Sonoma Water

VIA EMAIL

April 1, 2021

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

Re: Reporting Requirements for Terms 2, 5.b and 11 of the State Water Resources Control Board Order 2020-0102-EXEC (July 28, 2020)

Dear Mr. Ekdahl:

In accordance with the requirements of the State Water Resources Control Board Order 2020-0102-EXEC received July 28, 2021 that approved the Temporary Urgency Change Petitions for water-right Permits 12947A, 12949, 12950, and 16596 (Applications 12919A, 15736, 15737, and 19351), please accept the submittal of the following enclosed reports by Sonoma Water:

- Term 2 – Fisheries Monitoring Tasks
- Term 5.b – Russian River Water Quality Monitoring Summary
- Term 11 – Upper Russian River Diversion Forecast Reporting Program

If you have any questions about these reports, please do not hesitate to contact me at tschram@scwa.ca.gov.

Sincerely,

[redacted]

Todd J. Schram, P.E.
Water Agency Engineer IV

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

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State Water Resources Control Board
Order 7/28/2020

Term 2 – Fisheries Monitoring Tasks

April 1, 2021

Prepared by

Sonoma County Water Agency
404 Aviation Blvd
Santa Rosa, CA 95403

Introduction

On June 10, 2020, the Sonoma County Water Agency (Sonoma Water) filed a Temporary Urgency Change Petition (TUCP) with the State Water Resources Control Board (SWRCB) to temporarily reduce minimum instream flows in the upper Russian River to address low storage in Lake Mendocino and avoid potential violations if the Incidental Take Statement contained in the National Marine Fisheries Service (NMFS) Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed (Biological Opinion).

In summary, the Water Agency requested that the SWRCB make the following temporary changes to the Decision 1610 (D1610) instream flow requirements:

(1) From July 1, through December 27, 2020, reduce instream flow requirements for the upper Russian River (from its confluence with the East Fork of the Russian River to its confluence with Dry Creek) from 75 cubic feet per second (cfs) to 50 cfs.

(2) From July 1, through December 27, 2020, reduce instream flow requirements for the lower Russian River (downstream of its confluence with Dry Creek) from 85 cfs to 60 cfs.

The SWRCB issued an Order (Order) approving the Water Agency's TUCP on July 28, 2020 (SWRCB 2020).

The State Water Board's Order included fisheries monitoring and reporting tasks which are summarized in term 2 of the Order. Term 2 required that beginning September 1, 2020 the Water Agency monitor and record the daily number of adult salmonids moving upstream past the Mirabel fish ladder. Beginning October 1, 2020 if the mouth of the river was open and adult salmon and steelhead could enter the Russian River the Water Agency was to conduct adult salmonid spawning surveys in representative reaches in Dry Creek and in the upper Russian River (above Healdsburg, CA) on a weekly basis continuing through the duration of the order or until sustain flow at Hacienda (USGS gage 11467000) was above 135 cfs. Prior to October 15, 2020, or after a cumulative seasonal total of 100 adult salmon and steelhead move upstream past the Mirabel Dam fish counting station, whichever is earlier, the Water Agency was to consult with NMFS and CDFW regarding the possibility of increasing the instream flow at the Hacienda gage (USGS gage 11467000) to a level not to exceeding 135 cfs. Consultations were to occur every two weeks and a summary report of consultation details and any increases to the minimum flows was to be submitted to the Deputy Director for Water Rights within one week of each consultation meeting.

Methods

For this report, fisheries data from June 1 to December 27 has been summarize. This period encompasses the Order, which was requested on June 10, issued on July 28, and expired on December 27. At times additional fisheries information collected before June 1, and after December 27, is included in this report to put fisheries data into a broader context.

Adult fish counts

In 2020 the Water Agency operated an underwater video camera in the newly-constructed Mirabel fish ladder on the west side of the Mirabel Inflatable Dam, as well as the "old" fish ladder on the east side of the dam, to count adult salmon returning to the Russian River. Cameras were deployed in the west side on September 1, and east side on September 3.

Spawner surveys

Spawner surveys were conducted on a weekly basis at sites in Dry Creek and in the upper Russian River. The number of adult salmon and steelhead, and the number of redds were recorded.

Results

Flow

From June 1, 2020 to December 27, 2020 flow in the Russian River at Hacienda ranged from a high of 320 cfs at Hacienda on December 26, to a low of 68 cfs on September 9. Flow during the Order was typically between 87 cfs and 112 cfs (25th and 75th percentiles of the daily average flow when considering Hacienda, Diggers Bend, Jimtown, and Hopland). During the Order, the Russian River was influenced by tributary in-flow until June and was generally controlled by reservoir releases from June through October.
(Figure 1).

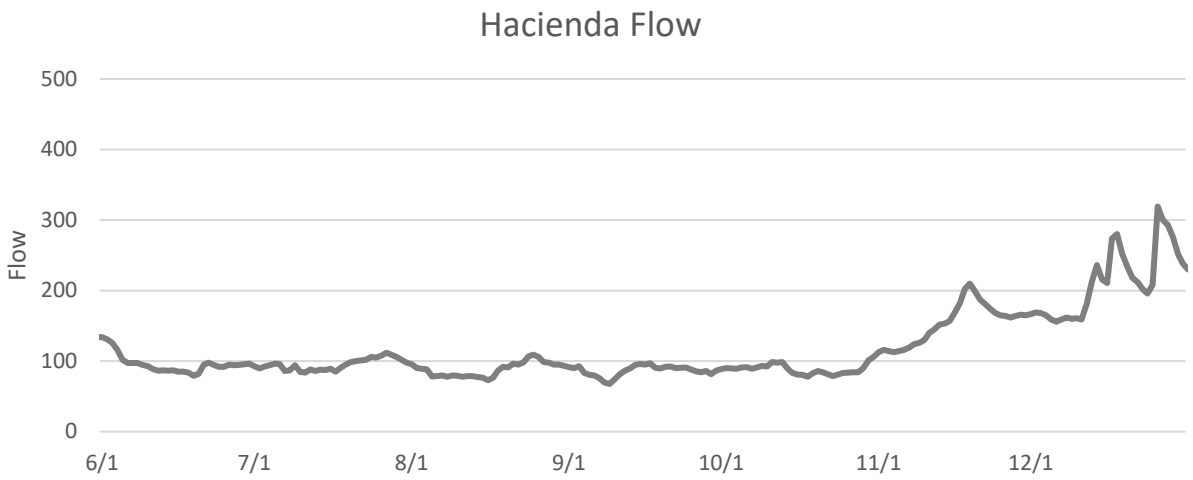


Figure 1. Flow at the USGS stream gages at Hacienda from June 1 through December 31.

Adult counts

Video counts

The Water Agency operated two video cameras at Mirabel from September 1 to after the Order expired (one in the east fish ladder and one in the west fish ladder). In 2020 we installed video cameras in west ladder on September 1 and in the east ladder on September 3. There were

brief periods of data loss at Mirabel due to technical problems mainly related to power loss. However, overall the system performed well (Figure 2).

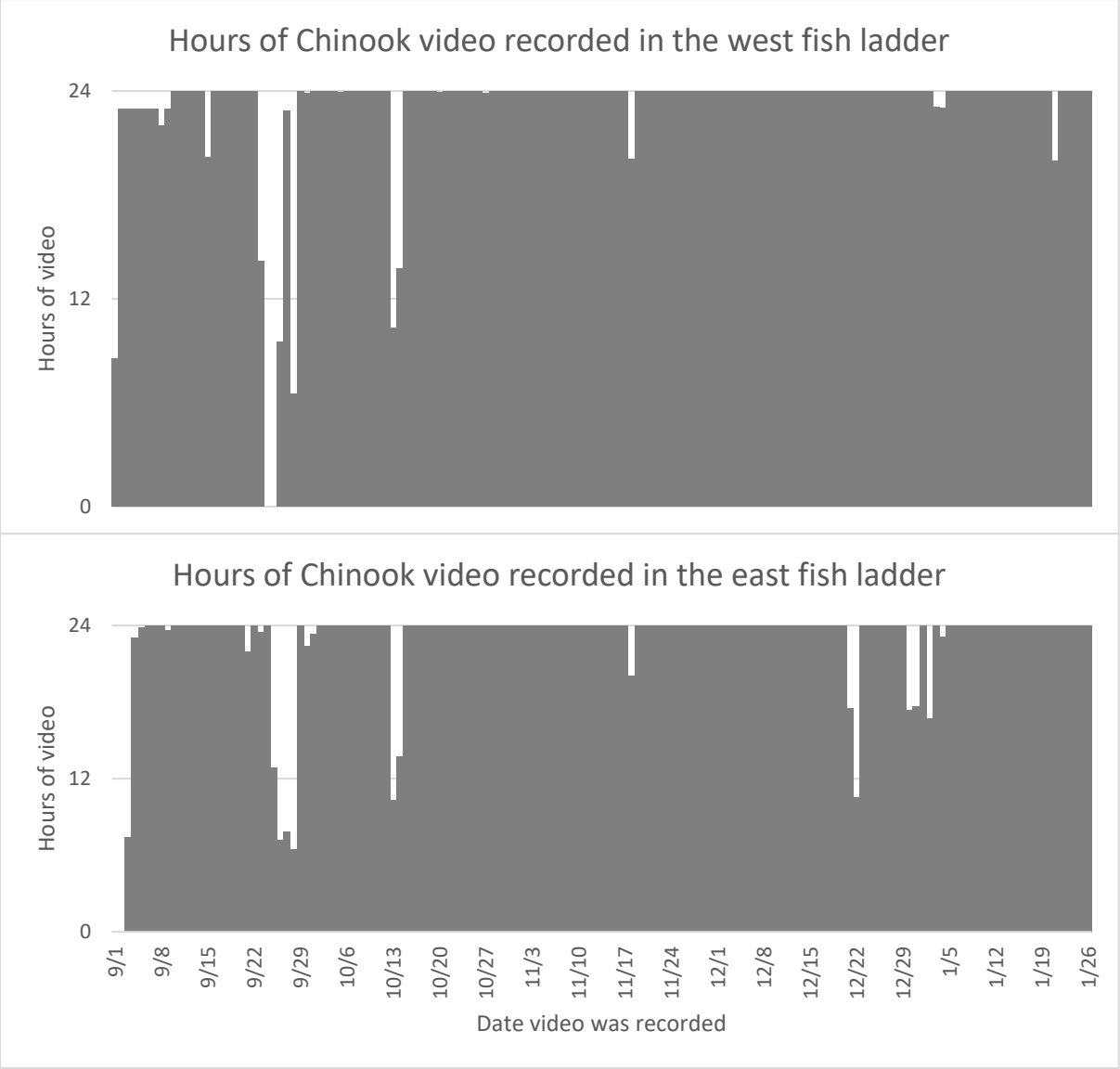


Figure 2. The number of hours of underwater video recorded per day at the Mirabel Fish ladder on the mainstem Russian River in the west ladder (upper panel) and east ladder (lower panel). Missing hours were due to corrupt data and technical difficulties mostly related to power loss.

At Mirabel, 598 Chinook, 228 coho and 112 steelhead adults were observed during the period covered by the Order (Figure 3).

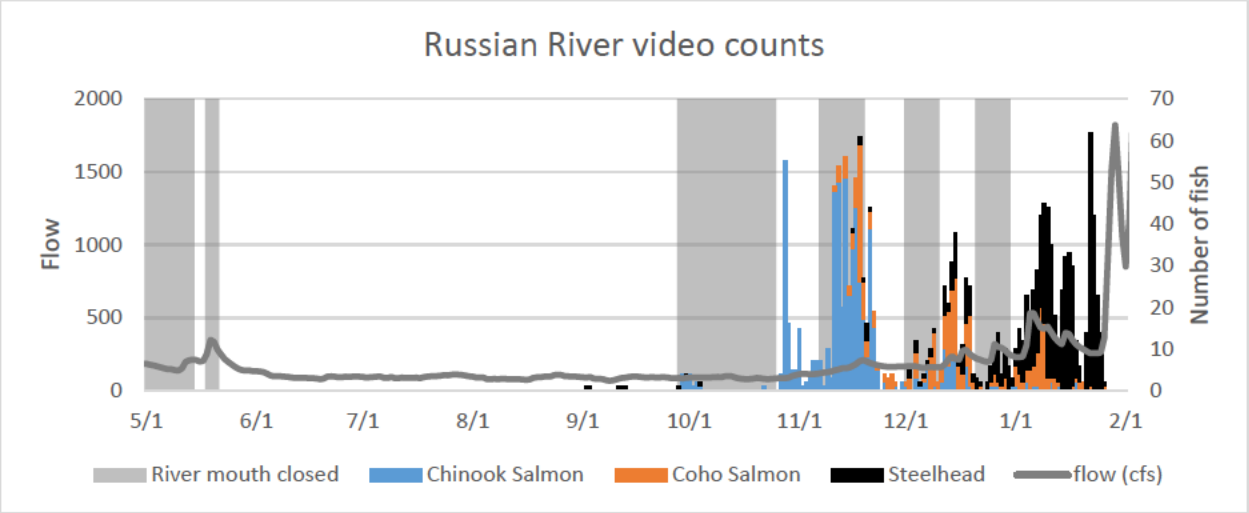


Figure 3. The period that the mouth of the Russian River was closed, flow in the Russian River at the USGS Hacienda gage (11467000), and the number of adult Chinook, Coho, and steelhead observed on the Mirabel underwater video.

Spawner Surveys

In addition to video counts collected at the Mirabel Dam, Sonoma Water staff also visited spawning grounds in Dry Creek and the mainstem Russian River above Healdsburg weekly. Weekly observations generally confirmed the presence of spawning fish (Table 1). More extensive spawning ground surveys were conducted in Dry Creek and the mainstem river during the weeks of December 3 and December 10. During these more extensive surveys 115 redds were observed during the week of December 3 and 23 redds were observed during the week of December 10 (Table 1).

Table 1. Sonoma Water salmon redd observations and flow in the lower river (Hacienda) and upstream of Dry Creek (Healdsburg).

Week	Redd Counts	Flow (cfs)	
	Chinook	Hacienda	Healdsburg
1-Oct	0	88-91	80-84
8-Oct	0	90-99	78-88
15-Oct	0	78 - 86	71 - 81
22-Oct	0	79 - 84	70 - 78
29-Oct	0	90 - 116	74 - 79
5-Nov	0	114 - 140	78 - 90
12-Nov	3	145 - 202	92 - 108
19-Nov	4	165 - 210	106 - 116
26-Nov	4	162 - 169	104 - 113
3-Dec	115*	156 - 168	109 - 112
10-Dec	23*	159 - 236	110 - 142
17-Dec	5	202 - 280	121 - 170
24-Dec	6	196 - 319	117 - 189
31-Dec	9	238	150

* Kayak based surveys were conducted on these days. They cover more spawner sites in a day than walk-in surveys

Discussion

Flow

Flow in the Russian River was controlled by releases from project reservoirs for much of the adult salmon migration season. The mouth of the river was closed for most of October and periodically in November and December. However, the mouth was sufficiently open to allow for upstream migration by adult salmonids. Flows in the lower river remained above 135 cfs in the lower river (Hacienda) and above 105 cfs in the upper river (Healdsburg) for the latter half of the adult migration period. When flows were below 135 cfs in the lower river and below 105 cfs in the upper river, water temperature were either unfavorable for adult salmonids (the month of September) or the river mouth was closed and blocking upstream movement of adult salmonids (most of October).

Adult Counts

Video counts

The bulk of the adult Chinook migration occurred after November 1. Adult salmonids are not typically seen in abundance in the Russian River until October. However, in 2020 the river mouth was closed for much of October. Upstream migration is influenced by barrier beach closures at the mouth of the river and streamflow in the river. Fall freshets reduce mainstem

temperatures and increase flows and likely stimulate upstream migration by adult salmonids into the Russian River.

The adult chinook count in 2020 was the lowest count since Sonoma Water began collecting these data in 2000. Although somewhat speculative, the low number of returning Chinook could be partially due to poor survival of incubating eggs in redds scoured by high winter flows for the predominant cohort returning in 2020. Poor ocean conditions may have also been a contributing factor. The 2020 adult steelhead counts at fish hatcheries on the Russian River were also unusually low in 2020/2021 (CDFW unpublished data). These hatcheries release similar numbers of steelhead smolts from year to year, so low numbers of returning adults may point to low ocean survival or other unidentified factors in freshwater.

Spawner Surveys

The number of Chinook redds observed during spawner surveys was relatively low in 2020. However, the number of returning adults was low in 2020 so it was expected that fewer redds would be encountered. Walk-in spawner surveys allow for limited spatial data to be collected when compared to boat-in spawner surveys. However, an advantage of walk-in surveys is that sites can be surveyed more frequently with less effort. In 2020 weekly walk-in spawner surveys allowed Sonoma Water to collect spawning information on a longer time scale and over a range of flows. This information was useful for making management decisions in 2020 and into 2021.

References

State Water Board, Order approving petitions for temporary urgency change of permits 12947A, 12949, 12950, and 16596 (applications 12919A, 15736, 15737, 19351) of Sonoma County Water Agency. June 28, 2020. State Water Resource Control Board. Sacramento Ca.

Russian River Water Quality Summary for the 2020 Temporary Urgency Change

Sonoma Water

Term 5.b

April 2021

Contents

1.0 Introduction

On 10 June 2020, the Sonoma County Water Agency (Sonoma Water) filed Temporary Urgency Change Petitions (TUCPs) with the State Water Resources Control Board (SWRCB) to temporarily reduce minimum instream flows in the Russian River to address low storage conditions in Lake Mendocino and to meet the terms and conditions of the Russian River Biological Opinion (NMFS 2008).

In summary, the SWRCB approved the following temporary changes to the Decision 1610 (D1610) instream flow requirements from 1 July 2020 through 27 December 2020 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 be reduced from 75 cubic feet per second (cfs) to 50 cfs.

(2) Minimum instream flow requirements in the lower Russian River (from its confluence with Dry Creek to the Pacific Ocean) shall be reduced from 85 cfs to 60 cfs.

(3) If storage in Lake Mendocino drops more than one percent below the target water storage level on any day during the period of this Order, then, from that date through December 27, 2020, reduce instream flow requirements for the Upper Russian River from 50 cfs to 40 cfs, and reduce instream flow requirements for the Lower Russian River from 60 cfs to 50 cfs.

For purposes of compliance with this term, the minimum instream flow requirements for the upper river shall be based on a five-day running average of average daily stream flow measurements, provided that instantaneous flows shall be no less than 40 cfs. For the lower river, the minimum instream flow requirements shall be based on instantaneous flow measurements and shall be no less than 50 cfs. If storage drops more than one percent below the target water supply storage at Lake Mendocino, then the instantaneous minimum instream flow would be no less than 30 cfs on the Upper Russian River and no less than 40 cfs on the Lower Russian River. Approval of the TUCP will increase storage levels in Lake Mendocino in the fall, which will be used for releases of stored water to benefit returning adult Chinook salmon, and improve the likelihood of carryover storage for use in 2021 in the event 2021 is also a dry year. The SWRCB issued the Order (Order) approving Sonoma Water's TUCP on 28 July 2020.

2.0 2020 Russian River Flow Summary

In early January 2020, following a relatively dry December in 2019, water storage levels in Lake Mendocino were similar to storage levels experienced in 2017, which was a normal water year. However, storage only increased by about 8,000 acre-feet through the month of February due to less than normal rainfall, and by April 2020 storage levels were approaching drought levels observed in 2013 and 2015 (Figure 2-1). Storage in Lake Mendocino peaked in early February at over 80,300 acre-feet, but dropped below 50,000 acre-feet by mid-August and below 40,000 acre-feet by 1 October. With no significant rainfall during the months of November and December, storage levels continued to decline and were approximately 28,500 acre-feet by 31 December (Figure 2-1).

The 2020 average daily flows at the Talmage, Hopland, Cloverdale, Jimtown, Digger Bend, and Hacienda U.S. Geological Survey (USGS) gaging stations are shown in Figure 2-2.

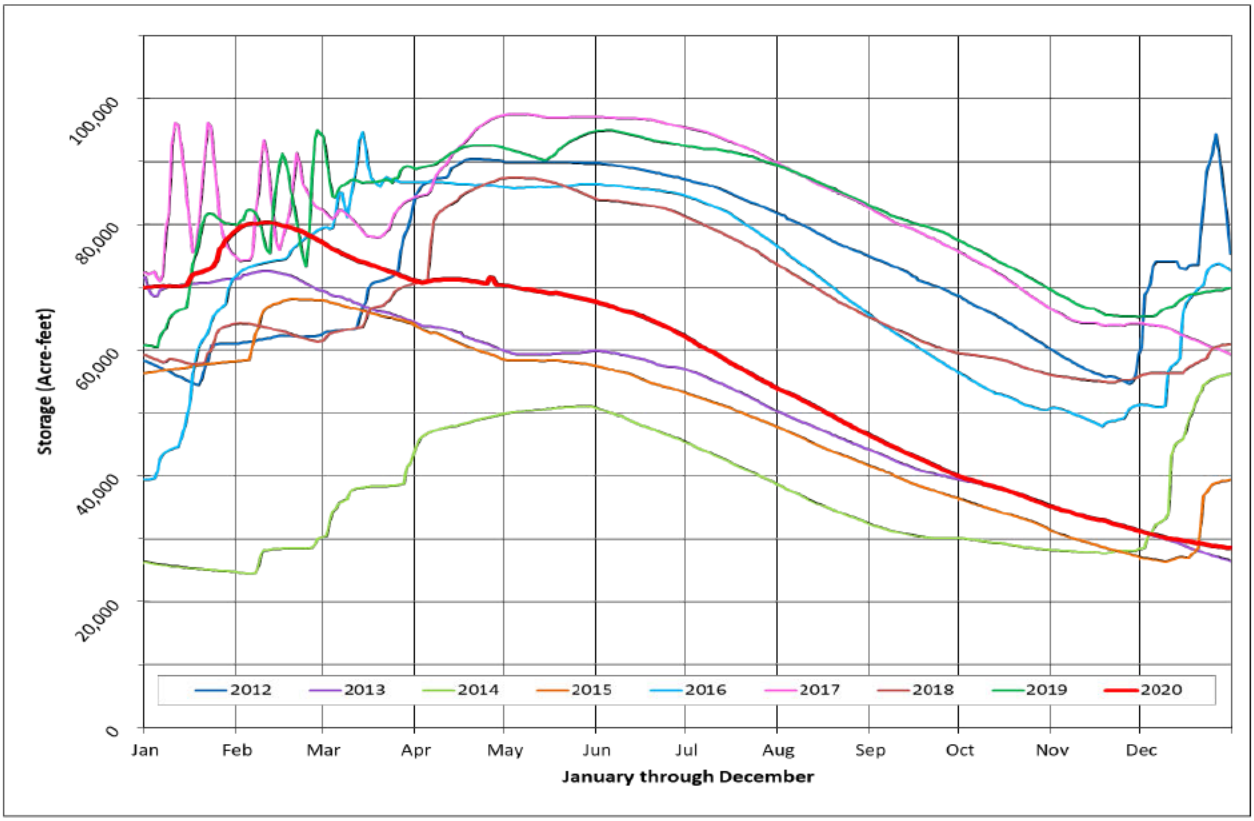


Figure 2-1. Lake Mendocino water storage levels, in acre-feet, from 2012 through 2020.

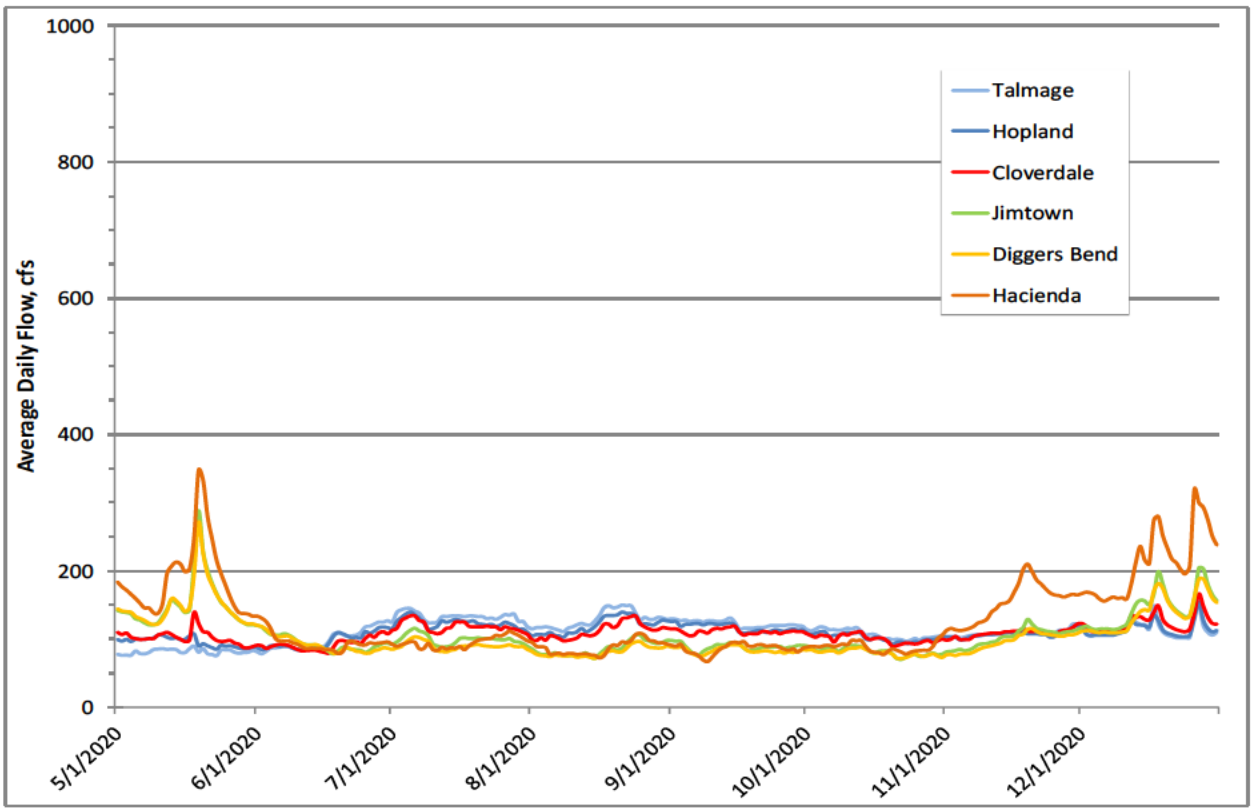


Figure 2-2. 2020 average daily flows in the Russian River as measured at U.S. Geological Survey (USGS) gages in cubic feet per second (cfs). Flow rates are preliminary and subject to final revision by USGS.

Although changes in upper Russian River minimum instream flow requirements authorized by the Order would allow flows to decline below D1610 minimum instream flows of 75 cfs, flows remained above the D1610 minimum at all stations with the exception of a few of days in August and October where flows declined slightly below the D1610 minimum at the Jimtown and Diggers Bend gages (Figure 2-3). Additionally, upper Russian River flows did not decline below the TUC minimum flows of 50 cfs or the instantaneous minimum flow of 40 cfs authorized by the Order (Figure 2-3).

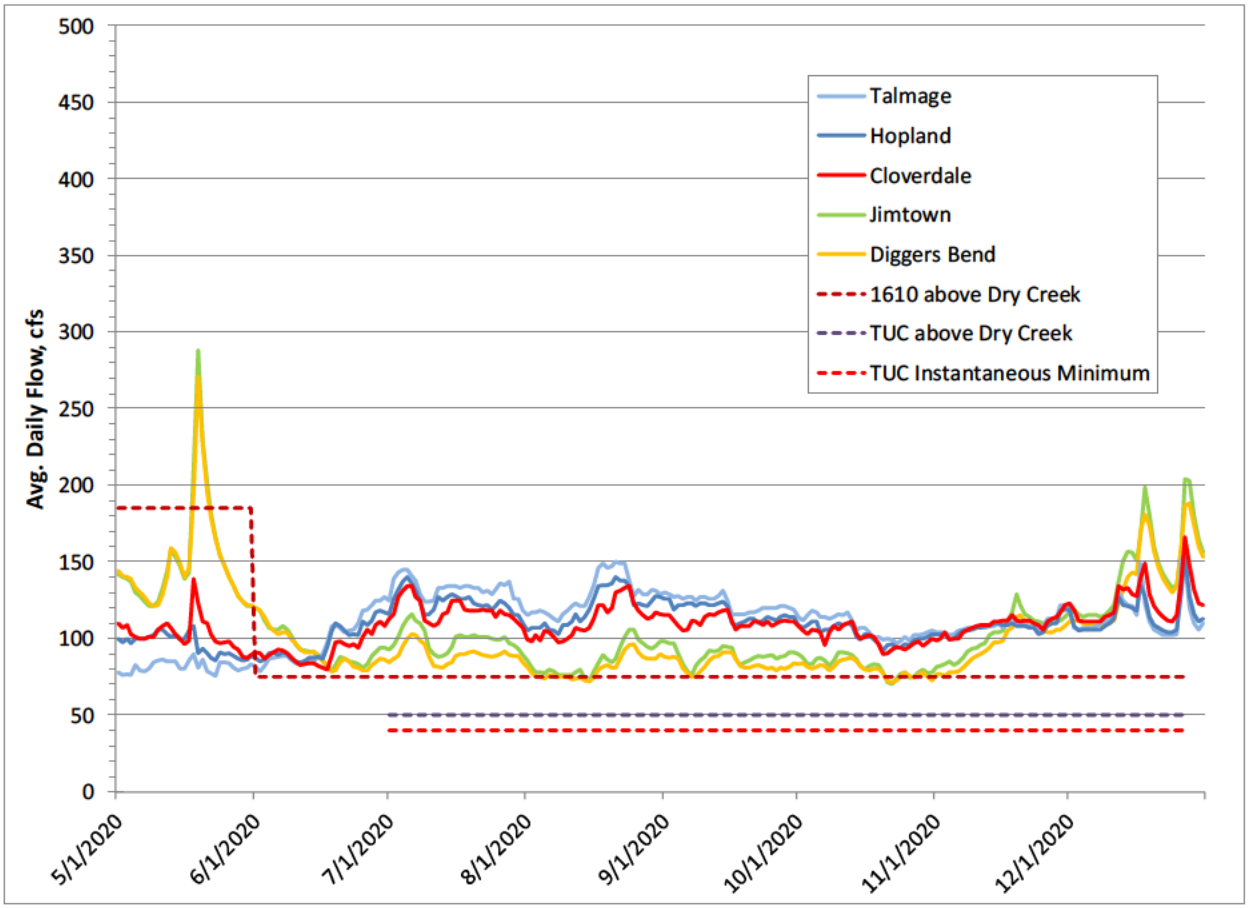


Figure 2-3. 2020 average daily flows in the upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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 periodically throughout the monitoring season (Figure 2-4). However, lower Russian River flows did not decline below the TUC minimum flows of 60 cfs or the instantaneous minimum flow of 50 cfs authorized by the Order (Figure 2-4).

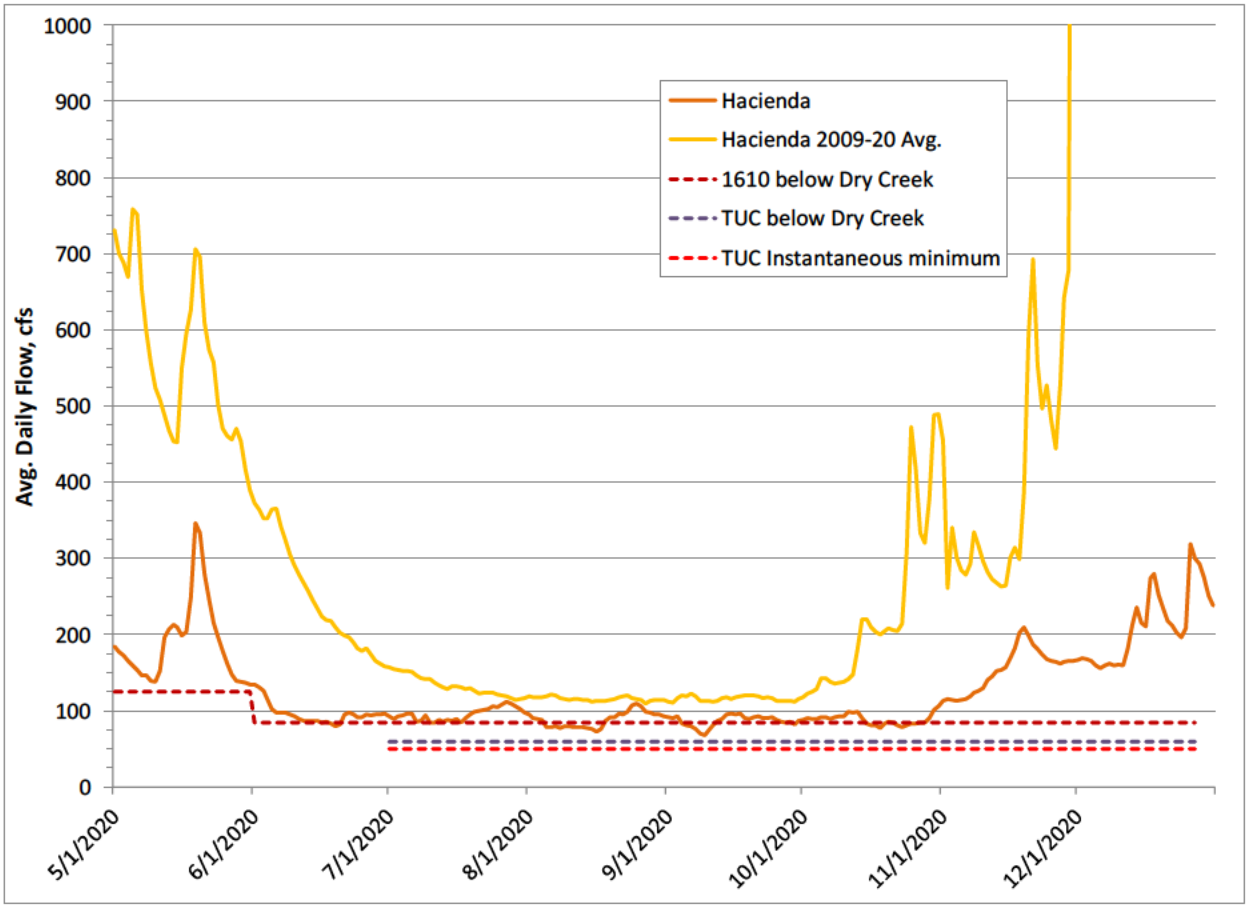


Figure 2-4. 2020 average daily flows in the lower Russian River as measured at USGS gages below the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

3.0 Water Quality Monitoring

Water quality data was collected to monitor TUC flows for potential effects to recreation and available aquatic habitat for salmonids. The data was used to supplement existing data to provide a more complete basis for analyzing spatial and temporal water quality trends due to Biological Opinion-stipulated changes in river flow and estuary management.

3.1 Mainstem Russian River Water Quality Monitoring

The North Coast Regional Water Quality Control Board (NCRWQCB), Sonoma County Department of Health Services (DHS), Sonoma Water, and Sonoma County Department of Parks and Recreation (Regional Parks) formed a workgroup to coordinate a monitoring approach for assessing cyanobacteria in the Russian River during the summer of 2016. Sonoma Water staff continue to consult and coordinate with NCRWQCB staff regarding monitoring activities related to the workgroup. As a result of ongoing consultation, Sonoma Water has made modifications to their existing Water Quality Monitoring Plan for the Russian River Estuary Management Project to include mainstem freshwater monitoring for the purpose of assisting in the evaluation of cyanobacteria harmful algal bloom (cyanoHAB) conditions and the risk of co-factors contributing to biostimulatory conditions and nuisance blooms (e.g., flow, temperature, nutrient, etc.).

In 2020, the Sonoma County DHS conducted weekly bacteriological and cyanotoxin sampling at ten (10) beaches with recreational activities involving the greatest body contact on the Russian River between Cloverdale and Patterson Point. Sonoma Water 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 2020 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 collected weekly beginning 26 May and continued until 17 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 no exceedances of the SSM for Total Coliform. There was one exceedance of the BAV for *E. coli* that occurred at Johnson's Beach on June 15. Results from the sampling program were reported by the Sonoma County DHS at their website and on the Sonoma County DHS Beach Sampling Hotline. The 2020 seasonal results are shown in Table 3-1 and in Figures 3-1 and 3-2.

Table 3-1. Sonoma County DHS 2020 Seasonal Mainstem Bacteria Sampling Results (Sonoma County DHS, 2020a).

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
26-May-20	4994	41	2481	52	2098	20	2143	10	312	<10	1565	<10	1126	<10	2382	<10	1785	<10	836	<10
1-Jun-20	3873	41	2143	<10	2987	<10	1956	<10	512	31	1539	<10	1597	31	1314	20	1414	148	2014	<10
8-Jun-20	3169	20	1483	20	1658	10	1086	<10	784	10	1989	10	1789	20	1050	<10	1553	31	1314	<10
15-Jun-20	4353	<10	1254	20	1211	10	2098	31	546	52	2849	<10	2014	10	1301	95	3873	537*	1850	41
17-Jun-20																	1043	31		
22-Jun-20	3873	52	1483	<10	3448	31	1541	<10	820	30	6488	41	1850	62	7270	41	1725	31	2247	52
29-Jun-20	3872	52	1469	<10	2613	10	1607	20	521	20	1314	41	1112	10	2481	31	1274	20	677	10
6-Jul-20	3448	63	2014	31	1723	52	1562	108	723	20	1860	<10	1153	41	2142	74	1014	<10	1236	20
13-Jul-20	3873	118	1376	<10	3282	10	1201	52	839	52	2098	86	1789	10	3044	52	1989	161	1071	10
20-Jul-20	4611	20	2603	20	1782	20	1597	10	776	10	1354	10	1624	63	1515	<10	857	41	3448	10
27-Jul-20	2603	30	624	<10	1291	<10	1565	<10	882	20	1333	31	1467	<10	906	10	959	120	627	<10
3-Aug-20	4352	41	1723	20	1956	<10	2359	20	712	<10	1396	<10	1333	10	1607	31	839	<10	749	10
10-Aug-20	9804	31	2603	52	2481	10	1782	20	1169	<10	1124	<10	1664	10	1259	31	1529	31	1720	<10
17-Aug-20	6131	185	1989	52	1785	20	2755	10	839	20	1850	10	1112	<10	1421	10	940	31	1918	20

* Resample conducted for confirmatory test.

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

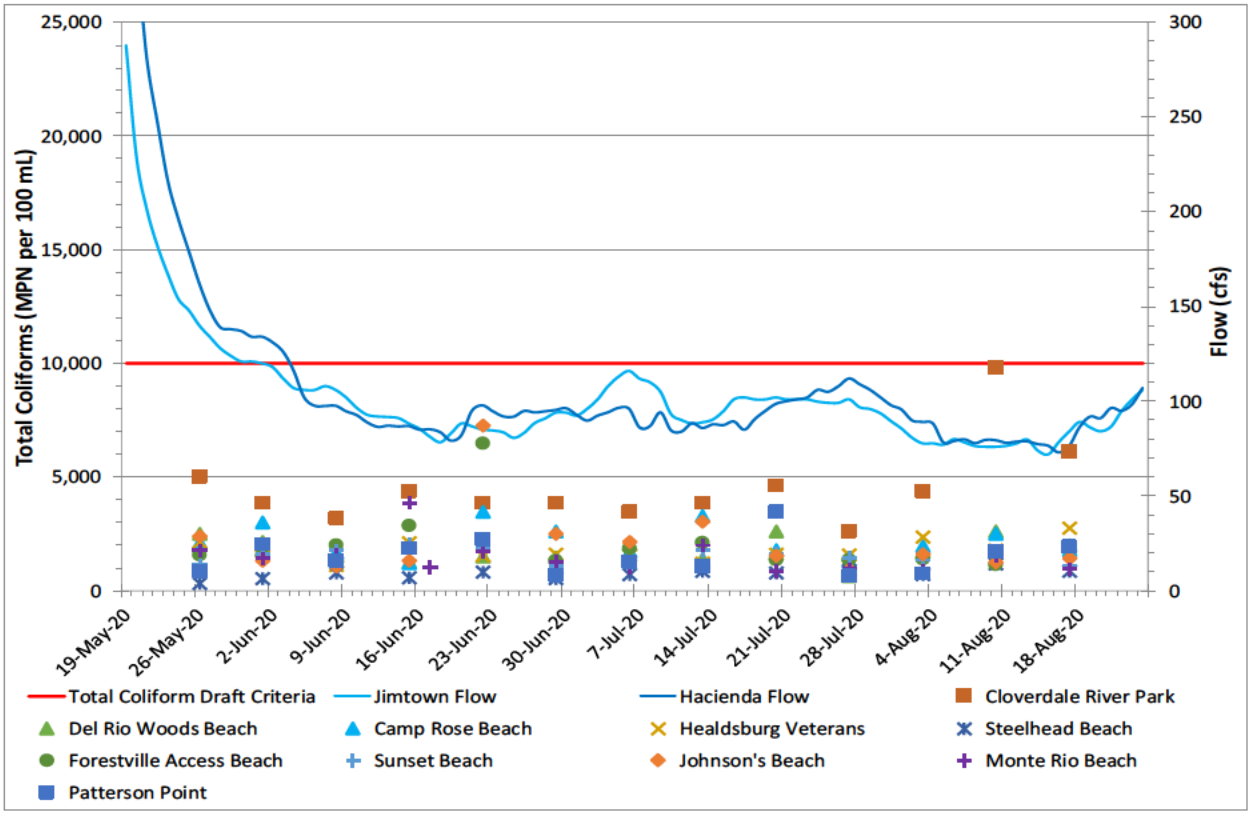


Figure 3-1. Sonoma County DHS 2020 Seasonal Mainstem Russian River Bacteria Sample Results for Total Coliform. Flow rates are preliminary and subject to final revision by USGS.

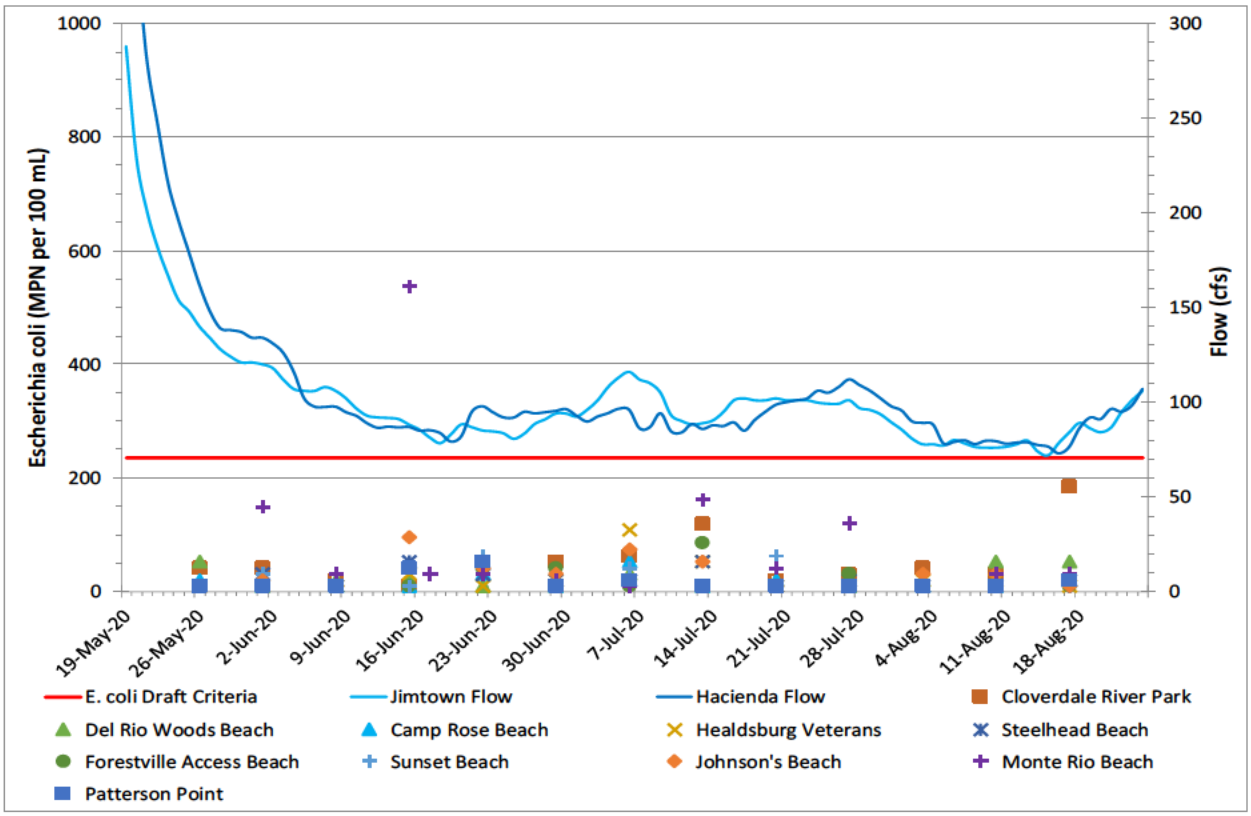


Figure 3-2. Sonoma County DHS 2020 Seasonal Mainstem Russian River Bacteria Sample Results for *E. coli*. Flow rates are preliminary and subject to final revision by USGS.

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

In 2020, the Sonoma County DHS conducted seasonal cyanotoxin sampling at ten (10) Russian River beaches with recreational activities involving the greatest body contact including 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. Cyanotoxin samples were collected weekly beginning 13 July and continued until 17 August.

Cyanobacteria are present in most freshwater and marine environments. When conditions are favorable, including abundant light, elevated water temperature, elevated levels of nutrients, and lack of water turbulence and velocity, cyanobacteria can quickly multiply into a bloom. Not every bloom is toxic; however, cyanoHABs are a concern as some species of cyanobacteria produce toxins that have the potential to impact drinking water, recreation, and fish and wildlife. Cyanotoxins were detected in the Russian River in 2015, 2016, 2017, and 2018, which led to Sonoma County DHS posting warning signs. Sonoma County DHS did not conduct cyanotoxin monitoring in 2019.

Currently, there are no federal or state standards for cyanotoxins in drinking water and recreational waters, however the EPA has issued draft guidance and continue to work toward identifying appropriate standards. Agencies participating in the California Water Quality Monitoring Council's (CWQMC) California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network, including the SWRCB, California Office of Environmental Health Hazard Assessment (OEHHA), and CDPH, have developed and are further refining suggested guidelines for addressing health concerns for cyanotoxins in recreation waters (CWQMC 2017). The CDPH, county health departments, and water body managers are encouraged to use this guidance for posting of water bodies when cyanoHABs pose a health threat. Three primary trigger levels have been developed for posting and closing beaches for Total Microcystins, Anatoxin-a, and Cylindrospermopsin. Caution signs are recommended when Total Microcystins exceed 0.8 micrograms per liter (µg/L), any detection is made of Anatoxin-a, and when Cylindrospermopsin exceeds 1 µg/L. Warning signs (Tier I) are recommended when Total Microcystins exceed 6 µg/L, Anatoxin-a exceeds 20 µg/L, and Cylindrospermopsin exceeds 4 µg/L. Danger signs (Tier II) are recommended when Total Microcystins exceed 20 µg/L, Anatoxin-a exceeds 90 µg/L, and Cylindrospermopsin exceeds 17 µg/L. Secondary triggers have also been developed for the posting of caution signs when cell densities of toxin producers exceed 4,000 cells/mL or if there are site specific indicators of cyanobacteria including blooms, scums, and mats.

Anatoxin-a was not detected at any of the monitoring sites during the monitoring period. Microcystin was detected at Johnson's Beach, Monte Rio Beach, and Patterson Point, however all of the results were below the caution level. Likewise, Cylindrospermopsin was detected at Johnson's Beach and Patterson Point, but all of the results were below the caution level. Results from the sampling program were reported on the Sonoma County DHS Beach Sampling Hotline and by Sonoma County DHS at their website: https://sonomacounty.ca.gov/Health/Environmental-Health/Water-Quality/Blue-Green-Algae/. The 2020 seasonal results are shown in Table 3-2.

Table 3-2. Sonoma County DHS 2020 Seasonal Mainstem Russian River Cyanotoxin Sampling Results (Sonoma County DHS, 2020b).

Anatoxin-a

	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
13-Jul-20	0	0	0	0	0	0	0	0	0	0
20-Jul-20	0	0	0	0	0	0	0	0	0	0
27-Jul-20	0	0	0	0	0	0	0	0	0	0
3-Aug-20	0	0	0	0	0	0	0	0	0	0
10-Aug-20	0	0	0	0	0	0	0	0	0	0
17-Aug-20	0	0	0	0	0	0	0	0	0	0

Microcystin

	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
13-Jul-20	0	0	0.141	0	0	0	0	0.164	0.156	0.193
20-Jul-20	0	0	0	0	0	0	0	0	0.145	0.167
27-Jul-20	0	0	0	0	0	0	0	0	0	0
3-Aug-20	0	0	0	0	0	0	0	0	0	0
10-Aug-20	0	0	0	0	0	0	0	0	0	0
17-Aug-20	0	0	0	0	0	0	0	0	0	0.166

Cylindrospermopsin

	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
13-Jul-20	0	0	0	0.069	0	0	0	0	0	0.067
20-Jul-20	0	0	0	0	0	0	0	0	0	0
27-Jul-20	0	0	0	0	0	0	0	0.07	0	0
3-Aug-20	0	0	0	0	0	0	0	0	0	0
10-Aug-20	0	0	0	0	0	0	0	0	0	0
17-Aug-20	0	0	0	0	0	0	0	0.059	0	0

All results are in µg/L. A value of zero (0) indicates that no toxins were detected.

State Trigger Levels

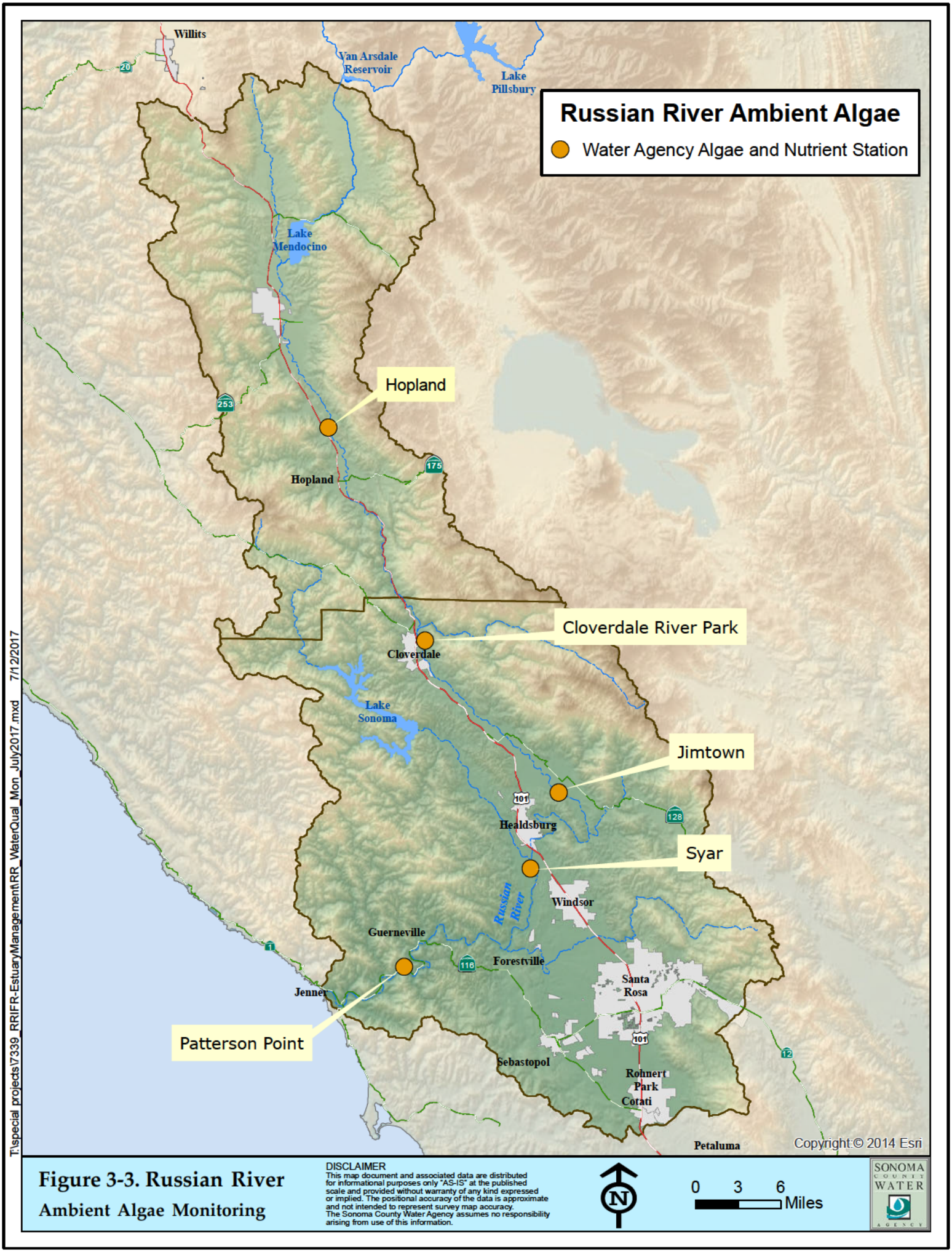
	Caution	Warning (Tier I)	Danger (Tier II)
Anatoxin-a	Any Detected	20 µg/L	90 µg/L
Microcystin	0.8 µg/L	6 µg/L	20 µg/L
Cylindrospermopsin	1 µg/L	4 µg/L	17 µg/L

Source: State Water Resources Control Board.

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

Ambient Algae

In 2020, Sonoma Water conducted biweekly ambient algae and cyanobacterial monitoring and sampling from 19 May through 18 December 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. This effort supports the NCRWQCB and Sonoma County DHS cyanotoxin monitoring and assessment for the potential for cyanoHABs in the Russian River (Figure 3-3). This effort is also being conducted to identify algal and cyanobacterial genera and species in the Russian River, as well as to estimate algal cover, frequency, and seasonal growth patterns.


Russian River Ambient Algae
Water Agency Algae and Nutrient Station
Willits
Van Arsdale Reservoir
Lake Pillsbury
Lake Mendocino
Hopland
Hopland
Cloverdale River Park
Cloverdale
Lake Sonoma
Jimtown
Healdsburg
Syar
Russian River
Windsor
Guerneville
Forestville
Jenner
Patterson Point
Santa Rosa
Sebastopol
Rohnert Park
Cotati
Petaluma
Copyright © 2014 Esri
T:\special projects\7339_RRIFR-EstuaryManagementRR_WaterQual_Mon_July2017.mxd 7/12/2017
Figure 3-3. Russian River
Ambient Algae Monitoring
DISCLAIMER
This map document and associated data are distributed for informational purposes only "AS-IS" at the published scale and provided without warranty of any kind expressed or implied. The positional accuracy of the data is approximate and not intended to represent survey map accuracy. The Sonoma County Water Agency assumes no responsibility arising from use of this information.
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SONOMA COUNTY WATER AGENCY

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

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

These algal groupings follow formal taxonomy for "Diatoms" (members of the Division Bacillariophyta) and "Cyanobacteria" (members of the Division Cyanophyta or photosynthetic bacteria), which are both considered microalgae for the purposes of monitoring cover and thickness. The Genera incorporated in "Green Macrophytes" are considered macroalgae and include both filamentous and single celled members of the Division Chlorophyta (green algae) and filamentous members of Xanthophyta (yellow-green algae). Specifically, "Green Macrophytes" described here include both green and yellow green macroscopic genera dominant in the periphyton such as *Vaucheria* (yellow green), *Cladophora* (green), *Spirogyra* (green), *Mouegotia* (green), *Oedogonium* (green), *Zygnema* (green), and *Tribonema* (yellow-green). The "Others" grouping includes the Divisions Rhodophyta (red algae), Chrysophyta (golden brown algae), and Dinophyta (Dinoflagellates).

Over the monitoring period, 462 slides were evaluated from multi-habitat samples collected from the 4 monitoring stations. Genera present in the samples were detected and identified a total of 7,489 times. Figure 3-4 illustrates the frequency of algal species observed in the mainstem Russian River between May 2020 and December 2020 at the four TUC stations. Figure 3-4 displays which algal genera were detected along the "x" axis while the "y" axis indicates the number of times each genus was detected. Some of the sampling dates vary between monitoring stations due to the occurrence of wildfires in Sonoma County during the monitoring period precluding sampling in September and October 2020.

For cover measurements, the periphyton was divided into two groups that are differentiated depending on their visibility without microscopic evaluation. Microalgae is comprised of microscopic algae genera that in the periphyton is dominated by diatoms and cyanobacteria but also includes other benthic green, red and yellow green microscopic algal genera. Macroalgae are the larger filamentous members of the periphyton that microalgae often grow on as epiphytes, and often form drift (or metaphyton) that accumulates in backwater areas and shallow shorelines.

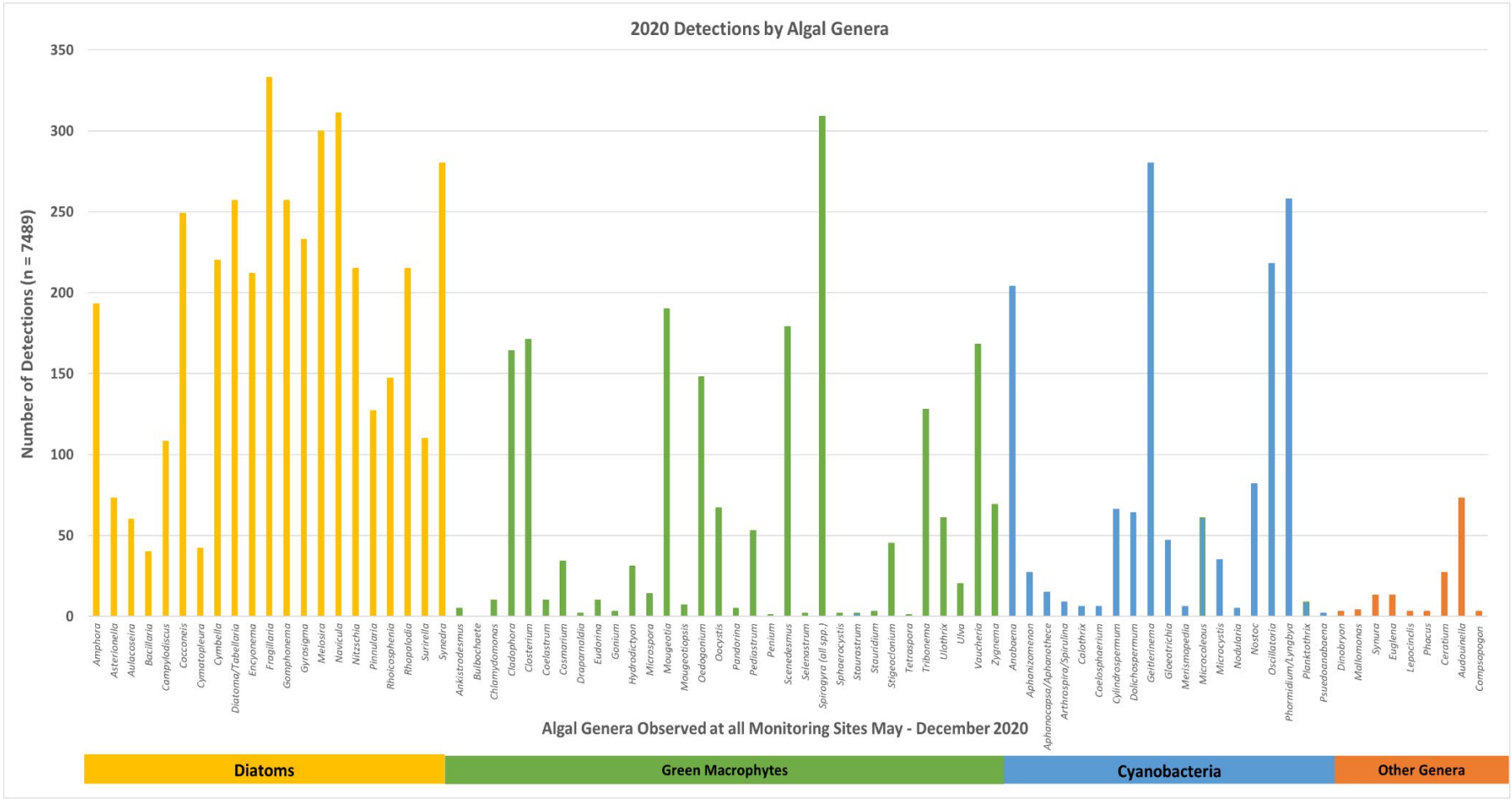


Figure 3-4. Algal Genera by Grouping Detected at the Hopland, Jimtown, Syar, and Patterson Point Ambient Algae Monitoring Stations in the Russian River in 2020.

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.

Overall, the river's littoral zone was only moderately scoured by flows in the winter of 2020. Significant gravel and bed movement was only observed at the Patterson Point monitoring station. Substrates were already colonized by microalgae at Hopland, Jimtown, and Syar in May and June of 2020.

In general, the development of filamentous algae in the Russian River in 2020 appeared to be affected by invertebrate grazing. High numbers of New Zealand mud snails were observed in the littoral zone between May and July at all monitoring sites. Filamentous algae species started developing in late July at the Jimtown, Syar, and Patterson Point monitoring stations and stayed prevalent through December.

Dominant filamentous species in the periphyton were observed to be *Vaucheria* all season long at Hopland while *Spirogyra* was the dominant filamentous species at Jimtown, Syar, and Patterson Point. Mats of *Microcoleus*/*Phormidium* were present, though not widespread at the Jimtown and Syar sites in August. These mats persisted at these locations through December 2020. The diatoms *Rhopalodia* and *Amphora* were observed to be microscopically associated (imbedded in mucilage) with the cyanobacterial mats.

Figures 3-5 through 3-8 illustrate the shifts in frequency of the four algal groupings through the monitoring season based on number of detections of algae genera collected from the range of algae habitats present in the littoral zone up to 100 feet (30 meters) upstream and downstream of the transect. Diatoms were consistently found in the greatest frequency at all stations. Green macrophyte frequency was generally higher during the monitoring season than Cyanobacteria. Diatom frequency stayed higher at all sites than frequency observed to be contributed by Green macrophytes and Cyanobacteria throughout the monitoring season.

Some direct observations regarding the algal groups are evident. Figure 3-9 illustrates the overall average frequency of detections for the algal groupings as a percentage calculated for all sites between May and December 2020. Diatoms made up 53% of all detections. Green Macrophytes comprised 26% of all detections, Cyanobacteria made up 19%, and the rest of the detections were represented by Others at 2%.

Figures 3-10 through 3-13 display estimated cover contributed by microalgae (diatoms and cyanobacteria) versus macroalgae (filamentous green and yellow-green algae) during the monitoring season. Microalgae cover stayed higher at all sites than cover observed to be contributed by Macroalgae throughout the monitoring season. At the Patterson Point station there was a dip observed in Diatoms that coincided with a river mouth/estuary closure in late August-early September. Because of increased water clarity and low turbidity at the Hopland monitoring station, it is hypothesized that cover by Green macrophytes (specifically *Vaucheria*) was unusually high during the monitoring season compared to previous years of monitoring.

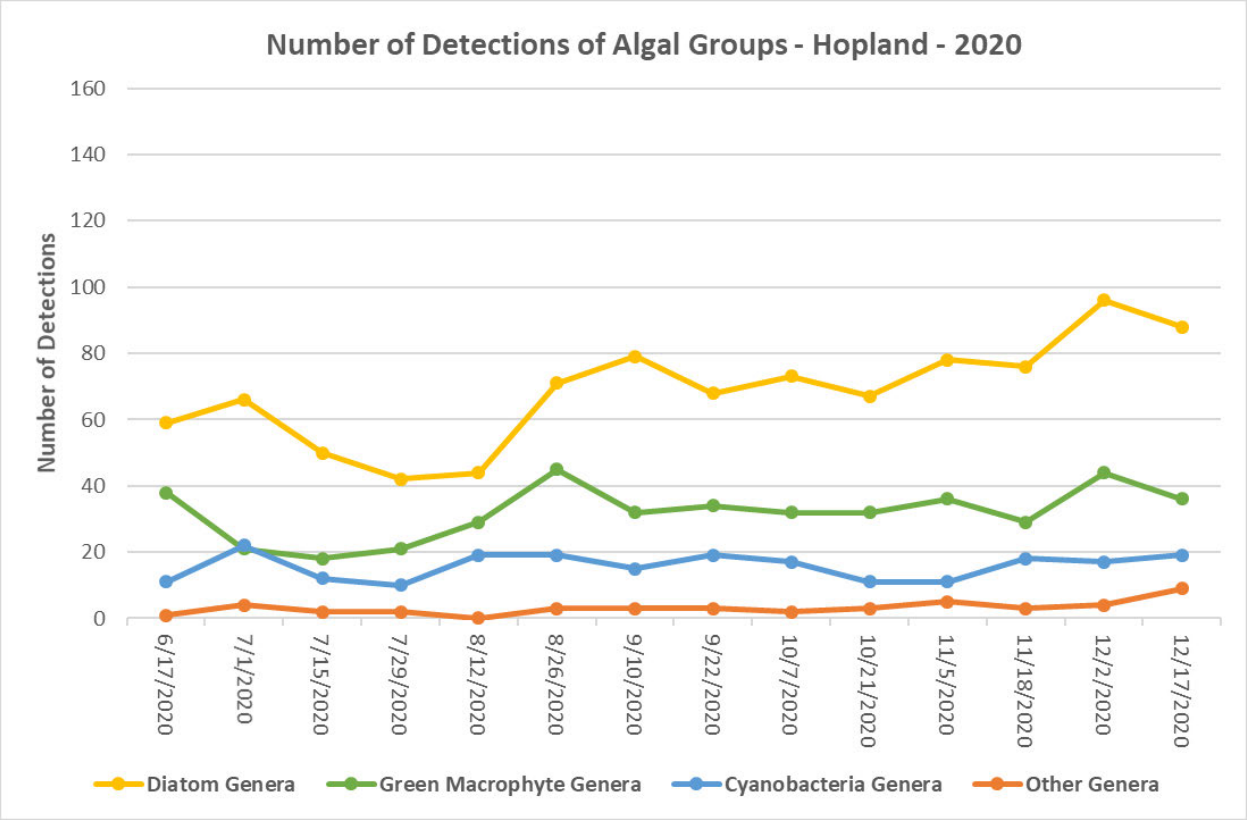


Figure 3-5. Number of Detections of Algal Groups at the Hopland Monitoring Station in 2020.

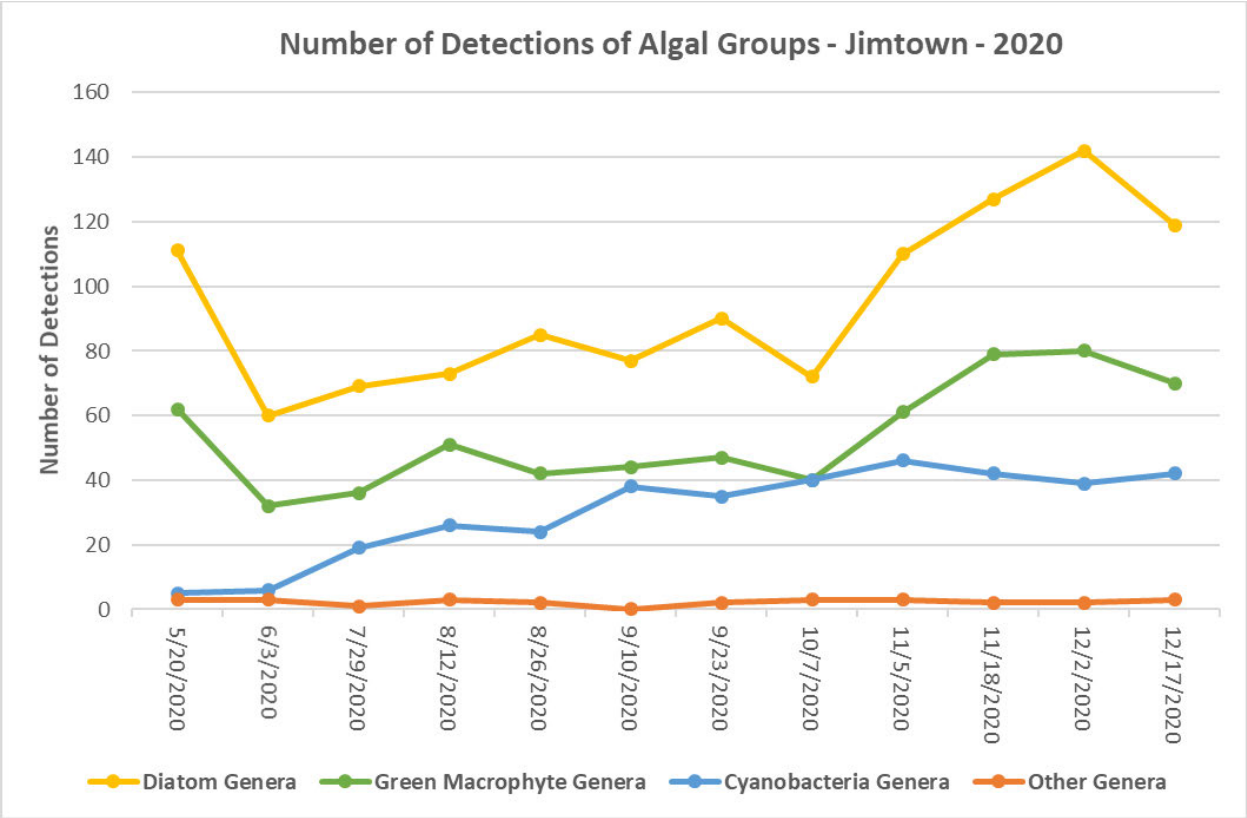


Figure 3-6. Number of Detections of Algal Groups at the Jimtown Monitoring Station in 2020.

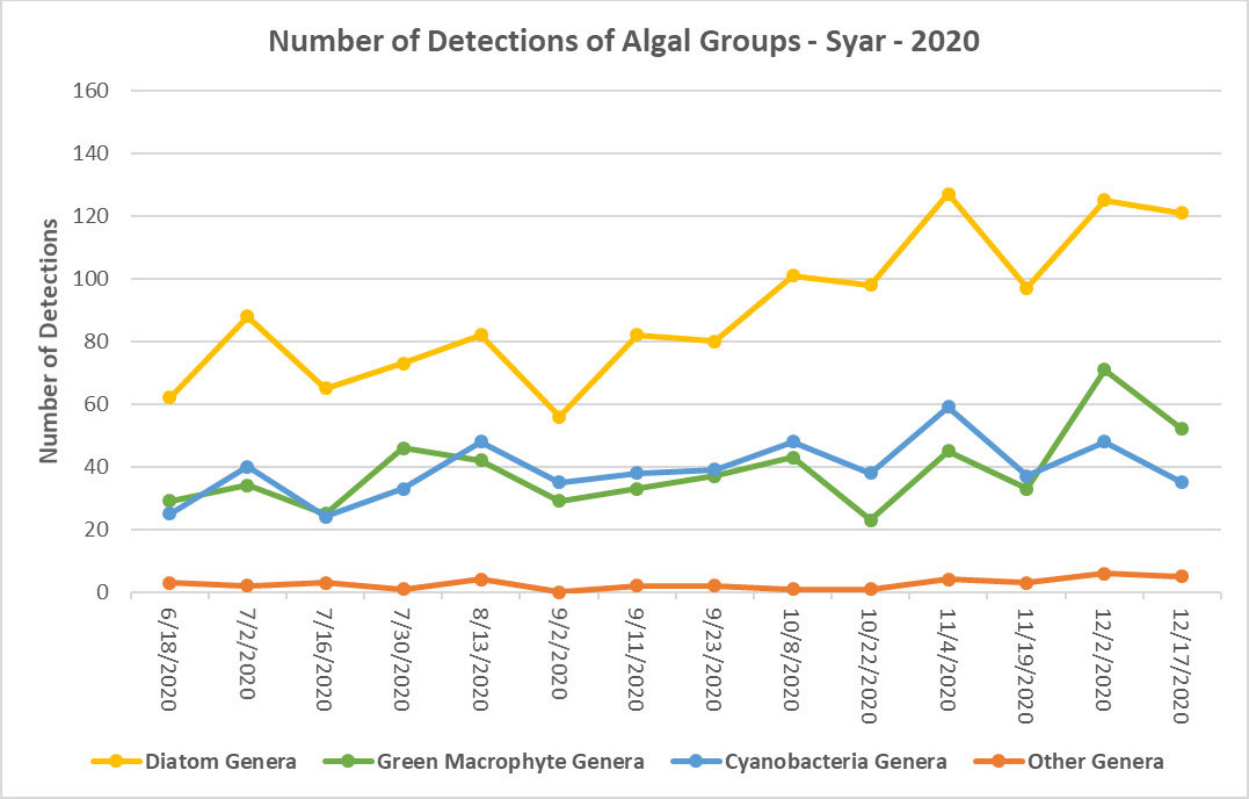


Figure 3-7. Number of Detections of Algal Groups at the Syar Monitoring Station in 2020.

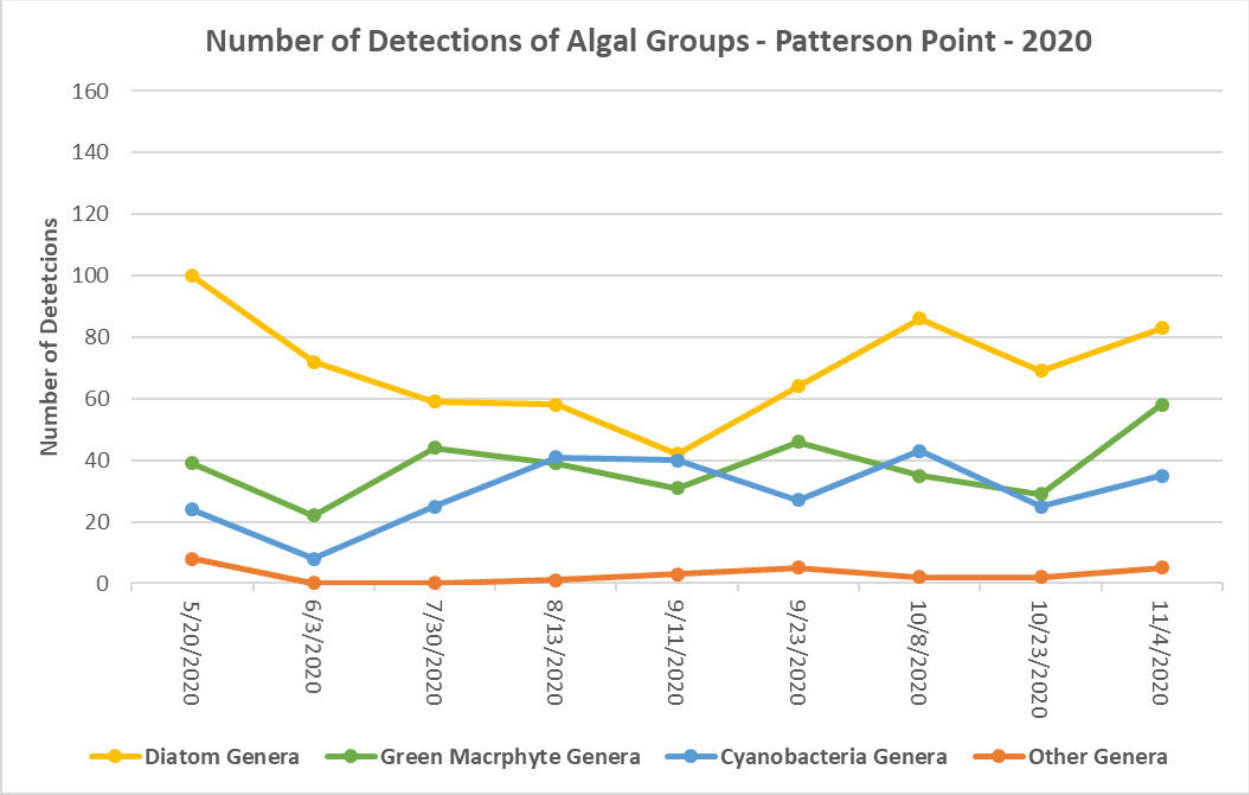


Figure 3-8. Number of Detections of Algal Groups at the Patterson Point Monitoring Station in 2020.

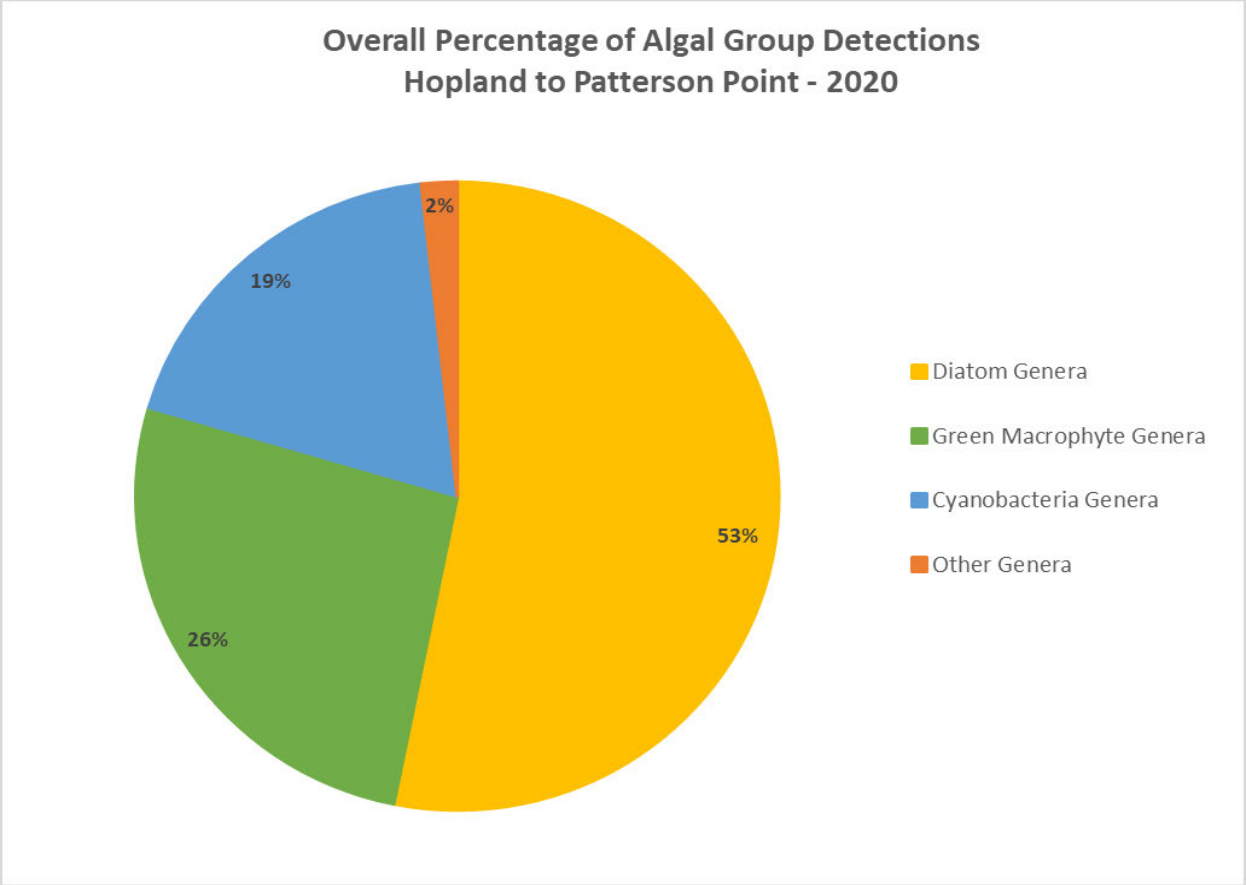


Figure 3-9. Overall Percentage of Algal Group Detections at Hopland, Jimtown, Syar, and Patterson Point in 2020.

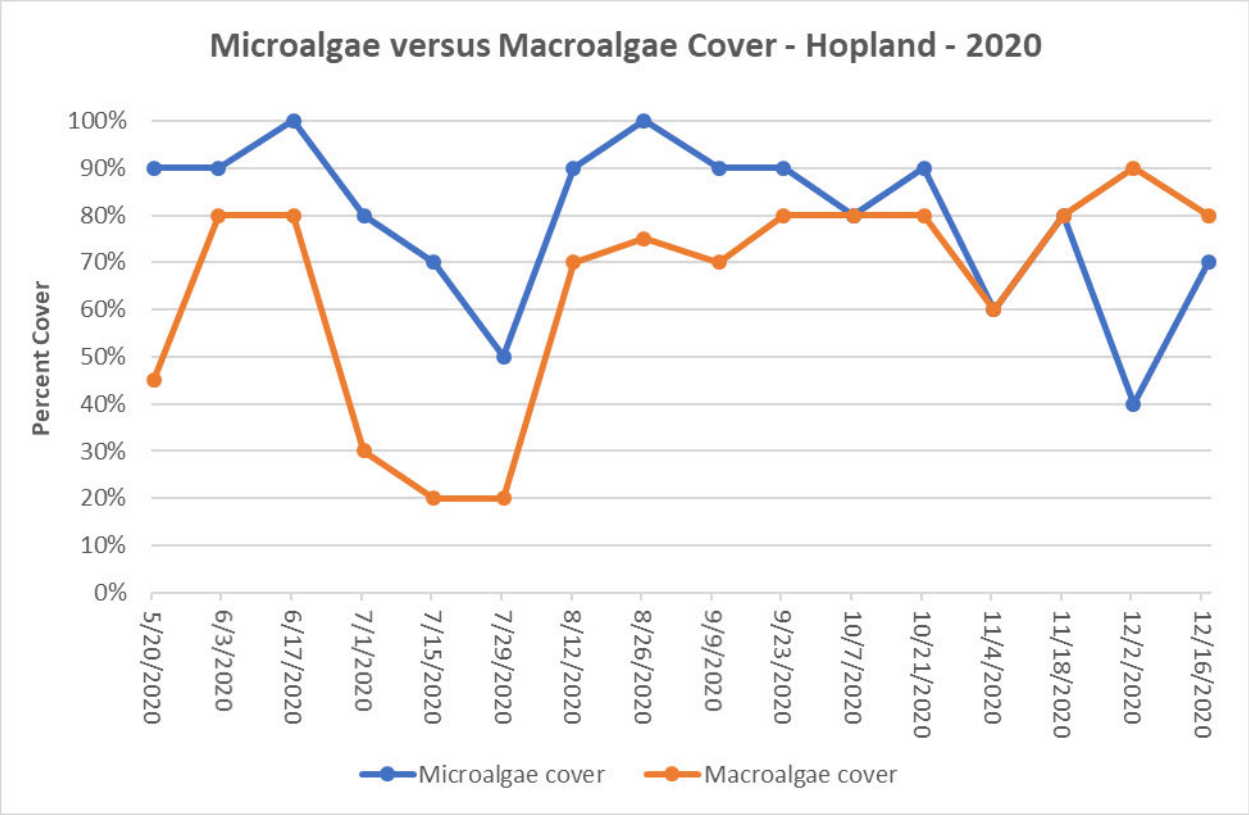


Figure 3-10. Microalgae versus Macroalgae Cover at Hopland in 2020.

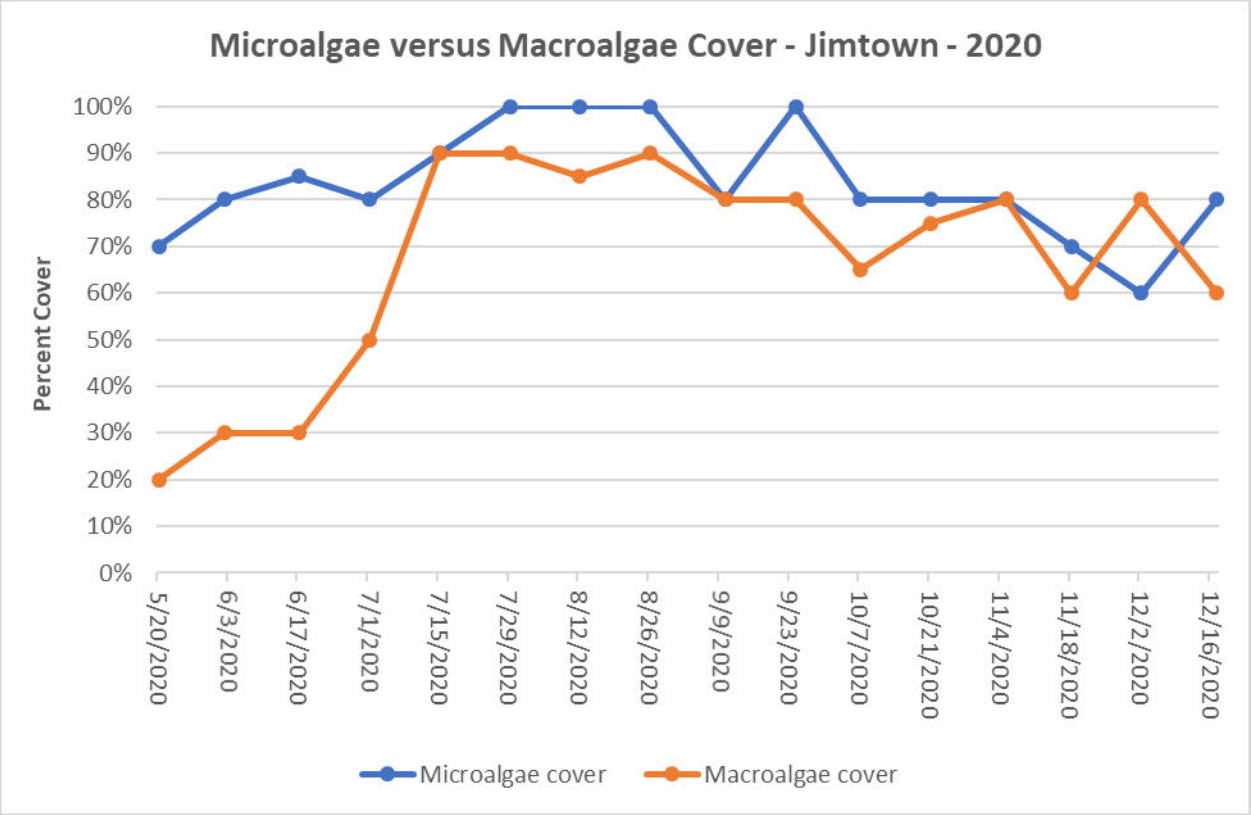


Figure 3-11. Microalgae versus Macroalgae Cover at Jimtown in 2020.

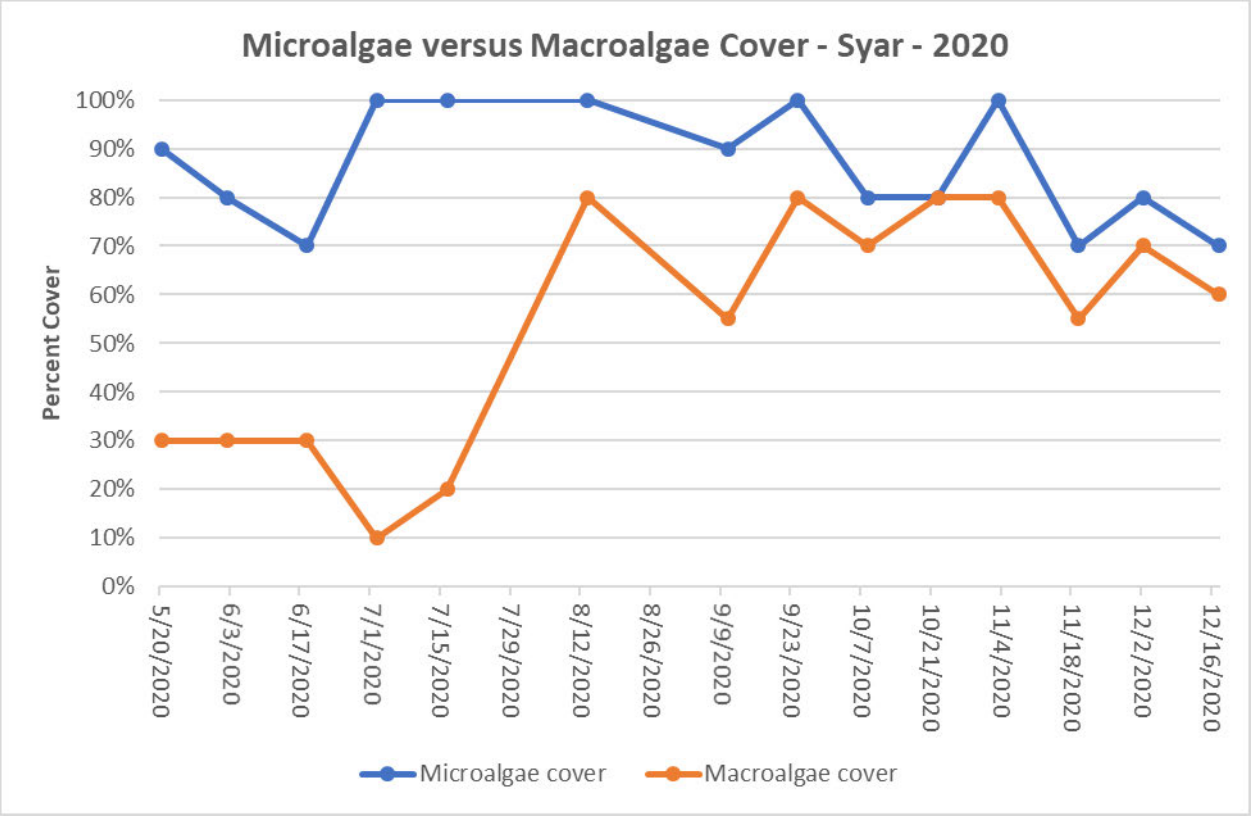


Figure 3-12. Microalgae versus Macroalgae Cover at Syar in 2020.

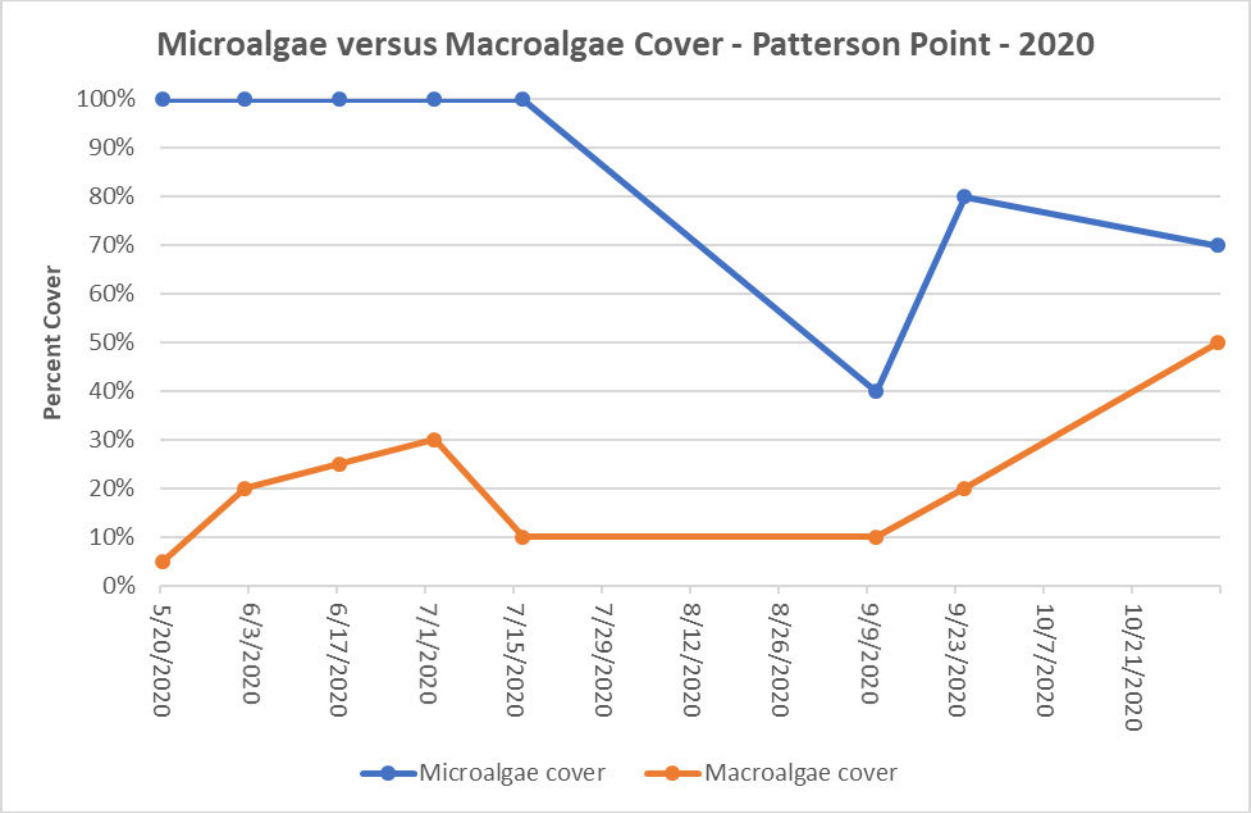


Figure 3-13. Microalgae versus Macroalgae Cover at Patterson Point in 2020.

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 3-3).

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

The sampling results for total nitrogen, total phosphorus, turbidity, and *chlorophyll a* are discussed below and summarized in Tables 3-3 through 3-5 and Figures 3-14 through 3-19. The United States Environmental Protection Agency (USEPA) has established section 304(a) nutrient criteria across 14 major ecoregions of the United States. The Russian River was designated in Aggregate Ecoregion III (USEPA, 2013a).

Highlighted values indicate those values exceeding EPA recommended criteria for "Nutrients, *Chlorophyll a*, and Turbidity in Rivers and Streams in Aggregate Ecoregion III" (EPA 2000). However, it must be emphasized that the EPA criteria are not adopted standards and are therefore both subject to change (if it is determined that the guidelines or criteria are not accurate indicators) and are not

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

Ambient algae, cyanobacteria, estuary response, and associated grab sampling data for 2020 is currently being compiled and will be discussed in greater detail in the Russian River Biological Opinion 2020-2021 annual report, which will be posted to Sonoma Water's website when available: http://www.scwa.ca.gov/bo-annual-report/.

Total Nitrogen

The USEPA desired goal for total nitrogen in Aggregate Ecoregion III is 0.38 mg/L for rivers and streams not discharging into lakes or reservoirs (USEPA, 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 two (2) times, representing 2.6% of the total samples collected (2 out of 77) during the ambient algae monitoring effort (Tables 3-3 through 3-5, and Figure 3-14).

Hopland had one (1) exceedance out of 13 samples collected of the total nitrogen criteria (7.7%), which measured 0.43 mg/L on 10 September with a flow of 119 cfs (Table 3-3 and Figure 3-14). Nitrogen values were observed to generally decline from spring into summer at Hopland then increase through the fall. However, Hopland also experienced two (2) spikes in concentration during the summer months including a value of 0.36 mg/L on 28 July and the seasonal maximum on 10 September.

Cloverdale River Park did not have any exceedances out of 13 samples collected of the total nitrogen criteria (0%), and the maximum seasonal value measured 0.35 mg/L on 18 November with a flow of approximately 116 cfs (Table 3-3 and Figure 3-14). Nitrogen values at Cloverdale were observed to generally decline from spring into summer then increase into the fall. Cloverdale also experienced increases in concentration during the summer months on 28 July and 10 September, though they were much lower concentrations than at Hopland.

Jimtown did not have any exceedances of the total nitrogen EPA criteria out of 13 samples collected (0%). The maximum seasonal value measured 0.35 mg/L on 18 November with a flow of approximately 116 cfs (Table 3-4 and Figure 3-14). Nitrogen values at Jimtown were also observed to generally decline from spring into summer, but they remained low through the fall, unlike Cloverdale and Hopland. However, Jimtown also experienced increases in concentration on 28 July and 10 September.

Syar had one (1) exceedance of the total nitrogen EPA criteria out of 13 samples collected (7.7%), which measured 0.65 mg/L on 20 May with a flow of approximately 353 cfs (Table 3-4 and Figure 3-14). Syar also had nitrogen values that generally declined from spring into summer and had similar increases in concentration that occurred on 28 July and 10 September.

Table 3-3. Sonoma Water 2020 Seasonal Mainstem Russian River Grab Sampling Results at Hopland and Cloverdale.

Hopland	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11462500 RR near Hopland****
MDL*				0 20	0.10	0.00010	0.040	0.050	0.20	0 50	0.010	0.030	0.600	0.300	10	0.10	0.0010	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/20/2020	14:00	15.3	7.7	ND	ND	ND	0.27	ND	ND	0 27	**0.022**	0.039	1.28	1.59	140	2.0	ND	105
6/3/2020	13:40	19.6	8.4	ND	ND	ND	0.17	ND	ND	0.17	0.019	ND	1.76	1.97	130	1.4	**0.0064**	85.2
6/17/2020	11:20	16.2	8.0	ND	ND	ND	0.11	ND	ND	0.11	0.019	ND	1.56	2.04	120	**3.8**	**0.0032**	92.8
7/1/2020	12:30	16.0	7.9	ND	ND	ND	0.086	ND	ND	0.086	**0.063**	0.056	1.43	2.14	140	**18**	**0.0021**	112
7/15/2020	11:40	15.9	7.8	ND	ND	ND	0.087	ND	ND	0.087	**0.062**	0.059	2.10	2.17	130	**18**	0.0016	125
7/28/2020	11:30	16.3	7.9	0 26	ND	ND	0.096	ND	0.26	0.36	**0.076**	0.084	1.62	2.12	130	**17.0**	0.0013	116
8/12/2020	12:10	17.4	8.2	ND	ND	ND	0.072	ND	ND	0.072	**0.064**	0.083	1.77	2.08	120	**9.8**	ND	113
8/26/2020	11:50	17.7	8.2	ND	ND	ND	ND	ND	ND	ND	**0.060**	0.087	1.75	2.32	120	**4.5**	ND	119
9/10/2020	11:50	16.2	8.0	0 21	ND	ND	0.16	0.059	0.21	**0.43**	**0.089**	0.18	1.65	2.22	120	**3.6**	**0.018**	119
9/23/2020	11:30	18.5	8.1	ND	ND	ND	0.12	ND	ND	0.12	**0.099**	0.22	1.95	2.42	130	1.4	**0.0020**	109
10/7/2020	11:50	18.1	8.1	ND	ND	ND	0.14	ND	ND	0.14	**0.073**	0.14	2.29	2.56	130	**2.9**	**0.0030**	103
10/21/2020	11:50	17.7	7.8	ND	ND	ND	0.15	ND	ND	0.15	**0.056**	0.12	2.08	2.31	160	**2.4**	ND	93.7
11/18/2020	12:00	13.7	7.7	0 26	ND	ND	0.11	ND	0.26	0.37	**0.050**	0.069	2.23	2.94	140	**7.2**	ND	107

Cloverdale River Park	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11463000 RR near Cloverdale***
MDL*				0 20	0.10	0.00010	0.040	0.050	0.20	0 50	0.010	0.030	0.600	0.300	10	0.10	0.0010	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/20/2020	13:00	17.4	8.4	ND	ND	ND	0.25	ND	ND	0 25	0.018	ND	1.39	1.70	150	1.8	0.0014	111
6/3/2020	12:50	22.8	8.2	ND	ND	ND	0.070	ND	ND	0.070	0.017	0.17	1.35	1.66	160	2.0	**0.0032**	86.7
6/17/2020	10:30	18.8	8.1	ND	ND	ND	0.070	ND	ND	0.070	0.015	ND	1.33	1.71	140	**2.6**	0.0011	79.9
7/1/2020	11:20	21.0	8.2	ND	ND	ND	ND	ND	ND	ND	0.020	ND	1.50	2.04	150	**2.4**	**0.0027**	113
7/15/2020	10:50	20.6	8.2	ND	ND	ND	ND	ND	ND	ND	**0.028**	ND	1.62	2.00	130	**6.4**	**0.0048**	125
7/28/2020	10:50	20.5	8.2	ND	ND	ND	0.058	ND	ND	0.058	**0.035**	ND	1.62	2.20	140	**3.4**	**0.0037**	115
8/12/2020	11:20	21.6	8.3	ND	ND	ND	ND	ND	ND	ND	**0.039**	0.050	1.77	1.99	140	**2.4**	0.0013	108
8/26/2020	11:00	19.8	8.3	ND	ND	ND	ND	ND	ND	ND	**0.036**	0.059	1.63	2.22	130	1.9	ND	118
9/10/2020	11:00	17.3	8.1	ND	ND	ND	0.068	ND	ND	0.068	**0.047**	0.08	1.53	2.37	150	**2.8**	**0.0032**	115
9/23/2020	10:40	18.1	8.4	ND	ND	ND	ND	ND	ND	ND	**0.050**	0.10	1.82	2.28	140	0.91	ND	109
10/7/2020	11:00	17.7	8.3	ND	ND	ND	ND	ND	ND	ND	**0.038**	0.070	2.01	2.30	140	1.2	0.0010	95.9
10/21/2020	11:00	17.3	8.1	0 26	ND	ND	0.045	ND	0.26	0.31	**0.033**	0.051	1.78	2.01	150	0.65	ND	90.7
11/18/2020	11:10	13.6	7.9	0 26	ND	ND	0.093	ND	0.26	0.35	**0.069**	0.041	1.77	2.16	140	**4.0**	**0.0052**	116

* 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.

*** Turbidity results after 6/16 were recorded using a YSI 6600 datasonde.

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

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

Recommended EPA Criteria based on Aggregate Ecoregion III

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

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

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

Patterson Point did not have any exceedances of the total nitrogen EPA criteria out of 25 samples collected (0%). The maximum seasonal value measured 0.063 mg/L on 16 June with a flow of 87.8 cfs (Table 3-5 and Figure 3-14). Total nitrogen values remained relatively low at Patterson Point throughout the monitoring season, including several non-detect results during the summer, and the station did not experience the July and September increases observed at the upstream stations.

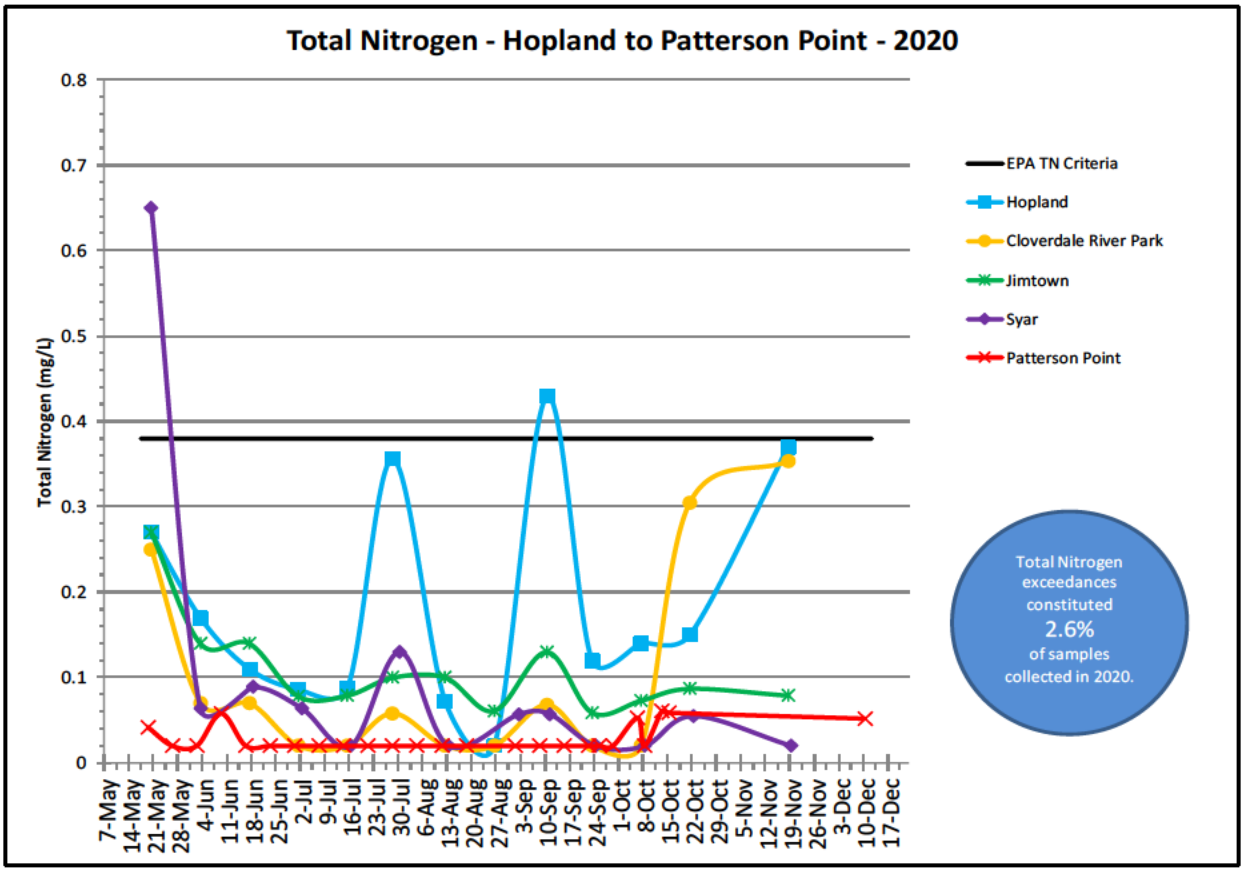


Figure 3-14. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Total Nitrogen Results in 2020.

Total Phosphorus

The USEPA'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 not discharging into lakes or reservoirs (USEPA, 2000). Four of the five monitoring stations were observed to have exceedances of the EPA criteria for total phosphorous during the monitoring season (Tables 3-3 through 3-5, and Figure 3-15). The EPA criteria was exceeded 44 times out of a total of 77 samples collected at the five stations (57.1%). The Hopland, Cloverdale, and Patterson Point stations predominantly exceeded the total phosphorus criteria during the monitoring season, whereas the Jimtown station had only one observed exceedance. The Syar station did not have any observed exceedances during the 2020 season.

The station at Hopland generally had higher concentrations than the other stations, with the exception of the Patterson Point station in the spring. Hopland was observed to have the highest overall concentration with a maximum value of 0.099 mg/L that occurred on 23 September with a flow of 109 cfs (Table 3-4). Hopland exceeded the EPA criteria for a majority of the season, including 11 of 13 samples (84.6%), under flows that ranged from 93.7 cfs to 125 cfs (Table 3-3 and Figure 3-15). Total phosphorus values were observed to generally increase from spring into summer at Hopland then decrease through the fall. Hopland also experienced two spikes in concentration during the summer months including a value of 0.076 mg/L on 28 July and the seasonal maximum on 23 September.

The Cloverdale River Park station also exceeded the total phosphorus EPA criteria for a majority of the season, including 9 of 13 samples (69.2%) under flows that ranged from 90.7 to 125 cfs. The maximum concentration measured 0.069 mg/L on 18 November with a flow of 116 cfs (Table 3-3 and Figure 3-15). Total phosphorus values at Cloverdale were observed to generally increase from spring into summer then decrease through the fall before spiking during the November sampling event. Cloverdale also experienced two spikes in concentration during the summer months on 12 August and 23 September, though they were much lower concentrations than at Hopland.

Concentrations at the Jimtown station were significantly lower compared to the Hopland and Cloverdale stations, including a single observed exceedance (1 of 13 or 7.7%) of the EPA criteria, which measured 0.022 mg/L on 10 September with a flow of 88.2 cfs (Table 3-4 and Figure 3-15). Total phosphorus values at Jimtown remained consistently low throughout the season, unlike Cloverdale and Hopland. However, Jimtown also experienced two minor increases in concentration, though slightly later in the season on 10 September and 7 October.

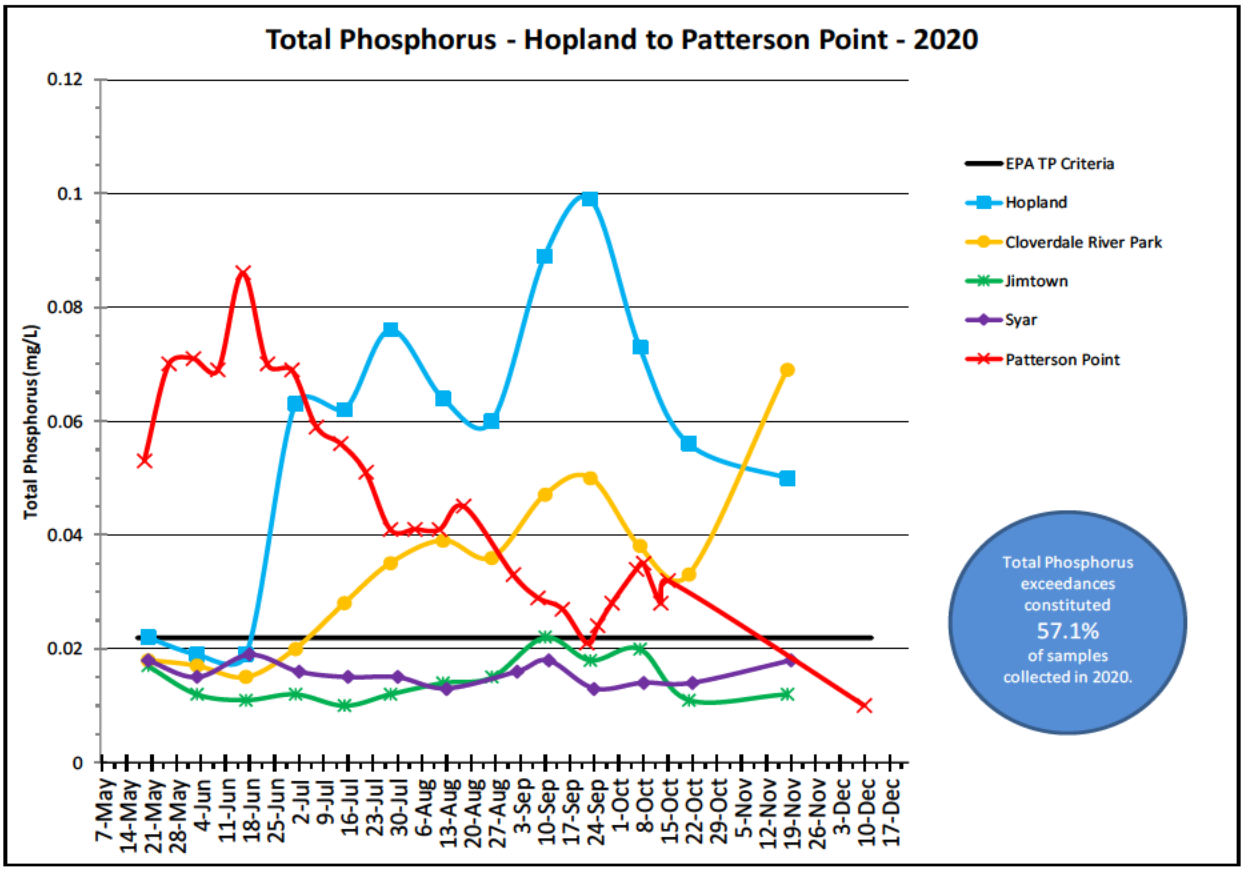


Figure 3-15. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Total Phosphorus Results in 2020.

Syar Vineyards had no exceedances (0 of 13 or 0%) of the total phosphorus EPA criteria during the season, with a maximum value of 0.019 mg/L that occurred on 18 June and a flow of 152 cfs (Table 3-4 and Figure 3-15). Total phosphorus values at Syar Vineyards remained consistently low throughout the season, similar to Jimtown.

Patterson Point exceeded the total phosphorus criteria on all but two sampling events (23 of 35 or 92%), including a maximum value of 0.086 mg/L that occurred on 16 June with a flow of 87.8 cfs (Table 3-5 and

Figure 3-15). Concentrations increased through spring then generally declined through the rest of the season following the seasonal maximum value measured on 16 June.

While total phosphorus concentrations generally increased through the season at Hopland and Cloverdale River Park compared to concentrations observed during the spring, they remained relatively level at Jimtown and Syar Vineyards, and generally decreased through the season at Patterson Point (Figure 3-15).

Table 3-4. Sonoma Water 2020 Seasonal Mainstem Russian River Grab Sampling Results at Jimtown and Syar.

Jimtown	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11463682 RR at Jimtown****
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0 50	0.010	0.030	0.600	0.300	10	0.10	0.0010	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/20/2020	12:20	18.1	7.8	ND	ND	ND	0.27	ND	ND	0 27	0.017	ND	1.13	1.6	170	1.8	**0.0025**	229
6/3/2020	11:50	22.9	7.6	ND	ND	ND	0.14	ND	ND	0.14	0.012	ND	0.959	1.23	200	1.5	0.0014	112
6/17/2020	9:20	18.6	7.5	ND	ND	ND	0.14	ND	ND	0.14	0.011	ND	1.09	1.21	160	0.69	**0.0018**	81.3
7/1/2020	9:40	21.1	7.7	ND	ND	ND	0.078	ND	ND	0.078	0.012	ND	0.926	1.52	170	0.40	0.0002	92.5
7/15/2020	9:20	20.7	7.6	ND	ND	ND	0.079	ND	ND	0.079	0.010	ND	1.15	1.61	160	**2.4**	**0.0032**	94.8
7/28/2020	9:40	20.4	7.6	ND	ND	ND	0.10	ND	ND	0.10	0.012	ND	1.12	1.58	160	0.47	**0.0067**	96.9
8/12/2020	10:00	21.0	7.6	ND	ND	ND	0.10	ND	ND	0.10	0.014	ND	1.19	1.47	170	0 39	**0.0024**	77 8
8/26/2020	9:40	20.2	7.8	ND	ND	ND	0.061	ND	ND	0.061	0.015	ND	1.25	1.58	150	0 25	0.0010	99.4
9/10/2020	9:40	18.3	7.6	ND	ND	ND	0.13	ND	ND	0.13	**0.022**	0.037	1.04	1.50	150	0 53	**0.0035**	88 2
9/23/2020	9:20	18.8	7.8	ND	ND	ND	0.059	ND	ND	0.059	0.018	ND	1.08	1.49	160	0 21	**0.0049**	88.1
10/7/2020	9:40	17.8	7.8	ND	ND	ND	0.073	ND	ND	0.073	0.020	ND	1.22	1.46	160	0 22	0.0015	85.7
10/21/2020	9:20	17.3	7.3	ND	ND	ND	0.087	ND	ND	0.087	0.011	ND	1.06	1.27	180	ND	ND	71.4
11/18/2020	10:10	14.5	7.6	ND	ND	ND	0.079	ND	ND	0.079	0.012	ND	1.24	1.58	170	0 26	**0.0059**	117

Syar	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11465390 RR near Windsor***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0 50	0.010	0.030	0.600	0.300	10	0.10	0.0010	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/20/2020	11:00	17.3	8.0	0 52	ND	ND	0.13	ND	0.52	**0.65**	0.018	ND	1.22	1.57	120	1.0	**0.0023**	353
6/3/2020	10:30	21.2	8.0	ND	ND	ND	0.064	ND	ND	0.064	0.015	ND	1.08	1.34	150	1.2	**0.0023**	197
6/18/2020	12:00	20.6	8.1	ND	ND	ND	0.089	ND	ND	0.089	0.019	ND	1.09	1.43	140	1.0	**0.0018**	152
7/2/2020	9:40	18.6	7.9	ND	ND	ND	0.064	ND	ND	0.064	0.016	ND	1.00	1.42	140	1.0	**0.0021**	190
7/16/2020	10:20	18.8	8.0	ND	ND	ND	ND	ND	ND	ND	0.015	ND	1.13	1.45	130	0.79	**0.0041**	193
7/30/2020	10:00	18.1	7.9	ND	ND	ND	0.13	ND	ND	0.13	0.015	ND	1.17	1.61	140	0 86	**0.0022**	192
8/13/2020	10:00	18.0	8.0	ND	ND	ND	ND	ND	ND	ND	0.013	ND	2.68	1.33	140	0 82	0.0010	166
9/2/2020	9:50	17.5	8.7	ND	ND	ND	0.057	ND	ND	0.057	0.016	ND	1.14	1.45	160	0 58	**0.0038**	169
9/11/2020	9:30	15.6	8.7	ND	ND	ND	0.057	ND	ND	0.057	0.018	ND	1.02	1.40	120	0 96	**0.0041**	172
9/24/2020	9:40	17.3	8.1	ND	ND	ND	ND	ND	ND	ND	0.013	ND	1.14	1.50	120	1.0	**0.0018**	176
10/8/2020	10:00	15.9	8.6	ND	ND	ND	ND	ND	ND	ND	0.014	ND	1.06	1.41	140	0.17	**0.011**	Out for season
10/22/2020	11:40	16.0	8.1	ND	ND	ND	0.055	ND	ND	0.055	0.014	ND	1.31	1.41	140	0 26	ND	Out for season
11/19/2020	10:00	12.8	7.5	ND	ND	ND	ND	ND	ND	ND	0.018	ND	1.26	1.51	120	0.68	ND	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.

*** Turbidity results after 6/16 were recorded using a YSI 6600 datasonde.

**** 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

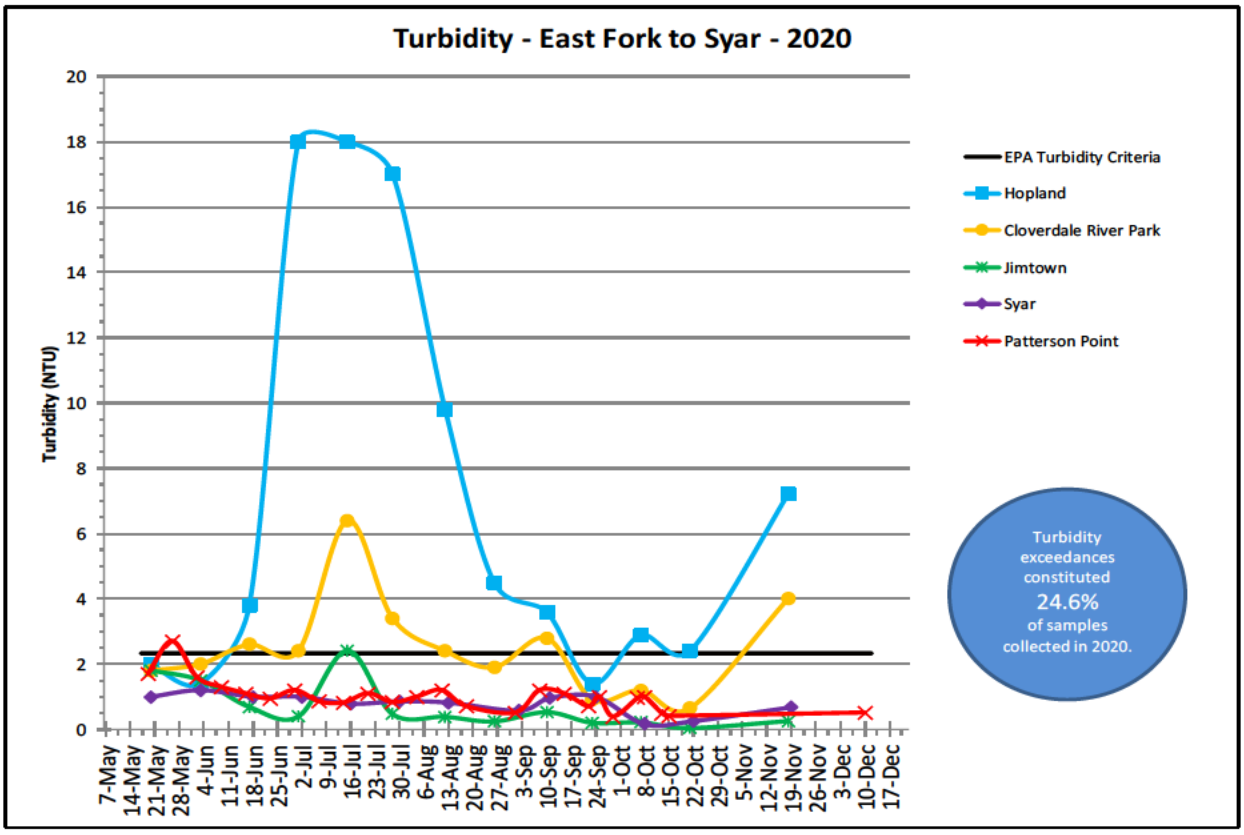
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

Turbidity

The EPA recommended criteria for turbidity is 2.34 Nephelometric Turbidity Units (NTU). Four of the five monitoring stations were observed to have exceedances of the EPA criteria during the monitoring season (Tables 3-3 through 3-5). The EPA criteria was exceeded 19 times out of a total of 77 samples collected (24.6%) at the five stations (Tables 3-3 through 3-5 and Figure 3-16). The Hopland and Cloverdale stations predominantly exceeded the turbidity criteria during the monitoring season, whereas the Jimtown and Patterson Point stations each had only one observed exceedance. The Syar station did not have any observed exceedances during the 2020 season.

Turbidity levels exceeded the EPA criteria for a majority of the monitoring season at the Hopland (10 of 13 or 76.9%) and Cloverdale River Park (7 of 13 or 53.9%) stations (Table 3-3). Values were observed to generally increase through the spring and peak in mid-July at Hopland and Cloverdale. Turbidity values then trended downward through the rest of the monitoring season before increasing on the last sample event of the season on 18 November (Figure 3-16). The maximum value observed at Hopland occurred twice, with a value of 18 NTU being observed on 1 July and 15 July. Cloverdale River Park was observed to have a maximum with a value of 6.4 NTU on 15 July (Table 3-3).



Figures 3-16. Sonoma Water Seasonal Mainstem Russian River Grab Sampling Turbidity in 2020.

A positive correlation between increases in turbidity values and increases in total phosphorus concentrations that was observed at Hopland and Cloverdale River Park in 2018 and 2019 was not observed to be as strongly correlated in 2020. For instance, there did appear to be a correlation early in the season when phosphorus and turbidity values were increasing through June into July. However, low seasonal turbidity values were observed at a time of elevated total phosphorus concentrations at both

stations on 23 September (Figures 3-15 and Figure 3-16). Additional data will continue to be collected to potentially determine whether there may be a positive correlation under certain environmental conditions in the upper mainstem.

Table 3-5. Sonoma Water 2020 Seasonal Mainstem Russian River Grab Sampling Results at Patterson Point.

Patterson Point	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0 50	0 010	0 030	0.600	0.300	10	0.10	0.0010	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/19/2020	11:20	19.4	7.9	ND	ND	ND	0.042	ND	ND	0.042	**0.053**	0.12	1.49	1.88	160	1.7	ND	347
5/26/2020	11:10	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.070**	0.16	1.56	2.19	150	**2.7**	0.0012	162
6/2/2020	10:30	22.3	7.7	ND	ND	ND	ND	ND	ND	ND	**0.071**	0.17	1.39	1.90	140	1.6	0.0011	131
6/9/2020	10:30	22.3	7.8	ND	ND	ND	0.058	ND	ND	0.058	**0.069**	0.16	1.41	1.73	150	1.3	ND	94.7
6/16/2020	10:20	22.9	7.8	ND	ND	ND	0.063	ND	ND	0.063	**0.086**	0.16	1.26	1.76	150	1.1	ND	85
6/23/2020	10:20	23.7	7.8	ND	ND	ND	ND	ND	ND	ND	**0.070**	0.15	1.01	1.70	170	0.94	**0.0021**	94.7
6/30/2020	10:10	23.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.069**	0.16	1.31	1.88	150	1.2	**0.0019**	96.3
7/7/2020	9:50	23.2	7.8	ND	ND	ND	ND	ND	ND	ND	**0.059**	0.13	1.39	1.75	160	0.85	0.0014	86.2
7/14/2020	10:00	24.5	7.9	ND	ND	ND	ND	ND	ND	ND	**0.056**	0.12	1.34	1.74	150	0.82	ND	87.8
7/21/2020	10:20	23.0	7.9	ND	ND	ND	ND	ND	ND	ND	**0.051**	0.093	1.38	1.72	140	1.1	ND	100
7/28/2020	10:20	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.041**	0.068	1.33	1.67	140	0.83	ND	109
8/4/2020	10:00	23.7	7.8	ND	ND	ND	ND	ND	ND	ND	**0.041**	0.067	1.39	1.84	130	1.0	ND	88.2
8/11/2020	10:00	23.4	7.9	ND	ND	ND	ND	ND	ND	ND	**0.041**	0.065	1.40	1.72	140	1.2	0.0010	78.1
8/18/2020	9:40	23.4	7.6	ND	ND	ND	ND	ND	ND	ND	**0.045**	0.081	1.31	1.57	140	0.71	ND	86.4
9/1/2020	9:50	20.9	8.0	ND	ND	ND	ND	ND	ND	ND	**0.033**	0.036	1.26	1.51	170	0.51	ND	91.3
9/8/2020	9:30	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.029**	0.038	1.23	1.72	140	1 2	ND	69.9
9/15/2020	9:30	19.8	7.8	ND	ND	ND	ND	ND	ND	ND	**0.027**	0.043	1.12	1.44	150	1.1	0.0011	95.9
9/22/2020	9:50	20.7	8.0	ND	ND	ND	ND	ND	ND	ND	0 021	0.032	1.18	1.50	120	0.70	0.0016	90.2
9/25/2020	10:40	21.2	7.9	ND	ND	ND	ND	ND	ND	ND	**0.024**	0.037	1.26	1.51	150	1 0	0.0013	88.1
9/29/2020	10:20	20.1	7.8	ND	ND	ND	ND	ND	ND	ND	**0.028**	0 047	1.20	1.52	130	0.39	ND	81.6
10/6/2020	9:20	18.8	8.1	ND	ND	ND	0.053	ND	ND	0.053	**0.034**	0 066	1.26	1.57	140	0.95	ND	91.3
10/8/2020	11:30	18.7	8.0	ND	ND	ND	ND	ND	ND	ND	**0.035**	0 056	1.16	1.54	140	1.0	0.0016	91.2
10/13/2020	9:20	17.9	8.0	ND	ND	ND	0.061	ND	ND	0.061	**0.028**	0 051	1.25	1.47	140	0.49	ND	98.6
10/15/2020	10:30	18.4	7.7	ND	ND	ND	0.059	ND	ND	0.059	**0.032**	0 046	1.28	1.45	140	0.41	ND	83.2
12/10/2020	11:30	8 5	7.8	ND	ND	ND	0.052	ND	ND	0.052	0 010	0 044	1.28	1.59	180	0.51	ND	164

* 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.

*** Turbidity results after 6/16 were recorded using a YSI 6600 datasonde.

**** 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

Turbidity values at Jimtown were observed to decline from spring into summer, but Jimtown also experienced a spike in value of 2.4 NTU on 15 July with a flow of 94.8 cfs (Table 3-4). This maximum value was the only exceedance of the EPA criteria (1 of 13 or 7.7%) at the station in 2020 (Table 3-4 and Figure 3-16). Turbidity values then remained consistently low through the rest of the monitoring season.

The Syar Vineyards station did not exceed the turbidity criteria (0 of 13 or 0%) during the monitoring season (Table 3-4). A maximum value of 1.2 NTU was observed at Syar Vineyards on 3 June with a flow of 197 cfs (Table 3-4 and Figure 3-16). Turbidity values then generally declined through the rest of the monitoring season.

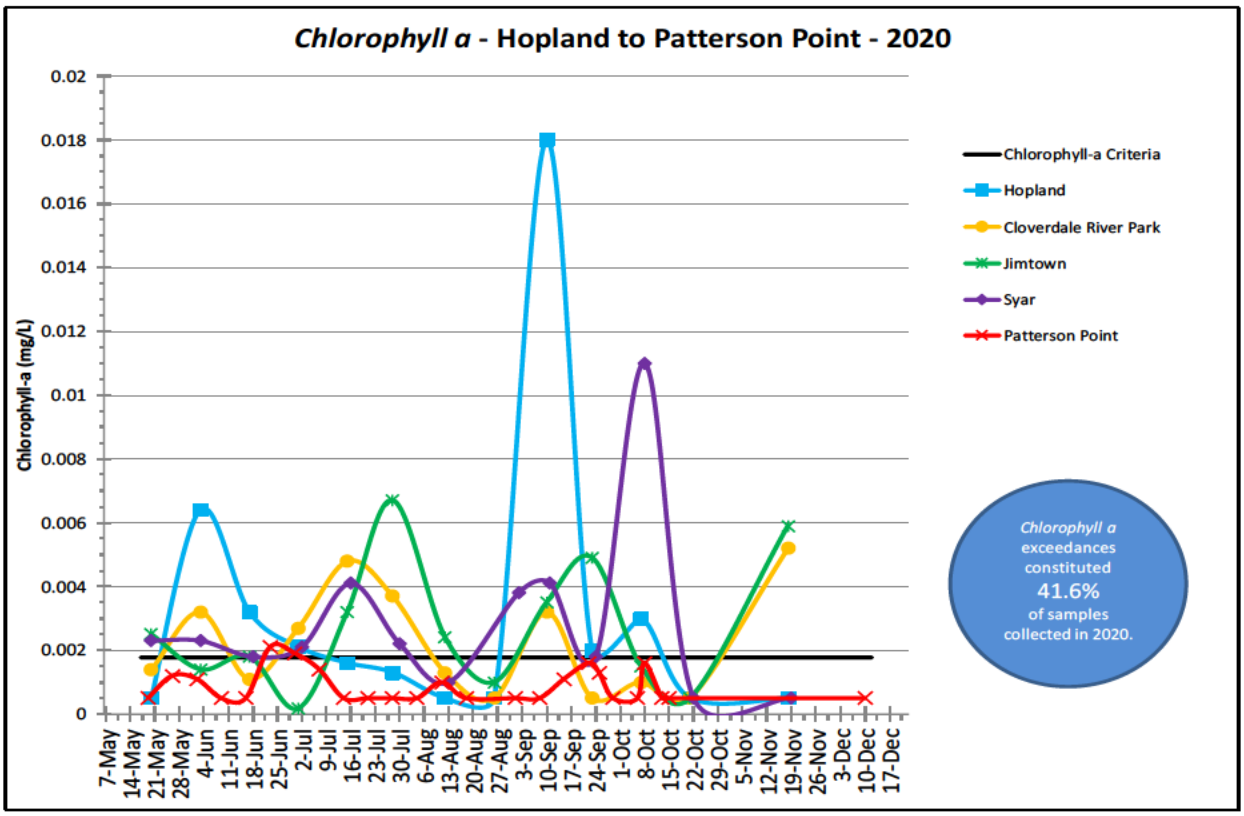
The Patterson Point station exceeded the turbidity criteria once (1 of 25 or 4%), with a maximum value of 2.7 NTU observed on 26 May with a flow of 166 cfs (Table 3-5 and Figure 3-16). Turbidity values then generally declined through the rest of the monitoring season.

Chlorophyll a

The USEPA criteria for *chlorophyll a* in Aggregate Ecoregion III is 1.78 µg/L, or approximately 0.0018 mg/L for rivers and streams not discharging into lakes or reservoirs (USEPA, 2000). *Chlorophyll a* results were observed to periodically exceed the EPA criteria at all five stations during the season (32 of 77 samples or 41.6%), most predominantly at Syar and least predominantly at Patterson Point (Tables 3-3 through 3-5 and Figure 3-17).

Hopland had six *chlorophyll a* exceedances (6 of 13 or 46.2%) and five non-detects, including a maximum value of 0.018 mg/L that occurred on 10 September with a flow of 119 cfs (Table 3-3 and Figure 3-17).

Cloverdale River Park had six *chlorophyll a* exceedances (6 of 13 or 46.2%) and three non-detects, including a maximum value of 0.0052 mg/L that occurred on 18 November with a flow of 116 cfs (Table 3-3 and Figure 3-17).



Figures 3-17. Sonoma Water Seasonal Mainstem Russian River Grab Sampling *Chlorophyll a* Results in 2020.

Jimtown had eight *chlorophyll a* exceedances (8 of 13 or 61.5%) and one non-detect, including a maximum value of 0.0067 mg/L that occurred on 28 July with a flow of 96.9 cfs (Table 3-4 and Figure 3-17).

Syar Vineyards had ten *chlorophyll a* exceedances (10 of 13 or 76.9%) and two non-detects, including a maximum value of 0.011 mg/L that occurred on 8 October with an estimated flow of 191 cfs. The USGS

near Windsor gaging station had been removed for the season, therefore estimated flow is based on a flow of 77.8 cfs at USGS RR at Healdsburg combined with a flow of 113 cfs at USGS Dry Creek near Mouth (Table 3-4 and Figure 3-17).

Patterson Point had two *chlorophyll a* exceedances (2 of 25 or 8%) and fifteen non-detects, including a maximum value of 0.0021 mg/L that occurred during open river mouth/estuary conditions on 23 June with a flow of 97.6 cfs at Hacienda (Table 3-5 and Figure 3-17).

3.2 Sonoma Water Russian River Estuary Water Quality Monitoring

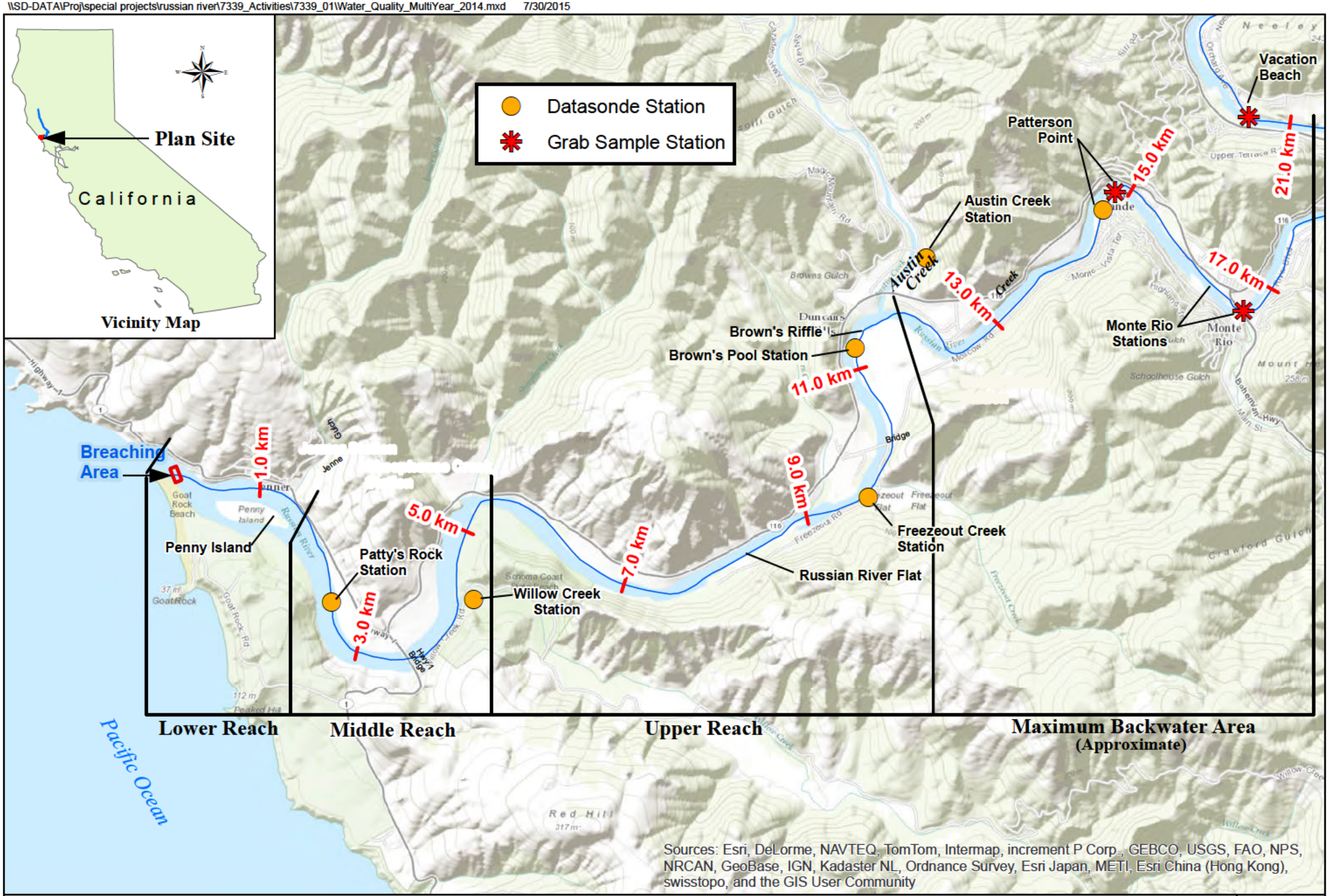
The changes in lower Russian River minimum instream flow requirements authorized by the Order allowed flows at Hacienda to decline below D1610 minimum instream flows of 85 cfs periodically during the term of the Order (Figure 2-4). However, lower Russian River flows did not decline below the TUC minimum flows of 60 cfs or the instantaneous minimum flow of 50 cfs authorized by the Order (Figure 2-4). Long-term water quality monitoring and weekly grab sampling was conducted in the lower, middle, and upper reaches of the Russian River Estuary and the upper extent of inundation and backwatering during lagoon formation, referred to as the maximum backwater area (MBA), 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 six (6) stations in the Russian River estuary, including two tributary stations during the 2020 monitoring season (Figure 3-18). 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 2020 is currently being compiled and will be discussed in the Russian River Biological Opinion 2020-2021 annual report, which will be posted to Sonoma Water's website when available: http://www.scwa.ca.gov/bo-annual-report/.

Sonoma Water staff conducted weekly grab sampling from 19 May to 10 December at three stations in the lower mainstem Russian River, including: Vacation Beach, Monte Rio, and Patterson Point (Figure 3-18). All samples were analyzed for bacterial indicators (Total Coliform, *E. coli*, and *Enterococcus*), nutrients, *chlorophyll a*, total and dissolved organic carbon, total dissolved solids, and turbidity. Sonoma Water submitted samples to the Sonoma County DHS Public Health Division Lab in Santa Rosa for bacteria analysis. Samples for all other constituents were submitted to Alpha Analytical Labs in Ukiah for analysis.

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



0 0.45 0.9 1.8 Kilometers

0 0.375 0.75 1.5 Miles

Russian River Estuary
Water Quality Monitoring Stations

This Map is for general reference only

Figure 3-18

Sampling for *Bacteroides* bacteria was conducted at public freshwater beaches when other bacteria samples were collected. Samples were submitted to the DHS lab where they were filtered, frozen and archived for possible future analyses of human-host *Bacteroides* bacteria by staff at the NCRWQCB. Lab analysis of *Bacteroides* bacteria will be conducted only for those sample dates and locations when operational standards for *E. coli* bacteria are exceeded. The analysis of *Bacteroides* bacteria will help determine if the source of the high level of *E. coli* bacteria is from human or other sources.

The grab sample sites are shown in Figure 3-18, and the results are summarized in Tables 3-6 through 3-11 and Figures 3-19 through 3-25. 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 recommended criteria for Nutrients, *Chlorophyll a*, and Turbidity in Rivers and Streams in Aggregate Ecoregion III (EPA 2000). However, it must be emphasized that the draft CDPH guidelines and 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.

Bacteria

Samples were collected in the lower river in 2020 for diluted and undiluted analysis of Total Coliform and *E. coli* for comparative purposes and the results are included in Tables 3-6 through 3-8 and Figures 3-19 and 3-20. Total Coliform and *E. coli* data presented in Figures 3-19 and 3-20 utilize undiluted sample results unless the reporting limit has been exceeded, at which point the diluted results are utilized. Samples collected for *Enterococcus* were undiluted only and results are included in Tables 3-6 through 3-8 and Figure 3-21. 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*.

Beginning in 2014, staff at the NCRWQCB indicated that *Enterococcus* was not being utilized as a fecal indicator bacteria 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 72 or 1.4%) of the CDPH guideline for Total Coliform during the 2020 monitoring season at the lower river stations. This exceedance was the maximum concentration observed at the Vacation Beach station, which occurred on 23 June with a value of >24196 MPN/100mL during open estuary conditions and a flow of approximately 94.7 cfs at the Hacienda USGS gage (Tables 3-6 through 3-8 and Figure 3-19). Aside from the one exceedance, Total Coliform concentrations remained low at all three stations during the monitoring season (Figure 3-19).

The maximum Total Coliform concentration observed at Monte Rio was 2419.6 MPN/100mL, which occurred four times during open and closed estuary conditions and flows that ranged from 69.9 to 94.7 cfs at the Hacienda USGS gage (Table 3-7 and Figure 3-19). There was a diluted sample that measured 12,997 MPN/100mL on 1 September. However, the undiluted sample result of 1299.7 MPN/100mL

collected during the same sampling event was utilized for reporting purposes, as the maximum reporting limit had not been exceeded.

The maximum Total Coliform concentration observed at Patterson Point was 3998 MPN/100mL, which occurred during open estuary conditions and a flow of approximately 78.1 cfs (Table 3-8 and Figure 3-19).

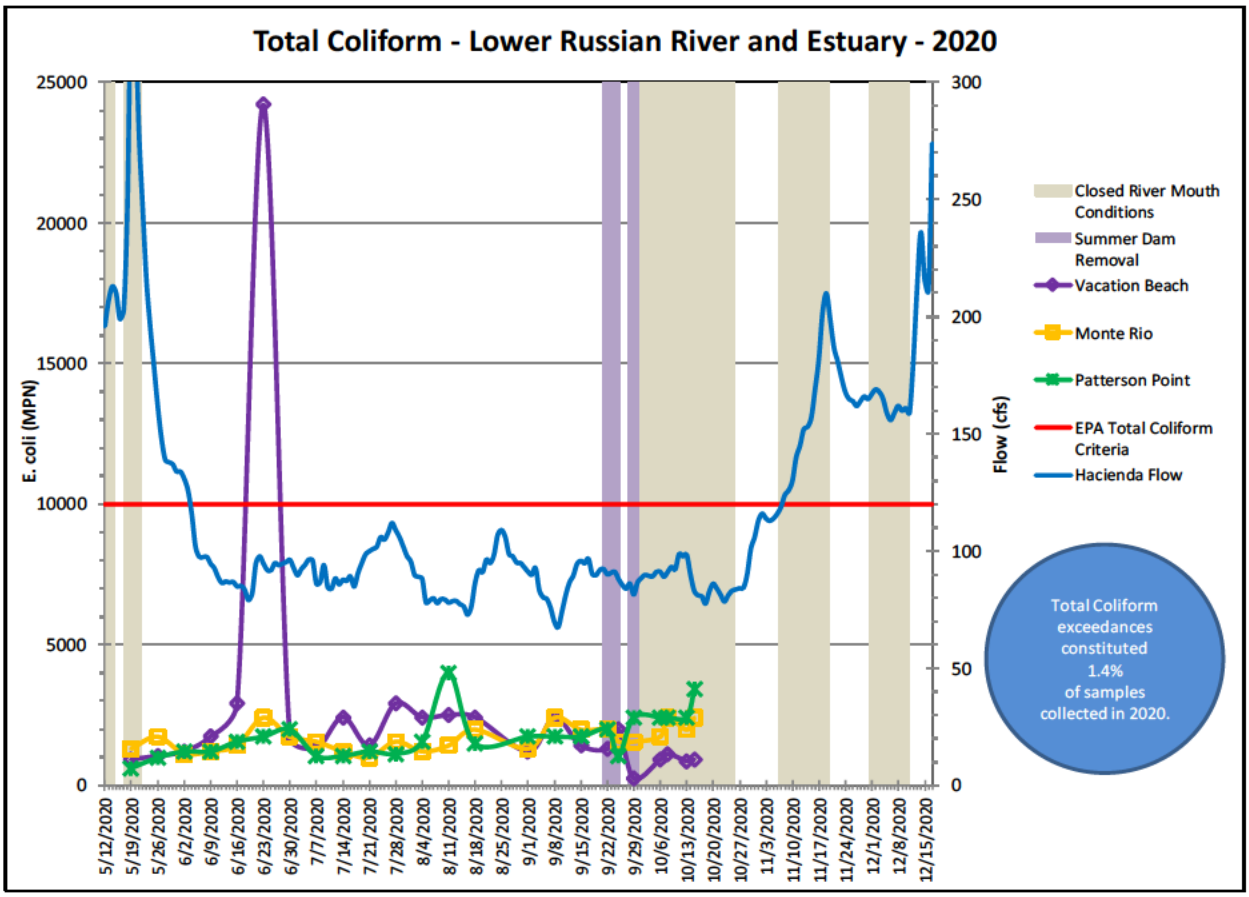


Figure 3-19. Total Coliform results for the Russian River from Vacation Beach to Patterson Point in 2020.

E. coli

There were no exceedances (0 of 72 or 0%) of the EPA criteria for *E. coli* during the 2020 monitoring season at the lower river stations (Tables 3-6 through 3-8 and Figure 3-20).

The maximum *E. coli* concentration observed at Vacation Beach was 96 MPN/100mL, which occurred on 26 May during open river mouth/estuary conditions and a flow of approximately 162 cfs at the Hacienda USGS gage (Table 3-6 and Figure 3-20). There was a diluted sample that had a concentration of 288 MPN/100mL on 29 September. However the undiluted sample result of 13.2 MPN/100mL collected during the same sampling event is utilized for reporting purposes, unless the maximum reporting limit had been exceeded.

The maximum *E. coli* concentration observed at Monte Rio was 129.6 MPN/100mL, which occurred on 13 October during closed river mouth/estuary conditions and a flow of approximately 98.6 cfs at the Hacienda USGS gage (Table 3-7 and Figure 3-20).

The maximum *E. coli* concentration observed at Patterson Point was 142.1 MPN/100mL, which occurred on 13 October during closed river mouth/estuary conditions and a flow of approximately 98.6 cfs at the Hacienda USGS gage (Table 3-8 and Figure 3-20).

Summer dam removal and river mouth/estuary closure may have had an effect on *E. coli* concentrations, as values were observed to increase at Monte Rio, Patterson Point, and Vacation Beach to a lesser degree, following removal of the Vacation Beach summer dam (Figure 3-20).

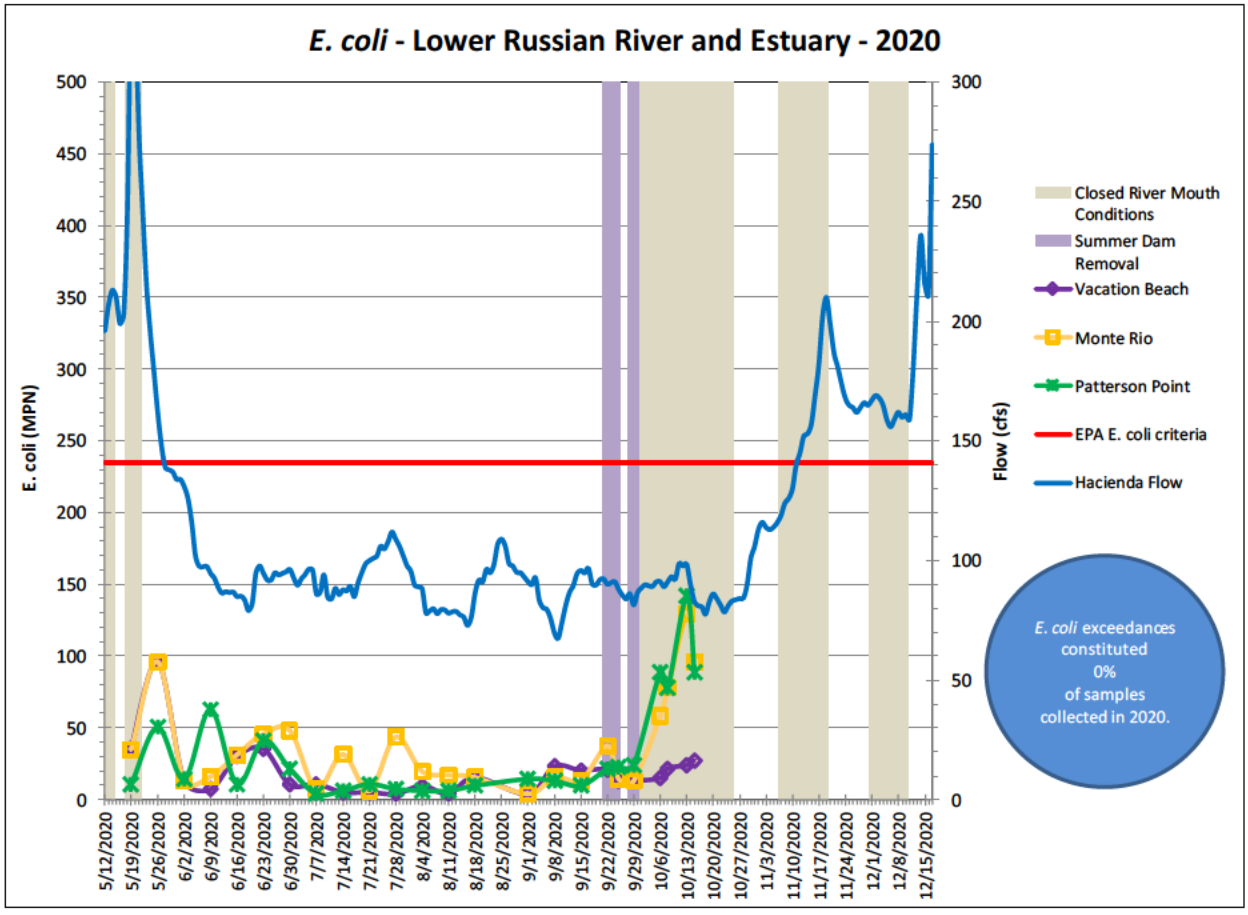


Figure 3-20. *E. coli* results for the Russian River from Vacation Beach to Patterson Point in 2020.

Enterococcus

Following river mouth/estuary closure in late September, the Monte Rio and Patterson Point stations were observed to have four exceedances each (8 of 72 or 11.1%) of the EPA criteria for *Enterococcus* with flows that ranged from 83.2 to 98.6 cfs at the Hacienda USGS gage (Figure 3-21).

The Vacation Beach station did not have any exceedances of the EPA criteria for *Enterococcus*, with a maximum concentration of 57.1 MPN/100mL that occurred on 23 June during open river mouth/estuary conditions and a flow of approximately 94.7 cfs at the Hacienda USGS gage (Table 3-6 and Figure 3-21).

The Monte Rio station had a maximum *Enterococcus* concentration of 107.0 MPN/100mL that occurred on 8 October during closed river mouth/estuary conditions with a flow of approximately 91.2 cfs at the Hacienda USGS gage (Table 3-7 and Figure 3-21).

The Patterson Point station had a maximum *Enterococcus* concentration of 145.0 MPN/100mL on 15 October during closed river mouth/estuary conditions with a flow of approximately 83.2 cfs at the Hacienda USGS gage (Table 3-8 and Figure 3-21).

All three stations were observed to have an increase in *Enterococcus* concentrations during the month of June, however, none of the stations exceeded the criteria. External factors including contact recreation, river mouth/estuary closure, and the late-September removal of summer dams in Guerneville likely had an effect on elevated *Enterococcus* concentrations observed in the Monte Rio to Patterson Point area during the 2020 monitoring season (Figure 3-21).

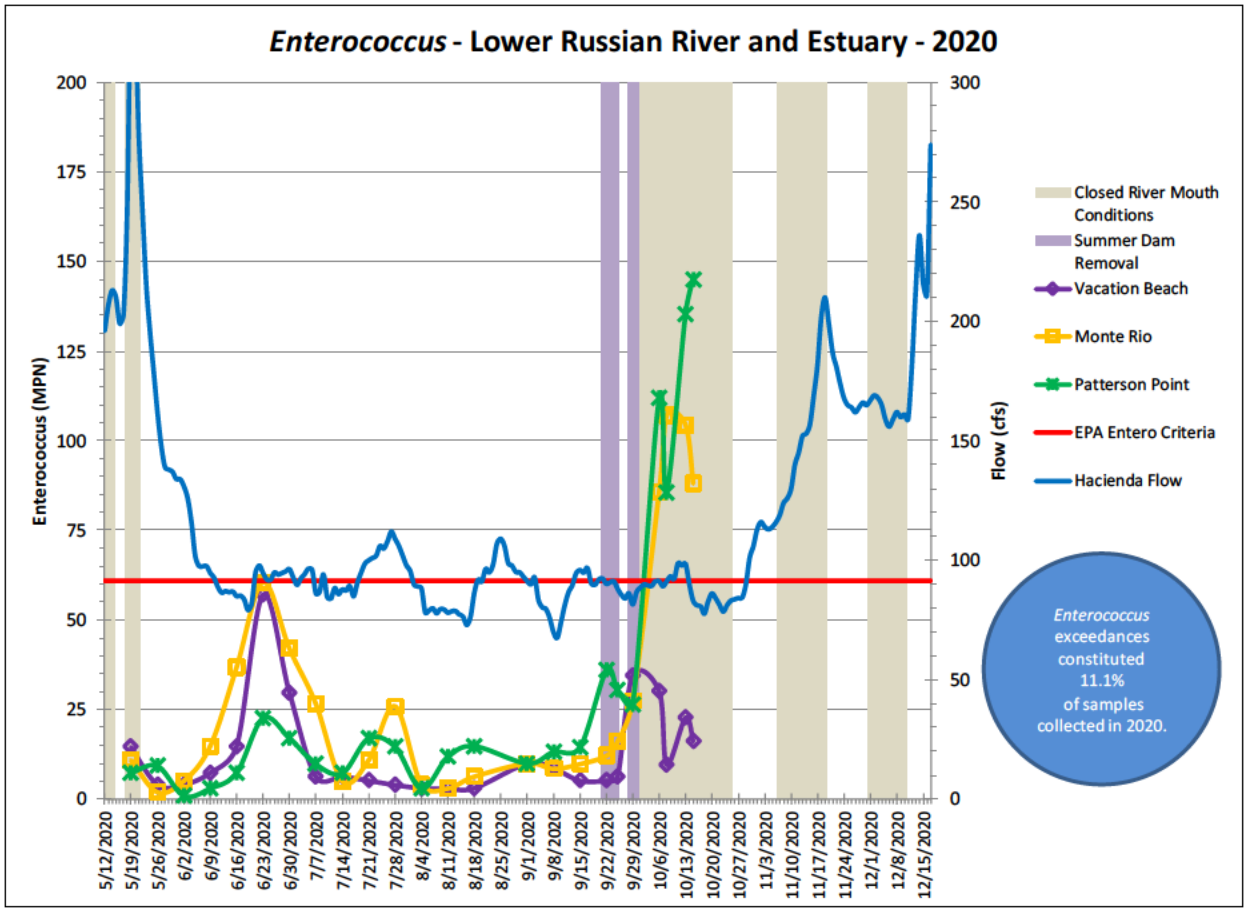


Figure 3-21. *Enterococcus* results for the Russian River from Vacation Beach to Patterson Point in 2020.

Table 3-6. 2020 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*				20		20		2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/19/2020	12:10	19.6	8.1	920.8	1450	35.5	41	14.6	349
5/26/2020	12:00	22.9	7.9	1046.2	2143	96	20	4.1	166
6/2/2020	11:20	22.5	7.9	1203.3	2046	13.4	31	4.1	134
6/9/2020	11:30	22.6	8.0	1732.9	1470	7.3	10	7.4	97.6
6/16/2020	11:30	23.5	8.1	>2419.6	2909	30.1	20	14.8	87.8
6/23/2020	11:30	24.8	8.0	>2419.6	**>24196**	35.4	52	57.1	97.6
6/30/2020	11:20	24.6	8.0	1732.9	1211	10.5	<10	29.8	99.1
7/7/2020	11:00	24.1	8.1	1299.7	1354	10.9	<10	6.3	89
7/14/2020	11:00	25.4	8.0	2419.6	2359	5.2	10	6.3	90.6
7/21/2020	11:10	23.4	8.1	1413.6	1198	5.2	10	5.2	103
7/28/2020	11:30	23.1	7.9	>2419.6	2909	4.1	<10	4.0	112
8/4/2020	10:50	24.1	8.0	2419.6	1616	9.7	10	3.1	91
8/11/2020	11:20	23.8	7.9	>2419.6	2495	4.1	<10	3.0	80.8
8/18/2020	11:00	24.3	7.8	2419.6	1483	15.5	10	3.1	89.2
9/1/2020	11:10	21.0	8.1	1203.3	986	4.1	20	<10	94.2
9/8/2020	10:50	23.2	8.0	2419.6	1725	23.3	20	8.6	72.5
9/15/2020	10:40	19.5	8.0	1413.6	1500	20.4	20	5.2	98.8
9/22/2020	11:00	21.0	8.1	1299.7	1187	21.1	10	5.2	93
9/25/2020	11:30	20.7	7.9	1986.3	1860	13.1	31	6.3	90.9
9/29/2020	11:30	19.8	8.0	248.1	**17329**	13.2	**288**	34.5	84.3
10/6/2020	10:30	18.7	8.1	920.8	1019	15.1	20	30.1	94.1
10/8/2020	10:00	18.6	8.1	1119.9	933	21.8	31	9.7	94.1
10/13/2020	10:50	17.8	8.2	866.4	298	24.1	<10	22.8	101
10/15/2020	11:30	18.8	7.8	920.8	677	27.5	52	16.1	85.9

* 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

Table 3-7. 2020 Monte Rio bacteria concentrations for samples collected by Sonoma Water. This site experiences freshwater conditions.

Monte Ro	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*				20		20		2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/19/2020	11:50	19.4	8.0	1299.7	1658	35	52	10.9	349
5/26/2020	11:40	23.0	7.8	1732.9	2014	96	31	2.0	166
6/2/2020	10:50	22.5	7.8	1119.9	1483	13.5	20	5.1	134
6/9/2020	11:00	22.3	7.9	1203.3	833	16.1	20	14.8	97.6
6/16/2020	11:10	22.6	7.8	1413.6	1616	31.3	63	36.8	87.8
6/23/2020	11:00	24.1	7.9	2419.6	2382	45.7	52	60.5	97.6
6/30/2020	10:50	24.1	7.9	1732.9	1396	48.0	31	42.0	99.1
7/7/2020	10:30	23.5	8.1	1553.1	1017	7.5	31	26.6	89
7/14/2020	10:30	24.7	8.0	1203.3	1396.0	31.5	86.0	5.1	90.6
7/21/2020	10:50	23.1	8.0	980.4	683	6.1	10	10.9	103
7/28/2020	11:00	23.1	7.9	1553.1	1723	43.5	85	25.9	112
8/4/2020	10:30	23.9	7.8	1203.3	1211	19.7	10	4.1	91
8/11/2020	10:50	23.3	7.8	1413.6	1467	17.3	30	3.0	80.8
8/18/2020	10:20	23.7	7.6	1986.3	2014	15.5	40	6.3	89.2
9/1/2020	10:30	20.9	8.0	1299.7	**12997**	4.1	10	<10	94.2
9/8/2020	10:20	22.7	7.9	2419.6	1616	15.8	31	8.5	72.5
9/15/2020	10:10	19.7	7.8	1986.3	1785	13.5	<10	9.8	98.8
9/22/2020	10:30	20.8	7.9	1986.3	1515	37.3	53	12.1	93
9/25/2020	11:10	20.7	8.0	1553.1	1421	14.5	20	16.1	90.9
9/29/2020	11:00	19.9	7.9	1553.1	1396	13.2	41	27.5	84.3
10/6/2020	10:00	18.5	8.0	1732.9	1664	58.1	52	**85.7**	94.1
10/8/2020	12:20	18.9	8.1	2419.6	2098	78.0	189	**107.0**	94.1
10/13/2020	10:10	17.6	8.1	1986.3	918	129.6	110	**104.3**	101
10/15/2020	11:00	18.4	7.6	2419.6	2282	96.0	132	**88.0**	85.9

* 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

Table 3-8. 2020 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*				20		20		2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/19/2020	11:20	19.4	7.9	613.1	906	10.8	<10	7.4	349
5/26/2020	11:10	22.6	7.8	980.4	1500	50.5	10	9.3	166
6/2/2020	10:30	22.3	7.7	1203.3	2359	14.5	20	1.0	134
6/9/2020	10:30	22.3	7.8	1203.3	1043	63	20	3.0	97.6
6/16/2020	10:20	22.9	7.8	1553.1	1014	11	41	7.4	87.8
6/23/2020	10:20	23.7	7.8	1732.9	2755	41.4	31	22.6	97.6
6/30/2020	10:10	23.6	7.8	1986.3	1178	21.6	10	17.1	99.1
7/7/2020	9:50	23.2	7.8	1046.2	1223	4.1	<10	9.8	89
7/14/2020	10:00	24.5	7.9	1046.2	1250.0	6.3	<10	7.3	90.6
7/21/2020	10:20	23.0	7.9	1203.3	1169	10.9	10	17.0	103
7/28/2020	10:20	22.6	7.8	1119.9	862	7.5	<10	14.6	112
8/4/2020	10:00	23.7	7.8	1553.1	1050	6.3	<10	3.0	91
8/11/2020	10:00	23.4	7.9	>2419.6	3998	6.3	10	11.8	80.8
8/18/2020	9:40	23.4	7.6	>2419.6	1483	9.8	<10	14.8	89.2
9/1/2020	9:50	20.9	8.0	1732.9	1553	14.5	<10	<10	94.2
9/8/2020	9:30	22.6	7.8	1732.9	1333	13.2	41	13.2	72.5
9/15/2020	9:30	19.8	7.8	1732.9	1450	9.8	10	14.5	98.8
9/22/2020	9:50	20.7	8.0	1986.3	1222	21.6	10	35.9	93
9/25/2020	10:40	21.2	7.9	1046.2	934	22.8	30	30.5	90.9
9/29/2020	10:20	20.1	7.8	2419.6	1565	24	72	26.5	84.3
10/6/2020	9:20	18.8	8.1	2419.6	1725	88.6	109	**111.9**	94.1
10/8/2020	11:30	18.7	8.0	2419.6	3255	78.0	72	**85.5**	94.1
10/13/2020	9:20	17.9	8.0	2419.6	2909	142.1	146	**135.4**	101
10/15/2020	10:30	18.4	7.7	>2419.6	3433	88.6	158	**145.0**	85.9
* 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									

Total Nitrogen

The EPA criteria for total nitrogen was not exceeded (0 of 75 or 0%) in the lower river during the 2020 monitoring season (Tables 3-9 through 3-11 and Figure 3-22). However, there were a few elevated concentrations of total nitrogen that occurred in the spring and early summer, as well as during summer dam removal in late September (Figure 3-22).

The maximum total nitrogen concentration observed at Vacation Beach was 0.35 mg/L, which occurred on 30 June during open river mouth/estuary conditions and a flow of approximately 96.3 cfs at the Hacienda USGS gage (Table 3-9 and Figure 3-22). The minimum concentration at Vacation Beach was

ND, which occurred eighteen (18) times during open and closed river mouth/estuary conditions and flows that ranged from approximately 69.9 to 162 cfs.

The maximum total nitrogen concentration observed at Monte Rio was 0.26 mg/L on 26 May during open river mouth/estuary conditions with a flow of approximately 162 cfs at the Hacienda USGS gage (Table 3-10 and Figure 3-22). The minimum concentration at Monte Rio was ND, which occurred eighteen (18) times during open and closed river mouth/estuary conditions and flows that ranged from approximately 69.9 to 347 cfs.

The maximum total nitrogen concentration observed at Patterson Point was 0.063 mg/L on 16 June during open river mouth/estuary conditions with a flow of approximately 85 cfs at the Hacienda USGS gage (Table 3-11 and Figure 3-22). The minimum concentration at Patterson Point was ND, which occurred eighteen (18) times during open and closed river mouth/estuary conditions and flows that ranged from approximately 69.9 to 162 cfs.

Total Phosphorus

All three lower river stations predominantly exceeded the EPA criteria for total phosphorous (72 of 75 or 96%) in 2020 with flows that ranged from 69.9 cfs to 347 cfs at the Hacienda USGS gage, continuing a trend of consistent exceedances observed in previous years (Tables 3-9 through 3-11). Patterson Point was the only station that did not exceed the total phosphorus criteria during every sampling event in 2020 (Table 3-11). Exceedances occurred during open and closed river mouth/estuary conditions, and concentrations were observed to generally be higher in the spring and early summer, especially during elevated storm flows in May, and trending downward through the rest of the season (Figure 3-23).

The maximum total phosphorus concentration observed at Vacation Beach was 0.068 mg/L on 19 May during closed river mouth/estuary conditions and a Hacienda flow of approximately 347 cfs (Table 3-9 and Figure 3-23). The minimum concentration at Vacation Beach was 0.022 mg/L, which occurred on 8 September during open river mouth/estuary conditions and a flow of approximately 69.9 cfs.

The maximum total phosphorus concentration observed at Monte Rio was 0.076 mg/L on 26 May during open river mouth/conditions with a flow of approximately 162 cfs at the Hacienda USGS gage (Table 3-10 and Figure 3-23). The minimum concentration at Monte Rio was 0.023 mg/L, which occurred on 25 September during open river mouth/estuary conditions and summer dam removal, with a flow of approximately 88.1 cfs. Finally, the lowest flow recorded during sampling was approximately 69.9 cfs, which occurred on 8 September, with a concentration of 0.027 mg/L.

The maximum total phosphorus concentration observed at Patterson Point was 0.086 mg/L on 16 June during open river mouth/estuary conditions with a Hacienda flow of approximately 85 cfs (Table 3-11 and Figure 3-23). The minimum concentration at Patterson Point was 0.010 mg/L, which occurred on 12 December during closed river mouth/estuary conditions and a flow of approximately 164 cfs (Table 3-11 and Figure 3-23). Finally, the lowest flow recorded during sampling was approximately 69.9 cfs, which occurred on 8 September, with a concentration of 0.029 mg/L (Table 3-11).

Turbidity

The EPA criteria for turbidity was exceeded twice at Vacation Beach, three times at Monte Rio, and once at Patterson Point (6 of 75 or 8%) during the 2020 monitoring season (Tables 3-9 through 3-11). Exceedances were observed to primarily occur during the first half of the season with open and closed river mouth/estuary conditions and Hacienda flows ranging from 131 cfs to 347 cfs (Figure 3-24). There was also an exceedance at Vacation Beach that occurred during summer dam removal. Turbidity values were generally higher at Vacation Beach than at the other stations, and are a result of increased turbulence from streamflow over the Vacation Beach summer dam and through the fish ladder just upstream of the monitoring location.

The maximum turbidity value observed at Vacation Beach was 3.9 NTU on 25 September during open river mouth/estuary conditions and summer dam removal, with a flow of approximately 88.1 cfs at the Hacienda USGS gage (Table 3-9 and Figure 3-24). The minimum value at Vacation Beach was 0.52 NTU, which occurred on 10 December during closed river mouth/estuary conditions and a flow of approximately 164 cfs. Finally, the lowest flow recorded during sampling was approximately 69.9 cfs, which occurred on 8 September, with a value of 1.1 NTU.

The maximum turbidity value observed at Monte Rio was 4.3 NTU on 26 May during open river mouth/estuary conditions and a Hacienda flow of approximately 162 cfs (Table 3-10 and Figure 3-24). The minimum value at Monte Rio was 0.44 NTU, which occurred on 10 December during closed river mouth/estuary conditions and a flow of approximately 164 cfs. Finally, the lowest flow recorded during sampling was approximately 69.9 cfs, which occurred on 8 September, with a value of 0.96 NTU.

The maximum turbidity value observed at Patterson Point was 2.7 NTU on 26 May during open river mouth/estuary conditions and a flow of approximately 162 cfs at the Hacienda USGS gage (Table 3-11 and Figure 3-24). The minimum value at Patterson Point was 0.39 NTU, which occurred on 29 September during closed river mouth/estuary conditions and summer dam removal, with a flow of approximately 81.6 cfs at the Hacienda USGS gage. Finally, the lowest flow recorded during sampling was approximately 69.9 cfs, which occurred on 8 September, with a value of 1.2 NTU.

Chlorophyll a

Algal (*chlorophyll a*) results exceeded the EPA criteria ten times at Vacation Beach and twice each at Monte Rio and Patterson Point (10 of 75 or 18.7%) under open and closed river mouth/estuary conditions and Hacienda flows that ranged from 88.1 cfs to 347 cfs (Tables 3-9 through 3-11 and Figure 3-25). *Chlorophyll a* values varied through the season with several ND values occurring at all three stations, including during river mouth/estuary closure in mid-October and in December (Figure 3-25).

The maximum *Chlorophyll a* concentration observed at Vacation Beach was 0.0042 mg/L on 25 September during open river mouth/estuary conditions and summer dam removal and a Hacienda flow of approximately 88.1 cfs (Table 3-9 and Figure 3-25). The minimum value at Vacation Beach was ND, which occurred six (6) times in the latter half of the season during open and closed river mouth/estuary conditions and flows that ranged from 69.9 to 164 cfs. *Chlorophyll a* values at Vacation Beach were generally higher in the spring and early summer, and trending downward through the season before increasing during summer dam removal and river mouth/estuary closure (Figure 3-25).

The maximum *Chlorophyll a* concentration observed at Monte Rio was 0.0019 mg/L on 22 September during open river mouth/estuary conditions and summer dam removal and a flow of approximately 90.2 cfs at the Hacienda USGS gage (Table 3-10 and Figure 3-25). The minimum value at Monte Rio was ND, which occurred ten (10) times through the season during open and closed river mouth/estuary conditions and summer dam removal with flows that ranged from 69.9 to 164 cfs

The maximum *Chlorophyll a* concentration observed at Patterson Point was 0.0021 mg/L on 23 June during open river mouth/estuary conditions with a flow of approximately 94.7 cfs at the Hacienda USGS gage (Table 3-11 and Figure 3-25). The minimum value at Patterson Point was ND, which occurred fifteen (15) times periodically through the season, during open and closed river mouth/estuary conditions and summer dam removal and flows that ranged from 69.9 to 347 cfs.

Table 3-9. 2020 Vacation Beach nutrient grab sample results. This site experiences freshwater conditions.

Vacation Beach	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.50	0.010	0.030	0.600	0.300	10	0.10	0.0010	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/19/2020	12:10	19.6	8.1	0.21	ND	ND	ND	ND	0.21	0.21	**0.068**	0.14	1.66	2.11	180	**2.4**	**0.0025**	347
5/26/2020	12:00	22.9	7.9	ND	ND	ND	ND	ND	ND	ND	**0.066**	0.14	1.52	2.10	160	2.2	**0.0019**	162
6/2/2020	11:20	22.5	7.9	ND	ND	ND	ND	ND	ND	ND	**0.062**	0.12	1.47	1.79	140	1.9	**0.0021**	131
6/9/2020	11:30	22.6	8.0	ND	ND	ND	ND	ND	ND	ND	**0.058**	0.12	1.37	1.73	160	1.7	**0.0023**	94.7
6/16/2020	11:30	23.5	8.1	ND	ND	ND	ND	ND	ND	ND	**0.059**	0.12	1.24	1.78	140	1.7	0.0013	85
6/23/2020	11:30	24.8	8.0	ND	ND	ND	ND	ND	ND	ND	**0.057**	0.10	1.39	1.91	160	1.6	**0.0030**	94.7
6/30/2020	11:20	24.6	8.0	0.35	ND	ND	ND	ND	0.35	0.35	**0.059**	0.12	1.34	1.91	140	1.4	**0.0019**	96.3
7/7/2020	11:00	24.1	8.1	ND	ND	ND	ND	ND	ND	ND	**0.043**	0.090	1.35	1.69	150	1.2	0.0016	86.2
7/14/2020	11:00	25.4	8.0	ND	ND	ND	ND	ND	ND	ND	**0.045**	0.084	1.37	1.77	150	1.6	**0.0022**	87.8
7/21/2020	11:10	23.4	8.1	ND	ND	ND	ND	ND	ND	ND	**0.037**	0.060	1.37	1.65	140	2.2	**0.0022**	100
7/28/2020	11:30	23.1	7.9	ND	ND	ND	0.083	ND	ND	0.083	**0.032**	0.043	1.28	1.71	140	0.93	**0.0021**	109
8/4/2020	10:50	24.1	8.0	ND	ND	ND	ND	ND	ND	ND	**0.031**	0.040	1.33	1.60	130	1.4	0.0017	88.2
8/11/2020	11:20	23.8	7.9	ND	ND	ND	ND	ND	ND	ND	**0.031**	0.041	1.34	1.67	140	1.7	ND	78.1
8/18/2020	11:00	24.3	7.8	ND	ND	ND	ND	ND	ND	ND	**0.031**	0.052	1.30	1.47	150	1.1	0.0017	86.4
9/1/2020	11:10	21.0	8.1	ND	ND	ND	ND	ND	ND	ND	**0.028**	ND	1.20	1.42	130	1.2	0.0011	91.3
9/8/2020	10:50	23.2	8.0	ND	ND	ND	ND	ND	ND	ND	**0.022**	ND	1.17	1.53	140	1.1	ND	69.9
9/15/2020	10:40	19.5	8.0	ND	ND	ND	ND	ND	ND	ND	**0.024**	0.031	1.12	1.37	140	2.3	ND	95.9
9/22/2020	11:00	21.0	8.1	ND	ND	ND	ND	ND	ND	ND	**0.024**	0.032	1.20	1.47	120	1.1	0.0013	90.2
9/25/2020	11:30	20.7	7.9	ND	ND	ND	ND	ND	ND	ND	**0.054**	0.045	1.15	1.49	140	**3.9**	**0.0042**	88.1
9/29/2020	11:30	19.8	8.0	ND	ND	ND	ND	ND	ND	ND	**0.028**	0.035	1.16	1.46	120	1.2	0.0017	81.6
10/6/2020	10:30	18.7	8.1	ND	ND	ND	0.052	ND	ND	0.052	**0.023**	ND	ND	0.453	130	2.2	0.0028	91.3
10/8/2020	10:00	18.6	8.1	ND	ND	ND	ND	ND	ND	ND	**0.025**	0.032	1.10	1.37	140	1.0	0.0012	91.2
10/13/2020	10:50	17.8	8.2	ND	ND	ND	0.051	ND	ND	0.051	**0.023**	ND	1.13	1.33	120	1.7	ND	98.6
10/15/2020	11:30	18.8	7.8	ND	ND	ND	0.051	ND	ND	0.051	**0.023**	0.033	1.16	1.36	130	0.61	ND	83.2
12/10/2020	12:00	9.3	7.9	ND	ND	ND	0.046	ND	ND	0.046	**0.023**	ND	1.25	1.56	170	0.52	ND	164

* 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 3-10. 2020 Monte Rio nutrient grab sample results. This site experiences freshwater conditions.

Monte Rio	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	Dissolved Organic Carbon	Total Organic Carbon	Total Dissolved Solids	Turbidity	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				0.20	0.10	0.00010	0.040	0.050	0.20	0.50	0.010	0.030	0.600	0.300	10	0.10	0.0010	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/19/2020	11:50	19.4	8.0	ND	ND	ND	ND	ND	ND	ND	**0.066**	0.14	1.47	2.07	160	**3.5**	0.0014	347
5/26/2020	11:40	23.0	7.8	0.26	ND	ND	ND	ND	0.26	0.26	**0.076**	0.15	1.58	2.14	160	**4.3**	0.0014	162
6/2/2020	10:50	22.5	7.8	ND	ND	ND	ND	ND	ND	ND	**0.070**	0.15	1.77	1.81	150	**2.9**	ND	131
6/9/2020	11:00	22.3	7.9	ND	ND	ND	0.057	ND	ND	0.057	**0.066**	0.15	1.40	1.75	160	0.79	ND	94.7
6/16/2020	11:10	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.065**	0.14	1.27	1.81	150	0.77	ND	85
6/23/2020	11:00	24.1	7.9	ND	ND	ND	ND	ND	ND	ND	**0.064**	0.13	1.44	1.72	160	0.89	0.0016	94.7
6/30/2020	10:50	24.1	7.9	ND	ND	ND	ND	ND	ND	ND	**0.067**	0.15	1.32	1.90	170	0.91	0.0016	96.3
7/7/2020	10:30	23.5	8.1	ND	ND	ND	ND	ND	ND	ND	**0.053**	0.12	1.69	1.72	160	0.88	0.0013	86.2
7/14/2020	10:30	24.7	8.0	ND	ND	ND	ND	ND	ND	ND	**0.052**	0.11	1.35	1.72	150	1.0	0.0011	87.8
7/21/2020	10:50	23.1	8.0	ND	ND	ND	ND	ND	ND	ND	**0.043**	0.076	1.35	1.71	140	1.6	0.0014	100
7/28/2020	11:00	23.1	7.9	ND	ND	ND	ND	ND	ND	ND	**0.038**	0.056	1.34	1.76	140	1.1	**0.0018**	109
8/4/2020	10:30	23.9	7.8	ND	ND	ND	ND	ND	ND	ND	**0.037**	0.052	1.43	1.66	130	0.90	0.0010	88.2
8/11/2020	10:50	23.3	7.8	ND	ND	ND	ND	ND	ND	ND	**0.047**	0.053	1.40	1.72	140	1.2	0.0012	78.1
8/18/2020	10:20	23.7	7.6	ND	ND	ND	ND	ND	ND	ND	**0.040**	0.069	1.30	1.52	140	0.83	ND	86.4
9/1/2020	10:30	20.9	8.0	ND	ND	ND	ND	ND	ND	ND	**0.029**	0.036	1.26	1.51	150	0.78	0.0011	91.3
9/8/2020	10:20	22.7	7.9	ND	ND	ND	ND	ND	ND	ND	**0.027**	0.038	1.25	1.61	150	0.96	ND	69.9
9/15/2020	10:10	19.7	7.8	ND	ND	ND	ND	ND	ND	ND	**0.025**	0.035	1.12	1.45	150	1.9	0.0017	95.9
9/22/2020	10:30	20.8	7.9	ND	ND	ND	ND	ND	ND	ND	**0.024**	ND	1.20	1.47	130	0.74	**0.0019**	90.2
9/25/2020	11:10	20.7	8.0	0.21	ND	ND	ND	ND	0.21	0.21	**0.023**	0.033	1.21	1.52	95	1.2	0.0014	88.1
9/29/2020	11:00	19.9	7.9	ND	ND	ND	ND	ND	ND	ND	**0.027**	0.039	1.16	1.49	140	0.62	ND	81.6
10/6/2020	10:00	18.5	8.0	ND	ND	ND	0.055	ND	ND	0.055	**0.038**	0.066	1.17	1.53	140	1.6	ND	91.3
10/8/2020	12:20	18.9	8.1	ND	ND	ND	ND	ND	ND	ND	**0.034**	0.061	1.35	1.45	130	1.0	0.0013	91.2
10/13/2020	10:10	17.6	8.1	ND	ND	ND	0.053	ND	ND	0.053	**0.028**	0.051	1.22	1.41	130	0.90	ND	98.6
10/15/2020	11:00	18.4	7.6	ND	ND	ND	0.056	ND	ND	0.056	**0.030**	0.050	1.23	1.36	130	0.54	ND	83.2
12/10/2020	11:40	8.7	7.8	ND	ND	ND	0.047	ND	ND	0.047	**0.028**	0.16	1.53	1.57	150	0.44	ND	164

* 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 3-11. 2020 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)
5/19/2020	11:20	19.4	7.9	ND	ND	ND	0.042	ND	ND	0.042	**0.053**	0.12	1.49	1.88	160	1.7	ND	347
5/26/2020	11:10	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.070**	0.16	1.56	2.19	150	**2.7**	0.0012	162
6/2/2020	10:30	22.3	7.7	ND	ND	ND	ND	ND	ND	ND	**0.071**	0.17	1.39	1.90	140	1.6	0.0011	131
6/9/2020	10:30	22.3	7.8	ND	ND	ND	0.058	ND	ND	0.058	**0.069**	0.16	1.41	1.73	150	1.3	ND	94.7
6/16/2020	10:20	22.9	7.8	ND	ND	ND	0.063	ND	ND	0.063	**0.086**	0.16	1.26	1.76	150	1.1	ND	85
6/23/2020	10:20	23.7	7.8	ND	ND	ND	ND	ND	ND	ND	**0.070**	0.15	1.01	1.70	170	0.94	**0.0021**	94.7
6/30/2020	10:10	23.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.069**	0.16	1.31	1.88	150	1.2	**0.0019**	96.3
7/7/2020	9:50	23.2	7.8	ND	ND	ND	ND	ND	ND	ND	**0.059**	0.13	1.39	1.75	160	0.85	0.0014	86.2
7/14/2020	10:00	24.5	7.9	ND	ND	ND	ND	ND	ND	ND	**0.056**	0.12	1.34	1.74	150	0.82	ND	87.8
7/21/2020	10:20	23.0	7.9	ND	ND	ND	ND	ND	ND	ND	**0.051**	0.093	1.38	1.72	140	1.1	ND	100
7/28/2020	10:20	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.041**	0.068	1.33	1.67	140	0.83	ND	109
8/4/2020	10:00	23.7	7.8	ND	ND	ND	ND	ND	ND	ND	**0.041**	0.067	1.39	1.84	130	1.0	ND	88.2
8/11/2020	10:00	23.4	7.9	ND	ND	ND	ND	ND	ND	ND	**0.041**	0.065	1.40	1.72	140	1.2	0.0010	78.1
8/18/2020	9:40	23.4	7.6	ND	ND	ND	ND	ND	ND	ND	**0.045**	0.081	1.31	1.57	140	0.71	ND	86.4
9/1/2020	9:50	20.9	8.0	ND	ND	ND	ND	ND	ND	ND	**0.033**	0.036	1.26	1.51	170	0.51	ND	91.3
9/8/2020	9:30	22.6	7.8	ND	ND	ND	ND	ND	ND	ND	**0.029**	0.038	1.23	1.72	140	1.2	ND	69.9
9/15/2020	9:30	19.8	7.8	ND	ND	ND	ND	ND	ND	ND	**0.027**	0.043	1.12	1.44	150	1.1	0.0011	95.9
9/22/2020	9:50	20.7	8.0	ND	ND	ND	ND	ND	ND	ND	0.021	0.032	1.18	1.50	120	0.70	0.0016	90.2
9/25/2020	10:40	21.2	7.9	ND	ND	ND	ND	ND	ND	ND	**0.024**	0.037	1.26	1.51	150	1.0	0.0013	88.1
9/29/2020	10:20	20.1	7.8	ND	ND	ND	ND	ND	ND	ND	**0.028**	0.047	1.20	1.52	130	0.39	ND	81.6
10/6/2020	9:20	18.8	8.1	ND	ND	ND	0.053	ND	ND	0.053	**0.034**	0.066	1.26	1.57	140	0.95	ND	91.3
10/8/2020	11:30	18.7	8.0	ND	ND	ND	ND	ND	ND	ND	**0.035**	0.056	1.16	1.54	140	1.0	0.0016	91.2
10/13/2020	9:20	17.9	8.0	ND	ND	ND	0.061	ND	ND	0.061	**0.028**	0.051	1.25	1.47	140	0.49	ND	98.6
10/15/2020	10:30	18.4	7.7	ND	ND	ND	0.059	ND	ND	0.059	**0.032**	0.046	1.28	1.45	140	0.41	ND	83.2
12/10/2020	11:30	8.5	7.8	ND	ND	ND	0.052	ND	ND	0.052	0.010	0.044	1.28	1.59	180	0.51	ND	164

* 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

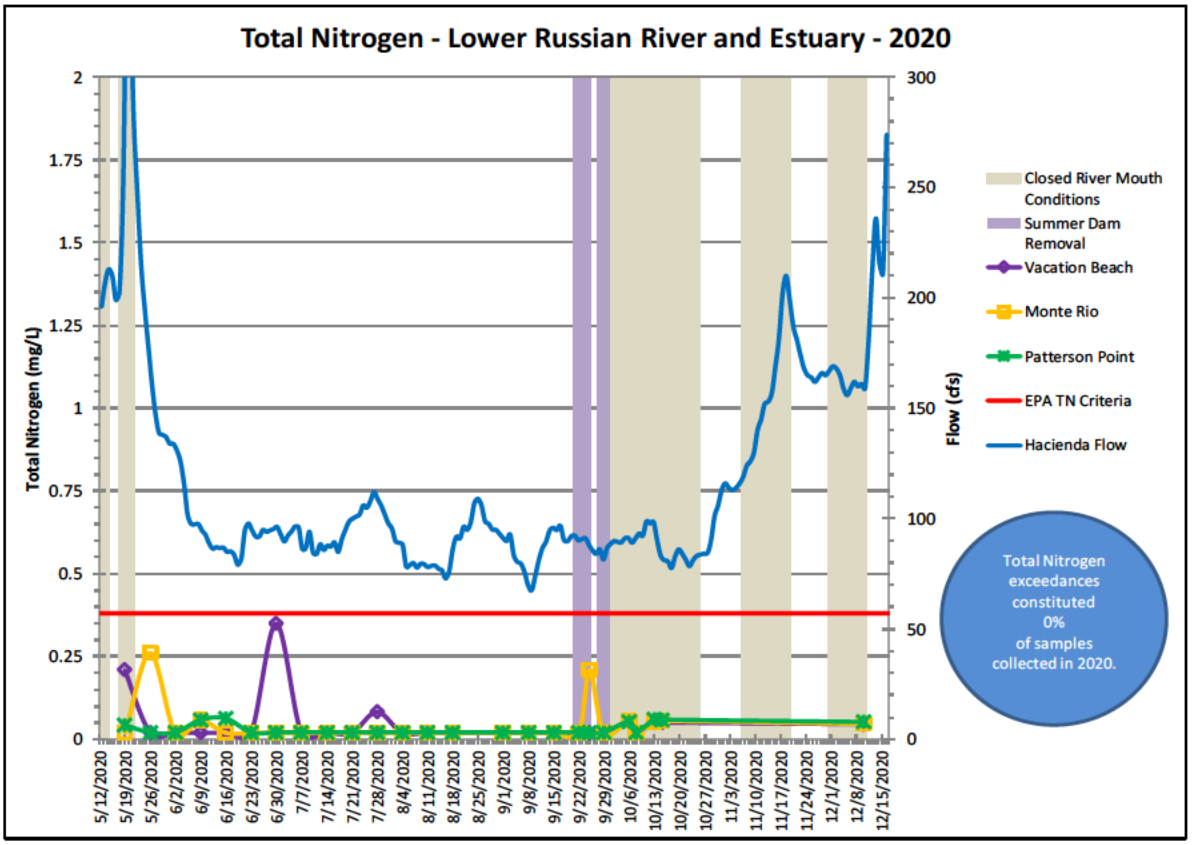


Figure 3-22. Total Nitrogen results for the Russian River from Vacation Beach to Patterson Point in 2020.

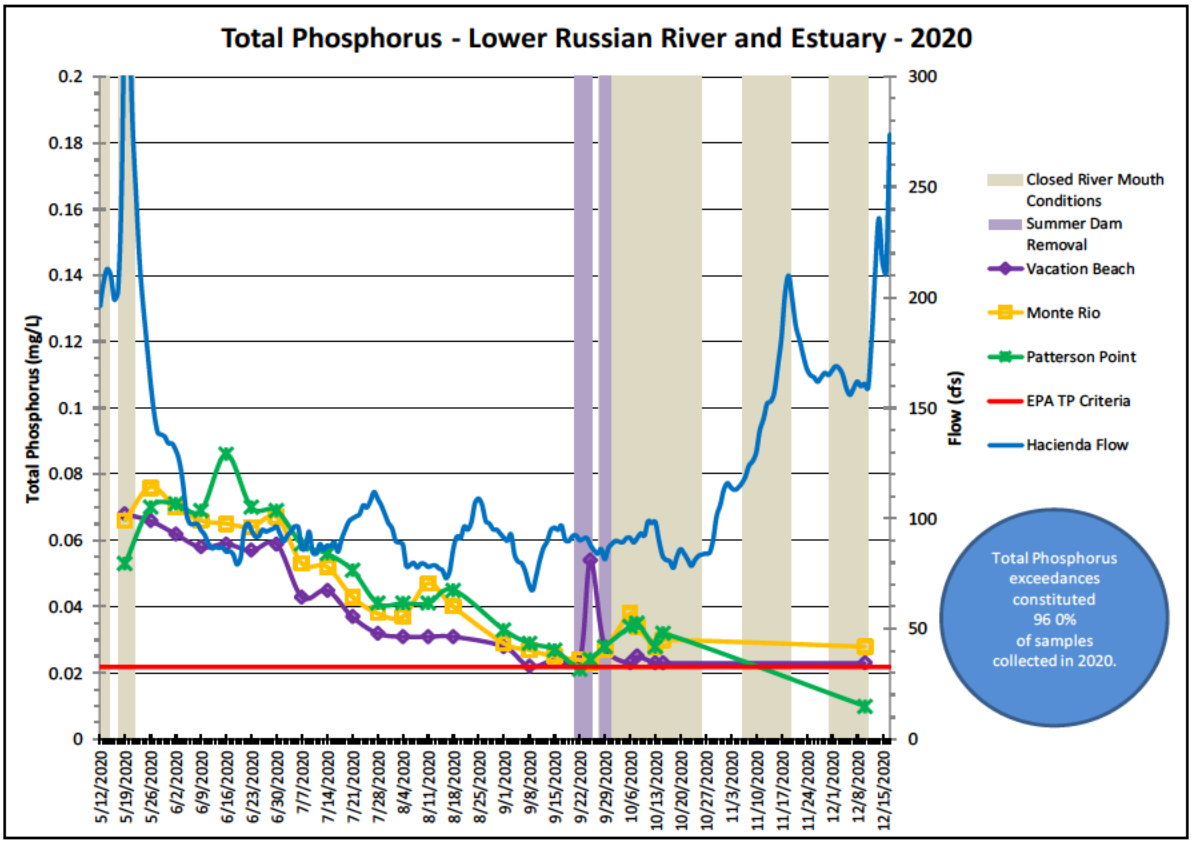


Figure 3-23. Total Phosphorus results for the Russian River from Vacation Beach to Patterson Point in 2020.

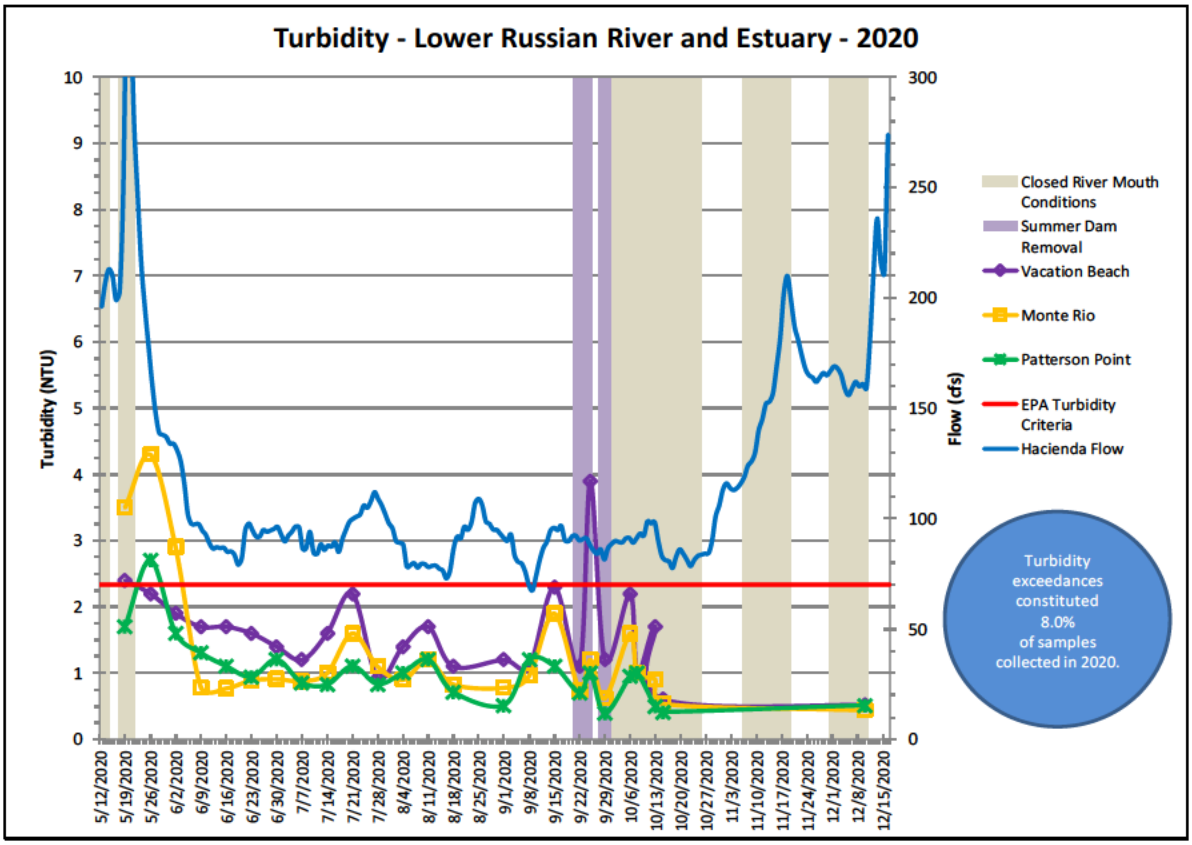


Figure 3-24. Turbidity results for the Russian River from Vacation Beach to Patterson Point in 2020.

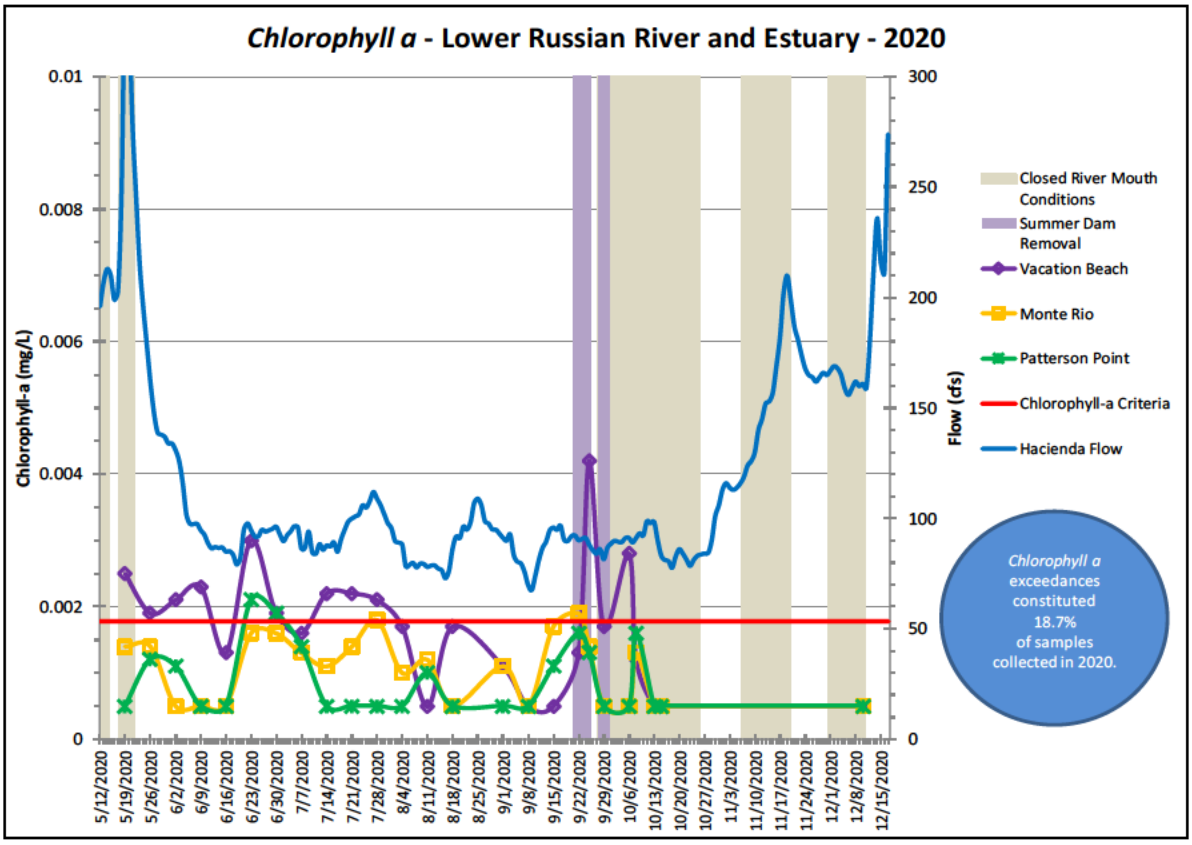


Figure 3-25. *Chlorophyll a* results for the Russian River from Vacation Beach to Patterson Point in 2020.

3.3 Discussion and Observations

The mainstem Russian River experienced less rainfall and lower flows in 2020 compared to Normal Water Year flow rates. These lower flows from a dry winter and spring resulted in a Dry Water Year designation that allowed D1610 flows to be reduced to the Dry Water Year minimum flow rates. This Dry Water Year condition, coupled with significantly low levels of water supply storage in Lake Mendocino, precipitated the request and issuing of a TUC Order to reduce minimum instream flow requirements below D1610 requirements to preserve water supply storage in Lake Mendocino.

Monitoring was conducted for the TUC Order as it has been conducted in the past years when TUC Orders have been issued in response to Dry Water Year conditions, as well as during years of normal rainfall, when TUCs are issued for the Biological Opinion proposed mainstem flows.

Based on the assemblage of data collected by Sonoma County DHS, USACE, CDFW, USGS, and Sonoma Water, it does not appear that lower flows observed in 2020 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 2020; a dry to critically dry water year, is provided for context. The 2019 data is available in the 2019 Russian River Water Quality Summary for the Temporary Urgency Change (Sonoma Water 2019).

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 3-26).

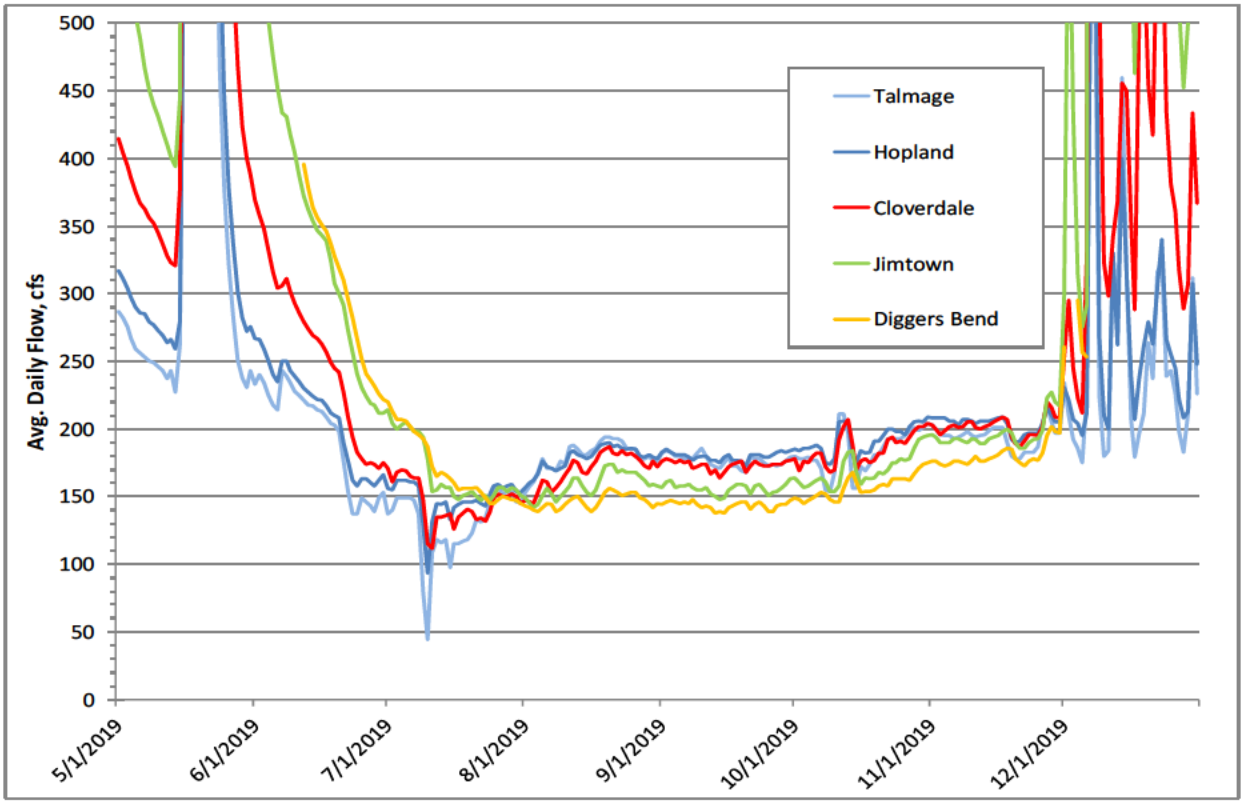


Figure 3-26. 2019 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Whereas, 2020 daily average flows in the upper river between Talmage and Diggers Bend generally ranged between 75 and 125 cfs during the months of June through October (Figure 3-27).

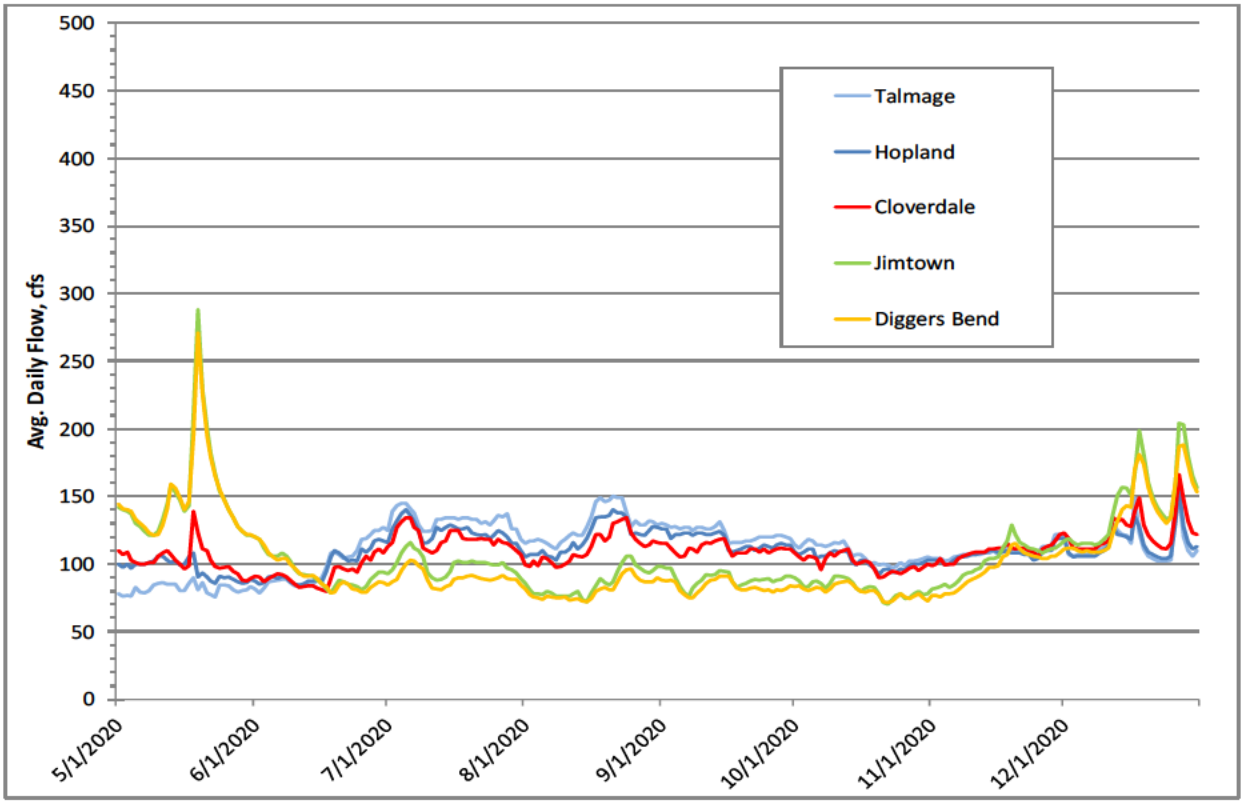


Figure 3-27. 2020 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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 2020 (Figure 3-28).

By comparison a much smaller late-season storm in 2020 only increased Hacienda flows from about 200 cfs to approximately 350 cfs in mid-May before dropping to 100 cfs by early June, resulting in flows decreasing earlier in the season compared to previous years (Figure 3-28).

Summertime base flows in the lower river at Hacienda remained above 150 cfs in 2019, whereas summertime base flows in 2020 were generally below 100cfs and frequently below 85 cfs (Figure 3-28).

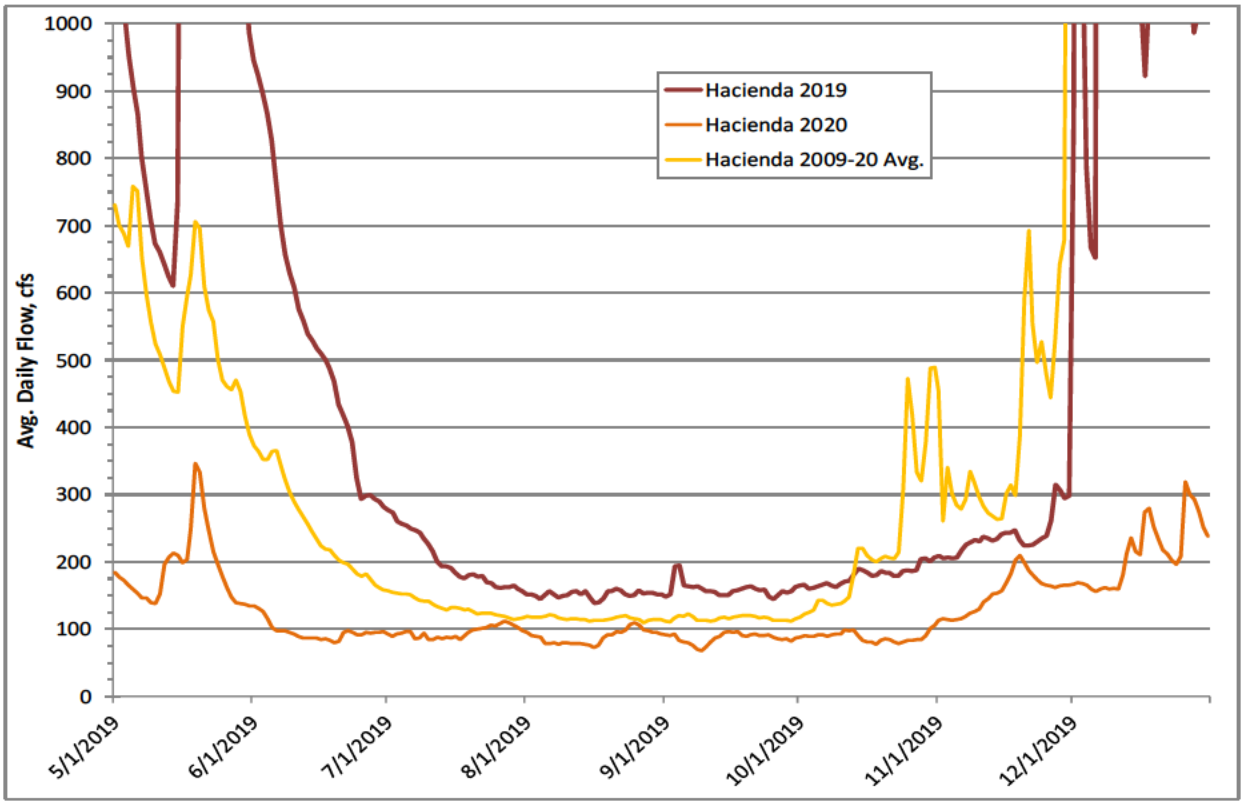


Figure 3-28. Comparison of 2019, 2020 and 2009-2020 average daily flows in the Lower Russian River as measured at USGS Hacienda gage in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

Overall, observed exceedances of EPA and CDPH criteria in the upper and lower river were less frequent, and concentrations were generally lower in 2020 compared with 2019. Included below is a brief discussion and comparison of some of the data collected in 2019 and 2020 that support the determination that lower flows in 2020 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. Similarly in 2020, Sonoma County DHS reported zero (0) total coliforms exceedances out of 131 total samples collected (0%) and one (1) *E. coli* exceedance out of 131 total samples collected (0.7%) 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 2020, Sonoma Water reported one (1) total coliforms exceedance out of 72 total samples collected (1.4%) and zero (0) *E. coli* exceedance out of 72 total samples collected (0%) at the ten stations.

DHS did not conduct cyanotoxin monitoring at the ten beach monitoring stations in 2019 so there are no comparative values; however, Anatoxin-a was not detected by DHS at any of the stations in 2020 and the few detections of microcystin and cylindrospermopsin that occurred were all below the level of caution and did not facilitate the posting of beach notifications.

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. CyanoHAB outbreaks were not observed to occur on the Russian River during the term of the Order. Additionally, flow conditions observed in 2020 were not observed to contribute to cyanoHAB outbreaks or issues during the term of the Order. However, Sonoma Water staff would recommend continued coordination and comprehensive monitoring across agencies (including the North Coast Regional Water Quality Control Board and DHS) to assess river conditions and specifically those conditions that may contribute to an elevated potential for cyanoHAB outbreaks. These conditions include but are not limited to nutrient availability, invertebrate grazing, water clarity, temperature, the timing and intensity of storm events, streamflow, and the potential for changing hydrology and bed scour to influence development of algal biomass. Sonoma Water staff would continue to promote the preservation of the cold water pool in Lake Mendocino through responsible reservoir management and river flow operations. Staff would also support US Army Corps of Engineers (USACE) efforts to address elevated turbidity issues associated with Lake Mendocino releases and improve water clarity in the upper Russian River.

Total nitrogen exceedances and concentrations at the upper river stations were fairly consistent from 2019 to 2020, with the exception of Hopland. Hopland had eight (8) exceedances out of 12 samples collected (66.7%) of the total nitrogen criteria in 2019, but only one (1) exceedance out of 13 collected (7.7%) in 2020.

Total nitrogen exceedances were also fairly consistent from 2019 to 2020 at the lower river stations of Vacation Beach, Monte Rio, and Patterson Point, with the exception of several exceedances that occurred during elevated storm flows in early May of 2019. Overall, total nitrogen concentrations were observed to be slightly higher in 2019 than in 2020.

Total phosphorus concentrations and numbers of exceedances were fairly consistent from 2019 to 2020 in Hopland and Cloverdale, but were significantly lower in Jimtown and at Syar in 2020. In 2019, Jimtown had six (6) exceedances of 12 samples collected (50%) and Syar had 11 exceedances of 18 samples collected (61.1%). Whereas in 2020, Jimtown had one (1) exceedance of the total phosphorus criteria out of 13 samples collected (7.7%) and Syar had zero (0) exceedances out of 13 samples collected (0%). Total phosphorus exceedances and concentrations at the three lower river stations were consistently high in 2019 and 2020, continuing a pattern of chronic elevated total phosphorus in the lower river area.

Turbidity values in the upper river were generally lower in 2020 than in 2019, especially at Jimtown and Syar. Turbidity values at Hopland exceeded the criteria through the entire 2019 season, with most values being above 10 NTU. Whereas in 2020, most values at Hopland were below 5 NTU, including three results below the EPA criteria. Cloverdale also exceeded the criteria through the entire 2019 season with a maximum value of 15 NTU. In 2020, Cloverdale had a maximum value of 6.4 NTU and six (6) results out of 13 samples collected (46.2%) that were below the criteria. 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 13 samples collected (7.7%) and a maximum value of 2.4 NTU in 2020. Syar had 14 exceedances of 18 samples collected (77.8%) with a maximum value of 30 NTU in 2019, but had zero (0) exceedances of 13 samples collected (0%) and a maximum value of 1.2 NTU in 2020.

Turbidity values were significantly lower at Vacation Beach, Monte Rio and Patterson Point in 2020 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. Monte Rio had 9 exceedances of 25 samples collected (36%) and Patterson Point had 11 exceedances of 25 samples collected (44%) in 2019. 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. In contrast, during the 2020 monitoring season Vacation Beach had two (2) exceedances of 25 samples collected (8%), Monte Rio had three (3) exceedances of 25 samples collected (12%), and Patterson Point had one (1) exceedance of 25 samples collected (4%). The majority of exceedances in 2020 were also during elevated spring flows in May.

Consequently, *Chlorophyll a* concentrations were slightly higher in the upper river in 2020 with more frequent exceedances of the EPA criteria compared to 2019. This was likely influenced by the increased clarity of the water and lower turbidity in 2020 allowing for greater light penetration into the water column. Additionally, early spring exceedances in 2020 were likely influenced by lower flows and less scouring of the substrate, resulting in lower turbidity that allowed algal growth to occur earlier in the season.

Interestingly, *Chlorophyll a* concentrations were lower in the lower river in 2020 compared to 2019, even with improved water clarity. In 2019, there were 12 exceedances of 25 samples collected (48%) at Vacation Beach with a maximum value of 0.0069 mg/L. In 2020, there were 10 exceedances of 25 samples collected (40%) at Vacation Beach with a maximum value of 0.0042 mg/L.

In 2019, there were 13 exceedances of 25 samples collected (52%) at Monte Rio with maximum values of 0.014 mg/L and 0.11 mg/L. Whereas, in 2020 there were two (2) exceedances of 25 samples collected (8%) at Monte Rio with a maximum value of 0.0019 mg/L.

Finally, while there were 11 exceedances of 25 samples collected (44%) at Patterson Point in 2019 with a maximum value of 0.0064 mg/L, there were only two (2) exceedances of 25 samples collected (8%) in 2020 with a maximum value of 0.0021 mg/L.

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.

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.

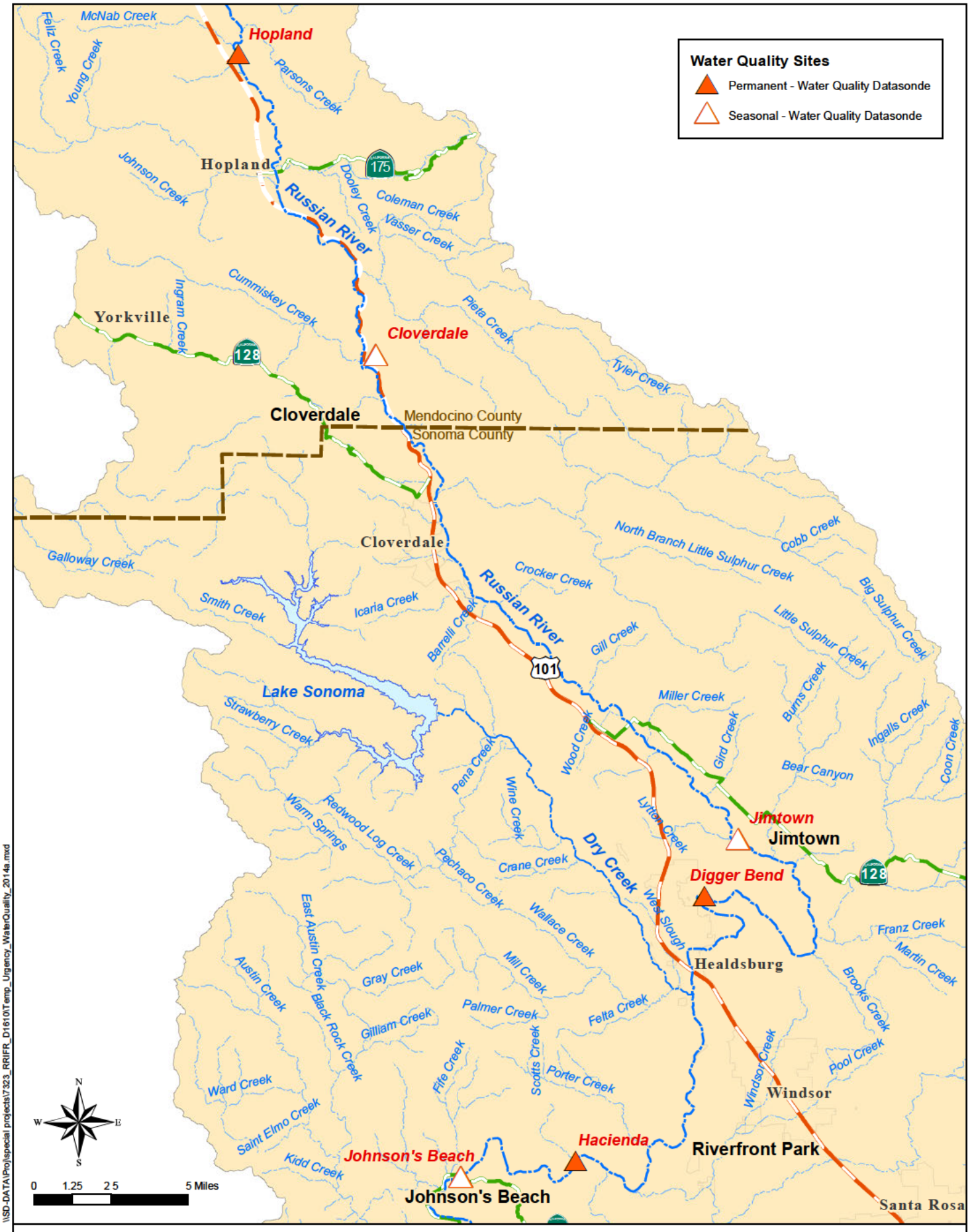
4.0 Additional Monitoring

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 maintains them as part of its early warning detection system for use year-round (Figure 4.1). The sondes take real time readings of water temperature, pH, dissolved oxygen content (DO), specific conductivity, turbidity, and depth, every 15 minutes. In addition, Sonoma Water maintains a permanent sonde on the East Fork of the Russian River approximately one-third of a mile (1/3 mi.) downstream of Lake Mendocino. However, this station is not a real-time station or part of the early warning detection system.

In addition to the permanent sondes, Sonoma Water, in cooperation with the USGS, installed three seasonal sondes with real-time telemetry at the USGS river gage station at Russian River near Cloverdale (north of Cloverdale at Comminsky Station Road), at the gage station at Russian River at Jimtown (Alexander Valley Road Bridge), and at Johnson's Beach in Guerneville (Figure 4.1). The two seasonal sondes at 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 2020 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: http://www.scwa.ca.gov/bo-annual-report/.



Water Agency and USGS Russian River Mainstem
Permanent and Seasonal Datasonde Monitoring Stations

This Map is for general reference only.

Figure 4-1

4.2 Aquatic Habitat for Salmonids

4.2.1 Introduction

In Term 5 (b) of the Temporary Urgency Change Order (Order) the State Water Resource Control Board (SWRCB) tasked Sonoma Water with evaluating impacts associated with reductions in minimum instream flows authorized by the Order to water quality and the availability of aquatic habitat for Russian River salmonids. This section of the report summarizes temperature and dissolved oxygen (DO) conditions in the Russian River during the Order and relates these conditions to fisheries monitoring data collected by Sonoma Water.

4.2.2 Russian River Salmonid Life Stages

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

Coho Timing and Distribution

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

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

Steelhead Timing and Distribution

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

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

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

Chinook Timing and Distribution

Based on video monitoring at Sonoma Water's Mirabel inflatable dam, adult Chinook are typically observed in the Russian River before coho and steelhead. Chinook enter the Russian River as early as September and the migration is complete by early February. Generally the bulk of Chinook pass the Mirabel dam from October through December. Chinook are mainstem spawners and deposit their eggs into the stream bed of the mainstem Russian River and in Dry Creek during the fall (Chase et al. 2005 and 2007, Cook 2003, Martini-Lamb and Manning 2011). Chinook offspring rear for approximately two to four months before emigrating to sea in the spring. The bulk of Chinook smolt emigration occurs from April through mid-July. Russian River Chinook smolt and adult life stages are present in the mainstem during the Order; therefore, only temperature and DO data relating to these two life stages will be analyzed for this report.

4.2.3 Methods

Sonoma Water uses underwater video, downstream migrant traps, and water quality data collected in the Russian River to summarize Russian River water quality conditions when salmonids where present. Sonoma Water operates underwater video cameras to enumerate adult salmonids, and downstream migrant traps to enumerate salmonid smolts. USGS stream gages and a Sonoma Water operated data sonde were used to provide water quality data in the mainstem Russian River.

To estimate the number of adult Chinook that return to the Russian River upstream of the Mirabel inflatable dam, Sonoma Water typically operates underwater video cameras in two fish ladders located on the east and west sides of the dam. In previous years Sonoma Water operated a DIDSON on Dry Creek (a tributary to the Russian River near Healdsburg) to collect adult salmonid information for a Coastal Monitoring Program (CMP) life cycle monitoring station. However, Sonoma Water determined that the DIDSON in Dry Creek was not providing accurate estimates of adult salmonids and discontinued its use.

Physical habitat conditions (flow, water temperature, and DO) were collected at multiple sites in the Russian River. USGS stream gages located on the Russian River at Hacienda, Digger Bend, Jimtown, and at Hopland provided flow, water temperature, and DO data. A data sonde that collected temperature and DO data in the mainstem Russian River near the confluence with Pieta Creek (approximately 5 miles downstream of Hopland, CA) was operated by Sonoma Water. These water quality conditions were compared to findings in the literature then used to construct temperature and DO criteria for Russian River salmonids (Table 4-1 through Table 4-4).

Table 4-1. Adult salmonid water temperature (°C) thresholds used for migration when describing water quality conditions during the term of the May 2016 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
lethal	23.9	23.9	23.9

Table 4-2. Juvenile salmonid rearing temperature (°C) thresholds used for describing water quality conditions during the term of the May 2016 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
lethal	23.9	23.9	23.9

Table 4-3. Salmonid smolting temperature (°C) thresholds used for describing water quality conditions during the term of the May 2016 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
lethal	23.9	23.9	23.9

Table 4-4. Dissolved oxygen (mg/L) thresholds for all salmonid life stages used for describing water quality conditions during the term of the May 2016 temporary urgency change order. Criteria are from SCWA (2016).

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

To evaluate temperature- and DO-related impacts from flow changes to the timing and magnitude of adult and smolt salmonid counts from counting stations, we compared count data to water quality information only where fish would either pass through a water quality station before being detected at a particular counting station. For instance, because Hacienda is downstream of the Mirabel dam, all adult salmonids observed at this site must first pass through the Hacienda water quality station. Therefore, displaying Mirabel adult salmonid counts with Hacienda water quality conditions allows us to relate the timing and magnitude of the adult salmonid run to water quality conditions they likely experienced at Hacienda. Because the majority of steelhead rearing habitat in the mainstem Russian River occurs upstream of Hopland, this report presents the water quality data from the USGS Hopland gaging station when analyzing temperature- and DO-related impacts to juvenile steelhead. Salmonid smolts of all three species moving downstream out of Dry Creek and the upper Russian River pass our downstream migrant trap on the Russian River at Mirabel then pass the Hacienda USGS stream gage before entering the ocean. Therefore, we paired salmonid smolt data from the Russian River downstream migrant trap to Hacienda water quality data to describe the conditions these fish likely experienced as they moved downstream through the lower Russian River.

4.2.4 Results

Flow

From June 1, 2020 to December 27, 2020 flow in the Russian River at Hacienda ranged from a high of 320 cfs at Hacienda on December 26, to a low of 68 cfs on September 9. Flow during the Order was typically between 87 cfs and 112 cfs (25th and 75th percentiles of the daily average flow when considering Hacienda, Digger Bend, Jimtown, and Hopland). During the Order, the Russian River was influenced by tributary in-flow until June, and was generally controlled by reservoir releases from June through December.

Temperature

Adult Salmonid Migration

The underwater video cameras at Mirabel dam were installed on September 1. At Mirabel, 598 Chinook, 228 coho and 112 steelhead adults were observed during the Order. The river mouth closed multiple times during the Order restricting adult salmonids form entering the river. The river mouth was closed 46 of the time from September 1, to December 27 (the period that the adult Chinook run that overlaps with the order) (Figure 4-1).

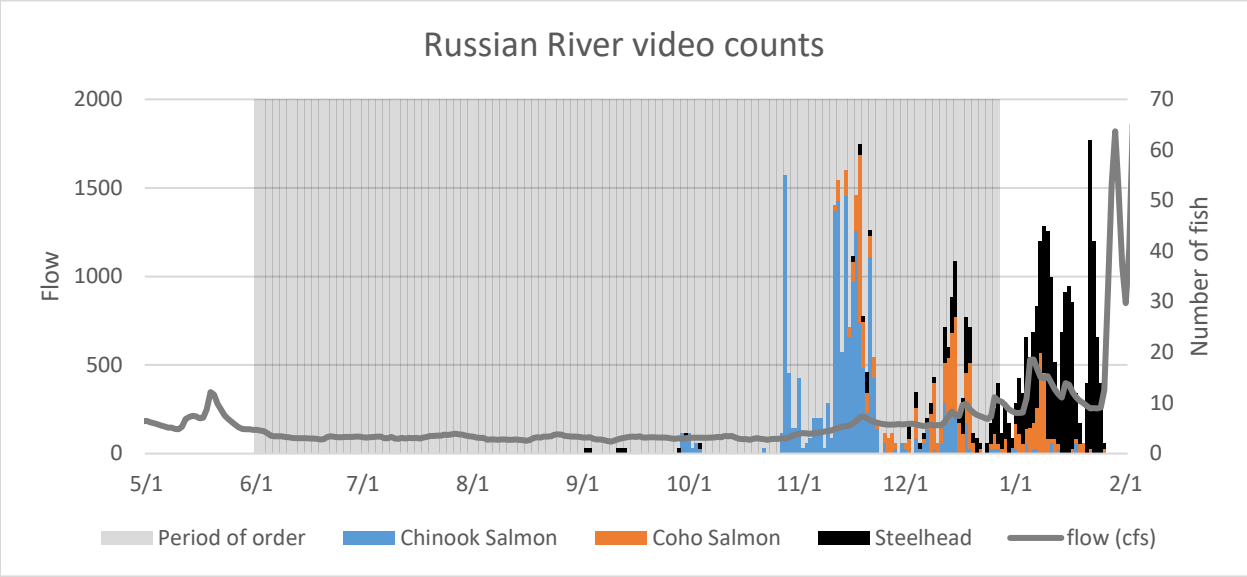


Figure 4-1. Flow in the Russian River at the USGS Hacienda stream gage (11467000). The period that the Adult Chinook run overlaps the Order is shaded. Also shown are the adult salmonid counts from video collected at Mirabel.

Table 4-5. The number of adult salmonids counted during and after the Order, the percentage of days in each period the river mouth was closed (thus blocking adult salmonids from entering the Russian River), the number of adult salmonids that could not be identified to species, and the number of Chinook observed on the underwater video cameras. The underwater video system was removed from the river on December 26, 2020 when the dam was deflated.

Time period	# of days	% of time river mouth closed	Observed Chinook	Observed Coho	Observed Steelhead
During order	117	46%	598	228	112
After order expired	29	51%	11	88	548

Chinook

Water temperatures for Chinook salmon were favorable during the period that most chinook were observed in the Russian River. At the Hacienda gage the temperature ranged from optimal to acutely stressful for adult salmonids (based on the criteria in Table 4-1 and Figure 4-2). However, temperatures at Hacienda were generally suitable to optimal when the majority of Chinook were observed at Mirabel. Moving upstream from Hacienda, Chinook would have experienced water temperatures similar to Hacienda at Digger Bend and Jimtown, but significantly cooler at the confluence of Pieta creek and at Hopland due to the influence of cool water released from Coyote Valley Dam (Figures 4-2 through 4-6).

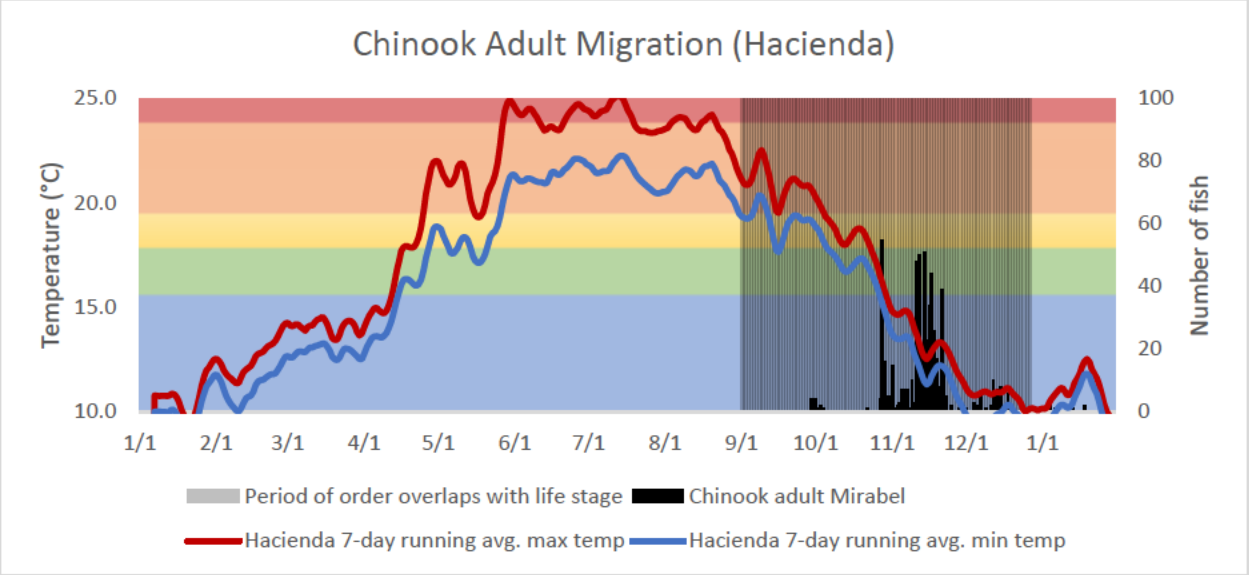


Figure 4-2. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook counts from the mainstem Russian River at Mirabel. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones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

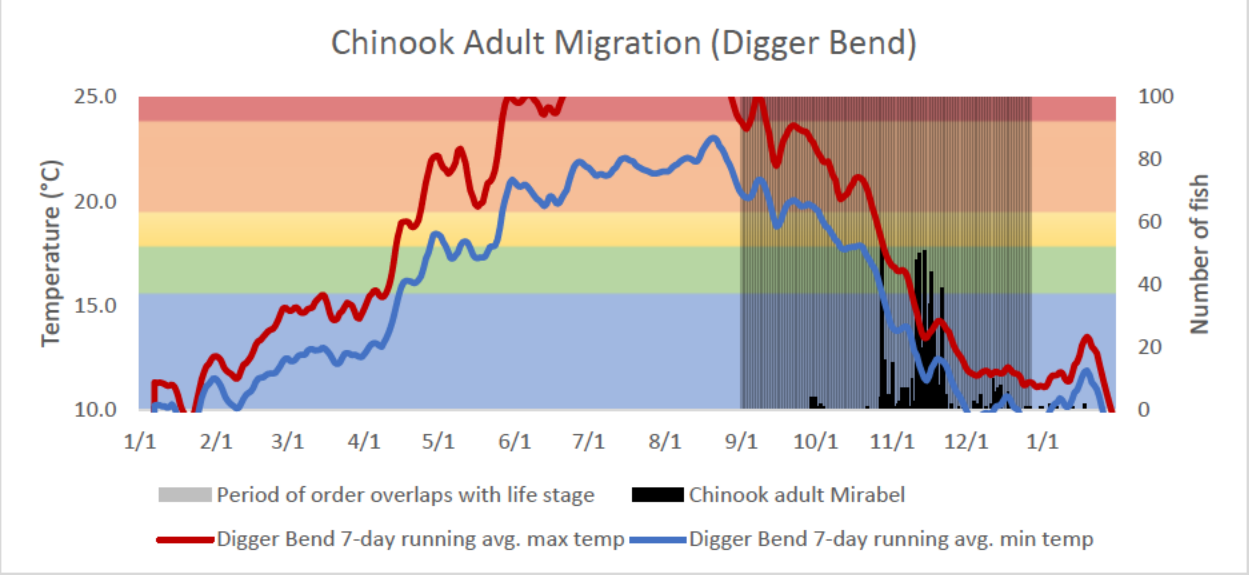


Figure 4-3. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

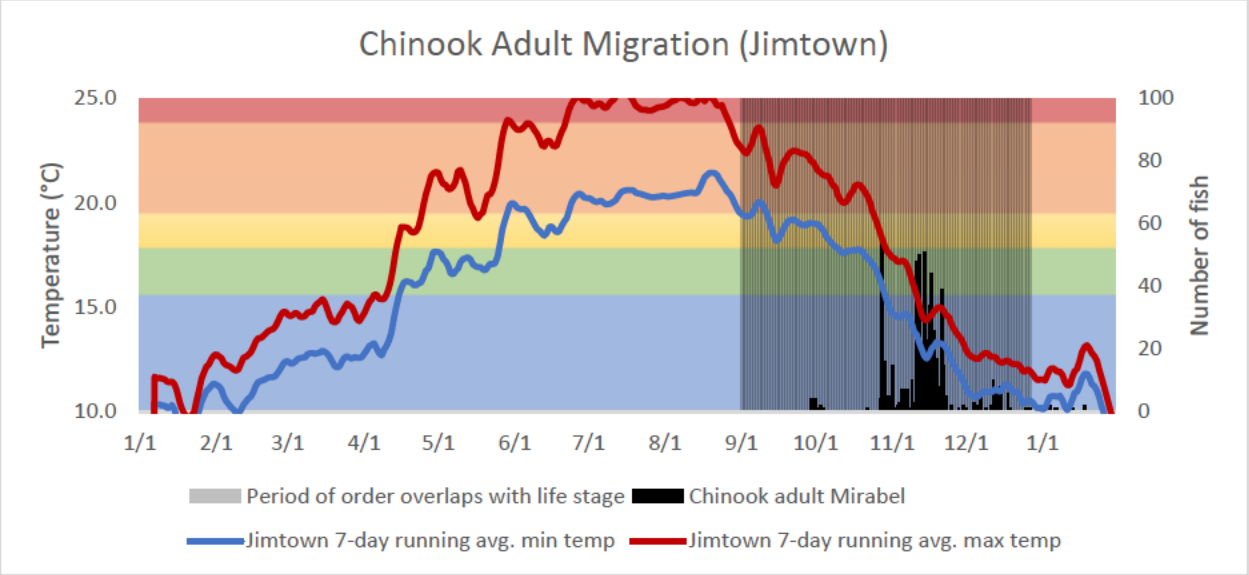


Figure 4-4. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

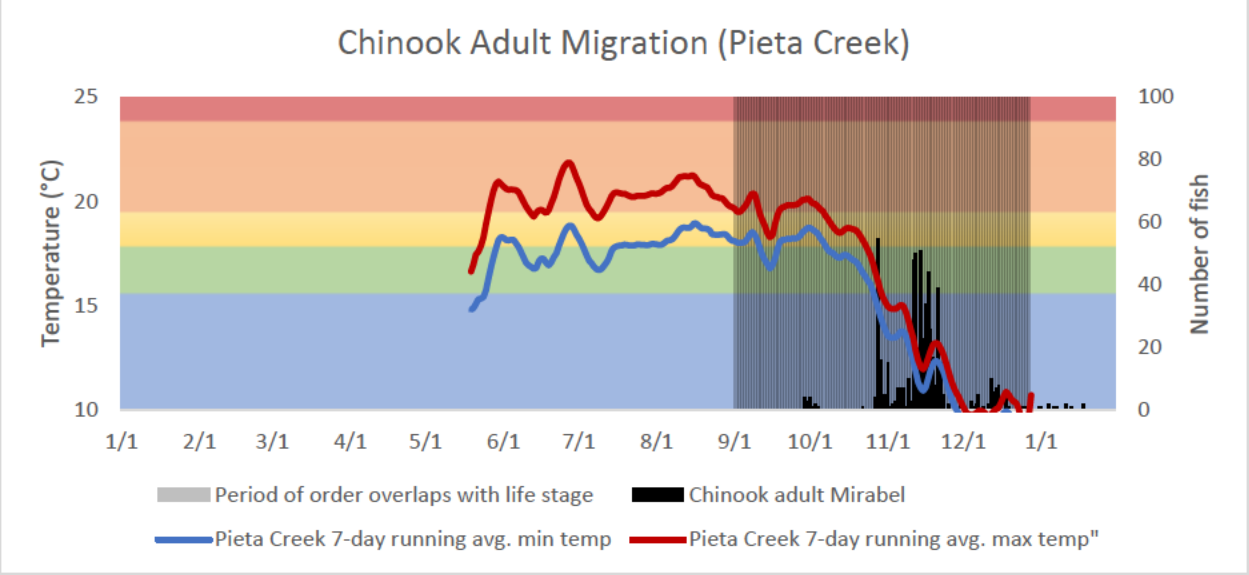


Figure 4-5. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

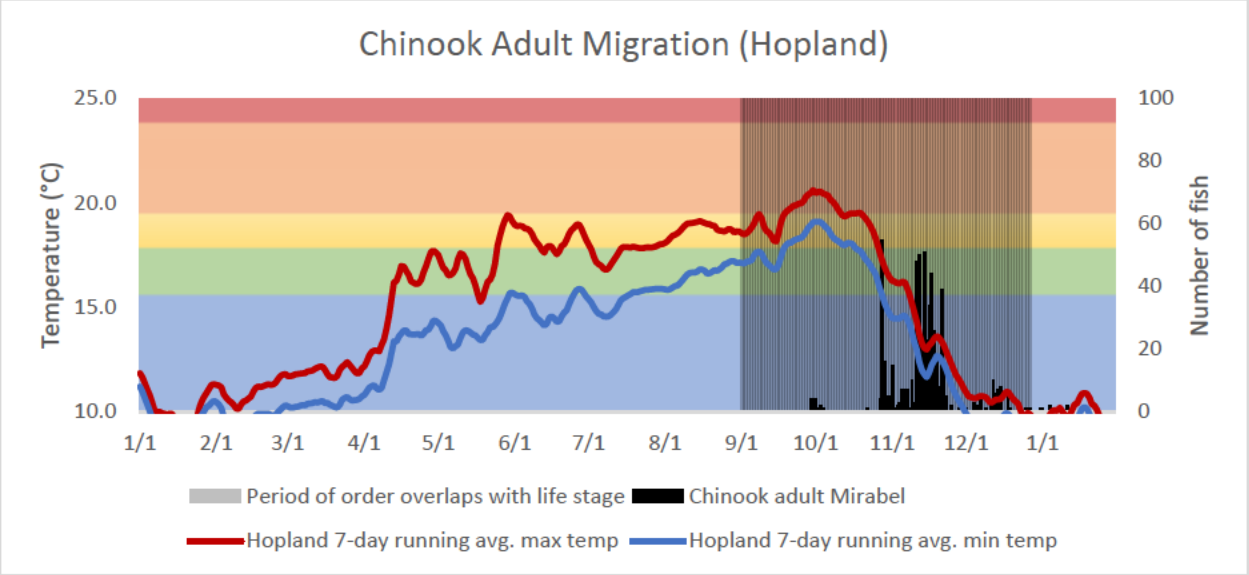


Figure 4-6. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

Coho

Water temperatures for coho were favorable during the portion of the Order that overlaps with the coho adult migration (November through December). At the Hacienda gage the temperature ranged from optimal to suitable for adult coho (based on the criteria in Table 4-1 and Figure 4-7). Moving upstream from Hacienda, coho would have experienced water temperatures similar to Hacienda (Figures 4-7 through 4-8).

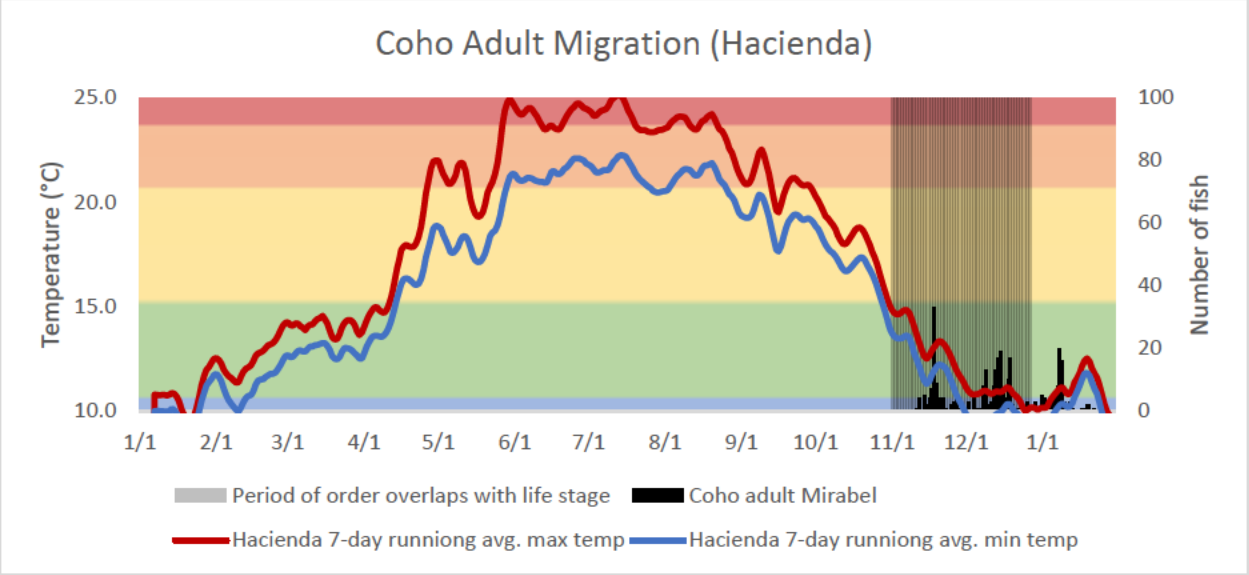


Figure 4-7. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the coho counts from the mainstem Russian River at Mirabel. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones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

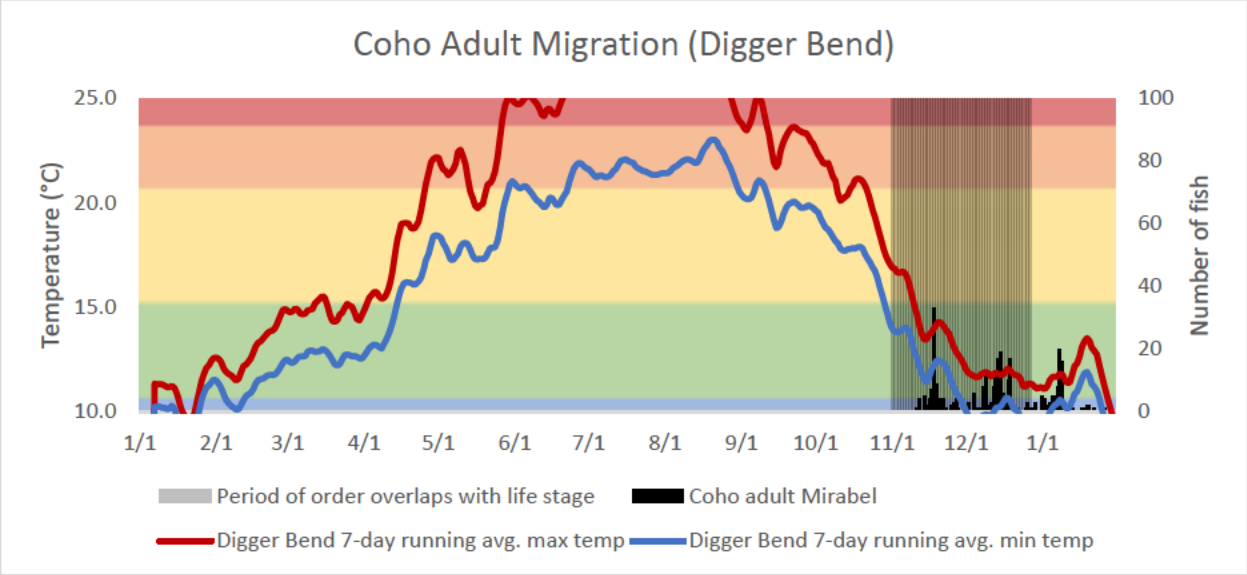


Figure 4-8. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for coho adult migration based on Table 4-1.

Steelhead

Water temperatures for steelhead were favorable during the portion of the Order that overlaps with the steelhead adult migration (December). At the Hacienda gage the temperature ranged from optimal to acutely suitable for adult steelhead based on our criteria (Table 4-1 and Figure 4-9). Moving upstream from Hacienda, steelhead would have experienced water temperatures similar to Hacienda (Figures 4-9 through 4-13).

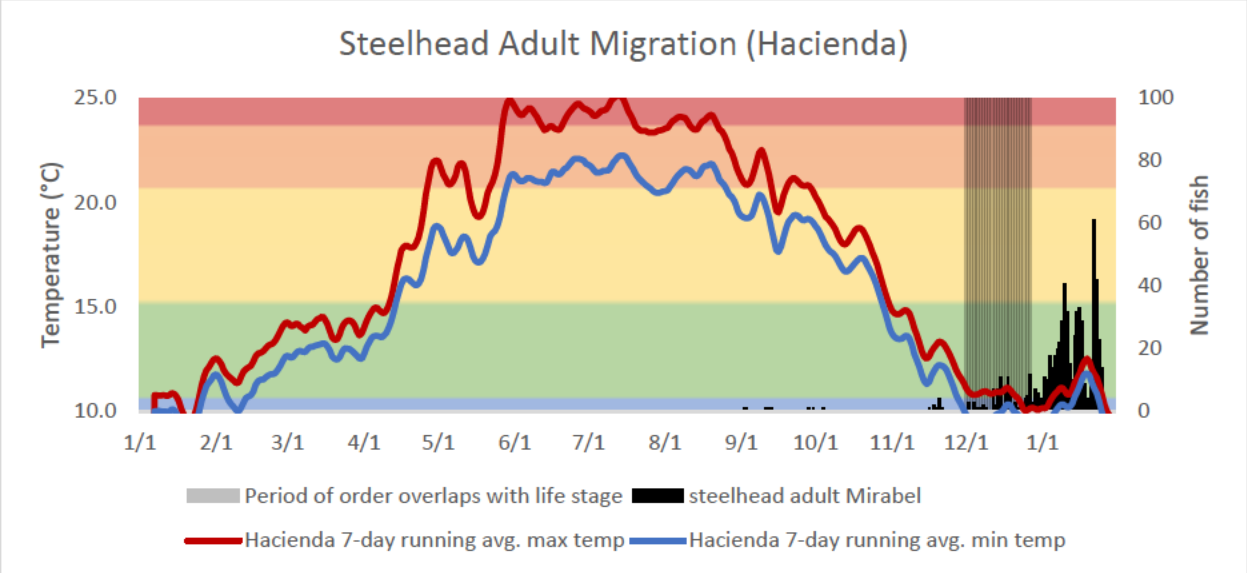


Figure 4-9. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the steelhead counts from the mainstem Russian River at Mirabel. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature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

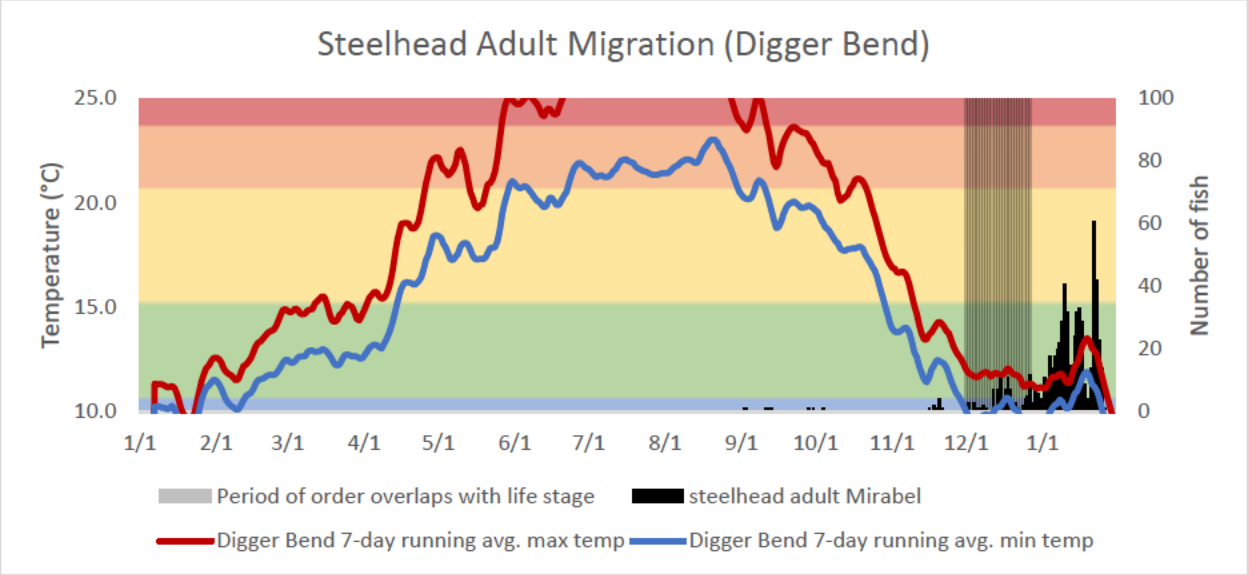


Figure 4-10. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

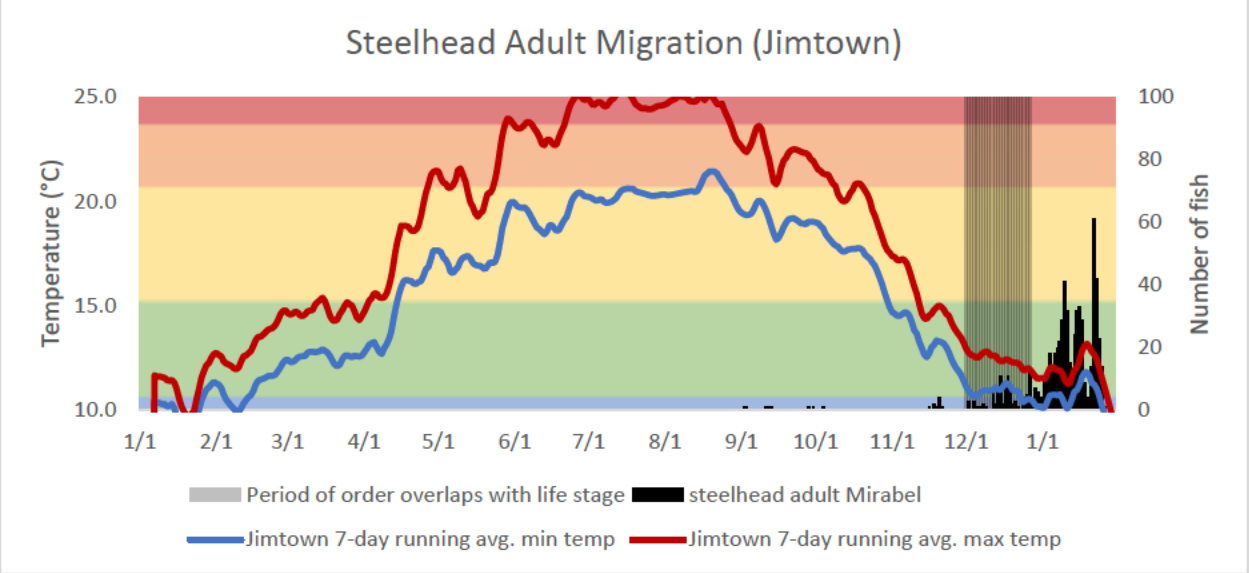


Figure 4-11. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

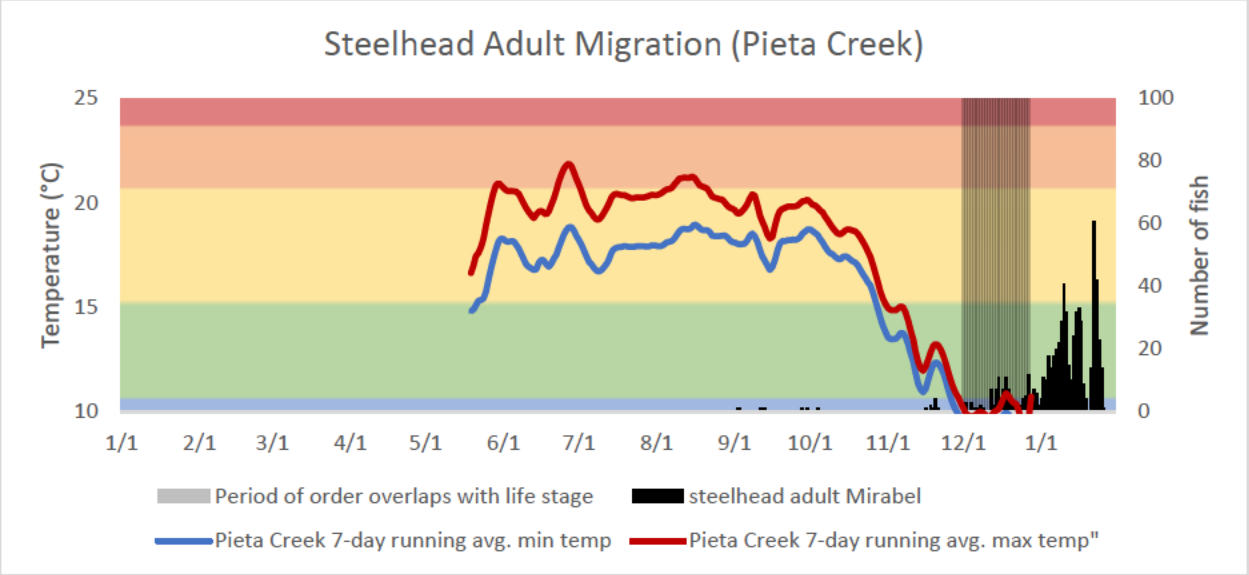


Figure 4-12. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River at the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

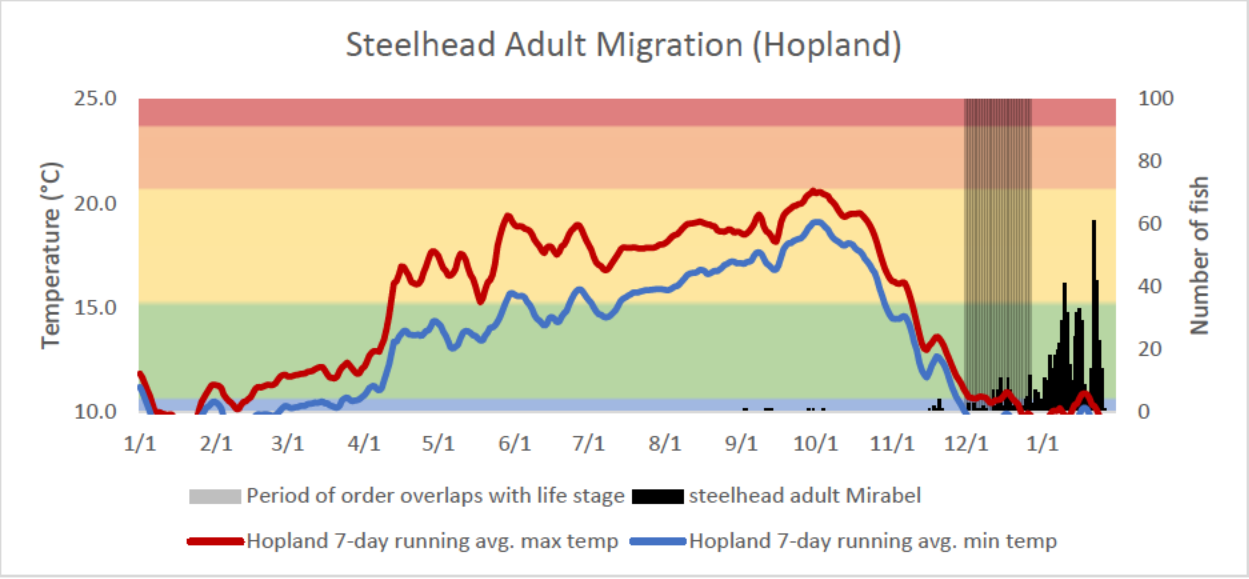


Figure 4-13. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

Salmonid Rearing

Salmonids must cope with water temperatures found at their rearing sites. In the Russian River basin much of the salmonid rearing habitat is located 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 throughout the River. As a result, Chinook rear at more locations in the Russian River, but for a shorter time than steelhead. Therefore, we relate water temperature at a number of mainstem Russian River sites to Chinook water temperature criteria. Steelhead rear in freshwater for one or more years and are primarily restricted to the portion of Russian River where water released from the cold-water pool (the bottom portion of the lake) in Lake Mendocino has the greatest cooling effect on mainstem rearing habitat near Coyote Valley Dam. This cooling effect has largely diminished by the time water has reached Cloverdale approximately 50 km downstream. We relate steelhead water temperature criteria to water temperature collected at Hopland and in the Russian river near the confluence of Pieta Creek (approximately 5 miles downstream of Hopland, CA) as these sites are within the section of the Russian River that can provide year-round rearing opportunities for juvenile steelhead. Juvenile coho salmon do not rear in the mainstem of the Russian River.

Chinook

During 2020, water temperatures for rearing Chinook were favorable in the early spring at all sites and became less favorable in May and June in the mainstem Russian River at Jimtown, Digger Bend, and Hacienda. Water temperatures were generally in the optimal or suitable range for Chinook salmon rearing in the Russian River near the confluence with Pieta Creek and at the USGS stream gage at Hopland (gauge number 11462500, Figure 4-14 and Figure 4-15). Although stressful and eventually acutely stressful conditions did occur. At Jimtown, Digger Bend, and Hacienda water temperatures were generally favorable for Chinook rearing until May, then temperatures became stressful and eventually acutely stressful or even potentially lethal by June (Figures 16-18). It is important to note that Chinook have evolved to migrate downstream and out to sea in the spring to avoid rearing at high temperatures and by June most Chinook had smolted and emigrated from the Russian River (see Salmonid Smolt Outmigration).

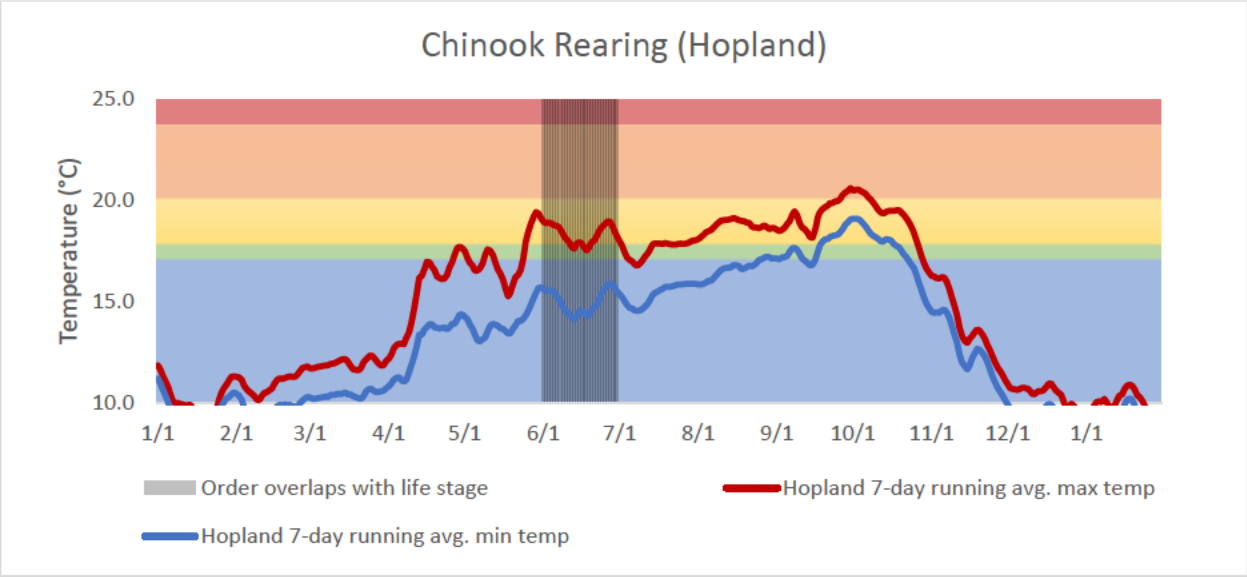


Figure 4-14. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

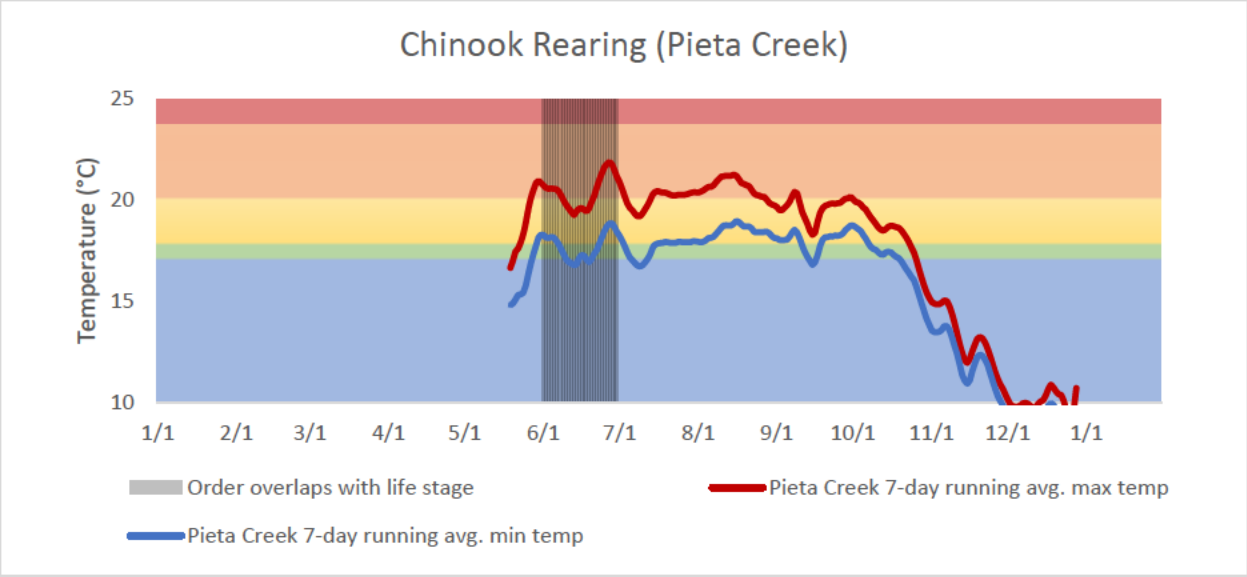


Figure 4-15. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature zones for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

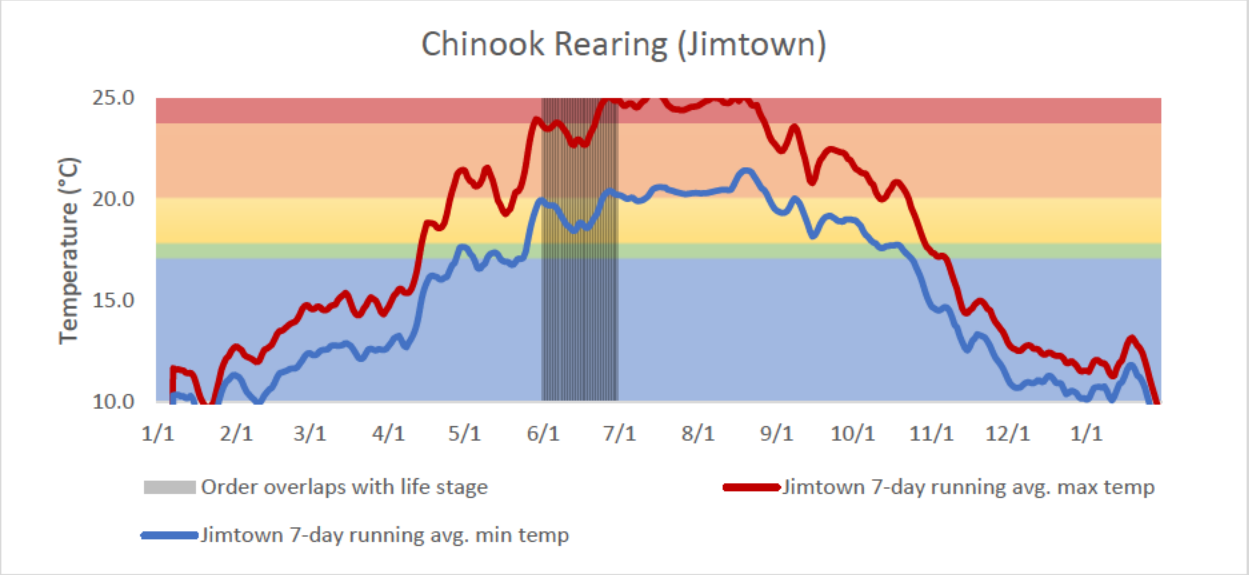


Figure 4-16. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

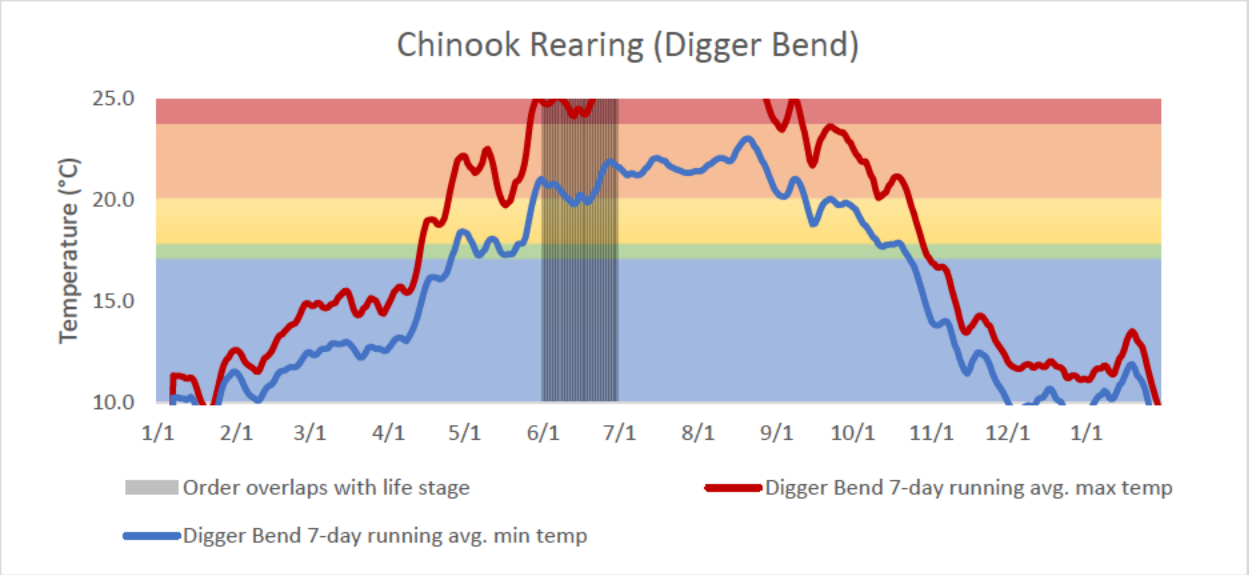


Figure 4-17. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

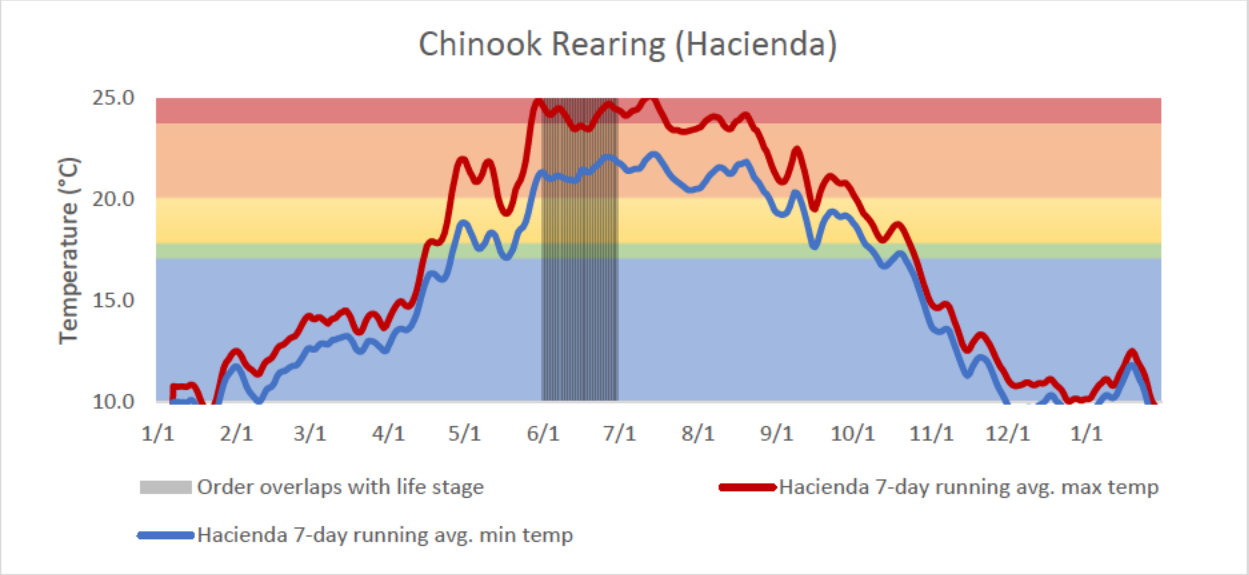


Figure 4-18. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hacienda (gage number 11467000) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

Steelhead

Steelhead parr rear year-round in the upper Russian River. During the Order water temperature at the USGS stream gage at Hopland was mainly suitable to optimal for steelhead rearing (Figure 4-19). Water temperature was optimal to stressful for most of the Order in the Russian River near Pieta Creek (Figure 4-20).

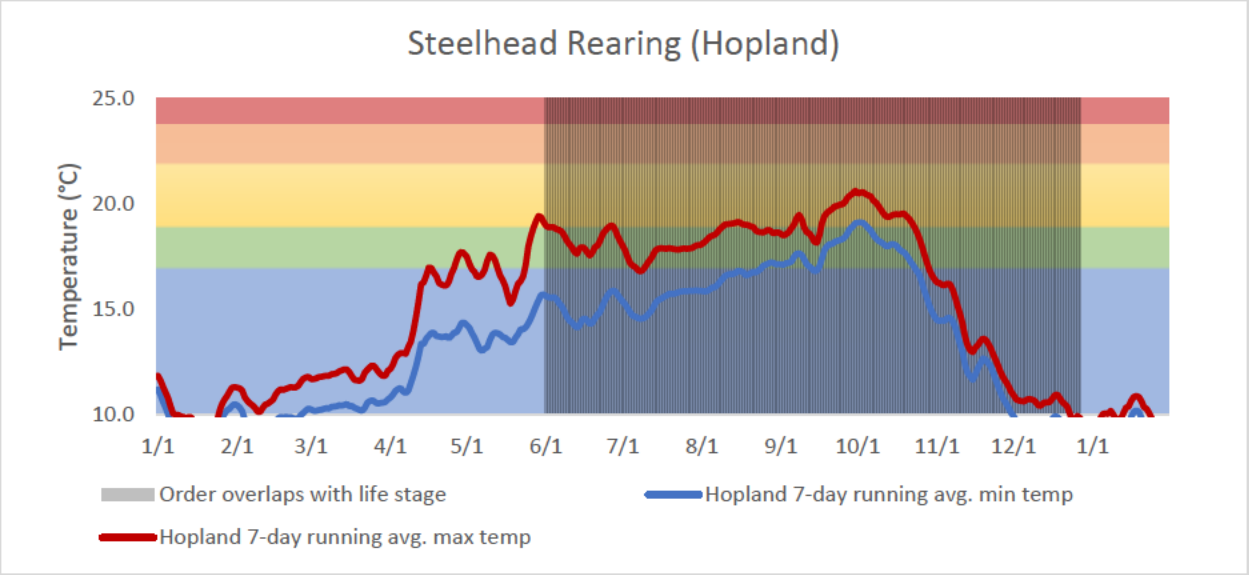


Figure 4-19. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead parr based on Table 4-2.

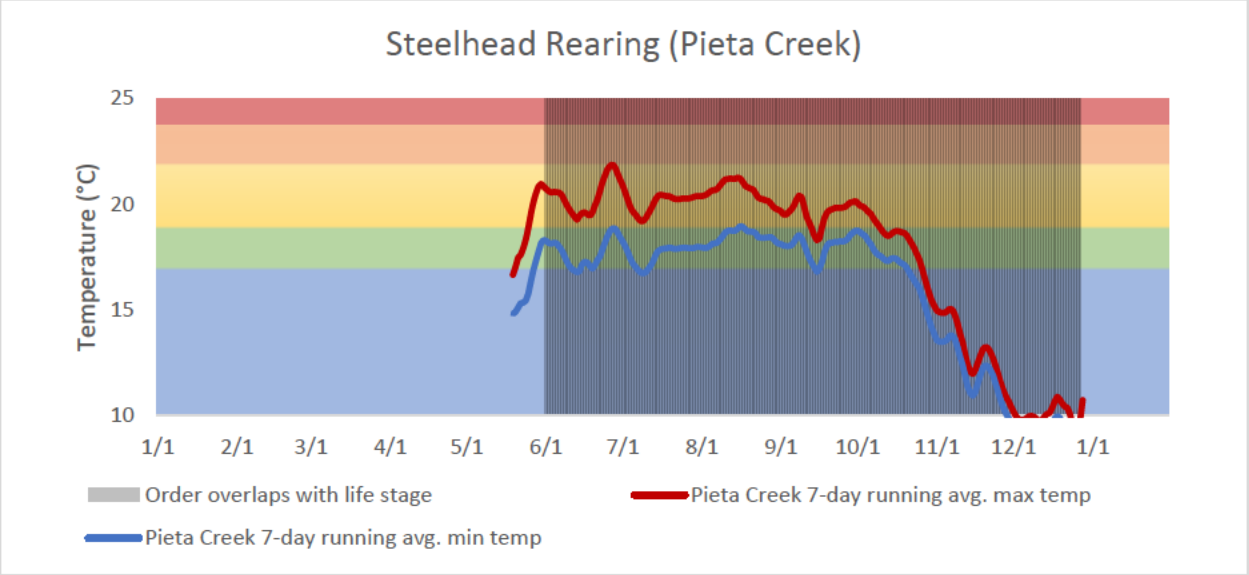


Figure 4-20. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead parr based on Table 4-2.

Salmonid Smolt Outmigration

For smolts produced in the upper portion of the watershed, we summarized Russian River water temperatures for Hopland, confluence with Pieta Creek, Jimtown, and Digger Bend gages and show these temperatures with water temperature criteria for Chinook smolts. For Chinook smolts passing through the lower mainstem of the Russian River, we considered migration timing based on downstream migrant trap catches on the Russian River near the Mirabel dam from April 21, 2020, until June 15, 2020. From June 1 to June 15, we captured 84 Chinook salmon smolts, 1 coho salmon smolt and 1 wild steelhead smolt at the Mirabel trap. Because so few coho and steelhead smolts were apparently emigrating through the lower river during this period (based on the historical Mirabel trap catch), we did not evaluate lower river temperature effects on smolts of these two species and instead restricted our analysis to Chinook smolts. We related Chinook catch data to temperature collected at Hacienda. Hacienda is located approximately 4 km downstream of the trap site and represents temperatures experienced by smolts as they emigrate through the lower river. It is noteworthy that many of these smolts emigrate from Dry Creek where temperatures are significantly cooler than temperatures at Hacienda.

Chinook

Water temperature in the upper Russian River near the Coyote Valley Dam was generally favorable for Chinook smolts during the period that Chinook are expected to emigrate from that potion of the Russian river (April through June, Figure 4-21). However, water temperature became less favorable in the later part of the migration season at sites located downstream of Hopland (Figure 4-22 through Figure 4-25). It is important to note that Chinook have evolved to emigrate during the spring before water temperatures become lethal and that most Chinook captured at the Mirabel fish trap emigrated before the Order went in effect in June (Figure 4-25).

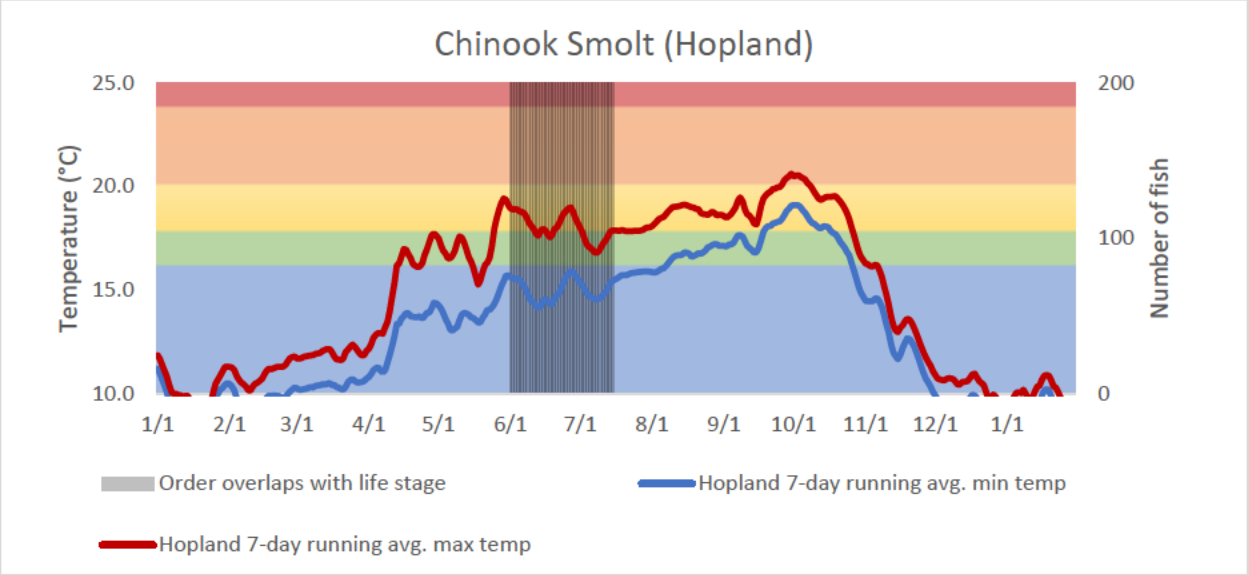


Figure 4-21. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). Shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

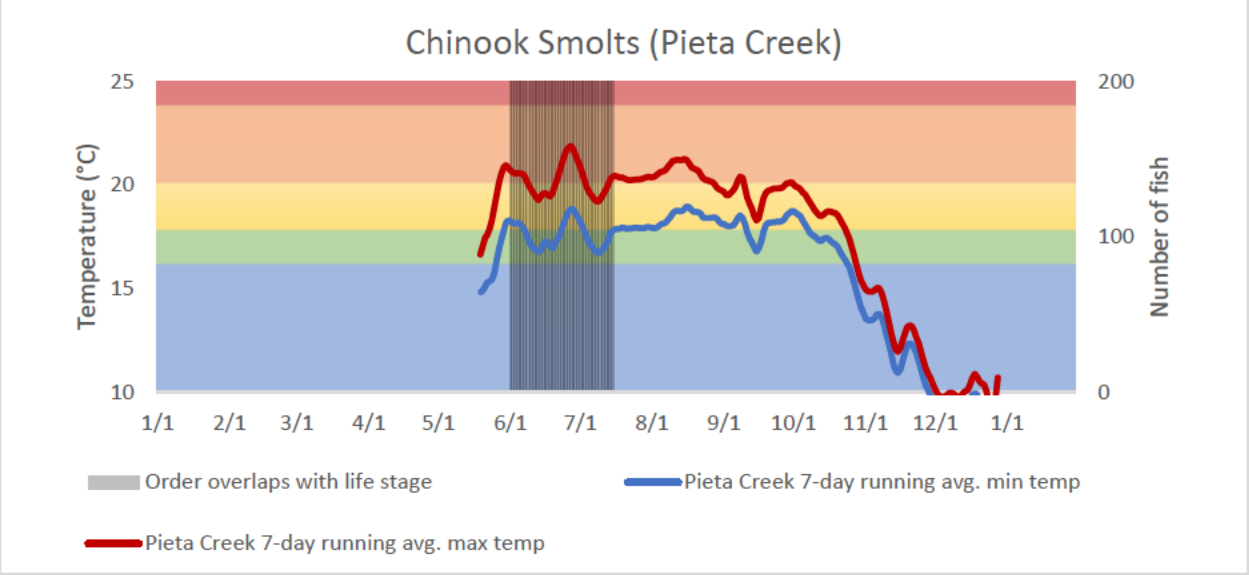


Figure 4-22. The 7-day running average of the minimum and maximum water temperatures collected in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook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

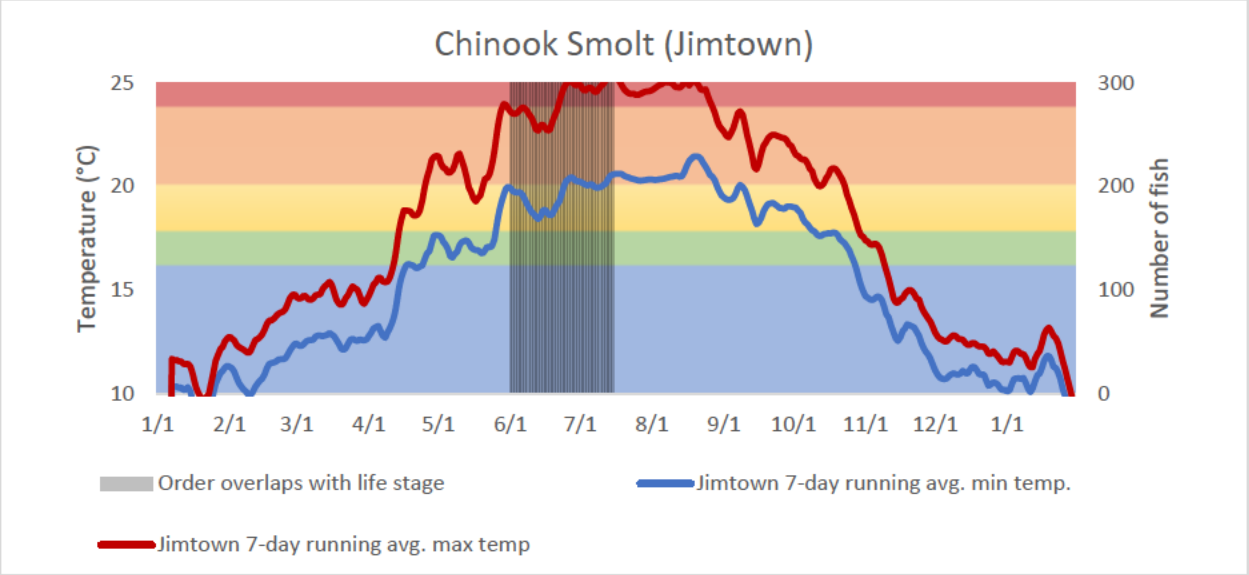


Figure 4-23. The 7-day running average of the minimum and maximum water temperatures collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

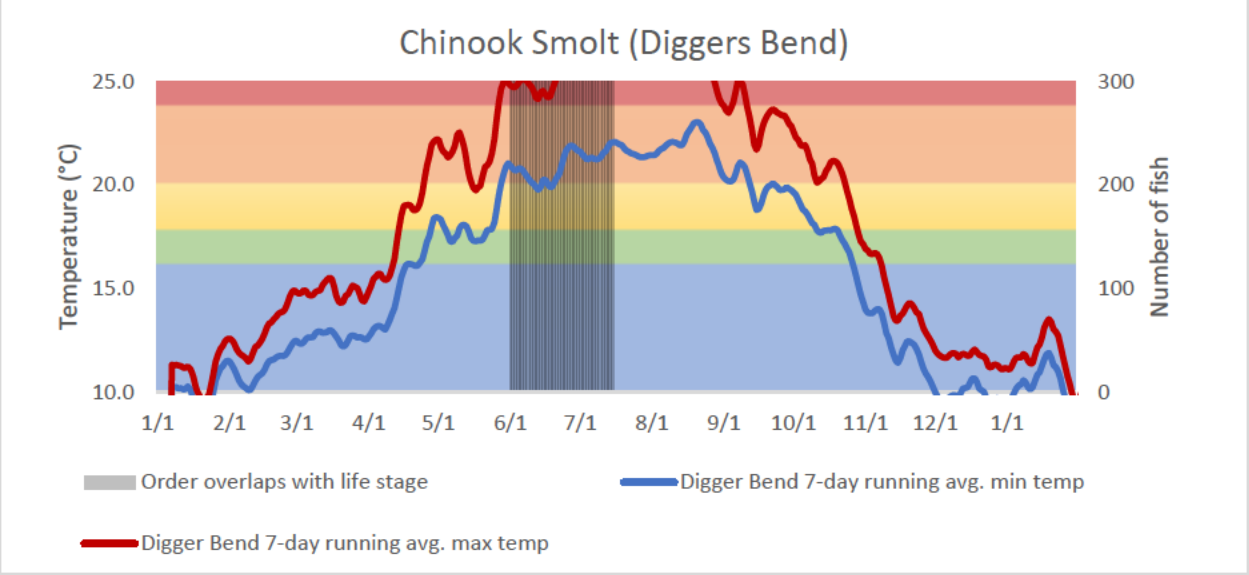


Figure 4-24. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) shown with the daily Chinook smolt catch from a fish trap located at Chalk Hill approximately 5 miles upstream of Digger Bend shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

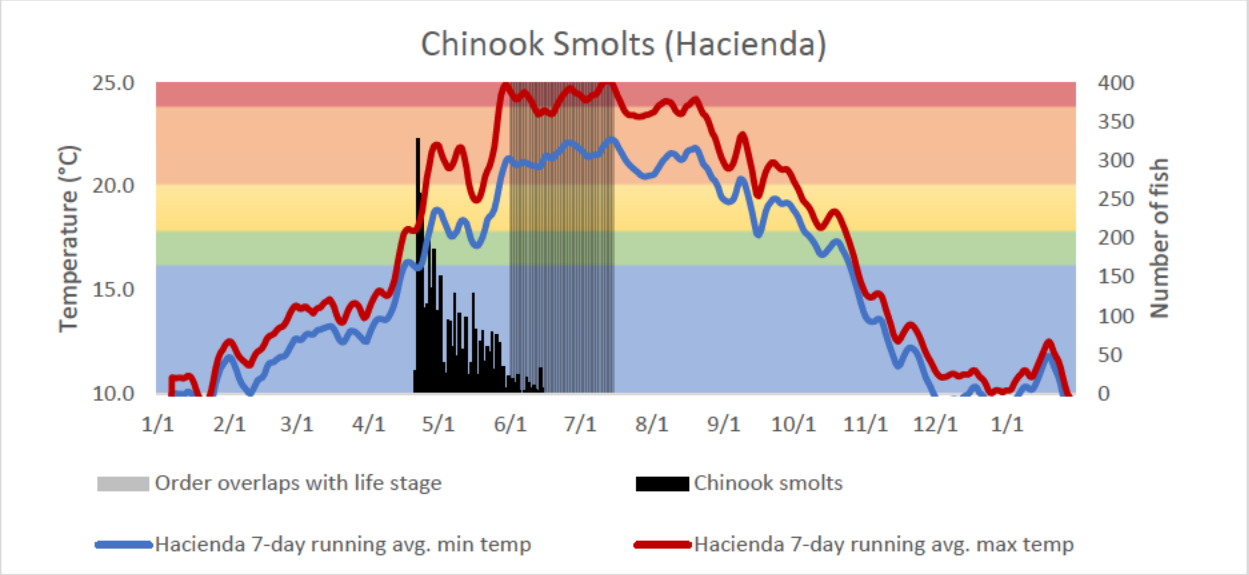


Figure 4-25. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook smolt catch from the Mainstem Russian River near Mirabel shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

Dissolved Oxygen

At most sites, dissolved oxygen was generally favorable for salmonids in the Russian River throughout the Order. At Hopland, the Russian River near the confluence of Pieta Creek, at Jimtown, Digger Bend, and at Hacienda, dissolved oxygen levels were generally in the optimal and suitable range although the minimum daily dissolved oxygen levels became stressful at some sites (Figures 4-26 through 4-30).

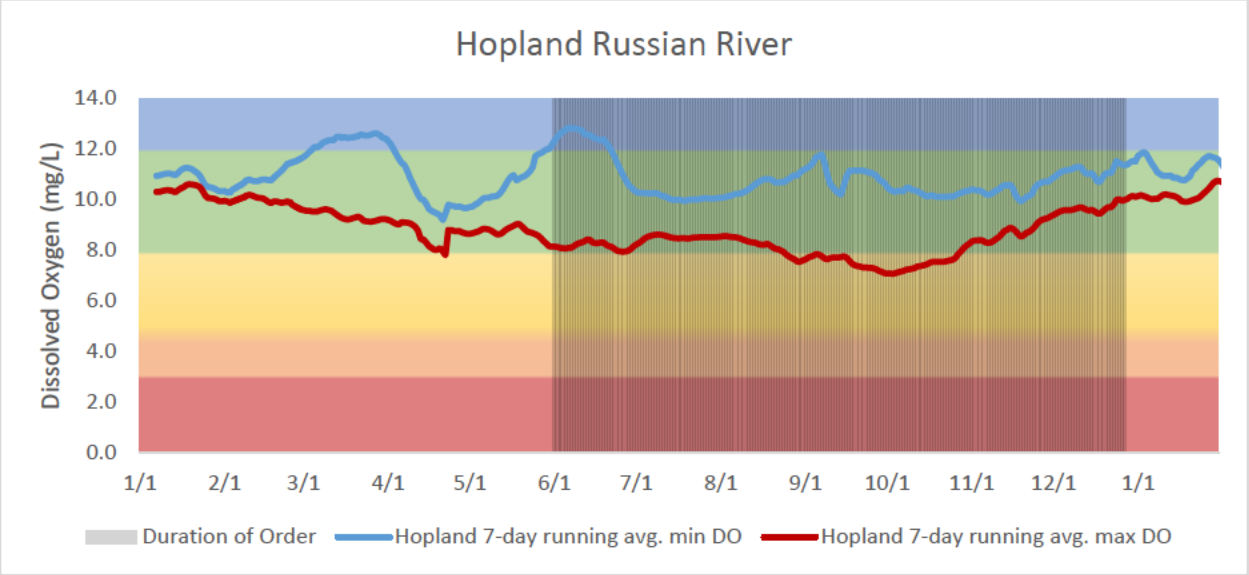


Figure 4-26. The 7-day running average of the minimum and maximum dissolved oxygen collected at Hopland (USGS stream gage number 11462500) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

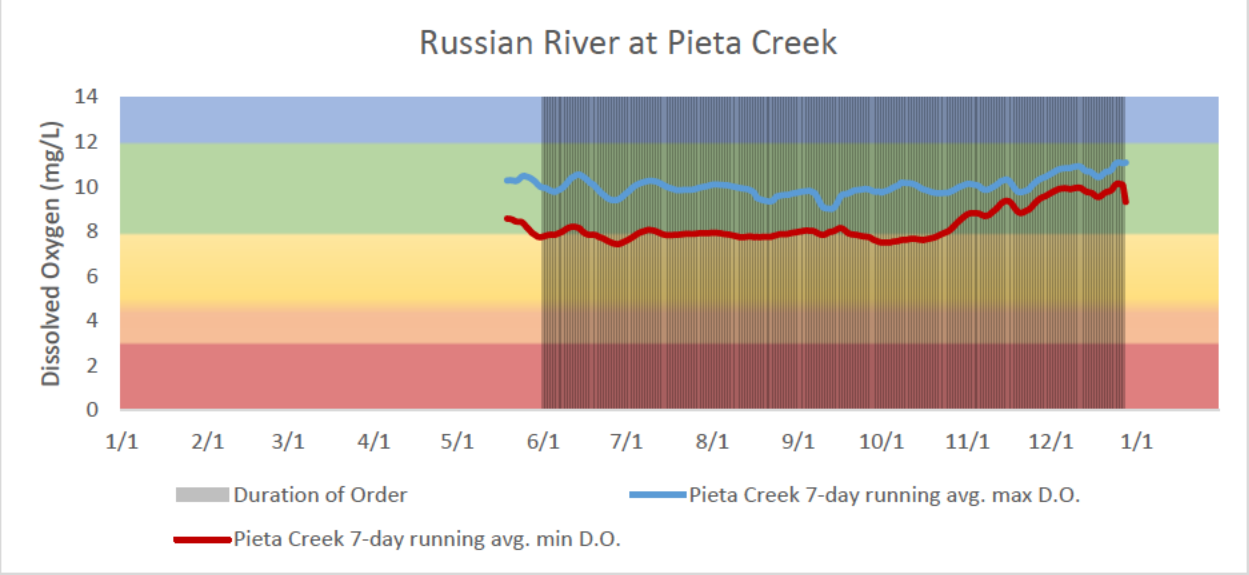


Figure 4-27. The 7-day running average of the minimum and maximum dissolved oxygen collected in in the Russian River near the confluence with Pieta Creek approximately 5 miles downstream of Hopland, CA shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

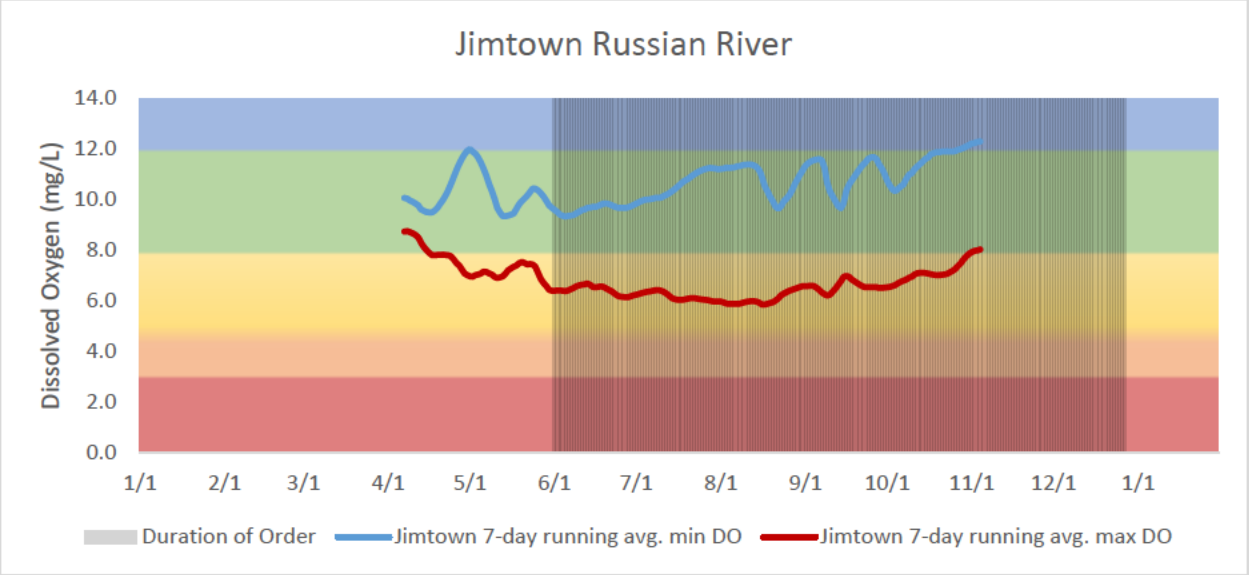


Figure 4-28. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

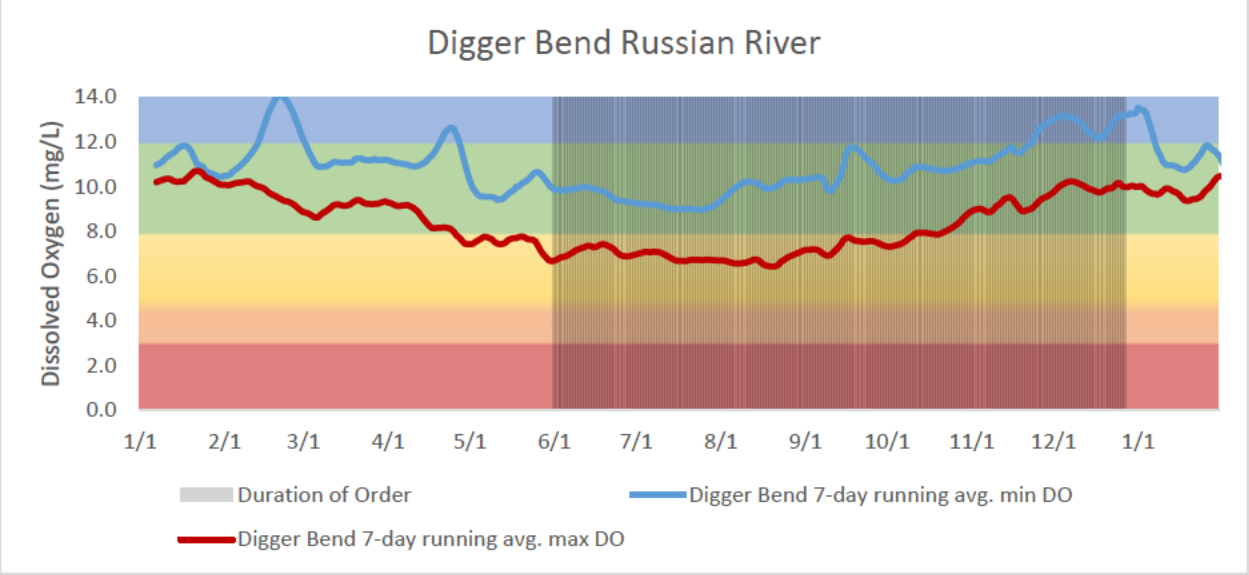


Figure 4-29. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

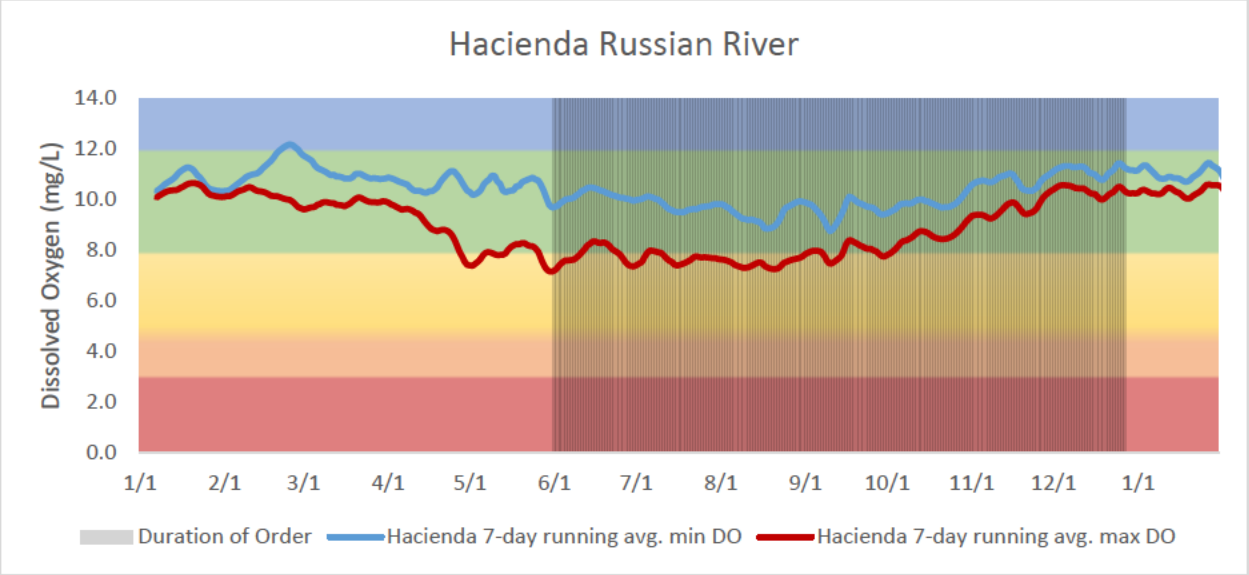


Figure 4-30. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Hacienda USGS stream gage (1146700) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

4.2.5 Summary

Physical habitat was generally favorable for salmonids in the Russian River for life stages that are expected to occur during the period of the Order (June 1 to December 27). Adult salmonids moved past Mirabel during the Order. When Chinook first began migrating upstream in 2020, water temperature at Hacienda was stressful to acutely stressful, but quickly changed to suitable to optimal. Water temperatures at sites upstream of Hacienda followed a similar trend where temperatures were acutely stressful to stressful then decreased as air temperatures decreased with the onset of fall. By November water temperatures were suitable to optimal for adult Chinook at all sites. By mid-November water temperatures were suitable or optimal for adult coho and adult steelhead at all sites. While temperatures were occasionally unfavorable for adult salmonids it is important to note that (1) these fish have evolved to cope with seasonally warm water temperatures by returning to the river in the fall when water temperatures are beginning to cool and (2) the vast majority of adult salmonids return to the Russian River after water temperatures in the river have become favorable.

For juvenile Chinook, water temperatures were favorable for rearing in the early spring at most sites but became unfavorable by the end of the rearing season. Water temperatures remained stressful to optimal at Hopland. Fish that remained in the river and emigrated as smolts late in the rearing season encountered unfavorable water temperatures as they moved downstream and out to sea. It is important to note that Chinook have likely adapted to warm temperatures in the Russian River and have adjusted their run timing to further cope with seasonally warmer water temperatures by emigrating earlier in the year.

Water temperatures near Hopland were favorable for steelhead rearing throughout the Order. In the Russian River near the confluence with Pieta Creek and near Hopland water temperature was typically

stressful to optimal for rearing steelhead. However, water temperatures fell to optimal levels by November due to cooling air temperatures.

Chinook salmon had favorable water temperatures for smolting at Hopland. Water temperatures became acutely stressful and even lethal after June 1 at the downstream monitoring sites. However, the bulk of Chinook smolts emigrate from the Russian River prior to June 1 when water temperatures are more favorable. Some Chinook smolts are captured after June 1 in a downstream migrant trap operated by Sonoma Water on Dry Creek (a tributary to the Russian River), after water temperatures in the Russian River became stressful and acutely stressful at Hacienda. Cold water released from Lake Sonoma may keep Chinook smolts from receiving migration cues they might otherwise receive as the water warmed from changing seasons. This may delay Chinook smolt emigration from Dry Creek. Once late emigrating fish leave Dry Creek, they would experience stressful and acutely stressful temperatures in the lower Russian River.

Dissolved oxygen was generally favorable for salmonids at all monitoring sites and for the duration of the Order. The 7-day running average of the minimum dissolved oxygen occasionally became stressful for salmonids at Hopland and in the Russian river near the confluence with Pieta Creek. At Jimtown, Digger bend, and Hacienda the 7-day running average of the minimum dissolved oxygen was frequently stressful for salmonids, but the least favorable conditions occurred mainly during the summer months when salmonids would not be occupying this section of the river.

References

Baker, P. F., T. P. Speed, and F. K. Ligon. 1995. Estimating the influence of temperature on the survival of Chinook salmon smolts (Oncorhynchus tshawytscha) migrating through the Sacramento-San Joaquin River Delta of California. Journal of Fisheries and Aquatic Sciences 52: 855-863.

Barnhart, R. A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) -- steelhead. U.S. Fish and Wildlife Service report 82(11.60). U.S. Army Corps of Engineers, TR EL-82-4. 21 pp.

Bell, M. C. 1986. Fisheries handbook of engineering requirements and biological criteria. Fisheries Engineering and Research Program, U.S. Army Corps of Engineers Division, Portland, Oregon.

Bell, M. C. 1991. Fisheries handbook of engineering requirements and biological criteria. Fisheries Engineering and Research Program, U.S. Army Corps of Engineers Division, Portland, Oregon.

Bisson, P. A. and J. L. Nielsen, and J. W. Ward. 1988. Summer production of coho salmon stocked in Mount St. Helens streams 3-6 years after the 1980 eruption. Transactions of the American Fisheries Society 117: 322-335.

Bovee, K. D. 1978. Probability of Use Criteria for the Family Salmonidae. U.S. Fish and Wildlife Service.(FWS/OBS-78/07.): 53.

Brett, J. R. 1952. Temperature tolerance in young Pacific salmon, genus Oncorhynchus. Journal of the Fisheries Research Board of Canada 9(6): 265-309.

Brett, J. R., M Hollands, and D. F. Alderdice. 1958. The effects of temperature on the cruising speed of young sockeye and coho salmon. Journal of the Fisheries Research Board of Canada. 15(4):587-605.

Brett, J. R., W. C. Clar, and J. E. Shelbourn. 1982. Experiments on the thermal requirements for growth and food conversion efficiency of juvenile Chinook salmon. Canadian Technical Report of Fisheries and Agricultural Science. 1127. Pacific Biological Station, Nanaimo, BC. 29 pp.

Carter, K. 2005. The Effects of Temperature on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and Function by Life Stage: Implication for the Klamath Basin TMDLs. Regional Water Quality Control Board North Coast Region.

CDPH (California Department of Public Health). 2011. Draft Guidance for Freshwater Beaches. Division of Drinking Water and Environmental Management. https://www.cdph.ca.gov/Programs/CEH/DRSEM/Pages/EMB/RecreationalHealth/Beaches-and-Recreational-Waters.aspx#. Last update: March 9, 2018.

Chase, S. D., R. C. Benkert, D. J. Manning, and S. K. White. 2004. Results of the Sonoma County Water Agency's Mirabel Rubber Dam/Wohler Pool Fish Sampling Program – Year 4 Results: 2003.

Chase, S.D., D. Manning, D. Cook, S. White. 2007. Historic accounts, recent abundance, and current distribution of threatened Chinook salmon in the Russian River, California. California Fish and Game 93(3):130-148. California Dept. Fish and Game, Sacramento California.

Chase, S.D., R.Benkert, D.Manning, and S. White. 2005. Sonoma County Water Agency's Mirabel Dam/ Wohler pool fish sampling program: year 5 results 2004. Sonoma County Water Agency, Santa Rosa, CA.

Church, Jeff. 2017. Personal communication regarding water quality conditions coming out of Lake Mendocino and into the East Fork Russian River. Sonoma County Water Agency.

Clarke, W. C. and J. E. Shelbourn, and J. Brett. 1981. Effects if artificial photoperiod cycles, temperature, and salinity on growth and smolting in underyearling coho (Oncorhynchus kisutch), Chinook (O. tshawytscha), and sockeye (O. nerka) salmon. Aquaculture 22:105-116.

Clarke, W. C. and J. E. Shelbourn. 1985. Growth and development of seawater adaptability by juvenile fall Chinook salmon (Oncorhynchus tshawytscha) in relation to temperature. Aquaculture 45:21-31.

Cook, D. 2003. Upper Russian River Steelhead Distribution Study. Sonoma County Water Agency, Santa Rosa, CA.

Cook, D. 2004. Chinook salmon spawning study: Russian River – Fall 2002-2003. Sonoma County Water Agency.

Crader, P. 2012. Order approving Sonoma County Water Agency's petition for temporary urgency change of permits 12947A, 12949, 12950, and 16596 (applications 12919a, 15736, 15736, 15737, 19351). Division of Water Rights, Permitting and Licensing Section. Sacramento, C A.

CWQMC (California Water Quality Monitoring Council). 2017. California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network. Updated February 15, 2018. http://www.mywaterquality.ca.gov/monitoring_council/cyanohab_network/index.html#background.

EPA (U.S. Environmental Protection Agency). 1977. Temperature criteria for freshwater fish: protocol and procedures. U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory, Duluth, MN. EPA-600/3-77-061.

EPA (U.S. Environmental Protection Agency). 2000. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion III. Office of Water. 4304. EPA-822-B-00-016. December 2000. https://www.epa.gov/nutrient-policy-data/ecoregional-nutrient-criteria-rivers-streams. Last updated on May 3, 2017.

EPA (U.S. Environmental Protection Agency). 2012. Recreational Water Quality Criteria. Office of Water. 820-F-12-058. https://www.epa.gov/wqc/2012-recreational-water-quality-criteria. Last updated on January 16, 2018.

Ferris, Miles. 2015. Personal communication. Sonoma County Department of Health Services. Santa Rosa, CA.

Griffiths, J. S. and D. F. Alderice. 1972. Effects of acclimation and acute temperature experience on the swimming speed of juvenile coho salmon. Journal of the Fisheries Research Board of Canada 29: 251-264.

Hallock, R. J., R. T. Elwell, and D. H. Tory. 1970. Migrations of adult king salmon (Oncorhynchus tshawytscha) in the San Joaquin Delta, as demonstrated by the use of sonic tags. Cal. Dept. Fish and Game, Fish Bull. 151.

Hinze, J. A. 1959. Annual report. Nimbus salmon and steelhead hatchery. Fiscal Year 1957-58. CDFG. Inland fish. Admin. Rept. 56-25.

Holt, R. A., J. E. Sanders, J. L. Zinn, J. L. Fryer, K. S. Pilche. 1975. Relation of water temperature to Flexibacter columnaris infection in steelhead trout (Salmo gairdneri), coho (Oncorhynchus kisutch) and Chinook (O. tshawytscha) salmon. Journal of the Fisheries Research Board of Canada 32: 1553-1559.

IDEXX Laboratories, Inc. 2015. Colilert-18™ Test Kit Procedure. Westbrook, Maine.

Jackson, T.A. 2007. California steelhead report-restoration card; a report to the legislature. Department of Fish and Game. Sacramento CA.

Marine, K. R. 1997. Effects of elevated water temperature on some aspects of the physiology and ecological performance of juvenile Chinook salmon (Oncorhynchus tshawytscha): implications for management of California's Central Valley salmon stocks. Masters Thesis. University of California, Davis.

Martini Lamb, J. and D.J. Manning, editors. 2011. Russian River Biological Opinion status and data report year 2010-11. Sonoma County Water Agency, Santa Rosa, CA. P.208

McDonald, J., J. Nelson, C. Belcher, K. Gates, K. Austin. 2003. Georgia estuarine and littoral sampling study to investigate relationship among three analytical methods used to determine the numbers of enterococci in coastal waters. The University of Georgia Marine Technology and Outreach Center. Brunswick, Georgia. 29pp.

McMahon, T. E. 1983. Habitat suitability index models: coho salmon. U.S. Department of Int., Fish and Wildlife Service. FWS/OBS-82/10.49. 29 pp.

Moyle, P. 2002. Inland Fishes of California. University of California Press. Berkeley and Los Angeles, CA.

Myrick, C. A. and J. J. Cech, Jr. 2000. Bay-Delta modeling forum technical publication 01-1

Nielsen, J., T. E. Lisle and V. Ozaki. 1994. Thermally stratified pools and their use by steelhead in northern California streams. Transactions of the American Fisheries Society 123: 613-626.

NCRWQCB (North Coast Regional Water Quality Control Board). 2000. Review of Russian River Water Quality Objectives for Protection of Salmonid Species Listed Under the Federal Endangered Species Act. Regional Water Quality Control Board North Coast Region. Santa Rosa, CA. 102 p.

NMFS (National Marine Fisheries Service). 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed. F/SWR/2006/07316. National Marine Fisheries Service, Southwest Region. September 24, 2008.

Obedzinski, M. 2012. Personal communication. University of California Cooperative Extension and Sea Grant Program; Russian River coho salmon monitoring program. Santa Rosa, CA.

Obedzinski, M., Pecharich J., Lewis, D., and Olin, P. 2007. Russian River Coho Salmon Captive Broodstock Program Monitoring Activates Annual report July 2006 to June 2007. University of California Cooperative Extension and Sea Grant Program Santa Rosa, CA.

Obedzinski, M., Pecharich, J., Vogeazopoulos, G., Davis, J., Lewis, D., and Olin, P. 2006. Monitoring the Russian River Coho Salmon Captive Broodstock Program: Annual Report July 2005 to June 2006

Pisciotta, J. M., D.F. Rath, P.A. Stanek, D.M. Flanery, and V.J. Harwood. 2002. Marine bacteria cause false-positive results in Colilert-18 rapid identification test kit for *Escherichia coli* in Florida waters. Applied and Environmental Microbiology. 68(2):539-544.

Raleigh, R. F., W. J. Miller, and P. C. Nelson. 1986. Habitat suitability index models and instream flow suitability curves: Chinook salmon. U.S. Fish and Wildlife Service Biological Report 82(10.022). 64 pp.

Reese, C. D., and B. C. Harvey. 2002. Temperature-dependent interactions between juvenile steelhead and Sacramento pikeminnow in laboratory streams. Transactions of the American Fisheries Society. 131:599-606.

Rich, A. A. 1987. Report on studies conducted by Sacramento County to determine the temperatures which optimize growth and survival in juvenile Chinook salmon (Oncorhynchus tshawytscha): McDonough, Holland & Allen, 555 Capitol Mall Sacramento.

Roelofs, T. D. W. Trush, and J. Clancy. 1993. Evaluation of juvenile salmonid passage through Benbow Lake State Recreation Area. Fisheries Department, Humboldt State University, Arcata, California. Santa Rosa, CA.

Sonoma County DHS (Department of Health Services). 2017a. Environmental Health & Safety. Fresh Water Quality. http://www.sonoma-county.org/health/services/freshwater.asp

Sonoma County DHS (Department of Health Services). 2017b. Environmental Health & Safety. Blue-Green Algae (Cyanobacteria). http://www.sonoma-county.org/health/services/bluegreen.asp

Sonoma County Water Agency. 2016. Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report. July 2016.

Sonoma Water. 2019. Russian River Water Quality Summary for the Temporary Urgency Change. March 2020.

Stein, R. A., P. E. Reimers, and J. H. Hall. 1972. Social interaction between juvenile coho (Oncorhynchus kisutch) and fall Chinook salmon (O. tshawytscha) in Sixes River, Oregon. Journal of Fisheries Research Board of Canada 29: 1737-1748.

Sullivan, K. D J. Martin, R. D. Cardwell, J. E. Toll, and S. Duke. 2000. An analysis on the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria. Sustainable Ecosystems Institute.

Thomas, R. E., J. A. Gharrett, M. G. Carls, S. D. Rice, A. Moles, S. Korn. 1986. Effects of fluctuating temperature on mortality, stress, and energy reserves of juvenile coho salmon. Transactions of the American Fisheries Society 115: 52-59.

Welsh, H. H. Jr., G. R. Hodgson, B. C. Harvey, and M. F. Roche. 2001. Distribution of juvenile coho salmon in relation to water temperatures in tributaries of the Mattole River, California. North American Journal of Fisheries Management. 21:464-470.

Werner, I, T. B. Smith, J. Feliciano, and M. Johnson. 2005. Heat shock proteins in juvenile steelhead reflect thermal conditions in the Navarro River Watershed, California. 134:399-410. Transactions of the American Fisheries Society.

Wurtzbaugh, W. A. and G. E. Davis. 1977. Effects of temperature and ration level on the growth and food conversion efficiency of Salmo gairdneri Richardson.

Verhille, C.E., K.K. English, D.E. Cocherell, A.P. Farrell, and N.A. Fangue. In Press. “A California trout species performs unexpectedly well at high temperature.”

State Water Resources Control Board
Order 2020-0102-EXEC
Dated July 28, 2020

Term 11

Upper Russian River Diversion Forecast Reporting Program

April 1, 2021

Prepared by

Sonoma County Water Agency
404 Aviation Blvd
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1 Introduction

The Sonoma County Water Agency (Sonoma Water) submitted Temporary Urgency Change Petitions (TUCP) on June 8, 2020 for modifications to water-rights Permits 12947A, 12949, 12950 and 16595 requesting reductions in the minimum instream flow requirements in the Russian River. The State Water Resources Control Board (State Board) issued Order 2020-0102-EXEC (Order) on July 28, 2020, approving Sonoma Water's petitions. This report has been prepared by Sonoma Water to fulfill the requirements of Term 11 of the Order.

Term 11 of the Order requires the following actions:

> 'To facilitate releases of Lake Mendocino stored water with minimal operational buffers, Sonoma Water shall coordinate with the Mendocino County Russian River Flood Control and Water Conservation Improvement District (District) regarding implementation of a program for real-time 3-day advance forecasts of hourly diversions by all of the District's irrigation and municipal customers under all bases of right. Sonoma Water shall provide an update to the Deputy Director for Water Rights, CDFW and NMFS regarding the outcome of consultation and the effectiveness of reporting by April 1, 2021.'

2 Water Agency Coordination

Sonoma Water staff contacted the Mendocino County Russian River Flood Control and Water Conservation Improvement District (District) on July 28, 2020 to initiate discussions on the requirements in Term 11. Sonoma Water and the District convened a meeting on July 31, 2020 to review requirements and lay out an approach that followed that which was previously implemented under similar prior Temporary Urgency Change Petition orders. Similar terms were included in the State Board's August 25, 2014 order approving the District's 2014 TUCP, as well as orders issued for Sonoma Water TUCPs--June 17, 2015 order and May 4, 2016 order. The State Board order on the District's 2020 TUCP included a term that required the District to develop a real-time forecasting plan for the District's customers' diversions. The District and Sonoma Water collaborated to develop an approach and protocols that were intended to provide useful and timely information to improve stream flow predictions and better manage releases from Lake Mendocino. As part of that plan, Sonoma Water developed an online diversion forecast reporting tool that allowed District customers to log diversion forecasts from any web browser device with an internet connection. This online reporting tool was retooled and updated for the diversion forecast reporting required under Term 11 of the 2020 Order.

3 Diversion Forecast Reporting Program

As discussed in the previous section of this report, the protocols and tool implemented to comply with Term 11 were based on a diversion forecasting plan developed in 2014 that the District submitted to the State Board. Sonoma Water developed an online reporting tool that collected and processed information about the time, duration, location, method and rate of diversions. While the online reporting form only required that each forecasted diversion be identified by river reach, diverters optionally could also identify themselves and the specific locations of their diversions. Because the temporal impacts on stream flows of diversions from river intakes and from wells are different, each diverter was required to describe the method of diversion in the online reporting form. Information for up to five diversion forecasts could be submitted at the same time for a single river reach and single method of diversion. If a diverter's diversions were located on multiple river reaches or if the diverter operated both river intakes and wells, then a separate new online form submittal was required for each river reach and each type of diversion. Reporting protocols were established under which submittals of forecasted hourly diversions would be provided by District customers for the upcoming period of 72 hours from the daily forecast report process time at 10:00 a.m.

The initial webpage of the online reporting tool is shown in Attachment 1. Based on the submitted forecast information, Sonoma Water processed the data and developed a daily forecast report for Sonoma Water Operations staff.

4 Daily Forecast Reports

Daily forecast reports were issued each weekday beginning on August 13, 2020 and ran through December 21, 2020. Each daily forecast report charted hourly streamflow data for the Upper Russian River gages and hourly diversion forecasts over a 10-day period. Each period included the 72-hour forecast and previous 7-day historical data. The hourly diversion forecast data was charted for each river reach along with the calculated net reach loss for comparison. The estimates of observed net reach loss were calculated as the difference in coincident upstream and downstream gage readings. Additionally, the daily report listed the total reported diversions forecasted during that 10-day period and a comparison of the total diversions to the expected estimated diversions during that period based on historical monthly reporting of diversions under the District's water right License 13898. Starting with the report issued for October 13th, a comparison of the total reported diversions forecasted during the 72-hour forecast period with estimated diversions was added. Attachment 2 includes an example of the daily forecast report that was prepared for Sonoma Water Operations staff.

Each report published two metrics to evaluate the volumes forecasted for diversion. The first metric was the comparison of the total diversions to the expected estimated diversions during that period based on historical monthly reporting of diversions under the District's water right License 13898. This metric was used to estimate how complete the diversion forecasts may be. A three-year average of monthly diversion data from 2017 through 2019 as reported on the District's annual water rights reports for License 13898 was used as the basis of comparison. The calculated average monthly diversions and the total diversion forecasts reported are shown in Table 1.

Table 1: Total Forecast Diversion Comparison with Estimated Monthly Diversions for District Customers

	Aug	Sep	Oct	Nov	Dec	Total
Estimated Total Diversions (ac-ft)	950	740	450	166	50	2,356
Total Forecasted Diversions (ac-ft)	113	180	296	52	0	641
Estimated Percentage Represented by Reported Diversions	12%	24%	66%	31%	0%	27%

The second metric was the observed net reach losses for each river reach. The calculated net reach loss was plotted on each reach's diversion forecast chart to illustrate how the diversion forecasts compared quantitatively as well matching flow change patterns with the reach losses. Table 2 provides the monthly estimated totalized volumes for reach losses over the period of the Order.

Table 2: Observed Estimated Monthly Net Reach Losses in 2020 (ac-ft)

Reach	Aug	Sep	Oct	Nov	Dec	Total
Forks-Talmage	1,459	1,059	975	464	175	6,053
Talmage-Hopland	531	318	294	101	121	1,901
Hopland-Cloverdale	502	375	138	25	0	1,374
Total	**2,491**	**1,751**	**1,406**	**590**	**296**	**9,328**

5 Program Review

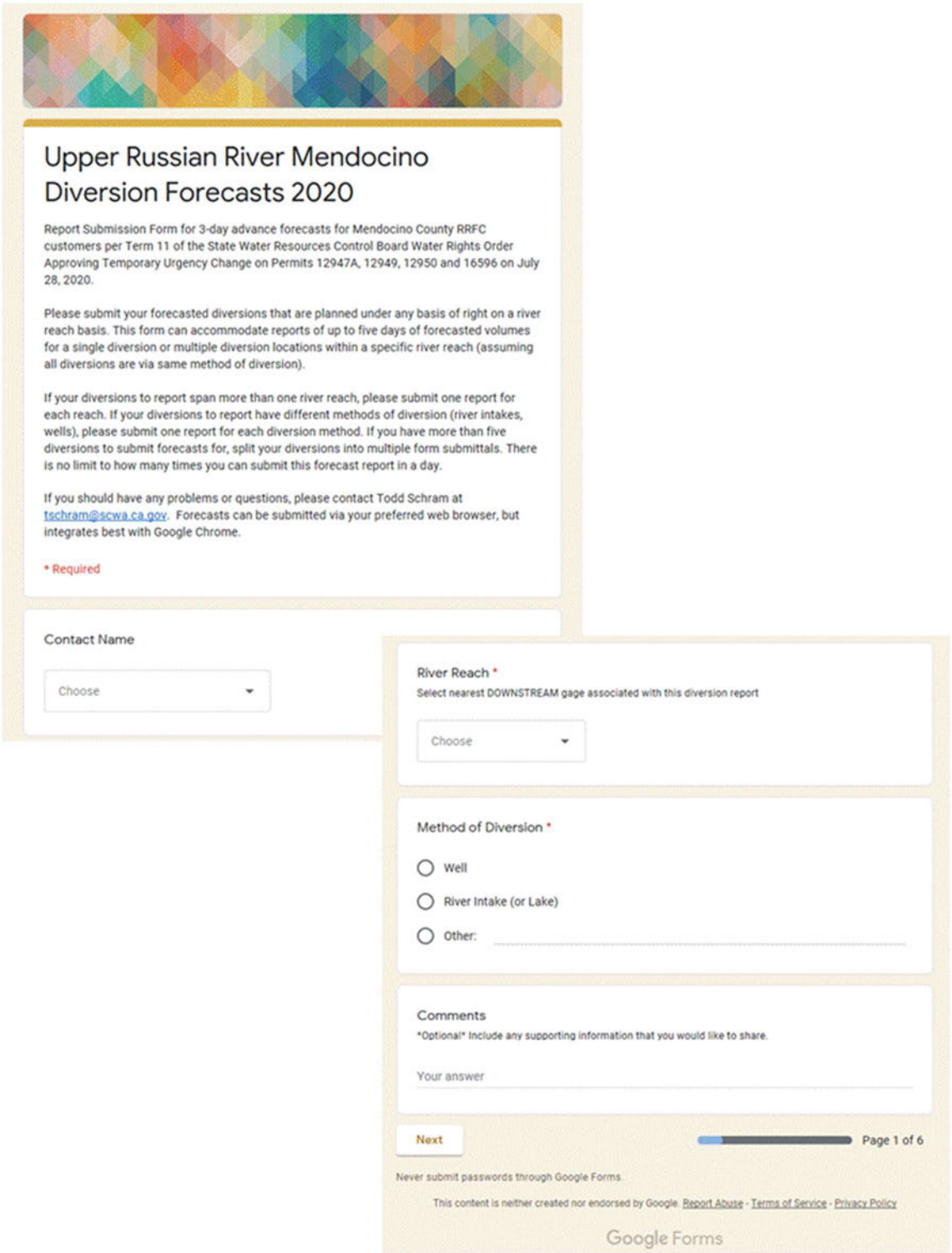
A summary of the daily river conditions over the reporting period and the forecasted diversions are included in Attachment 3 as a chart and in Attachment 4 in tabular format. The dataset includes daily average recorded stream flows at the river gages and the total diversions forecasted for the District's service area. As presented in the previous section of this report, the total of the daily diversion forecasts was only a small portion of the total estimated total diversions. During the full period of diversion forecast reporting, it was estimated that forecasts were provided for about 27% of the total estimated diversions by District customers.

If all District contractors were to participate in the diversion forecast program, it is likely that the forecasts would still underestimate total diversions under all water-right claims. This is due to the presence of diversions by non-District customer water-right claims. While it may be feasible to develop correlations and operational tools with a partially complete forecast dataset, the volume differences between calculated observed net reach losses and forecasted diversions is quite large. This point is illustrated by

comparing Table 1 and Table 2. Table 2 shows the monthly observed losses over the three listed river reaches. The total reported diversions that were forecasted in Table 1 represent about 7% of the total observed losses. If all diversions in the Upper Russian River by District customers were reported, forecasts would be expected to represent about a quarter of the total observed reach losses. The remainder of the observed losses may be attributed to other surface water diversions (e.g. City of Ukiah and other public water systems), groundwater pumping and recharge, evaporation, and riparian corridor vegetation.

Sonoma Water Operations staff consulted the daily forecasted diversion reports when evaluating river conditions and setting reservoir release rates. However, in order for these reports to have operational value there would have to be much higher participation rates by diverters and involve all water rights-holders in the region.

Attachment 1 -- Diversion Questionnaire Sample



Upper Russian River Mendocino Diversion Forecasts 2020

Report Submission Form for 3-day advance forecasts for Mendocino County RRFC customers per Term 11 of the State Water Resources Control Board Water Rights Order Approving Temporary Urgency Change on Permits 12947A, 12949, 12950 and 16596 on July 28, 2020.

Please submit your forecasted diversions that are planned under any basis of right on a river reach basis. This form can accommodate reports of up to five days of forecasted volumes for a single diversion or multiple diversion locations within a specific river reach (assuming all diversions are via same method of diversion).

If your diversions to report span more than one river reach, please submit one report for each reach. If your diversions to report have different methods of diversion (river intakes, wells), please submit one report for each diversion method. If you have more than five diversions to submit forecasts for, split your diversions into multiple form submittals. There is no limit to how many times you can submit this forecast report in a day.

If you should have any problems or questions, please contact Todd Schram at tschram@scwa.ca.gov. Forecasts can be submitted via your preferred web browser, but integrates best with Google Chrome.

* Required

Contact Name

Choose

River Reach *

Select nearest DOWNSTREAM gage associated with this diversion report

Choose

Method of Diversion *

Well

River Intake (or Lake)

Other:

Comments

Optional Include any supporting information that you would like to share.

Your answer

Next

Page 1 of 6

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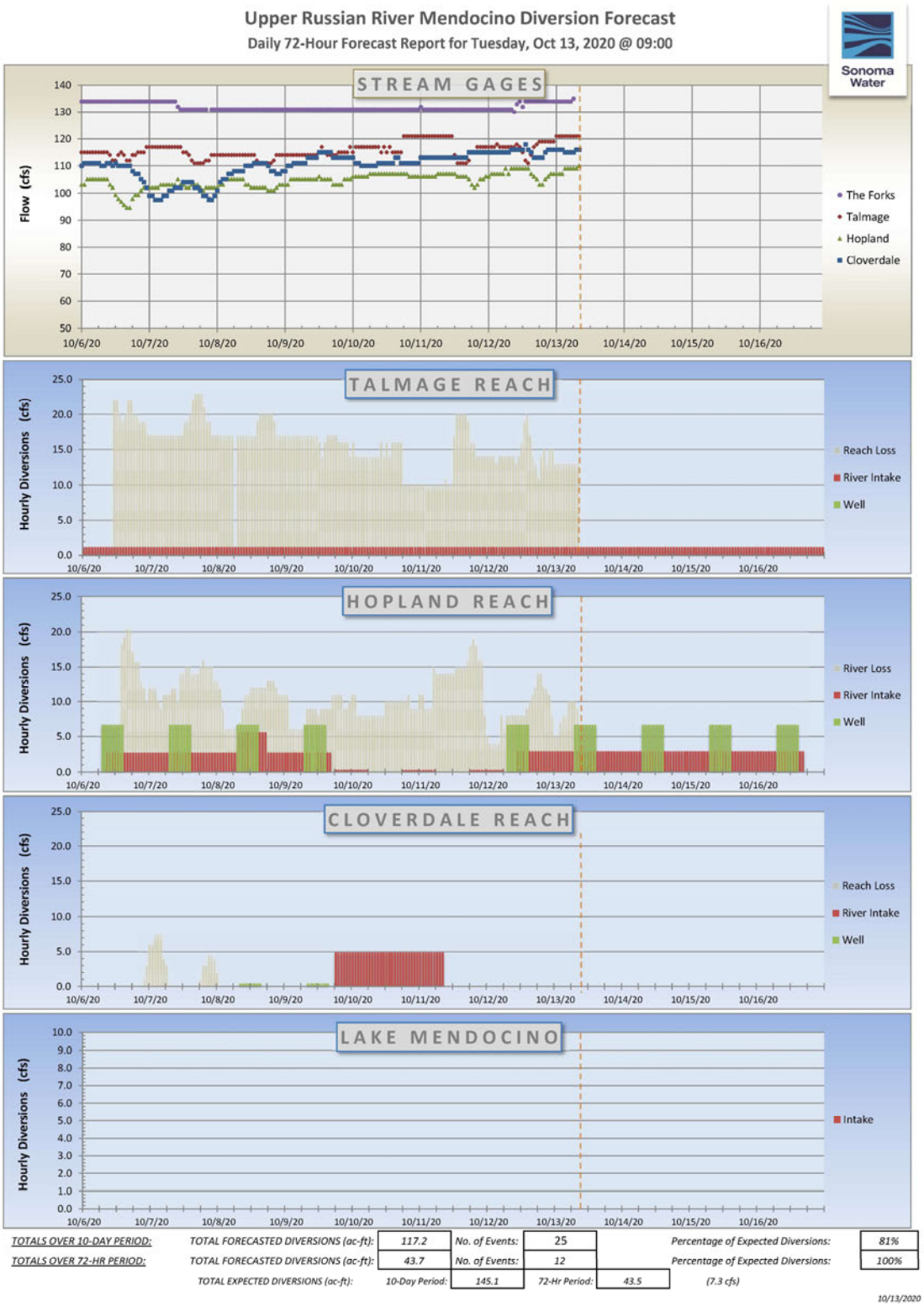
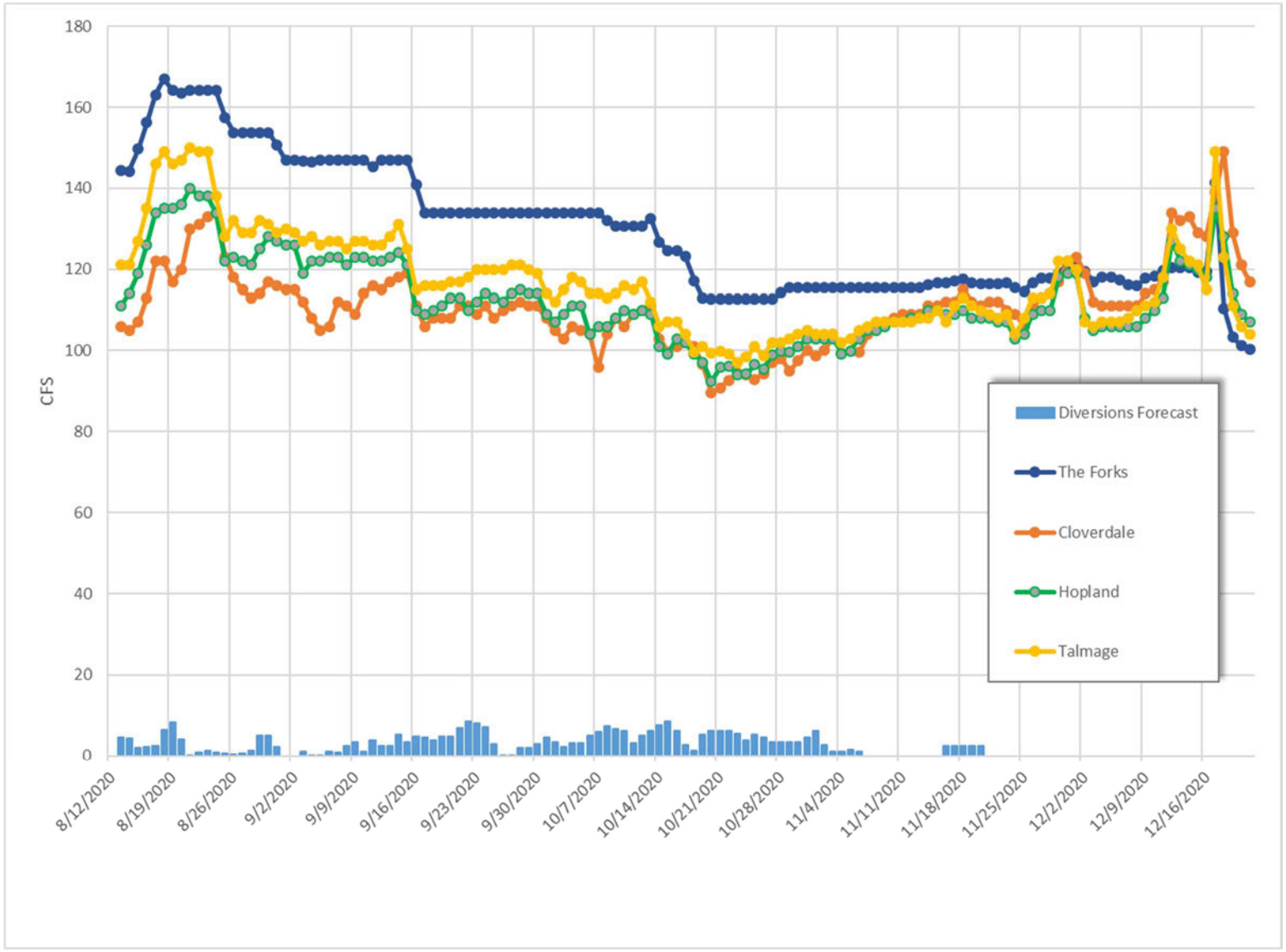
Attachment 2 -- Example of Daily Diversion Forecast Report



Attachment 3 -- Summary Chart of Daily River Gage Flow Rates and Reported Forecast Diversions



Attachment 4 – Summary Table of Daily River Gage Flow Rates and Reported Forecast Diversions

	USGS Gage Stream Flow				Forecasted Diversion Total	
Date	The Forks (cfs)	Talmage (cfs)	Hopland (cfs)	Cloverdale (cfs)	(cfs)	(ac-ft)
8/13/2020	144	121	111	106	4.67	9.27
8/14/2020	144	121	114	105	4.38	8.68
8/15/2020	150	127	119	107	2.03	4.03
8/16/2020	156	135	126	113	2.32	4.59
8/17/2020	163	146	134	122	2.56	5.07
8/18/2020	167	149	135	122	6.43	12.76
8/19/2020	164	146	135	117	8.23	16.33
8/20/2020	164	147	136	120	4.14	8.21
8/21/2020	164	150	140	130	0.08	0.15
8/22/2020	164	149	138	131	0.88	1.74
8/23/2020	164	149	138	133	1.35	2.68
8/24/2020	164	138	134	134	0.81	1.62
8/25/2020	158	128	122	123	0.55	1.10
8/26/2020	154	132	123	118	0.29	0.58
8/27/2020	154	129	122	115	0.61	1.22
8/28/2020	154	129	121	113	1.30	2.58
8/29/2020	154	132	125	114	5.04	10.01
8/30/2020	154	131	128	117	5.03	9.99
8/31/2020	151	129	127	116	2.31	4.59
9/1/2020	147	130	126	115	0.00	0.00
9/2/2020	147	129	126	115	0.00	0.00
9/3/2020	147	127	119	112	1.02	2.03
9/4/2020	146	128	122	108	0.08	0.15
9/5/2020	147	126	122	105	0.14	0.28
9/6/2020	147	127	123	106	1.12	2.21
9/7/2020	147	127	123	112	0.92	1.82
9/8/2020	147	125	121	111	2.37	4.70
9/9/2020	147	127	123	109	3.34	6.63
9/10/2020	147	127	123	114	0.97	1.93
9/11/2020	145	126	122	116	3.88	7.70
9/12/2020	147	126	122	115	2.37	4.70
9/13/2020	147	128	123	117	2.36	4.68
9/14/2020	147	131	124	118	5.27	10.44
9/15/2020	147	125	121	119	3.43	6.81
9/16/2020	141	115	110	111	4.86	9.65
9/17/2020	134	116	109	106	4.62	9.17

	USGS Gage Stream Flow				Forecasted Diversion Total	
Date	The Forks (cfs)	Talmage (cfs)	Hopland (cfs)	Cloverdale (cfs)	(cfs)	(ac-ft)
9/18/2020	134	116	110	108	3.84	7.62
9/19/2020	134	116	111	108	4.74	9.40
9/20/2020	134	117	113	108	4.73	9.39
9/21/2020	134	117	113	111	6.83	13.55
9/22/2020	134	118	110	111	8.52	16.90
9/23/2020	134	120	112	109	8.03	15.94
9/24/2020	134	120	114	111	7.07	14.03
9/25/2020	134	120	113	108	3.05	6.05
9/26/2020	134	120	112	110	0.14	0.28
9/27/2020	134	121	114	111	0.13	0.26
9/28/2020	134	121	115	112	2.02	4.00
9/29/2020	134	120	114	111	1.95	3.87
9/30/2020	134	119	114	111	2.84	5.63
10/1/2020	134	114	109	108	4.62	9.17
10/2/2020	134	112	107	105	3.43	6.81
10/3/2020	134	115	109	103	2.21	4.38
10/4/2020	134	118	111	106	3.12	6.19
10/5/2020	134	117	111	105	3.14	6.22
10/6/2020	134	114	104	104	5.01	9.94
10/7/2020	134	114	106	96	6.02	11.93
10/8/2020	132	113	106	104	7.36	14.61
10/9/2020	131	114	108	108	6.67	13.23
10/10/2020	131	116	110	106	6.16	12.22
10/11/2020	131	115	109	109	3.08	6.12
10/12/2020	131	117	110	110	4.98	9.87
10/13/2020	132	112	109	111	6.24	12.37
10/14/2020	127	106	101	103	7.63	15.14
10/15/2020	125	107	99	100	8.47	16.79
10/16/2020	125	107	103	101	6.12	12.14
10/17/2020	123	104	102	102	2.72	5.39
10/18/2020	117	100	99	101	1.25	2.47
10/19/2020	113	101	97	97	5.22	10.35
10/20/2020	113	99	92	90	6.24	12.37
10/21/2020	113	100	96	91	6.24	12.37
10/22/2020	113	99	96	93	6.24	12.37
10/23/2020	113	97	94	94	5.47	10.85
10/24/2020	113	98	94	94	3.96	7.86
10/25/2020	113	101	97	93	5.26	10.43

	USGS Gage Stream Flow			Forecasted Diversion Total	
Date	The Forks (cfs)	Talmage (cfs)	Hopland (cfs)	Cloverdale (cfs)	(cfs)	(ac-ft)
10/26/2020	113	99	96	94	4.58	9.08
10/27/2020	113	102	99	97	3.34	6.63
10/28/2020	114	102	100	98	3.34	6.63
10/29/2020	116	103	100	95	3.34	6.63
10/30/2020	116	104	101	98	3.42	6.78
10/31/2020	116	105	103	100	4.48	8.89
11/1/2020	116	104	103	99	6.15	12.19
11/2/2020	116	104	103	100	2.81	5.58
11/3/2020	116	104	103	104	1.11	2.21
11/4/2020	116	102	99	100	1.11	2.21
11/5/2020	116	103	100	100	1.58	3.13
11/6/2020	116	105	103	100	1.02	2.03
11/7/2020	116	106	105	104	0.00	0.00
11/8/2020	116	107	105	106	0.00	0.00
11/9/2020	116	107	106	107	0.00	0.00
11/10/2020	116	107	107	108	0.00	0.00
11/11/2020	116	107	107	109	0.00	0.00
11/12/2020	116	107	108	109	0.00	0.00
11/13/2020	116	108	108	109	0.00	0.00
11/14/2020	116	108	110	111	0.00	0.00
11/15/2020	117	110	110	111	0.00	0.00
11/16/2020	117	107	109	112	2.43	4.82
11/17/2020	117	111	109	112	2.43	4.82
11/18/2020	118	113	110	115	2.43	4.82
11/19/2020	117	111	108	112	2.43	4.82
11/20/2020	116	110	108	111	2.43	4.82
11/21/2020	116	109	108	112	0.00	0.00
11/22/2020	116	108	107	112	0.00	0.00
11/23/2020	117	109	107	110	0.00	0.00
11/24/2020	115	104	103	109	0.00	0.00
11/25/2020	115	108	104	106	0.00	0.00
11/26/2020	117	113	109	111	0.00	0.00
11/27/2020	118	113	110	113	0.00	0.00
11/28/2020	118	114	110	114	0.00	0.00
11/29/2020	119	122	118	117	0.00	0.00
11/30/2020	121	122	119	122	0.00	0.00
12/1/2020	121	120	119	123	0.00	0.00
12/2/2020	120	107	108	119	0.00	0.00

	USGS Gage Stream Flow			Forecasted Diversion Total	
Date	The Forks (cfs)	Talmage (cfs)	Hopland (cfs)	Cloverdale (cfs)	(cfs)	(ac-ft)
12/3/2020	117	106	105	112	0.00	0.00
12/4/2020	118	107	106	111	0.00	0.00
12/5/2020	118	107	106	111	0.00	0.00
12/6/2020	117	107	106	111	0.00	0.00
12/7/2020	116	108	106	111	0.00	0.00
12/8/2020	116	110	106	111	0.00	0.00
12/9/2020	118	111	108	114	0.00	0.00
12/10/2020	118	112	110	115	0.00	0.00
12/11/2020	120	118	113	117	0.00	0.00
12/12/2020	120	130	127	134	0.00	0.00
12/13/2020	120	125	122	132	0.00	0.00
12/14/2020	120	122	121	133	0.00	0.00
12/15/2020	119	121	120	129	0.00	0.00
12/16/2020	120	115	118	128	0.00	0.00
12/17/2020	141	149	135	139	0.00	0.00
12/18/2020	110	123	128	149	0.00	0.00
12/19/2020	103	111	114	129	0.00	0.00
12/20/2020	101	106	109	121	0.00	0.00
12/21/2020	100	104	107	117	0.00	0.00