 cfs (Table 3-8). The minimum value during the terms of the Order was 1.2 NTU on 21 September with a flow of 69.6 cfs (Table 3-8). Values were observed to remain relatively low prior to and during the terms of the Order with a few periodic exceedances in the spring and summer (Figure 3-23).

Table 3-9. Sonoma Water 2022 Seasonal Mainstem Russian River Grab Sampling Results at Jimtown and Syar.

Jimtown	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11463682 RR at Jimtown***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
2/9/2022	12:00	12.3	7.9	0.30	ND	ND	0.39	ND	0.30	**0.69**	0.0078	ND	1.37	1.70	190	0.97	**0.012**	250
3/9/2022	12:20	14.6	7.6	ND	ND	ND	0.33	ND	ND	0.33	0.0054	ND	1.09	1.29	200	0.65	**0.0040**	111
3/23/2022	12:20	17.2	7.4	0.33	ND	ND	0.23	ND	0.33	**0.56**	0.012	ND	0.986	1.08	190	0.51	ND	89.2
4/6/2022	12:40	17.6	7.4	0.20	ND	ND	0.15	ND	0.20	0.35	0.0071	ND	0.902	1.15	220	1.3	ND	73.6
4/20/2022	13:20	14.3	7.3	ND	ND	ND	0.17	ND	ND	0.17	ND	ND	1.99	2.44	190	2.2	**0.0056**	263
5/4/2022	11:50	18.2	8.0	ND	ND	ND	0.10	ND	ND	0.10	ND	ND	1.18	1.43	190	1.3	ND	152
5/18/2022	11:20	18.7	7.7	ND	ND	ND	0.12	ND	ND	0.12	ND	ND	0.956	1.35	220	0.82	ND	83.8
6/15/2022	12:40	21.7	7.7	ND	ND	ND	0.11	ND	ND	0.11	**0.022**	ND	1.33	1.76	180	0.90	**0.0056**	73.6
6/29/2022	12:40	20.8	7.4	ND	ND	ND	0.20	ND	ND	0.20	**0.024**	ND	0.695	0.923	250	0.69	ND	35.2
7/13/2022	12:30	21.0	7.6	ND	ND	0.0068	0.20	ND	0.23	**0.43**	**0.022**	ND	1.12	1.45	220	0.34	**0.0035**	36.8
7/27/2022	13:00	21.4	7.6	ND	ND	0.0014	0.15	ND	ND	0.151	ND	ND	1.15	1.62	200	0.98	**0.0040**	34.9
8/10/2022	12:10	20.6	7.5	ND	ND	ND	0.14	ND	ND	0.14	**0.023**	ND	1.15	1.77	220	0.94	**0.0059**	33.7
8/24/2022	12:00	21.4	7.7	ND	ND	ND	0.16	ND	ND	0.16	**0.022**	ND	1.24	2.36	200	**2.5**	**0.018**	36.2
9/7/2022	11:40	21.6	7.7	ND	ND	ND	0.16	ND	ND	0.16	ND	ND	1.04	1.44	200	0.45	**0.0048**	34.6
9/21/2022	12:10	19.8	8.3	ND	ND	0.0033	0.074	ND	ND	0.077	ND	ND	1.49	1.97	180	0.60	**0.0093**	71.8
10/5/2022	12:00	18.9	7.3	ND	0.15	0.00097	0.13	ND	ND	0.281	ND	ND	1.14	1.31	210	0.45	**0.0069**	49.2

Syar	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11465390 RR near Windsor***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
2/9/2022	11:10	11.4	8.0	0.29	ND	ND	0.26	ND	0.29	**0.55**	0.011	ND	1.49	1.73	190	1.0	**0.0088**	Out for season
3/9/2022	11:30	13.5	7.8	ND	ND	ND	0.22	ND	ND	0.22	0.010	ND	1.34	1.59	170	1.1	ND	Out for season
3/23/2022	11:10	15.1	7.7	0.28	ND	ND	0.18	ND	0.28	**0.46**	0.018	ND	1.31	1.41	180	0.93	ND	Out for season
4/6/2022	11:30	15.4	7.8	ND	ND	ND	0.11	ND	ND	0.11	0.014	ND	1.31	1.58	200	1.0	**0.0035**	Out for season
4/20/2022	12:00	14.7	7.5	ND	ND	ND	0.089	ND	ND	0.089	ND	ND	2.14	2.65	160	**2.8**	**0.0059**	Out for season
5/4/2022	11:00	17.4	8.1	ND	ND	ND	0.072	ND	ND	0.072	ND	ND	1.39	1.66	190	1.4	**0.0075**	286
5/18/2022	10:20	18.2	7.9	ND	ND	ND	0.049	ND	ND	0.049	0.021	ND	1.31	1.76	160	1.2	**0.0064**	213
6/15/2022	11:30	18.6	8.0	0.21	ND	ND	0.095	ND	0.21	0.30	ND	ND	1.53	1.91	120	1.4	**0.0040**	270
6/29/2022	11:20	19.1	8.2	0.24	ND	ND	0.043	ND	0.24	0.283	**0.030**	ND	1.43	1.72	160	1.0	**0.0043**	122
7/13/2022	11:20	19.1	8.0	ND	0.15	0.0049	0.068	ND	ND	0.223	**0.031**	ND	1.82	2.04	150	0.94	**0.0061**	133
7/27/2022	12:00	19.0	8.0	ND	ND	0.0035	0.041	ND	ND	0.045	0.020	ND	1.76	2.25	140	1.6	**0.0051**	123
8/10/2022	11:10	18.4	8.1	ND	ND	ND	0.046	ND	0.20	0.246	**0.029**	ND	1.75	2.58	140	1.0	**0.0085**	119
8/24/2022	11:00	18.4	8.2	0.34	ND	ND	0.093	ND	0.34	**0.43**	**0.028**	ND	1.79	2.45	140	1.5	**0.0037**	121
9/7/2022	10:50	18.7	7.8	ND	ND	ND	0.098	ND	ND	0.098	0.020	ND	1.57	1.92	130	0.80	ND	122
9/21/2022	11:00	18.9	9.0	ND	ND	0.015	0.054	ND	ND	0.069	0.021	ND	1.52	1.93	130	1.0	ND	143
10/5/2022	10:30	16.5	7.8	ND	0.17	0.0036	0.10	ND	ND	0.274	ND	ND	1.59	1.82	150	0.75	**0.0035**	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

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

Cloverdale River Park had one (1) exceedance of the EPA criteria that occurred prior to the terms of the Order out of 16 samples collected (1 of 16 or 6.3%), with a maximum value of 3.6 NTU measured on 20 April during a flow of 197 cfs (Table 3-8 and Figure 3-23). The maximum value during the terms of the Order was 2.2 NTU on 24 August with a flow of 62.7 cfs (Table 3-8). The minimum seasonal value of 0.45 NTU occurred during the terms of the Order on 5 October with a flow of approximately 52.7 cfs (Table 3-8). Other than the exceedance during elevated flows in April, values were observed to remain consistently low through the monitoring season (Figure 3-23).

Jimtown had one exceedance (1 of 16 or 6.3%) of the EPA criteria in 2022 (Table 3-9 and Figure 3-23), with a maximum seasonal value of 2.5 NTU that occurred during the terms of the Order on 24 August with a flow of approximately 36.2 cfs (Table 3-9). The minimum seasonal value was 0.34 NTU, which occurred during the terms of the Order on 13 July with a flow of approximately 36.8 cfs (Table 3-9). Turbidity values remained consistently low through the monitoring season (Figure 3-23).

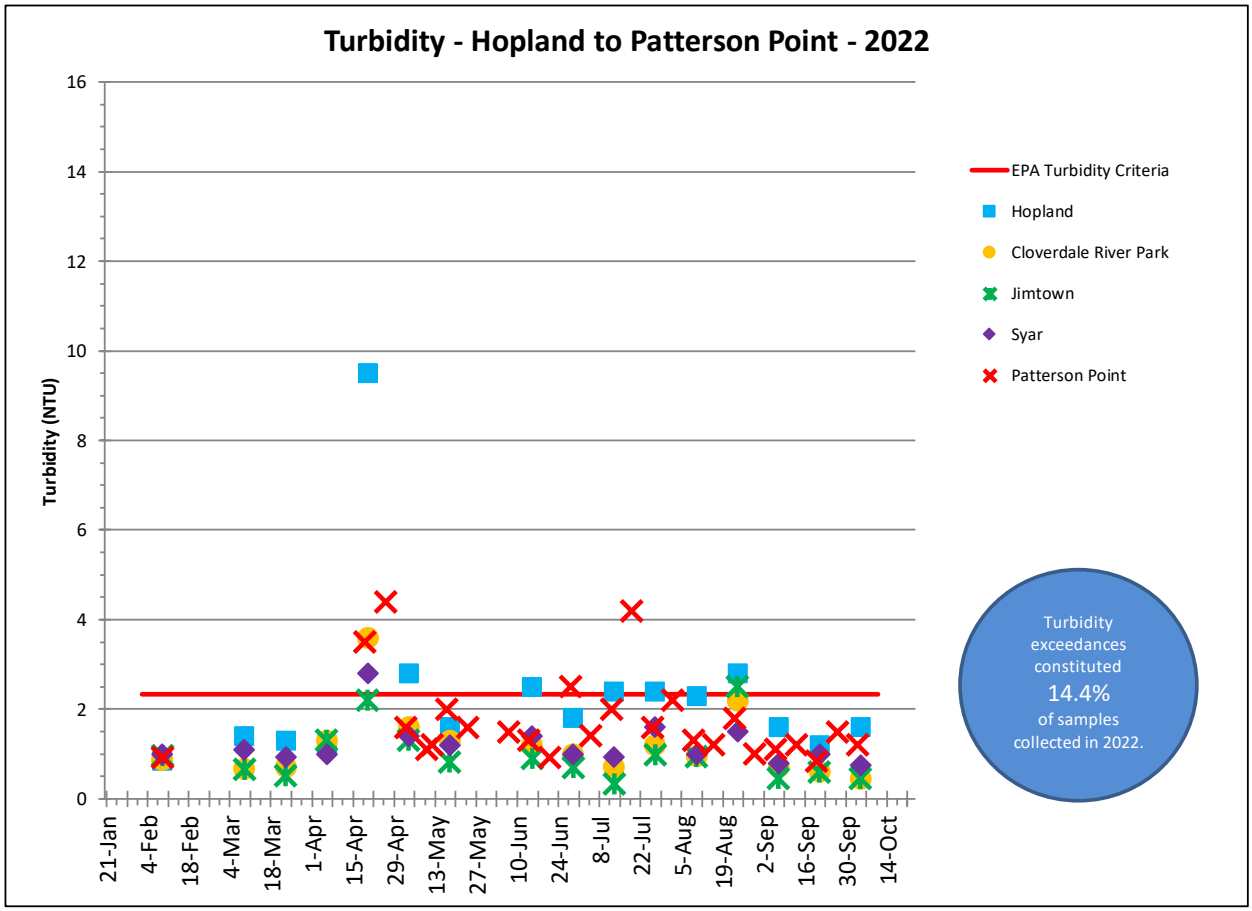

Figure 3-23. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Turbidity in 2022.

Syar Vineyards had one (1) exceedance of the turbidity criteria (1 of 16 or 6.3%) that occurred prior to the terms of the Order (Table 3-9 and Figure 3-23), with a maximum seasonal value of 2.8 NTU on 20 April with an estimated flow of 340 cfs (Table 3-9). The maximum value during the terms of the Order was 1.6 NTU, which occurred on 27 July with a flow of 123 cfs (Table 3-9). The minimum seasonal value was 0.75 NTU, which occurred during the terms of the Order on 5 October with an estimated flow of 133 cfs (Table 3-9). Estimated flows are based on flow at the USGS RR at Healdsburg gage combined

with flow at the USGS Dry Creek near Mouth gage. Other than the exceedance during elevated flows in April, values were observed to remain consistently low through the monitoring season (Figure 3-23).

Table 3-10. Sonoma Water 2022 Seasonal Mainstem Russian River Grab Sampling Results at Patterson Point.

Patterson Point	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.30	0.020	0.030	0.200	0.300	10	0.10	0.0030	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
2/9/2022	9:40	11.2	7.6	0.29	ND	ND	0.17	ND	0.29	**0.46**	0.017	ND	1.71	2.12	190	0.93	**0.0040**	439
4/19/2022	10:30	15.0	7.5	0.23	ND	ND	0.095	ND	0.23	0.32	**0.058**	0.14	3.07	3.21	170	**3.5**	**0.0059**	424
4/26/2022	8:20	17.0	8.1	ND	ND	ND	0.041	ND	ND	0.041	**0.064**	0.12	3.23	3.75	150	**4.4**	**0.0048**	463
5/3/2022	9:50	17.7	7.8	ND	ND	ND	ND	ND	ND	ND	**0.066**	0.15	2.20	2.85	180	1.6	ND	219
5/10/2022	10:20	17.0	7.9	ND	ND	ND	0.072	ND	ND	0.072	**0.068**	0.16	2.16	2.62	170	1.1	ND	153
5/12/2022	9:50	17.7	8.0	ND	ND	ND	0.095	ND	ND	0.095	**0.064**	0.14	1.91	2.47	170	1.2	**0.0083**	141
5/17/2022	9:40	20.1	7.8	ND	ND	ND	0.053	ND	ND	0.053	**0.061**	0.12	1.75	2.20	180	2.0	ND	110
5/24/2022	8:40	22.1	7.9	ND	ND	ND	0.054	ND	ND	0.054	**0.078**	0.18	1.94	2.30	180	1.2	**0.0064**	75.2
6/7/2022	9:40	22.3	7.8	ND	ND	ND	0.053	ND	ND	0.053	**0.070**	0.15	1.58	1.89	190	1.5	**0.0043**	73.7
6/14/2022	9:20	23.2	7.6	0.24	ND	ND	ND	ND	0.24	0.24	**0.080**	0.18	2.06	2.48	170	1.3	ND	130
6/21/2022	9:30	22.2	7.9	0.20	ND	ND	0.053	ND	0.20	0.253	**0.045**	0.081	1.94	2.12	150	0.93	ND	96.7
6/28/2022	9:10	23.3	7.9	0.27	ND	ND	ND	ND	0.27	0.30	**0.062**	0.11	1.73	2.07	170	**2.5**	**0.0048**	48.5
7/5/2022	11:40	22.8	8.1	0.30	ND	ND	ND	ND	0.30	0.30	**0.068**	0.14	1.70	2.09	160	1.4	ND	51.1
7/12/2022	10:00	23.9	7.9	0.30	ND	ND	ND	ND	0.30	0.30	**0.060**	0.12	1.99	2.79	150	2.0	ND	54.2
7/19/2022	9:20	23.7	8.0	ND	ND	ND	ND	ND	ND	ND	**0.059**	0.12	2.24	2.56	150	**4.2**	**0.0048**	47.7
7/26/2022	10:00	22.9	8.0	ND	ND	ND	ND	ND	ND	ND	**0.056**	0.099	1.99	2.52	160	1.6	ND	44.9
8/2/2022	10:10	23.5	7.8	0.24	ND	ND	ND	ND	0.24	0.24	**0.042**	0.078	2.06	2.66	150	2.2	**0.0048**	43.7
8/9/2022	9:40	23.2	7.8	ND	0.10	0.0031	ND	ND	ND	0.1031	**0.045**	0.057	1.97	2.33	150	1.3	ND	51.3
8/16/2022	8:40	23.5	7.8	ND	ND	ND	ND	ND	ND	ND	**0.056**	0.079	1.91	2.24	140	1.2	**0.0051**	43.7
8/23/2022	8:20	23.3	8.1	0.21	ND	ND	ND	ND	0.21	0.21	**0.048**	0.077	1.90	2.24	140	1.8	**0.0040**	53.8
8/30/2022	9:40	22.3	7.8	ND	ND	ND	0.065	ND	ND	0.065	**0.041**	0.071	1.68	2.07	140	1.0	**0.0045**	58.8
9/6/2022	9:50	23.5	7.8	ND	ND	ND	ND	ND	ND	ND	**0.036**	0.053	1.75	2.09	150	1.1	ND	50.8
9/13/2022	9:10	21.8	7.5	ND	ND	0.00074	ND	ND	ND	0.0007	**0.037**	0.064	1.64	2.01	150	1.2	ND	64.0
9/20/2022	8:40	19.9	7.6	ND	ND	0.00014	ND	ND	ND	0.0001	**0.032**	0.038	1.71	2.17	140	0.85	ND	88.6
9/27/2022	8:50	19.9	7.6	0.40	ND	0.00023	ND	ND	0.40	**0.40**	**0.025**	0.034	1.63	2.06	170	1.5	ND	87.4
10/4/2022	8:40	19.1	7.7	ND	0.20	0.0033	0.066	ND	ND	0.2693	**0.029**	0.040	1.54	1.80	160	1.2	ND	78.1

* 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

The Patterson Point station had four (4) exceedances of the turbidity criteria (4 of 26 or 15.4%) prior to and during the terms of the Order with flows ranging from 47.7 cfs to 463 cfs (Table 3-10 and Figure 3-23). The maximum seasonal value was 4.4 NTU on 26 April with a flow of approximately 463 cfs (Table 3-10). The maximum value during the terms of the Order was 4.2 NTU on 19 July with a flow of 47.7 cfs (Table 3-10). The minimum seasonal value was 0.85 NTU, which occurred during the terms of the Order on 20 September with a flow of 88.6 cfs (Table 3-10). Other than the four exceedances, including two prior to the terms of the Order during elevated spring flows, values were observed to remain consistently low through the monitoring season (Figure 3-23).

Chlorophyll a

The EPA criteria for *chlorophyll a* in Aggregate Ecoregion III is 1.78 µg/L, or approximately 0.0018 mg/L for rivers and streams (EPA, 2000). *Chlorophyll a* results were observed to periodically exceed the EPA criteria at all five stations prior to and during the terms of the Order (50 of 90 samples or 55.6%), most predominantly at Jimtown and Syar and least predominantly at Cloverdale River Park (Tables 3-8

through 3-10 and Figure 3-24). *Chlorophyll a* values varied through the season with several ND values occurring at all five stations (Figure 3-24).

As mentioned above, lab analysis constraints in 2022 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 nine (9) *chlorophyll a* exceedances (9 of 16 or 56.3%) and seven (7) non-detects prior to and during the terms of the Order, including a maximum value of 0.0077 mg/L that occurred during the terms of the Order on 24 August with a flow of 66.3 cfs (Table 3-8 and Figure 3-24). Hopland had exceedances periodically throughout the monitoring period, but more predominantly during the latter half of the monitoring period (Table 3-8).

Cloverdale River Park had six (6) *chlorophyll a* exceedances (6 of 16 or 37.5%) and ten (10) non-detects prior to and during the terms of the Order, including a maximum value of 0.0048 mg/L that occurred prior to and during the terms of the Order on 9 February and 10 August with flows of 171 cfs and 57.0 cfs, respectively (Table 3-8 and Figure 3-24). Similar to Hopland, exceedances were more predominant during the latter half of the monitoring period (Table 3-8).

Jimtown had eleven (11) *chlorophyll a* exceedances (11 of 16 or 68.8%) and five (5) non-detects prior to and during the terms of the Order, including a maximum value of 0.018 mg/L that occurred during the terms of the Order on 24 August with a flow of 36.2 cfs (Table 3-9 and Figure 3-24). Jimtown also had exceedances periodically throughout the monitoring period, but more predominantly during the latter half of the monitoring period (Table 3-9).

Syar Vineyards had twelve (12) *chlorophyll a* exceedances (12 of 16 or 75%) and four (4) non-detects prior to and during the terms of the Order, including a maximum value of 0.0088 mg/L that occurred on 9 February with an estimated flow of approximately 365 cfs (Table 3-9 and Figure 3-24). The maximum value during the terms of the Order was 0.0085 mg/L on 10 August with a flow of 119 cfs (Table 3-9). Estimated flow is based on a flow of 265 cfs at USGS RR at Healdsburg gage combined with a flow of 100 cfs at USGS Dry Creek near Mouth gage. Exceedances at Syar occurred throughout the monitoring period (Table 3-9).

Patterson Point had twelve (12) *chlorophyll a* exceedances (12 of 26 or 46.2%) and fourteen (14) non-detects prior to and during the terms of the Order, including a maximum value of 0.0083 mg/L that occurred on 12 May with a flow of approximately 141 cfs at Hacienda (Table 3-10 and Figure 3-24). The maximum value during the terms of the Order was 0.0067 mg/L with a flow of 51.3 cfs (Table 3-10). Exceedances at Patterson Point occurred periodically through the spring and summer, with several non-detects occurring during the terms of the Order at the end of the monitoring period (Table 3-10).

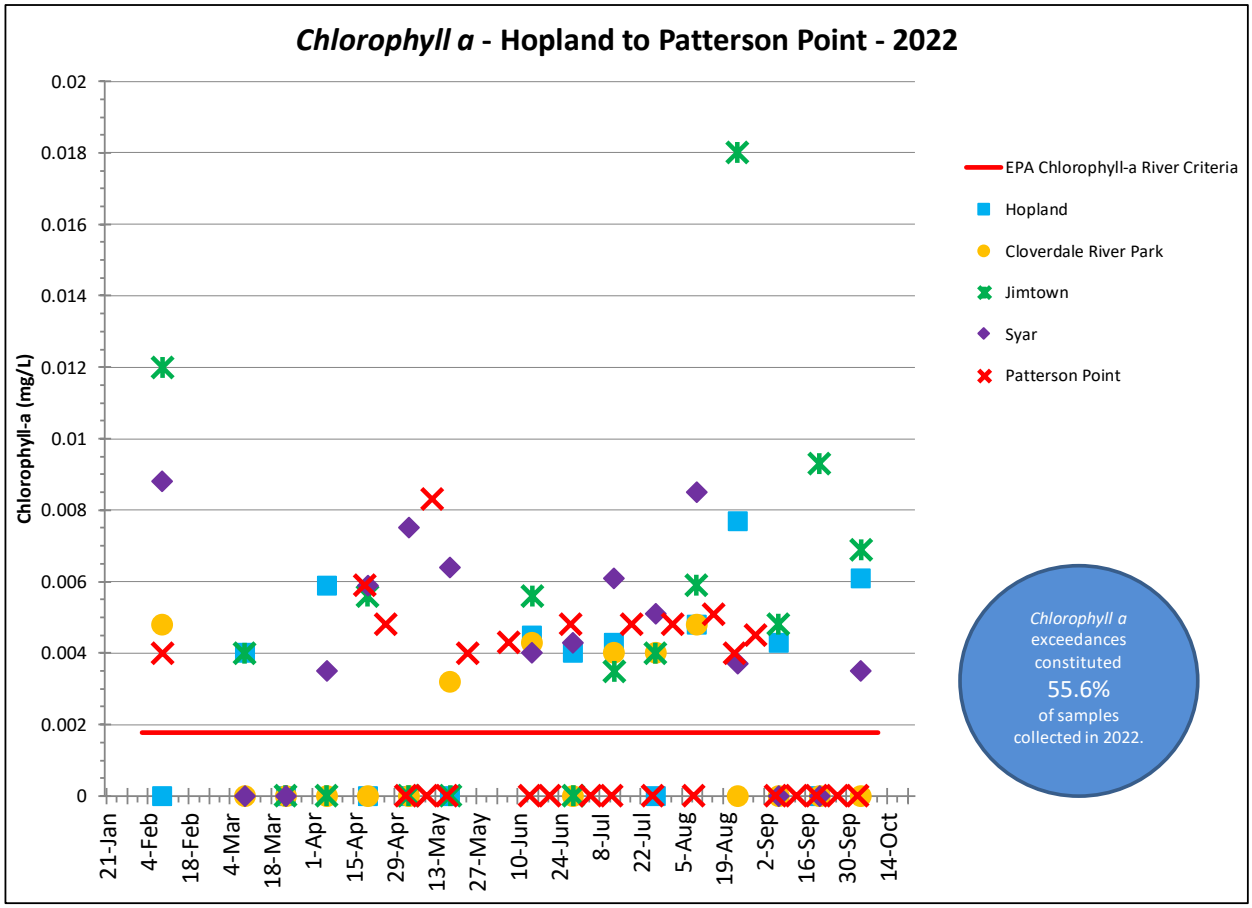

Figure 3-24. Sonoma Water Seasonal Mainstem Russian River Grab Sampling *Chlorophyll a* Results in 2022.

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). However, lower Russian River flows did not decline below the TUC minimum flows of 35 cfs, or 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 prior to and during the term of the Order 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 2022 monitoring season (Figure 3-25). 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 2022 is currently being compiled and will be discussed in the Russian River Biological Opinion 2022-2023 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 19 April to 18 October at three stations in the lower mainstem Russian River, including: Vacation Beach, Monte Rio, and Patterson Point (Figure 3-25). . 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. However, sampling results are only included up to 4 October for nutrients, *chlorophyll a*, total and dissolved organic carbon, total dissolved solids, and turbidity, and 11 October for bacterial indicators due to the timing of this report and delay associated with receiving sample results. Additional grab sampling was conducted at Patterson Point for nutrients, *chlorophyll a*, total and dissolved organic carbon, total dissolved solids, and turbidity in February. 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.

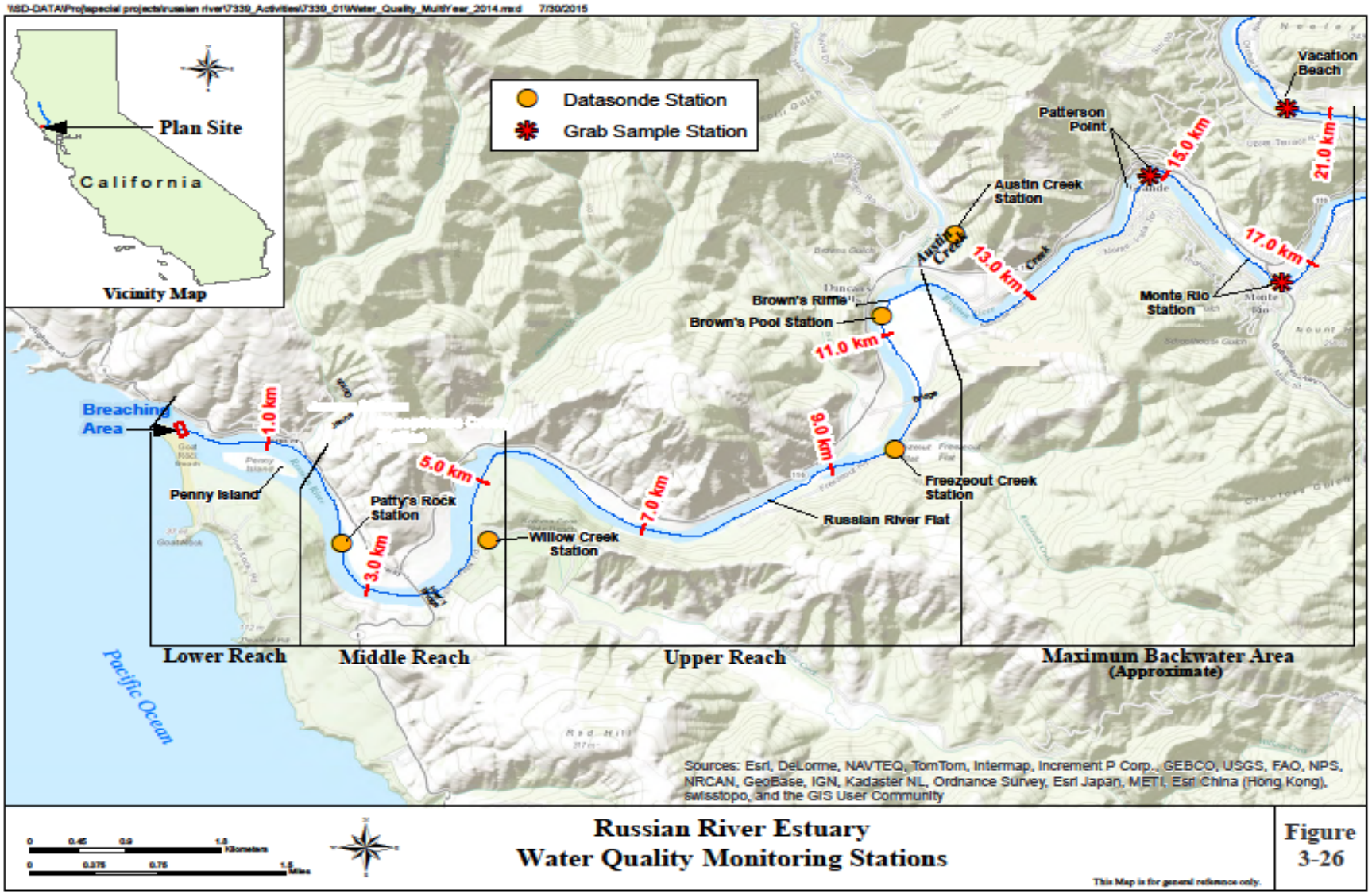

Figure 3-25. Sonoma Water 2022 Russian River Estuary water quality monitoring stations.

The grab sample sites are shown in Figure 3-25, and the results are summarized in Tables 3-11 through 3-16 and Figures 3-26 through 3-32. 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 2022 resulted in a method detection limit (MDL) for *chlorophyll a*, which is the level of accuracy for a given lab analysis to provide a valid concentration of a given constituent, that was higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Put simply, the EPA exceedance criteria for *chlorophyll a* in rivers and streams is approximately 0.0018 mg/L, whereas the lab analysis MDL for *chlorophyll a* was 0.0030 mg/L. Therefore, some lab results for *chlorophyll a* that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL, which in turn could result in an under representation of the actual number of exceedances observed. However, for reporting purposes, only those exceedances that are quantified will be included in the summation.

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

Bacteria

Samples were collected in the lower river prior to and during the terms of the Order in 2022 for diluted and undiluted analysis of Total Coliform and *E. coli* for comparative purposes and the results are included in Tables 3-11 through 3-13 and Figures 3-26 and 3-27. Total Coliform and *E. coli* data presented in Figures 3-26 and 3-27 utilize undiluted sample results unless the reporting limit has been exceeded, at which point the diluted results are utilized. Samples collected for *Enterococcus* prior to and during the terms of the Order were undiluted only and results are included in Tables 3-11 through 3-13 and Figure 3-28. 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 was one exceedance (1 of 75 or 1.3%) of the CDPH guideline for Total Coliform during the 2022 monitoring season at the lower river stations (Tables 3-11 through 3-13 and Figure 3-26). The exceedance occurred during the terms of the Order on 21 June at the Vacation Beach station (1 of 25 or 4%), with a maximum value of 11,119 MPN/100mL during open estuary conditions and a flow of 97.4 cfs (Table 3-11 and Figure 3-26). The minimum concentration at Vacation Beach measured 307.6 MPN/100mL prior to the terms of the Order on 3 May during open estuary conditions and a flow of 219

cfs (Table 3-11 and Figure 3-26). The minimum concentration at Vacation Beach during the terms of the Order was 1046.2 MPN/100mL on 11 October during open estuary conditions and a flow of 79.7 cfs (Table 3-11 and Figure 3-26). Aside from the exceedance at Vacation Beach, Total Coliform concentrations remained low at all three stations during the monitoring season (Figure 3-26).

Table 3-11. 2022 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)
4/26/2022	9:20	16.7	8.1	1986.3	933	83.9	109	25.6	463
5/3/2022	10:50	17.6	8.0	307.6	389	6.3	20	3.1	219
5/10/2022	11:10	17.1	7.9	344.8	384	5.2	<10	2.0	153
5/12/2022	10:50	16.2	7.9	517.2	350	15.5	<10	8.6	141
5/17/2022	10:30	20.5	7.8	1119.9	1664	11.0	40	**85.7**	110
5/24/2022	10:00	22.7	8.0	2419.6	3076	8.6	20	5.2	75.2
6/7/2022	10:40	22.9	8.1	2419.6	2382	45.7	10	13.4	73.7
6/14/2022	10:10	22.6	8.0	2419.6	3076	63.0	63	16.0	130
6/21/2022	10:20	22.3	8.0	>2419.6	**11199**	60.2	20	**146.7**	97.4
6/28/2022	9:50	23.8	8.1	>2419.6	8664	14.5	20	18.5	48.6
7/5/2022	12:20	23.1	7.8	2419.6	2359	6.3	10	6.3	51.4
7/12/2022	10:50	24.5	8.1	2419.6	5475	17.3	<10	7.4	54.8
7/19/2022	10:20	24.4	8.1	>2419.6	9208	13.5	<10	41	47.7
7/26/2022	10:50	23.3	8.1	>2419.6	31	**344.8**	<11	1.0	44.9
8/2/2022	10:10	23.5	7.8	>2419.6	6488	2	10	8.4	43.7
8/9/2022	9:40	23.2	7.8	>2419.6	2282	3.0	<10	2.0	51.3
8/16/2022	9:50	24.0	7.8	1986.3	1597	12.2	10	31	43.7
8/23/2022	9:10	23.7	8.1	1986.3	1439	13.5	<10	4.1	53.8
8/30/2022	10:40	22.6	8.1	>2419.6	1956	17.3	10	22.1	58.8
9/6/2022	10:40	24.1	8.0	2419.6	3654	23.1	31	7.5	50.8
9/13/2022	9:50	22.3	7.9	2419.6	3076	63.7	31	15.5	64.0
9/20/2022	9:30	19.6	7.8	1986.3	2098	59.1	52	25.9	88.6
9/27/2022	9:20	19.6	7.7	2419.6	1918	25.6	10	32.3	87.4
10/4/2022	9:40	19.0	7.8	1119.9	1658	12.2	10	5.2	78.1
10/11/2022	9:30	18.3	7.9	1046.2	**14281**	19.9	20	22.8	79.7
* 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 >2419.6 MPN/100mL, which occurred three times prior to and during the terms of the Order on 26 April, 17 May, and 12 July during open estuary conditions and flows of 463 cfs, 110 cfs, and 54.8 cfs, respectively (Table 3-12 and Figure 3-26). The minimum concentration measured 365.4 MPN/100mL on 3 May during open estuary conditions and a flow of 219 cfs (Table 3-12 and Figure 3-26). The minimum concentration during the

terms of the Order measured 958 MPN/100mL on 16 August during open estuary conditions and a flow of 43.7 cfs (Table 3-12 and Figure 3-26).

The maximum Total Coliform concentration observed at Patterson Point was >2419.6 MPN/100mL, which occurred on 26 April, during open estuary conditions and a flow of 463 cfs (Table 3-13 and Figure 3-26). The maximum Total Coliform concentration observed during the terms of the Order was 2419.6 MPN/100mL, which twice occurred on 12 July and 20 September, during open estuary conditions and flows of 54.8 cfs and 88.6 cfs, respectively (Table 3-13 and Figure 3-26). The minimum concentration measured 344.8 MPN/100mL on 3 May during open estuary conditions and a flow of 219 cfs (Table 3-13 and Figure 3-26). The minimum concentration during the terms of the Order measured 816.4 MPN/100mL on 26 July during open estuary conditions and a flow of approximately 44.9 cfs (Table 3-13 and Figure 3-26).

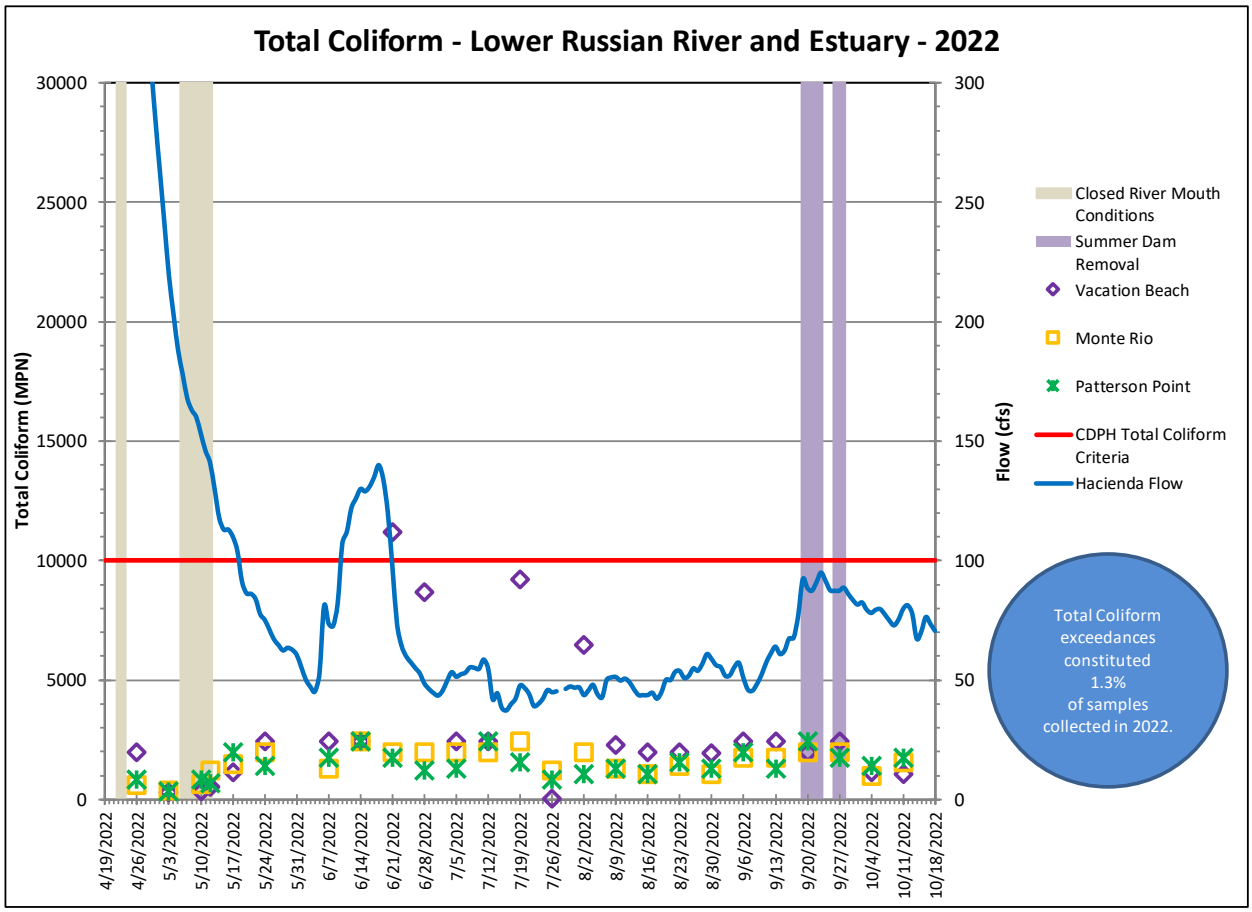

Figure 3-26. Total Coliform results for the Russian River from Vacation Beach to Patterson Point in 2022.

E. coli

There was one exceedance (1 of 75 or 1.3%) of the EPA criteria for *E. coli* during the 2022 monitoring season at the lower river stations (Tables 3-11 through 3-13 and Figure 3-27).

The exceedance was observed during the terms of the Order on 26 July at the Vacation Beach station (1 of 25 or 4%), with a maximum value of 344.8 MPN/100mL during open estuary conditions and a flow of 44.9 cfs (Table 3-11 and Figure 3-27). The minimum concentration measured 2 MPN/100mL during the

terms of the Order on 2 August during open estuary conditions and a flow of 43.7 cfs (Table 3-11 and Figure 3-27).

The maximum *E. coli* concentration observed at Monte Rio was 70.6 MPN/100mL, which occurred during the terms of the Order on 20 September during open estuary conditions and a flow of 88.6 cfs (Table 3-12 and Figure 3-27). The minimum concentration measured 2.0 MPN/100mL on 3 May during open estuary conditions and a flow of 219 cfs (Table 3-12 and Figure 3-27). The minimum concentration during the terms of the Order measured 10.8 MPN/100mL on 16 August during open estuary conditions and a flow of 43.7 cfs (Table 3-12 and Figure 3-27).

Table 3-12. 2022 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)
4/26/2022	9:00	16.7	8.0	>2419.6	624	17.5	20	18.3	463
5/3/2022	10:20	18.0	8.0	365.4	201	2.0	<10	4.1	219
5/10/2022	10:50	17.3	8.0	648.8	823	49.5	41	42.8	153
5/12/2022	10:20	17.3	7.9	1203.3	932	46.5	31	**65.1**	141
5/17/2022	10:10	20.4	7.7	>2419.6	1467	17.3	<10	5.2	110
5/24/2022	9:40	22.0	7.9	1986.3	2909	42.0	20	27.5	75.2
6/7/2022	10:10	22.4	7.9	1299.7	1396	18.9	20	29.2	73.7
6/14/2022	9:40	23.7	7.7	2419.6	1850	23.8	20	10.8	130
6/21/2022	10:00	22.5	7.8	1986.3	2064	46.2	10	22.6	97.4
6/28/2022	9:30	23.2	7.9	1986.3	1918	22.8	10	9.8	48.6
7/5/2022	12:00	23.0	7.8	1986.3	2282	38.4	75	21.3	51.4
7/12/2022	10:30	23.7	7.9	>2419.6	1989	18.7	41	49.5	54.8
7/19/2022	10:00	23.9	8.0	2419.6	2046	39.3	41	56.3	47.7
7/26/2022	10:30	23.1	8.1	1203.3	1670	14.6	20	44.1	44.9
8/2/2022	9:50	23.2	7.8	1986.3	1354	21.6	20	18.5	43.7
8/9/2022	9:20	23.6	7.9	1299.7	2978	23.3	20	13.2	51.3
8/16/2022	9:20	23.6	7.8	1046.2	958	10.8	<10	10.9	43.7
8/23/2022	8:50	23.5	7.9	1413.6	1500	19.9	31	8.4	53.8
8/30/2022	10:10	22.2	8.1	1046.2	1720	12.2	<10	9.7	58.8
9/6/2022	10:20	23.7	7.8	1732.9	2143	30.9	41	7.5	50.8
9/13/2022	9:30	21.9	7.8	1732.9	**12997**	17.5	10	7.5	64.0
9/20/2022	9:10	19.8	7.6	1986.3	1467	70.6	85	21.3	88.6
9/27/2022	9:10	19.8	7.7	1986.3	2359	51.2	41	53.7	87.4
10/4/2022	9:10	18.9	7.7	980.4	1162	23.1	31	12.1	78.1
10/11/2022	9:10	17.9	7.7	1553.1	1014	73.3	10	27.5	79.7
* 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 93.3 MPN/100mL, which occurred on 3 May during open estuary conditions and a flow of 219 cfs (Table 3-13 and Figure 3-27). The maximum concentration during the terms of the Order measured 65.7 MPN/100mL on 6 September during open estuary conditions and a flow of 50.8 cfs (Table 3-13 and Figure 3-27). The minimum concentration measured 4.1 MPN/100mL, which occurred twice on 17 May and 2 August during open estuary conditions and flows of 110 cfs and 43.7 cfs, respectively (Table 3-13 and Figure 3-27).

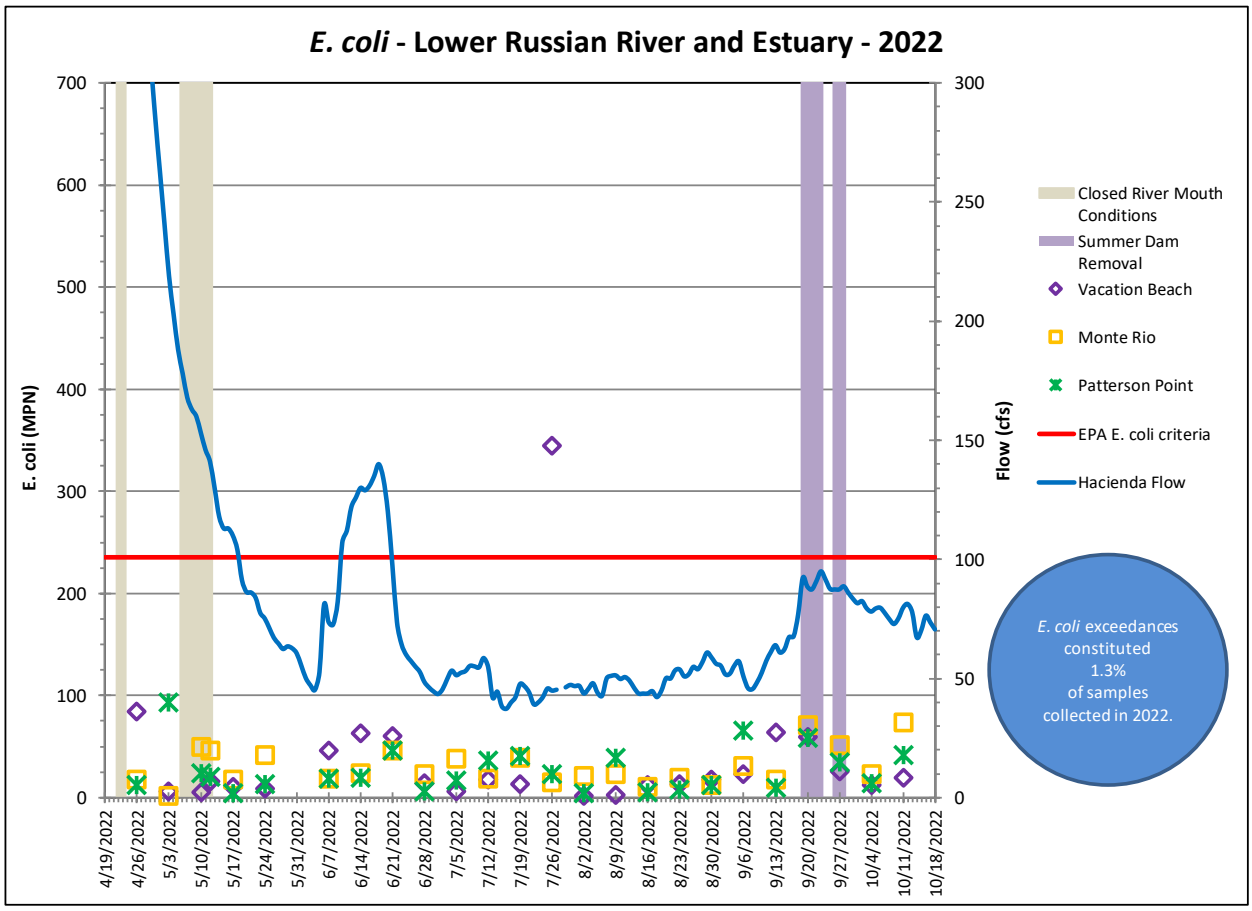

Figure 3-27. *E. coli* results for the Russian River from Vacation Beach to Patterson Point in 2022.

Enterococcus

There were six (6) exceedances (6 of 75 or 8%) of the EPA criteria for *Enterococcus* at the lower river stations prior to and during the terms of the Order, with flows that ranged from 47.7 to 141 cfs at the Hacienda USGS gage (Tables 3-11 through 3-13 and Figure 3-28).

The Vacation Beach station had two (2) exceedances of the EPA criteria for *Enterococcus* prior to and during the terms of the Order (2 of 25 or 8%), including a maximum concentration of 146.7 MPN/100mL that occurred during the terms of the Order on 21 June during open estuary conditions and a flow of 97.4 cfs (Table 3-11 and Figure 3-28). The minimum seasonal concentration measured 1.0 MPN/100mL and occurred during the terms of the Order on 26 July during open estuary conditions and a flow of 44.9 cfs (Table 3-11 and Figure 3-28).

The Monte Rio station had one (1) exceedance of the EPA criteria for *Enterococcus* that occurred prior to the terms of the Order (1 of 25 or 4%), with a maximum concentration of 65.1 MPN/100mL on 12 May

during closed estuary conditions and a flow of 141 cfs (Table 3-12 and Figure 3-28). The maximum concentration during the terms of the Order measured 56.3 MPN/100mL on 19 July during open estuary conditions and a flow of 47.7 cfs (Table 3-12 and Figure 3-28). The minimum concentration measured 4.1 MPN/100mL on 3 May during open estuary conditions and a flow of approximately 219 cfs at the Hacienda USGS gage (Table 3-12 and Figure 3-28). The minimum concentration during the terms of the Order measured 7.5 MPN/100mL, which occurred twice on 6 September and 13 September during open estuary conditions and flows of 50.8 cfs and 64.0 cfs, respectively (Table 3-12 and Figure 3-28).

The Patterson Point station had three (3) exceedances of the EPA criteria for *Enterococcus* (3 of 25 or 12%) that occurred during the terms of the Order, including a maximum concentration of 151.5 MPN/100mL on 20 September during open estuary conditions and a flow of 88.6 cfs (Table 3-13 and Figure 3-28). The minimum concentration at Patterson Point measured 2.0 MPN/100mL, which occurred three times during the terms of the Order on 5 July, 2 August, and 13 September during open estuary conditions and flows of 51.4 cfs, 43.7 cfs, and 64.0 cfs, respectively (Table 3-13 and Figure 3-28).

Table 3-13. 2022 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)
4/26/2022	8:20	17.0	8.1	>2419.6	816	12.2	10	21.1	463
5/3/2022	9:50	17.7	7.8	344.8	435	93.3	121	4.1	219
5/10/2022	10:20	17.0	7.9	816.4	776	24	41	19.9	153
5/12/2022	9:50	17.7	8.0	686.7	323	20.1	31	7.5	141
5/17/2022	9:40	20.1	7.8	1986.3	2412	4.1	<10	8.6	110
5/24/2022	8:40	22.1	7.9	1413.6	1439	13.5	<10	6.3	75.2
6/7/2022	9:40	22.3	7.8	1732.9	1259	18.7	20	9.8	73.7
6/14/2022	9:20	23.2	7.6	2419.6	1616	19.9	31	30.9	130
6/21/2022	9:30	22.2	7.9	1732.9	1439	46.4	20	52.1	97.4
6/28/2022	9:10	23.3	7.9	1203.3	1169	6.3	<10	6.3	48.6
7/5/2022	11:40	22.8	8.1	1299.7	1500	17.1	20	2.0	51.4
7/12/2022	10:00	23.9	7.9	2419.6	1860	35.9	31	39.9	54.8
7/19/2022	9:20	23.7	8.0	1553.1	1314	41	<10	**63**	47.7
7/26/2022	10:00	22.9	8.0	816.4	959	23.1	20	16.0	44.9
8/2/2022	9:20	23.1	7.9	1046.2	1017	4.1	10	2.0	43.7
8/9/2022	8:50	23.2	7.8	1299.7	2140	39.3	31	27.5	51.3
8/16/2022	8:40	23.5	7.8	1046.2	789	5.2	<10	5.2	43.7
8/23/2022	8:20	23.3	8.1	1553.1	1236	7.5	41	8.6	53.8
8/30/2022	9:40	22.3	7.8	1299.7	1720	12.1	<10	3.1	58.8
9/6/2022	9:50	23.5	7.8	1986.3	2014	65.7	135	**65.1**	50.8
9/13/2022	9:10	21.8	7.5	1299.7	1515	9.7	10	2.0	64.0
9/20/2022	8:40	19.9	7.6	2419.6	3282	58.3	63	**151.5**	88.6
9/27/2022	8:50	19.9	7.6	1732.9	1850	34.5	52	60.9	87.4
10/4/2022	8:40	19.1	7.7	1413.6	1296	14.4	10	14.5	78.1
10/11/2022	8:50	18.2	7.7	1732.9	880	41.4	30	23.8	79.7
* 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									

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 2022 monitoring season (Figure 3-28).

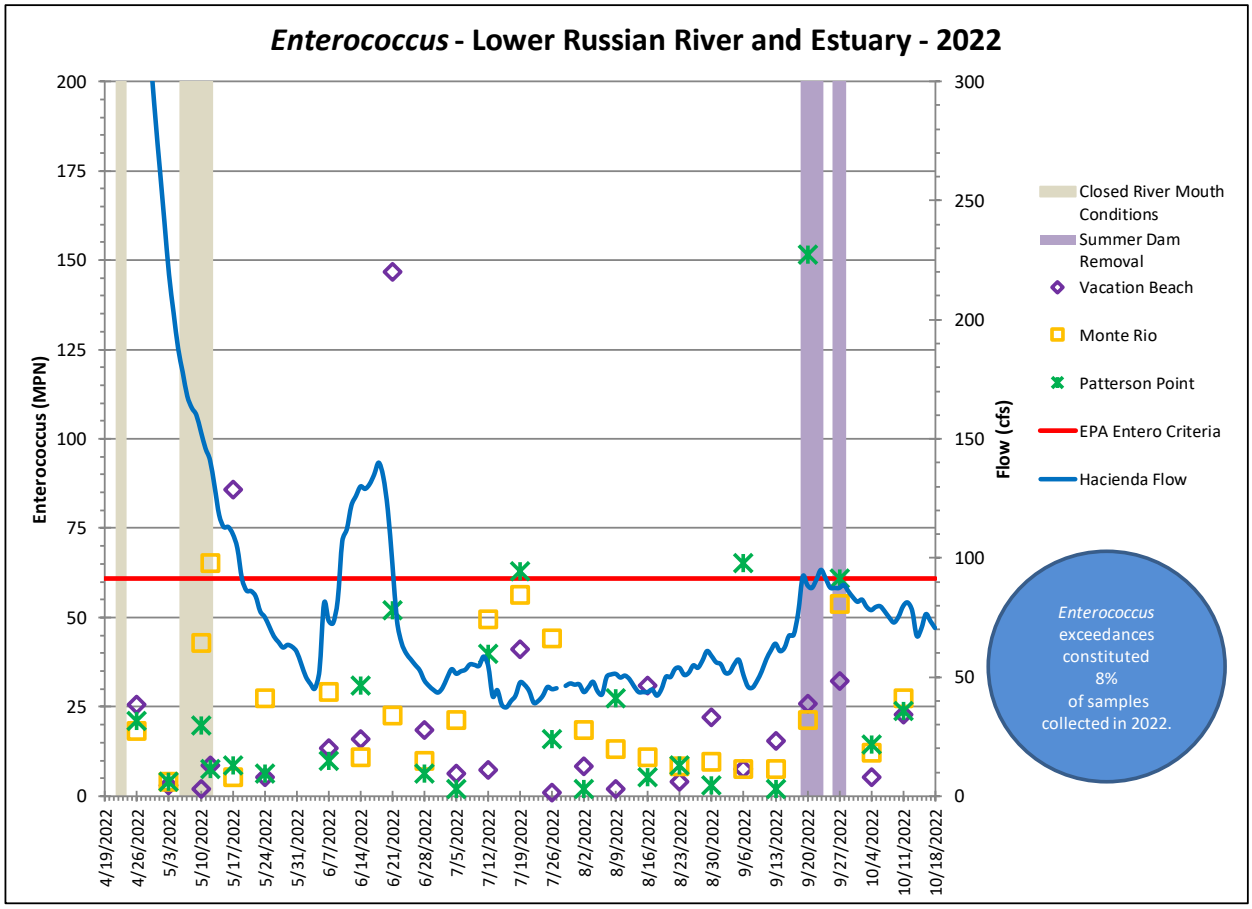

Figure 3-28. *Enterococcus* results for the Russian River from Vacation Beach to Patterson Point in 2022.

Total Nitrogen

There were three (3) exceedances (3 of 76 or 4.0%) of the EPA criteria for total nitrogen that occurred prior to and during the terms of the Order at the lower river stations, with flows that ranged from 47.7 to 439 cfs (Tables 3-14 through 3-16 and Figure 3-29). Exceedances were observed at Vacation Beach and Patterson Point, but there were no exceedances at Monte Rio (Figure 3-29).

The Vacation Beach station had one (1) exceedance of the EPA total nitrogen criteria (1 of 25 or 4%) that occurred during the terms of the Order on 19 July with a maximum concentration of 0.50 mg/L during open estuary conditions and a flow of 47.7 cfs (Table 3-14 and Figure 3-29). The minimum concentration at Vacation Beach was ND, which occurred eight (8) times prior to and during the terms of the Order during open and closed estuary conditions and flows that ranged from 43.7 to 153 cfs (Table 3-14).

There were no exceedances of the total nitrogen criteria at the Monte Rio station in 2022. The maximum total nitrogen concentration observed at Monte Rio was 0.34 mg/L, which occurred prior to the terms of the Order on 19 April during open estuary conditions with a flow of 424 cfs (Table 3-15 and Figure 3-29). The maximum concentration during the terms of the Order was 0.31 mg/L on 12 July

during open conditions and a flow of 54.8 cfs (Table 3-15 and Figure 3-29). The minimum concentration at Monte Rio was ND, which occurred seven (7) times prior to and during the terms of the Order during open estuary conditions and flows that ranged from 43.7 to 219 cfs (Table 3-15).

The Patterson Point station had two (2) exceedances of the EPA total nitrogen criteria (2 of 26 or 7.7%) prior to and during the terms of the Order, including a maximum concentration of 0.46 mg/L that occurred prior to the terms of the Order on 9 February during open estuary conditions and a flow of 439 cfs (Table 3-16 and Figure 3-29). The maximum concentration during the terms of the Order was 0.40 mg/L on 27 September during open conditions and a flow of 87.4 cfs (Table 3-16 and Figure 3-29). The minimum concentration at Patterson Point was ND, which occurred five (5) times prior to and during the terms of the Order during open estuary conditions and flows that ranged from 43.7 to 219 cfs (Table 3-16).

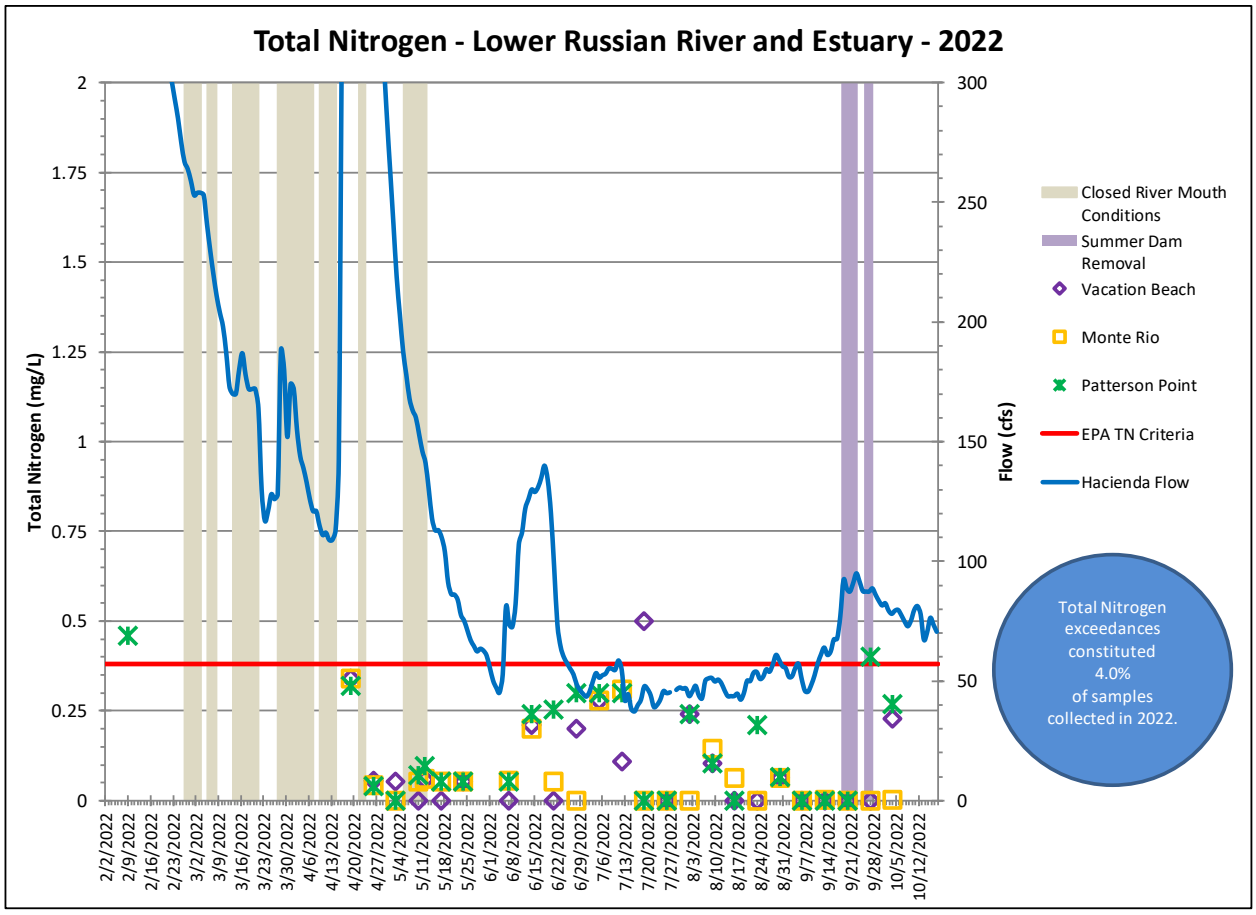

Figure 3-29. Total Nitrogen results for the Russian River from Vacation Beach to Patterson Point in 2022.

Total Phosphorus

All three lower river stations predominantly exceeded the EPA criteria for total phosphorous (75 of 76 or 98.7%) prior to and during the terms of the Order with flows that ranged from 43.7 cfs to 463 cfs, continuing a trend of consistent exceedances observed in previous years (Tables 3-14 through 3-16 and Figure 3-30). Exceedances occurred during open and closed estuary conditions and generally trended downward through the monitoring season (Figure 3-30).

Vacation Beach had twenty-five (25) exceedances of the EPA total phosphorus criteria (25 of 25 or 100%) that occurred prior to and during the terms of the Order, including a maximum concentration of 0.071 mg/L that occurred during the terms of the Order on 7 June during open estuary conditions and a flow of 73.7 cfs (Table 3-14 and Figure 3-30). The minimum concentration at Vacation Beach was 0.026 mg/L, which occurred during the terms of the Order on 6 September during open estuary conditions and a flow of 50.8 cfs. Finally, the lowest flow recorded during sampling was approximately 43.7 cfs, which occurred twice during the terms of the Order, on 2 August and 16 August during open estuary conditions, with concentrations of 0.042 mg/L and 0.044 mg/L, respectively (Table 3-14).

Monte Rio had twenty-five (25) exceedances of the EPA total phosphorus criteria (25 of 25 or 100%) that occurred prior to and during the terms of the Order, including a maximum concentration of 0.079 mg/L that occurred on prior to the terms of the Order on 24 May during open estuary conditions and a flow of 75.2 cfs (Table 3-15 and Figure 3-30). The maximum concentration during the terms of the Order was 0.69 mg/L on 5 July during open estuary conditions and a flow of 51.4 cfs (Table 3-15 and Figure 3-30). The minimum concentration at Monte Rio was 0.028 mg/L, which occurred during the terms of the Order on 27 September during open estuary conditions and a flow of 87.4 cfs. Finally, the lowest flow recorded during sampling was approximately 43.7 cfs, which occurred twice during the terms of the Order, on 2 August and 16 August during open estuary conditions, with concentrations of 0.052 mg/L and 0.051 mg/L, respectively (Table 3-15).

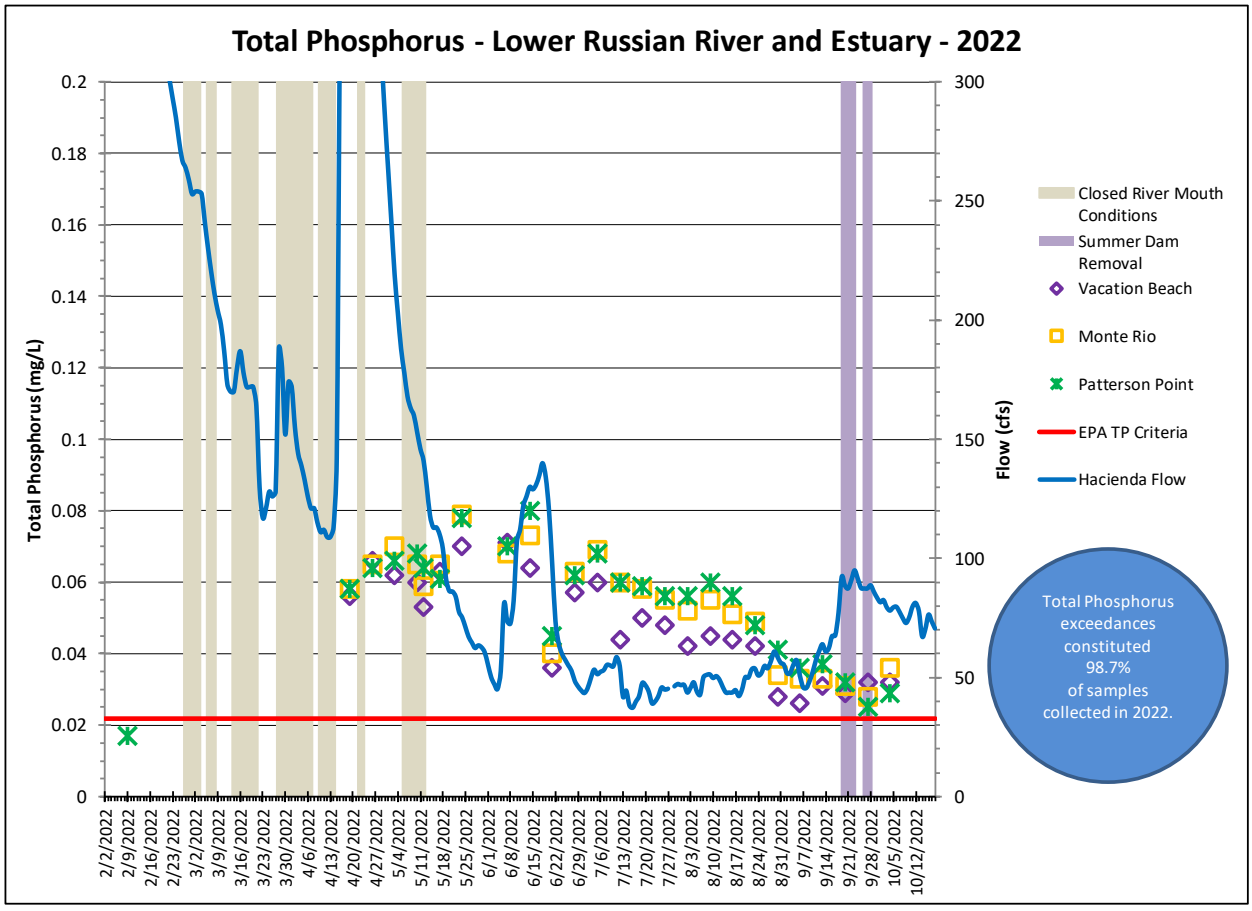

Figure 3-30. Total Phosphorus results for the Russian River from Vacation Beach to Patterson Point in 2022.

Patterson Point had twenty-five (25) exceedances of the EPA total phosphorus criteria (25 of 26 or 96.2%) that occurred prior to and during the terms of the Order, including a maximum concentration of 0.080 mg/L that occurred prior to the terms of the Order on 14 June during open estuary conditions and a flow of 130 cfs (Table 3-16 and Figure 3-30). The maximum concentration during the terms of the Order was 0.068 mg/L on 5 July during open estuary conditions and a flow of 51.4 cfs (Table 3-16 and Figure 3-30). The minimum concentration at Patterson Point was 0.017 mg/L, which occurred prior to the terms of the Order on 9 February during open estuary conditions and a flow of 439 cfs (Table 3-16 and Figure 3-30). The minimum concentration during the terms of the Order was 0.025 mg/L on 27 September during open estuary conditions and a flow of 87.4 cfs (Table 3-16 and Figure 3-30). Finally, the lowest flow recorded during sampling was approximately 43.7 cfs, which occurred twice during the terms of the Order, on 2 August and 16 August during open estuary conditions, with concentrations of 0.056 mg/L, respectively (Table 3-16).

Turbidity

The EPA criteria for turbidity was exceeded five times each at Vacation Beach and Monte Rio and four times at Patterson Point (14 of 76 or 18.4%) prior to and during the terms of the Order (Tables 3-14 through 3-16). Exceedances were observed to periodically occur throughout the monitoring season with open and closed estuary conditions, summer dam removal, and Hacienda flows ranging from 43.7 cfs to 463 cfs (Figure 3-31).

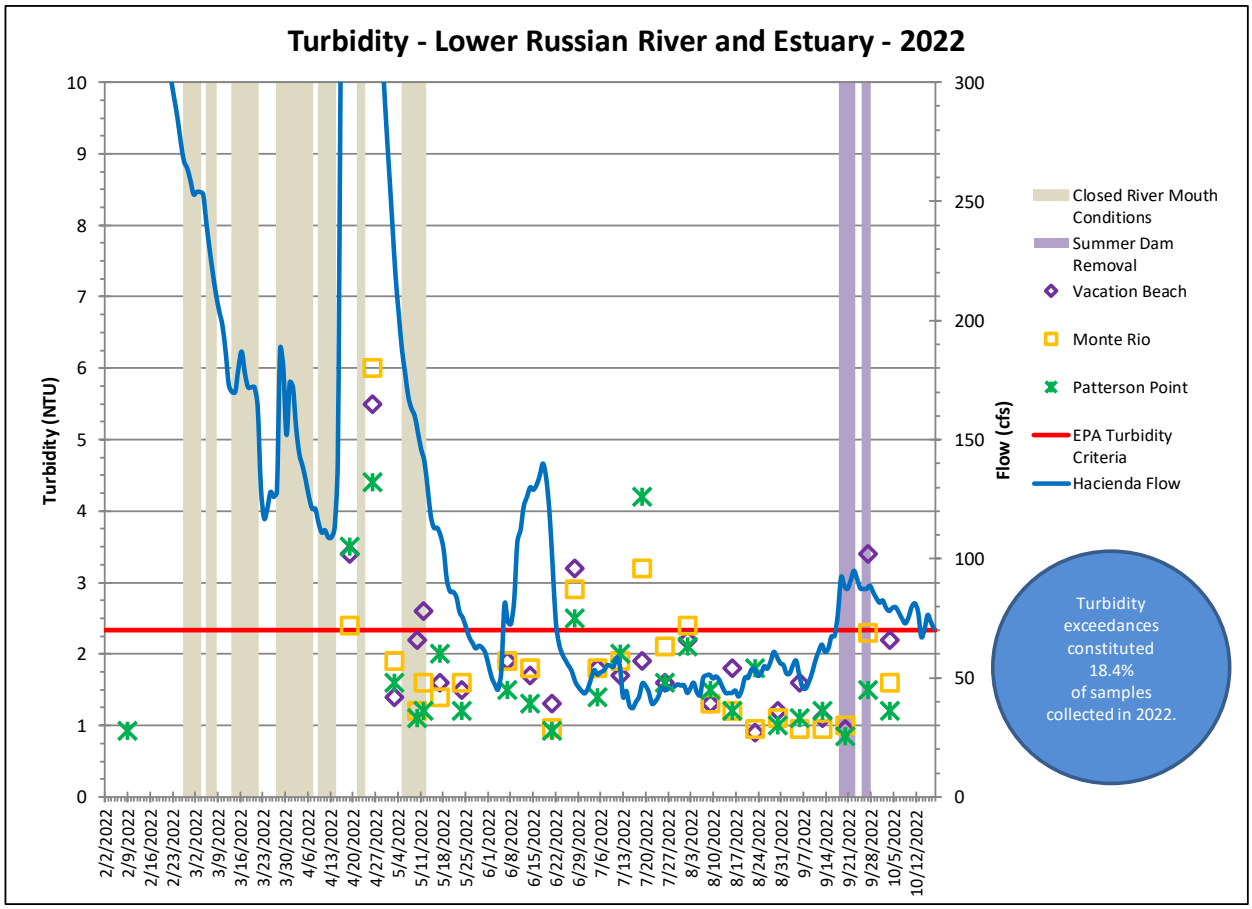

Figure 3-31. Turbidity results for the Russian River from Vacation Beach to Patterson Point in 2022.

The maximum turbidity value observed at Vacation Beach occurred prior to the terms of the Order and was 5.5 NTU on 26 April during open estuary conditions and a flow of 463 cfs (Table 3-14 and Figure 3-31). The maximum turbidity value observed during the terms of the Order and was 3.4 NTU on 27 September during open estuary conditions and a flow of 87.4 cfs (Table 3-14 and Figure 3-31). The minimum value at Vacation Beach was 0.90 NTU, which occurred during the terms of the Order on 23 August during open estuary conditions and a flow of 53.8 cfs (Table 3-14). Finally, the lowest flow recorded during sampling was approximately 43.7 cfs, which occurred twice during the terms of the Order, on 2 August and 16 August during open estuary conditions, with values of 2.2 NTU and 1.8 NTU, respectively.

The maximum turbidity value observed at Monte Rio occurred prior to the terms of the Order and was 6.0 NTU on 26 April during open estuary conditions and a flow of 463 cfs (Table 3-15 and Figure 3-31). The maximum turbidity value observed during the terms of the Order and was 3.2 NTU on 19 July during open estuary conditions and a flow of 47.7 cfs (Table 3-15 and Figure 3-31). The minimum value at Monte Rio was 0.95 NTU, which occurred three times during the terms of the Order, on 23 August, 6 September, and 13 September during open estuary conditions and flows of 53.8 cfs, 50.8 cfs, and 64.0 cfs, respectively (Table 3-15). Finally, the lowest flow recorded during sampling was approximately 43.7 cfs, which occurred on twice during the terms of the Order, on 2 August and 16 August during open estuary conditions, with values of 2.4 NTU and 1.2 NTU, respectively.

The maximum turbidity value observed at Patterson Point occurred prior to the terms of the Order and was 4.4 NTU on 26 April during open estuary conditions and a flow of 463 cfs (Table 3-16 and Figure 3-31). The maximum turbidity value observed during the terms of the Order and was 4.2 NTU on 19 July during open estuary conditions and a flow of 47.7 cfs (Table 3-16 and Figure 3-31). The minimum value at Patterson Point was 0.85 NTU, which occurred during the terms of the Order on 20 September during open estuary conditions and a flow of 88.6 cfs. Finally, the lowest flow recorded during sampling was approximately 43.7 cfs, which occurred twice during the terms of the Order, on 2 August and 16 August during open estuary conditions, with values of 2.1 NTU and 1.2 NTU, respectively.

Chlorophyll a

Algal (*chlorophyll a*) results exceeded the EPA criteria sixteen (16) times at Vacation Beach, eight (8) times at Monte Rio, and twelve (12) times at Patterson Point (36 of 76 or 47.4%) prior to and during the terms of the Order under open and closed estuary conditions and flows that ranged from 43.7 to 463 cfs (Tables 3-14 through 3-16 and Figure 3-32). *Chlorophyll a* values varied through the monitoring season with several ND values occurring at all three stations prior to and during the terms of the Order, including during estuary closure in May and summer dam removal in September (Figure 3-32).

As mentioned above, lab analysis constraints in 2022 resulted in the MDL for *chlorophyll a* being higher than the EPA criteria for exceedances for *chlorophyll a* in rivers and streams. Therefore, some lab results for *chlorophyll a* that are listed as non-detect (ND) could potentially have concentrations above the criteria and below the MDL. However, for reporting purposes, only those exceedances that are quantified will be included in the summation.

The maximum *chlorophyll a* concentration observed at Vacation Beach occurred prior to the terms of the Order and was 0.0096 mg/L on 26 April during open estuary conditions and a flow of 463 cfs (Table

3-14 and Figure 3-32). The maximum value observed during the terms of the Order and was 0.0067 mg/L on 9 August during open estuary conditions and a flow of 51.3 cfs (Table 3-14 and Figure 3-32). The minimum value at Vacation Beach was ND, which occurred nine (9) times prior to and during the terms of the Order during open and closed estuary conditions, summer dam removal, and flows that ranged from 47.7 to 219 cfs (Table 3-14).

The maximum *chlorophyll a* concentration observed at Monte Rio occurred prior to the terms of the Order and was 0.0064 mg/L on 26 April during open estuary conditions and a flow of 463 cfs (Table 3-15 and Figure 3-32). The maximum value observed during the terms of the Order and was 0.0045 mg/L, which occurred twice on 19 July and 2 August during open estuary conditions and flows of 47.7 cfs and 43.7 cfs, respectively (Table 3-15 and Figure 3-32). The minimum value at Monte Rio was ND, which occurred seventeen (17) times prior to and during the terms of the Order during open and closed estuary conditions, summer dam removal, and flows that ranged from 43.7 to 153 cfs (Table 3-15).

The maximum *chlorophyll a* concentration observed at Patterson Point occurred prior to the terms of the Order and was 0.0083 mg/L on 12 May during closed estuary conditions and a flow of 141 cfs (Table 3-16 and Figure 3-32). The maximum value observed during the terms of the Order and was 0.0051 mg/L, which occurred 16 August during open estuary conditions and a flow of 43.7 cfs (Table 3-16 and Figure 3-32). The minimum value at Patterson Point was ND, which occurred fourteen (14) times prior to and during the terms of the Order during open and closed estuary conditions, summer dam removal, and flows that ranged from 44.9 to 219 cfs (Table 3-16).

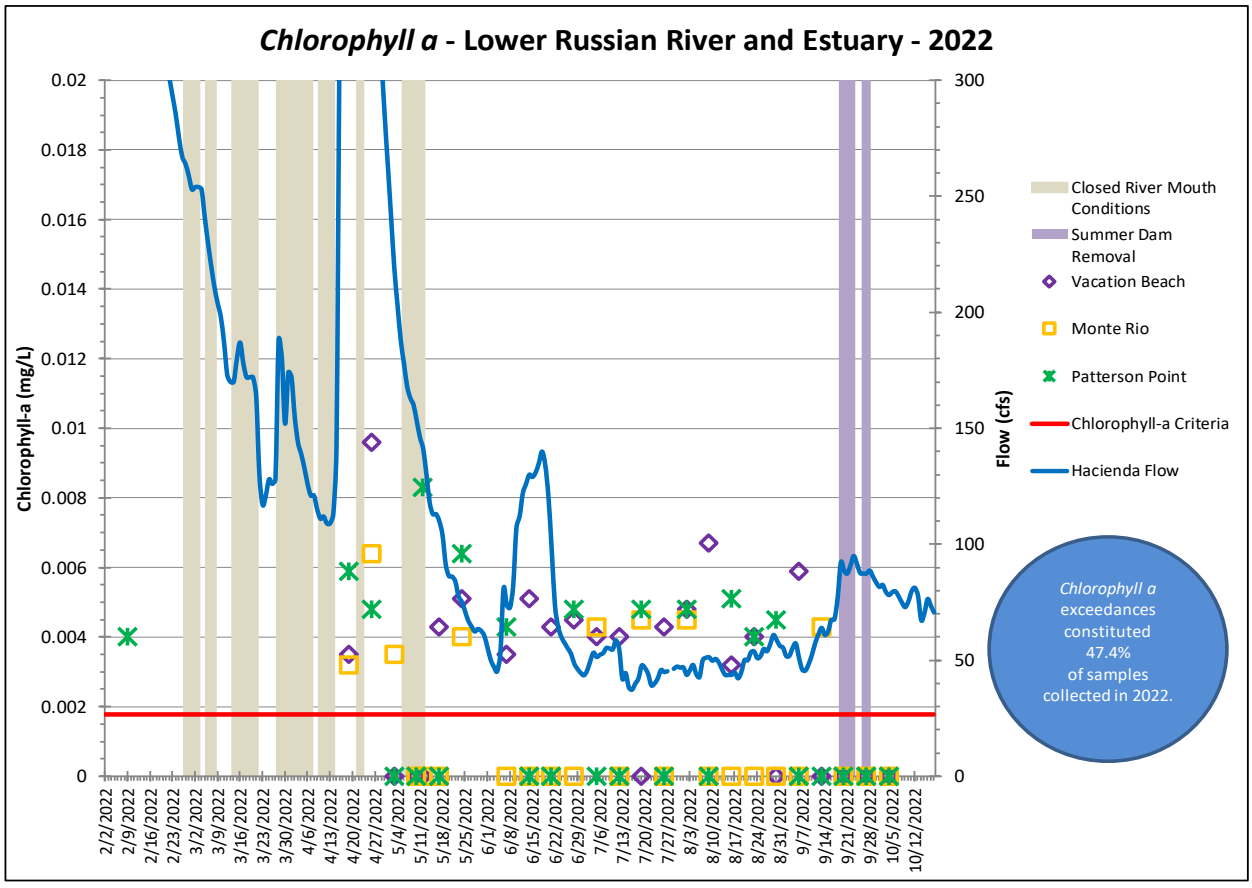

Figure 3-32. *Chlorophyll a* results for the Russian River from Vacation Beach to Patterson Point in 2022.

Table 3-14. 2022 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)
4/19/2022	11:50	15.3	7.9	0.24	ND	ND	0.10	ND	0.24	0.34	**0.056**	0.12	3.03	3.47	160	**3.4**	**0.0035**	424
4/26/2022	9:20	16.7	8.1	ND	ND	ND	0.056	ND	ND	0.056	**0.066**	0.13	3.06	3.62	160	**5.5**	**0.0096**	463
5/3/2022	10:50	17.6	8.0	ND	ND	ND	0.054	ND	ND	0.054	**0.062**	0.13	2.26	2.72	170	1.4	ND	219
5/10/2022	11:10	17.1	7.9	ND	ND	ND	ND	ND	ND	ND	**0.060**	0.12	1.88	2.29	170	2.2	ND	153
5/12/2022	10:50	16.2	7.9	ND	ND	ND	0.058	ND	ND	0.058	**0.053**	0.11	1.77	2.28	180	**2.6**	ND	141
5/17/2022	10:30	20.5	7.8	ND	ND	ND	ND	ND	ND	ND	**0.063**	0.17	1.80	2.34	170	1.6	**0.0043**	110
5/24/2022	10:00	22.7	8.0	ND	ND	ND	0.053	ND	ND	0.053	**0.070**	0.14	1.84	2.13	190	1.5	**0.0051**	75.2
6/7/2022	10:40	22.9	8.1	ND	ND	ND	ND	ND	ND	ND	**0.071**	0.14	1.64	1.94	180	1.9	**0.0035**	73.7
6/14/2022	10:10	22.6	8.0	0.21	ND	ND	ND	ND	0.21	0.21	**0.064**	0.13	1.88	2.31	160	1.7	**0.0051**	130
6/21/2022	10:20	22.3	8.0	ND	ND	ND	ND	ND	ND	ND	**0.036**	0.061	2.17	2.14	160	1.3	**0.0043**	97.4
6/28/2022	9:50	23.8	8.1	ND	ND	ND	ND	ND	0.20	0.20	**0.057**	0.093	1.83	2.15	180	**3.2**	**0.0045**	48.6
7/5/2022	12:20	23.1	7.8	0.28	ND	ND	ND	ND	0.28	0.28	**0.060**	0.11	1.72	2.22	160	1.8	**0.0040**	51.4
7/12/2022	10:50	24.5	8.1	ND	0.11	ND	ND	ND	ND	0.11	**0.044**	0.077	1.98	2.77	140	1.7	**0.0040**	54.8
7/19/2022	10:20	24.4	8.1	0.47	ND	ND	ND	ND	0.47	**0.50**	**0.050**	0.089	2.07	2.56	150	1.9	ND	47.7
7/26/2022	10:50	23.3	8.1	ND	ND	ND	ND	ND	ND	ND	**0.048**	0.076	2.01	2.44	150	1.6	**0.0043**	44.9
8/2/2022	10:10	23.5	7.8	0.24	ND	ND	ND	ND	0.24	0.24	**0.042**	0.078	2.06	2.66	150	2.2	**0.0048**	43.7
8/9/2022	9:40	23.2	7.8	ND	0.10	0.0031	ND	ND	ND	0.1031	**0.045**	0.057	1.97	2.33	150	1.3	**0.0067**	51.3
8/16/2022	9:50	24.0	7.8	ND	ND	ND	ND	ND	ND	ND	**0.044**	0.043	2.04	2.19	140	1.8	**0.0032**	43.7
8/23/2022	9:10	23.7	8.1	ND	ND	ND	ND	ND	ND	ND	**0.042**	0.049	1.86	2.18	150	0.90	**0.0040**	53.8
8/30/2022	10:40	22.6	8.1	ND	ND	ND	0.063	ND	ND	0.063	**0.028**	0.042	1.67	2.07	130	1.2	ND	58.8
9/6/2022	10:40	24.1	8.0	ND	ND	ND	ND	ND	ND	ND	**0.026**	ND	1.62	1.96	140	1.6	**0.0059**	50.8
9/13/2022	9:50	22.3	7.9	ND	ND	0.00068	ND	ND	ND	0.0007	**0.031**	0.039	1.67	2.07	130	1.1	ND	64.0
9/20/2022	9:30	19.6	7.8	ND	ND	0.00065	ND	ND	ND	0.0007	**0.029**	0.034	1.62	2.04	94	0.95	ND	88.6
9/27/2022	9:20	19.6	7.7	ND	ND	0.00012	ND	ND	ND	0.0001	**0.032**	0.030	1.56	1.88	170	**3.4**	ND	87.4
10/4/2022	9:40	19.0	7.8	ND	0.16	0.0038	0.064	ND	ND	0.2278	**0.032**	0.04	1.47	1.75	170	2.2	ND	78.1

* 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 3-15. 2022 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)
4/19/2022	11:10	15.1	7.6	0.26	ND	ND	0.082	ND	0.26	0.34	**0.058**	0.13	2.88	3.67	260	**2.4**	**0.0032**	424
4/26/2022	9:00	16.7	8.0	ND	ND	ND	0.042	ND	ND	0.042	**0.065**	0.13	3.51	3.69	150	**6.0**	**0.0064**	463
5/3/2022	10:20	18.0	8.0	ND	ND	ND	ND	ND	ND	ND	**0.070**	0.15	2.31	2.83	180	1.9	**0.0035**	219
5/10/2022	10:50	17.3	8.0	ND	ND	ND	0.053	ND	ND	0.053	**0.065**	0.15	2.02	2.44	200	1.2	ND	153
5/12/2022	10:20	17.3	7.9	ND	ND	ND	0.061	ND	ND	0.061	**0.059**	0.13	1.87	2.35	180	1.6	ND	141
5/17/2022	10:10	20.4	7.7	ND	ND	ND	0.053	ND	ND	0.053	**0.065**	0.12	1.78	2.26	190	1.4	ND	110
5/24/2022	9:40	22.0	7.9	ND	ND	ND	0.054	ND	ND	0.054	**0.079**	0.17	1.93	2.33	200	1.6	**0.0040**	75.2
6/7/2022	10:10	22.4	7.9	ND	ND	ND	0.055	ND	ND	0.055	**0.068**	0.15	1.61	1.92	190	1.9	ND	73.7
6/14/2022	9:40	23.7	7.7	0.20	ND	ND	ND	ND	0.20	0.20	**0.073**	0.17	1.91	2.34	160	1.8	ND	130
6/21/2022	10:00	22.5	7.8	ND	ND	ND	0.054	ND	ND	0.054	**0.040**	0.077	1.93	2.24	180	0.96	ND	97.4
6/28/2022	9:30	23.2	7.9	ND	ND	ND	ND	ND	ND	ND	**0.063**	0.12	1.77	2.07	200	**2.9**	ND	48.6
7/5/2022	12:00	23.0	7.8	0.28	ND	ND	ND	ND	0.28	0.28	**0.069**	0.13	1.75	2.05	160	1.8	**0.0043**	51.4
7/12/2022	10:30	23.7	7.9	0.25	ND	ND	0.063	ND	0.25	0.31	**0.060**	0.11	1.92	2.62	150	1.9	ND	54.8
7/19/2022	10:00	23.9	8.0	ND	ND	ND	ND	ND	ND	ND	**0.058**	0.11	1.98	2.50	160	**3.2**	**0.0045**	47.7
7/26/2022	10:30	23.1	8.1	ND	ND	ND	ND	ND	ND	ND	**0.055**	0.099	2.03	2.41	150	2.1	ND	44.9
8/2/2022	9:50	23.2	7.8	ND	ND	ND	ND	ND	ND	ND	**0.052**	0.098	2.25	2.73	170	**2.4**	**0.0045**	43.7
8/9/2022	9:20	23.6	7.9	ND	0.14	0.0049	ND	ND	ND	0.1449	**0.055**	0.085	1.96	2.39	160	1.3	ND	51.3
8/16/2022	9:20	23.6	7.8	ND	ND	ND	0.063	ND	ND	0.063	**0.051**	0.071	1.87	2.29	140	1.2	ND	43.7
8/23/2022	8:50	23.5	7.9	ND	ND	ND	ND	ND	ND	ND	**0.049**	0.069	1.88	2.21	160	0.95	ND	53.8
8/30/2022	10:10	22.2	8.1	ND	ND	ND	0.063	ND	ND	0.063	**0.034**	0.059	1.65	2.07	130	1.1	ND	58.8
9/6/2022	10:20	23.7	7.8	ND	ND	ND	ND	ND	ND	ND	**0.033**	0.041	1.68	2.03	140	0.95	ND	50.8
9/13/2022	9:30	21.9	7.8	ND	ND	0.0013	ND	ND	ND	0.0013	**0.033**	0.056	1.78	2.16	150	0.95	**0.0043**	64.0
9/20/2022	9:10	19.8	7.6	ND	ND	0.00058	ND	ND	ND	0.0006	**0.031**	0.034	1.72	2.11	120	1.0	ND	88.6
9/27/2022	9:10	19.8	7.7	ND	ND	0.00083	ND	ND	ND	0.0008	**0.028**	0.030	1.57	1.89	170	2.3	ND	87.4
10/4/2022	9:10	18.9	7.7	ND	0.18	0.0030	0.063	ND	ND	0.0030	**0.036**	0.036	1.67	1.79	160	1.6	ND	78.1

* 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 3-16. 2022 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)
2/9/2022	9:40	11.2	7.6	0.29	ND	ND	0.17	ND	0.29	**0.46**	0.017	ND	1.71	2.12	190	0.93	**0.0040**	439
4/19/2022	10:30	15.0	7.5	0.23	ND	ND	0.095	ND	0.23	0.32	**0.058**	0.14	3.07	3.21	170	**3.5**	**0.0059**	424
4/26/2022	8:20	17.0	8.1	ND	ND	ND	0.041	ND	ND	0.041	**0.064**	0.12	3.23	3.75	150	**4.4**	**0.0048**	463
5/3/2022	9:50	17.7	7.8	ND	ND	ND	ND	ND	ND	ND	**0.066**	0.15	2.20	2.85	180	1.6	ND	219
5/10/2022	10:20	17.0	7.9	ND	ND	ND	0.072	ND	ND	0.072	**0.068**	0.16	2.16	2.62	170	1.1	ND	153
5/12/2022	9:50	17.7	8.0	ND	ND	ND	0.095	ND	ND	0.095	**0.064**	0.14	1.91	2.47	170	1.2	**0.0083**	141
5/17/2022	9:40	20.1	7.8	ND	ND	ND	0.053	ND	ND	0.053	**0.061**	0.12	1.75	2.20	180	2.0	ND	110
5/24/2022	8:40	22.1	7.9	ND	ND	ND	0.054	ND	ND	0.054	**0.078**	0.18	1.94	2.30	180	1.2	**0.0064**	75.2
6/7/2022	9:40	22.3	7.8	ND	ND	ND	0.053	ND	ND	0.053	**0.070**	0.15	1.58	1.89	190	1.5	**0.0043**	73.7
6/14/2022	9:20	23.2	7.6	0.24	ND	ND	ND	ND	0.24	0.24	**0.080**	0.18	2.06	2.48	170	1.3	ND	130
6/21/2022	9:30	22.2	7.9	0.20	ND	ND	0.053	ND	0.20	0.253	**0.045**	0.081	1.94	2.12	150	0.93	ND	97.4
6/28/2022	9:10	23.3	7.9	0.27	ND	ND	ND	ND	0.27	0.30	**0.062**	0.11	1.73	2.07	170	**2.5**	**0.0048**	48.6
7/5/2022	11:40	22.8	8.1	0.30	ND	ND	ND	ND	0.30	0.30	**0.068**	0.14	1.70	2.09	160	1.4	ND	51.4
7/12/2022	10:00	23.9	7.9	0.30	ND	ND	ND	ND	0.30	0.30	**0.060**	0.12	1.99	2.79	150	2.0	ND	54.8
7/19/2022	9:20	23.7	8.0	ND	ND	ND	ND	ND	ND	ND	**0.059**	0.12	2.24	2.56	150	**4.2**	**0.0048**	47.7
7/26/2022	10:00	22.9	8.0	ND	ND	ND	ND	ND	ND	ND	**0.056**	0.099	1.99	2.52	160	1.6	ND	44.9
8/2/2022	9:20	23.1	7.9	ND	ND	ND	ND	ND	ND	0.24	**0.056**	0.11	2.11	2.58	180	2.1	**0.0048**	43.7
8/9/2022	8:50	23.2	7.8	ND	0.12	0.0038	ND	ND	ND	0.1031	**0.060**	0.093	2.02	2.43	160	1.5	ND	51.3
8/16/2022	8:40	23.5	7.8	ND	ND	ND	ND	ND	ND	ND	**0.056**	0.079	1.91	2.24	140	1.2	**0.0051**	43.7
8/23/2022	8:20	23.3	8.1	0.21	ND	ND	ND	ND	0.21	0.21	**0.048**	0.077	1.90	2.24	140	1.8	**0.0040**	53.8
8/30/2022	9:40	22.3	7.8	ND	ND	ND	0.065	ND	ND	0.065	**0.041**	0.071	1.68	2.07	140	1.0	**0.0045**	58.8
9/6/2022	9:50	23.5	7.8	ND	ND	ND	ND	ND	ND	ND	**0.036**	0.053	1.75	2.09	150	1.1	ND	50.8
9/13/2022	9:10	21.8	7.5	ND	ND	0.00074	ND	ND	ND	0.0007	**0.037**	0.064	1.64	2.01	150	1.2	ND	64.0
9/20/2022	8:40	19.9	7.6	ND	ND	0.00014	ND	ND	ND	0.0001	**0.032**	0.038	1.71	2.17	140	0.85	ND	88.6
9/27/2022	8:50	19.9	7.6	0.40	ND	0.00023	ND	ND	0.40	**0.40**	**0.025**	0.034	1.63	2.06	170	1.5	ND	87.4
10/4/2022	8:40	19.1	7.7	ND	0.20	0.0033	0.066	ND	ND	0.2693	**0.029**	0.040	1.54	1.80	160	1.2	ND	78.1

* 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

3.3 Discussion and Observations

The mainstem Russian River experienced less rainfall and lower flows in 2022 compared to Normal Water Year flow rates. These lower flows from a dry winter and spring resulted in a Dry Spring Water Year designation that allowed D1610 flows to be reduced to the Dry Spring Water Year minimum flow rates of 75 cfs in the upper Russian River and 85 cfs in the lower Russian River. This Dry Spring 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 Spring Water Year requirements to preserve water storage in Lake Mendocino.

Monitoring conducted for the TUC Order was similar (methods, locations) to monitoring conducted prior years when TUC Orders were issued in response to dry watershed conditions and low reservoir storage levels, as well as to comply with Biological Opinion proposed mainstem flows. Given that 2022 was a dry year beginning in January, monitoring was conducted prior to the terms of the TUC Order taking effect in June to provide additional context on conditions in the watershed prior to the term of the Order, which was active from 17 June through 14 December.

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 2022 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 2022; a 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 3-33).

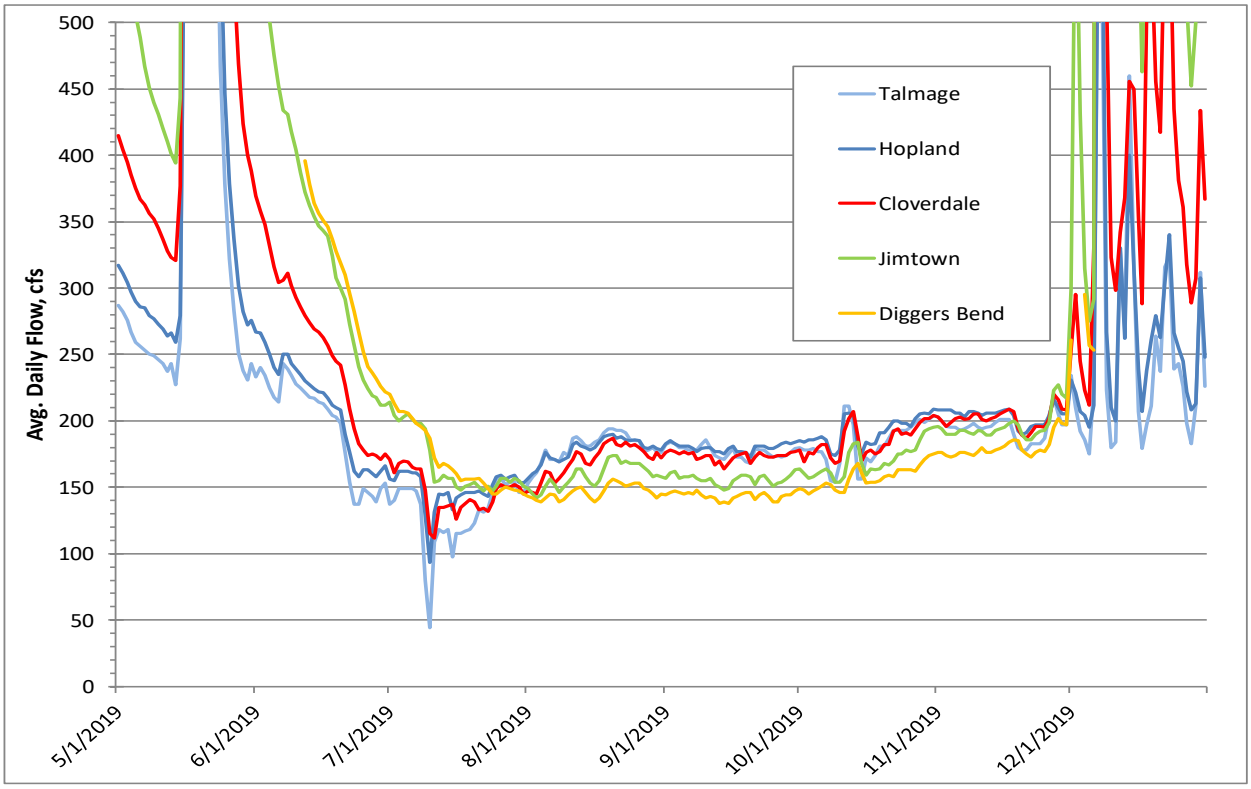

Figure 3-33. 2019 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Whereas, 2022 daily average flows in the upper river between Talmage and Diggers Bend generally ranged between 25 and 75 cfs during the months of July through October (Figure 3-34).

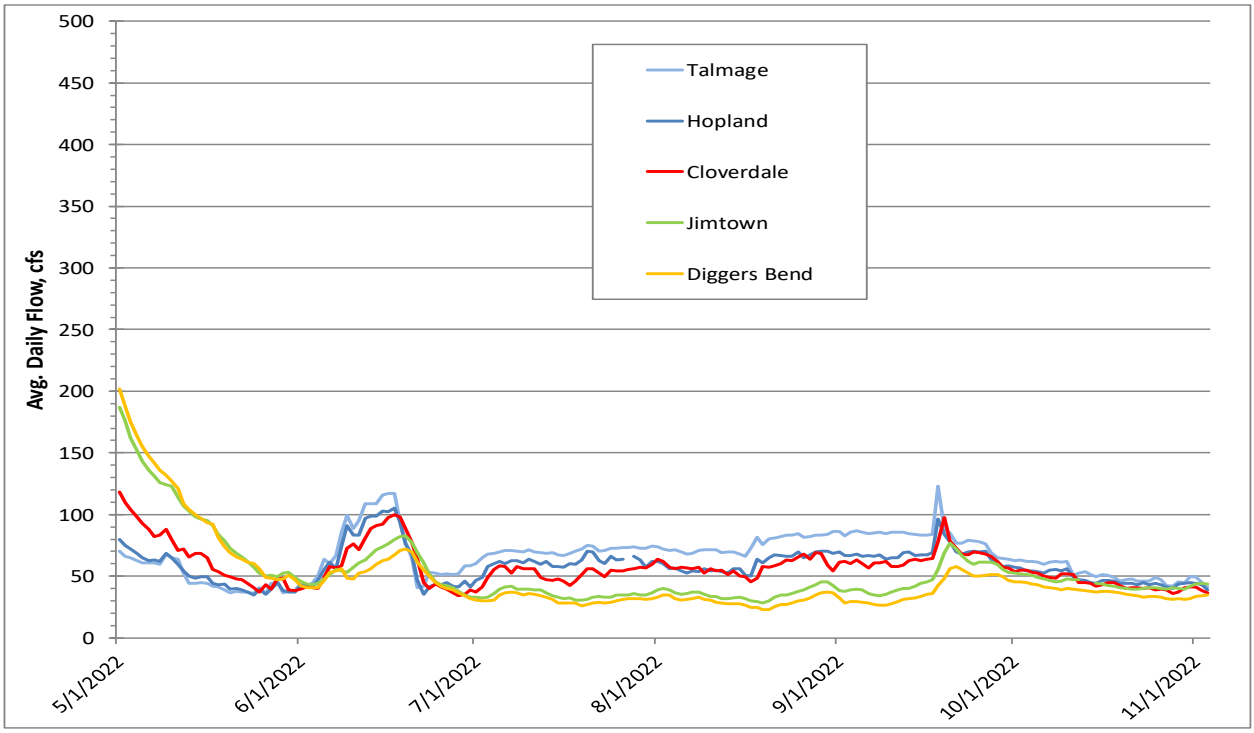

Figure 3-34. 2022 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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 2022 (Figure 3-35).

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

Summertime base flows in the lower river at Hacienda remained above 150 cfs in 2019, whereas summertime base flows in 2022 were generally below 75 cfs (Figure 3-35).

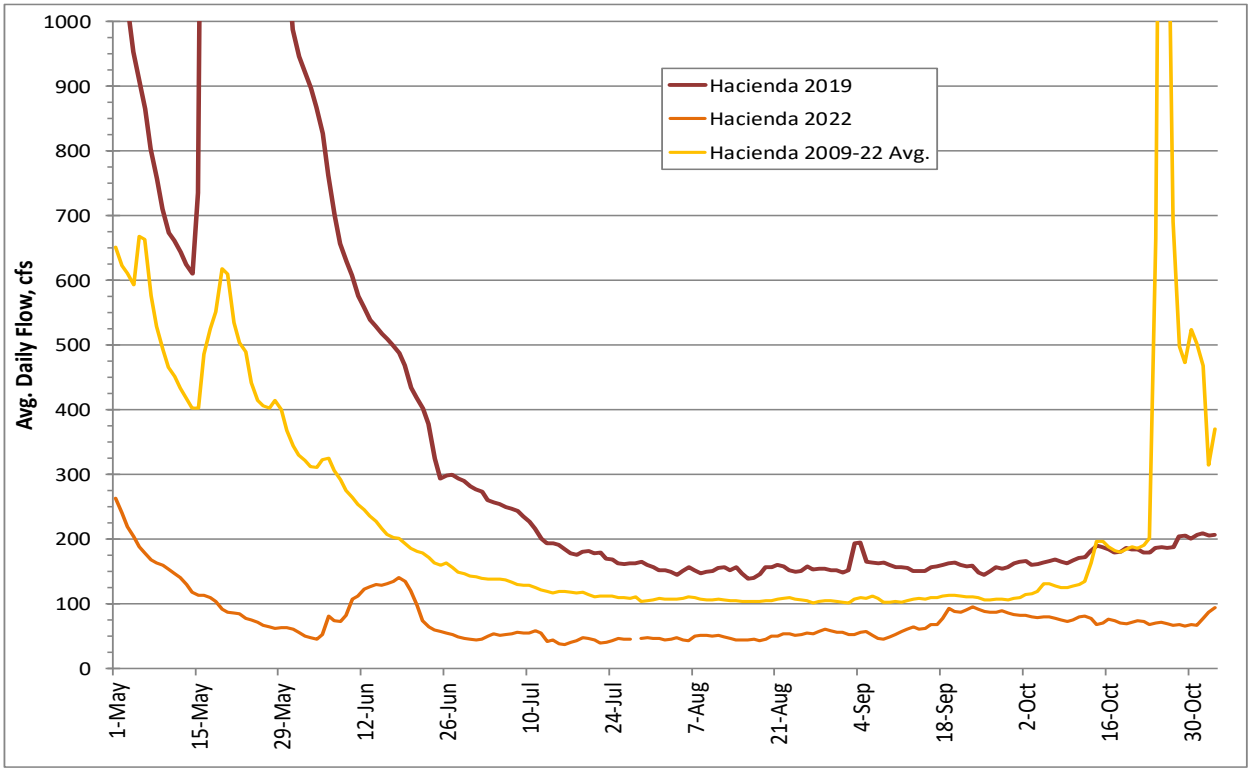

Figure 3-35. Comparison of 2019, 2022 and 2009-2022 average daily flows in the Lower Russian River as measured at USGS Hacienda gage in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Overall, observed exceedances of EPA and CDPH criteria in the upper and lower river in 2022 were generally consistent with, and in some cases less frequent, than in 2019. Included below is a brief discussion and comparison of some of the data collected in 2019 and 2022 that demonstrate that lower flows in 2022 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 2022 with eight (8) total coliform exceedances out of 152 total samples collected (5.3%). Similarly, in 2022 Sonoma County DHS reported eight (8) *E. coli* exceedances out of 152 total samples collected (5.3%) 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 2022, Sonoma Water reported one (1) total coliforms exceedance out of 75 total samples collected (1.3%) and one (1) *E. coli* exceedance out of 75 total samples collected (1.3%) at the three lower river stations.

DHS did not conduct cyanotoxin monitoring at the ten beach monitoring stations in 2019 or 2022 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 invertebrate grazers as well as rearrangement of the littoral zone during high storm flows have been observed to affect the timing and composition of cyanoHABs.

As such, Sonoma Water staff would recommend continued coordination and comprehensive monitoring across agencies (including the North Coast Regional Water Quality Control Board and DHS) to assess river conditions and specifically those conditions that may contribute to an elevated potential for cyanoHAB outbreaks. These conditions include but are not limited to nutrient availability, invertebrate grazing, water clarity, temperature, the timing and intensity of storm events, streamflow, and the potential for changing hydrology and bed scour to influence development of algal biomass. Sonoma Water staff would continue to promote the preservation of the cold water pool in Lake Mendocino through responsible reservoir management and river flow operations.

Total nitrogen exceedances and concentrations at the upper river stations were fairly consistent from 2019 to 2022, with 2019 having ten (10) exceedances of 49 total samples (20.4%) and 2022 having twenty-one (21) exceedances of 90 total samples (23.3%). Hopland was also observed to have the most total nitrogen exceedances of the four upper river stations in 2019 and in 2022.

Total nitrogen exceedances in 2019 and 2022 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 2022 experiencing three (3) exceedances of 76 samples (4.0%).

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

out of 16 samples collected (25%). Total phosphorus exceedances and concentrations at the three lower river stations were consistently high in 2019 and 2022, with values typically declining in September and October during both years. These exceedances in both 2019 and 2022 continue a pattern of chronic elevated total phosphorus in the lower river area.

Turbidity values in the upper river were significantly lower in 2022 than in 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 2022, Hopland only had six (6) exceedances of 16 samples (37.5%), with most values below 3 NTU and a maximum of 9.5 NTU. Cloverdale also exceeded the criteria through the entire 2019 season (7 of 7 or 100%) with most values above 5 NTU and a maximum value of 15 NTU. Whereas, Cloverdale only experienced one (1) exceedance out of 16 samples collected (6.3%) in 2022, with most values below 2 NTU and a maximum value of 3.6 NTU. Jimtown had six (6) exceedances of 12 samples collected (50%) and a maximum value of 6.6 NTU in 2019, but only one (1) exceedance of 16 samples collected (6.3%) and a maximum value of 2.5 NTU in 2022. Syar had 14 exceedances of 18 samples collected (77.8%) with a maximum value of 30 NTU in 2019, but only one (1) exceedance of 16 samples collected (6.3%) and a maximum value of 2.8 NTU in 2022.

Turbidity values were significantly lower at Vacation Beach, Monte Rio and Patterson Point in 2022 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 five (5) exceedances of 25 samples collected (20%) in 2022. Monte Rio had nine (9) exceedances of 25 samples collected (36%) in 2019 compared with five (5) exceedances of 25 samples collected (20%) in 2021. Patterson Point had eleven (11) exceedances of 25 samples collected (44%) in 2019 compared with four (4) exceedances of 25 samples collected (25%) in 2022. 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. Similarly, exceedances in 2022 occurred at all three stations at the beginning of the monitoring season during elevated storm flows, as well as periodically through the season with flows ranging from 43.7 to 141 cfs.

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

Again, a comparison of *chlorophyll a* exceedances between 2019 and 2022 is not possible due to the higher lab MDL for *chlorophyll a* concentrations in 2022. However, maximum *chlorophyll a* concentrations were somewhat similar in the lower river in 2022 compared to 2019, even with improved water clarity. In 2019, Vacation Beach had less exceedances (12 of 25 or 48%) and maximum value of 0.0069 mg/L, compared with 2022 (16 of 25 or 64%) and a maximum value of 0.0096 mg/L. However, Monte Rio had more exceedances in 2019 (13 of 25 or 52%) and a maximum value of 0.11

mg/L, compared with 2022 (8 of 25 or 32%) and a maximum value of 0.0064 mg/L. Finally, Patterson Point had 11 of 25 exceedances (44%) in 2019 with a maximum value of 0.0064 mg/L, compared with 12 of 26 exceedances (46.2%) and a maximum value of 0.0083 mg/L in 2022.

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 in 2022.

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

4.0 Additional Monitoring

4.1 Sonoma Water and USGS Permanent and Seasonal Datasondes

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

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

The data collected by the sondes described above are evaluated in Section 4.2 in response to the terms of the SWRCB TUC Order to evaluate whether and to what extent the reduced flows authorized by the Order caused any impacts to water quality or availability of aquatic habitat for salmonids. In addition, the 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. 2022 Sonoma Water and USGS Russian River permanent and seasonal datasonde monitoring stations.

4.2 Aquatic Habitat for Salmonids

4.2.1 Introduction

In Term 7 of the Temporary Urgency Change Order (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. 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 although there is evidence that coho have spawned in the Maacama system in recent years. Therefore, water quality data from only the Hacienda and Digger Bend sites will be summarized for coho salmon in this report.

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) suggest 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 steelhead in this report.

Chinook Timing and Distribution

Based on video monitoring at Sonoma Water's Mirabel inflatable dam (river Km 39.67), adult Chinook are typically observed in the Russian River before coho and steelhead. Chinook enter the Russian River as early as September and migration is complete by early February with the majority of migration occurring prior to mid-December in most years. 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 Chinook salmon 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 Sonoma Water operated data sondes 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, Cloverdale, 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) and in the east fork Russian River 0.5 km downstream of Coyote Valley Dam, near Ukiah (Figure 4-1 and Table 4-1). These sondes were operated by Sonoma Water. Water quality conditions at these sites were compared to literature-based thresholds for temperature and DO (Tables 4-2 through Table 4-5).

Figure 4-1. The river Km for sites on the Russian River where continuous temperature and dissolved oxygen data was collected by USGS or Sonoma Water in 2022 and used in this report.

Table 4-1. The name and river Km for sites on the Russian River where continuous temperature and dissolved oxygen data was collected by USGS or Sonoma Water in 2022.

Tributary	River Km	Site
East Fork Russian River	1.35	Downstream of Coyote Valley Dam
Russian River	136.49	USGS 11462500 Russian River near Hopland
	120.02	Pieta Creek confluence
	114.27	USGS 11463000 Russian River near Cloverdale
	77.81	USGS 11463682 Russian River at Jimtown
	61.36	USGS 11463980 Russian River at Digger Bend
	34.77	USGS 11467000 Russian River at Hacienda Bridge

Table 4-2. 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 4-3. 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 4-4. 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 4-5. 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	>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 we compared count data (when available) to water quality information only where fish would either pass a water quality station before being detected at a particular counting station. For instance, because most steelhead rearing habitat in the mainstem Russian River occurs upstream of Hopland, this report presents the water quality data from the USGS Hopland gaging station when analyzing temperature- and DO-related impacts to juvenile steelhead. Salmonid smolts of all three species moving downstream out of Dry Creek and the upper Russian River pass our downstream migrant trap on the Russian River at Mirabel then pass the Hacienda USGS stream gage before entering the ocean. Therefore, we paired salmonid smolt data from the Russian River downstream migrant trap to Hacienda water quality data to describe the conditions these fish likely experienced as they moved downstream through the lower Russian River. This report summarizes data from when the Order went into effect on June 17, 2022, to October 31, 2022.

4.2.4 Results

Flow

The TUCO went into effect on June 17, 2022. From June 17 to October 31, 2022, the Russian River was generally controlled by reservoir releases and not strongly influenced by tributary in-flow (Figure 4-2).

Temperature

Adult Salmonid Migration

The underwater video camera at the Mirabel dam was installed on September 1, 2022. Video was reviewed and daily counts of adult salmonids were summarized. In total 105 adult chinook and 6 adult coho were observed on the Mirabel video camera between September 1 and October 31, 2022.

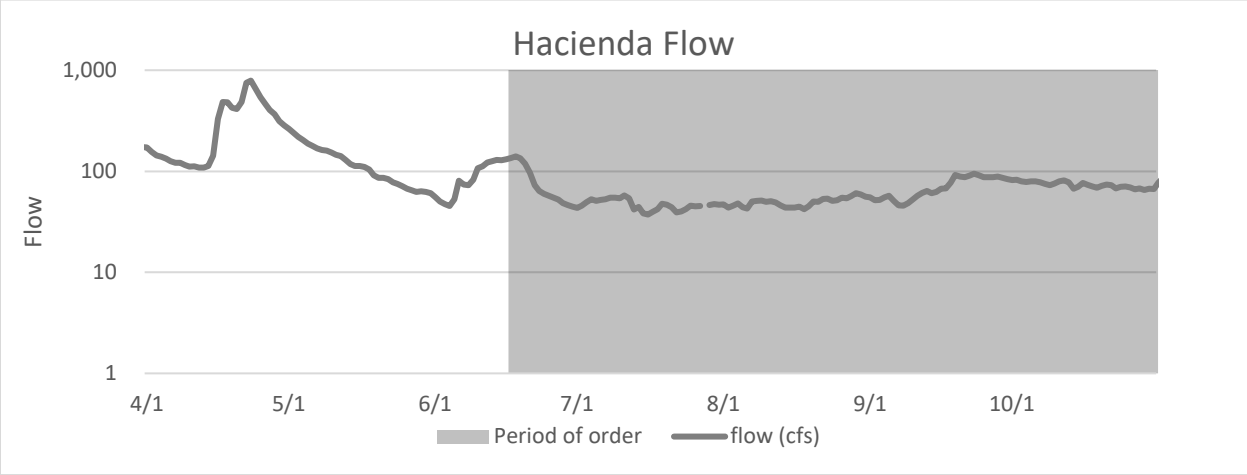

Figure 4-2. Flow in cubic feet per second (cfs) in the Russian River at the U.S. Geological Survey Hacienda stream gage (USGS gage number 11467000) from June 17 to October 31, 2022. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022.

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 4-2 and Figure 4-3). 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, Jimtown, the confluence with Pieta creek and Hopland (Figures 4-3 through 4-8).

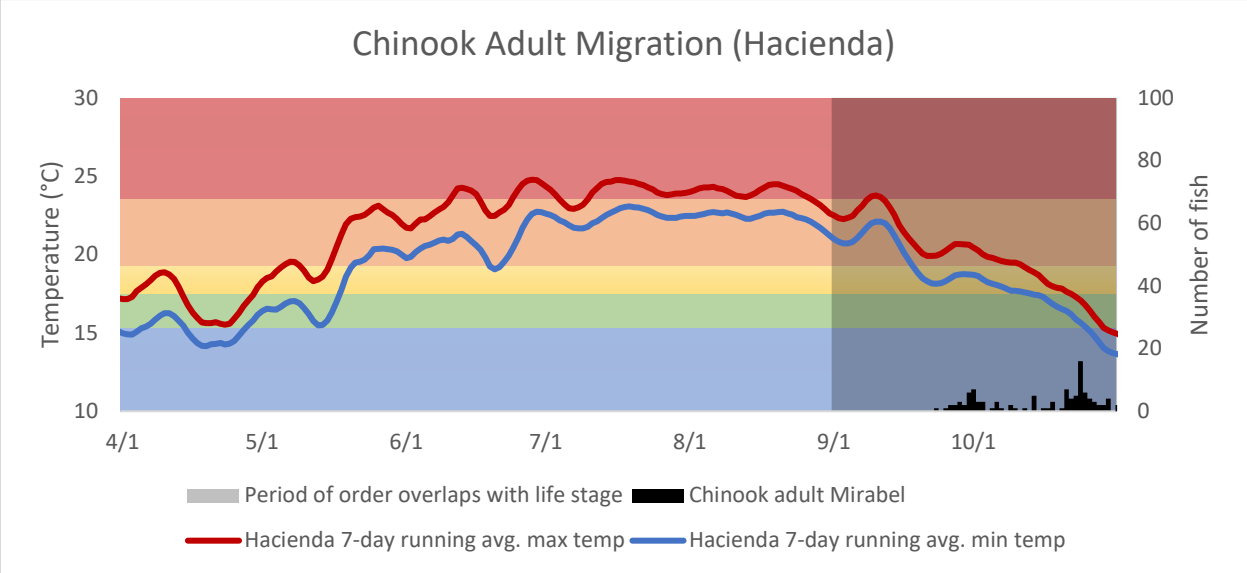

Figure 4-3. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) from April 1 to October 31, 2022, and number of adult Chinook observed on the Mirabel video camera. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult Chinook based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022 that overlaps with this species and life stage being assessed.

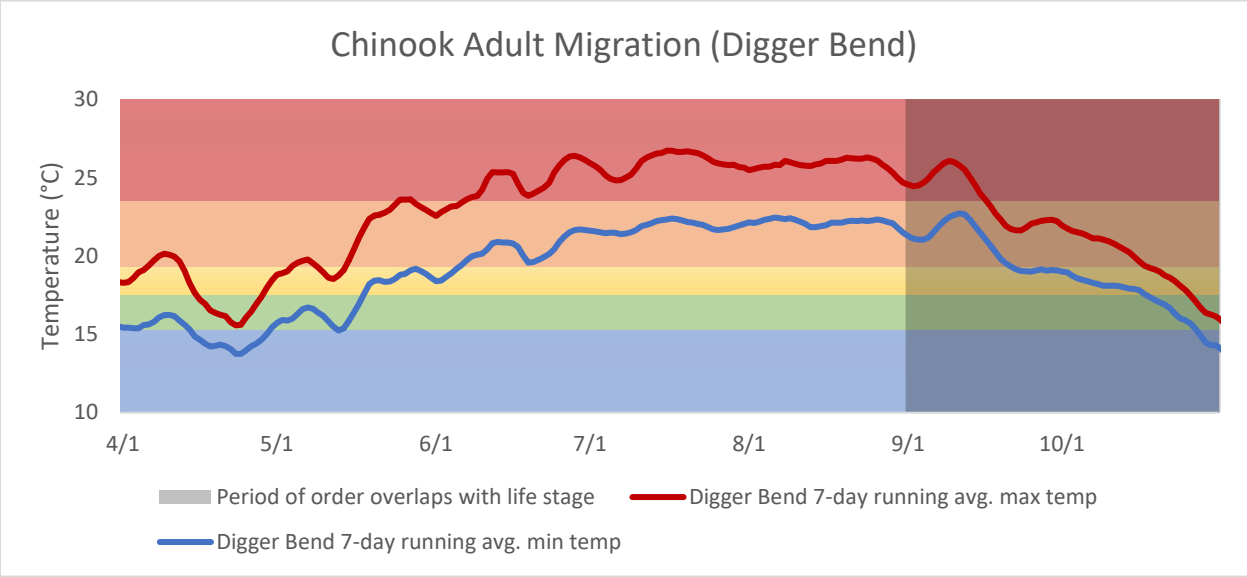

Figure 4-4. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022 that overlaps with this species and life stage being assessed.

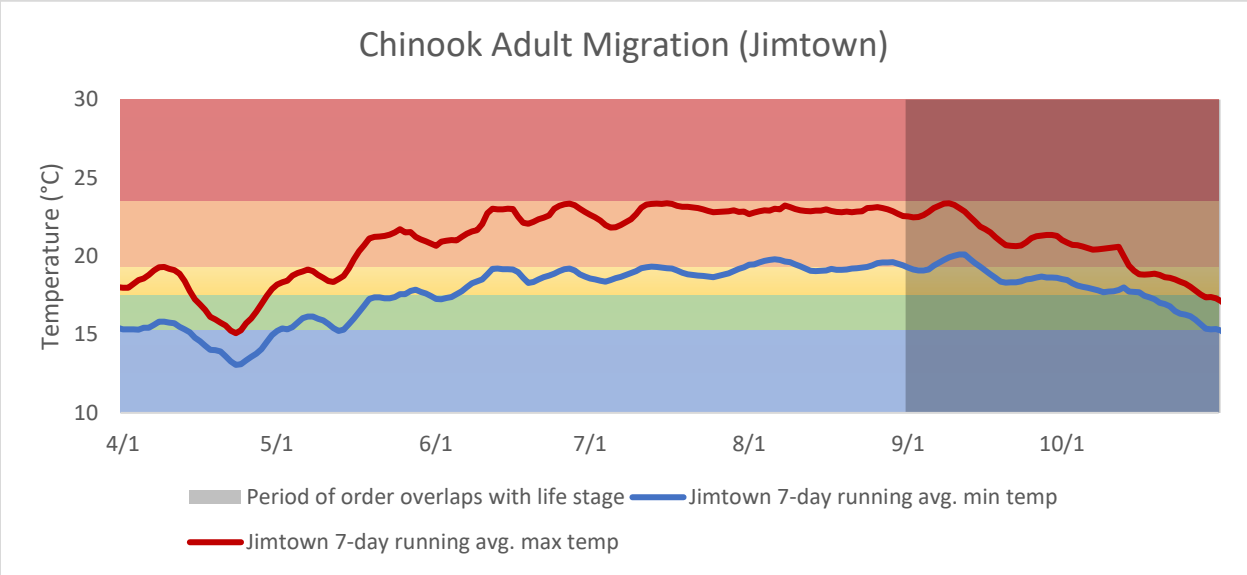

Figure 4-5. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022 that overlaps with this species and life stage being assessed.

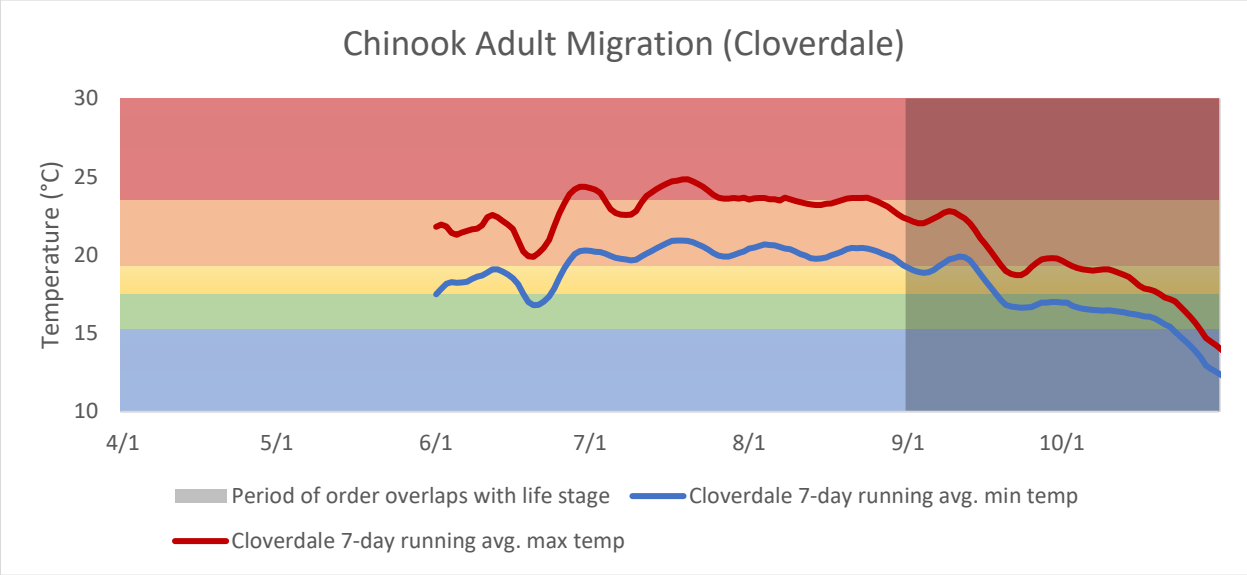

Figure 4-6. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Cloverdale (USGS gage number 11463000) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022 that overlaps with this species and life stage being assessed.

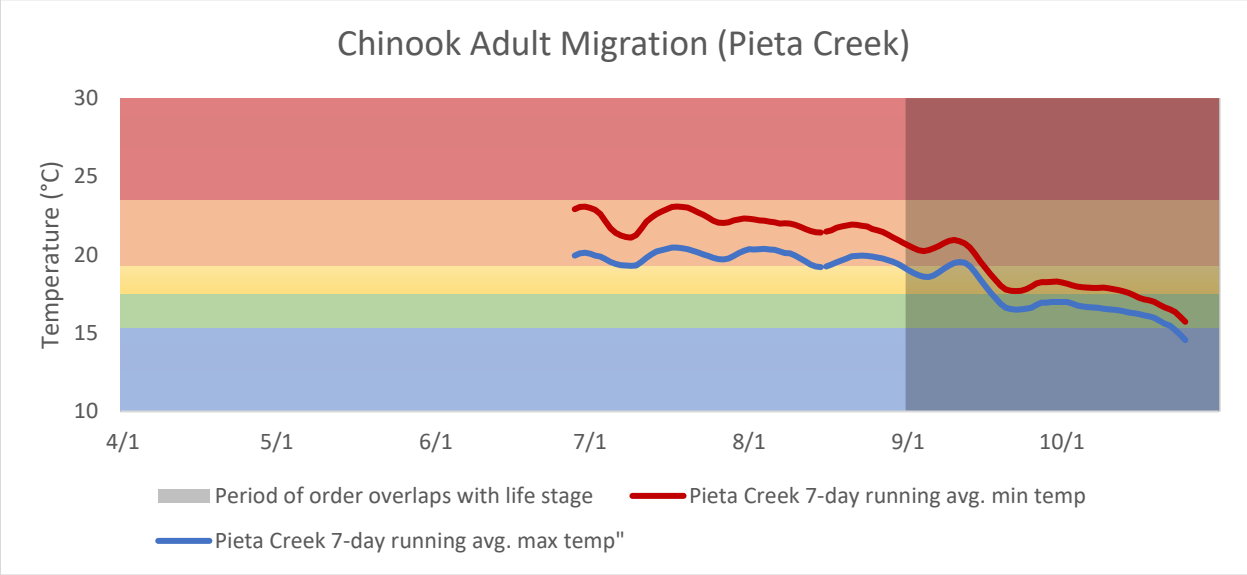

Figure 4-7. The 7-day running average of the minimum and maximum water temperatures collected in the mainstem Russian River at the confluence with Pieta Creek from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022 that overlaps with this species and life stage being assessed.

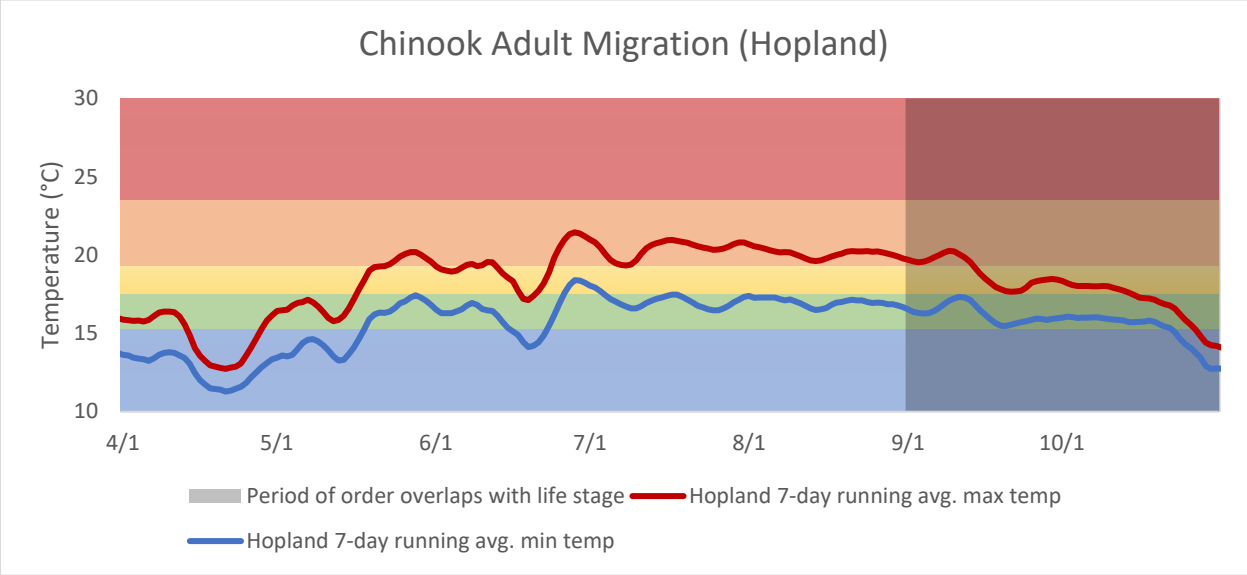

Figure 4-8. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) from April 1 to October 31, 2022,shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022 that overlaps with this species and life stage being assessed.

Water temperature in the east fork Russian River downstream of Coyote Valley Dam ranged from optimal to stressful during the Chinook migration period (Figure 4-9). The warmer water temperature in the east fork Russian River in late October is related to releases from Coyote Valley Dam and temperature conditions in Lake Mendocino.

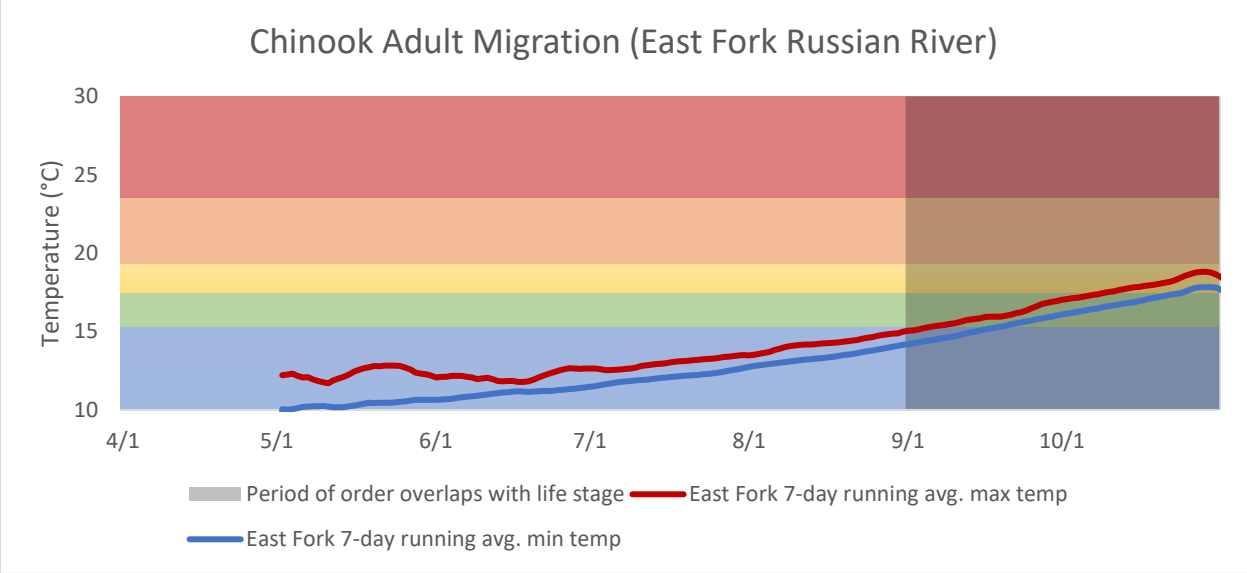

Figure 4-9. The 7-day running average of the minimum and maximum water temperatures collected in the east fork of the Russian River 0.5 km downstream of Coyote Valley Dam from April 1 to October 31, 2022. Shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022 that overlaps with this species and life stage being assessed.

Coho

The coho adult migration period typically begins in November. Temperature for adult coho were generally favorable during the time period that adult coho migrate upstream. Adult coho temperature suitability criteria is displayed with water temperature data collected up to October 31, 2022, for this report (Figures 4-10 and 4-11). However, because adult coho typically migrate after November 1, it is recommended that data collected after November 1 be used for interpreting the temperature conditions that adult coho experienced in 2022.

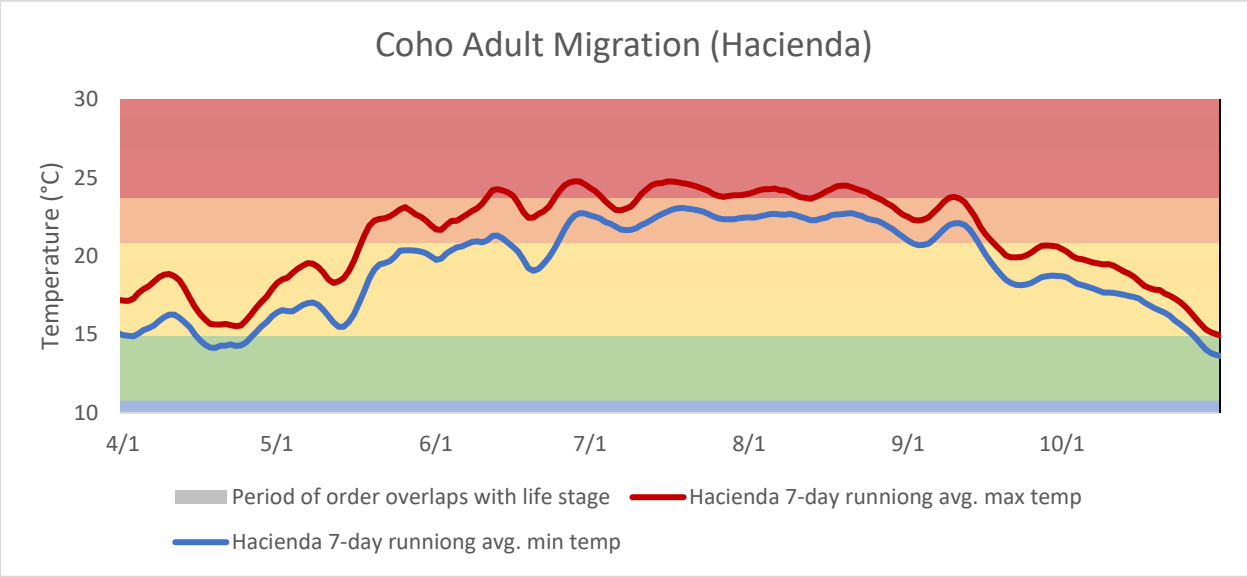

Figure 4-10. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) from April 1 to October 31, 2022. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult coho based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

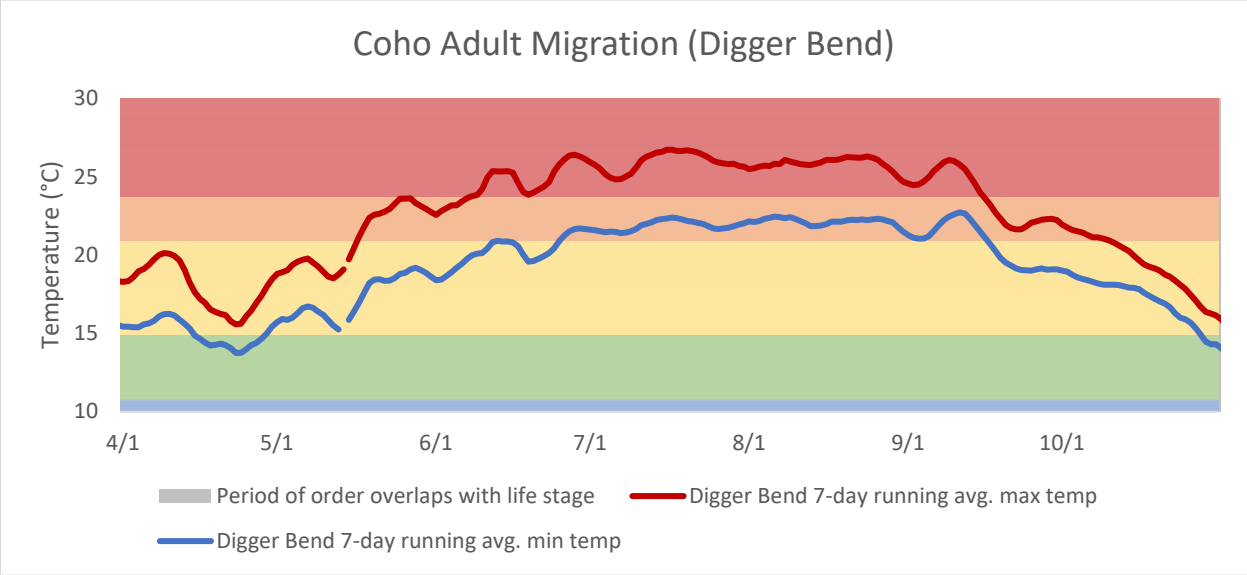

Figure 4-11. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for coho adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

Steelhead

The adult steelhead migration period typically begins in December. In most years water temperature for adult steelhead is favorable during the time period that steelhead adults migrate upstream. Steelhead adult temperature suitability criteria is displayed with water temperature data collected up to October 31, 2022, for this report (Figures 4-12 through 4-18). Because adult steelhead typically migrate after December 1, it is recommended that data collected after December 1, be used for interpreting the temperature conditions that adult steelhead experienced in 2022.

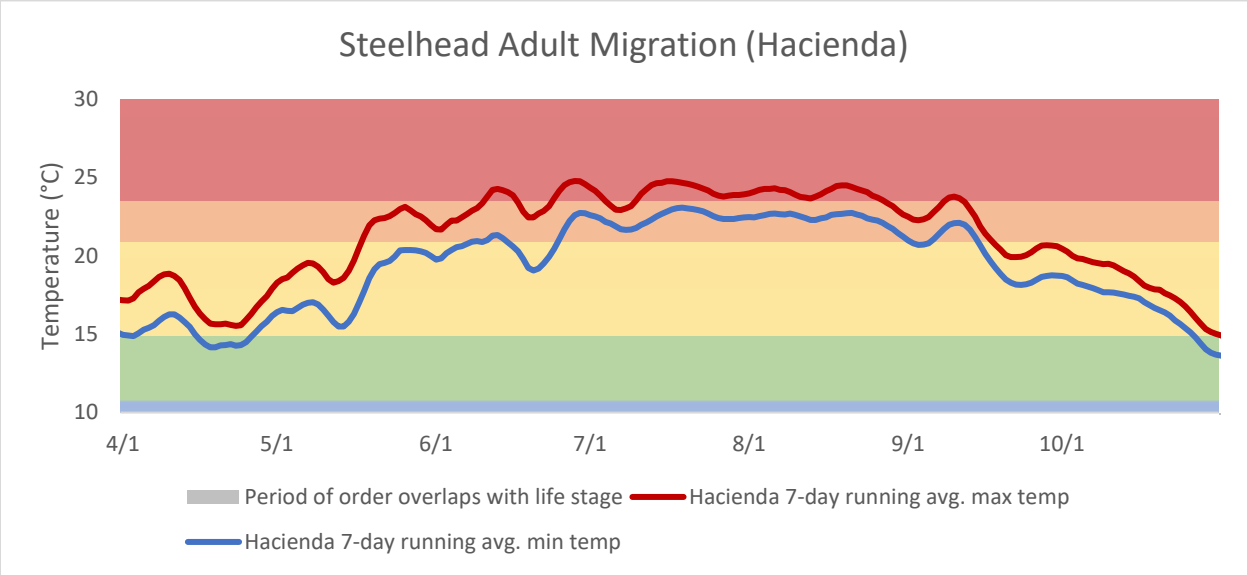

Figure 4-12. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) from April 1 to October 31, 2022. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult steelhead based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

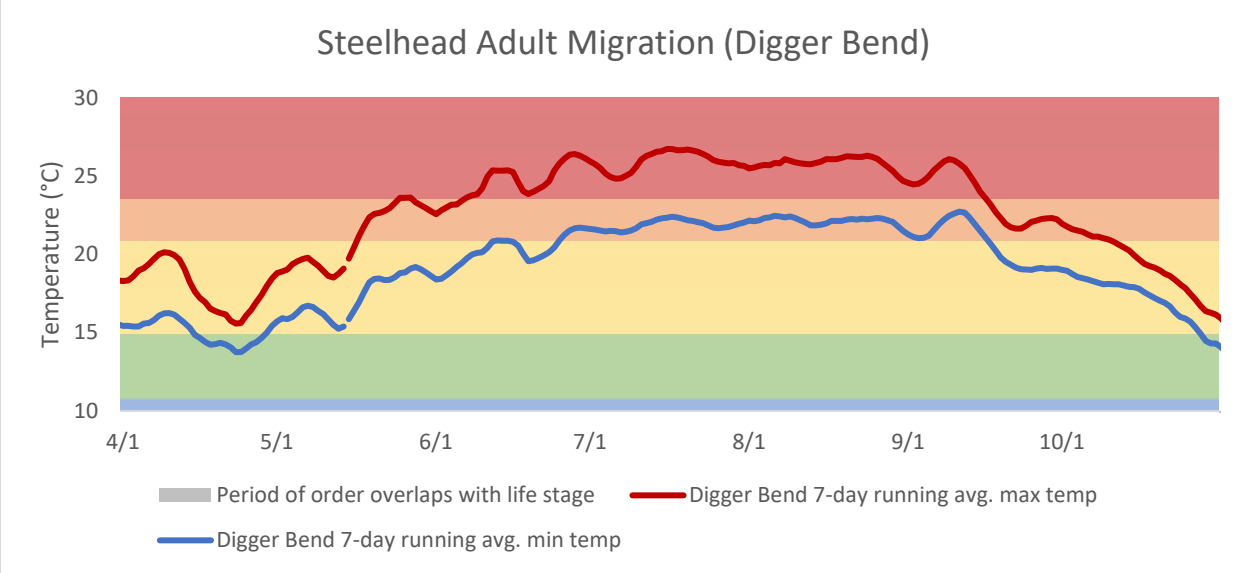

Figure 4-13. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

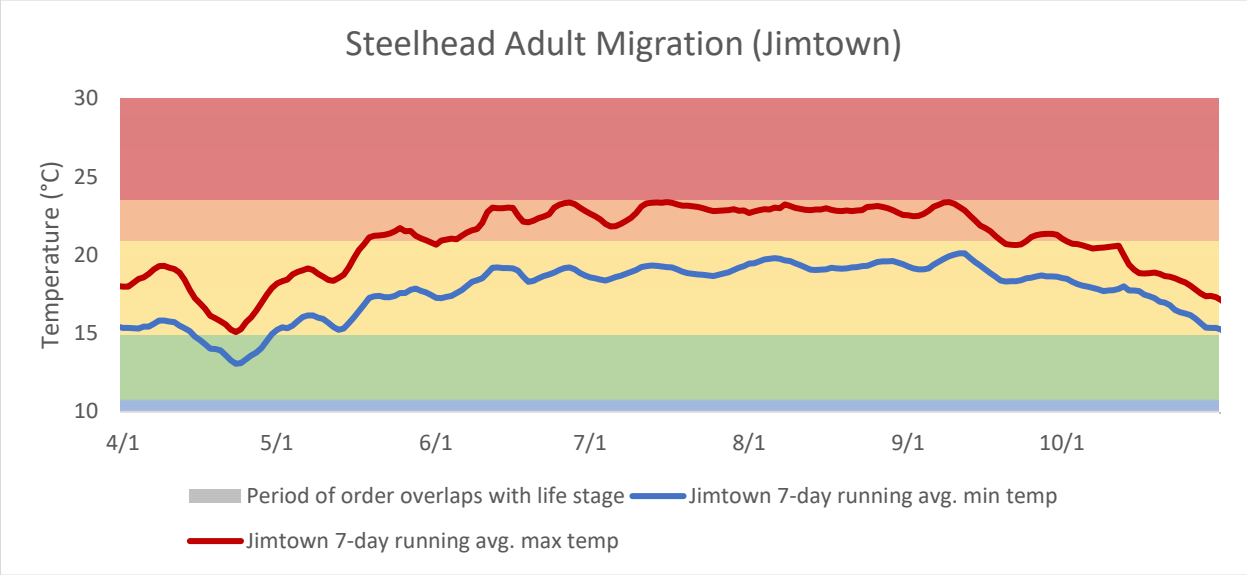

Figure 4-14. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

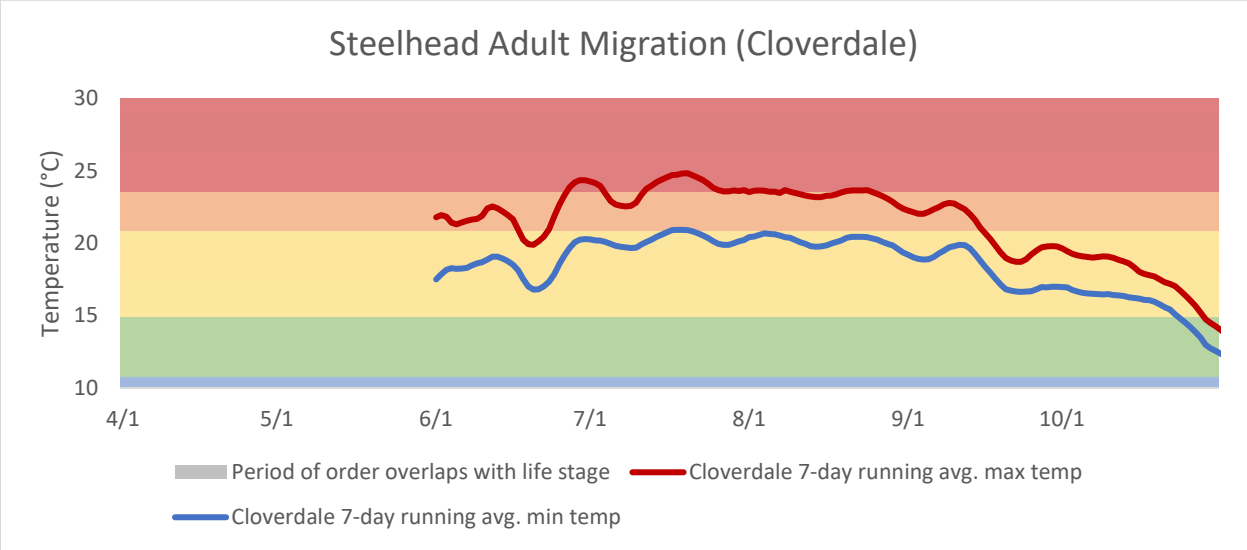

Figure 4-15. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Cloverdale (11463000) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

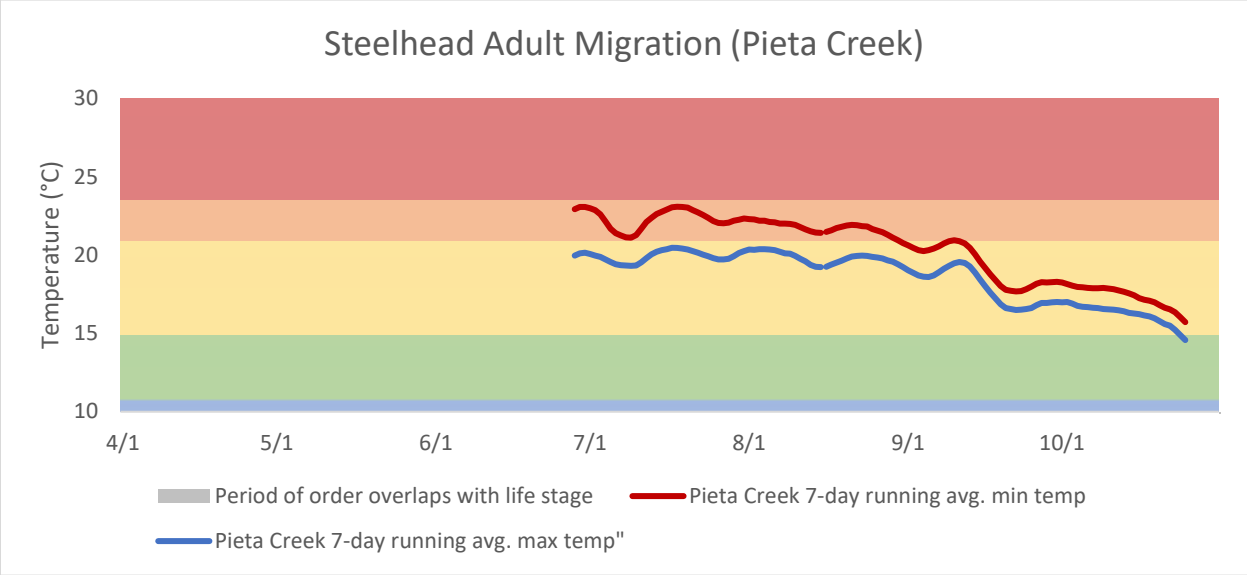

Figure 4-16. The 7-day running average of the minimum and maximum water temperatures collected in the mainstem Russian River at the confluence with Pieta Creek from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

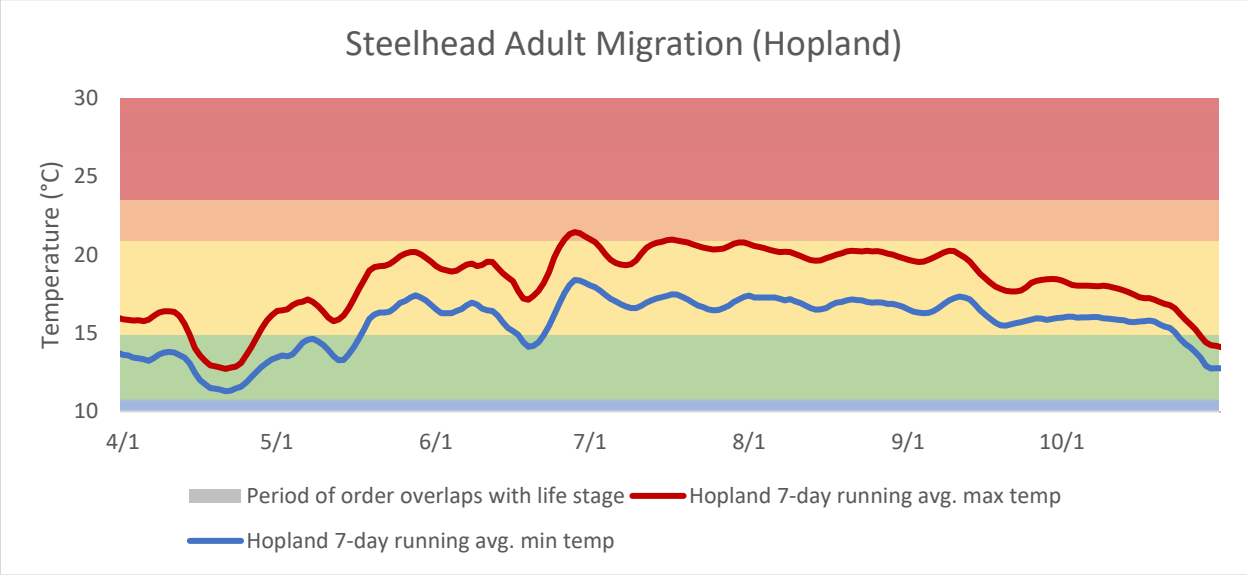

Figure 4-17. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

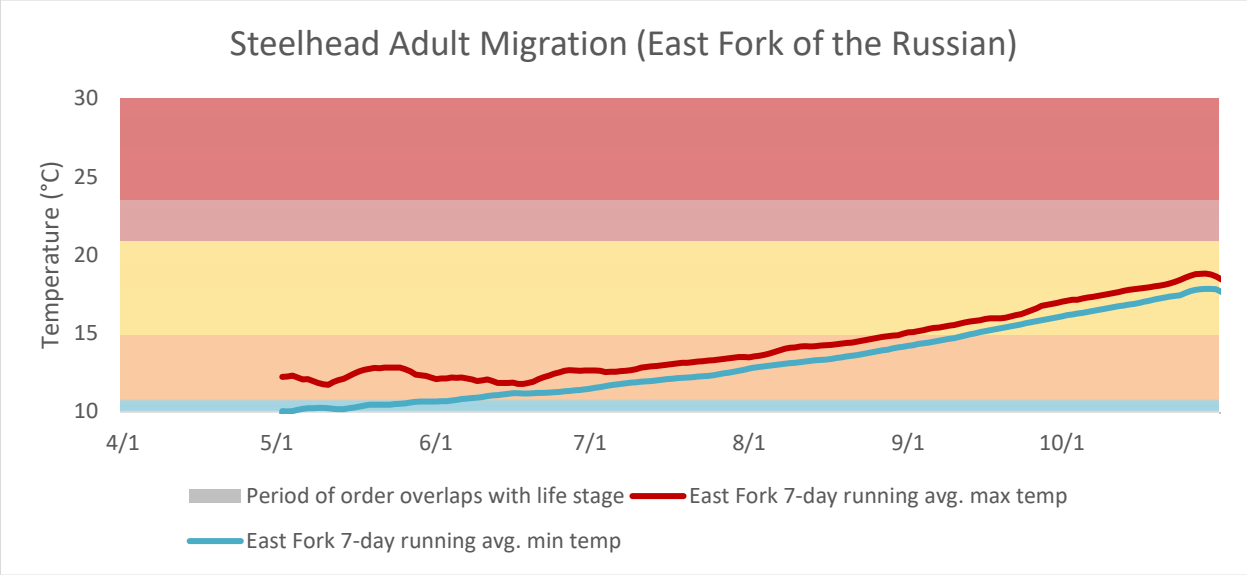

Figure 4-18. The 7-day running average of the minimum and maximum water temperatures collected in the East fork of the Russian River 0.5 km downstream of Coyote Valley Dam from April 1 to October 31, 2022. Shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead adult migration based on Table 4-1. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

Salmonid Rearing

In the Russian River basin much of the salmonid rearing habitat is in tributaries to the Russian River including Dry Creek, but Chinook and steelhead rear in the mainstem Russian River as well. Chinook emerge from redds constructed in the upper Russian River in the early spring and begin rearing in the shallow portions of the stream margins. In the mainstem Russian River, Chinook finish rearing in the early spring when water temperatures are still relatively cool. Because juvenile Chinook salmon may be found rearing near any of the Russian River water quality monitoring sites, water temperatures from all Russian River monitoring sites are shown in relation to juvenile Chinook salmon rearing criteria. Steelhead rear in freshwater for one or more years and are primarily in tributaries of the Russian River and those portions of the 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, in the Russian River near the confluence of Pieta Creek (approximately 8 km downstream of Hopland) and at Cloverdale 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 the time period that the Order overlaps with the presence of rearing Chinook Salmon water temperatures for rearing Chinook ranged from optimal to lethal depending on the site and time period within the Chinook rearing season. It is important to note that Chinook in the Russian River 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). Although stressful and eventually acutely stressful conditions did occur at those sites in late spring and summer, water temperatures were optimal for Chinook salmon rearing in the east fork Russian River downstream of Coyote Valley Dam (Figure 4-19). Water temperature near the USGS stream gage at Hopland (gage number 11462500) ranged from optimal to acutely stressful (Figure 4-20). At Pieta Creek water temperature was stressful to acutely stressful during the period of Chinook rearing season when data was available (Figure 4-21). Water temperature at Cloverdale ranged from suitable to acutely stressful (Figure 4-22). Water temperature at Jimtown and ranged from stressful to acutely stressful (Figure 4-23). At Digger Bend water temperature became stressful and eventually acutely stressful or even potentially lethal by mid-June (Figure 4-24). At Hacienda Water temperature ranged from stressful to acutely stressful for rearing Chinook Salmon (Figure 4-25).

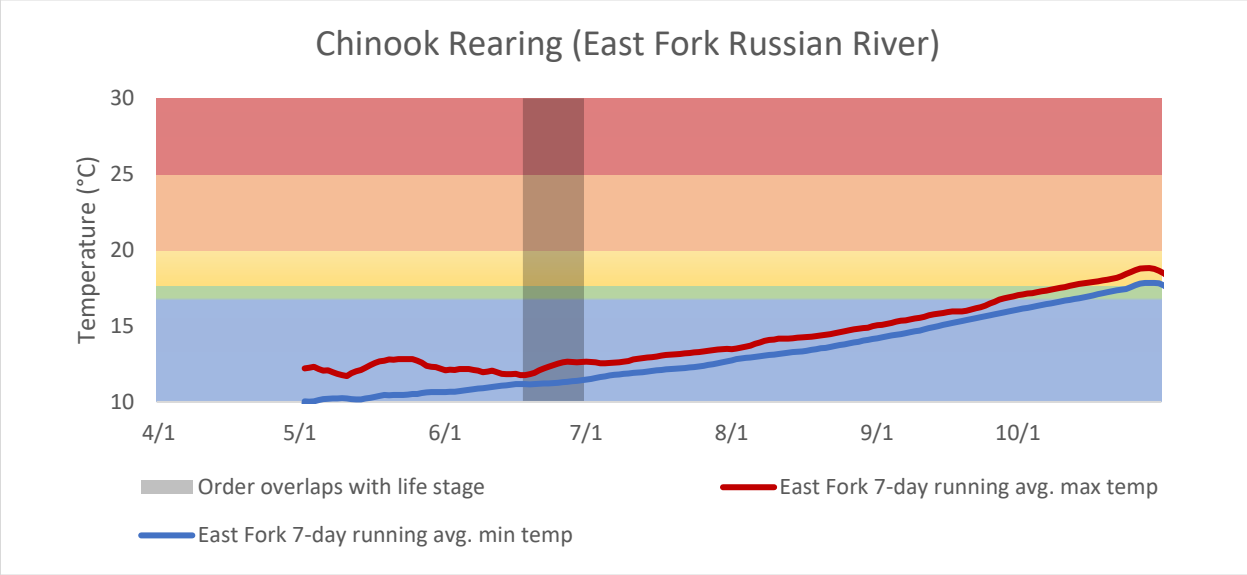

Figure 4-19. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water in the east fork Russian River 0.5 km downstream of Coyote Valley Dam shown from April 1 to October 31, 2022, with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook rearing based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

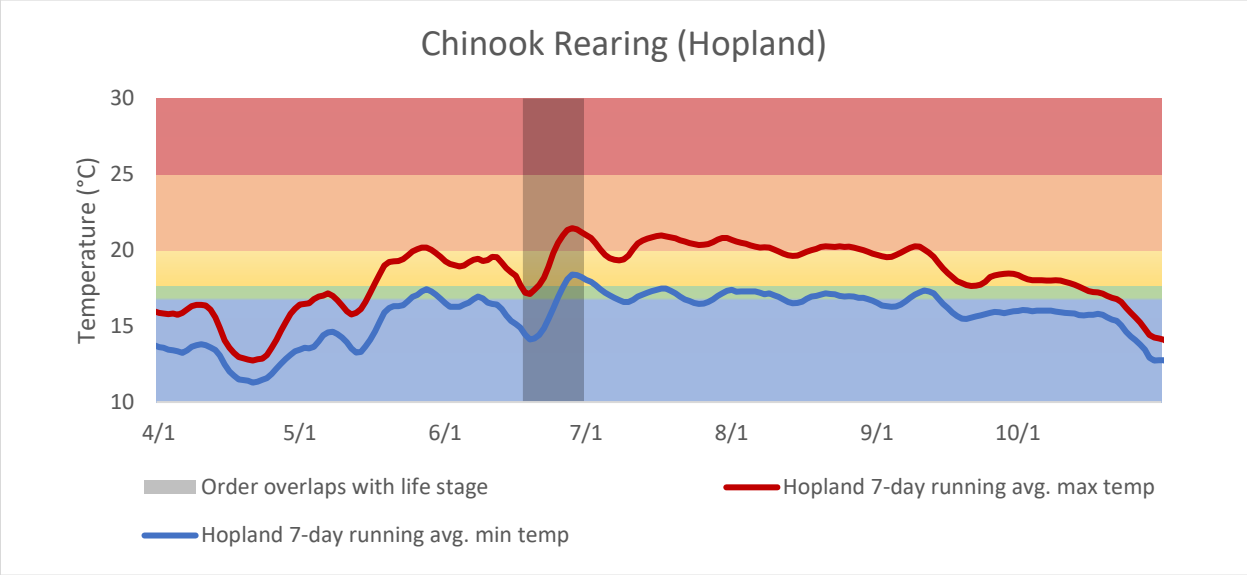

Figure 4-20. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook rearing based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

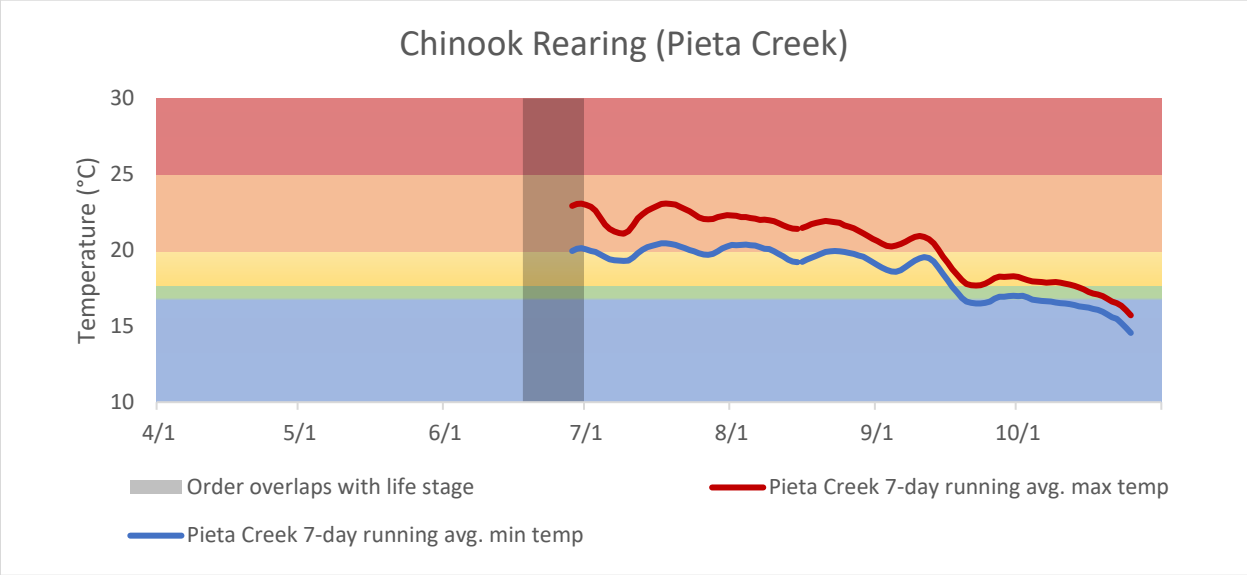

Figure 4-21. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland from April 1 to October 31, 2022, shown with the optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook rearing based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

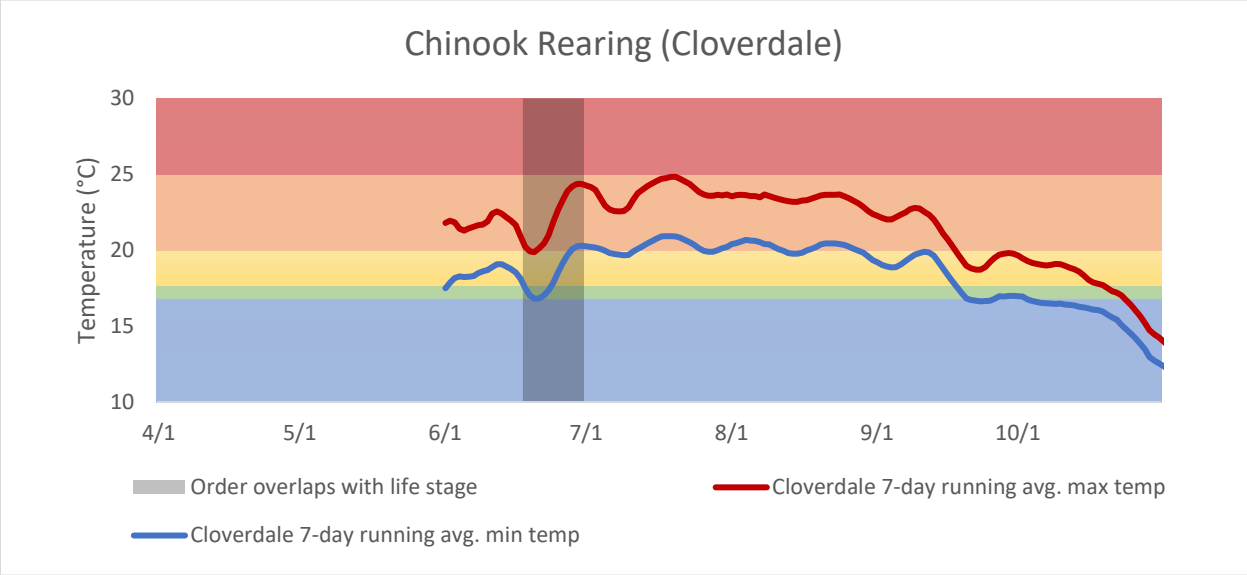

Figure 4-22. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Cloverdale (USGS gage number 11463000) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook rearing based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

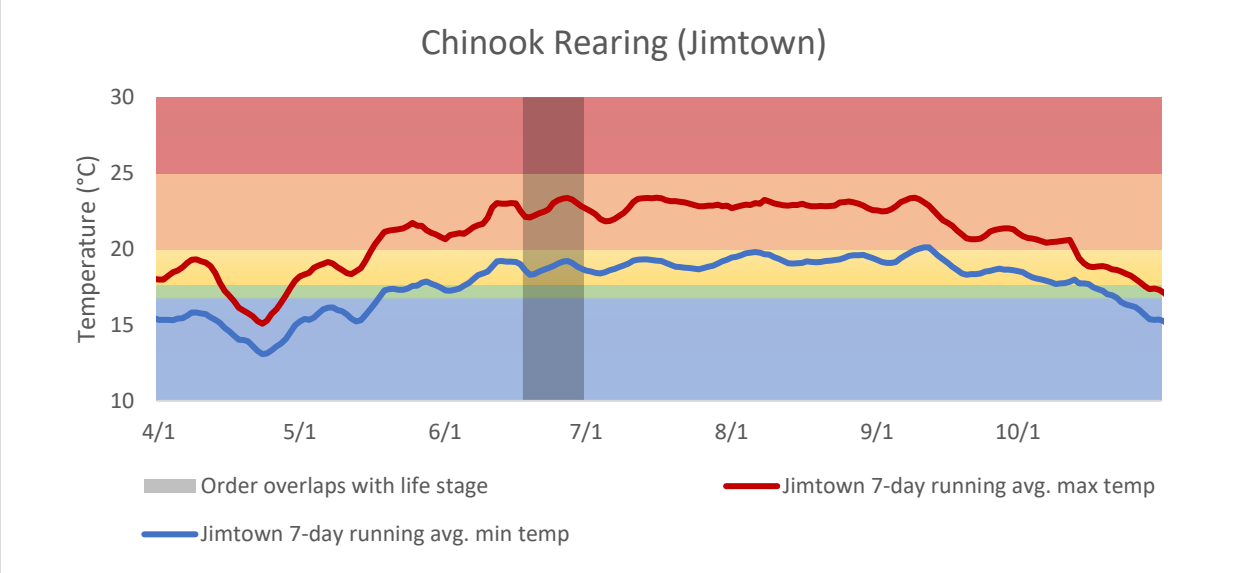

Figure 4-23. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook rearing based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

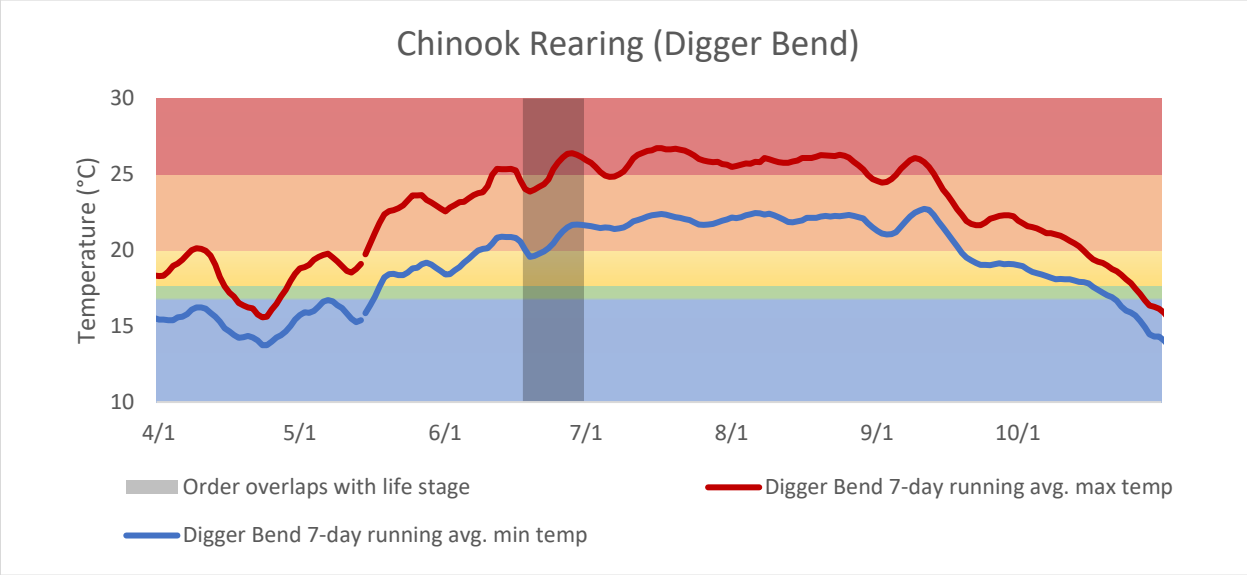

Figure 4-24. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) from April 1 to October 31, 2022, shown with the optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook rearing based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

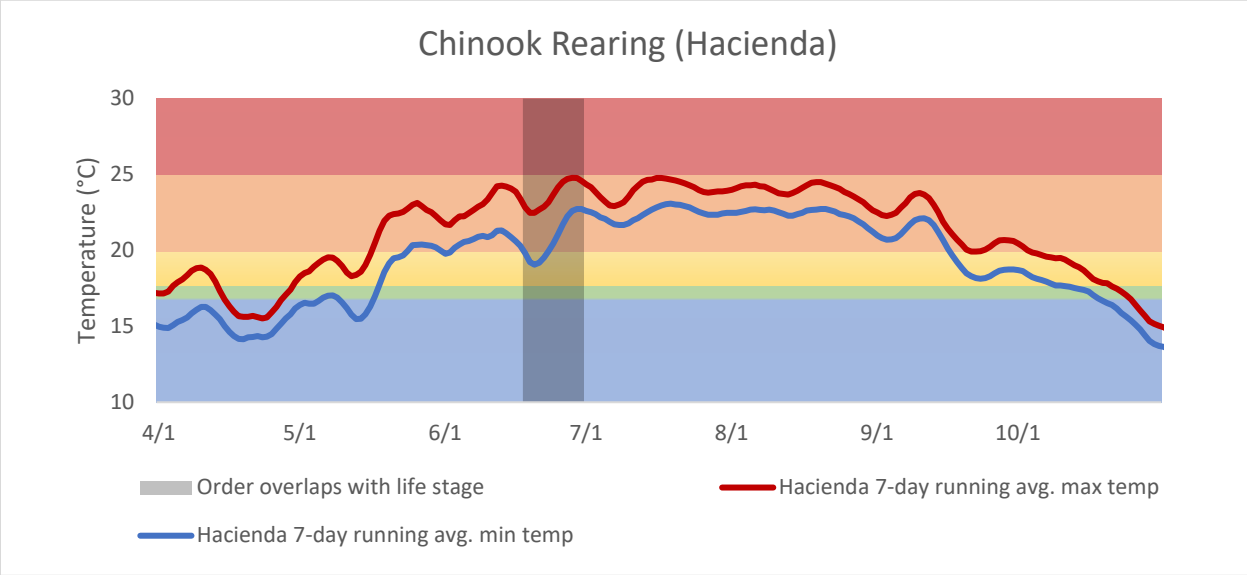

Figure 4-25. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hacienda (gage number 11467000) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook rearing based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

Steelhead

Steelhead parr rear year-round in portions of the upper Russian River. Based on water quality conditions, it is likely that steelhead rear in that portion of the river that is most influenced by cold water released from Lake Mendocino (i.e., upstream of Cloverdale). During the period covered by the Order, water temperature in the east fork of the Russian River downstream of Coyote Valley Dam was optimal until October, then water temperatures gradually increased becoming stressful by the end October (Figure 26). At the USGS stream gage at Hopland, water temperature was generally suitable to stressful for steelhead rearing (Figure 4-27). In the Russian River near the confluence with Pieta Creek water temperature was stressful to acutely stressful for most of the steelhead rearing period (Figure 4-28). At Cloverdale water temperatures ranged from optimal to potentially lethal (Figure 29).

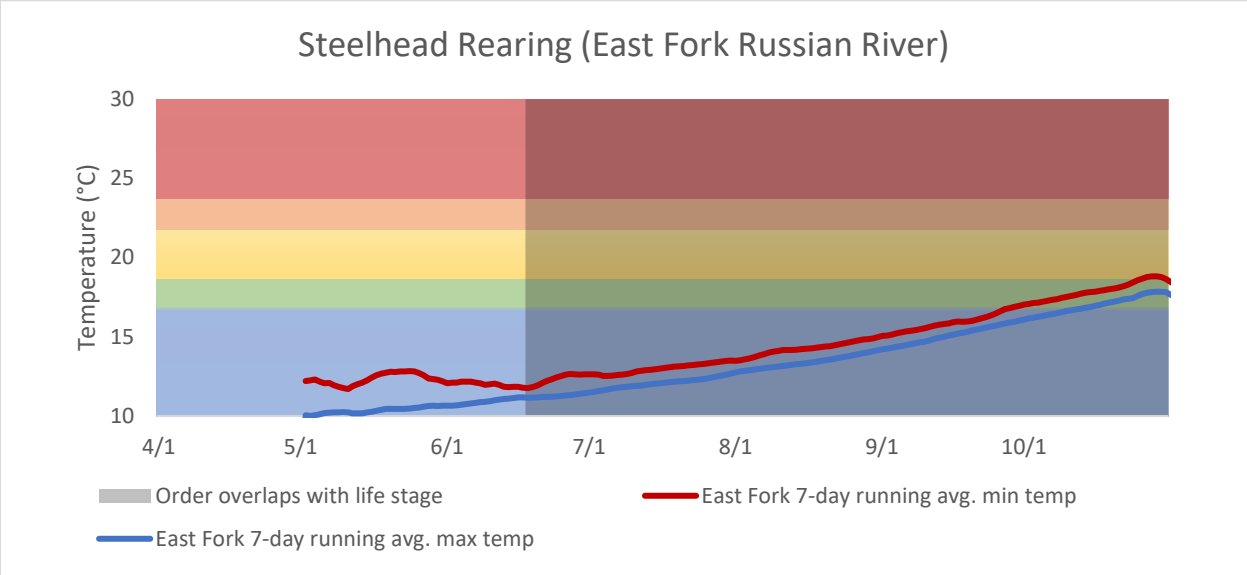

Figure 4-26. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water at the east fork Russian River downstream of Coyote Valley Dam from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead parr based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

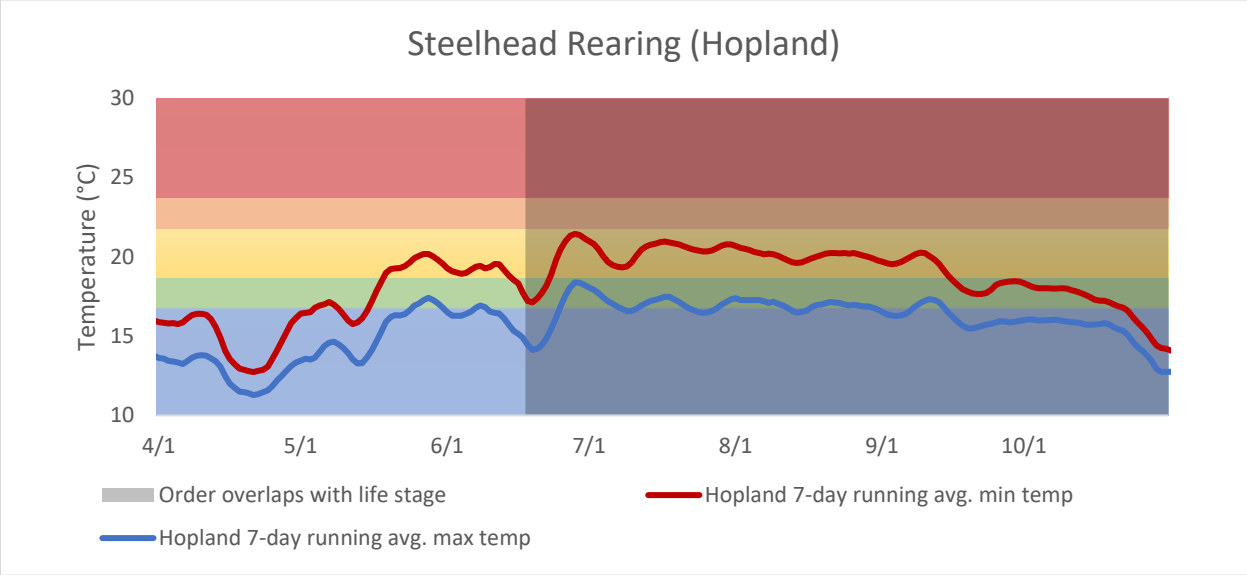

Figure 4-27. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead parr based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

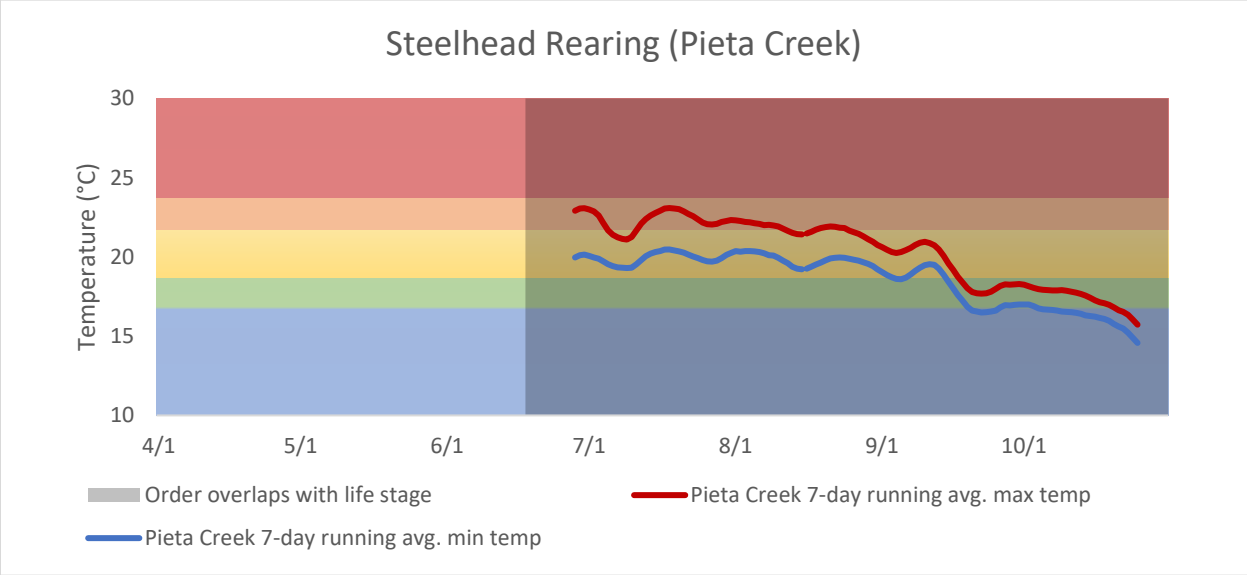

Figure 4-28. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead parr based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

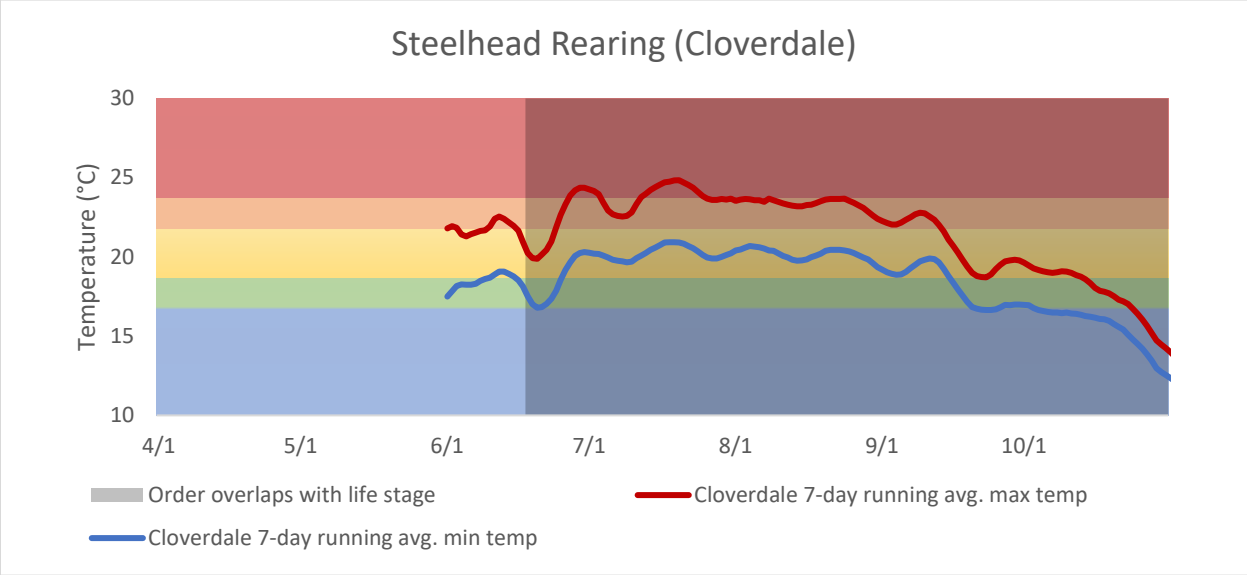

Figure 4-29. The 7-day running average of the minimum and maximum water temperatures collected at Cloverdale (USGS stream gage number 11463000) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead parr based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

Salmonid Smolt Outmigration

For smolts produced in the upper portion of the watershed, Russian River water temperatures for the east fork Russian River downstream of Coyote Valley Dam, Hopland, confluence with Pieta Creek, Jimtown, and Digger Bend gages was summarized and shown with water temperature criteria for Chinook smolts. Because the Mirabel trap site is located near the Hacienda stream gage, Chinook smolt catches at Mirabel are also displayed for water temperature collected at the Hacienda gage. It is noteworthy that many Chinook smolts (over 18,000 captured in the trap) emigrated from the Russian River before the Order went into effect. Because so few coho and steelhead smolts typically emigrate 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 for smolt migration to Chinook.

Chinook

Water temperature in the upper Russian River near the Coyote Valley Dam was generally favorable for Chinook smolts during the period of time that the Order overlaps with when Chinook are expected to emigrate from that potion of the Russian river (Figure 4-30). However, water temperature became stressful to potentially lethal at some sites located downstream of Hopland (Figure 4-31 through Figure 4-36). It is important to note that Chinook have evolved to emigrate during the spring before water temperatures become lethal and that many Chinook captured at the Mirabel downstream migrant trap emigrated before the Order went in effect in June (Figure 4-36).

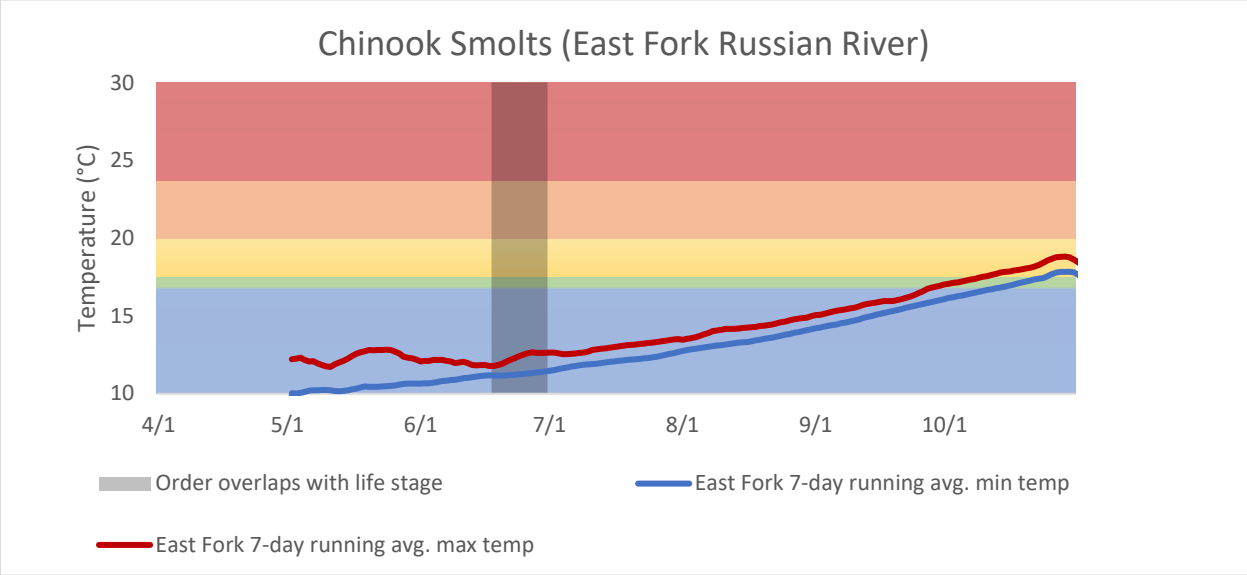

Figure 4-30. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water at the east fork of the Russian River downstream of the Coyote Valley Dam from April 1 to October 31, 2022. Shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook smolts based on Table 4-3. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

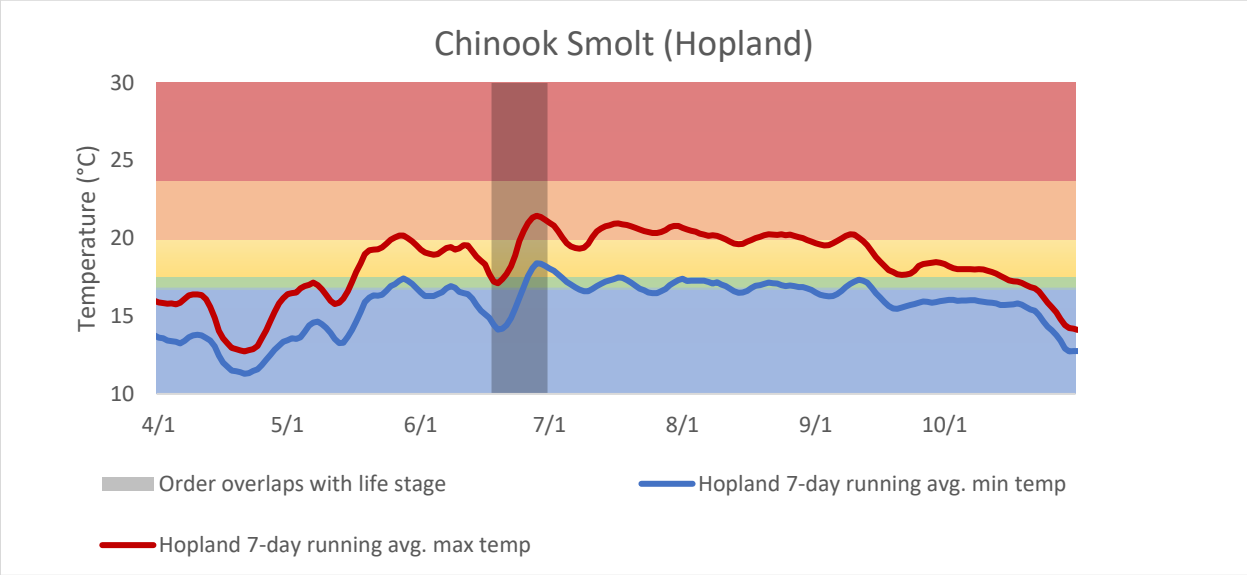

Figure 4-31. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500) from April 1 to October 31, 2022. Shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook smolts based on Table 4-3. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

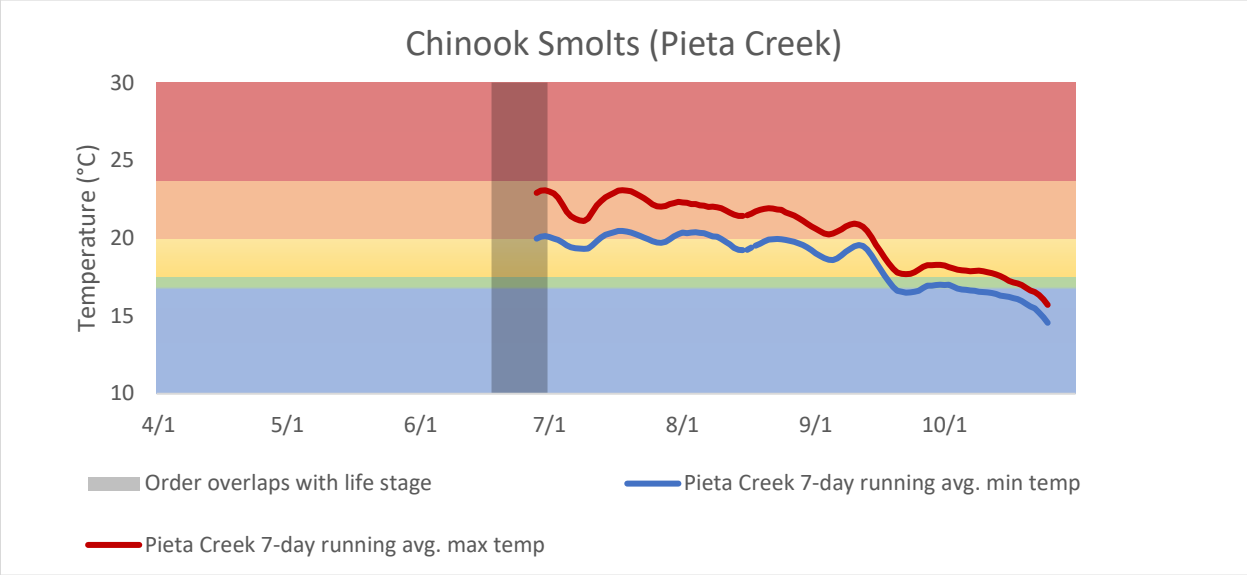

Figure 4-32. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook smolts based on Table 4-3. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

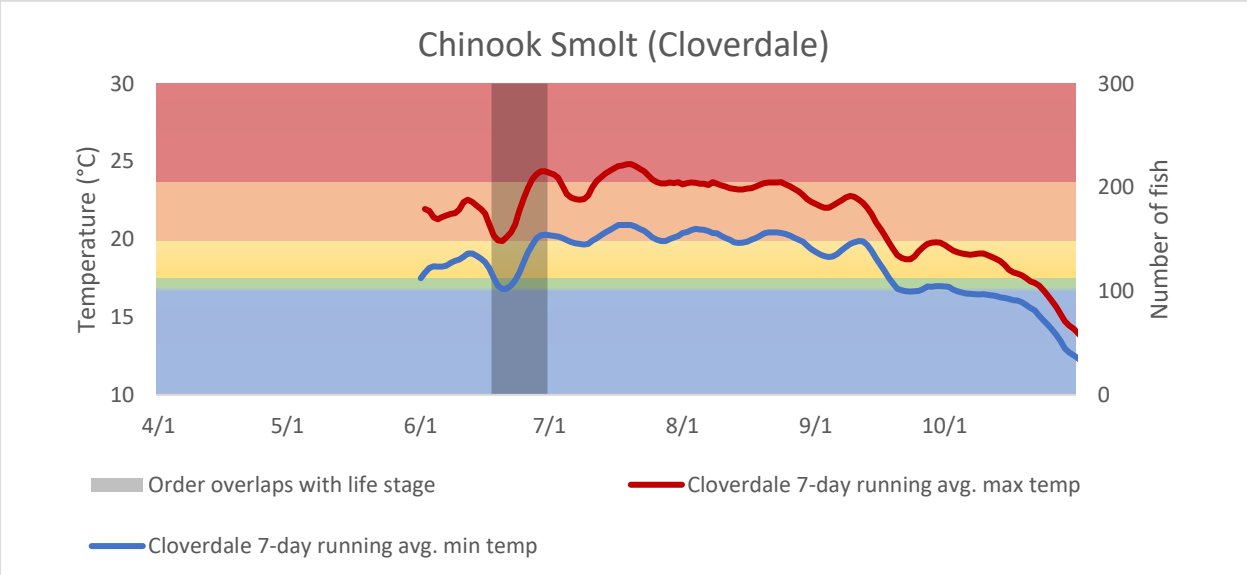

Figure 4-33. The 7-day running average of the minimum and maximum water temperatures collected at the Cloverdale USGS stream Gage (11463000) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook smolts based on Table 4-3. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

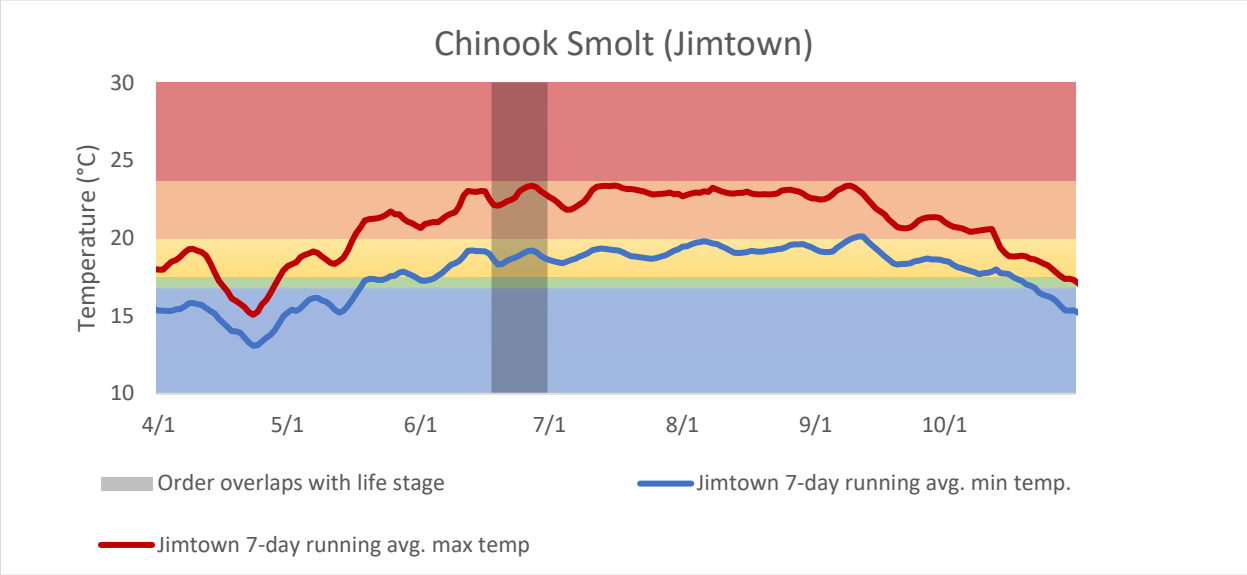

Figure 4-34. The 7-day running average of the minimum and maximum water temperatures collected at the Jimtown USGS stream Gage (1146382) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook smolts based on Table 4-3. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

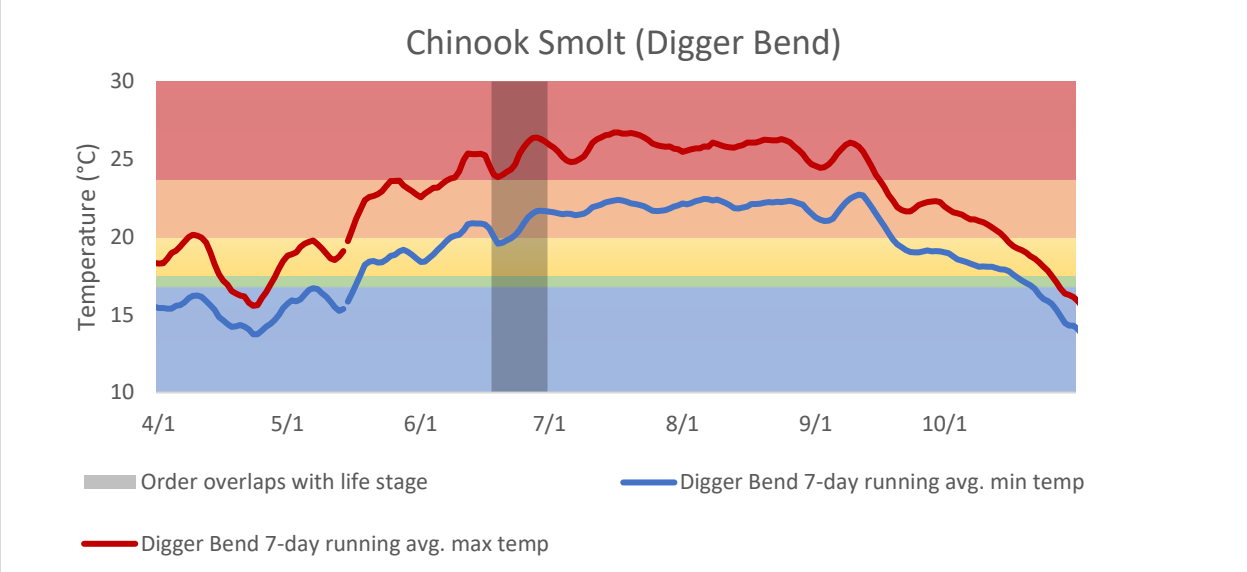

Figure 4-35. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook smolts based on Table 4-3. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

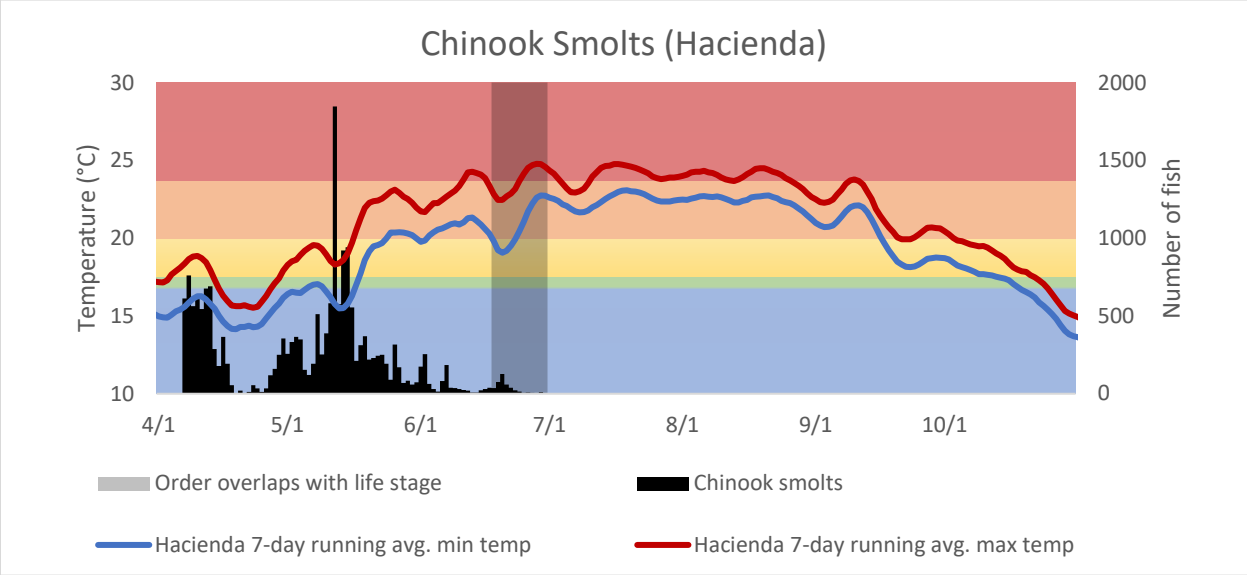

Figure 4-36. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) from April 1 to October 31, 2022, shown with the Chinook smolt catch from the Mainstem Russian River near Mirabel and optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for Chinook smolts based on Table 4-3. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

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 4-37). It is worth noting that dissolved oxygen in summer and early fall is typically poor immediately downstream of Coyote Valley Dam due to reservoir releases and that dissolved oxygen generally recovers fairly quickly downstream of the dam.

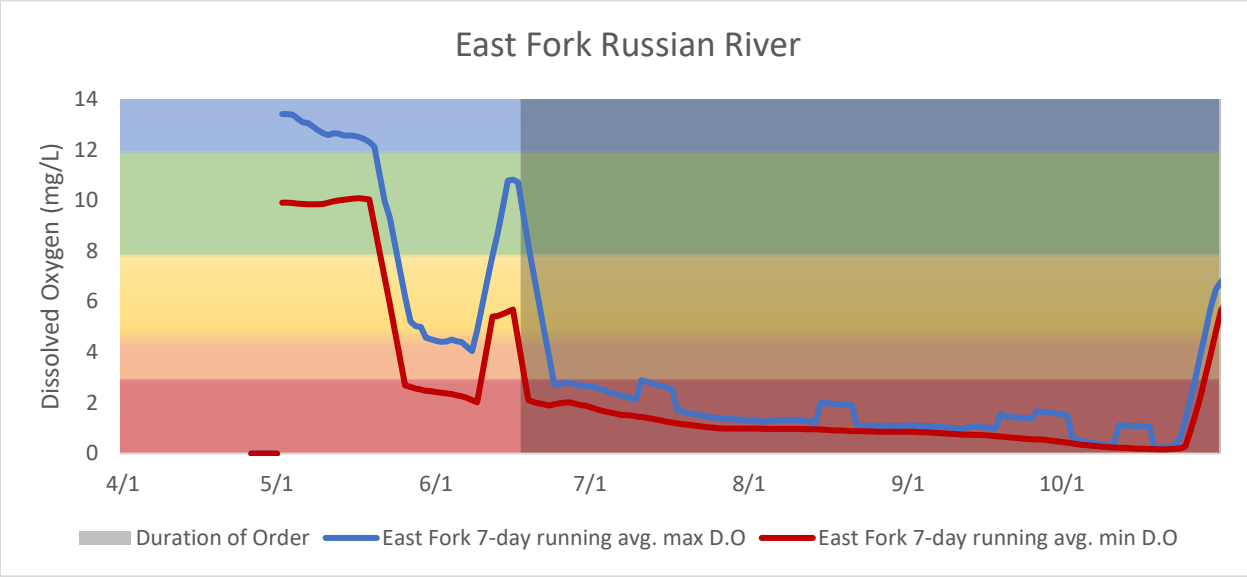

Figure 4-37. The 7-day running average of the minimum and maximum dissolved oxygen collected by Sonoma Water in the east fork of the Russian River downstream of Coyote Valley Dam from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

At Hopland, the Russian River near the confluence of Pieta Creek, Cloverdale, 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 4-38 through 4-43).

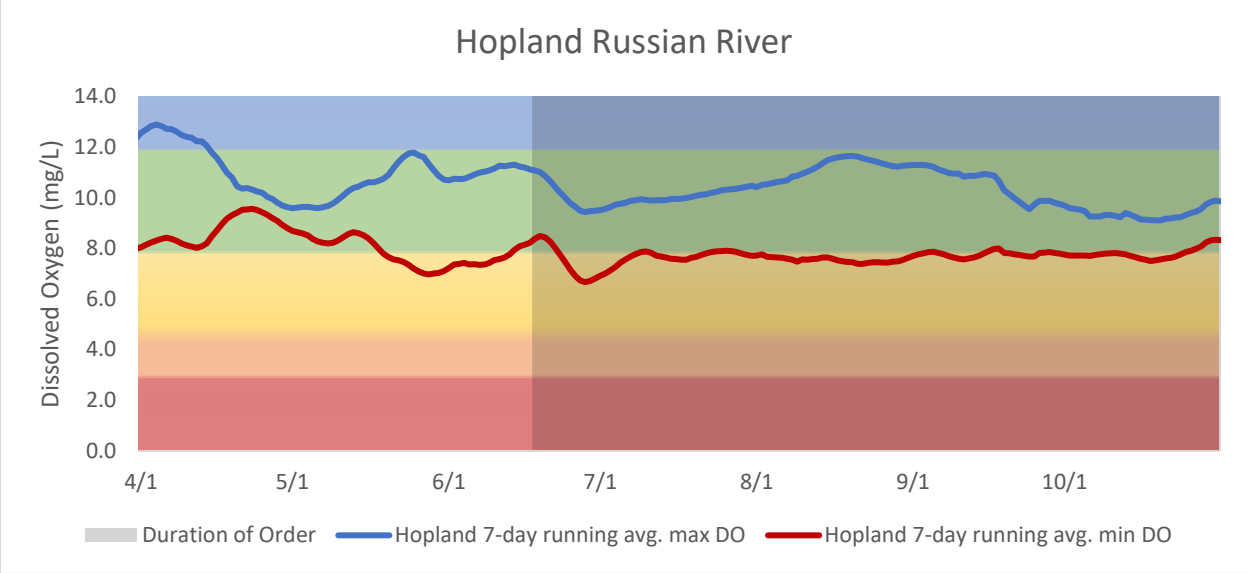

Figure 4-38. The 7-day running average of the minimum and maximum dissolved oxygen collected at Hopland (USGS stream gage number 11462500) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

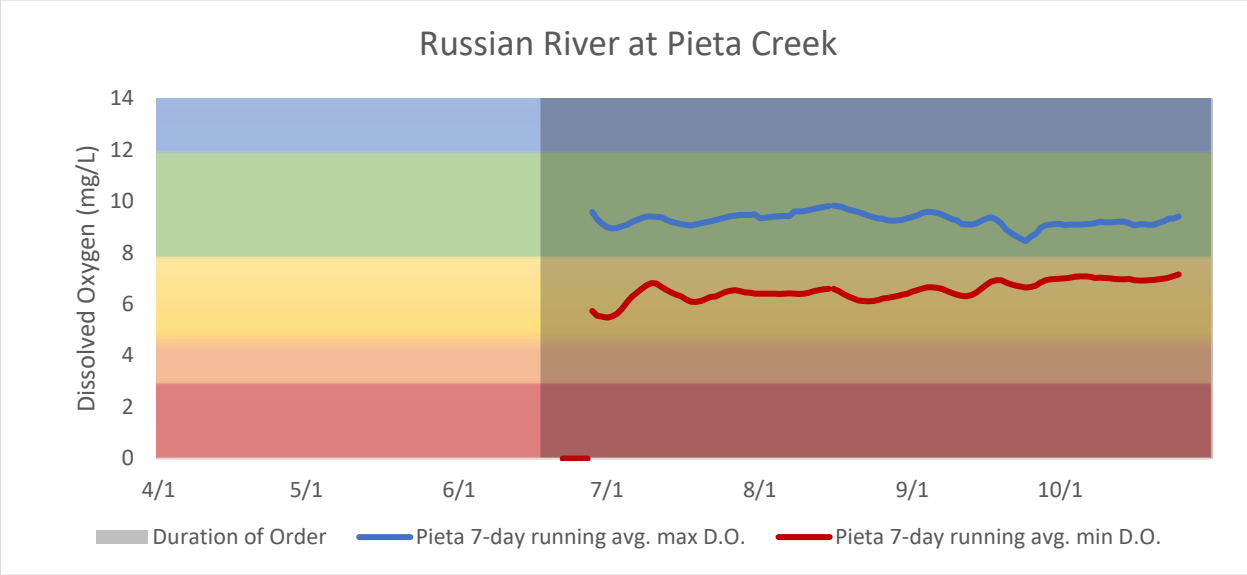

Figure 4-39. The 7-day running average of the minimum and maximum dissolved oxygen collected in in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

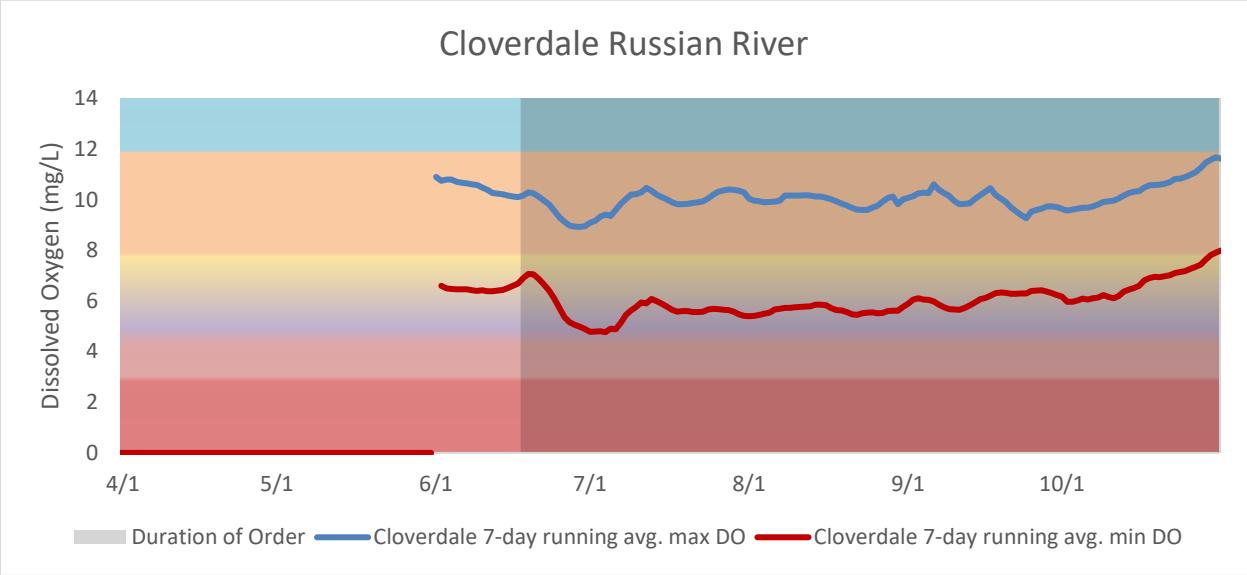

Figure 4-40. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Cloverdale USGS stream Gage (11463000) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

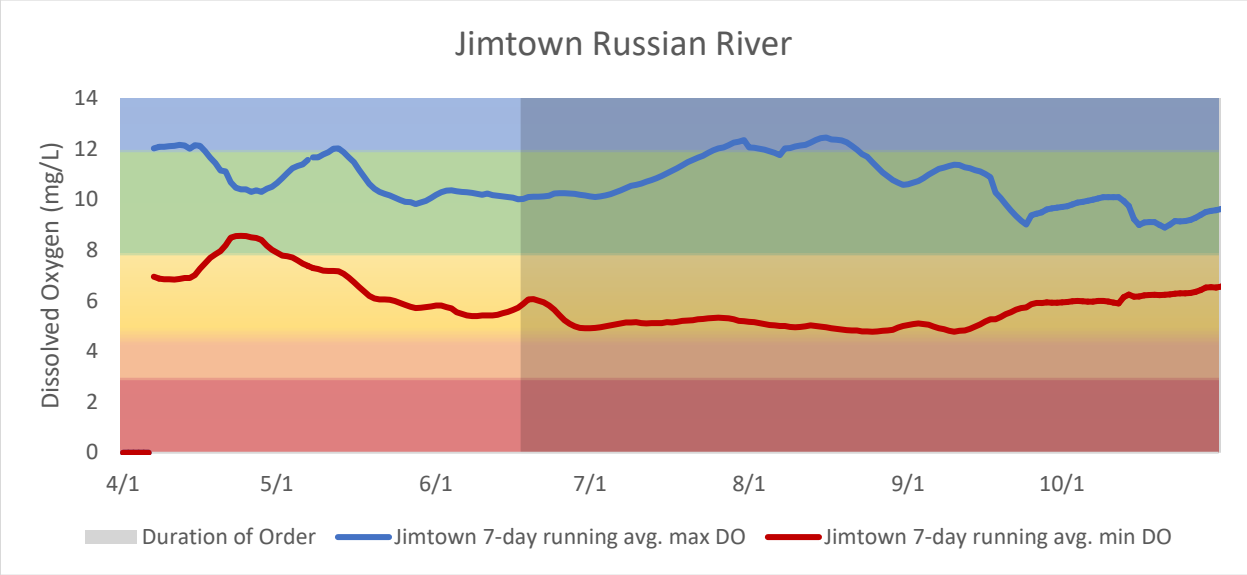

Figure 4-41. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Jimtown USGS stream Gage (1146382) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

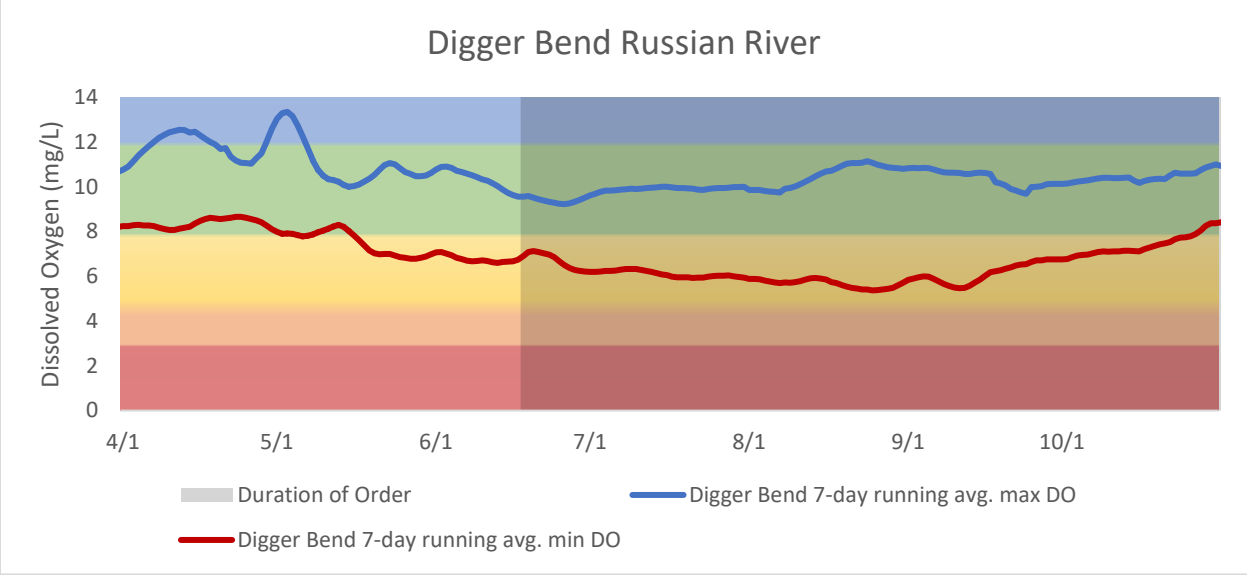

Figure 4-42. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Digger Bend USGS stream gage (11463980) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

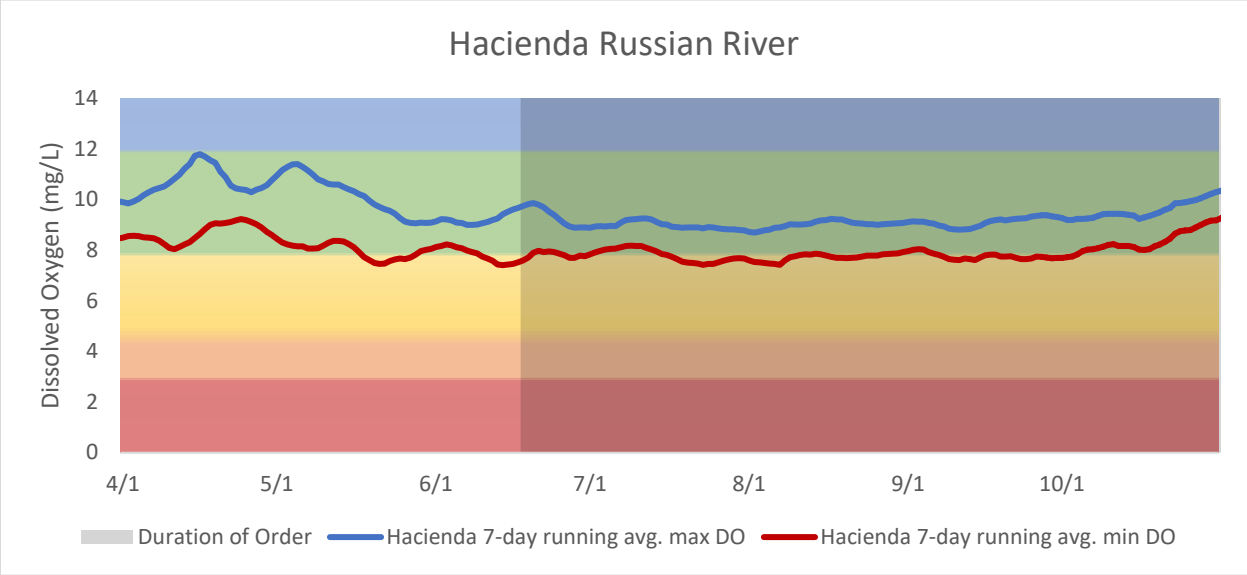

Figure 4-43. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Hacienda USGS stream gage (1146700) from April 1 to October 31, 2022, shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

4.2.5 Summary

During the typical onset of upstream migration of adult Chinook, 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. While temperatures were at times 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 in the Russian River 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.

For steelhead rearing, water temperatures in the east fork Russian River ranged from optimal to stressful. The increase in water temperature at this site was likely due to depletion of the cold water pool in the reservoir. Water temperature in the east fork Russian River was cooler in 2022 when compared to 2021 (Figure 4-37). This is due to improved water quality conditions in Lake Mendocino in 2022. At Hopland, water temperature for steelhead rearing ranged from optimal to stressful. In the Russian River near the confluence with Pieta Creek, water temperature was typically stressful to acutely stressful for rearing steelhead. At Cloverdale maximum daily water temperatures occasionally became potentially lethal.

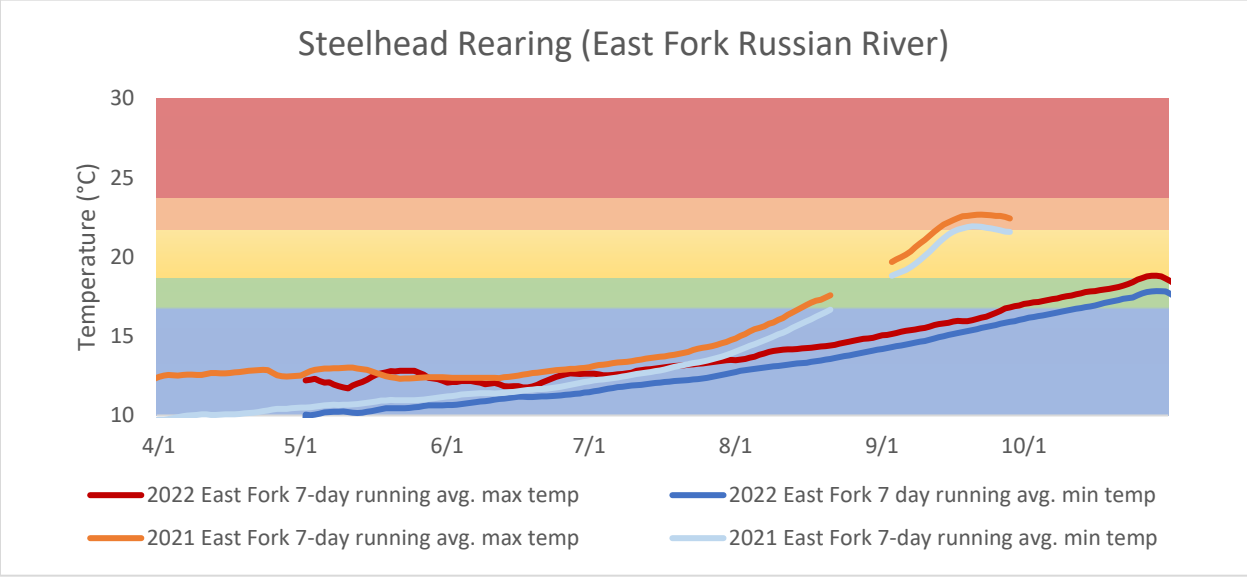

Figure 4-37. The 7-day running average of the minimum and maximum water temperatures collected in the East fork of the Russian River 0.5 km downstream of Coyote Valley Dam in 2021 and 2022 from April 1 to October 31. Shown with optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for steelhead rearing based on Table 4-2. Gray indicates the period included in the TUC Order issued by the State Water Resources Control Board on June 17, 2022, that overlaps with this species and life stage being assessed.

Chinook salmon experienced suitable to acutely stressful water temperatures for smolt migration at Hopland and in the Russian River at the confluence with Pieta Creek. 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 2022, over 18,000 (98%) Chinook smolts were captured at the Mirabel downstream migrant trap (not adjusted for trap efficiency) before the Order went into effect on June 17.

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). 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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