Russian River Water Quality Summary for the 2017 Temporary Urgency Change

SONOMA COUNTY WATER AGENCY

March 2018

Contents

1.0 Introduction

On 19 April, 2017, the Sonoma County Water Agency (Water Agency) 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 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 May 2017, until 15 October 2017 to the following:

(1) Minimum instream flow in the upper Russian River (from its confluence of the East and West Forks of the Russian River to its confluence with Dry Creek) shall remain at or above 125 cubic feet per second (cfs).

(2) Minimum instream flow requirements in the lower Russian River (from its confluence with Dry Creek to the Pacific Ocean) shall remain at or above 70 cfs.

For purposes of compliance with this term, the minimum instream flow requirements shall be based on instantaneous flow measurements. Approval of the request to temporarily reduce minimum instream flows to benefit the fishery would also maintain storage levels in Lake Mendocino for a longer period of time so that water would be available in the fall for fisheries purposes. The SWRCB issued the Order (Order) approving the Water Agency's TUCP on 19 May 2017.

2.0 2017 Russian River Flow Summary

In early January 2017, water storage in Lake Mendocino was similar to storage levels experienced in 2011 before the onset of drought conditions. Storage quickly increased through a series of storms between January and March, and by mid-April storage levels were above those observed in all prior years except 2010 (Figure 2-1). Storage in Lake Mendocino peaked in early May at over 97,400 acre-feet and remained above 80,000 acre-feet through early September. In addition, 2017 storage remained above conditions experienced during the drought in 2013 through 2015 for the remaining calendar year. However, late-season storms seen in prior years in November and December did not materialize, and storage continued to decrease through the remainder of the season. Storage declined from 80,000 acre-feet in early September to just over 59,000 acre-feet by 31 December 2017 (Figure 2-1).

The 2017 average daily flows at the Talmage, Hopland, Cloverdale, Jimtown, Digger Bend, and Hacienda USGS gaging stations are shown in Figure 2-2.

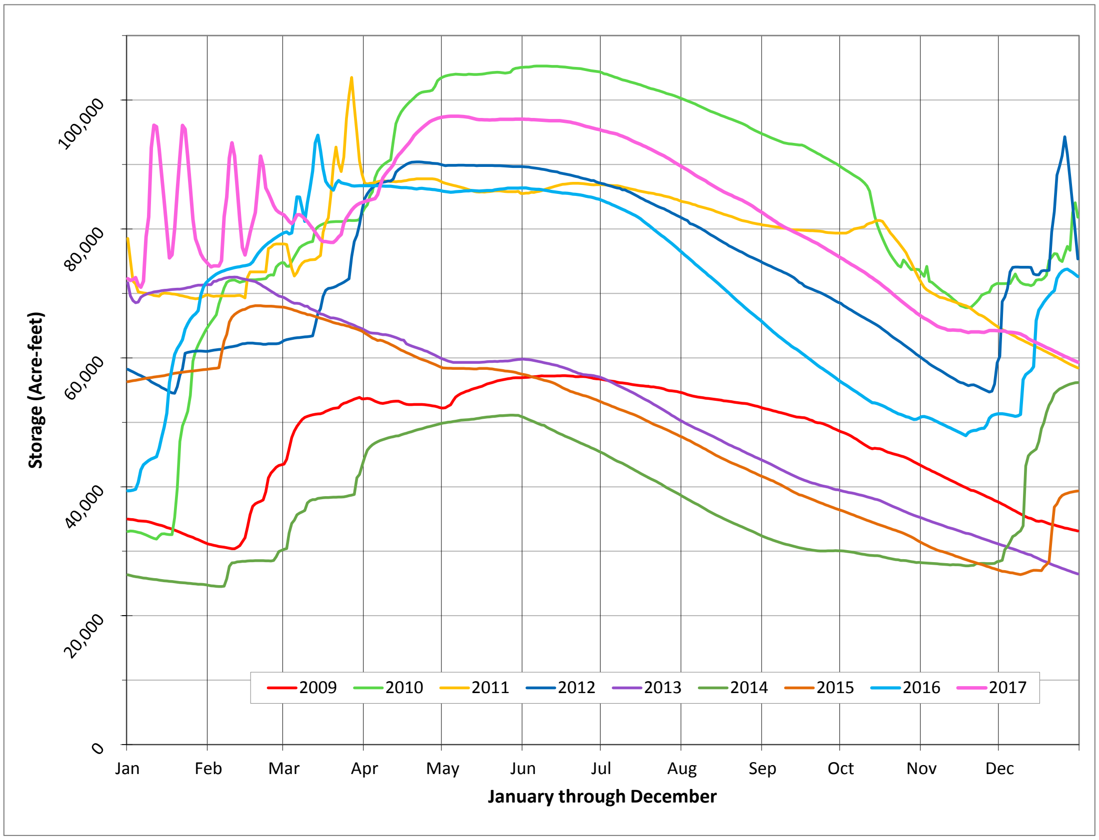


Figure 2-1. Lake Mendocino water storage levels, in acre-feet, from 2009 through 2017.

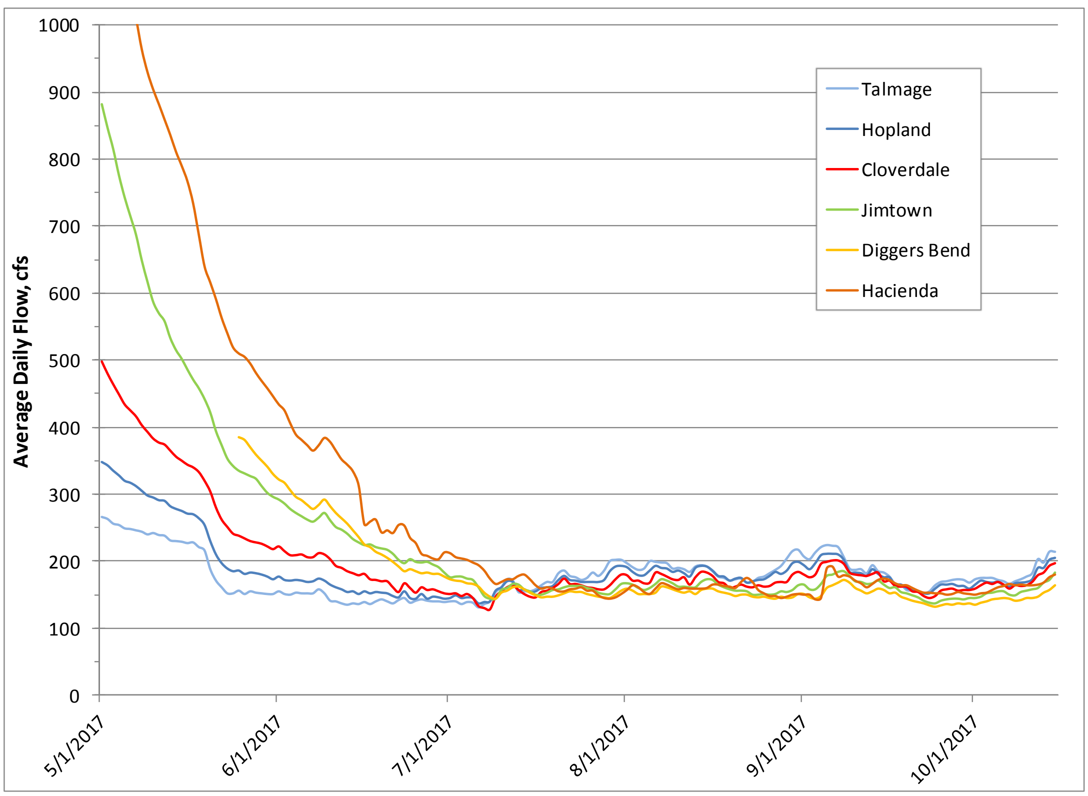


Figure 2-2. 2017 average daily flows in the Russian River as measured at U.S. Geological Survey (USGS) gages in cubic feet per second (cfs). Flow rates are preliminary and subject to final revision by USGS.

The changes in upper Russian River minimum instream flow requirements authorized by the Order allowed flows to decline below D1610 minimum instream flows of 185 cfs during the month of May at the Talmage and Hopland gages, and in mid- to late June at the Cloverdale, Jimtown, and Diggers Bend gages (Figure 2-3). However, upper Russian River flows did not decline below the instantaneous minimum flow of 125 cfs authorized by the Order (Figure 2-3).

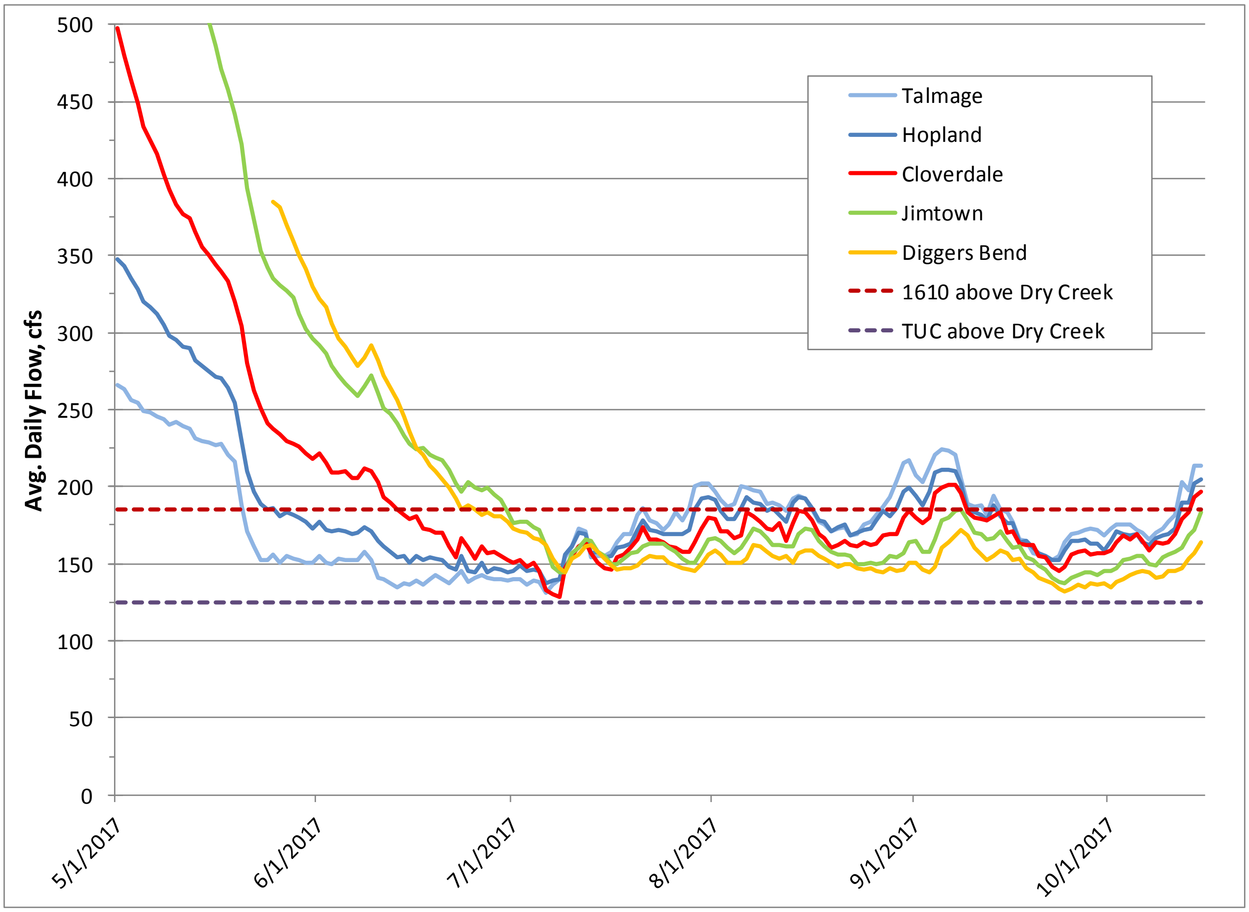


Figure 2-3. 2017 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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

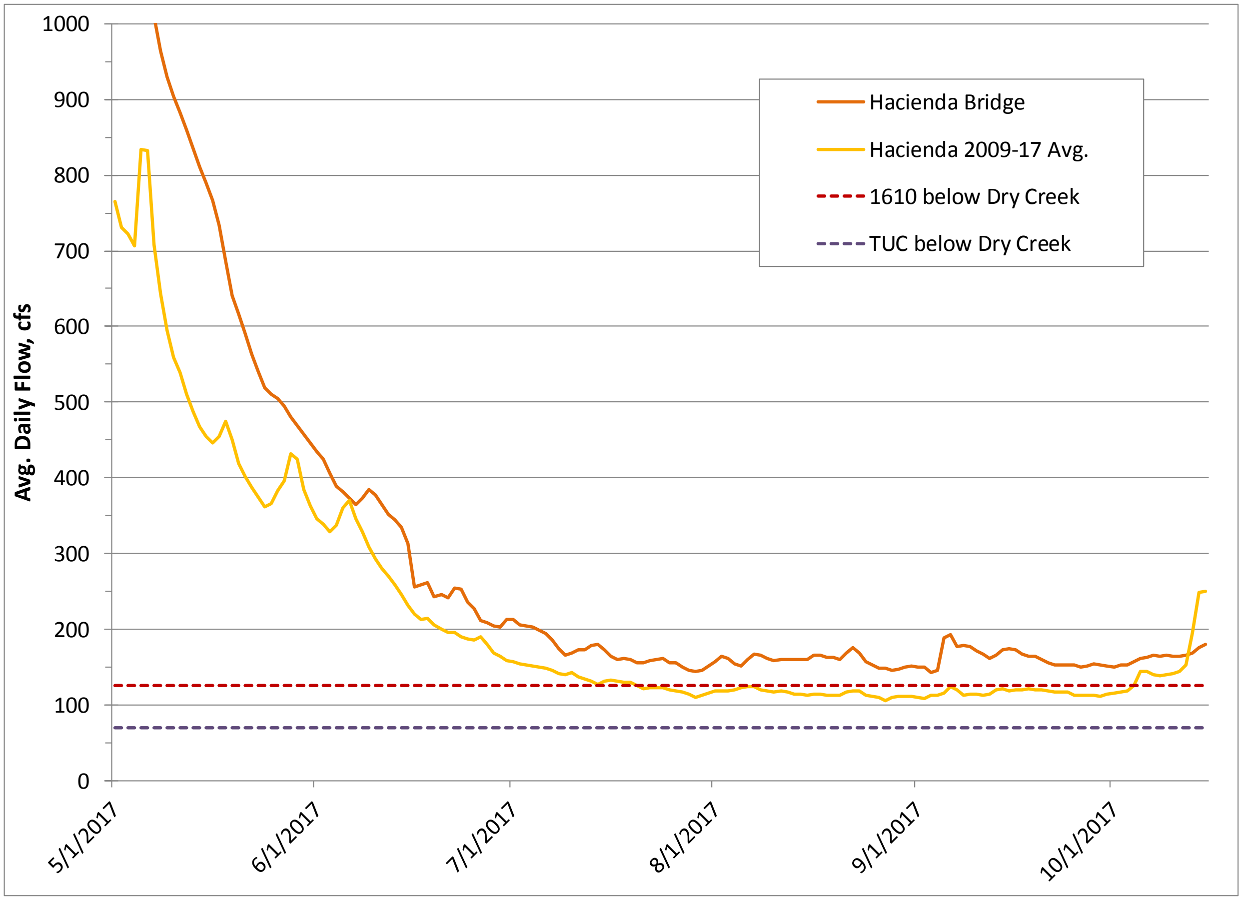


Figure 2-4. 2017 average daily flows in the Lower Russian River as measured at USGS gages below the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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), Water Agency, 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. Water Agency staff consulted with NCRWQCB staff regarding monitoring activities related to the workgroup. As a result of the consultation, the Water Agency made modifications to their existing Water Quality Monitoring Plan for the Russian River Estuary Management Project to modify the monitoring that is occurring in the estuary and to include freshwater monitoring for the purpose of assisting in the evaluation of cyanobacteria harmful algal bloom (cyanoHAB) conditions and the risk co-factors contributing to nuisance blooms (e.g., flow, temperature, nutrient, etc.).

In 2017, 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. The Water Agency conducted mainstem sampling for nutrients at six sites, and algae and cyanobacteria at four sites, along the Russian River between Talmage and Patterson Point to support NCRWQCB analysis and evaluation of water quality data relating to biostimulatory conditions and cyanotoxins. In addition, the Water Agency 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, including in two tributaries.

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 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 fecal indicator bacteria: 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. However, the EPA recommends using STV values as SSM values for potential recreational beach posting and those values are provided in this report for comparative purposes. Exceedances of the STV values 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.

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 and 2016, which led to Sonoma County DHS posting warning signs.

Currently, there are no federal or state standards for cyanotoxins in drinking water and recreational waters. 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.

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 2017 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 30 May and continued until 11 September. The samples were analyzed using the Colilert quantitray MPN method for Total Coliform and *E. coli*. 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 2017 seasonal results are shown in Table 3-1 and in Figures 3-1 and 3-2.

Table 3-1. Sonoma County DHS 2017 Seasonal Mainstem Bacteria Sampling Results (Sonoma County DHS, 2017a).

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
30-May-17	6,867	31	3,654	52	4,106	20	2,187	41	988	41	839	10	717	20	437	10	450	10	327	10
5-Jun-17	541	20	461	<10	548	20	477	30	354	52	465	20	372	10	448	<10	634	20	375	10
12-Jun-17	2,755	63	1,616	<10	1,989	20	1,374	20	1,017	20	1,467	20	1,421	20	857	41	3,076	30	960	10
19-Jun-17	6,488	41	3,076	10	2,481	30	2,247	52	1,723	63	1,935	31	1,725	<10	3,448	75	2,613	63	1,658	<10
26-Jun-17	2,909	31	2,603	20	2,755	10	2,755	122	1,553	41	2,481	20	1,722	74	1,935	31	1,401	10	932	10
3-Jul-17	1,989	52	2,359	10	2,755	20	1,607	41	1,467	10	2,755	41	1,918	30	2,613	20	10462*	41	8,164	41
5-Jul-17																	11,199**	833**		
6-Jul-17																	10,462**	110		
9-Jul-17																	11,199**	144		
10-Jul-17	5,172	20	2,909	20	2,359	10	2,755	63	1,172	10	3,255	20	1,872	10	2,755	31	7,772	13	13,520*	78
11-Jul-17																			5,646	13
17-Jul-17	2,755	52	2,613	<10	1,989	20	2,359	<10	2,247	10	2,046	10	2,359	10	2,755	10	10462*	275*	8,664	31
19-Jul-17																	6,867	63		
24-Jul-17	3,654	63	3,873	10	3,448	<10	2,909	10	2,098	20	2,909	20	2,481	10	2,481	10	4,352	120	6,131	41
31-Jul-17	2,495	63	2,282	20	3,448	31	2,613	31	1,296	10	1,354	10	1,500	10	1,450	<10	2,282	31	2,187	10
7-Aug-17	2,909	74	2,481	10	2,613	10	1,354	20	1,246	20	1,872	41	1,334	20	1,785	61	3,076	98	2,909	20
14-Aug-17	2,282	52	2,359	31	3,873	52	2,755	31	1,650	10	2,187	10	2,755	20	2,143	20	12,033*	3,255*	2,187	52
15-Aug-17																	2,489	97		
21-Aug-17	2,359	171	2,481	20	2,413	20	2,489	97	1,401	20	1,333	20	1,119	<10	1,106	20	>24,196*	530*	1,722	63
22-Aug-17																	2,481	63		
28-Aug-17	1,067	52	3,448	20	3,255	20	1,396	10	1,019	20	959	10	1,529	<10	1,414	31	3,448	20	1,789	10
5-Sep-17	3,255	22	3,076	<10	4,106	20	2,755	63	984	<10	1,789	10	1,723	<10	1,789	20	1,720	31	1,723	30
11-Sep-17	2,481	20	2,489	<10	3,873	41	2,755	20	2,282	31	1,281	<10	2,282	30	1,553	20	3,255	173	1,720	<10

*Resample conducted for confirmatory test.

** Beach closed.

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 and Environmental Protection Agency (EPA) Recreational Water Quality Criteria - Statistical Threshold Values (STV):

(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

Total Coliforms (STV): 10,000 per 100ml

E. coli (STV): 235 per 100 ml

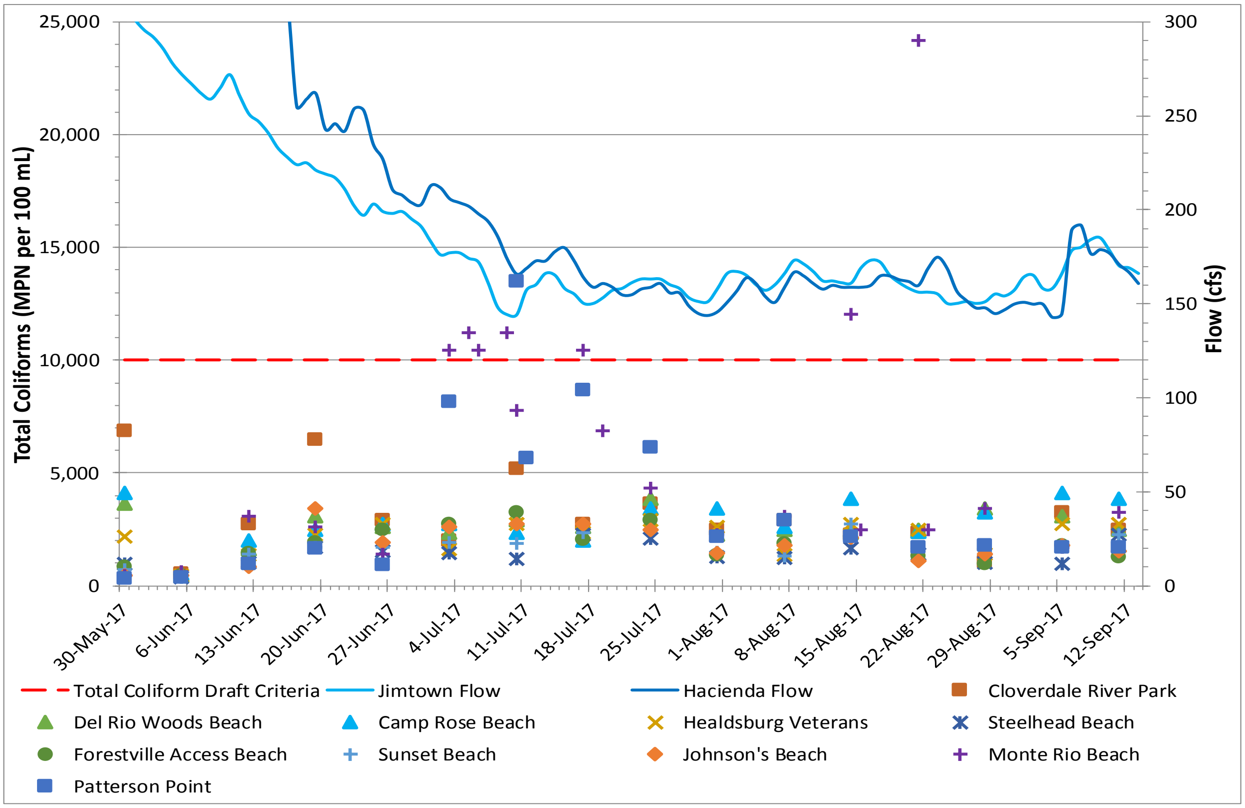


Figure 3-1. Sonoma County DHS 2017 Seasonal Mainstem Russian River Bacteria Sample Results for Total Coliform. Flow rates are preliminary and subject to final revision by USGS.

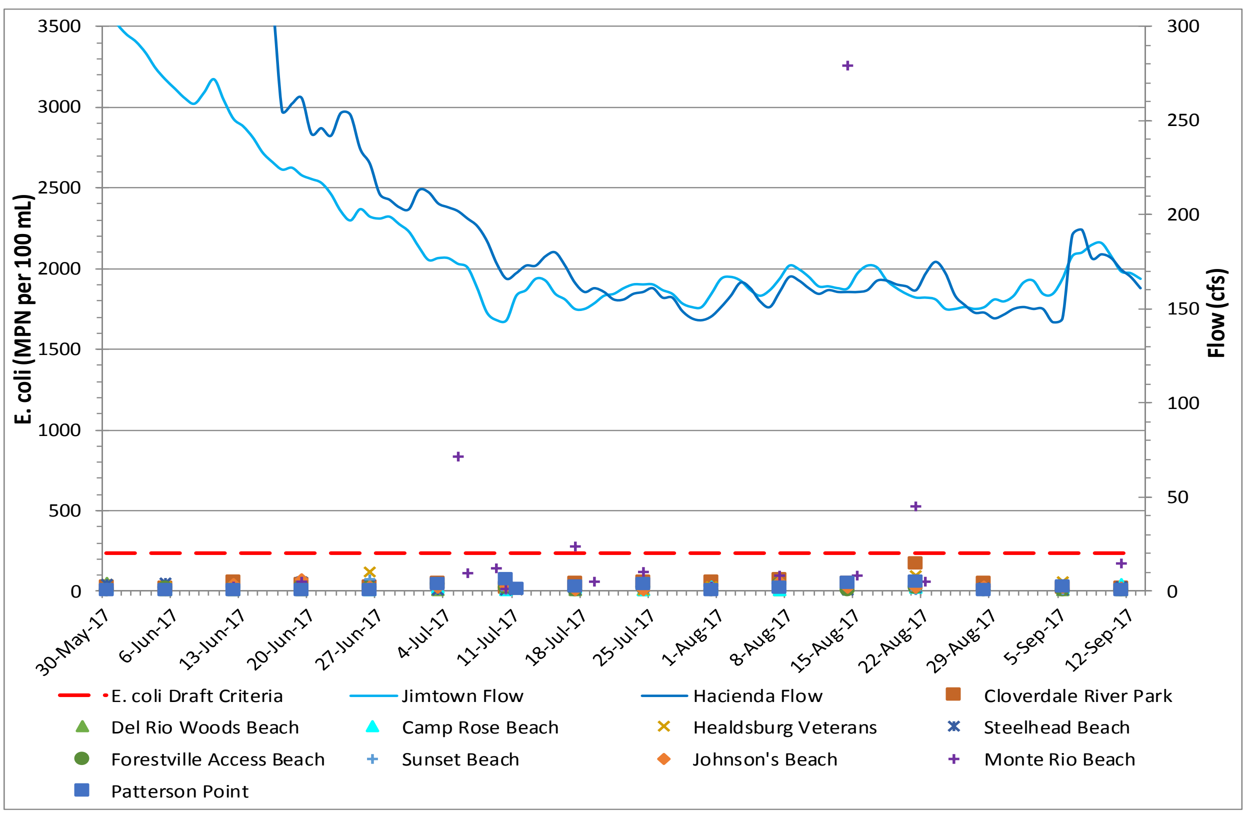


Figure 3-2. Sonoma County DHS 2017 Seasonal Mainstem Russian River Bacteria Sample Results for *E. coli*. Flow rates are preliminary and subject to final revision by USGS.

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

In 2017, 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 17 July and continued until 11 September. 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 2017 seasonal results are shown in Table 3-2.

Table 3-2. Sonoma County DHS 2017 Seasonal Mainstem Russian River Cyanotoxin Sampling Results (Sonoma County DHS, 2017b).

Anatoxin

	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
17-Jul-17	0	0	0	0	0	0	0	0	0	0
24-Jul-17	0.16	0.15	0	0	0	0	0	0	0	0.14
31-Jul-17	0	0	0	0	0.16	0	0	0.25	0	0
7-Aug-17	0	0	0	0	0	0	0	0	0	0
14-Aug-17	0	0	0	0	0	0	0	0	0	0
21-Aug-17	0	0	0	0	0	0.12	0	0	0	0
28-Aug-17	0	0	0	0	0	0	0	0	0	0
5-Sep-17	0	0	0	0	0	0	0	0	0	0
11-Sep-17	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
17-Jul-17	0	0	0	0	0	0	0	0	0	0
24-Jul-17	0	0	0	0	0	0	0	0	0	0
31-Jul-17	0	0	0	0	0	0	0	0	0	0
7-Aug-17	0	0	0	0	0	0	0	0	0	0
14-Aug-17	0	0	0	0	0	0	0	0	0	0
21-Aug-17	0	0	0	0	0	0	0	0	0	0
28-Aug-17	0	0	0	0	0	0	0	0	0	0
5-Sep-17	0	0	0	0	0	0	0	0	0	0
11-Sep-17	0	0	0	0	0	0	0	0	0	0

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
17-Jul-17	0.06	0.06	0	0	0	0.06	0	0	0	0.06
24-Jul-17	0	0	0	0	0	0	0	0	0	0
31-Jul-17	0	0	0	0	0	0	0	0	0	0
7-Aug-17	0	0	0	0	0	0	0	0	0	0
14-Aug-17	0	0	0	0	0	0	0	0	0	0
21-Aug-17	0	0	0	0	0	0	0	0	0	0
28-Aug-17	0	0	0	0	0	0	0	0	0	0
5-Sep-17	0	0	0	0	0	0	0	0	0	0
11-Sep-17	0	0	0	0	0	0	0	0	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)
Microcystin	0.8 µg/L	6 µg/L	20 µg/L
Anatoxin	Any Detected	20 µg/L	90 µg/L
Cylindrospermopsin	1 µg/L	4 µg/L	17 µg/L

Source: State Water Resources Control Board.

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

In 2017, Ambient algae and cyanobacterial monitoring and sampling was conducted from 22 June through 31 October 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 to support NCRWQCB and Sonoma County DHS cyanotoxin monitoring and assessment of 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, density, and seasonal growth patterns. Table 3-3 and Figure 3-4 provide a list and relative abundance of algal species observed in the mainstem Russian River during the 2017 monitoring season. Relative abundance is represented as the number of sample slides a given species was observed on out of a total of 460 sample slides.

Water Agency staff conducted biweekly nutrient grab sampling monitoring at six (6) stations in the mainstem Russian River including: the Talmage USGS gaging station in Ukiah, Hopland, Cloverdale River Park in Cloverdale, Jimtown, Syar, and Patterson Point. Grab sampling involves the collection of water from the water column for laboratory analysis. The grab sample sites are shown in Figure 3-3, and results are summarized in Tables 3-4 through 3-6 and Figures 3-5 through 3-10.

All grab samples were analyzed for nutrients, *chlorophyll a*, total dissolved solids, and turbidity. Grab samples were submitted to Alpha Analytical Labs in Ukiah for analysis. Grab sample data was collected during the Water Agency's ambient algae and cyanobacteria monitoring and sample collection effort.

Ambient algae, cyanobacteria, estuary response, and associated grab sampling data for 2017 is currently being compiled and will be discussed in greater detail in the Russian River Biological Opinion 2018 annual report, which will be posted to the Water Agency's website when available: http://www.scwa.ca.gov/bo-annual-report/.

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.

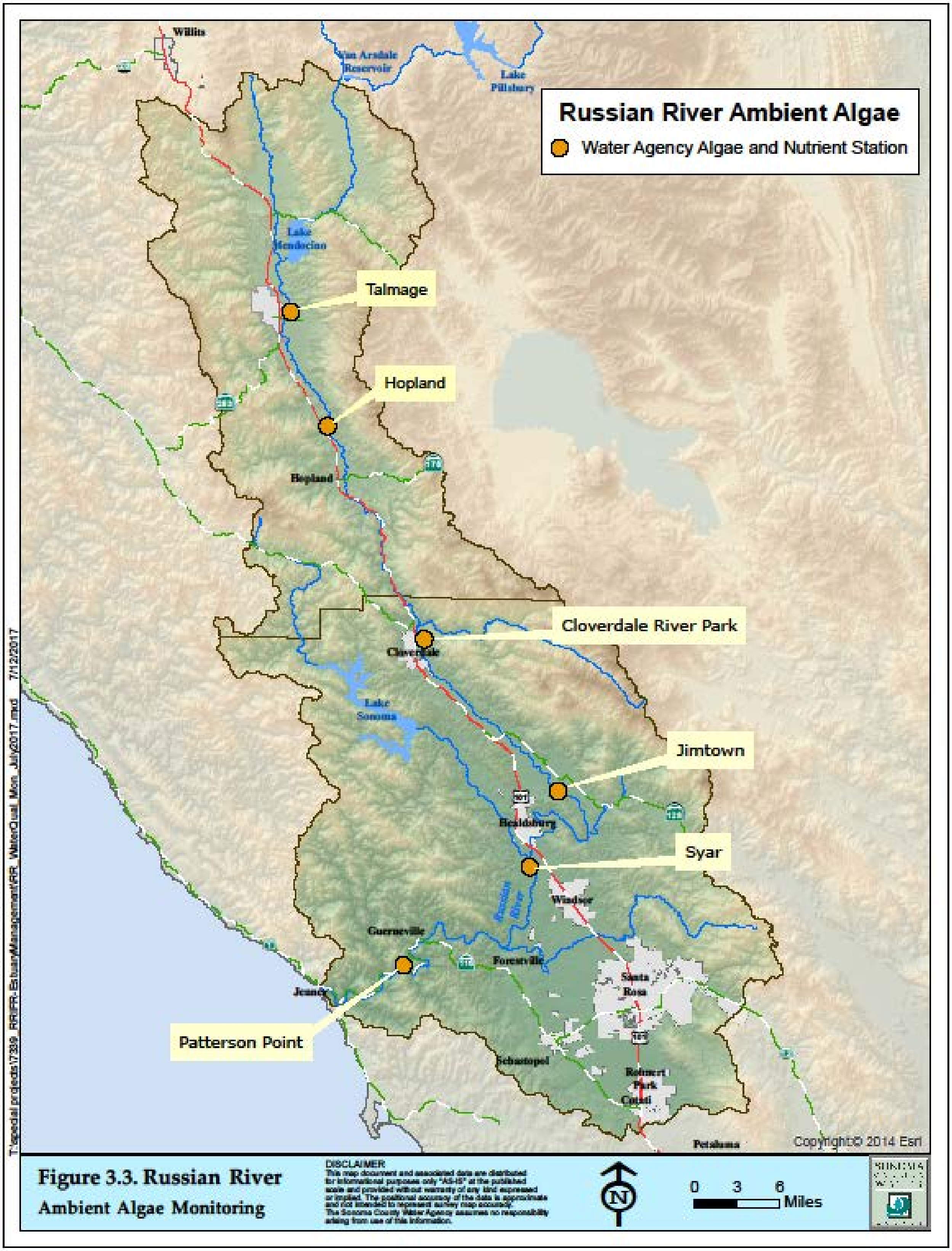


Figure 3-3. Water Agency 2017 Seasonal Mainstem Russian River Ambient Algae and Nutrient Grab Sampling Stations.

Table 3-3. Genera observed during algae monitoring, June - October 2017.

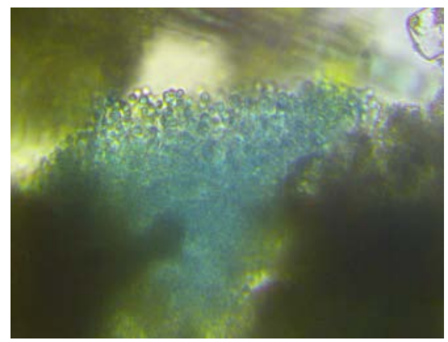
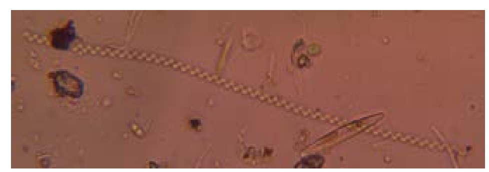
Algae Division	Genus/Genera	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Known Toxins (4)	Photograph
Cyanophyta	*Anabaena**	148 (All)	Alkilibiontic (1)	Microcystins, Anatoxin-a, Saxitoxins, BMAA	
Cyanophyta	*Aphanocapsa**	8 (P, S, J)	Open water in bogs (2)	Microcystins	
	Aphanothece	8 (P, S, J)	Hard and soft standing water (2) Oligotrophic (2) Range of Salinity (2)		
Cyanophyta	*Arthrospira/ Spirulina*	4 (P & S)	Heavy pollution (3) Mineral springs (3) Saline lakes (3)		

Table 3-3 cont.

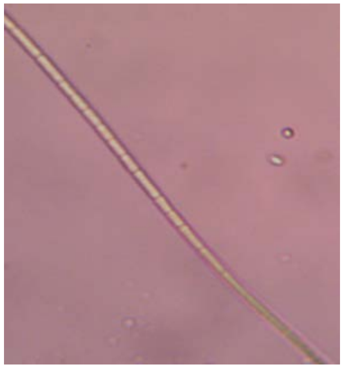
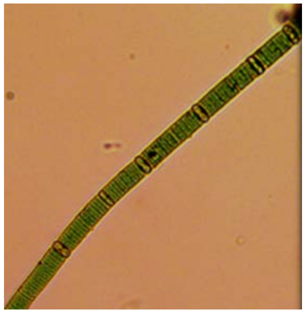
Algae Division	Genus/Genera	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Known Toxins (4)	Photograph
Cyanophyta	*Cylindrospermum**	35 (All)	Soft,acid lakes (2) Nitrogen fixer	Anatoxin-*a*	
Cyanophyta	*Geitlerinema*	171 (All)	Soft, clean freshwater biotopes(2) Some species are found in mineral waters and thermal springs(2) Inhabits periphyton of oligotrophic to mesotrophic waters(2)		
Cyanophyta	*Nodularia**	32 (P & S)	N-fixer	Nodularin N-fixer	

Table 3-3 cont.

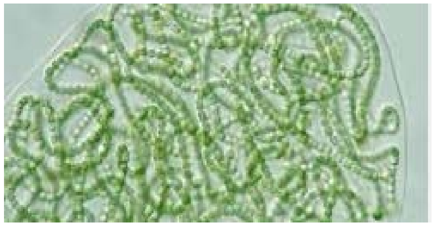
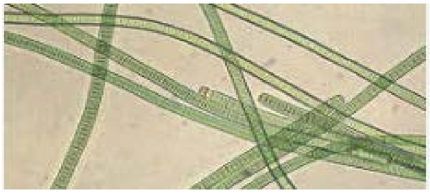
Algae Division	Genus/Genera	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Known Toxins (4)	Photograph
Cyanophyta	*Nostoc**	1 (P)	Nitrogen fixer Low N concentrations-2 High N:P ratio-2	Microcystins, Nodularin, BMAA	
Cyanophyta	*Oscillatoria**	88 (All)	Organic pollution (2)	Microcystins, Anatoxin-a, Aplysiatoxins	
Cyanophyta	*Phormidium*/ Lyngbya**	119 (All)	Low temp., low light (2)	Lyngbyatoxin-a, Aplysiatoxins, Saxitoxins, Anatoxins (Phormidium)	

Table 3-3 cont.

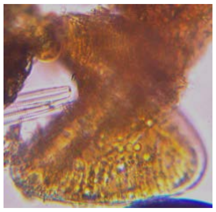
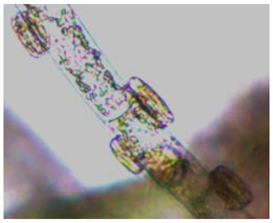
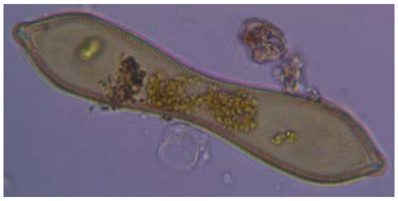
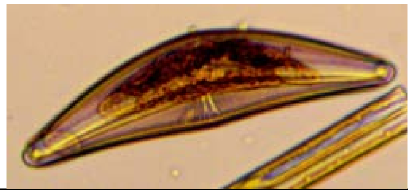
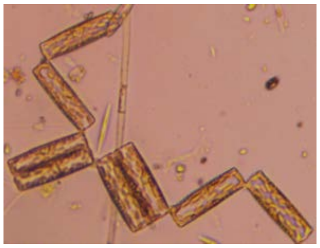
Algae Division	Genus	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Photograph
Bacillariophyta	*Bacillaria*	220	Brackish (1) Low DO (1) Eutrophic (1)	
Bacillariophyta	*Campylodiscus*	39	Epipelic habitats in lentic ecosystems	
Bacillariophyta	*Cocconeis*	62	Alkiliphilous (1) Fresh-brackish (1) Moderate-high DO (1) Eutrophic (1)	
Bacillariophyta	*Cymatopleura*	53	Epipelic habitats in lakes, rivers and wetlands	
Bacillariophyta	*Cymbella*	76	Alkiliphilous (1) Fresh (1) Oligotrophic (1) High DO (1)	
Bacillariophyta	*Diatoma/ Tabellaria*	216	Alkiliphilous (1) Fresh-brackish(1) High to moderate DO (1) Meso-eutrophic (1)	

Table 3-3 cont.

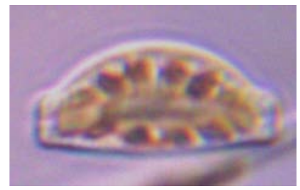
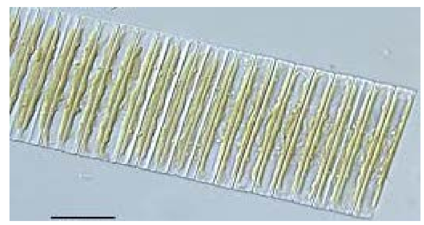
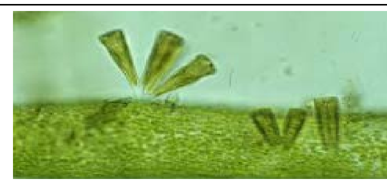
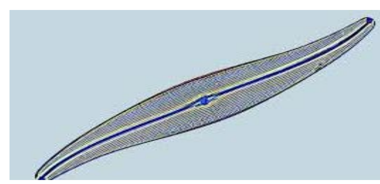
Algae Division	Genus	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Photograph
Bacillariophyta	*Encyonema*	168	Alkiliphilous (1) Fresh (1) Oligotrophic (1) High DO (1)	
Bacillariophyta	*Fragilaria*	220	Alkiliphilous (1) Fresh (1) High to moderate DO (1) Eurytrophic (1)	
Bacillariophyta	*Gomphonema*	96	Alkiliphilous (1) Fresh (1) Organic pollution (2)	
Bacillariophyta	*Gyrosigma*	169	Alkiliphilous (1)	
Bacillariophyta	*Melosira*	318	Alkiliphilous (1) Fresh (1) Moderate DO (1) Eutrophic (1)	
Bacillariophyta	*Navicula*	256	Alkiliphilous (1) Fresh – brackish (1) Organic pollution (smaller species) (2) Soft substrate (2)	

Table 3-3 cont.

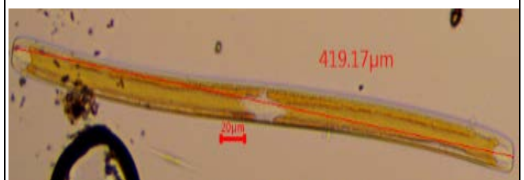
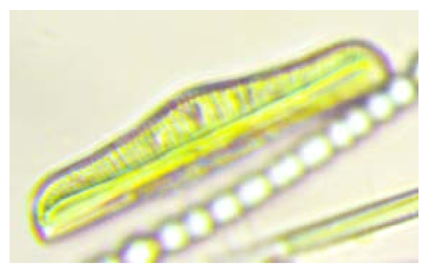
Algae Division	Genus	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Photograph
Bacillariophyta	*Nitzschia*	106	Moderate DO (1) Eutrophic (1) Organic pollution (smaller species (2) Soft Substrate (2)	
Bacillariophyta	*Pinnularia*	124	Soft substrate (2)	
Bacillariophyta	*Rhopalodia*	93	Alkilibiontic (1) Fresh (1) Moderate DO (1) Eutrophic (1) Nitrogen fixer	
Bacillariophyta	*Surirella*	86	Alkiliphilous (1) Fresh (1) Moderate DO (1) Eutrophic (1)	
Bacillariophyta	*Synedra*	195	Fresh (1) Organic pollution (1 & 2)	

Table 3-3 cont.

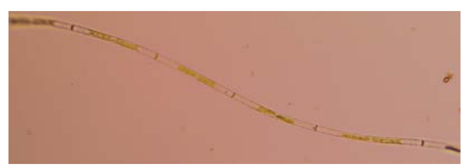
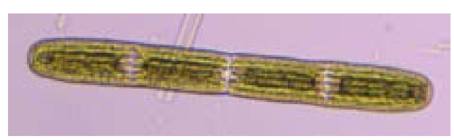
Algae Division	Genus	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Photograph
Charophyta	*Closterium* sp.	207	Oligotrophic (2) Low pH bogs (2)	
Charophyta	*Cosmarium*	7	Oligotrophic (2) Low pH bogs (2)	
Charophyta	*Mougeotia*	183	High and Low pH (2) Low nutrients (2)	
Charophyta	*Mougeotiopsis*	42	Freshwater benthic	
Charophyta	*Penium*	2 (Patterson)	Oligotrophic (2) Low pH bogs (2)	
Charophyta	*Pleurotaenium*	1 (Patterson)	Oligotrophic (2) Low pH bogs (2)	

Table 3-3 cont.

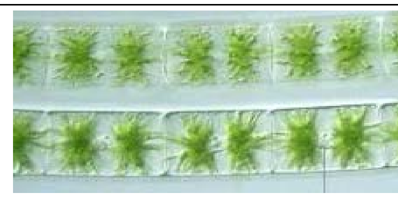
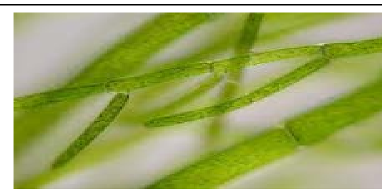
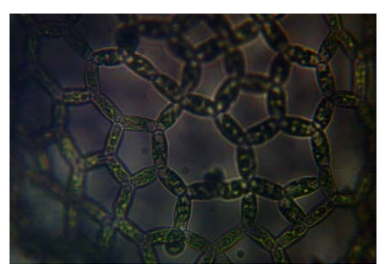
Algae Division	Genus	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Photograph
Charophyta	*Spirogyra*	269	Standing and running waters (2) Low pH bogs (2)	
Charophyta	*Zygnema*	109	Shallow freshwater benthos	
Chlorophyta	*Ankistrodesmus*	23	Organic pollution (2)	
Chlorophyta	*Cladophora* sp. (few species)	229	Eutrophic to Hypertrophic (2)	
Chlorophyta	*Coelastrum*	2- S, J	Planktonic, abundant in eutrophic conditions(2) Freshwater habitats from arctic to tropical	No photo in archive.
Chlorophyta	*Hydrodictyon*	22	Hard water-high Ca concentration (2)	

Table 3-3 cont.

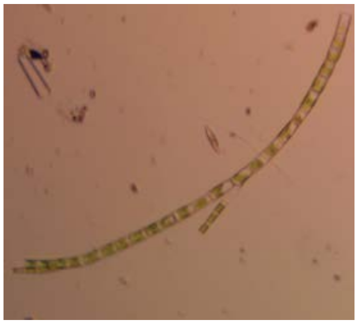
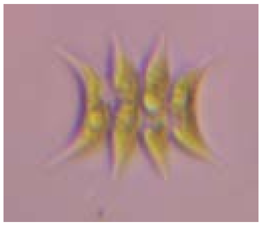
Algae Division	Genus	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Photograph
Chlorophyta	*Microspora*	48	Cool water (3) Low pH (3)	
Chlorophyta	*Oedogonium*	138-	Standing water (2)	
Chlorophyta	*Pediastrum* sp.	35	Standing water (2) Eutrophic to Hypertrophic (1 & 2)	
Chlorophyta	*Scenedesmus* sp.	74	Standing and running waters (2) Eutrophic to Hypertrophic (2) Organic pollution (2)	
Chlorophyta	*Selenastrum* sp.	23	Standing waters-wetlands (2)	

Table 3-3 cont.

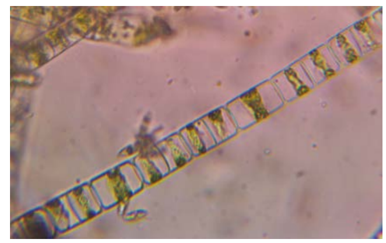
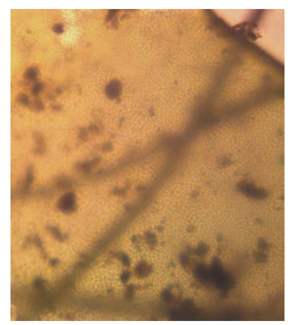
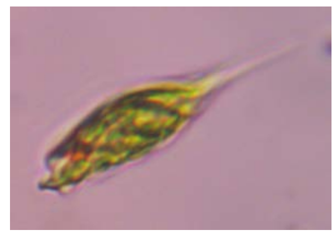
Algae Division	Genus	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Photograph
Chlorophyta	*Stigeoclonium* sp.	69	Organic pollution (2)	
Chlorophyta	*Ulothrix* sp.	101	Damp soil or stagnant water (3)	
Chlorophyta	*Ulva* sp.	17	Flowing water (3) Fresh to saline water (3)	
Chlorophyta	*Volvox* sp.	4	Cosmopolitan (3)	
Xanthophyta	*Tribonema*	8	Humic water (2)	
Xanthophyta	*Vaucheria*	35	Brackish water (2)	

Table 3-3 cont.

Algae Division	Genus	No. Slides Genera Present (out of 460)	Bioindicator Type(s)	Photograph
Chromista (taxonomy of *Ceratium* varies among sources)	*Ceratium*	11	Hard water – high Ca concentrations (2) High P concentrations in deeper water (2)	
Euglenozoa	*Euglena*		Very high nutrients, i.e. sewage (2) Organic pollution (2)	
Ochraphyta	*Dinobryon*	1 (H)	Slightly acidic to strongly acidic water (2) Oligotrophic (2)	
Rhodophyta	*Batrachospermum*	11	Polluted (3)	

1. Asarian, J.E. et al. 2014. *Spatial and Temporal Variation of Periphyton Assemblages in the Klamath River 2004-2012*. Prepared by Kier Associates, Portland State University, and Aquatic Ecosystem Sciences LLC. for the Klamath Basin Tribal Water Quality Work Group. 50p. + appendices.
2. Bellinger, E.G. and Sigee, D.C. 2015. *Freshwater Algae: Identification, Enumeration, and Use as Bioindicators*. 2nd edition. John Wiley and Sons, Ltd., Hoboken, New Jersey.
3. Wehr, J.D., Sheath, R.G., Kociolek, J.P. 2015. *Freshwater Algae of North America: Ecology and Classification*. 2nd edition. Elsevier, San Diego, CA.
4. www.cees.iupui.edu/research/algal-toxicology/cyanotoxins. January 23, 2017. "Cyanotoxin Fact Page." Center for Earth and Environmental Science, Indiana University-Purdue University, Indianapolis, IN.

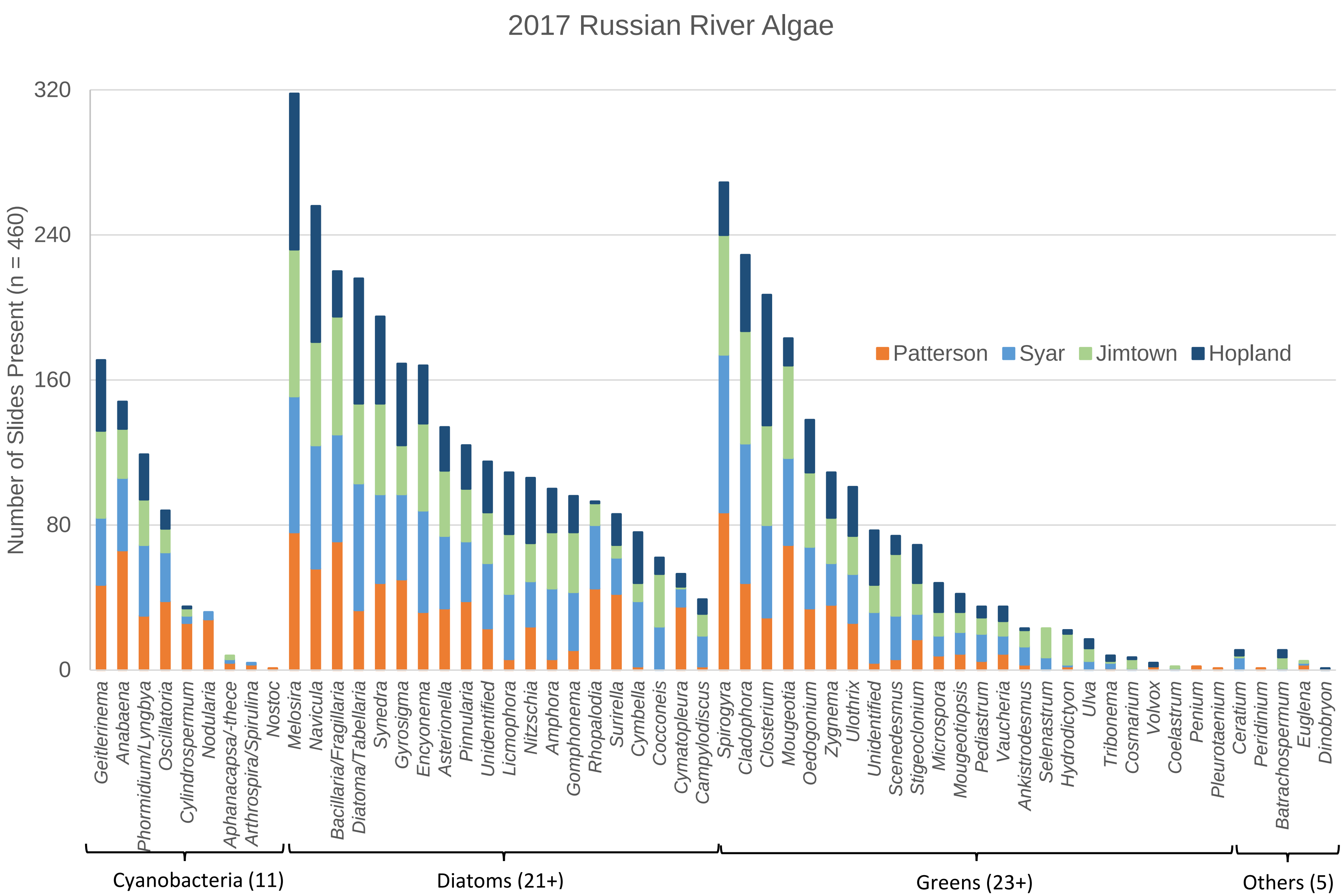


Figure 3-4. 2017 Russian River Algae Observed at Hopland, Jimtown, Syar, and Patterson Point Ambient Algae Sampling Stations.

The Talmage, Hopland, and Cloverdale River Park stations all had exceedances of the EPA criteria for Total Nitrogen during the ambient algae monitoring effort (Tables 3-4 and 3-5). Talmage and Cloverdale River Park had three exceedances, and Hopland had six exceedances that occurred at various times throughout the season with flows ranging from 104 cfs to 196 cfs at the Talmage, Hopland, and Cloverdale USGS gages. By contrast, the Jimtown and Syar stations did not have any exceedances of the EPA criteria (Tables 3-5 and 3-6). While the Patterson Point station had only one exceedance that occurred on 19 July during open estuary conditions and a flow of 159 cfs at the Hacienda USGS gage (Table 3-6 and Figure 3-10a).

Table 3-4. Water Agency 2017 Seasonal Mainstem Russian River Grab Sampling Results at Talmage and Hopland.

Talmage	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 Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11462080 RR near Talmage****
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	4.2	0.020	0.000050	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
6/22/2017	14:40	15.6	7.6	0.24	ND	ND	0.097	ND	0.24	**0.38**	**0.049**	110		**0.0025**	142
7/6/2017	15:20	15.7	7.8	0.70	ND	ND	0.077	ND	0.70	**0.82**	**0.068**	100		**0.0030**	104
7/19/2017	14:50	14.9	7.3	ND	ND	ND	0.040	ND	ND	0.18	**0.059**	110	**14.8**	**0.0021**	165
8/2/2017	15:20	15.2	7.8	ND	ND	ND	0.047	ND	ND	0.15	**0.064**	97	**12.5**	**0.0026**	191
8/16/2017	15:00	15.0	7.6	ND	ND	ND	ND	ND	ND	0.16	**0.098**	95	**9.7**	0.0016	185
8/30/2017	15:10	15.1	7.5	0.24	ND	ND	ND	ND	0.24	0.27	**0.11**	120	**14.7**	**0.0035**	213
9/13/2017	15:00	15.7	7.6	ND	ND	ND	ND	ND	ND	0.19	**0.11**	100	**21.4**	**0.0028**	193
9/27/2017	14:30	15.8	7.4	0.24	ND	ND	0.058	ND	0.24	0.31	**0.13**	110	**22.2**	0.0013	169
10/18/2017	15:30	16.6	7.4	0.35	ND	ND	0.060	ND	0.35	**0.42**	**0.19**	110	**31.6**	0.0016	196
10/31/2017	16:10	17.8	7.6	0.21	ND	ND	ND	ND	0.21	0.25	**0.087**	120	**28.7**	**0.0029**	192

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 Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11462500 RR near Hopland****
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	4.2	0.020	0.000050	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
6/22/2017	14:00	17.9	7.5	0.28	ND	ND	0.25	ND	0.28	**0.57**	**0.058**	120		**0.0023**	146
7/6/2017	14:40	17.2	7.7	0.24	ND	ND	0.19	ND	0.24	**0.48**	**0.060**	110	**4.3**	0.0016	131
7/19/2017	13:50	15.3	7.2	ND	ND	ND	0.087	ND	ND	0.26	**0.055**	120	**12.0**	0.00081	159
8/2/2017	14:25	15.8	7.1	0.46	ND	ND	0.11	ND	0.46	**0.56**	**0.065**	100	**10.5**	0.0013	180
8/16/2017	14:20	15.3	7.8	ND	ND	ND	0.067	ND	ND	0.24	**0.075**	98	**6.2**	0.0016	186
8/30/2017	14:10	14.9	7.5	ND	ND	ND	0.066	ND	ND	0.24	**0.079**	110	**8.9**	**0.0023**	198
9/13/2017	14:00	15.7	7.3	ND	ND	ND	0.066	ND	0.21	0.28	**0.091**	110	**16.0**	**0.0023**	188
9/27/2017	13:30	14.8	7.4	0.24	ND	ND	0.13	ND	0.24	**0.38**	**0.11**	120	**17.4**	0.0011	166
10/18/2017	14:40	14.7	7.4	0.24	ND	ND	0.14	ND	0.24	**0.39**	**0.17**	110	**25.7**	0.00035	192
10/31/2017	15:10	15.7	7.5	0.21	ND	ND	0.21	ND	0.21	**0.44**	**0.10**	130	**21.2**	**0.0062**	185

* 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

Table 3-5. Water Agency 2017 Seasonal Mainstem Russian River Grab Sampling Results at Cloverdale River Park and Jimtown.

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 Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11463000 RR near Cloverdale****
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	4.2	0.020	0.000050	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
6/22/2017	13:10	23.6	8.2	0.28	ND	ND	0.18	ND	0.28	**0.49**	**0.042**	140		**0.0023**	154
7/6/2017	14:00	21.7	8.4	ND	ND	ND	0.076	ND	ND	0.22	**0.029**	140		0.0014	134
7/19/2017	13:10	20.2	8.2	ND	ND	ND	ND	ND	ND	0.21	**0.037**	130	**6.2**	**0.0028**	160
8/2/2017	13:40	20.6	8.2	0.38	ND	ND	0.055	ND	0.38	**0.44**	**0.042**	130	**4.9**	**0.0025**	173
8/16/2017	13:30	19.1	8.1	ND	ND	ND	ND	ND	ND	0.14	**0.057**	100	**4.6**	**0.0042**	176
8/30/2017	13:20	19.1	8.0	ND	ND	ND	0.041	ND	ND	0.22	**0.055**	120	**4.6**	**0.0021**	180
9/13/2017	13:20	18.4	8.1	ND	ND	ND	0.051	ND	ND	0.23	**0.058**	140	**8.9**	**0.0025**	180
9/27/2017	12:50	16.5	8.0	ND	ND	ND	0.10	ND	ND	0.24	ND	120	**9.6**	0.0015	162
10/18/2017	13:50	14.1	7.7	ND	ND	ND	0.12	ND	ND	0.30	**0.10**	100	**15.3**	**0.0018**	187
10/31/2017	14:30	15.3	8.0	ND	ND	ND	0.28	ND	ND	**0.46**	**0.074**	140	**9.8**	**0.0028**	180

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 Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11463682 RR at Jimtown****
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	4.2	0.020	0.000050	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
6/22/2017	12:30	24.4	7.6	0.21	ND	ND	0.16	ND	0.21	0.37	0.019	170		0.0016	208
7/6/2017	13:10	22.9	7.7	ND	ND	ND	0.069	ND	ND	0.21	0.018	160	0.9	0.0011	155
7/19/2017	12:00	22.2	7.7	ND	ND	ND	ND	ND	ND	0.20	0.012	160	1.2	0.0016	161
8/2/2017	12:40	22.9	7.9	ND	ND	ND	0.054	ND	ND	0.19	0.020	150	0.4	**0.0028**	165
8/16/2017	12:30	21.4	7.9	ND	ND	ND	0.046	ND	ND	0.15	**0.030**	140	2.3	0.0016	175
8/30/2017	12:20	22.1	7.7	ND	ND	ND	0.048	ND	ND	0.19	**0.028**	140	0.7	**0.0033**	158
9/13/2017	12:10	20.4	7.5	ND	ND	ND	ND	ND	ND	0.14	**0.034**	150	**4.8**	**0.0022**	167
9/27/2017	11:50	18.9	7.6	ND	ND	ND	0.075	ND	ND	0.26	**0.030**	140	**5.2**	**0.0029**	145
10/18/2017	12:40	14.9	7.6	ND	ND	ND	0.070	ND	ND	0.25	**0.048**	130	**6.1**	**0.0025**	182
10/31/2017	13:10	16.5	7.7	0.24	ND	ND	0.13	ND	0.24	0.37	**0.043**	150	**4.5**	**0.0023**	178

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

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

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Recommended EPA Criteria based on Aggregate Ecoregion III

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

Turbidity: 2.34 FTU/NTU

All six monitoring stations were observed to have exceedances of the EPA criteria for Total Phosphorous during the monitoring season (Tables 3-4 through 3-6). The station at Talmage was observed to have the highest concentrations of the six stations, including a maximum value of 0.19 mg/L on 18 October, and exceeded the EPA criteria during the entire term of the Order under flows that ranged from 104 cfs to 213 cfs (Table 3-4 and Figure 3-5b). Maximum concentrations also occurred on 18 October at the Hopland, Cloverdale River Park, and Jimtown stations (Tables 3-4 and 3-5). Hopland had a concentration of 0.17 mg/L with a flow of 192 cfs, Cloverdale River Park had a concentration of 0.10 mg/L with a flow of 187 cfs, and Jimtown had a concentration of 0.048 mg/L with a flow of 182 cfs (Figures 3-6b through

3-8b). The Jimtown station had exceedances during the latter half of the season; however, concentrations were significantly lower than those at Talmage, Hopland, and Cloverdale River Park (Tables 3-4 and 3-5). Syar Vineyards had eight exceedances during the season, including a maximum value of 0.029 mg/L, with flows ranging from 186 cfs to 338 cfs (Table 3-6 and Figure 3-9b). Patterson Point exceeded the criteria throughout the season during open and closed conditions, including a maximum value of 0.045 mg/L, with flows ranging from 138 cfs to 252 cfs (Table 3-6 and Figure 3-10b). While concentrations generally increased through the season at Talmage, Hopland, Cloverdale River Park, and Jimtown, they remained relatively level at Syar Vineyards and Patterson Point.

Table 3-6. Water Agency 2017 Seasonal Mainstem Russian River Grab Sampling Results at Syar and Patterson Point.

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 Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11465390 RR near Windsor***
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
6/22/2017	11:20	21.5	7.9	ND	ND	ND	0.093	ND	ND	0.27	**0.029**	150	**4.0**	**0.0028**	338
7/6/2017	12:00	21.2	8.2	ND	ND	ND	0.042	ND	ND	0.22	**0.022**	140	**3.6**	0.0014	261
7/19/2017	10:50	20.7	8.0	ND	ND	ND	ND	ND	ND	0.12	0.018	150	**2.9**	0.0011	229
8/2/2017	11:25	21.4	8.0	0.21	ND	ND	ND	ND	0.21	0.24	**0.024**	150	1.8	0.0013	233
8/16/2017	11:25	20.3	8.0	0.21	ND	ND	ND	ND	0.21	0.24	**0.025**	130	2.3	**0.0018**	233
8/30/2017	10:40	19.7	8.0	ND	ND	ND	ND	ND	ND	0.21	0.020	140	**2.8**	**0.0023**	207
9/13/2017	10:50	19.6	7.8	ND	ND	ND	ND	ND	ND	0.091	**0.025**	140	**6.3**	0.0017	223
9/27/2017	10:10	17.0	7.7	ND	ND	ND	0.062	ND	ND	0.085	**0.028**	130	**6.3**	0.00049	186
10/18/2017	11:20	13.8	7.7	ND	ND	ND	0.046	ND	ND	0.12	**0.028**	130	**6.5**	**0.0018**	253
10/31/2017	11:20	14.4	7.8	ND	ND	ND	0.043	ND	ND	0.18	**0.029**	88	**6.2**	0.0013	282

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 Dissolved Solids	Turbidity***	Chlorophyll-a	USGS 11467000 RR near Guerneville (Hacienda)****
MDL*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	4.2	0.020	0.000050	Flow Rate*****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
6/22/2017	9:50	25.0	8.2	0.32	ND	ND	ND	ND	0.32	0.33	**0.038**	170	0.9	**0.11**	252
7/6/2017	10:20	22.6	8.0	0.21	ND	ND	ND	ND	0.21	0.23	**0.039**	160	1.8	**0.0044**	184
7/19/2017	9:20	23.7	7.6	0.38	ND	ND	ND	ND	0.38	**0.38**	**0.045**	160	**2.8**	**0.0018**	159
8/2/2017	9:30	23.0	7.8	0.32	ND	ND	ND	ND	0.32	0.33	**0.030**	150	1.6	0.0016	159
8/16/2017	10:00	23.0	7.7	ND	ND	ND	ND	ND	ND	0.16	**0.029**	130	**5.5**	0.00074	156
8/30/2017	9:00	22.1	7.6	0.24	ND	ND	ND	ND	0.24	0.27	**0.028**	140	1.2	0.0016	138
9/13/2017	9:10	22.8	7.7	ND	ND	ND	ND	ND	ND	0.10	**0.029**	120	**5.5**	**0.0020**	152
9/27/2017	9:10	18.6	7.5	ND	ND	ND	0.044	ND	ND	0.085	**0.028**	130	**5.1**	0.00049	140
10/31/2017	9:30	15.5	7.7	ND	ND	ND	ND	ND	ND	0.18	**0.037**	130	**5.1**	ND	211

* 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

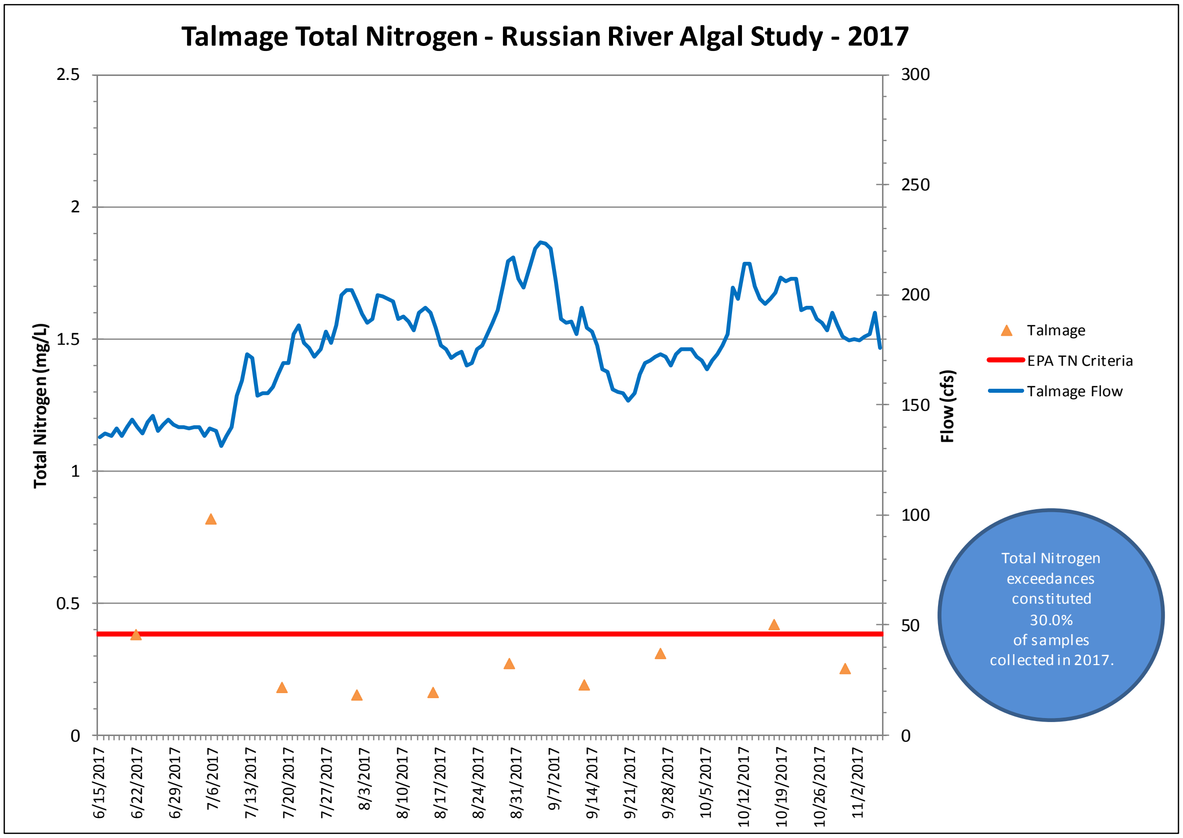
Total Nitrogen: 0.38 mg/L

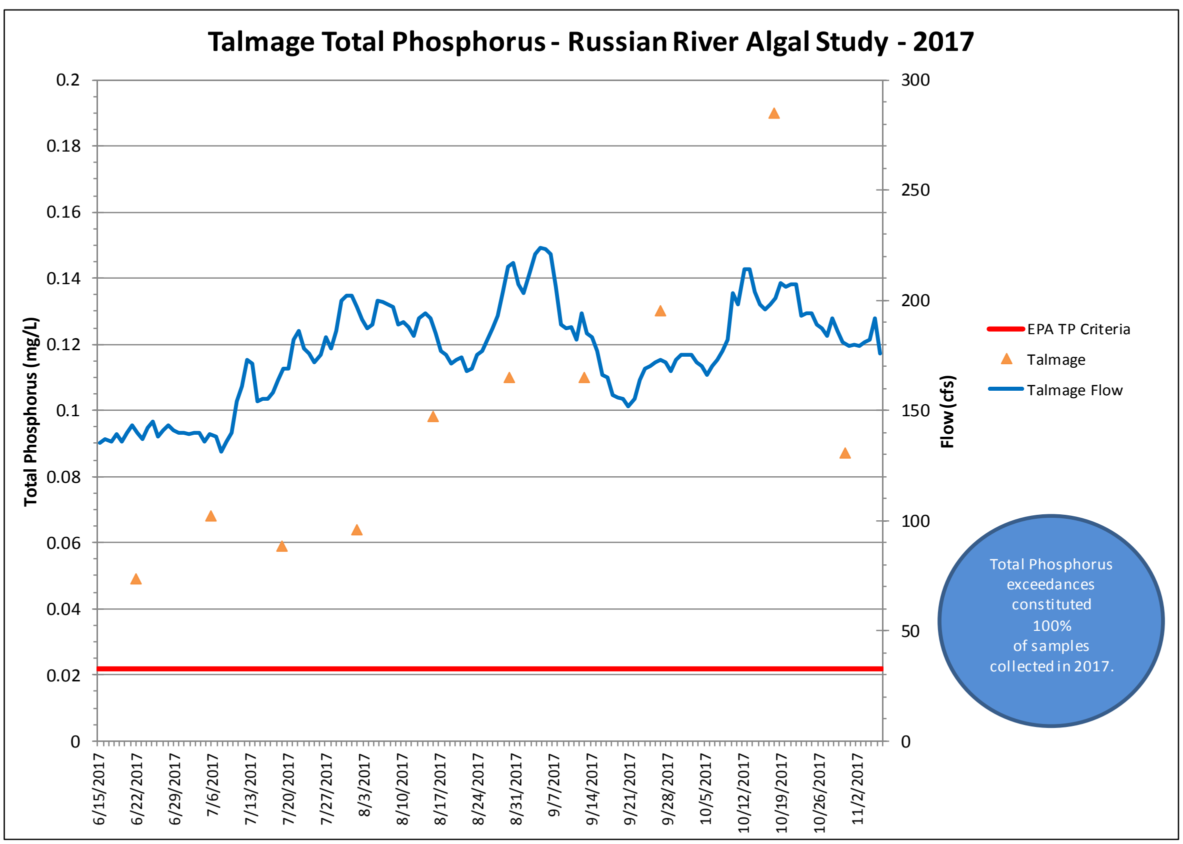
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

Turbidity: 2.34 FTU/NTU

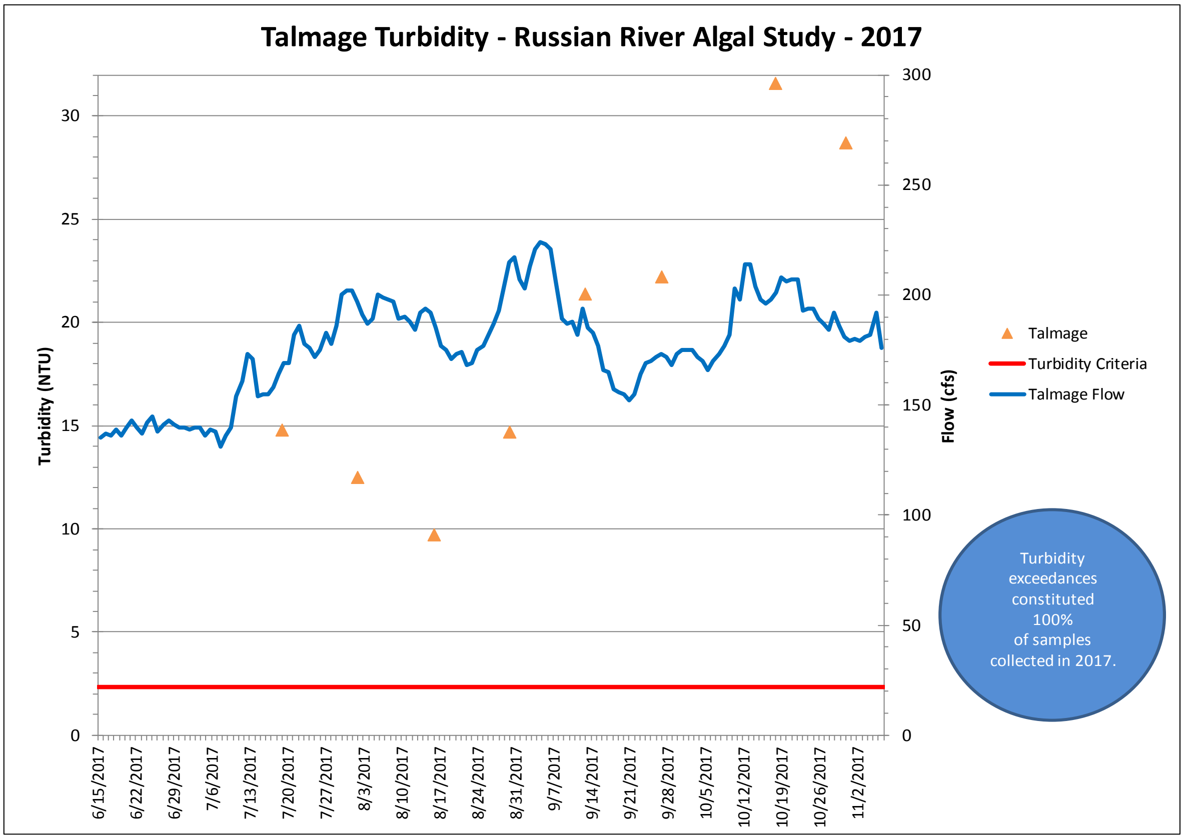
Turbidity levels exceeded the Turbidity EPA criteria during the entire monitoring season at the Talmage, Hopland, and Cloverdale River Park stations (Tables 3-4 and 3-5). Values were observed to generally increase through the season at these stations, similar to the pattern observed for Total Phosphorus (Figures 3-5b through 3-7 b and 3-5c through 3-7c). The maximum values observed occurred on 18 October with values of 31.6 NTU, 25.7 NTU, and 15.3 NTU, at Talmage, Hopland, and Cloverdale River Park, respectively (Tables 3-4 and 3-5). Tubidity values were also observed to increase through the season at Jimtown (Table 3-5). However, values only exceeded the EPA criteria during the latter half of the season with a maximum value of 6.1 NTU that occurred on 18 October with a flow of 182 cfs (Table 3-5 and Figure 3-8c). It is possible that the increasing turbidity values may be associated with the increasing Total Phosphorus values Talmage, Hopland, Coverdale River Park, and possibly Jimtown (Figures 3-5c through 3-8c). However, additional data would need to be collected to confirm if there is a positive correlation. The Syar Vineyards station exceeded the EPA criteria a majority of the time with flows ranging from 186 to 338 cfs (Table 3-6). A maximum value of 6.5 NTU was observed at Syar Vineyards on 18 October with a flow of 253 cfs (Table 3-6 and Figure 3-9c). The Patterson Point station exceeded the turbidity criteria five times throughout the season, during open and closed estuary conditions and summer dam removal, with flows ranging from 140 to 211 cfs (Table 3-6 and Figure 3-10c).

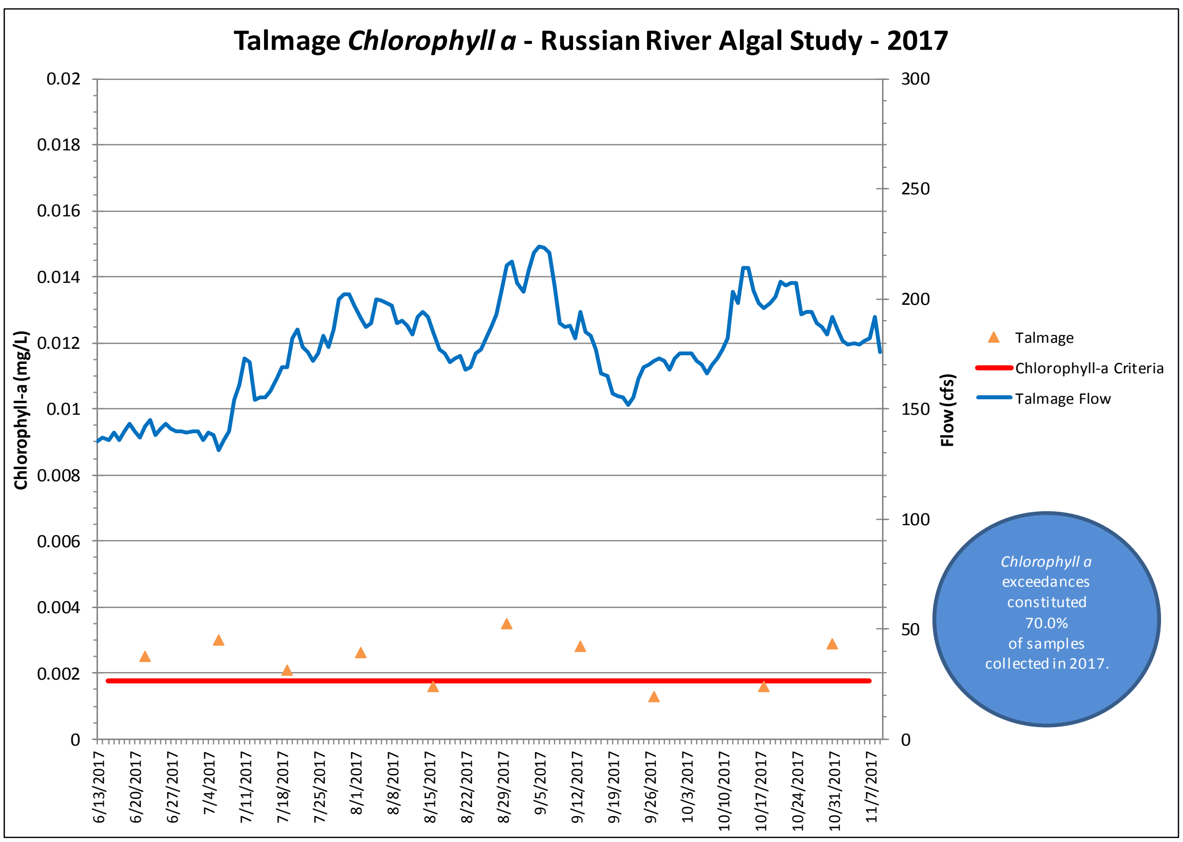
Chlorophyll a (used as an indicator for algae) results were observed to periodically exceed the EPA criteria at all six stations during the season, with flows that ranged from 104 cfs to 338 cfs (Tables 3-4 through 3-6). Talmage had seven exceedances, including a maximum value of 0.0035 mg/L that occurred on 30 August with a flow of 213 cfs (Table 3-4 and Figure 3-5d). Hopland had four exceedances, including a maximum value of 0.0062 mg/L that occurred on 31 October with a flow of 185 cfs (Table 3-4 and Figure 3-6d). Cloverdale River Park had eight exceedances, including a maximum value of 0.0042 mg/L that occurred on 16 October with a flow of 176 cfs (Table 3-5 and Figure 3-7d). Jimtown had six exceedances, including a maximum value of 0.0033 mg/L that occurred on 30 August with a flow of 158 cfs (Table 3-5 and Figure 3-8d). Syar vineyards had four *chlorophyll a* exceedances, including a maximum value of 0.0028 mg/L that occurred on 22 June with a flow of 338 cfs (Table 3-6 and Figure 3-9d). Patterson Point had four *chlorophyll a* exceedances, including a maximum value of 0.11 mg/L that occurred during closed estuary conditions on 22 June with a flow of 252 cfs at Hacienda (Table 3-6 and Figure 3-10d).



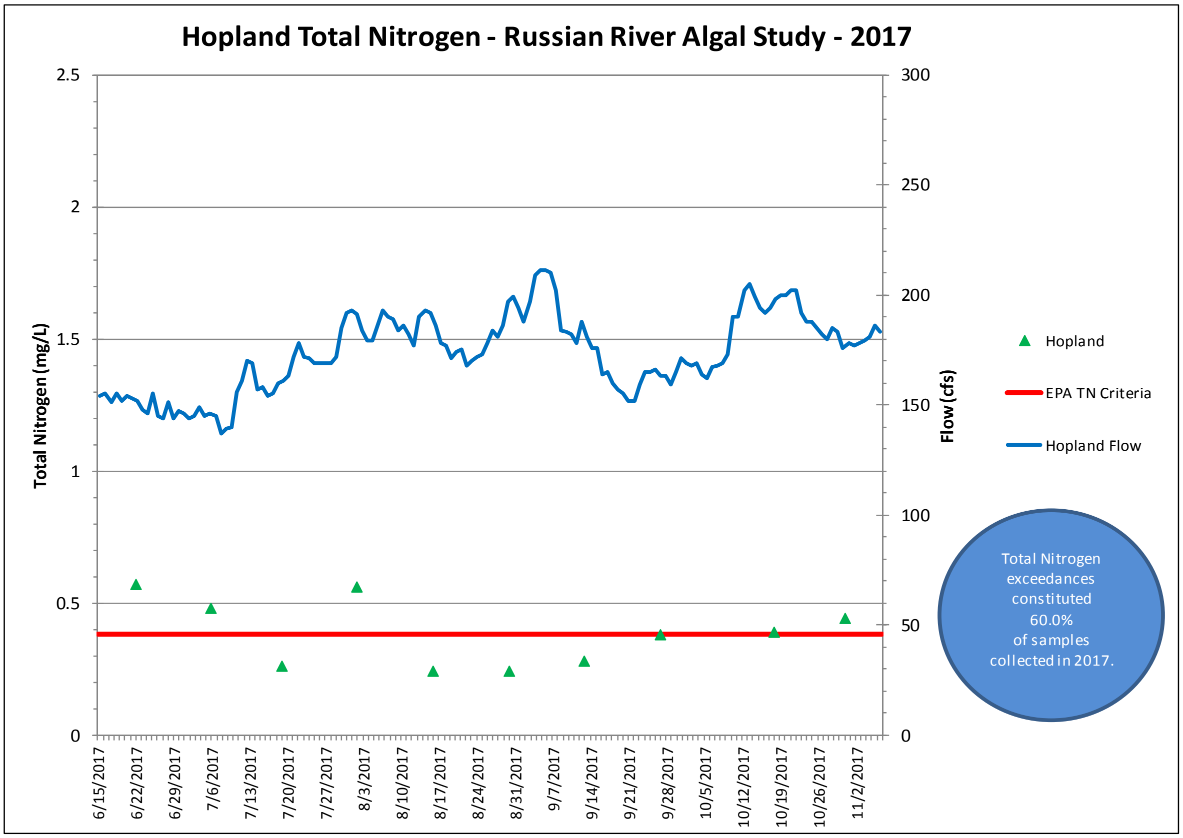


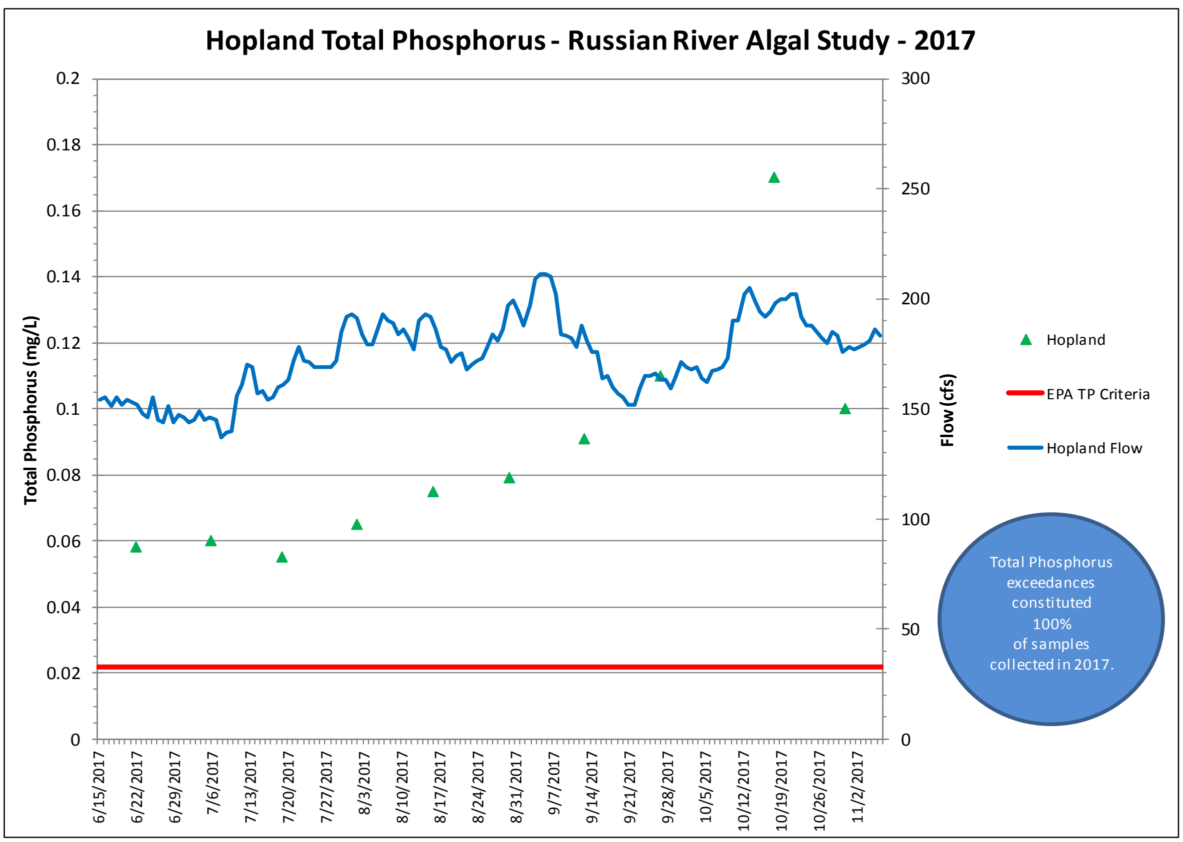
Figures 3-5 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Talmage in 2017.



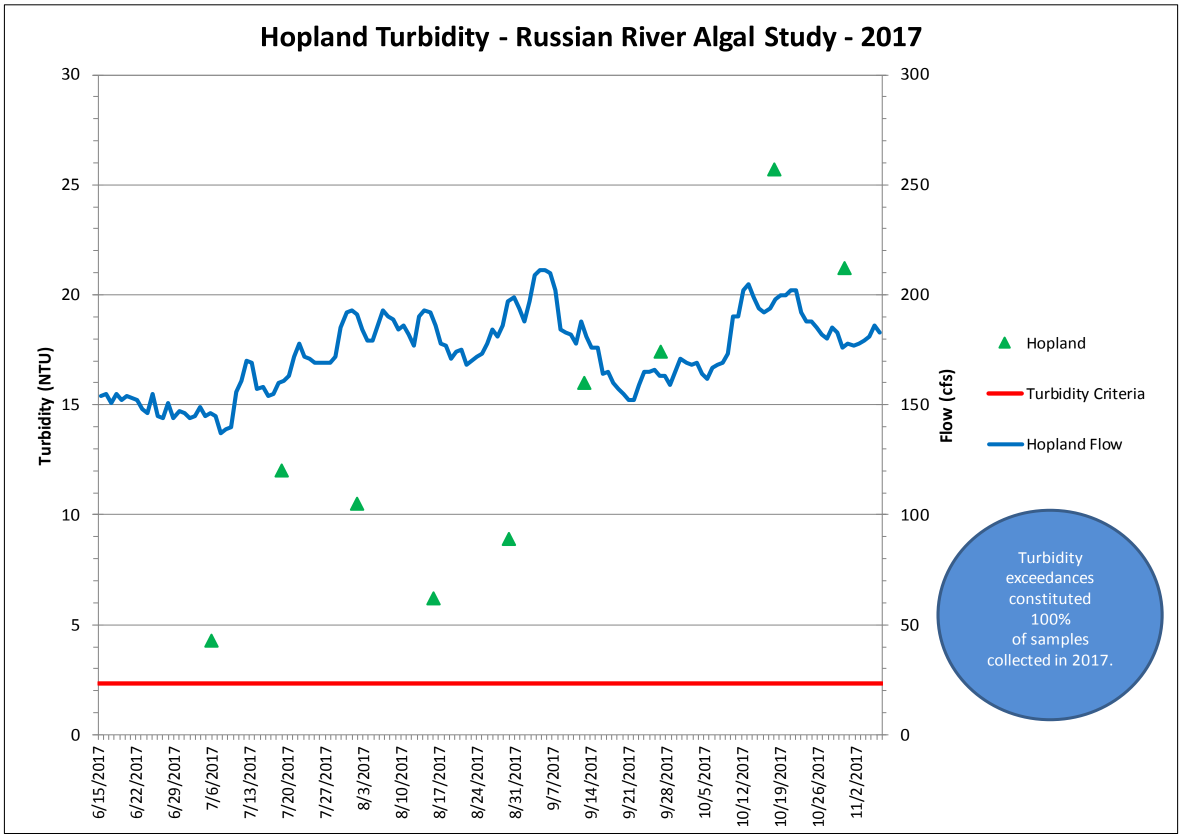


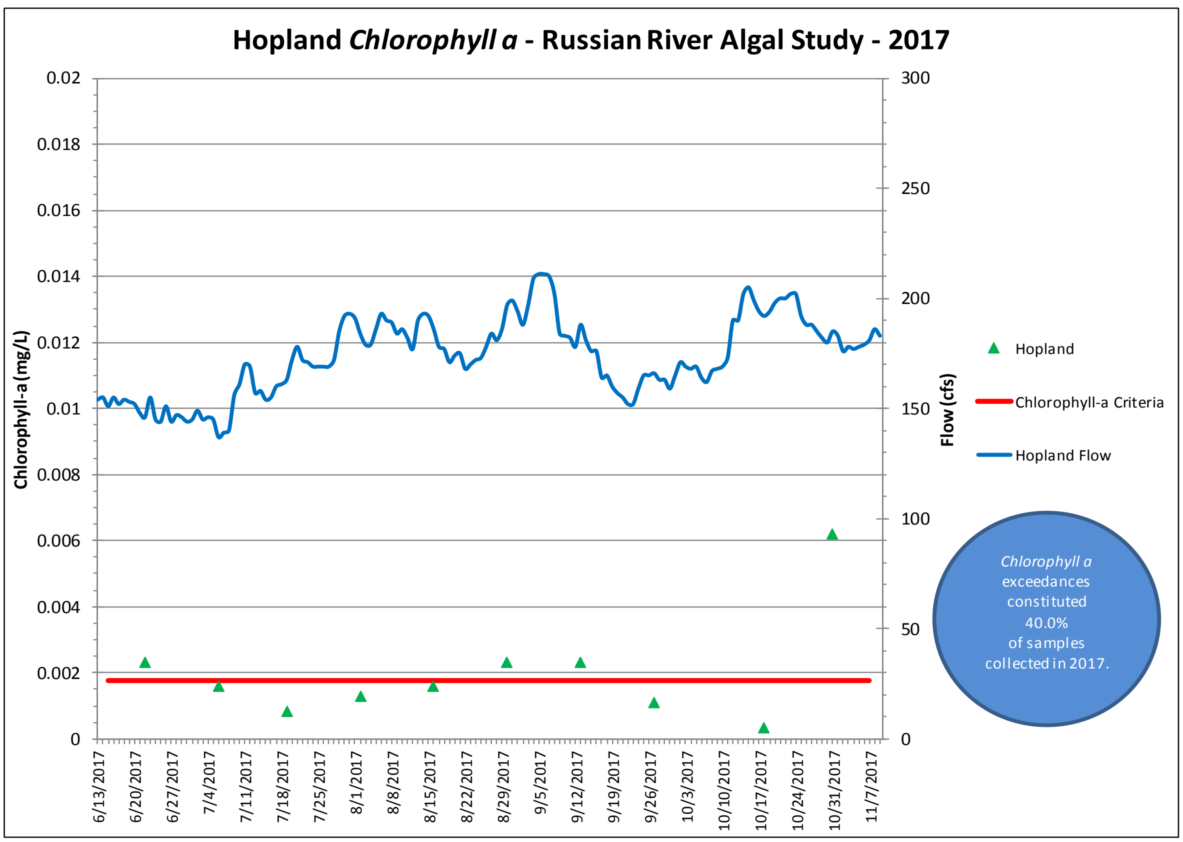
Figures 3-5 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll a* Results from Talmage in 2017.



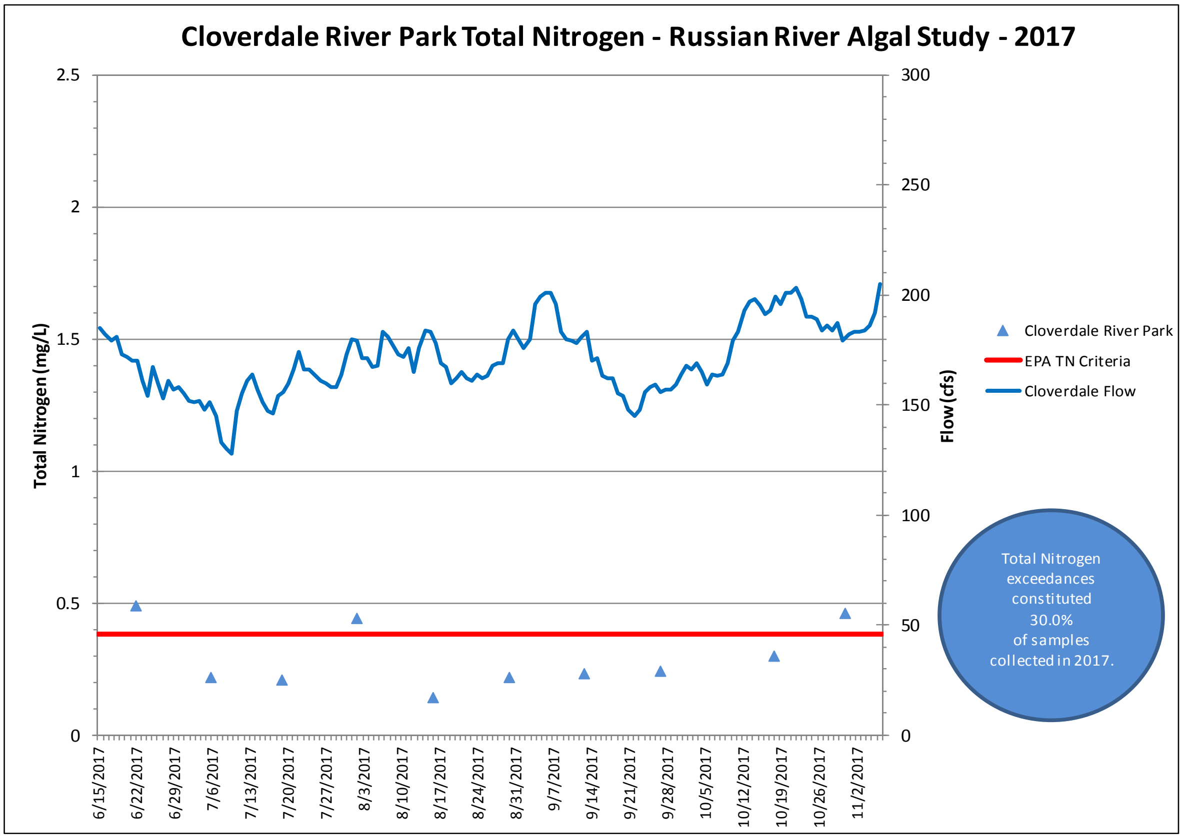


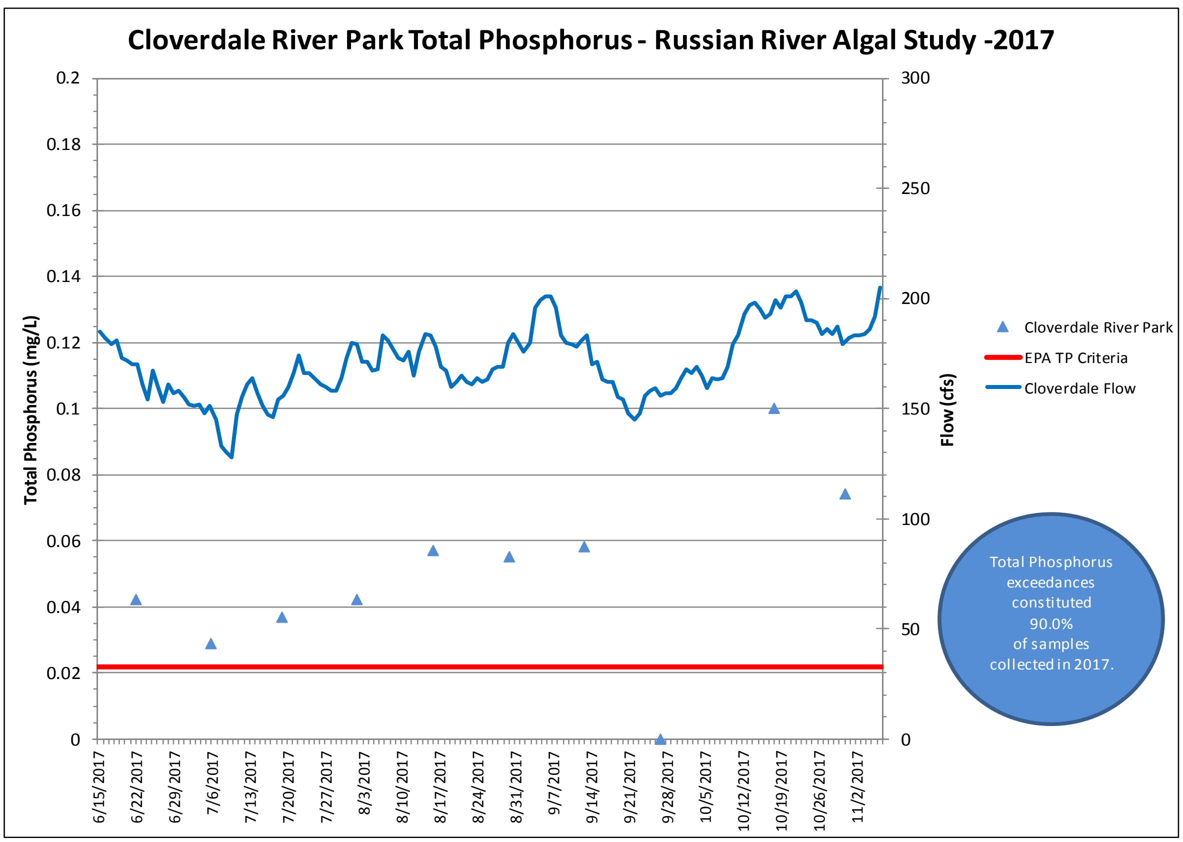
Figures 3-6 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Hopland in 2017.



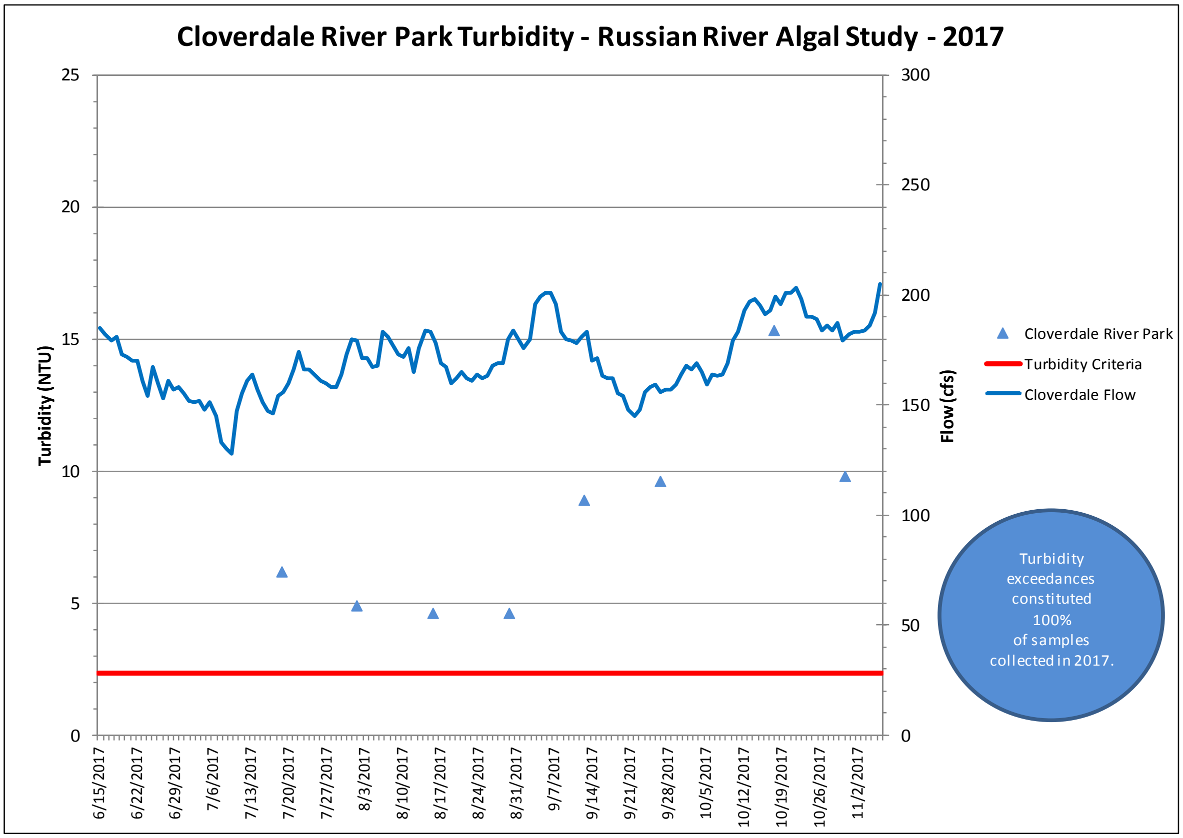


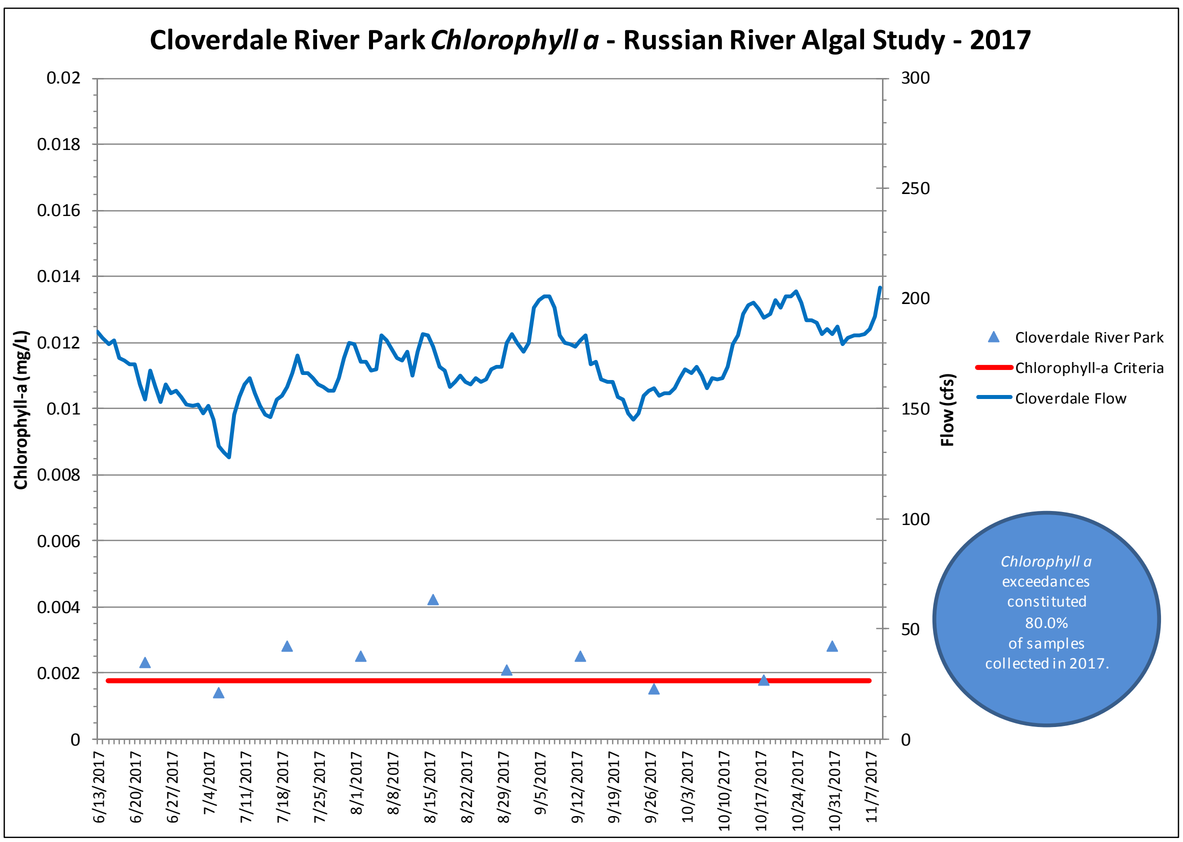
Figures 3-6 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll a* Results from Hopland in 2017.



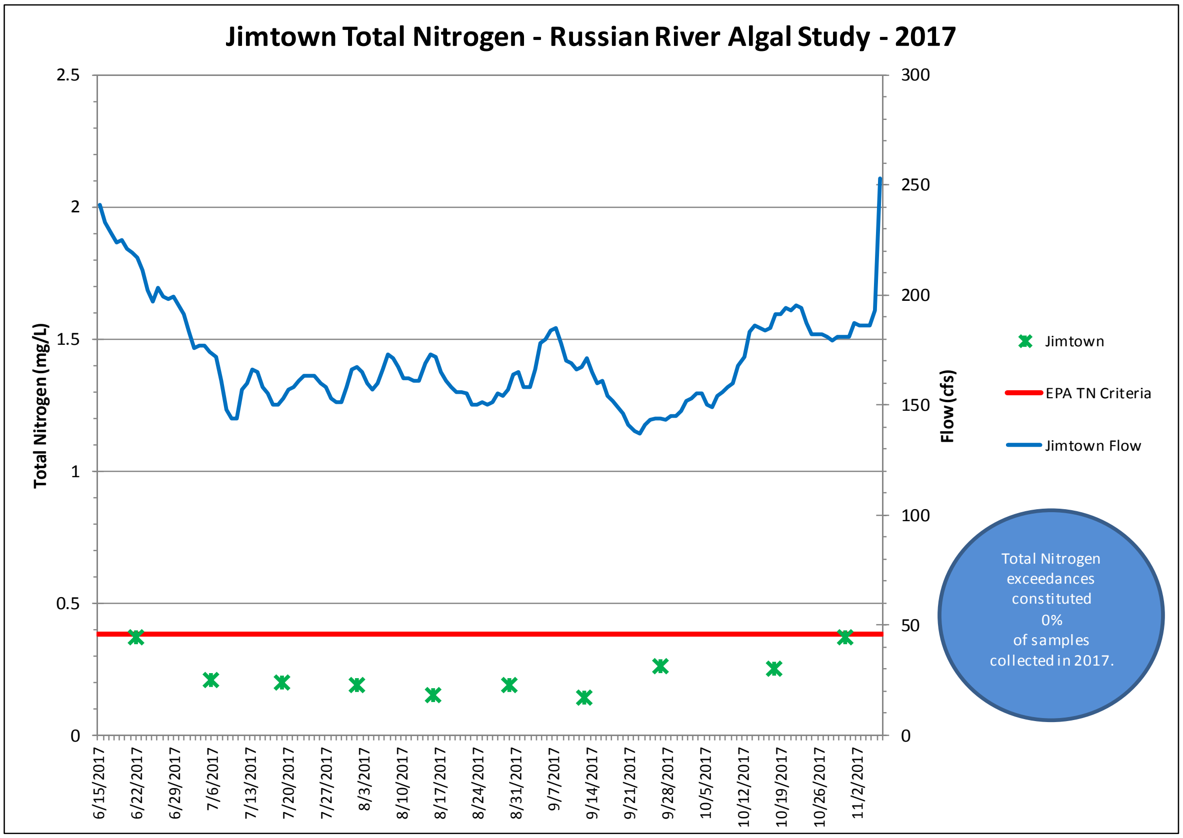


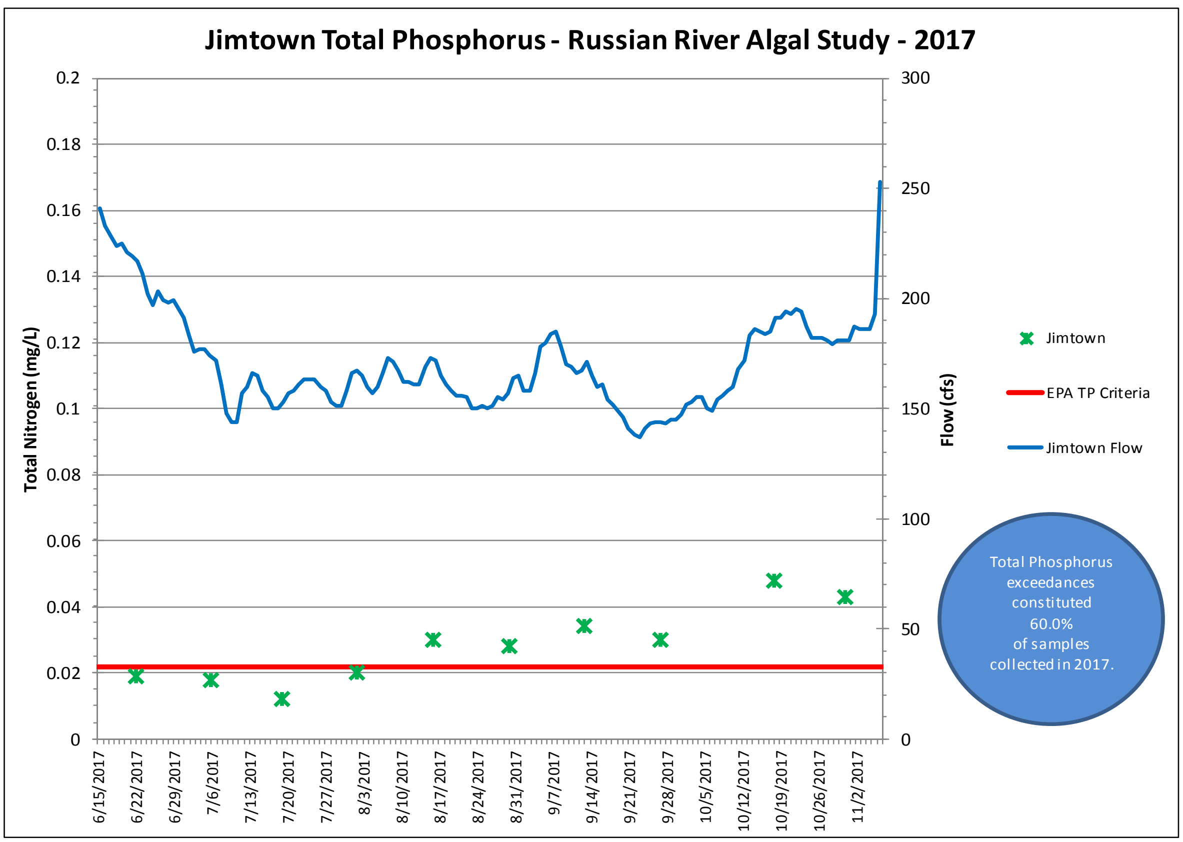
Figures 3-7 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Cloverdale River Park in 2017.



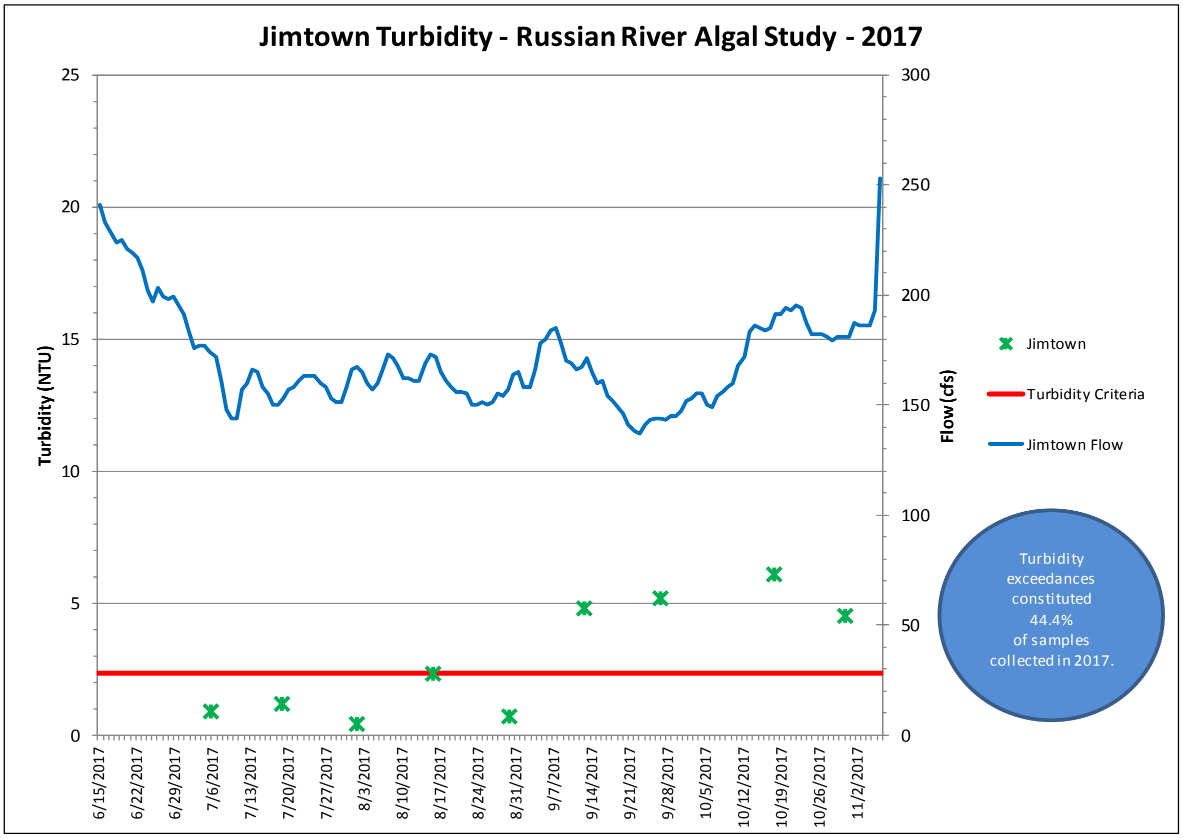


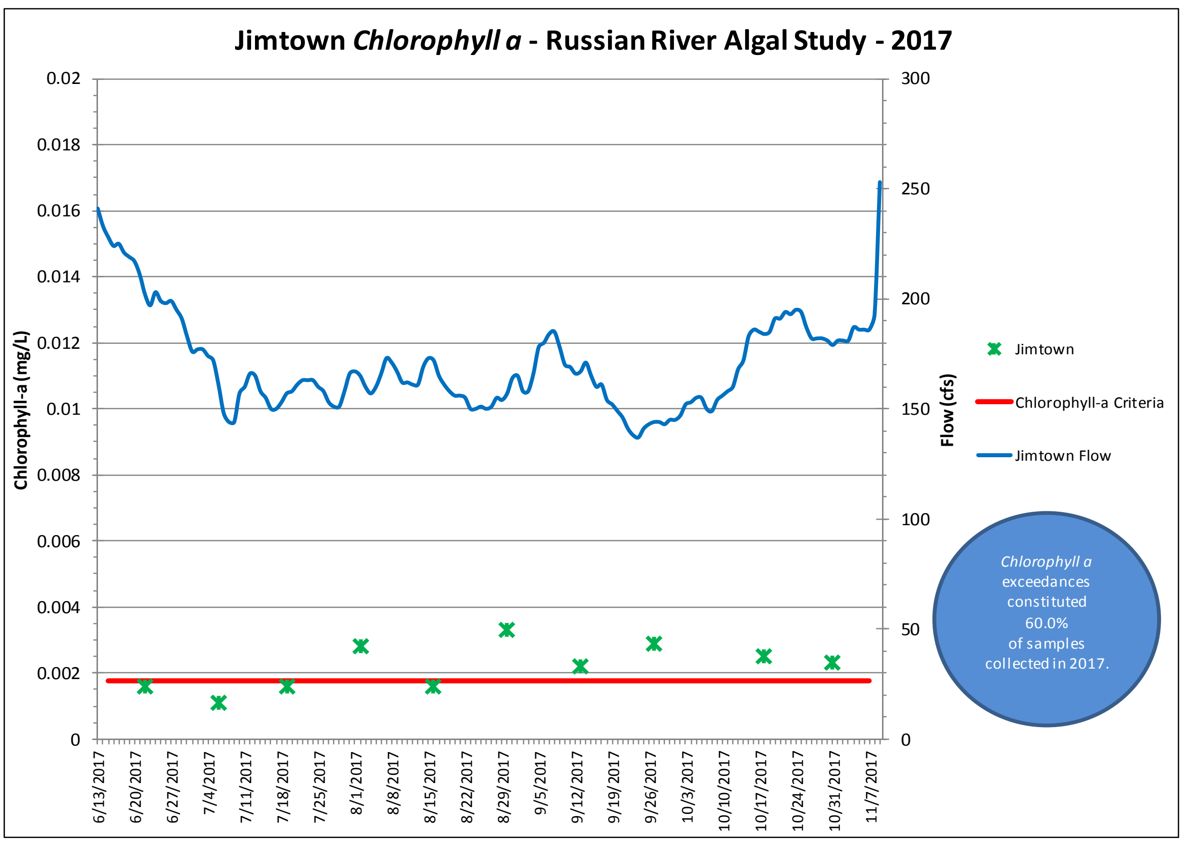
Figures 3-7 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll-a* Results from Cloverdale River Park in 2017.



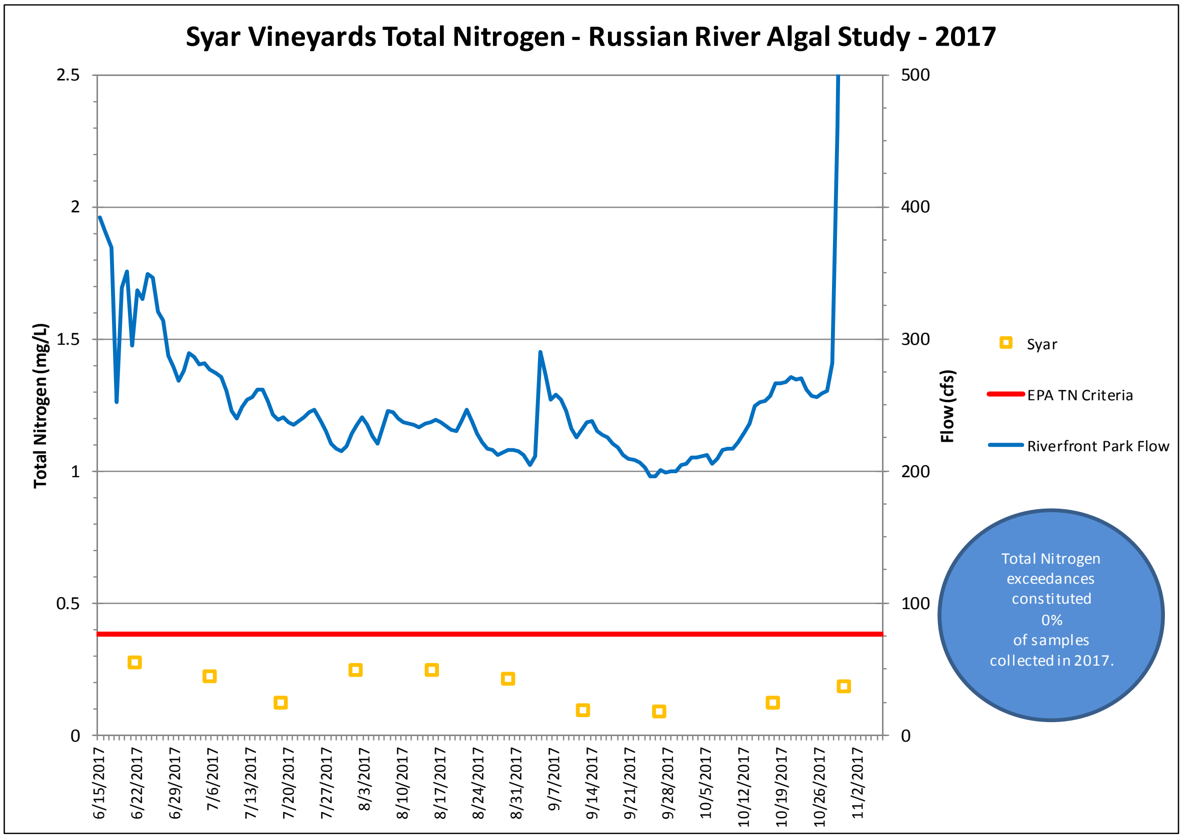


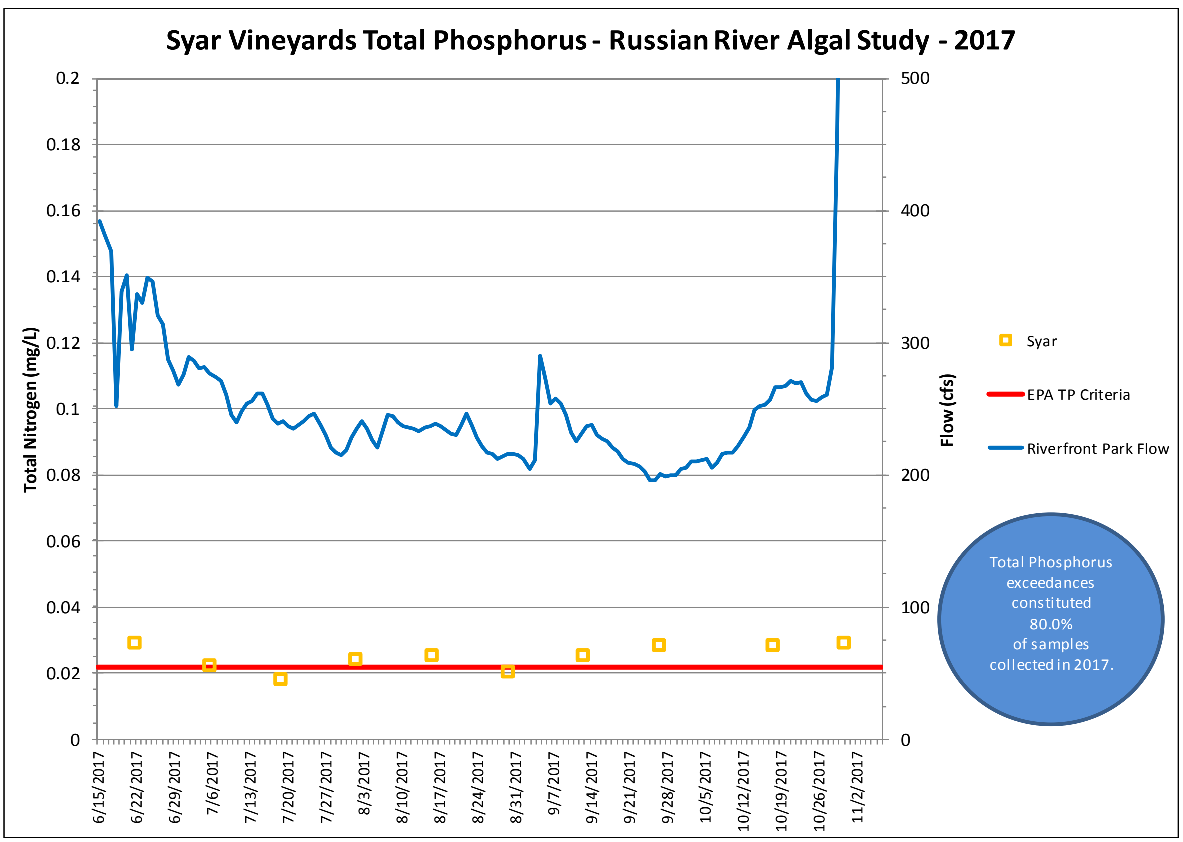
Figures 3-8 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Jimtown in 2017.



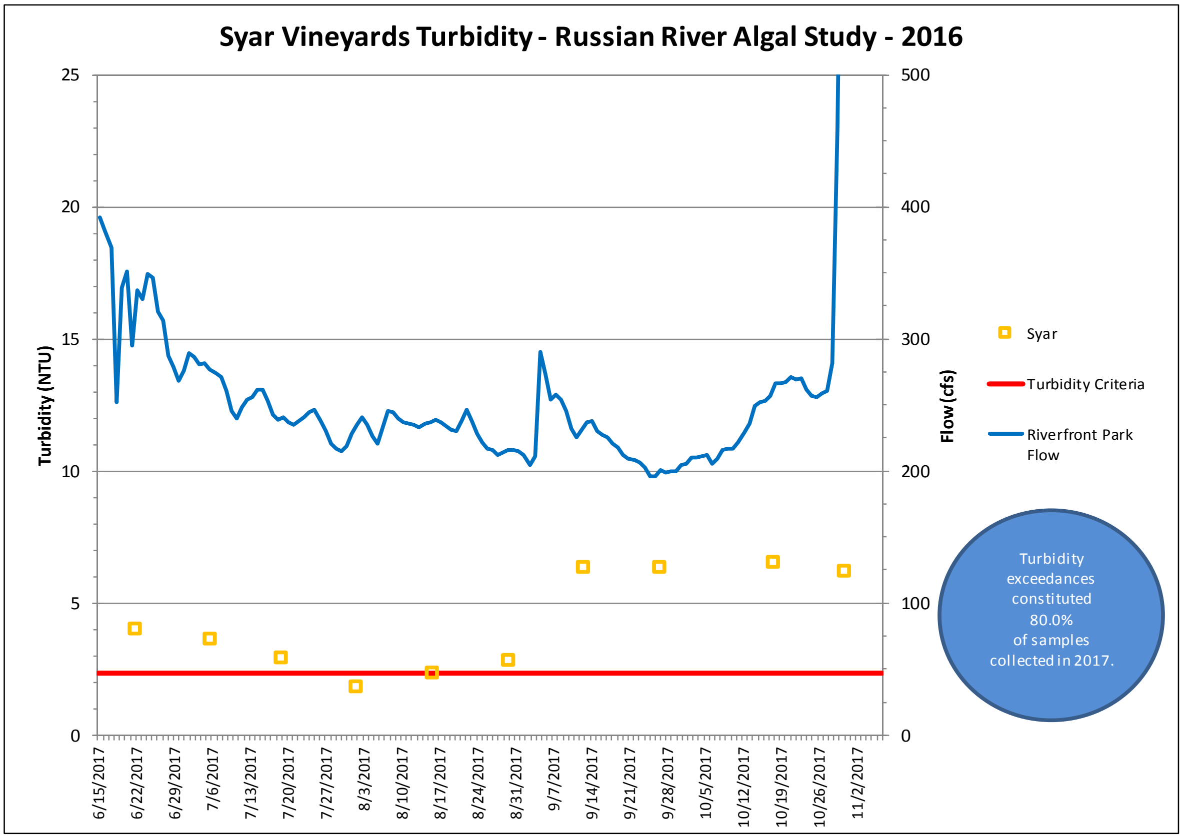


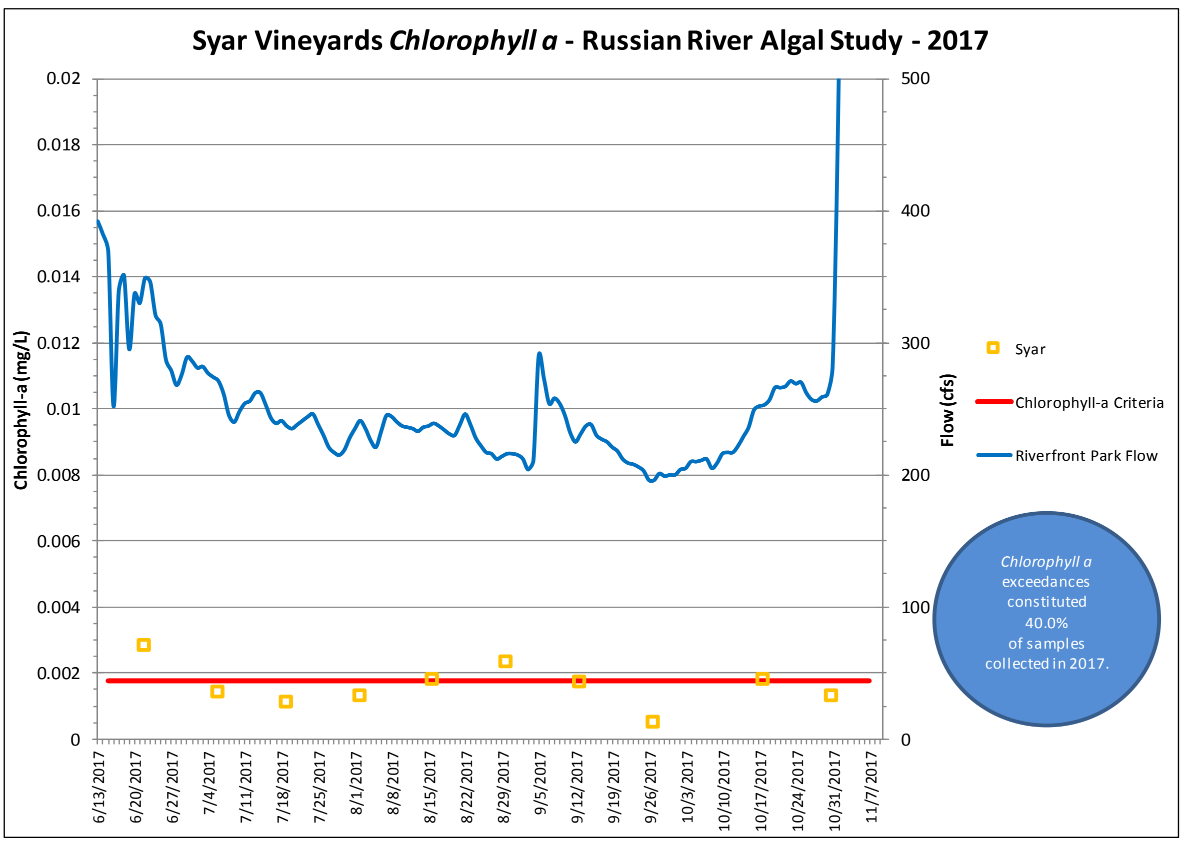
Figures 3-8 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll-a* Results from Jimtown in 2017.



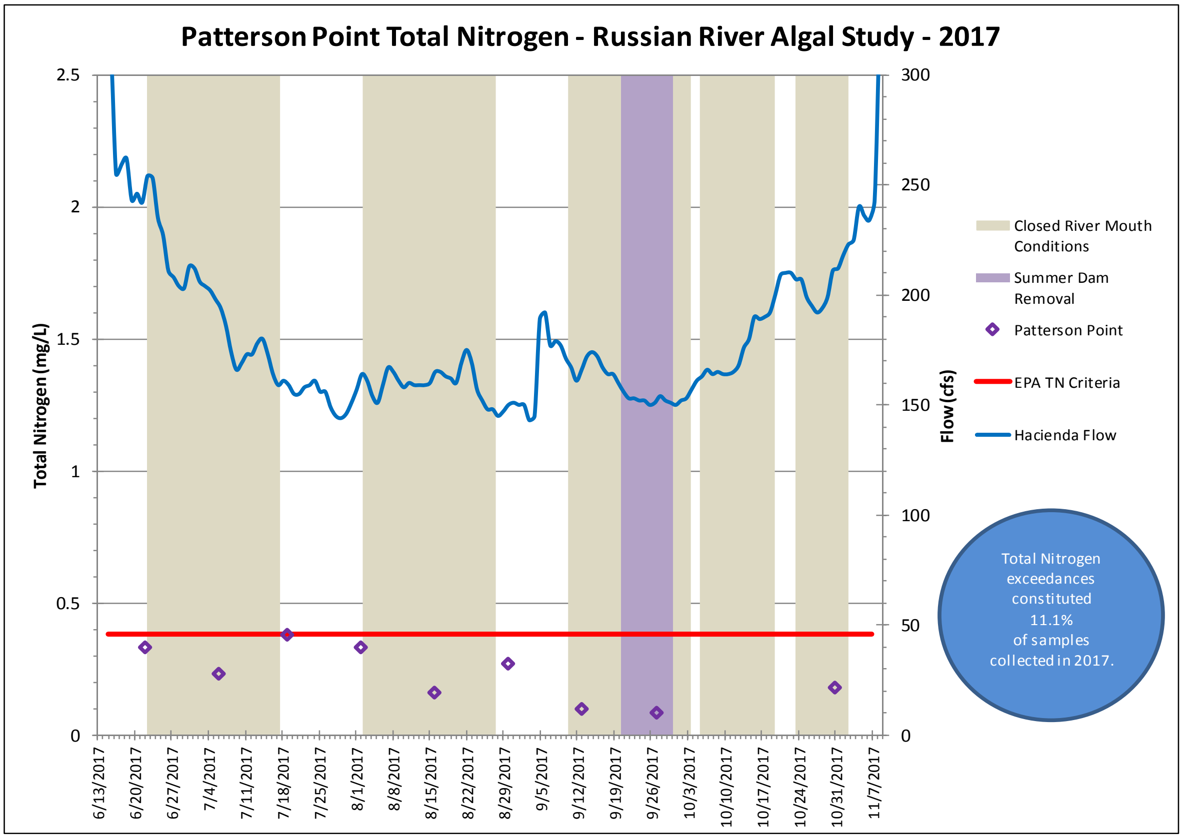


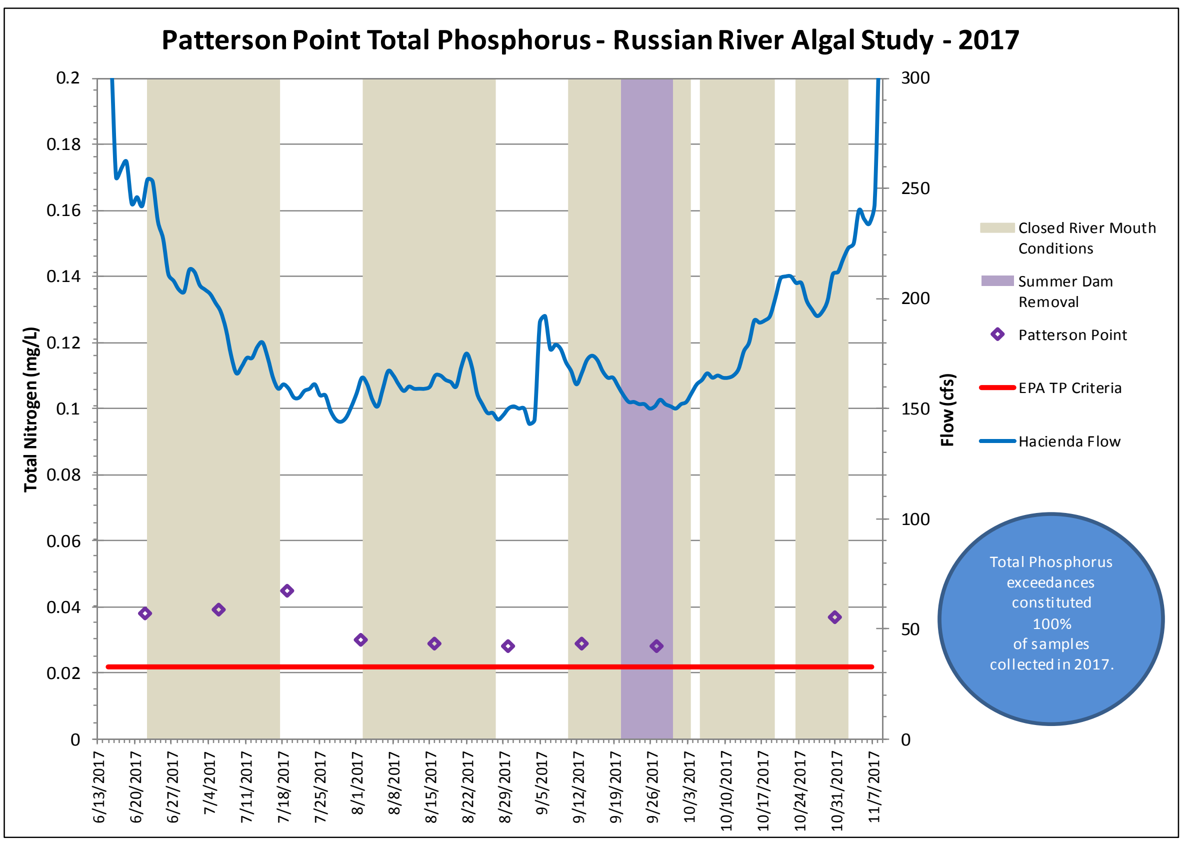
Figures 3-9 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Syar Vineyards in 2017.



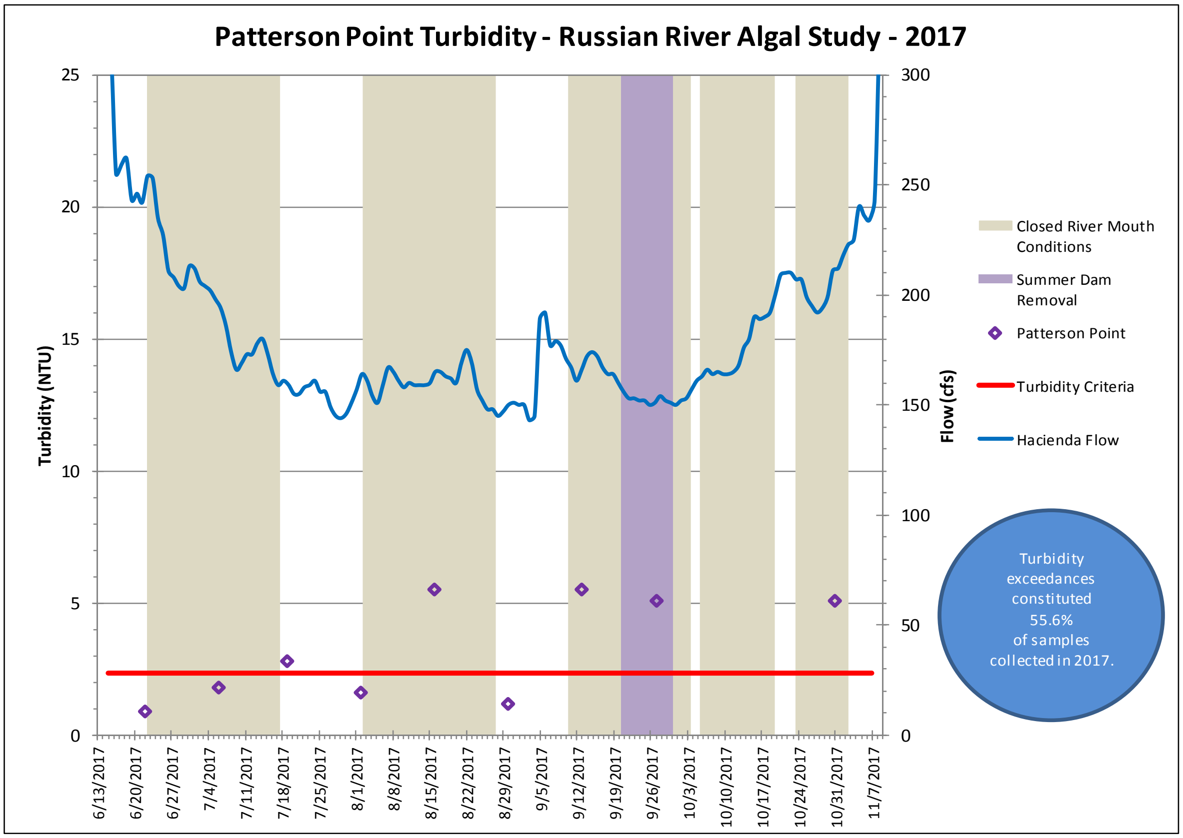


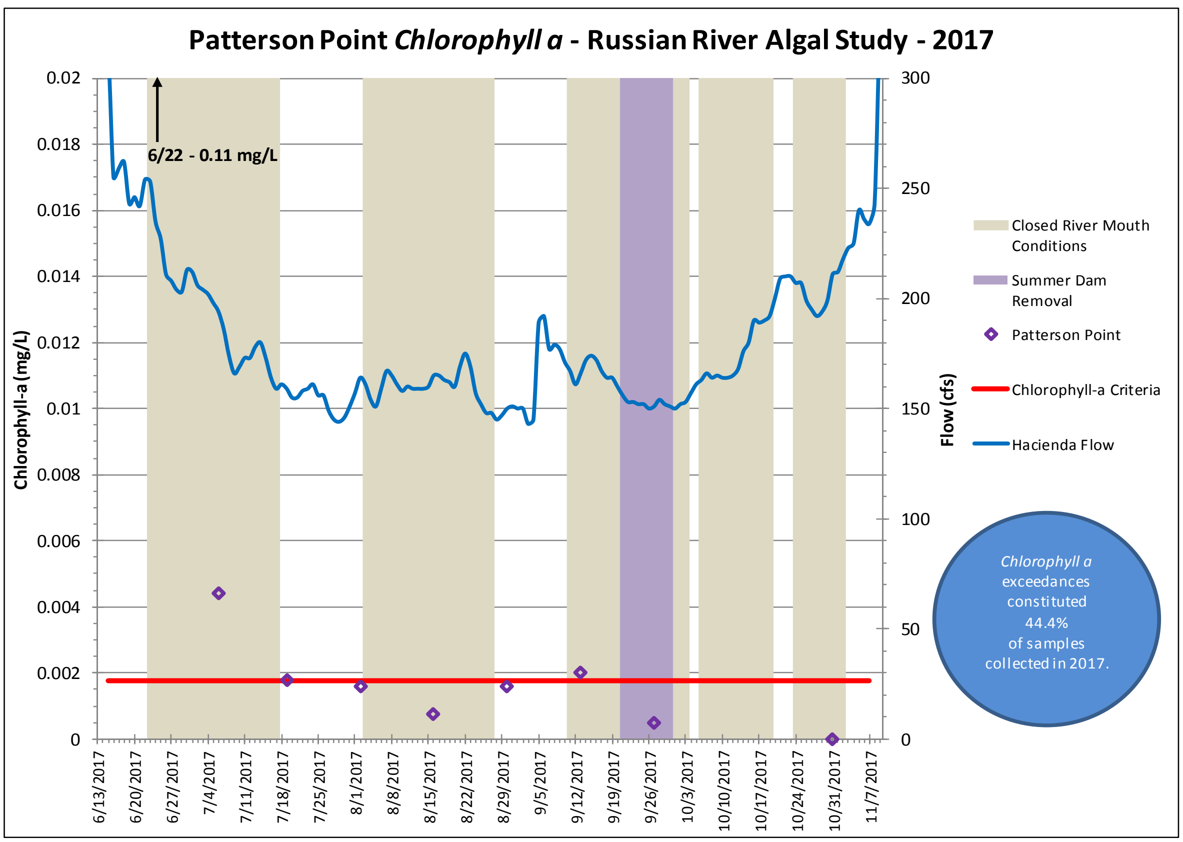
Figures 3-9 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll- a* Results from Syar Vineyards in 2017.





Figures 3-10 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Patterson Point in 2017.





Figures 3-10 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll-a* Results from Patterson Point in 2017.

3.2 Water Agency Russian River Estuary Water Quality Monitoring

Flows in the lower Russian River at Hacienda (downstream of the confluence with Dry Creek) did not drop below the D1610 minimum flow of 125 cfs while the Order was in effect from 1 May through 15 October (Figure 2-4). Long-term water quality monitoring and weekly grab sampling was conducted in the middle and upper reaches of the Russian River Estuary and the upper extent of inundation and backwatering during lagoon formation, referred to as the maximum backwater area (MBA), between Patty's Rock at Jenner and Vacation Beach, 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.

Water Agency 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 seven stations in the Russian River estuary, including two tributary stations during the 2017 monitoring season (Figure 3-11). Data was not collected at the Sheephouse Creek station in 2017 due to malfunctioning equipment. The Water Agency submits an annual report to the National Marine Fisheries Service and California Department of Fish and Wildlife documenting the status updates of the Water Agency's efforts in implementing the Biological Opinion. The water quality monitoring data for 2017 is currently being compiled and will be discussed in the Russian River Biological Opinion 2018 annual report, which will be posted to the Water Agency's website when available: http://www.scwa.ca.gov/bo-annual-report/.

Water Agency staff conducted weekly grab sampling from 16 May to 17 October at three stations in the lower mainstem Russian River, including: Vacation Beach, Monte Rio, and Patterson Point (Figure 3-11). All samples were analyzed for nutrients, *chlorophyll a*, standard bacterial indicators (Total Coliform, *E. coli*, and *Enterococcus*), total and dissolved organic carbon, total dissolved solids, and turbidity. Samples were collected during the monitoring season for diluted and undiluted analysis of Total Coliform and *E. coli* for comparative purposes and the results are included in Tables 3-7 through 3-9 and Figures 3-12 and 3-13. Samples collected for *Enterococcus* were undiluted only and results are included in Tables 3-7 through 3-9 and Figure 3-14. The Water Agency submitted samples to the Sonoma County DHS Public Health Division Lab in Santa Rosa for bacteria analysis. Total Coliform and *E. coli* were analyzed using the Colilert method and *Enterococcus* was analyzed using the Enterolert method. Samples for all other constituents were submitted to Alpha Analytical Labs in Ukiah for analysis. Total Coliform and *E. coli* data presented in Figures 3-12 and 3-13 utilize undiluted sample results unless the reporting limit has been exceeded, at which point the diluted results are utilized.

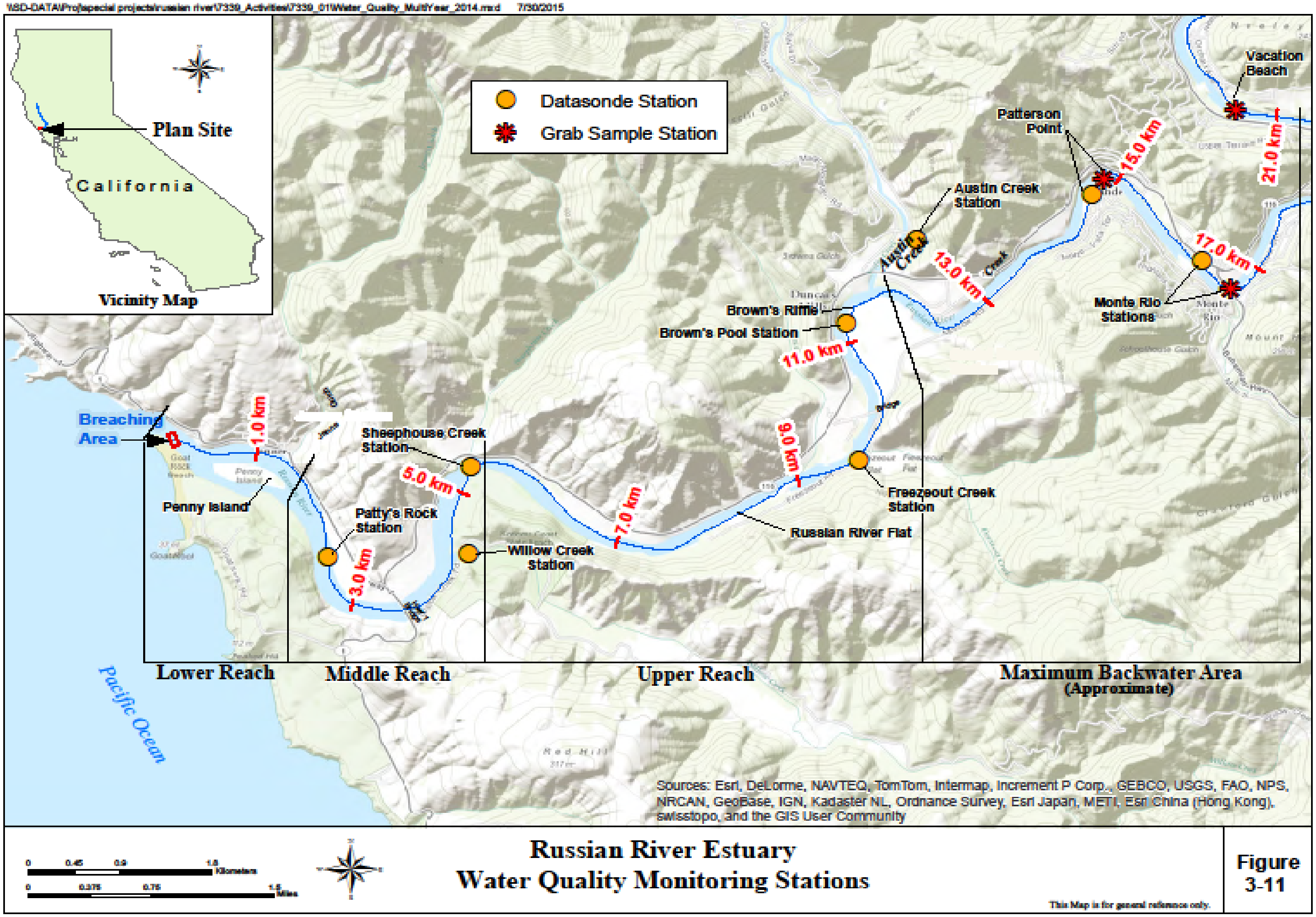


Figure 3-11. Water Agency 2017 Russian River Estuary water quality monitoring stations.

NCRWQCB staff has indicated, based on guidance from Sonoma County DHS, that *Enterococcus* is not currently being utilized as a fecal indicator bacteria in freshwater conditions due to uncertainty in the validity of the lab analysis to produce accurate results, as well as evidence that *Enterococcus* colonies can be persistent in the water column and therefore its presence at a given site may not always be associated with a fecal source. Water Agency 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 including mechanical breaching of the barrier beach to address potential threats to public health.

Sampling for human-host *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 human-host *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 3-11, and the results are summarized in Tables 3-7 through 3-12 and Figures 3-12 through 3-18. Highlighted values indicate those values exceeding California Department of Public Health Draft Guidance 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.

There were two exceedances of the recommended EPA Recreational Water Quality Criteria (RWQC) for Total Coliform at the Monte Rio station and one exceedance at the Patterson Point station during open and closed estuary conditions with Hacienda flows that ranged from 136 to 175 cfs (Figure 3-12). Total Coliform concentrations were observed to increase through the early part of the season before peaking in July and generally declining through the remainder of the monitoring season (Figure 3-12). The Monte Rio station was also observed to have one exceedance of the RWQC for *E. coli* during closed estuary conditions on 22 August with flows at 149 cfs (Table 3-8 and Figure 3-13). Exceedances of the *Enterococcus* RWQC were observed periodically through the season at all three monitoring stations during open and closed estuary conditions, with Hacienda flows ranging from 138 to 179 cfs (Tables 3-7 through 3-9). During the latter half of the season, all three stations were observed to have *Enterococcus* exceedances during estuary closure and summer dam removal (Figure 3-14). External factors including contact recreation, estuary closure, and the late-September removal of summer dams in Guerneville likely had an effect on elevated bacterial concentrations observed in the Vacation Beach to Patterson Point area during the 2017 monitoring season (Figures 3-12 through 3-14).

Table 3-7. 2017 Vacation Beach bacteria concentrations for samples collected by the Water Agency. 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)
5/16/2017	10:10	16.5	7.9	727.0	435	8.6	<10	3.0	777
5/23/2017	10:30	20.3	7.9	547.5	776	12.2	10	2.0	561
5/30/2017	11:00	19.4	7.9	344.1	448	16.7	20	1.0	483
6/6/2017	14:30	22.4	8.0	980.4	1126	8.6	20	3.1	400
6/13/2017	11:00	19.2	7.9	770.1	697	5.2	<10	9.7	364
6/20/2017	11:30	25.5	8.1	1553.1	3255	37.9	52	39.0	243
6/27/2017	11:10	23.3	8.1	>2419.6	2909	22.6	31	10.9	207
7/5/2017	11:00	23.0	8.1	1986.3	1553	13.5	10	9.6	197
7/11/2017	10:50	24.6	8.0	>2419.6	5794	3.0	31	15.5	175
7/13/2017	13:00	24.2	8.1	>2419.6	4352	8.6	<10	10.9	179
7/18/2017	11:50	24.6	8.0	>2419.6	5475	8.4	<10	10.9	164
7/25/2017	10:20	23.6	8.0	1986.3	3076	10.9	<10	7.5	141
8/1/2017	11:15	23.5	8.0	387.3	2282	5.2	10	4.1	139
8/8/2017	9:30	22.7	7.9	2419.6	1935	11	20	30.5	144
8/10/2017	10:40			1986.3	2613	3.1	<10		136
8/15/2017	10:30	23.3	7.9	1986.3	2098	18.9	<10	34.1	136
8/22/2017	9:50	20.7	7.8	1553.1	2014	6.3	10	20.1	149
8/29/2017	10:30	22.7	7.8	1732.9	2359	5.2	20	21.1	135
9/5/2017	11:40	23.5	7.8	1986.3	1374	15.8	<10	13.2	177
9/12/2017	10:30	23.0	7.8	1553.1	1054	20.9	52	25.9	148
9/19/2017	10:10	19.9	7.7	1203.3	1664	14.5	63	17.5	151
9/21/2017	8:40	18.9	7.6	1533.1	1314	21.6	10	**61.3**	143
9/26/2017	10:10	18.1	7.6	1299.7	958	23.1	41	**73.8**	138
9/28/2017	10:20	18.4	7.6	1553.1	624	14.8	52	57.3	142
10/3/2017	10:30	17.5	7.7	980.4	677	23.1	52	**85.7**	140

* 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 EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)

(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml | Enterococcus (STV): 61 per 100 ml

E. coli (GM): 126 per 100mL | Enterococcus (GM): 33 per 100 mL

Table 3-8. 2017 Monte Rio bacteria concentrations for samples collected by the Water Agency. This site experiences freshwater conditions.

Monte Rio	Time	Temperature	pH	Total Coliforms (Colilert)	Total Coliforms Diluted 1:10 (Colilert)	E. coli (Colilert)	E. coli Diluted 1:10 (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				20		20		2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/16/2017	9:50	16.3	7.7	866.4	523	9.7	10	4.1	777
5/23/2017	10:10	19.9	7.8	727.0	613	7.3	<10	8.5	561
5/30/2017	10:35	19.3	7.8	501.2	546	12.0	<10	1.0	483
6/6/2017	14:00	22.0	7.9	1413.6	1401	8.6	10	1.0	400
6/13/2017	10:40	19.5	7.9	816.4	1050	11.0	<10	1.0	364
6/20/2017	11:10	25.3	8.0	>2419.6	2143	24.6	10	15.8	243
6/27/2017	10:50	22.7	7.9	920.8	1723	7.5	20	3.1	207
7/5/2017	10:40	22.7	8.0	>2419.6	7270	19.7	10	5.2	197
7/11/2017	10:20	24.6	8.0	>2419.6	**17329**	52.0	63	59.8	175
7/13/2017	12:40	24.5	8.0	>2419.6	5172	26.2	10	**62.6**	179
7/18/2017	11:30	23.9	7.7	>2419.6	**12033**	18.5	85	19.5	164
7/25/2017	10:00	23.6	7.8	>2419.6	3255	31.7	52	**152.9**	141
8/1/2017	10:50	23.1	7.8	325.5	3076	10.9	10	4.1	139
8/8/2017	9:00	22.6	7.7	2419.6	2014	14.5	20	5.2	144
8/10/2017	10:20			>2419.6	3448	113.7	123		136
8/15/2017	10:10	23.5	7.9	2419.6	3448	38.4	74	20.9	136
8/22/2017	9:30	21.1	7.8	>2419.6	4611	**270.0**	**275**	**135.4**	149
8/29/2017	10:00	22.5	7.6	1119.9	1421	7.2	10	1.0	135
9/5/2017	11:20	23.5	7.7	2419.6	1850	6.3	31	17.1	177
9/12/2017	10:00	22.9	7.7	1732.9	1483	9.7	20	6.2	148
9/19/2017	9:40	20.2	7.8	1986.3	1553	47.3	74	**69.7**	151
9/21/2017	8:20	19.6	7.8	1203.3	2603	73.8	85	**69.7**	143
9/26/2017	9:50	18.4	7.6	1119.9	1130	37.3	20	60.9	138
9/28/2017	10:00	18.9	7.6	1203.3	1566	77.1	63	**83.6**	142
10/3/2017	10:00	18.2	7.8	1203.3	801	48.7	30	**88.0**	140

* 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 EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)

(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml — Enterococcus (STV): 61 per 100 ml

E. coli (GM): 126 per 100mL — Enterococcus (GM): 33 per 100 mL

Table 3-9. 2017 Patterson Point bacteria concentrations for samples collected by the Water Agency. This site experiences freshwater conditions.

Patterson Point	Time	Temperature	pH	Total Coliforms (Collilert)	Total Coliforms Diluted 1:10 (Collilert)	E. coli (Collilert)	E. coli Diluted 1:10 (Collilert)	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)
5/16/2017	9:20	16.1	7.6	686.7	383	12.0	10	3.0	777
5/23/2017	9:40	19.6	7.8	1119.9	706	11.0	20	<1.0	561
5/30/2017	10:10	19.2	7.8	344.1	457	110.0	**310**	3.0	483
6/6/2017	13:30	22.1	7.9	727.0	987	14.6	<10	1.0	400
6/13/2017	10:00	19.4	8.0	770.1	857	12.1	<10	3.1	364
6/20/2017	10:40	25.1	8.1	1732.9	2481	11.0	<10	13.4	243
6/27/2017	10:20	23.2	8.0	1413.6	1246	11.0	10	6.1	207
7/5/2017	10:10	22.7	8.0	>2419.6	8664	18.7	20	6.2	197
7/11/2017	9:50	24.1	8.0	>2419.6	7701	12.1	20	35.0	175
7/13/2017	12:20	23.7	7.9	>2419.6	7270	23.3	20	13.1	179
7/18/2017	10:50	23.9	7.8	>2419.6	9804	27.9	10	20.9	164
7/25/2017	8:30	23.4	7.8	>2419.6	3255	12.1	10	31.2	141
8/1/2017	10:20	22.9	7.8	325.5	2224	6.3	<10	4.1	139
8/8/2017	8:30	22.6	7.7	>2419.6	2489	29.8	52	**64.4**	144
8/10/2017	9:40			>2419.6	2613	42.6	31		136
8/15/2017	9:30	23.4	7.9	>2419.6	**14136**	35.9	52	**>2419.6**	136
8/22/2017	9:10	21.2	7.8	1986.3	1722	8.4	20	52.0	149
8/29/2017	9:30	22.2	7.6	1203.3	1019	10.7	<10	14.5	135
9/5/2017	10:30	23.2	7.7	>2419.6	2909	14.8	<10	25.9	177
9/12/2017	9:30	22.9	7.8	1986.3	1989	5.2	<10	7.4	148
9/19/2017	9:20	20.1	7.9	>2419.6	4106	25	20	**129.6**	151
9/21/2017	8:00	19.8	7.9	2419.6	2909	71.2	75	**920.8**	143
9/26/2017	9:20	18.5	7.5	1119.9	1291	33.6	31	**62.4**	138
9/28/2017	9:40	18.7	7.7	1553.1	1137	46.4	30	44.1	142
10/3/2017	9:40	18.4	7.6	1299.7	1274	20.9	20	36.4	140

* 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 EPA Recreational Water Quality Criteria - Statistical Threshold Value (STV) and Geomteric Mean (GM)

(Beach posting is recommended when indicator organisms exceed the STV) - Indicated by red text

E. coli (STV): 235 per 100 ml — Enterococcus (STV): 61 per 100 ml

E. coli (GM): 126 per 100mL — Enterococcus (GM): 33 per 100 mL

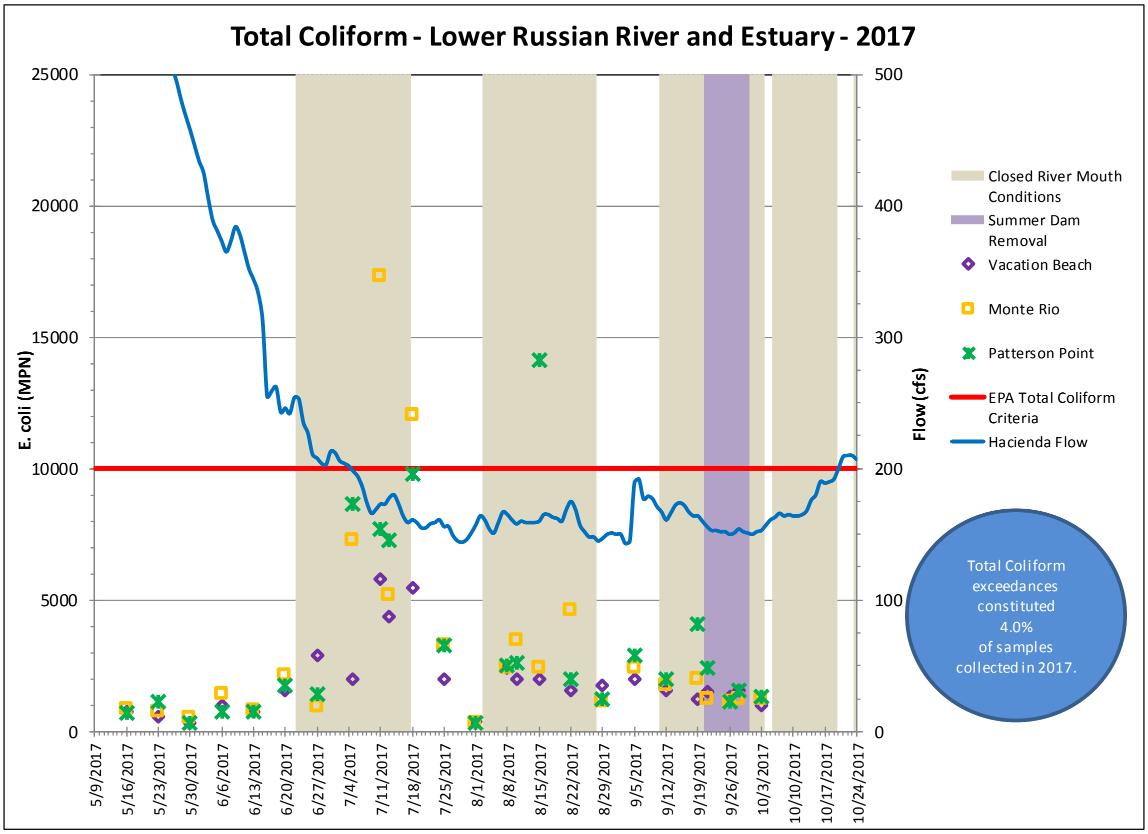


Figure 3-12. Total Coliform results for the Russian River from Vacation Beach to Patterson Point in 2017.

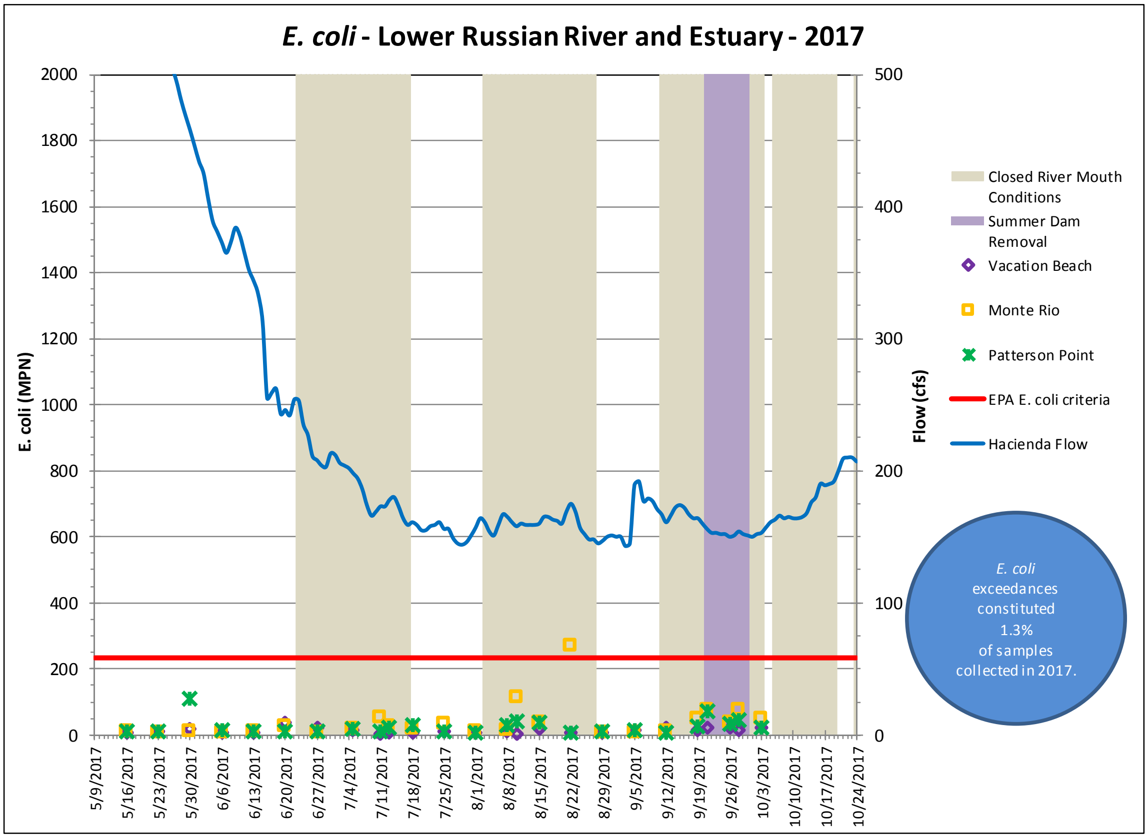


Figure 3-13. *E. coli* results for the Russian River from Vacation Beach to Patterson Point in 2017.

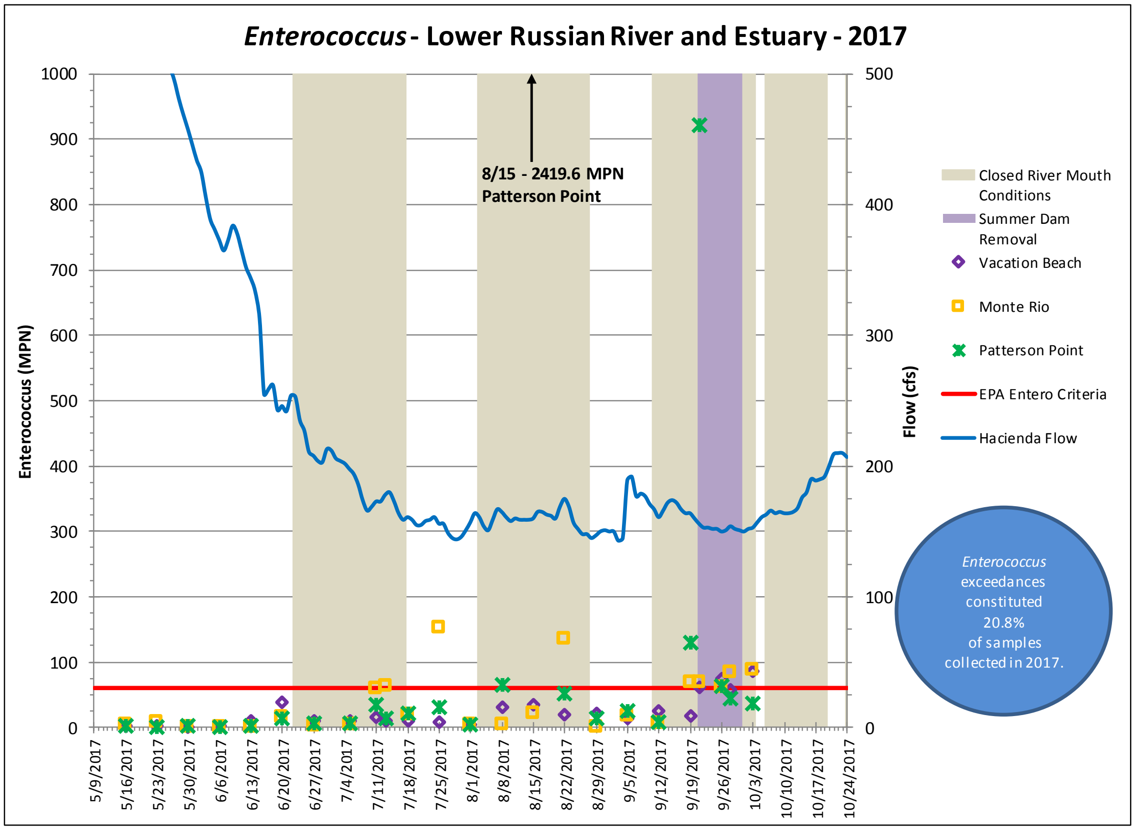


Figure 3-14. ***Enterococcus*** **results for the Russian River from Vacation Beach to Patterson Point in 2017.**

The EPA criteria for Total Nitrogen was exceeded three times at Vacation Beach and twice at Monte Rio and Patterson Point with Hacienda flows ranging from 243 cfs to 561 cfs (Tables 3-10 through 3-12). All exceedances were observed to occur during open estuary conditions at the beginning of the season, with all three stations exceeding the criteria on 13 June and 20 June (Figure 3-15). In contrast, all three stations predominantly exceeded the EPA criteria for Total Phosphorous during the term of the Order and with flows that ranged from 135 cfs to 777 cfs, continuing a trend of consistent exceedances observed in previous years (Tables 3-10 through 3-12). Interestingly, the Monte Rio station had two concentrations below the Total Phosphorus criteria during estuary closure, removal of the summer dams, and flows of 143 cfs on 21 September and 140 cfs on 3 October (Table 3-11 and Figure 3-16).

The EPA criteria for Turbidity was exceeded periodically at Monte Rio and Patterson Point and predominantly at Vacation Beach throughout the season (Tables 3-10 through 3-12). Exceedances were observed to occur during open and closed estuary conditions with Hacienda flows ranging from 135 cfs to 777 cfs (Figure 3-17). Streamflow over the Vacation Beach summer dam and through the fish ladder is likely contributing to the elevated turbidity values at the Vacation Beach station.

Algal (*chlorophyll a*) results exceeded the EPA criteria at all three stations periodically throughout the season, under open and closed conditions and Hacienda flows that ranged from 136 cfs to 777 cfs (Tables 3-10 through 3-12 and Figure 3-18). However, algal concentrations and exceedances were observed to be more pronounced during the first half of the season when flows were still declining from spring storm events (Figure 3-18).

Table 3-10. 2017 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*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2017	10:10	16.5	7.9	0.21	ND	ND	0.066	ND	0.21	0.28	**0.034**	0.084	1.46	1.68	160	**4.5**	**0.0049**	777
5/23/2017	10:30	20.3	7.9	0.24	ND	ND	0.060	ND	0.24	**0.88**	**0.035**	0.075	1.59	1.72	150	**3.0**	**0.0023**	561
5/30/2017	11:00	19.4	7.9	0.28	ND	ND	0.047	ND	0.28	0.33	**0.038**	0.076	1.37	1.52	170	**3.1**	**0.0022**	483
6/6/2017	14:30	22.4	8.0	ND	ND	ND	0.068	ND	ND	0.24	**0.036**	0.087	0.958	1.11	170	**2.5**	**0.0099**	400
6/13/2017	11:00	19.2	7.9	0.42	ND	ND	0.059	ND	0.42	**0.52**	**0.038**	0.087	1.64	1.59	170	**3.2**	**0.0035**	364
6/20/2017	11:30	25.5	8.1	0.46	ND	ND	0.046	ND	0.46	**0.50**	**0.037**	0.081	1.73	1.84	160	2.2	**0.0035**	243
6/27/2017	11:10	23.3	8.1	ND	ND	ND	ND	ND	ND	0.18	**0.039**	0.10	1.31	1.43	160	1.9	**0.0069**	207
7/5/2017	11:00	23.0	8.1	ND	ND	ND	ND	ND	ND	0.18	**0.041**	0.065	1.65	2.10	150	**2.9**	**0.0050**	197
7/11/2017	10:50	24.6	8.0	ND	ND	ND	ND	ND	ND	0.18	**0.036**	0.073	1.12	1.49	150	1.8	**0.0034**	175
7/13/2017	13:00	24.2	8.1	ND	ND	ND	ND	ND	ND	0.10	**0.035**	0.083	1.68	1.84	160	1.9	**0.0026**	179
7/18/2017	11:50	24.6	8.0	ND	ND	ND	ND	ND	ND	0.18	**0.033**	0.057	1.74	1.75	150	1.8	**0.0020**	164
7/25/2017	10:20	23.6	8.0	ND	ND	ND	ND	ND	ND	0.070	**0.032**	0.066	1.68	1.91	140	2.2	**0.0030**	141
8/1/2017	11:15	23.5	8.0	ND	ND	ND	ND	ND	ND	0.16	**0.030**	0.069	1.63	1.95	150	**2.4**	**0.0018**	139
8/8/2017	9:30	22.7	7.9	ND	ND	ND	ND	ND	ND	0.19	**0.032**	0.055	1.75	1.87	150	**2.7**	0.0013	144
8/15/2017	10:30	23.3	7.9	ND	ND	ND	ND	ND	ND	0.19	**0.025**	0.061	1.81	1.99	130	2.2	0.0012	136
8/22/2017	9:50	20.7	7.8	ND	ND	ND	ND	ND	ND	0.070	**0.023**	0.038	1.53	1.88	130	2.1	0.0011	149
8/29/2017	10:30	22.7	7.8	ND	ND	ND	ND	ND	ND	0.10	**0.12**	0.05	1.45	1.69	140	**2.6**	0.0015	135
9/5/2017	11:40	23.5	7.8	ND	ND	ND	ND	ND	ND	0.14	**0.025**	0.047	1.64	1.68	140	1.8	0.0016	177
9/12/2017	10:30	23.0	7.8	ND	ND	ND	ND	ND	ND	0.10	**0.027**	0.064	1.51	1.84	120	**2.5**	0.0014	148
9/19/2017	10:10	19.9	7.7	ND	ND	ND	ND	ND	ND	0.19	**0.11**	0.078	1.37	1.46	110	**2.4**	**0.13**	151
9/21/2017	8:40	18.9	7.6	ND	ND	ND	ND	ND	ND	0.16	**0.029**	0.055	1.21	1.36	140	**3.3**	0.00097	143
9/26/2017	10:10	18.1	7.6	ND	ND	ND	0.10	ND	ND	0.24	**0.031**	0.053	1.35	1.37	130	**4.8**	0.00065	138
9/28/2017	10:20	18.4	7.6	ND	ND	ND	0.042	ND	ND	0.15	**0.030**	0.056	1.33	1.56	120	**3.3**	0.0010	142
10/3/2017	10:30	17.5	7.7	ND	ND	ND	ND	ND	ND	0.14	**0.026**	0.044	1.51	1.56	130	**3.4**	0.0016	140
10/17/2017	9:40	14.2	7.8	ND	ND	ND	ND	ND	ND	0.14	**0.030**	0.061	1.39	1.67	130	**4.4**	0.00018	189

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

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

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

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

Recommended EPA Criteria based on Aggregate Ecoregion III

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

Total Nitrogen: 0.38 mg/L

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

Turbidity: 2.34 FTU/NTU

Table 3-11. 2017 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*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2017	9:50	16.3	7.7	0.24	ND	ND	0.061	ND	0.24	0.31	**0.034**	0.072	1.50	1.72	160	**4.9**	**0.0080**	777
5/23/2017	10:10	19.9	7.8	0.28	ND	ND	0.050	ND	0.28	0.37	**0.030**	0.063	1.66	1.79	170	**2.7**	**0.0048**	561
5/30/2017	10:35	19.3	7.8	0.24	ND	ND	ND	ND	0.24	0.28	**0.033**	0.065	1.40	1.53	170	**3.4**	**0.0075**	483
6/6/2017	14:00	22.0	7.9	0.21	ND	ND	0.064	ND	0.21	0.27	**0.040**	0.083	1.41	1.67	170	2.0	**0.0072**	400
6/13/2017	10:40	19.5	7.9	0.35	ND	ND	ND	ND	0.35	**0.39**	**0.038**	0.079	0.916	1.09	180	2.3	**0.0026**	364
6/20/2017	11:10	25.3	8.0	0.46	ND	ND	ND	ND	0.46	**0.48**	**0.037**	0.073	1.78	1.81	160	1.8	**0.012**	243
6/27/2017	10:50	22.7	7.9	0.21	ND	ND	ND	ND	0.21	0.21	**0.035**	0.066	1.47	1.58	150	1.4	**0.0049**	207
7/5/2017	10:40	22.7	8.0	0.21	ND	ND	ND	ND	0.21	0.21	**0.044**	0.081	1.72	2.08	160	**2.8**	**0.0038**	197
7/11/2017	10:20	24.6	8.0	0.24	ND	ND	ND	ND	0.24	0.24	**0.042**	0.081	1.10	1.52	160	1.6	**0.0026**	175
7/13/2017	12:40	24.5	8.0	ND	ND	ND	ND	ND	ND	0.14	**0.036**	0.083	1.28	1.78	160	1.6	**0.0018**	179
7/18/2017	11:30	23.9	7.7	ND	ND	ND	ND	ND	ND	0.035	**0.039**	0.073	1.84	1.75	150	1.7	**0.0020**	164
7/25/2017	10:00	23.6	7.8	0.21	ND	ND	ND	ND	0.21	0.21	**0.038**	0.070	1.60	2.04	140	**2.6**	**0.0021**	141
8/1/2017	10:50	23.1	7.8	ND	ND	ND	ND	ND	ND	0.10	**0.035**	0.077	1.51	1.89	150	**3.2**	**0.0020**	139
8/8/2017	9:00	22.6	7.7	ND	ND	ND	ND	ND	ND	0.086	**0.030**	0.074	1.62	1.89	130	**3.4**	**0.0019**	144
8/15/2017	10:10	23.5	7.9	ND	ND	ND	ND	ND	ND	0.16	**0.029**	0.065	1.97	1.98	140	1.7	0.0013	136
8/22/2017	9:30	21.1	7.8	ND	ND	ND	ND	ND	ND	0.090	**0.027**	0.050	1.73	1.94	140	1.3	0.00093	149
8/29/2017	10:00	22.5	7.6	ND	ND	ND	ND	ND	ND	0.18	**0.030**	0.070	1.56	1.69	140	1.6	0.0011	135
9/5/2017	11:20	23.5	7.7	ND	ND	ND	ND	ND	ND	0.14	**0.029**	0.047	1.62	1.73	140	1.7	**0.0021**	177
9/12/2017	10:00	22.9	7.7	ND	ND	ND	ND	ND	ND	0.10	**0.031**	0.064	1.48	1.72	130	2.2	0.00078	148
9/19/2017	9:40	20.2	7.8	ND	ND	ND	ND	ND	ND	0.12	**0.030**	0.066	1.41	1.47	120	1.6	0.00057	151
9/21/2017	8:20	19.6	7.8	ND	ND	ND	ND	ND	ND	0.12	0.019	0.051	1.19	1.44	130	1.9	0.00097	143
9/26/2017	9:50	18.4	7.6	ND	ND	ND	0.086	ND	ND	0.19	**0.026**	0.05	1.45	1.42	130	1.4	0.00032	138
9/28/2017	10:00	18.9	7.6	ND	ND	ND	ND	ND	ND	0.14	**0.024**	0.048	1.41	1.58	130	1.0	0.00033	142
10/3/2017	10:00	18.2	7.8	ND	ND	ND	ND	ND	ND	0.18	0.021	0.048	1.62	1.64	140	0.93	0.0013	140
10/17/2017	9:10	14.0	7.9	ND	ND	ND	ND	ND	ND	0.10	**0.022**	0.069	1.50	1.62	120	1.4	0.00018	189

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

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

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

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

Recommended EPA Criteria based on Aggregate Ecoregion III

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

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

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-12. 2017 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*				0.200	0.10	0.00010	0.030	0.030	0.10		0.020	0.020	0.0400	0.0400	4.2	0.020	0.000050	Flow Rate****
Date		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	(cfs)
5/16/2017	9:20	16.1	7.6	ND	ND	ND	0.063	ND	ND	0.24	**0.034**	0.076	1.49	1.82	150	**4.4**	**0.0035**	777
5/23/2017	9:40	19.6	7.8	0.28	ND	ND	0.053	ND	0.28	0.37	**0.030**	0.071	1.70	1.69	160	**2.4**	**0.0038**	561
5/30/2017	10:10	19.2	7.8	0.28	ND	ND	0.041	ND	0.28	0.32	**0.032**	0.065	1.44	1.5	160	**2.5**	**0.0038**	483
6/6/2017	13:30	22.1	7.9	0.21	ND	ND	0.075	ND	0.21	0.32	**0.032**	0.075	0.754	0.896	170	1.7	**0.0029**	400
6/13/2017	10:00	19.4	8.0	0.42	ND	ND	0.046	ND	0.42	**0.47**	**0.034**	0.083	1.58	1.78	170	2.2	**0.0023**	364
6/20/2017	10:40	25.1	8.1	0.49	ND	ND	ND	ND	0.49	**0.51**	**0.037**	0.073	1.57	2.15	160	1.7	**0.0061**	243
6/27/2017	10:20	23.2	8.0	0.21	ND	ND	ND	ND	0.21	0.23	**0.035**	0.070	1.42	1.50	150	1.4	**0.0044**	207
7/5/2017	10:10	22.7	8.0	0.24	ND	ND	ND	ND	0.24	0.26	**0.044**	0.069	1.64	2.13	160	2.0	**0.0047**	197
7/11/2017	9:50	24.1	8.0	ND	ND	ND	ND	ND	ND	0.18	**0.038**	0.092	1.24	1.60	160	1.4	0.0014	175
7/13/2017	12:20	23.7	7.9	ND	ND	ND	ND	ND	ND	0.18	**0.039**	0.083	1.24	1.75	160	1.3	**0.0018**	179
7/18/2017	10:50	23.9	7.8	ND	ND	ND	ND	ND	ND	0.10	**0.040**	0.077	1.75	1.74	160	1.6	0.0016	164
7/25/2017	8:30	23.4	7.8	ND	ND	ND	ND	ND	ND	0.035	**0.042**	0.070	1.67	2.01	140	2.1	**0.0030**	141
8/1/2017	10:20	22.9	7.8	ND	ND	ND	ND	ND	ND	0.12	**0.031**	0.073	1.52	1.88	160	2.2	**0.0023**	139
8/8/2017	8:30	22.6	7.7	ND	ND	ND	ND	ND	ND	0.12	**0.029**	0.059	1.42	1.90	140	**2.9**	0.0015	144
8/15/2017	9:30	23.4	7.9	ND	ND	ND	ND	ND	ND	0.19	**0.027**	0.061	1.84	1.96	110	1.7	**0.0018**	136
8/22/2017	9:10	21.2	7.8	ND	ND	ND	ND	ND	ND	0.053	**0.027**	0.054	1.86	2.00	140	1.1	0.0017	149
8/29/2017	9:30	22.2	7.6	ND	ND	ND	ND	ND	ND	0.16	**0.031**	0.070	1.44	1.67	140	2.1	0.0013	135
9/5/2017	10:30	23.2	7.7	ND	ND	ND	ND	ND	ND	0.10	**0.028**	0.059	1.51	1.64	140	1.4	0.0014	177
9/12/2017	9:30	22.9	7.8	ND	ND	ND	ND	ND	ND	0.28	**0.032**	0.068	1.57	1.75	120	2.2	0.0012	148
9/19/2017	9:20	20.1	7.9	ND	ND	ND	ND	ND	ND	0.20	**0.033**	0.078	1.35	1.51	140	**2.5**	0.00095	151
9/21/2017	8:00	19.8	7.9	0.21	ND	ND	ND	ND	0.21	0.24	**0.031**	0.071	1.26	1.48	140	**5.2**	0.0013	143
9/26/2017	9:20	18.5	7.5	ND	ND	ND	0.10	ND	ND	0.21	**0.023**	0.046	1.49	1.41	130	1.6	0.0007	138
9/28/2017	9:40	18.7	7.7	ND	ND	ND	0.040	ND	ND	0.15	**0.025**	0.044	1.33	1.64	120	2.1	0.00099	142
10/3/2017	9:40	18.4	7.6	ND	ND	ND	0.046	ND	ND	0.22	**0.022**	0.048	1.38	1.68	140	1.4	0.00082	140
10/17/2017	8:50	14.1	7.8	ND	ND	ND	0.046	ND	ND	0.22	**0.024**	0.040	1.36	1.67	130	1.4	ND	189

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

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

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

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

Recommended EPA Criteria based on Aggregate Ecoregion III

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

Total Nitrogen: 0.38 mg/L

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

Turbidity: 2.34 FTU/NTU

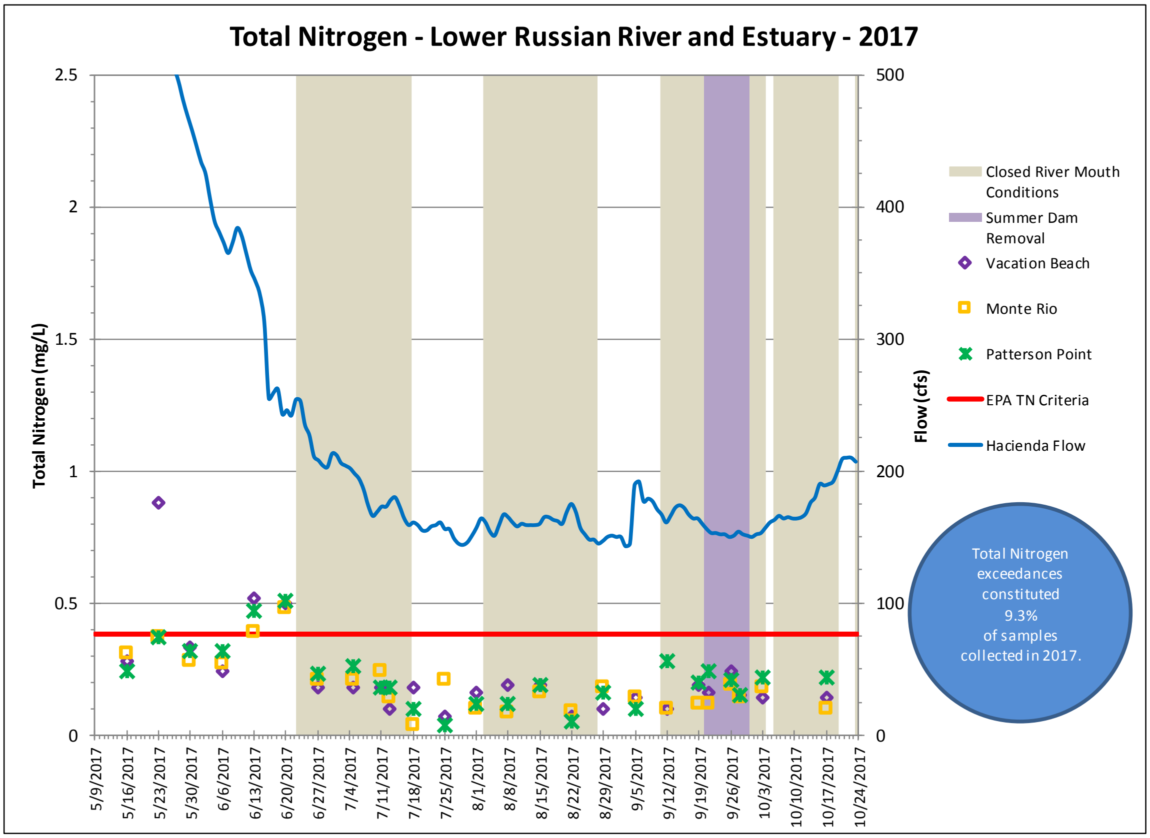


Figure 3-15. Total Nitrogen results for the Russian River from Vacation Beach to Patterson Point in 2017.

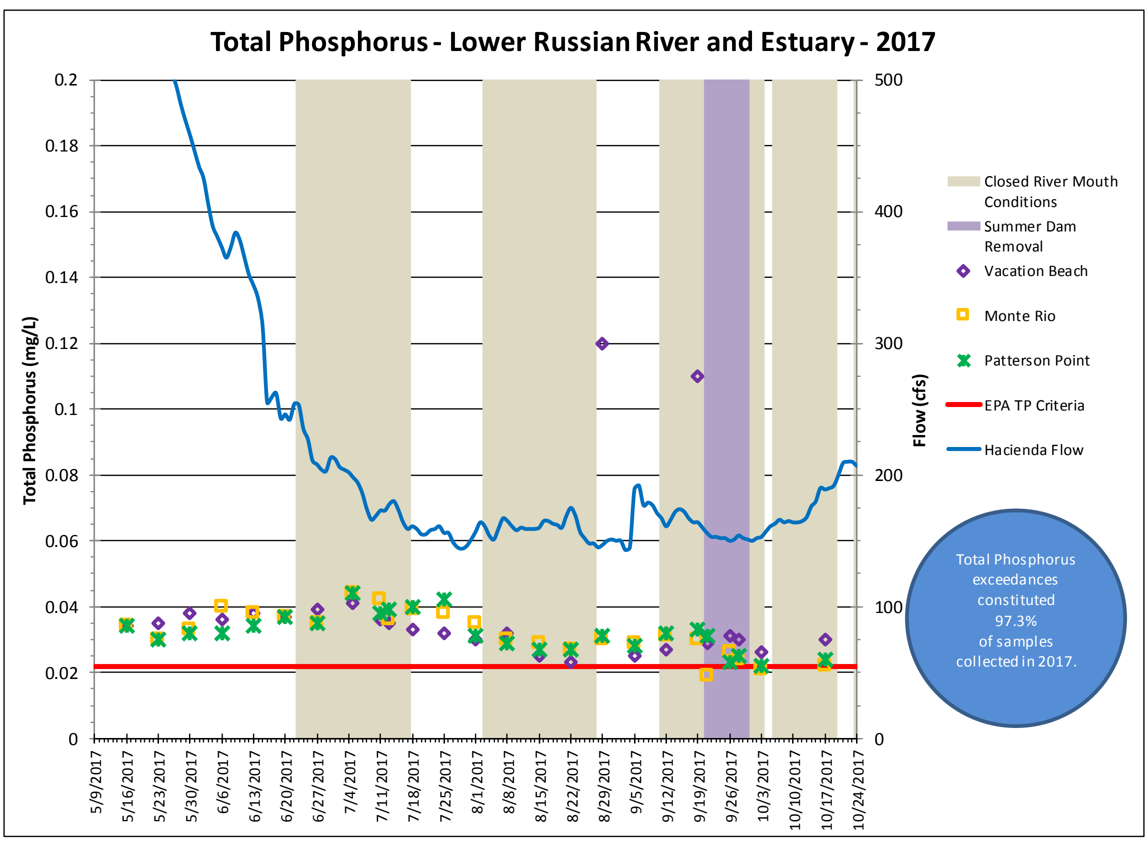


Figure 3-16. Total Phosphorus results for the Russian River from Vacation Beach to Patterson Point in 2017.

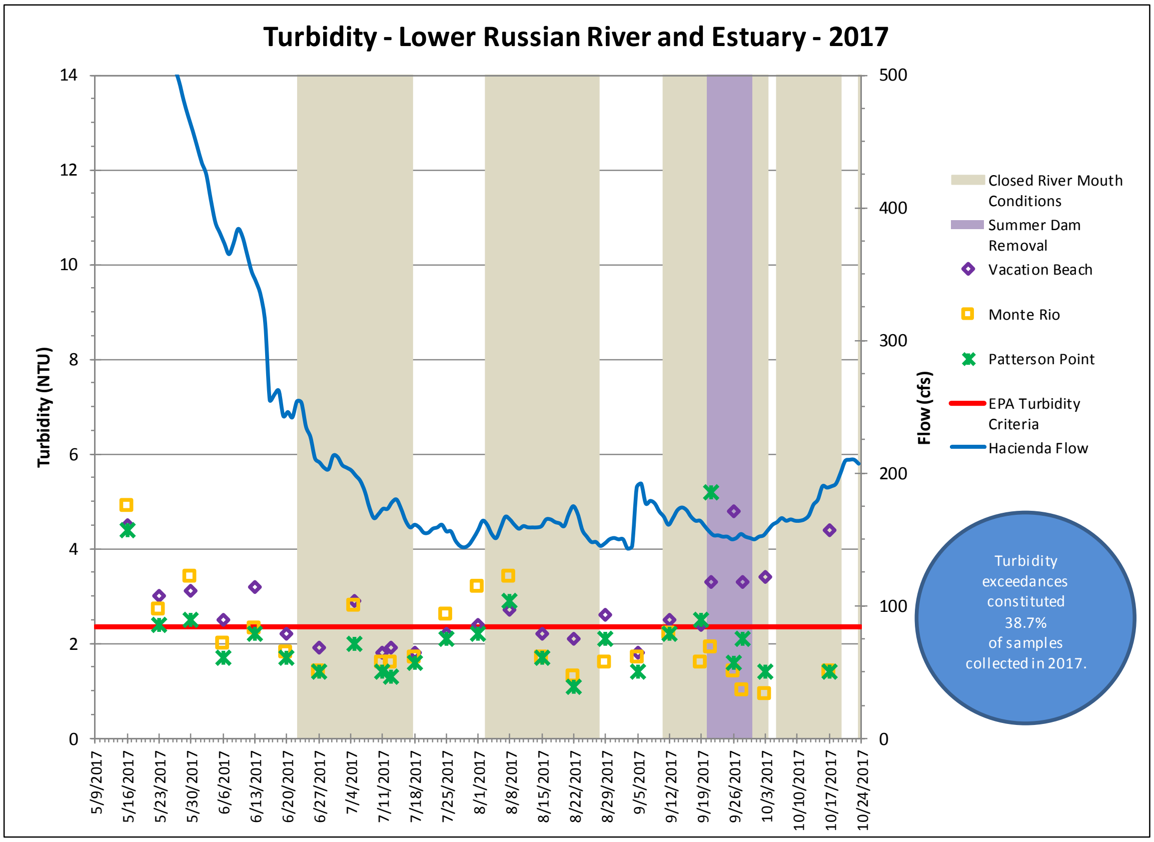


Figure 3-17. Turbidity results for the Russian River from Vacation Beach to Patterson Point in 2017.

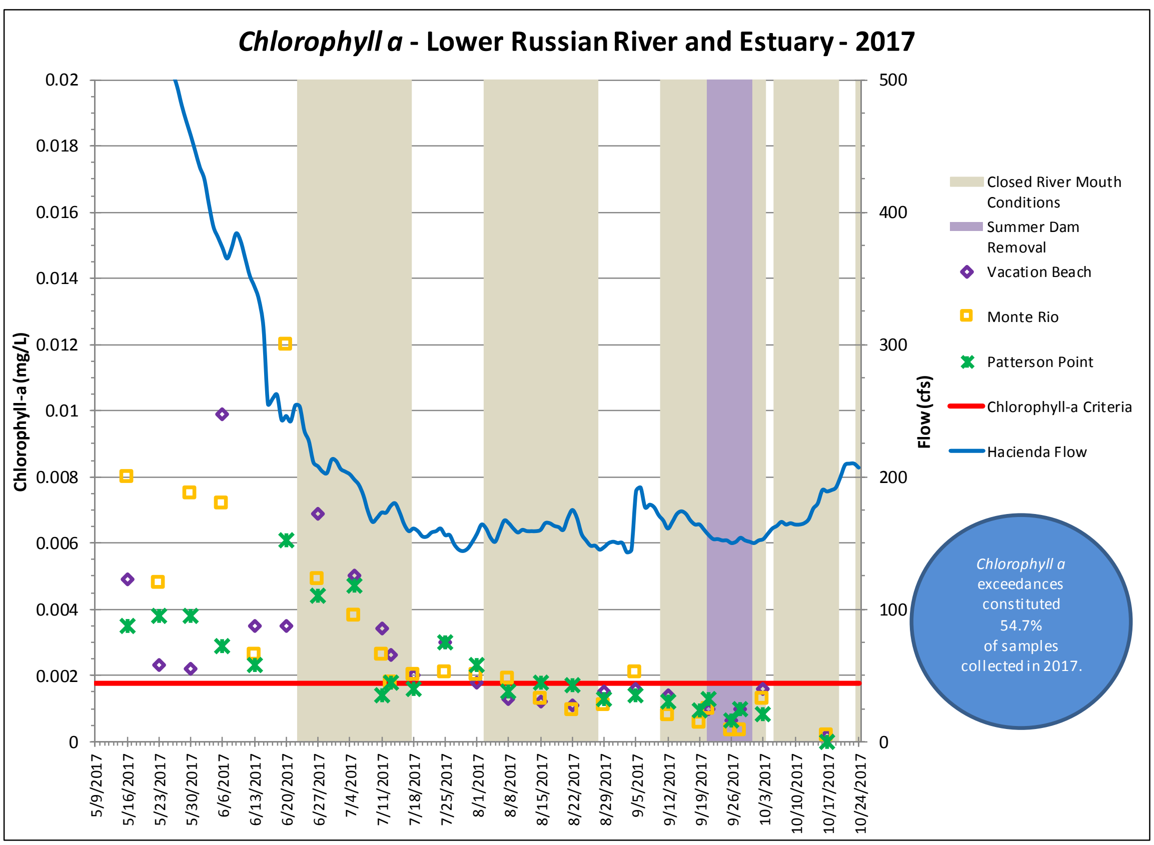


Figure 3-18. *Chlorophyll a* results for the Russian River from Vacation Beach to Patterson Point in 2017.

4.0 Additional Monitoring

4.1 Water Agency and USGS Permanent and Seasonal Datasondes

In coordination with the USGS the Water Agency 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 the Water Agency 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, the Water Agency 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, the Water Agency, 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 2017 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 the Water Agency's website: http://www.scwa.ca.gov/bo-annual-report/.

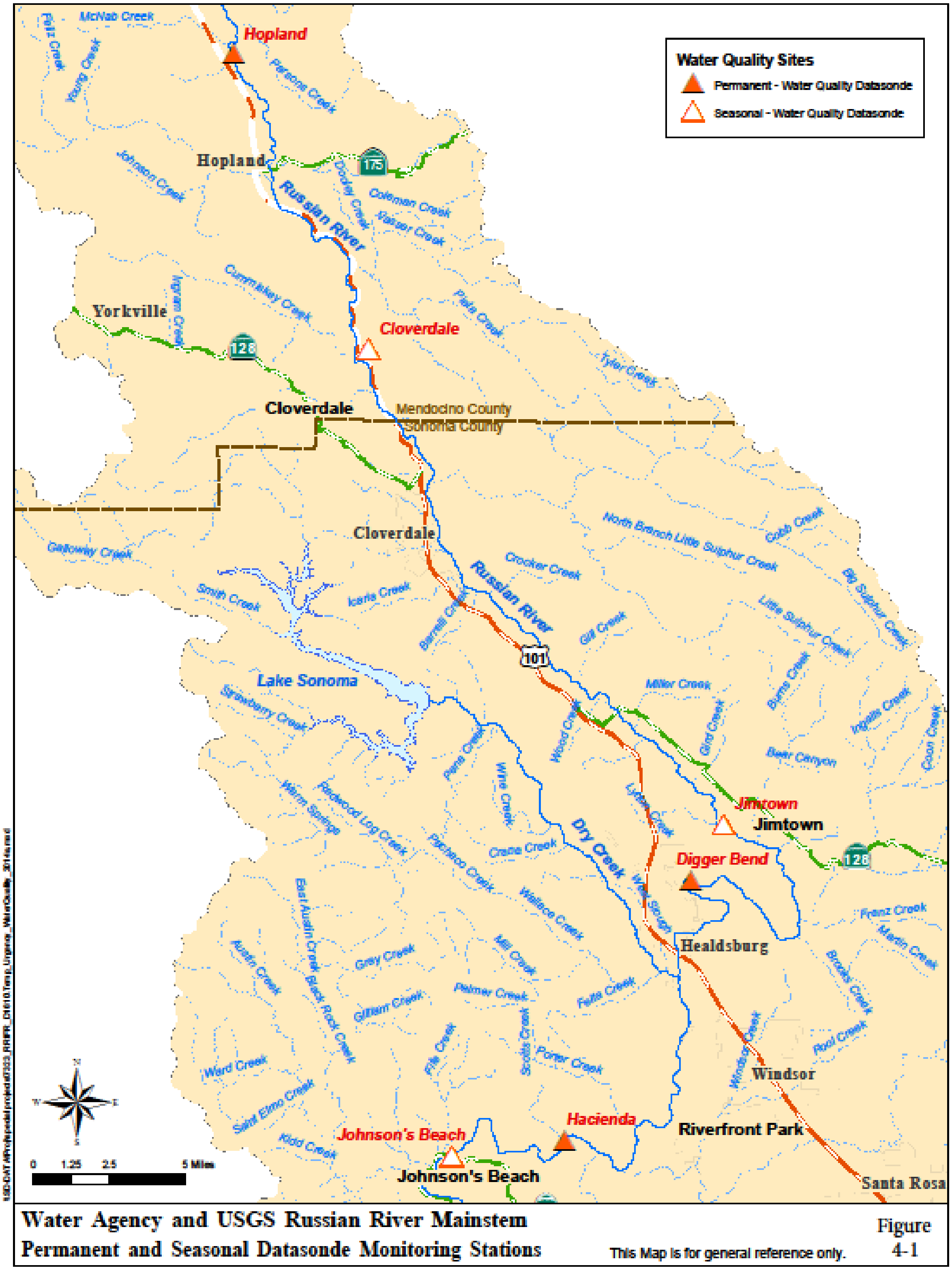


Figure 4-1. 2017 Water Agency and USGS Russian River mainstem permanent and seasonal datasonde water quality monitoring stations.

4.2 Aquatic Habitat for Salmonids

4.2.1 Introduction

In term 6 (b) of the temporary urgency change order (Order) the State Water Resource Control Board (SWRCB) tasked the Water Agency 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 conditions in the Russian River during the Order and relates these conditions to fisheries monitoring data collected by the Water Agency.

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. Adults migrate from the ocean to the river and move upstream to spawn in the fall and winter. Females dig nests called redds in the stream substrate and deposit eggs which remain in the redd for several weeks before hatching. After hatching, the larval fish remain in the gravel for another 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 some freshwater growth. Parr rear for a few months (Chinook) to 2 years (steelhead) in freshwater before undergoing a physiological change identified as smoltification. At this stage, fish are identified as smolts, are physiologically able to adapt to living in saltwater, and are 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 (Moyle 2002). Because all three species of Russian River salmonids spend a period of time in the Russian River, they 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 have become scarce in the Russian River and monitoring data relies mainly on fish released from the hatchery as part of the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP). Data collected on the Water Agency's Mirabel inflatable dam video camera system in 2011 through 2013 indicate that the adult coho salmon run may start in late October and continue through at least January. The bulk of the adult coho migrate through 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 the tributaries to the Russian River (NMFS 2008). Downstream migrant trapping in tributaries of the Russian River indicate that the coho smolt out-migration starts before April and continues through mid-June (Obedzinski et al. 2006). Coho salmon have been detected as late as mid-July in the mainstem Russian River downstream migrant traps operated by the Water Agency (Martini-Lamb and Manning 2011). Most coho smolts emigrate from the Russian River from March through May. For coho, the temperature and DO data relating to juvenile rearing and smolt life stages will be analyzed for this report as these are the life stages likely to be present in the Russian River during the time period governed by the Order (May 19, 2017 through October 15, 2017).

Steelhead timing and distribution

Based on video monitoring at the Water Agency'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 in the tributaries of the Russian River while some steelhead rear in the upper mainstem Russian River (NMFS 2008, Cook 2003). Cook (2003) found that summer rearing steelhead in the mainstem of the 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 fast water habitats that include riffles and cascades (Cook 2003). Both the Canyon and Ukiah reaches generally have cooler water temperatures when compared to other mainstem reaches due to releases made from Lake Mendocino.

The steelhead smolt migration in the Russian River begins at least as early as March and continues through June, peaking between March and May (Martini-Lamb and Manning 2011). For Russian River steelhead, parr (rearing) and smolt life stages are present in the mainstem during the time period covered by the Order. Therefore only the temperature and DO data relating to the juvenile rearing and smolt life stages will be analyzed for this report.

Chinook timing and distribution

Based on video monitoring at the Water Agency'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 out-migrating to sea in the spring. The bulk of Chinook smolt out-migration occurs from April through mid-July. The adult and smolt life stages are present in the mainstem of the Russian River during the time period covered by the Order. Therefore, temperature and DO data relating to the adult and smolt life stage will be analyzed for this report.

4.2.3 Methods

The Water Agency uses underwater video, dual frequency identification sonar (DIDSON), downstream migrant traps, and water quality data collected in the Russian River and Dry Creek to summarize Russian River water quality conditions when salmonids were present. The Water Agency operates underwater video cameras and DIDSON to enumerate adult salmonids, and downstream migrant traps to enumerate salmonid smolts. USGS stream gages and a Water Agency 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 the Water Agency typically operates underwater video cameras in two fish ladders located on the east and west sides of the Mirabel Inflatable Dam. However, a large construction project to improve fish passage at Mirabel Dam in 2014 through 2016 created new challenges in operating video camera at this site. In 2017 we experiment with a camera in the newly constructed fish ladder as well as in the existing fish ladder on the east side. In addition to the Mirabel camera system, the Water Agency collected adult counts from a DIDSON at Dry Creek (a tributary to the Russian River near Healdsburg). The DIDSON collects sonar images of fish as they pass the sample site. This allows us to count fish across a larger area of the stream channel than can be captured by video images and collect images of fish during periods of high turbidity when an underwater camera would be ineffective. The resolution of DIDSON precludes the accurate identification of species. In years past, the Water Agency experimented with operating an underwater video camera alongside the DIDSON in order to collect species information and prorate DIDSON images. Unfortunately the underwater video camera did not capture enough images to prove useful. Data from these monitoring sites were used to determine when adult salmonids were present in the Russian River during 2017.

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 in the east fork of the Russian River downstream of Lake Mendocino provided water temperature, and DO data. These water quality conditions were compared to findings in the literature and were used to construct temperature and DO criteria for Russian River salmonids (Table 4-1 through Table 4-4).

Table 4-1. Adult salmonid temperature (°C) thresholds used for migration when describing water quality conditions during the term of the May 2017 temporary urgency change order. Citations used to develop these criteria are found in 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. Salmonid rearing temperature (°C) thresholds used for describing water quality conditions during the term of the May 2017 temporary urgency change order. Citations used to develop these criteria are found in 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 2017 temporary urgency change order. Citations used to develop these criteria are found in SCWA (2016).

Description	Chinook	Coho	Steelhead
optimal upper limit	16.9	10.0	11.1
suitable upper limit	17.8	13.9	12.8
tolerance upper limit	20.0	16.9	15.0
resistance upper limit	23.8	23.8	23.8
lethal	23.9	23.9	23.9

Table 4-4. Dissolved oxygen (mg/L) thresholds used for describing water quality conditions during the term of the May 2017 temporary urgency change order. Citations used to develop these criteria are found in 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

Adult salmonid counts are used to relate water quality conditions to the timing and magnitude of the adult salmonid run. We compared adult counts from counting stations with water quality information only where fish would either pass through a water quality station before being detected at a particular counting station. For instance since Hacienda is downstream of Dry Creek, all adult salmonids observed at these sites must first pass through the Hacienda water quality station. Therefore displaying Dry Creek 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 discussing juvenile steelhead. Smolts moving downstream out of Dry Creek first pass our Dry Creek downstream migrant trap then pass the Hacienda USGS stream gage before entering the ocean. Therefore we have paired Dry Creek salmonid smolt data with Dry Creek and Hacienda water quality data to describe the conditions these fish likely experienced as they moved downstream out of Dry creek and the lower Russian River.

4.2.4 Results

Flow

From May 19, 2017 to October 15, 2017 flow in the Russian River at Hacienda ranged from a high of 640 cfs on May 19 to a low of 143 cfs in early September. Flow during the Order was typically between 160 cfs and 230 cfs (25^{th} and 75^{th} percentiles of the daily average flow). During the period of the Order, the Russian River was influenced by tributary in-flow until July, and was generally controlled by reservoir releases from July through October.

Temperature

Adult Salmonid Migration

The Dry Creek DIDSON was installed on September 1, the camera in the west fish ladder at Mirabel was installed on September 13, and the camera in the east ladder was installed on September 29. During the period of the Order, 422 adult salmonids were observed when combining the Mirabel and Dry Creek counts. However, this includes double counting since fish passing Dry Creek would have first passed and been counted at Mirabel. At Mirabel 146 Chinook, 3 steelhead adults, and 2 unidentified adult salmonids were observed during the Order. At the Dry Creek DIDSON 271 adult salmonids were observed during the order. The river mouth was closed for much of September (Figure 4-1) which likely limited the number of salmonids that entered the Russian River in September, 2017.

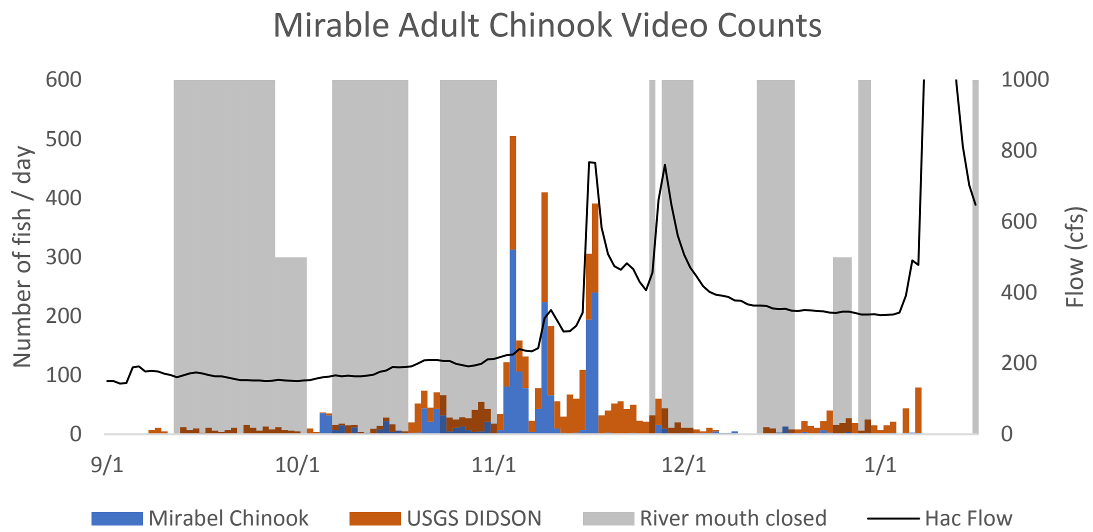


Figure 4-1. Flow in the Russian River at the USGS Hacienda stream gage (11467000). Times when the mouth of the Russian River was closed due to the formation of a sand bar are shown as shaded areas. Also shown are the adult salmonid counts from video collected at Mirabel and DIDSON collected on Dry Creek.

Table 4-5. The number of days of the adult salmonid run that occurred in each time period, the percentage of those days the river mouth was closed and blocked 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 time periods are separated into the period of the Order that overlaps with the adult salmonid run (September 1, 2017 through October 15, 2017) and the period of time from when the order expired (October 15, 2017) to December 31, 2017. Additional adult salmonids were observed after December 31, 2017, and are not included in this table.

Time period	# of days	% of time river mouth closed	Observed Chinook	Unidentified salmonids
During order	44	68 %	146	271
After order expired	77	38 %	1,914	2,741

Water temperatures for Chinook salmon were favorable during the portion of the Order that overlaps with the Chinook adult migration (October). At the Hacienda gage the temperature ranged from optimal to acutely stressful for adult salmonids based on our criteria (Table 4-1 and Figure 4-2). Moving upstream from Hacienda, Chinook would experience water temperatures similar to Hacienda at Digger Bend and Jimtown, but significantly cooler at Hopland and in the East Fork Russian River near Coyote Valley Dam (Figures 4-2 through 4-6).

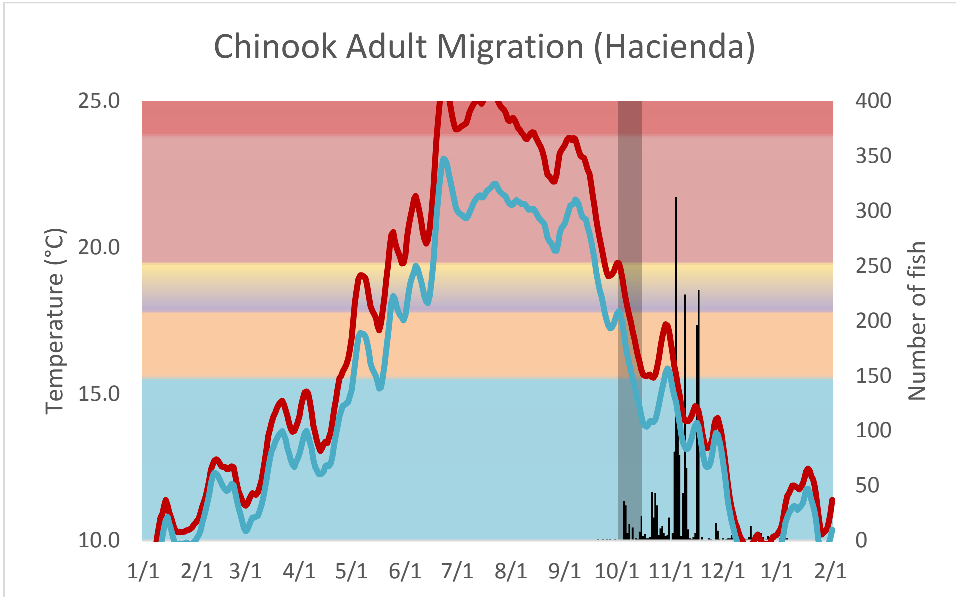


Figure 4-2. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook counts from the mainstem Russian River at Mirabel. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature thresholds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

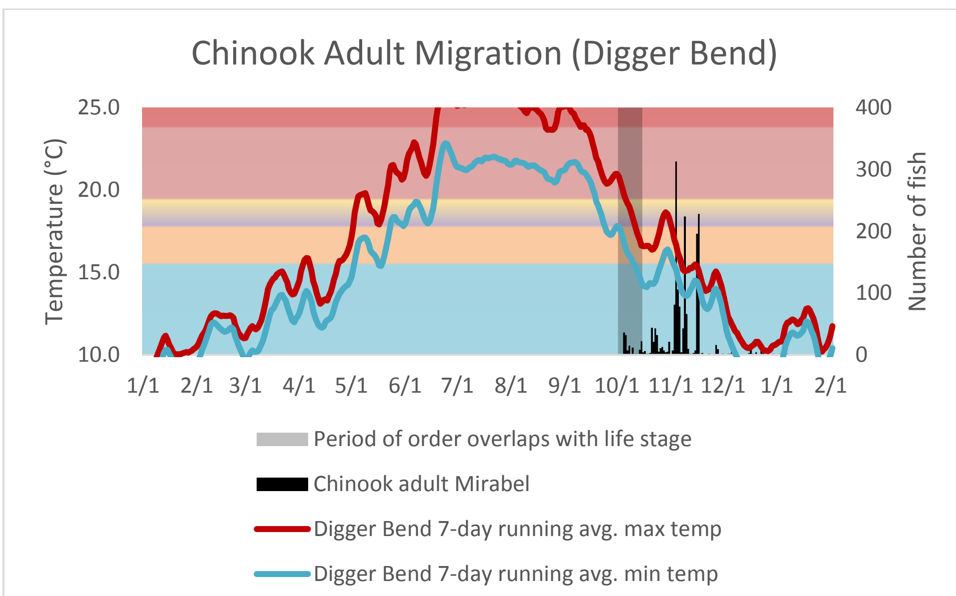


Figure 4-3 The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook adult migration based on Table 4-1.

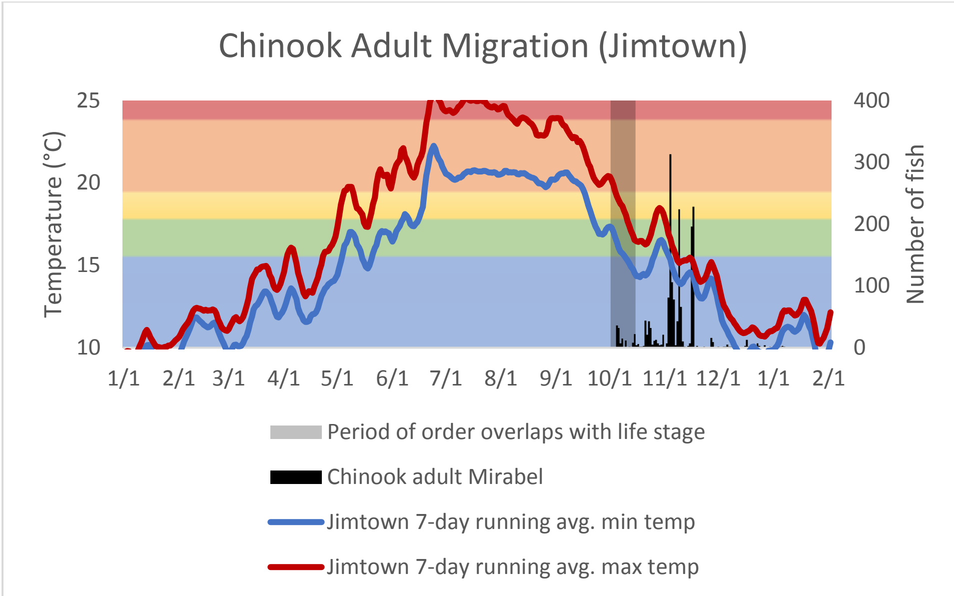


Figure 4-4. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook adult migration based on Table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

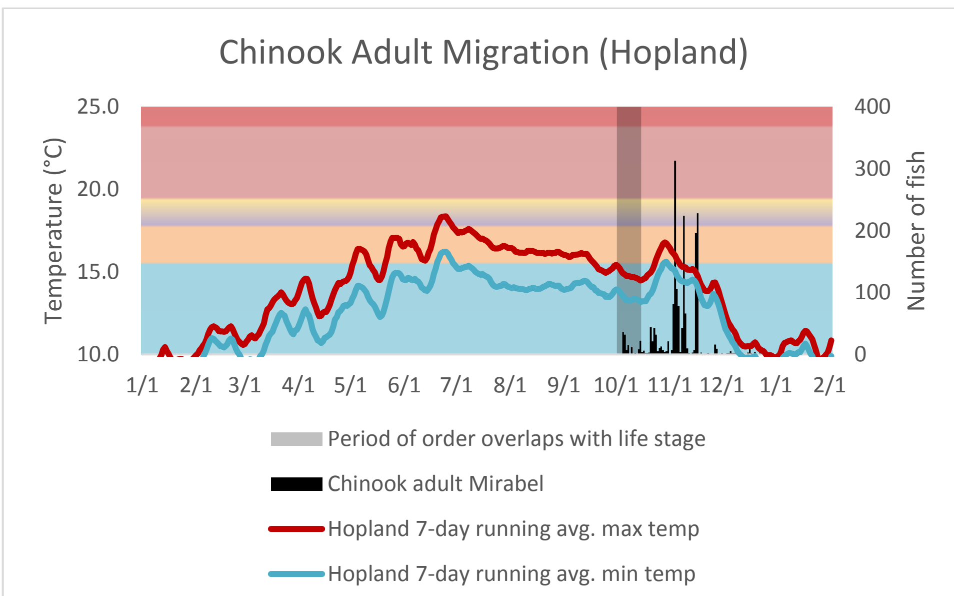


Figure 4-5. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook adult migration based on Table 4-1.

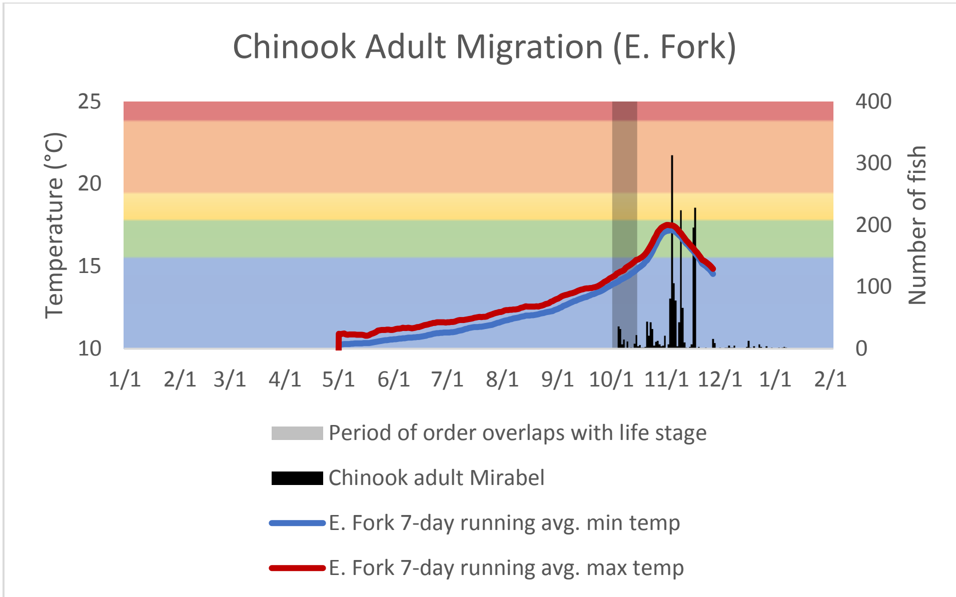


Figure 4-6. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River approximately 1/3 of a mile downstream of the Coyote Valley Dam shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook 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 sites are located in tributaries to the Russian River including Dry Creek. Water temperatures from Dry Creek are shown with the temperature criteria for Chinook, coho, and steelhead as this is an important rearing area for these species. 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 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 season than steelhead. We relate water temperature at a number of mainstem Russian River sites to Chinook water temperature criteria. Steelhead rear for over one year and are restricted to the portion of Russian River where water released from the cold water pool (the bottom portion of the lake) in Lake Mendocino. We relate steelhead water temperature criteria to water temperature collected in the East Fork Russian River and at Hopland as these sites are within the section of the Russian River that can provide year round rearing opportunities for juvenile steelhead.

Chinook

During 2017 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 East Fork Russian River and at the USGS stream gage at Hopland (gauge number 11462500, Figure 4-8 and Figure 4-9). 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 4-10-12). 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.

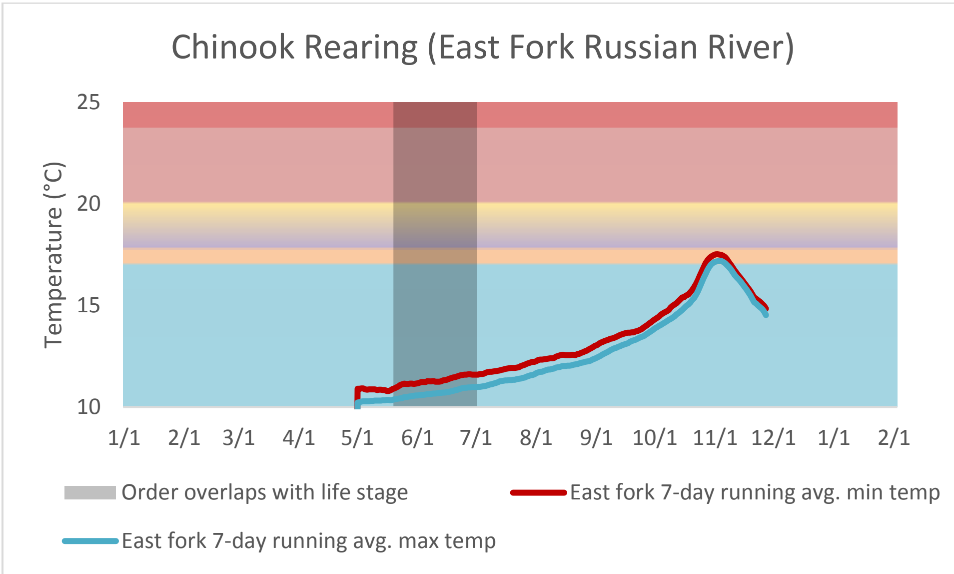


Figure 4-8. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River approximately 1/3 of a mile downstream of the Coyote Valley Dam shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

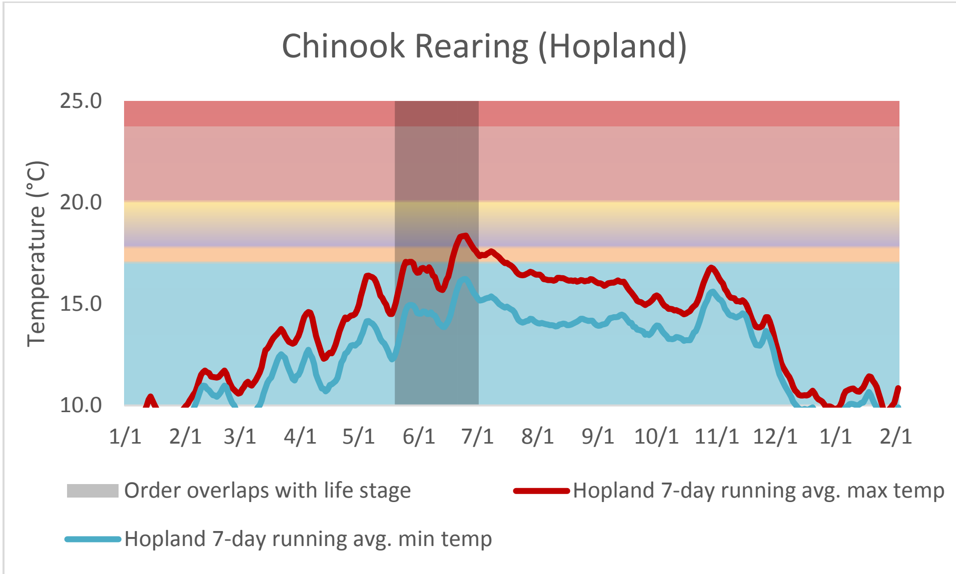


Figure 4-9. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

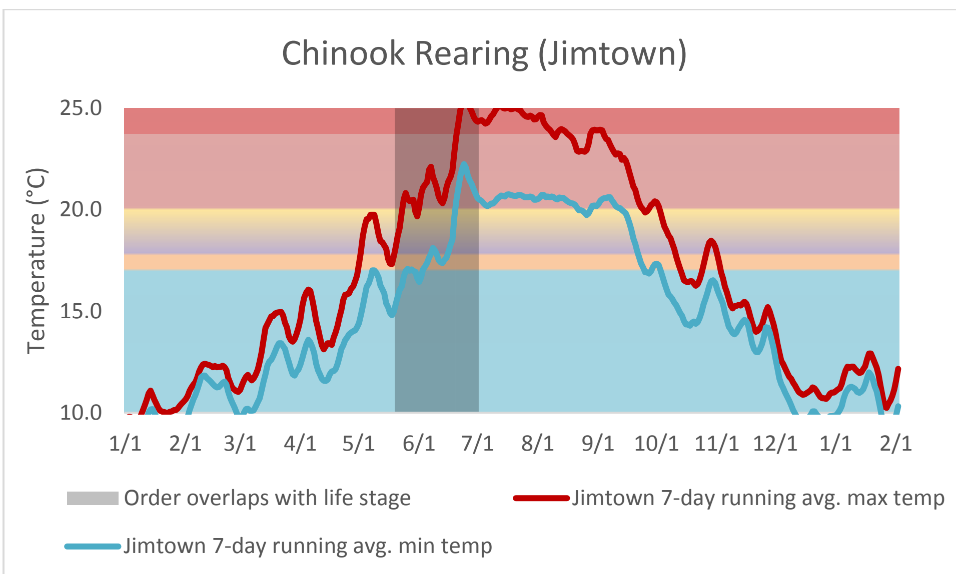


Figure 4-10. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

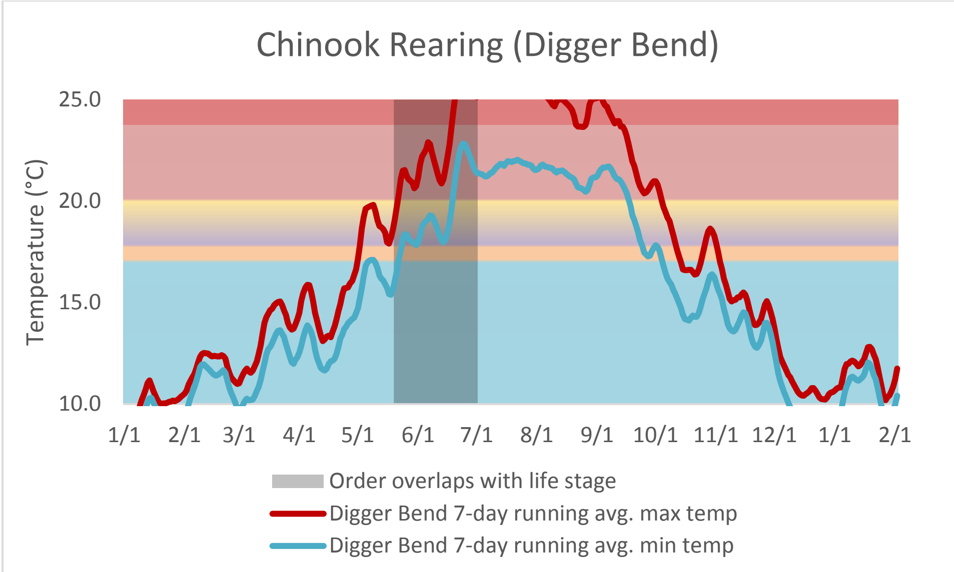


Figure 4-11. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

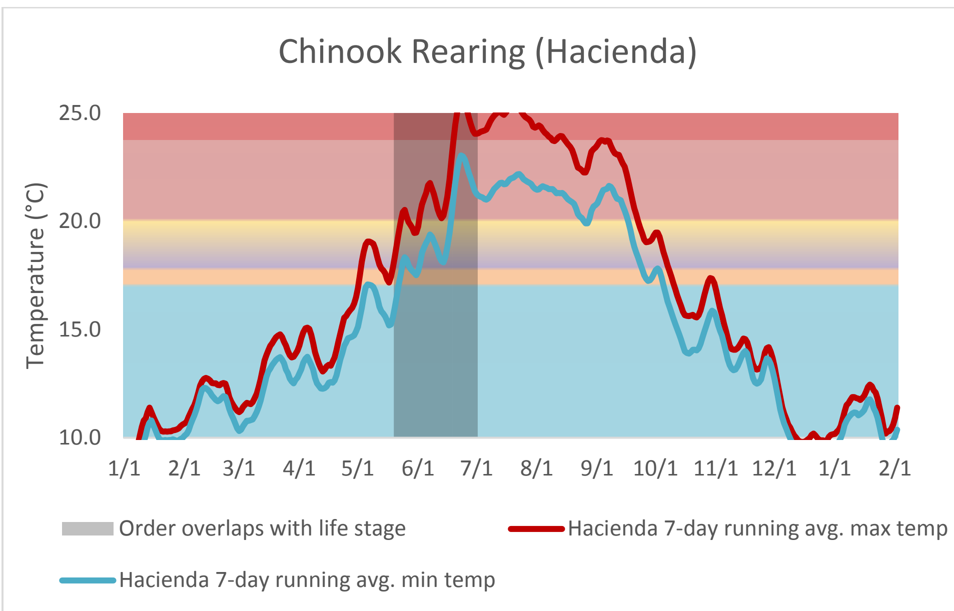


Figure 4-12. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hacienda (gage number 11467000) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

Steelhead

Steelhead parr rear year round in the upper Russian River. Water temperature was optimal for most of the order in the East Fork Russian River (Figure 4-15). During the Order water temperature at the USGS stream gage at Hopland mainly fell in the optimal to suitable range for steelhead parr (Figure 4-16).

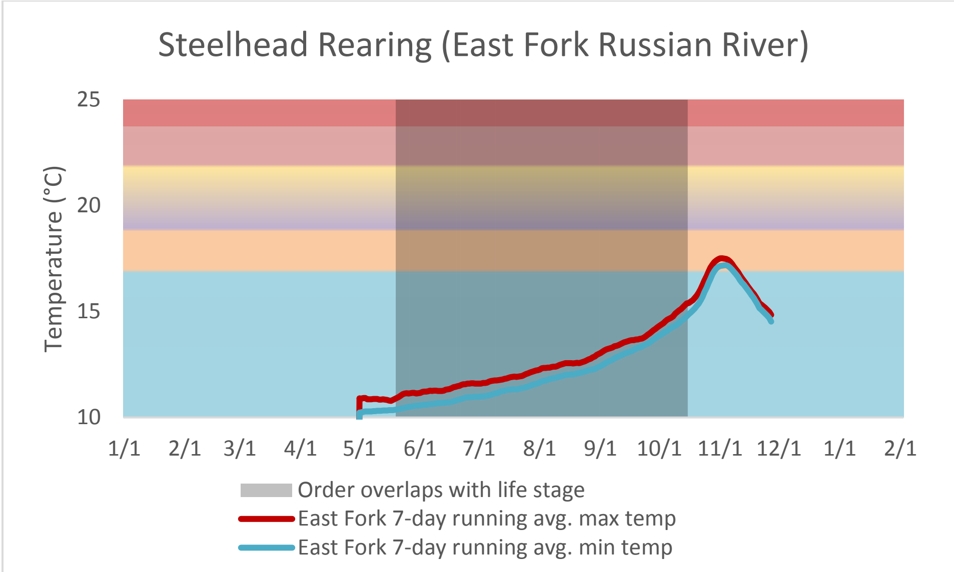


Figure 4-15. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River. The optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead parr based on Table 4-2 are also shown.

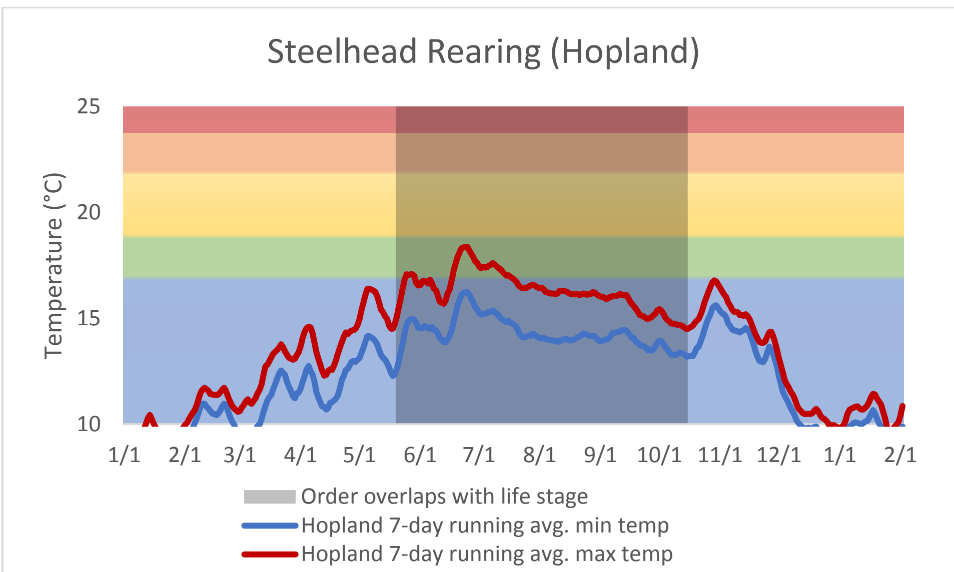


Figure 4-16. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). The optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead parr based on Table 2 are also shown.

Salmonid Smolt Outmigration

As salmonid smolts immigrate to the ocean they experience river temperatures that are often warmer than their natal tributary or mainstem river habitat. We summarize water temperatures for the East Fork Russian River, Hopland, Jimtown, and Digger Bend gages and show these temperatures with water temperature criteria for Chinook and steelhead. We operated a downstream migrant trap at Dry Creek from April 21, 2017, until July 30, 2017. During the Order (May 19, 2017 to July 31, 2017) we captured 2,552 Chinook salmon smolts, 118 coho salmon smolts and 40 wild and steelhead smolts at this trapping site. We relate these catch data to temperature collected at Dry Creek and at Hacienda. Hacienda is located approximately 20 km downstream of the trap site and represents temperatures experienced by smolts as they emigrate through the lower river. It is worth noting that temperatures at the trap site are significantly cooler than temperatures at Hacienda.

Chinook

Water temperature in the Russian River near the Coyote Valley Dam was favorable for Chinook smolts during the period of time that Chinook are expected to emigrate from that potion of the Russian river (April through June, Figure 4-17 and Figure 4-18)). However, water temperature became less favorable in the later part of the migration at sites located downstream of Hopland (Figure 4-19 through Figure 4-21). It is important to note that Chinook have evolved to emigrate during the spring before water temperatures become lethal.

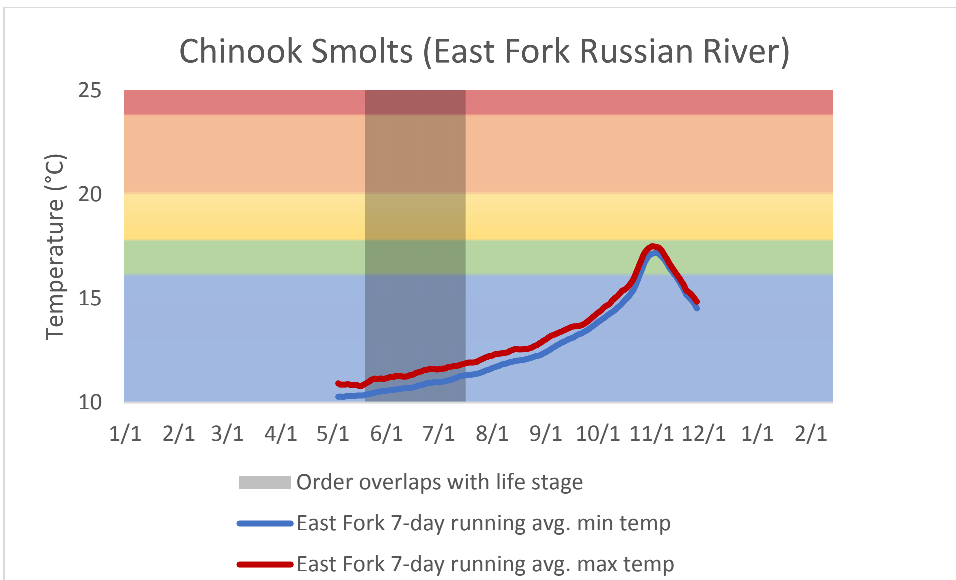


Figure 4-17. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

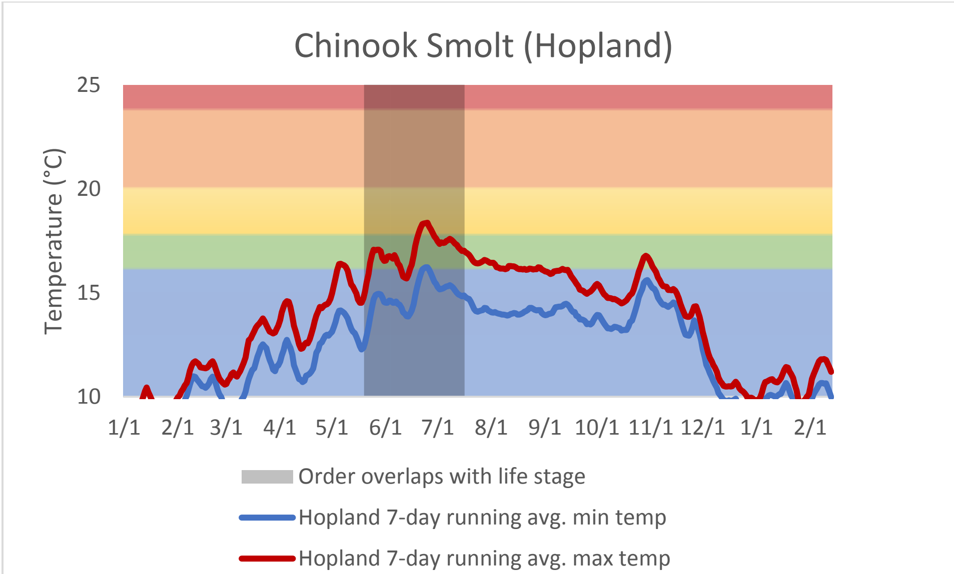


Figure 4-18. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). Shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

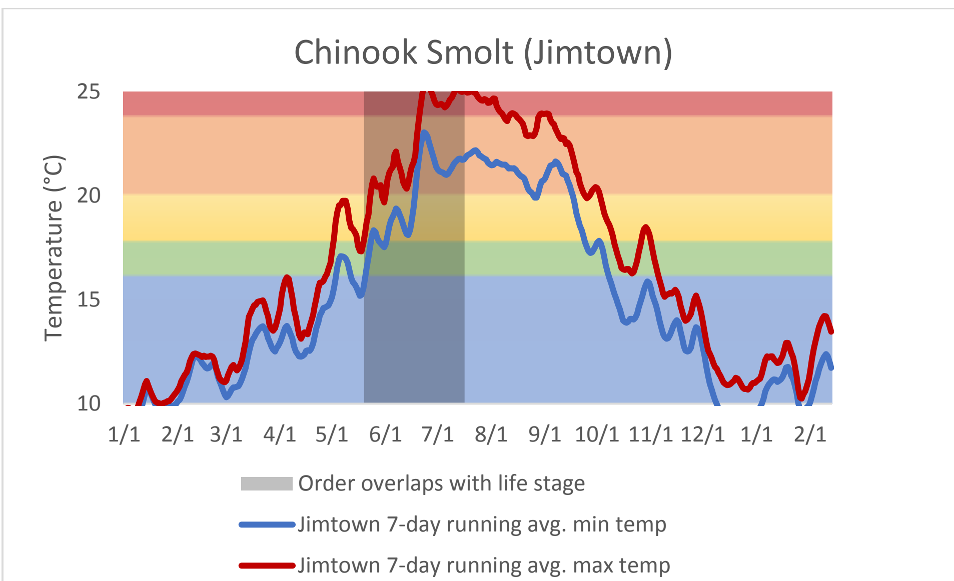


Figure 4-19. The 7-day running average of the minimum and maximum water temperatures collected at the Jimtown USGS stream Gage (1146382) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

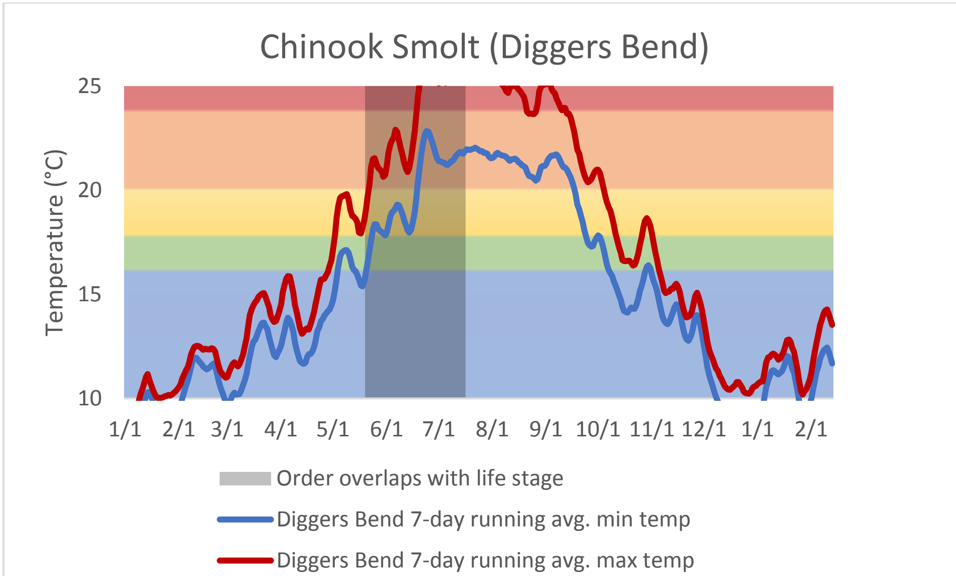


Figure 4-20. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) shown with the daily Chinook smolt catch from a fish trap located at Chalk Hill approximately 5 miles upstream of Digger Bend. Also show are the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

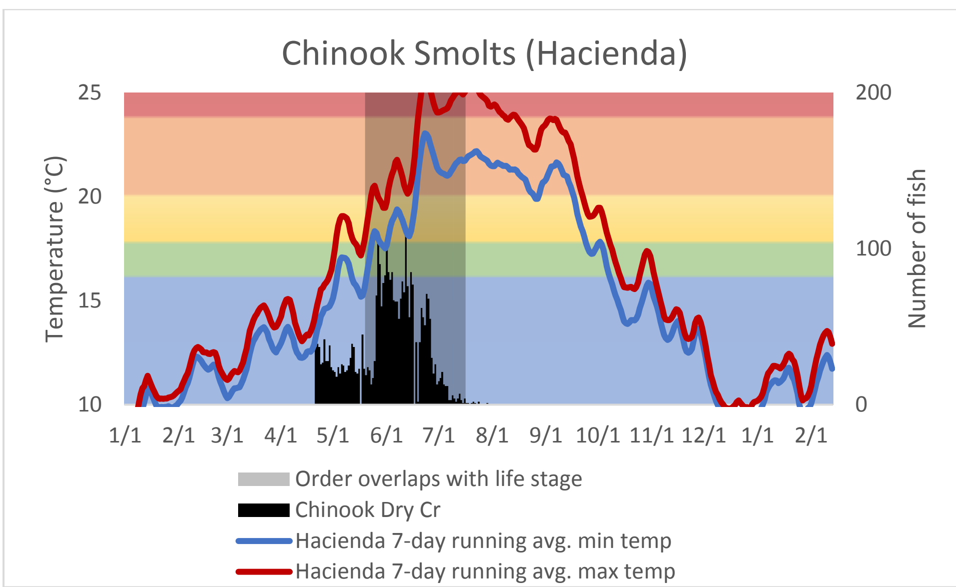


Figure 4-21. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook smolt catch from Dry Creek. Also show are the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

Coho

A total of 118 Coho smolts were captured at the downstream migrant trap from May 19, 2017 until July 2, 2017. The water temperature at Hacienda ranged from 16.2 °C to 26.3 °C during the time we captured coho smolts. For the days that we captured coho smolts the maximum and minimum daily water temperature were generally in the stressful to acutely stressful range (Figure 4-4).

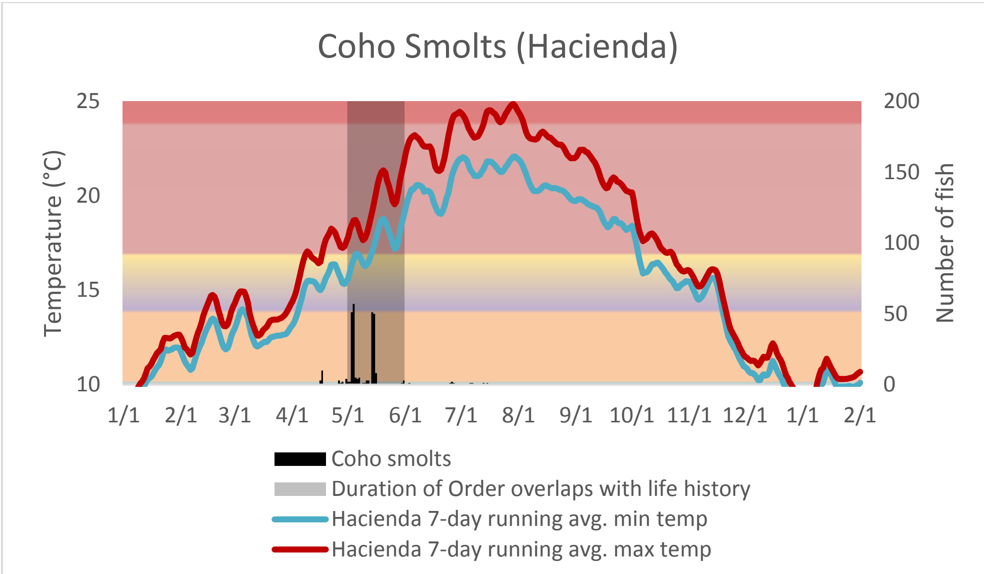


Figure 4-24. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the coho smolt catch from Dry Creek. Also show are the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for coho smolts based on Table 4-3.

Steelhead

Water temperature for steelhead smolting ranged from suitable to lethal during the time period that steelhead smolts are expected to be in the Russian River (March 1, to May 31). Water temperatures in the East Fork Russian River were suitable for steelhead smolting (Figure 4-25). At Hopland water temperatures for smolting steelhead were stressful to acutely stressful (Figure 4-26). At Jimtown water temperatures were acutely stressful (Figure 4-27). At Digger Bend water temperatures were acutely stressful to lethal (Figure 4-28). We did not captured steelhead smolts in the downstream migrant trap at Wohler in 2017. We did capture steelhead smolts in Dry Creek from April 21, 2017, until May 31, 2017. The water temperature at Hacienda ranged from 15.1 °C to 24.9 °C during the time we captured steelhead smolts. For days that fish were captured during the order the minimum and maximum daily water temperature was generally acutely stressful at Hacienda (Figure 4-29). At Dry Creek water temperatures ranged from suitable to acutely stressful (Figure 4-30).

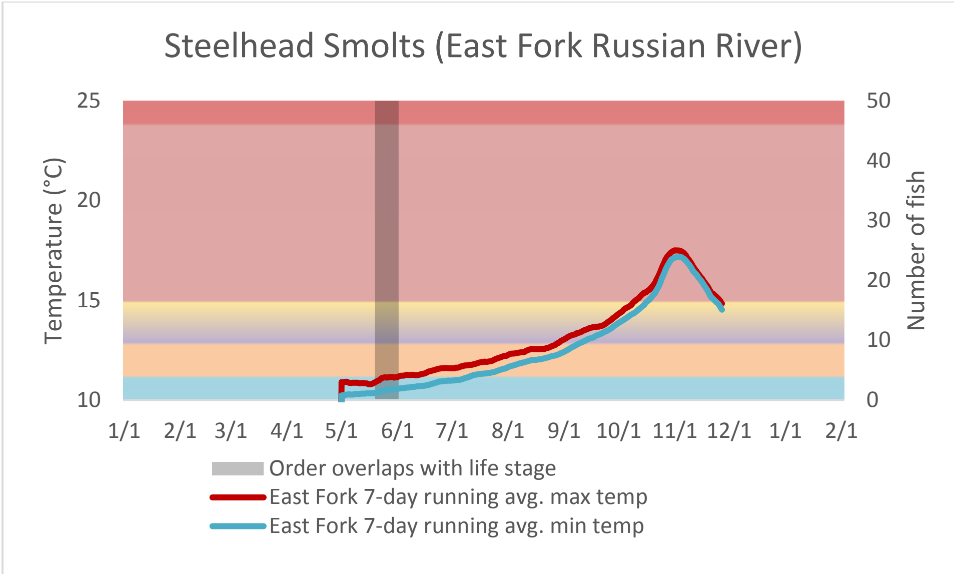


Figure 4-25. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

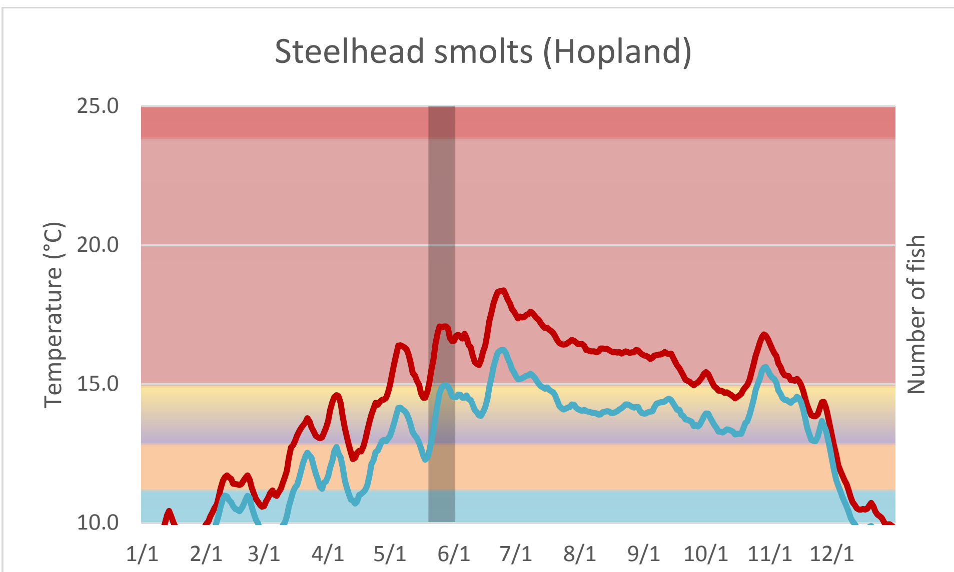


Figure 4-26. The 7-day running average of the minimum and maximum water temperatures collected at the USGS gage at Hopland (gage number 11462500) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

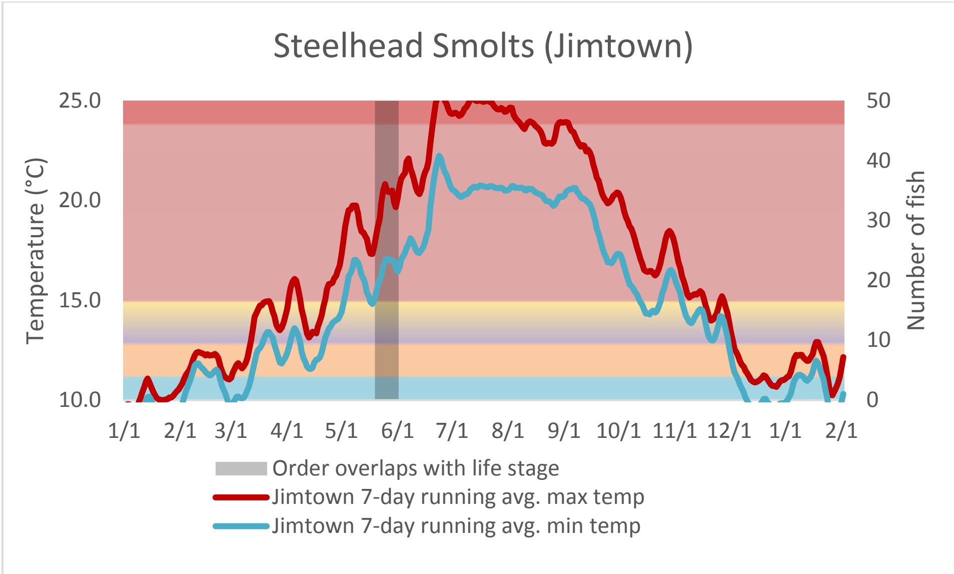


Figure 4-27. The 7-day running average of the minimum and maximum water temperatures collected at the USGS gage at Jimtown (USGS gage number 11463682) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

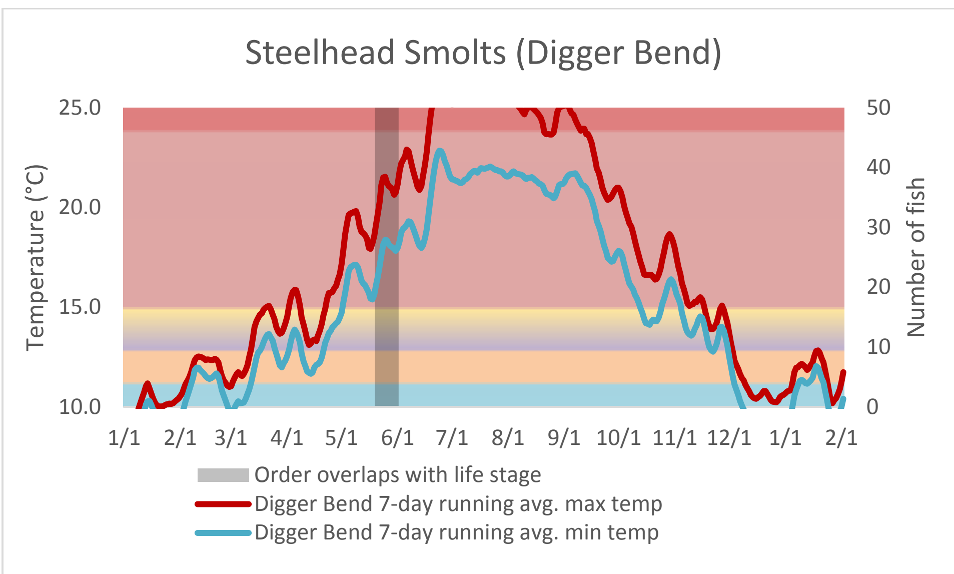


Figure 4-28. The 7-day running average of the minimum and maximum water temperatures collected at the USGS gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

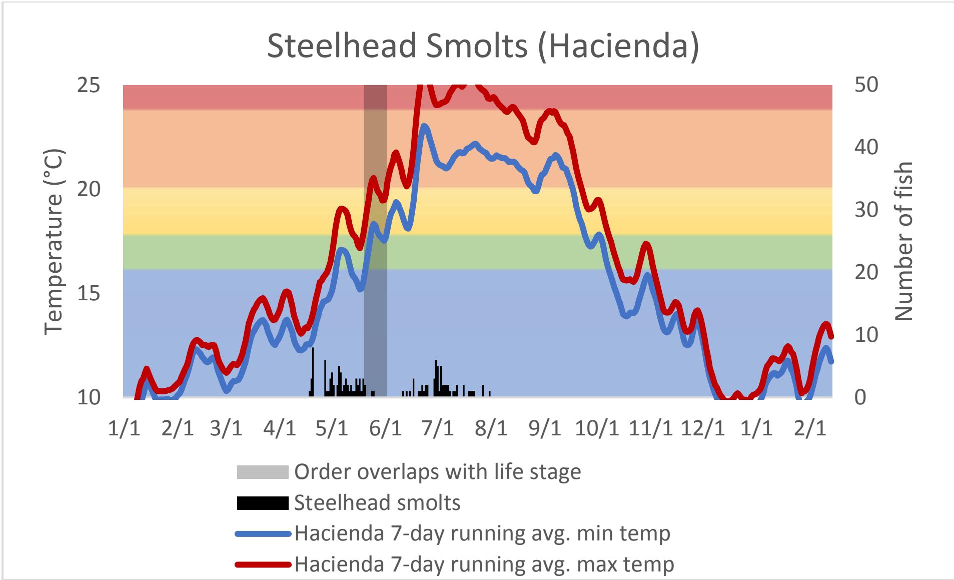


Figure 4-29. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the steelhead smolt catch from Dry Creek. Also show are the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

Dissolved Oxygen

Dissolved oxygen was generally favorable for salmonids in the Russian River throughout the Order at most sites. However, dissolved oxygen declined throughout the year in the East Fork of the Russian River to a level that was very poor for salmonids (Figure 4-31). At Hopland, 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 4-32 through 4-35).

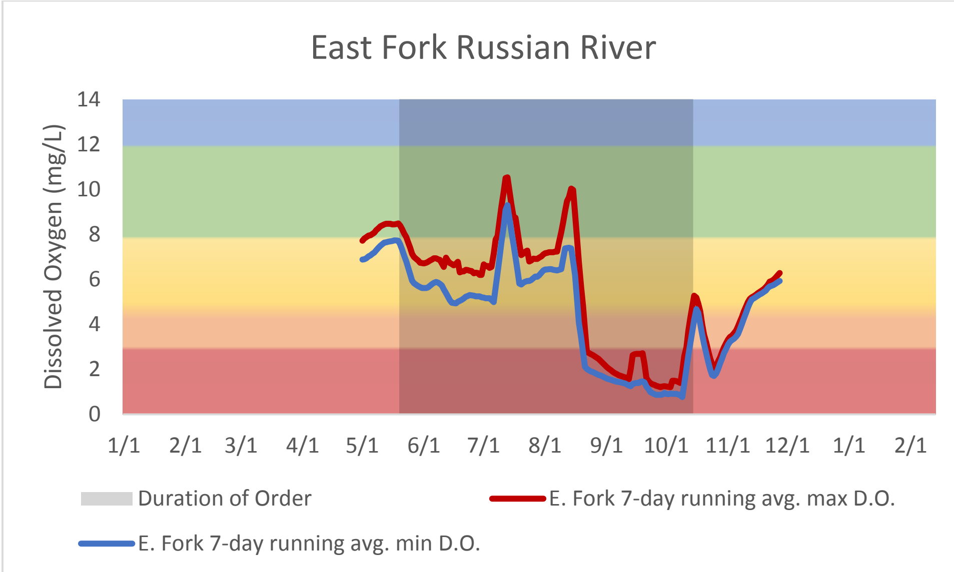


Figure 4-31. The 7-day running average of the minimum and maximum dissolved oxygen collected in the East Fork Russian River approximately 1/3 mile downstream of the Coyote Valley Dam. Shown with the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 3 for a description of water quality zones.

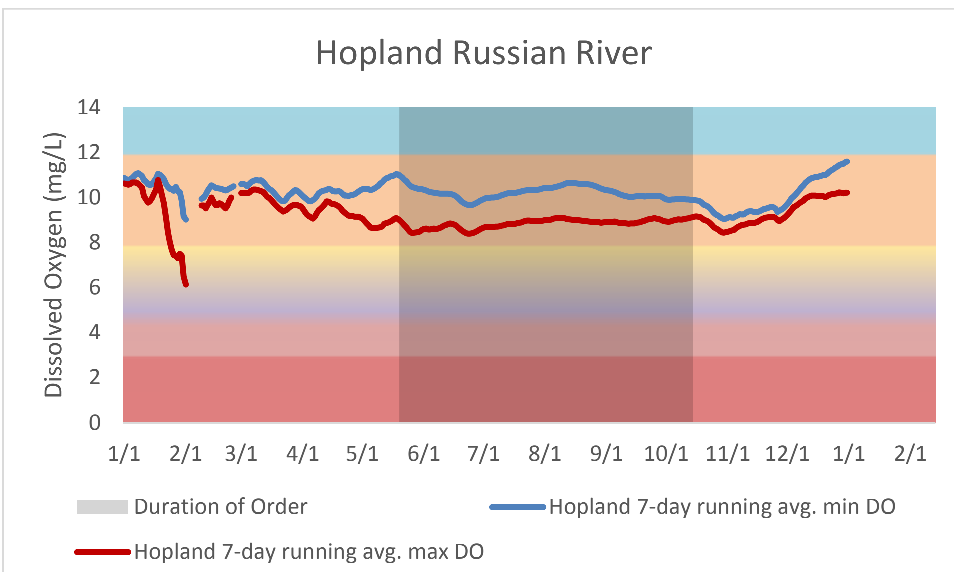


Figure 4-32. The 7-day running average of the minimum and maximum dissolved oxygen collected at Hopland (USGS stream gage number 11462500). Also shown are the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 4-4 for a description of water quality zones.

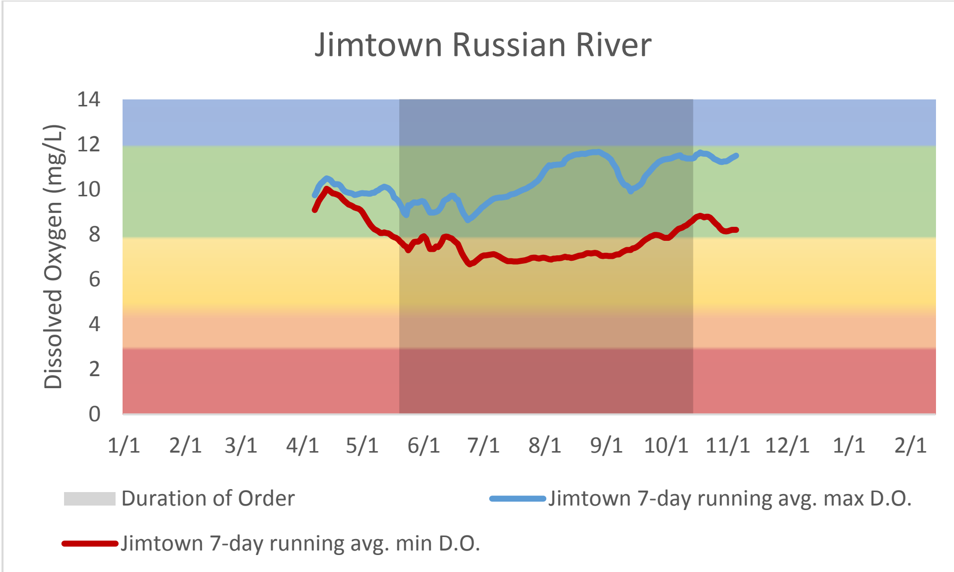


Figure 4-33. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Jimtown USGS stream Gage (1146382). Also shown are the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 4-4 for a description of water quality zones.

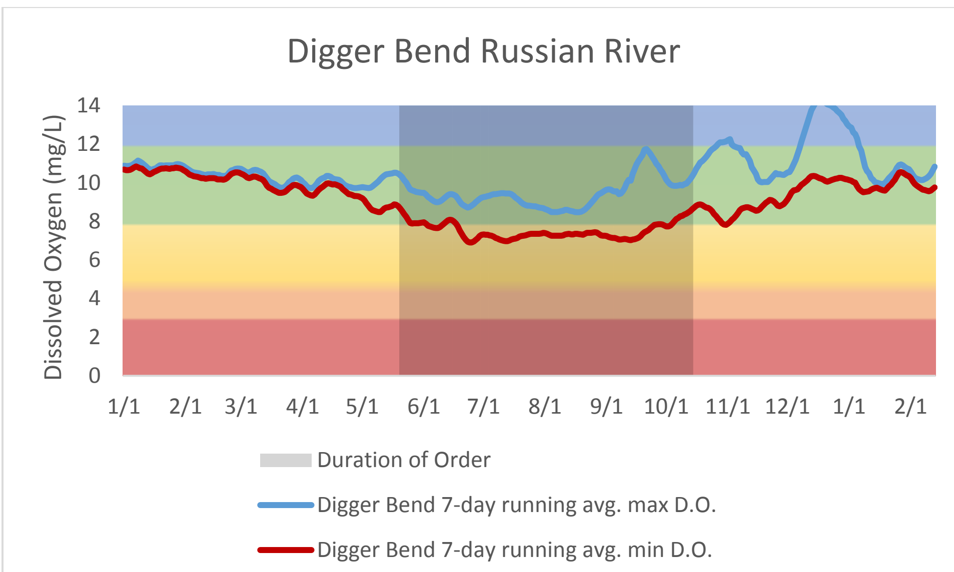


Figure 4-34. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Digger Bend USGS stream gage (11463980). Also shown are the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 4-4 for a description of water quality zones.

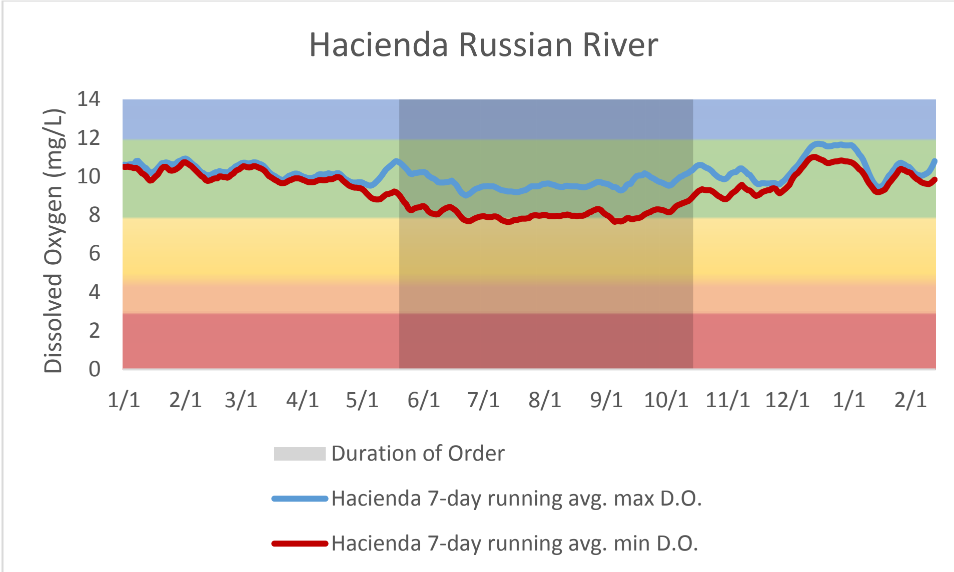


Figure 4-35. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Hacienda USGS stream gage (1146700). Also shown are the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 4-4 for a description of water quality zones.

4.2.5 Discussion

Compared to the last few years of significant drought, flows in 2017 were higher in the Russian River during the spring, summer, and fall. Adult fish moved past Mirabel during the Order. However, like in previous years, a sand bar that formed at the mouth of the river, limiting fish from entering the river during the beginning of the adult migration season. Significant rain events and higher streamflows in October likely scoured the sand bar and motivated adult Chinook salmon to migrate upstream. When Chinook first began migrating upstream in 2017, water temperature at Hacienda was stressful to acutely stressful, but quickly decline to suitable to optimal temperatures. Water temperatures at sites upstream of Hacienda followed a similar trend where temperatures were acutely stressful to stressful then declined as air temperatures declined with the onset of fall. By mid-October water temperatures were suitable to optimal for adult Chinook at all sites with the exception of the East Fork Russian River. Water temperature in the East Fork Russian River increased to stressful levels in mid-October as the cold water pool in Lake Mendocino was exhausted. However, atmospheric temperatures cooled water released from Lake Mendocino and by no farther than Hopland water temperatures were suitable to optimal for adult Chinook. While temperatures were occasionally unfavorable for adult Chinook it is important to remember that Chinook have evolved to cope with seasonally warm water temperatures by returning to the river in the fall when water temperatures are cooler and that the vast majority of adult Chinook return to the Russian River after mid-October when water temperatures in the river are becoming favorable.

For Chinook smolts, water temperatures were favorable for rearing in the early spring and at most sites, but became unfavorable by the end of the rearing season. Water temperatures remained suitable to optimal in the East Fork Russian River and in Dry Creek throughout the rearing season. Fish that remained at these sites to rear 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 were favorable for coho salmon rearing in Dry Creek in 2017. It is because of these favorable water temperatures that the NMFS recommended 6-miles of habitat enchantments be constructed in Dry Creek (NMFS 2008). The Water Agency has begun implementing these habitat enhancements (SCWA 2016). In the future there will be even more habitat available for coho rearing in Dry Creek.

Water temperatures near Hopland and in Dry Creek were favorable for steelhead rearing throughout the order. In the East Fork Russian River water temperature began to warm from August to the end of the order as the cold water pool in Lake Mendocino was depleted. However, water temperature in the East Fork Russian River remained below stressful levels for rearing steelhead.

Chinook salmon had favorable water temperatures for smolting at the East Fork Russian River and Hopland. Water temperatures became acutely stressful after June 1, when most of the smolts had migrated past Chalk Hill based on trap catches. Many Chinook smolts were captured in the Dry Creek downstream migrant trap after June 1, when water temperatures 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 some Chinook from emigrating from Dry Creek. Once these late emigrating fish leave Dry Creek they would experience stressful and acutely stressful temperatures in the lower Russian River.

According to our criteria water temperatures for coho and steelhead smolts in Dry Creek was suitable to acutely stressful, but this criteria may not represent fish that have adapted to local conditions. Recent studies suggest that salmonids may adapt to local conditions and that salmonids may tolerate a much wider range of temperatures than reported in the literature (Verhille et al. 2015). Returning adults are evidence that steelhead and coho successfully smolt in the Russian River basin (SCWA 2016). Russian River steelhead and coho that successfully smolt may either undergo the smoltification process earlier in the year when water is cooler, or they may be able to tolerate warmer water temperatures than reported in the literature. Furthermore, water temperatures in Dry Creek are significantly cooler in May and June than they would be under natural hydrology (unregulated).

Dissolved oxygen was favorable for salmonids at all sites and for the duration of the Order, with the exception of the East Fork Russian River. In the East Fork Russian River dissolved oxygen decreased throughout the season eventually reaching lethal levels. This would primarily affect summer rearing steelhead that are restricted by temperature to the upper Russian River. In the summer of 2017, water released from the cold water pool was hypoxic. However, oxygen levels typically recover by the time the released water reaches the confluence with the West Fork (Jeff Church personal communication). Low dissolved oxygen in this section of river probably has a relatively small impact on the steelhead population since the section of river from Coyote Valley Dam to the confluence with the West Fork Russian River is short. Furthermore summer rearing steelhead may have left this section of stream when dissolved oxygen became depressed and sought out more favorable habitat downstream. Adult Chinook migrating upstream in the fall could avoid this section of river if dissolved oxygen levels were unfavorable. Therefore adult Chinook salmon are likely not affected by low dissolved oxygen in the East Fork Russian River.

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