Russian River Water Quality Summary for the 2016 Temporary Urgency Change

SONOMA COUNTY WATER AGENCY

March 2017

Contents

1.0 Introduction

On 13 April, 2016, the Sonoma County Water Agency (Water Agency) filed a Temporary Urgency Change Petition (TUCP) 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 Water Agency requested that the SWRCB make the following temporary changes to the Decision 1610 (D1610) instream flow requirements from 1 May, 2016, until 27 October, 2016:

(1) Reduce the required minimum instream flow requirements for the upper Russian River (from its confluence of the East and West Forks of the Russian River to its confluence with Dry Creek) from 185 cubic feet per second (cfs) to 125 cfs.

(2) Reduce the required minimum instream flow requirements for the lower Russian River (from its confluence with Dry Creek to the Pacific Ocean) from 125 cfs to 70 cfs.

The TUCP also requested that the minimum instream flow requirements be implemented on a 5-day running average of average daily stream flow measurements, with the condition that instantaneous flows on the upper Russian River be no less than 110 cfs and on the lower Russian River be no less than 60 cfs. This would allow the Water Agency to manage stream flows with a smaller operational buffer, thereby facilitating the attainment of the flow conditions that the Biological Opinion has identified as being conducive to the enhancement of salmonid habitat. 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 an Order (Order) approving the Water Agency's TUCP on 4 May, 2016.

2.0 2016 Russian River Flow Summary

In early January 2016, water storage in Lake Mendocino was below conditions experienced in 2015. However, storage quickly increased to levels above those observed in prior years (2009-2015) by 1 February. January 2016 storms increased storage from just under 40,000 acre-feet to over 71,000 acre-feet by 31 January (Figure 2-1). Storage in Lake Mendocino peaked in mid-March at over 94,000 acre-feet and remained above 80,000 acre-feet through mid-July. In addition, 2016 storage remained above conditions experienced in 2013 through 2015 for the remaining calendar year. Finally, late-season storms in November and December 2016 increased storage from just under 50,000 acre-feet in mid-November to over 72,000 acre-feet by 31 December 2016 (Figure 2-1).

Figure 2-2 shows 2016 average daily flows at the Talmage, Hopland, Cloverdale, Jimtown, Digger Bend, and Hacienda USGS gaging stations.

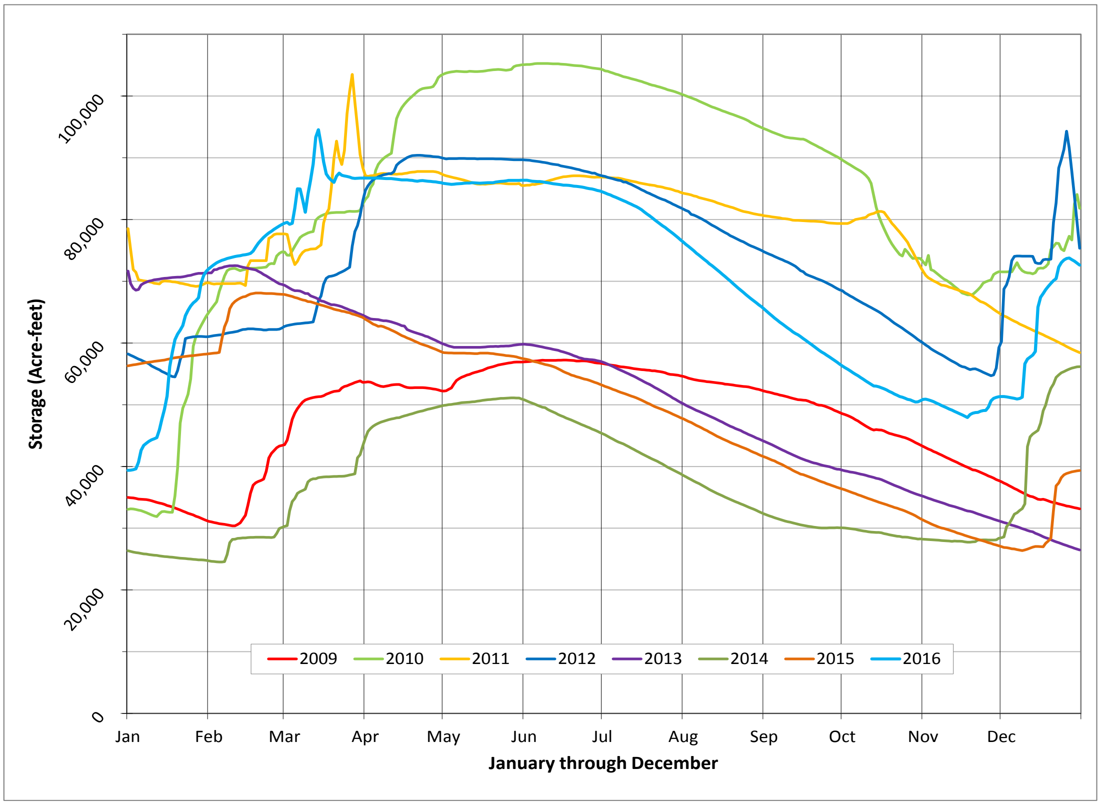

Figure 2-1. Lake Mendocino water storage levels, in acre-feet, from 2009 through 2016.

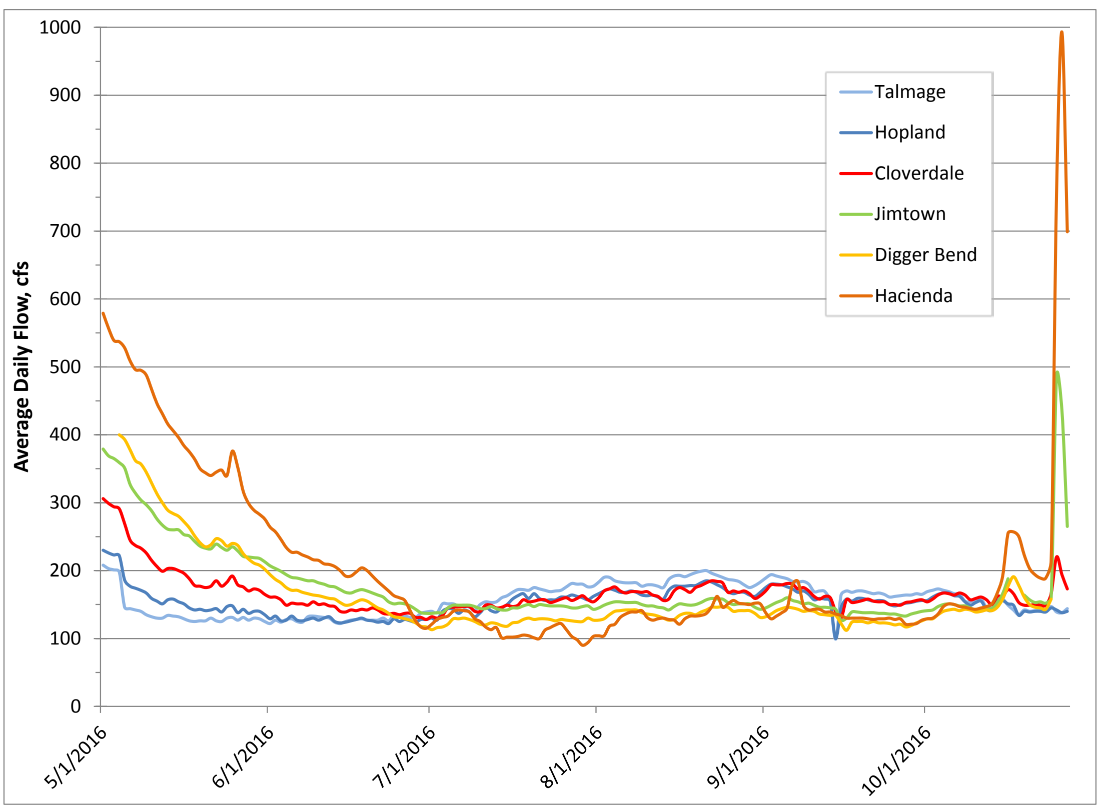

Figure 2-2. 2016 average daily flows in the Russian River as measured at U.S. Geological Survey (USGS) gages in cubic feet per second (cfs). Flow rates are preliminary and subject to final revision by USGS.

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, and D1610 dry water supply condition minimum flows of 150 cfs after 1 June in most reaches of the upper Russian River (Figure 2-3). However, flows in the lower Russian River at Hacienda were only below the D1610 minimum flows of 125 cfs for a portion of the month of July (Figure 2-4).

While the Order was in effect, upper Russian River flows declined below the 125 cfs five-day running average TUC flow three times at Digger Bend in late June/early July, mid-July, and late September. Five-day running average flows during those periods were as low as 116 cfs (Figure 2-3). Upper Russian River flows declined below the instantaneous flow of 110 cfs authorized by the Order for one day on 14 September at Talmage and Hopland after releases from Lake Mendocino were reduced to allow the U.S. Army Corps of Engineers to perform maintenance on the reservoir outlet (Figure 2-3). Flows on 14 September were 99 cfs at Talmage and 100 cfs at Hopland.

While the Order was in effect, lower Russian River flows at Hacienda (downstream of the confluence with Dry Creek) did not drop below the five-day running average TUC flow of 70 cfs or the instantaneous minimum flow of 60 cfs (Figure 2-4).

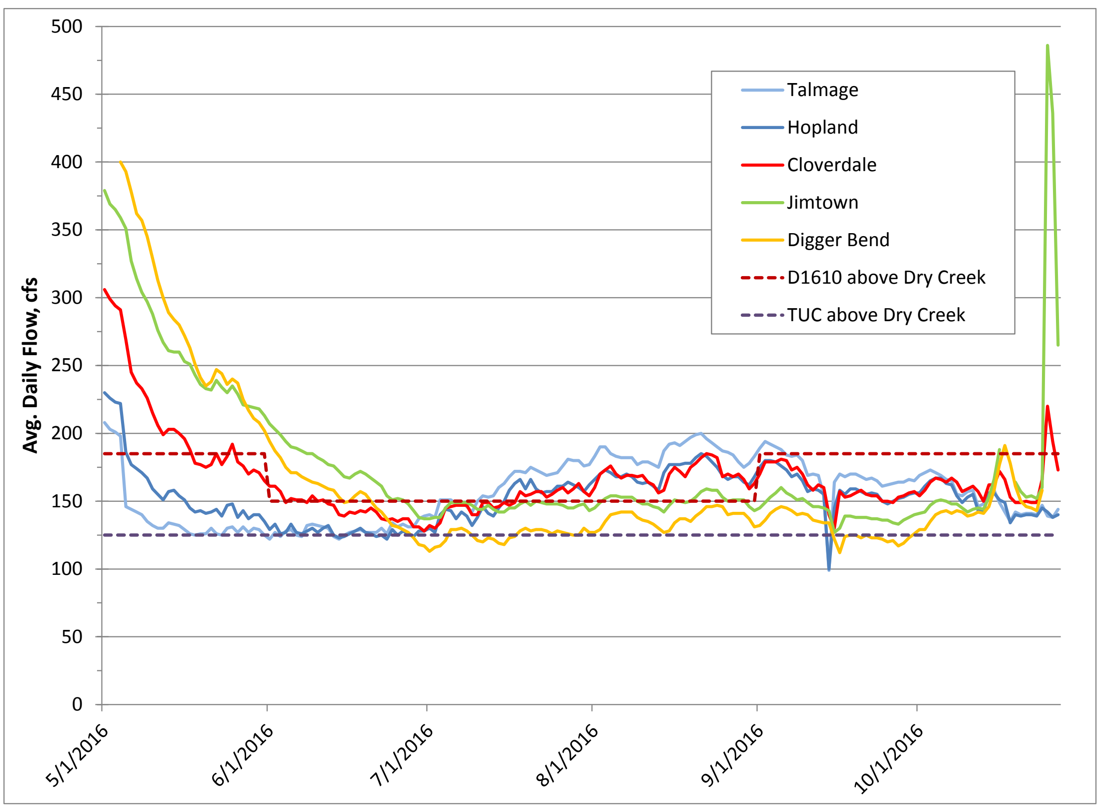

Figure 2-3. 2016 average daily flows in the Upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

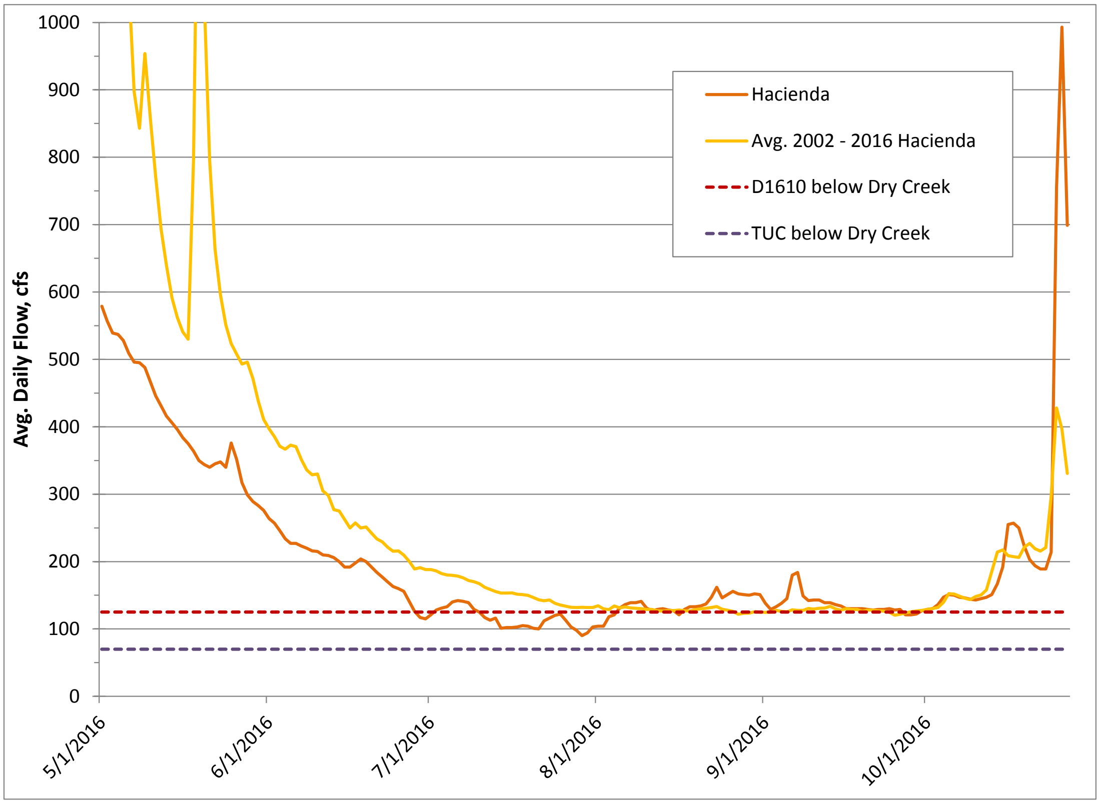

Figure 2-4. 2016 average daily flows in the Lower Russian River as measured at USGS gages below the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

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.).

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, algae, and cyanobacteria at four sites along the Russian River between Hopland and Patterson Point to support NCRWQCB analysis and evaluation of water quality data relating to biostimulatory conditions and cyanotoxins. In addition, the Water Agency continued to conduct long-term water quality monitoring and weekly grab sampling for nutrients, bacteria, and algae in the lower, middle, and upper reaches of the Russian River Estuary and the upper extent of inundation and backwatering during lagoon formation, between the mouth of the river at 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 75^{th} 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 present in the Russian River in 2015, 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 2016 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 31 May and continued until 19 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 2016 seasonal results are shown in Table 3-1 and in Figures 3-1 and 3-2.

Table 3-1. Sonoma County DHS 2016 Seasonal Mainstem Bacteria Sampling Results (Sonoma County DHS, 2016a).

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
31-May-16	2,909	52	1,658	10	1,178	20	<10	<10	388	10	1,296	10	1,100	52	631	<10	1,607	175	2,359	20
6-Jun-16	4,106	31	2,481	30	2,755	20	1,376	98	1,172	63	1,076	20	1,210	52	836	10	1,187	63	1,842	20
13-Jun-16	3,654	20	1,720	10	1,401	<10	1,450	109	1,296	31	855	52	1,500	20	1,050	10	1,354	480	383	<10
20-Jun-16	2,359	41	1,793	20	1,872	10	1,956	109	1,296	20	884	<10	1,354	10	1,274	30	2,613	*	2,755	52
21-Jun-16																	3,654	122		
27-Jun-16	4,352	97	2,481	31	1,720	<10	2,247	75	1,624	31	16,279	20	1,722	10	2,489	20	2,481	63	4,106	*
29-Jun-16																			4,106	41
5-Jul-16	5,173	63	2,014	10	2,247	20	4,611	20	1,616	10	2,098	20	2,359	10	2,489	31	2,909	20	5,794	41
11-Jul-16	4,106	31	1,785	<10	2,851	41	1,616	10	1,187	10	1,850	10	1,723	30	1,918	10	*	*	3,255	74
12-Jul-16																	5,475	52		
18-Jul-16	6,488	20	1,376	<10	3,676	30	1,100	31	1,565	10	2,481	20	1,553	<10	4,884	31	*	10	1,500	<10
20-Jul-16																	2,098	20		
25-Jul-16	2,481	20	3,256	41	2,359	31	1,187	20	2,909	63	2,046	10	1,860	10	2,098	<10	2,282	20	4,352	30
1-Aug-16	3,076	10	1,850	10	2,755	10	1,396	20	1,439	<10	3,448	31	2,046	10	1,989	20	1,017	10	4,352	<10
8-Aug-16	2,481	41	3,076	<10	2,909	<10	1,674	<10	1,541	<10	932	10	1,169	20	1,515	<10	1,334	<10	2,098	31
15-Aug-16	3,076	52	1,989	<10	2,481	<10	1,860	31	1,106	10	1,334	<10	1,112	<10	1,376	31	1,723	<10	1,354	31
22-Aug-16	2,755	52	1,281	20	2,755	20	1,904	20	2,014	52	809	<10	1,178	<10	1,153	<10	1,223	110	1,722	30
29-Aug-16	2,481	52	1,354	20	2,613	10	1,017	75	1,198	10	1,210	10	882	<10	959	10	1,725	52	1,223	52
6-Sep-16	1,850	52	1,314	<10	1,782	10	1,515	20	602	10	816	<10	1,050	10	1,467	10	1,658	<10	1,723	10
12-Sep-16	2,723	63	1,145	10	1,396	10	1,333	10	776	20	1,354	10	1,314	20	2,098	10	1,017	20	1,017	41
19-Sep-16	3,488	52	1,500	20	2,359	20	1,483	160	960	10	987	10	627	31	11,187	10	4,611	132	1,664	52

*Resample conducted.

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, but are not associated with a known or suspected human sewage release.

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

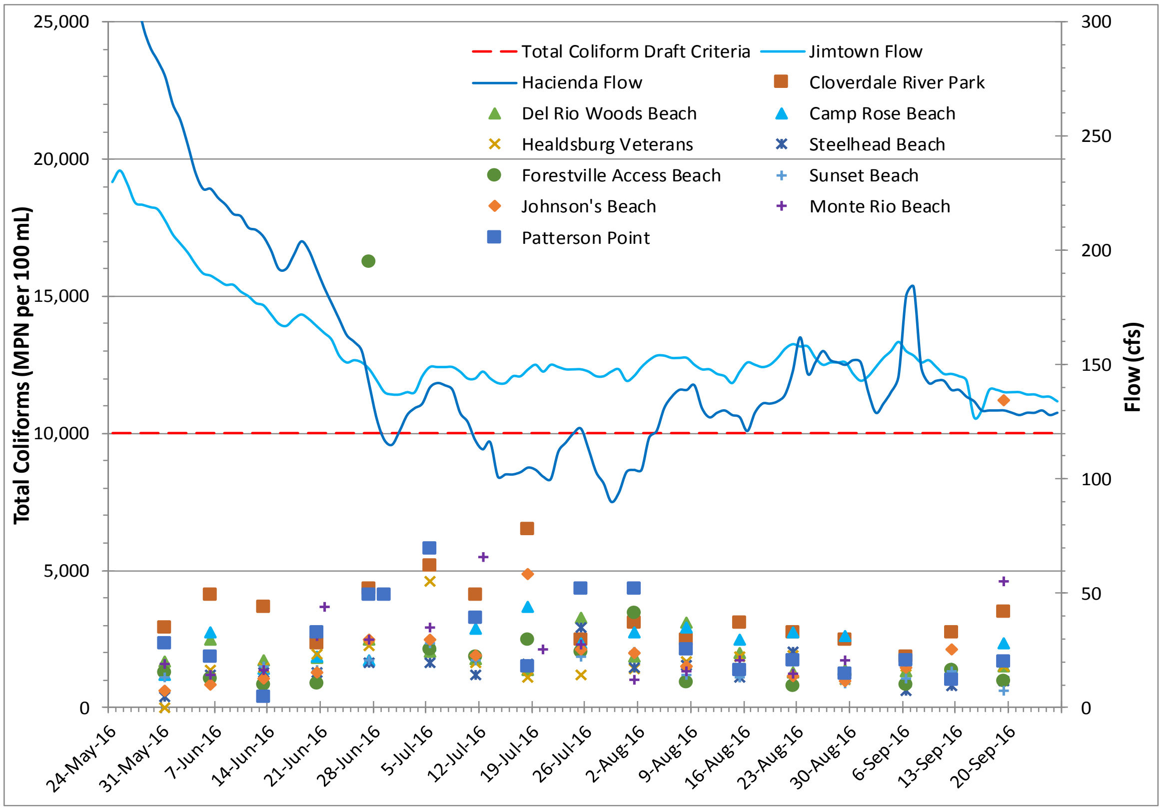

Figure 3-1. Sonoma County DHS 2016 Seasonal Mainstem Russian River Bacteria Sample Results for Total Coliform. Flow rates are preliminary and subject to final revision by USGS.

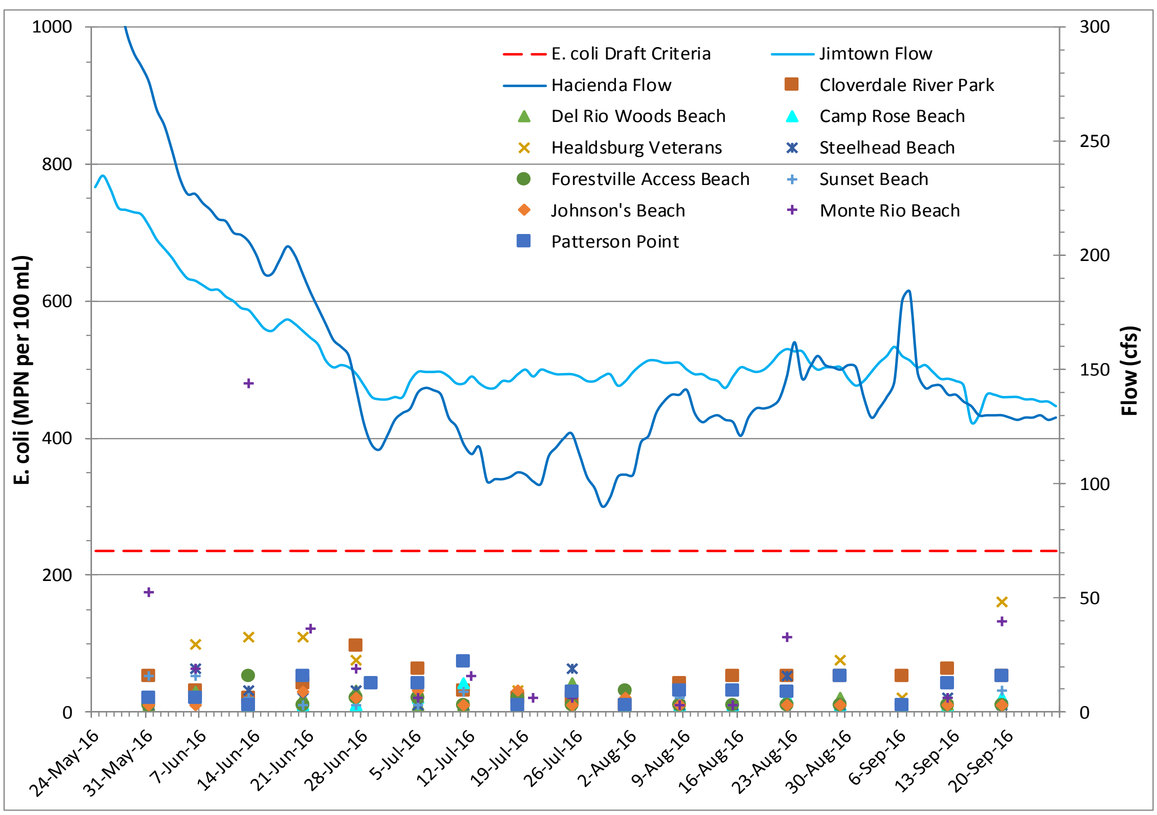

Figure 3-2. Sonoma County DHS 2016 Seasonal Mainstem Russian River Bacteria Sample Results for *E. coli*. Flow rates are preliminary and subject to final revision by USGS.

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

In 2016, 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 1 August and continued until 19 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 2016 seasonal results are shown in Table 3-2.

Table 3-2. Sonoma County DHS 2016 Seasonal Mainstem Russian River Cyanotoxin Sampling Results (Sonoma County DHS, 2016b).

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
1-Aug-16	ND	ND	ND	ND	0.167	0.153	ND	ND	0.237	0.193
8-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
22-Aug-16	ND	ND	ND	ND	ND	ND	0.35	ND	ND	ND
29-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Sep-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	.17*
12-Sep-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Sep-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
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
1-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15-Aug-16	ND	ND	ND	ND	ND	ND	ND	0.68	ND	ND
22-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
29-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Sep-16	ND	ND	ND	>5*	ND	>5*	>5*	>5*	3*	>5*
12-Sep-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Sep-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
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
1-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
22-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
29-Aug-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Sep-16	ND	ND	ND	>2*	ND	ND	ND	>2*	ND	>2*
12-Sep-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Sep-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

All results are in µg/L. ND indicates that no toxins were detected.
*Final results were inconclusive.

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 Nutrient Grab Sampling

In 2016, Water Agency staff conducted biweekly nutrient grab sampling and ambient algae monitoring from 16 June through 6 October at four stations in the mainstem Russian River including: the Hopland USGS gaging station north of Hopland, the Jimtown USGS gaging station in Alexander Valley, Riverfront Park upstream of the Windsor USGS gaging station, and at Patterson Point in Villa Grande. 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 3-3 and 3-4 and Figures 3-4 through 3-7.

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. This effort is 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. Ambient algae and cyanobacterial monitoring and sampling was conducted to support NCRWQCB and Sonoma County DHS cyanotoxin monitoring and assessment of the potential for cyanoHABs in the Russian River. Ambient algae, cyanobacteria, and associated grab sampling data for 2016 is currently being compiled and will be discussed in the "Russian River Biological Opinion Status and Data Report Year 2016-17" due to be released in June 2017. The annual report will be available on the Water Agency's website: 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 Mainstem Russian River Nutrient Grab Sampling

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SONOMA COUNTY WATER AGENCY

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Hopland was the only station that exceeded the EPA criteria for Total Nitrogen during the ambient algae monitoring effort (Table 3-3 and Figure 3-4a). Two exceedances occurred at the beginning of the season and one at the end of the season with flows ranging from 129 cfs to 163 cfs at the Hopland gage.

By contrast, all four monitoring stations were observed to have exceedances of the EPA criteria for Total Phosphorous during the monitoring season (Tables 3-3 and 3-4). The station at Hopland was observed to have the highest concentrations of the four stations, including a maximum value of 0.11 mg/L, and exceeded the EPA criteria during the entire term of the Order under flows that ranged from 129 cfs to 170 cfs (Table 3-3 and Figure 3-4b). The Jimtown station had exceedances during July and in the latter half of the season; however, concentrations were significantly lower than those at Hopland (Table 3-3 and Figure 3-5b). Riverfront Park had three exceedances early in the season with flows over 178 cfs at the Windsor gage, and one exceedance at the end of the season with a flow of 220 cfs (Table 3-4 and Figure 3-6b). Patterson Point had three exceedances at the beginning of the season with flows ranging from 104 cfs to 134 cfs at the Hacienda gage, and one exceedance at the end of the season with a flow of 148 cfs (Table 3-4 and Figure 3-7b). While Total Phosphorus concentrations generally decreased through the season at Riverfront Park and Patterson Point, they increased early in the season at Hopland and Jimtown and then leveled off through the remainder of the season. Interestingly, Total Phosphorus concentrations at Hopland increased with increasing flows (Figure 3-4b).

Hopland station turbidity levels exceeded the Turbidity EPA criteria during the entire monitoring season, with values increasing to 20.6 NTU by 25 August before declining through the rest of the season (Table 3-3 and Figure 3-4c). It is possible that the increasing turbidity values may have contributed to increasing Total Phosphorus values early in the season at Hopland, and possibly Jimtown (Figures 3-4b and 3-5b). However, additional data is needed to determine if there is a positive correlation. The Jimtown and Riverfront Park stations each exceeded the Turbidity criteria on 22 September, with flows of 138 cfs at Jimtown and 214 cfs at Windsor (Table 3-3 and 3-4). Patterson Point did not exceed turbidity criteria during the ambient algae monitoring effort (Table 3-4).

Algal (*chlorophyll a*) results predominantly exceeded the EPA criteria at the Hopland and Jimtown stations throughout the season, with flows that ranged from 130 cfs to 170 cfs at Hopland and 138 cfs to 159 cfs at Jimtown (Table 3-3 and Figures 3-4d and 3-5d). Riverfront Park had one *chlorophyll a* exceedance early in the season with flows of 178 cfs at Windsor (Table 3-4 and Figure 3-6d). Patterson Point had two *chlorophyll a* exceedances early in the season with flows of 104 cfs and 132 cfs at Hacienda (Table 3-4 and Figure 3-7d).

Table 3-3. Water Agency 2016 Seasonal Mainstem Russian River Grab Sampling Results at Hopland and Jimtown.

Hopland	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	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	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	mg/L	NTU	mg/L	(cfs)
6/16/2016	14:30	15.5	7.6	0.24	ND	ND	0.22	ND	0.24	**0.46**	**0.065**	0.13	130	**6.4**	**0.0021**	130
6/30/2016	16:30	18.2	7.7	0.37	ND	ND	0.13		0.37	**0.50**	**0.069**	-----	-----	**3.7**	0.00084	129
7/13/2016	13:30	16.7	7.4	ND	ND	ND	0.10	ND	ND	0.20	**0.071**	0.19	110	**4.2**	0.0017	137
7/28/2016	8:30	15.6	7.7	0.28	ND	ND	0.079	ND	0.28	0.36	**0.084**	-----	120	**12.2**	**0.0041**	163
8/10/2016	14:20	16.5	7.5	0.28	ND	ND	0.067	ND	0.28	0.35	**0.093**	-----	120	**19.2**	**0.0018**	162
8/25/2016	12:30	15.0	7.4	0.21	ND	ND	0.091	0.049	0.21	0.35	**0.11**	-----	120	**20.6**	**0.0024**	165
9/8/2016	15:00	16.9	7.4	0.2	ND	ND	0.070	ND	0.24	0.32	**0.095**	-----	130	**10.2**	**0.0018**	170
9/22/2016	14:50	16.2	7.7	ND	ND	ND	0.11	ND	ND	0.25	**0.11**	-----	120	**7.5**	**0.0024**	157
10/6/2016	13:20	15.8	7.7	ND	ND	ND	0.19	0.043	ND	**0.40**	**0.11**	-----	140	**8.2**	**0.0020**	163

Jimtown	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	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	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	mg/L	NTU	mg/L	(cfs)
6/16/2016	13:20	19.3	7.7	ND	ND	ND	0.18	ND	ND	0.36	ND	0.032	170	0.96	**0.0029**	159
6/30/2016	15:20	23.9	7.8	ND	ND	ND	0.082		ND	0.22	ND	-----	-----	0.1	0.0013	126
7/13/2016	11:50	22.2	7.7	ND	ND	ND	0.091	ND	ND	0.23	**0.022**	0.031	160	0.5	**0.0028**	138
7/27/2016	14:20	24.5	8.1	ND	ND	ND	0.062	ND	ND	0.24	**0.022**	-----	150	0.4	**0.0049**	138
8/10/2016	13:00	22.3	8.1	ND	ND	ND	ND	ND	ND	0.14	0.036	-----	150	0.9	**0.0028**	143
8/25/2016	10:20	19.6	7.5	ND	ND	ND	ND	ND	ND	0.21	**0.029**	-----	160	1.6	**0.0050**	155
9/8/2016	14:00	21.6	8.1	ND	ND	ND	ND	ND	ND	0.20	**0.033**	-----	160	1	0.0016	153
9/22/2016	13:40	19.2	8.0	ND	0.14	0.0051	0.045	ND	ND	0.15	**0.032**	-----	150	**2.9**	0.00060	138
10/6/2016	12:20	17.2	7.8	ND	ND	ND	0.11	ND	ND	0.18	**0.031**	-----	160	1.2	**0.0023**	153

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

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

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

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

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

Recommended EPA Criteria based on Aggregate Ecoregion III

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

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

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

Table 3-4. Water Agency 2016 Seasonal Mainstem Russian River Grab Sampling Results at Riverfront Park and Patterson Point.

Riverfront Park	Time	Temperature	pH	Total Organic Nitrogen	Ammonia as N	Ammonia as N Unionized	Nitrate as N	Nitrite as N	Total Kjeldahl Nitrogen	Total Nitrogen**	Phosphorus, Total	Total Orthophosphate	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	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	mg/L	NTU	mg/L	(cfs)
6/16/2016	11:00	17.7	7.7	ND	ND	ND	0.13	ND	ND	0.30	**0.026**	0.032	160	1.4	0.0013	255
6/30/2016	13:20	21.5	8.0	ND	ND	ND	0.049		ND	0.15	**0.025**	-----	-----	0.6	**0.0020**	178
7/13/2016	10:20	20.5	7.8	ND	ND	ND	0.072	ND	ND	0.21	**0.022**	0.031	140	1.3	0.0017	220
7/27/2016	11:50	21.5	7.9	ND	ND	ND	ND	ND	ND	0.14	ND	-----	140	0.6	0.0012	226
8/10/2016	12:00	20.2	7.8	ND	ND	ND	ND	ND	ND	0.070	ND	-----	140	0.7	0.0012	169
8/30/2016	12:20	19.7	7.9	ND	ND	ND	ND	ND	ND	0.12	ND	-----	140	0.7	0.0014	282
9/8/2016	11:50	19.3	7.8	ND	ND	ND	ND	ND	ND	0.15	0.020	-----	150	0.8	0.0014	226
9/22/2016	12:20	17.1	7.5	ND	ND	ND	ND	ND	ND	0.13	ND	-----	140	**2.9**	0.00060	214
10/6/2016	11:30	15.6	7.8	ND	ND	ND	0.091	ND	ND	0.13	**0.022**	-----	140	0.9	0.0012	226

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	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	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	NTU	mg/L	(cfs)
6/30/16	11:50	23.3	7.8	ND	ND	ND	ND		ND	0.070	**0.044**	-----	-----	1.0	**0.0024**	132
7/13/16	9:00	23.1	7.7	ND	ND	ND	0.0042	ND	ND	0.14	**0.042**	0.085	150	1.5	0.0015	132
7/27/16	9:20	23.5	7.7	ND	ND	ND	ND	ND	ND	0.14	**0.031**	-----	10000	2.0	**0.0019**	104
8/10/16	10:40	22.3	7.8	ND	ND	0.00096	ND	ND	ND	0.10	**0.026**	-----	150	2.0	0.0013	134
8/30/16	10:40	21.2	8.1	ND	ND	ND	ND	ND	ND	0.10	0.021	0.055	140	1.8	0.0016	148
9/8/16	10:40	21.4	7.9	ND	ND	ND	ND	ND	ND	0.14	0.021	-----	150	1.6	0.0011	146
9/22/16	10:10	20.0	7.7	ND	ND	ND	ND	ND	ND	0.070	0.020	0.042	130	2.2	0.00090	129
10/6/16	10:20	16.6	7.5	ND	ND	ND	0.072	ND	ND	0.11	**0.028**	-----	130	1.8	0.00067	148

Patterson Point data for 8/30 and 9/22 was derived from concurrent estuary grab sampling results.

* 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.

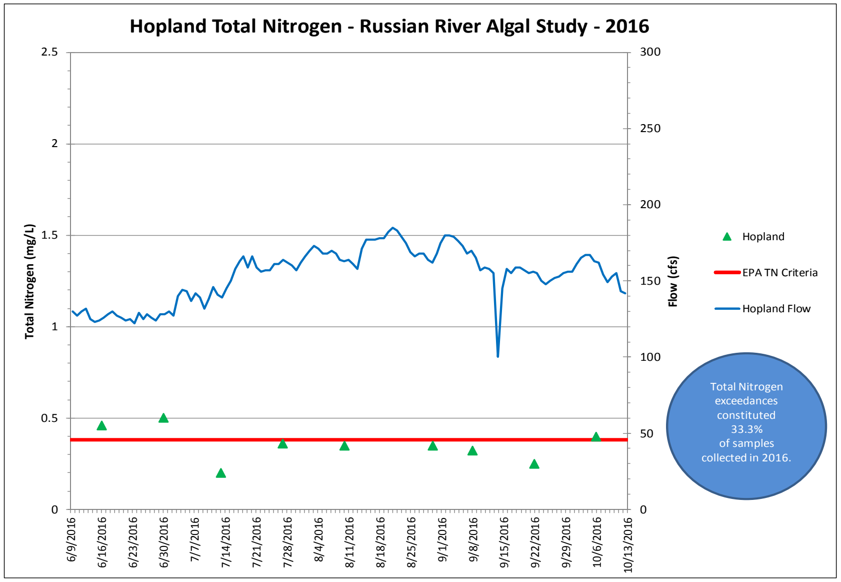
Recommended EPA Criteria based on Aggregate Ecoregion III

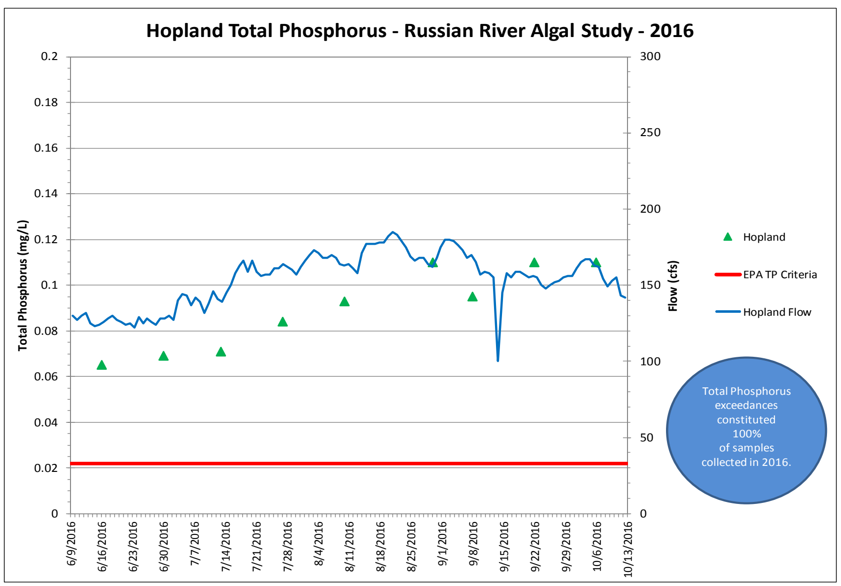
Total Phosporus: 0.02188 mg/L (21.88 ug/L) ≈ 0.022 mg/L

Total Nitrogen: 0.38 mg/L

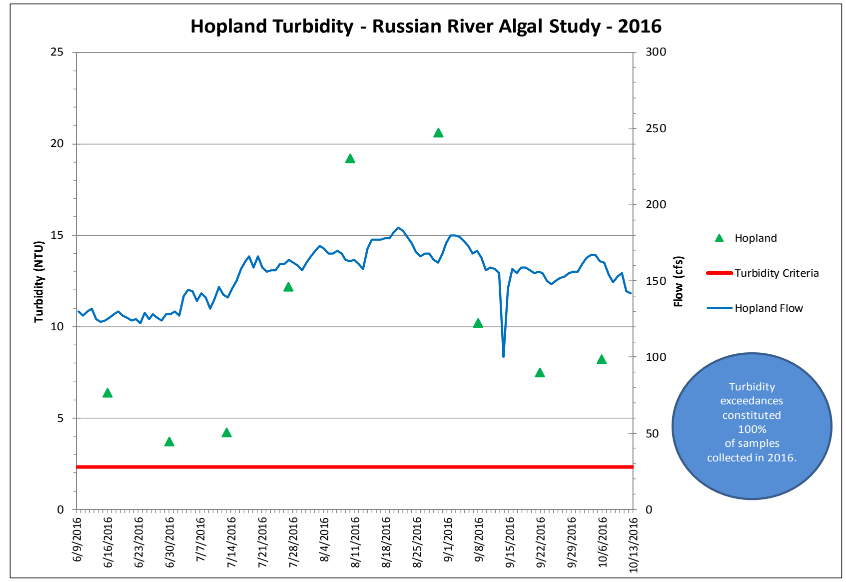
Chlorophyll *a*: 0.00178 mg/L (1.78 ug/L) ≈ 0.0018 mg/L

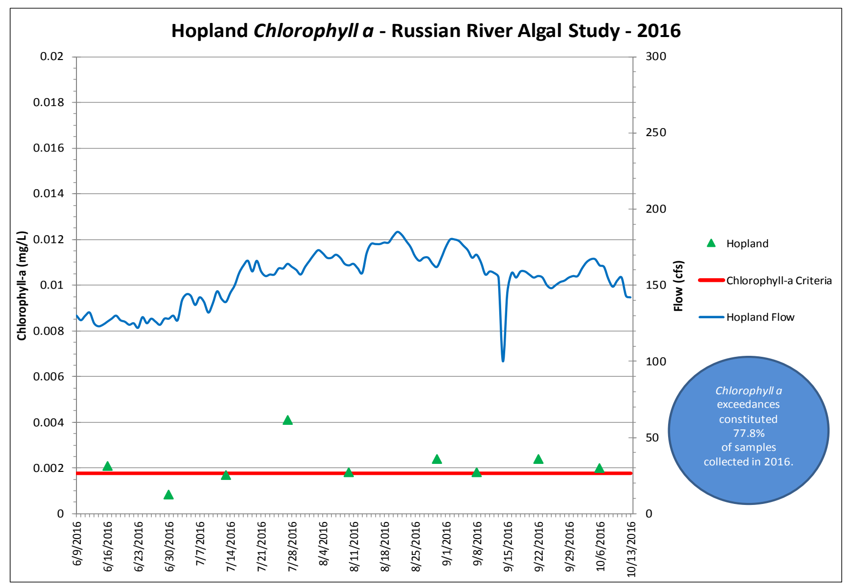
Turbidity: 2.34 FTU/NTU



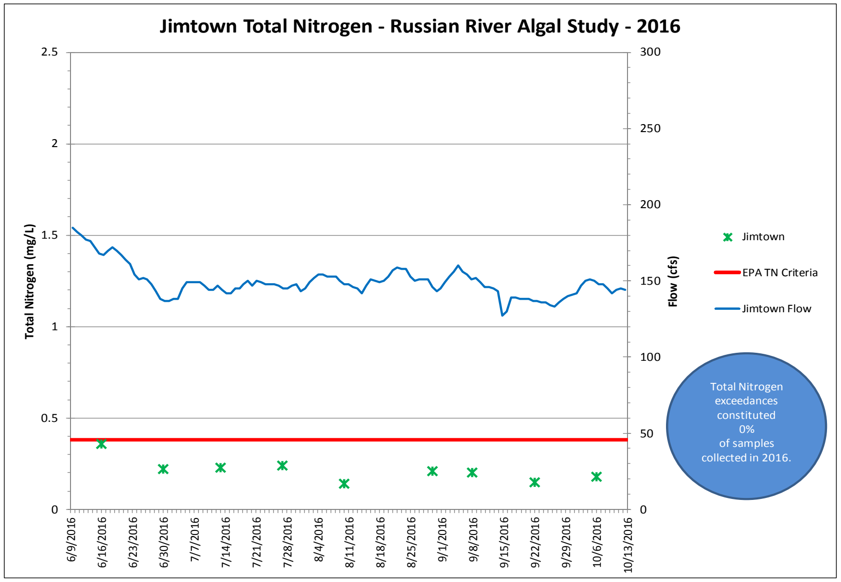


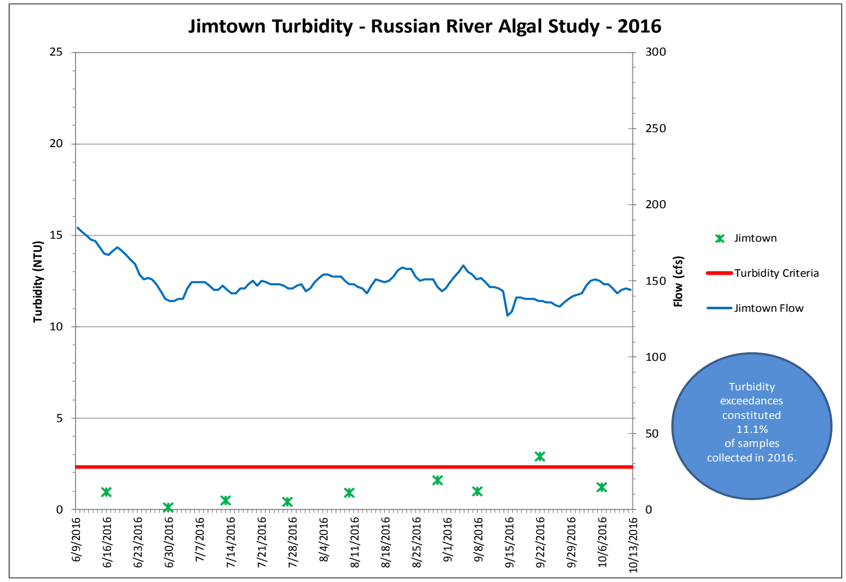
Figures 3-4 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Hopland in 2016.

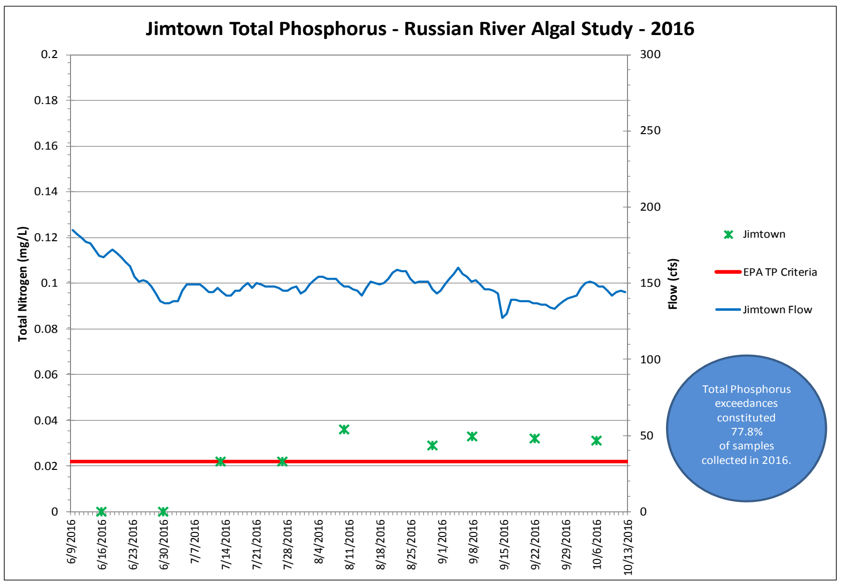


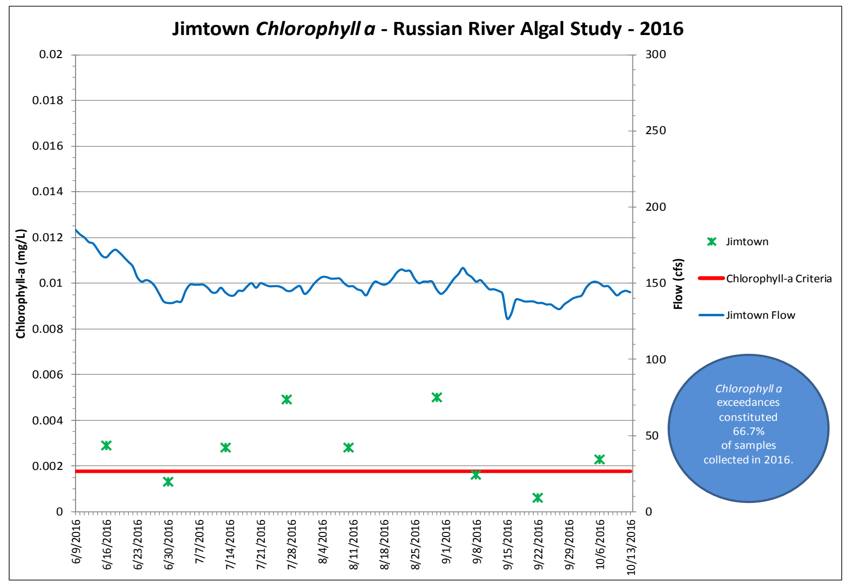


Figures 3-4 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and Results from Hopland in 2016.



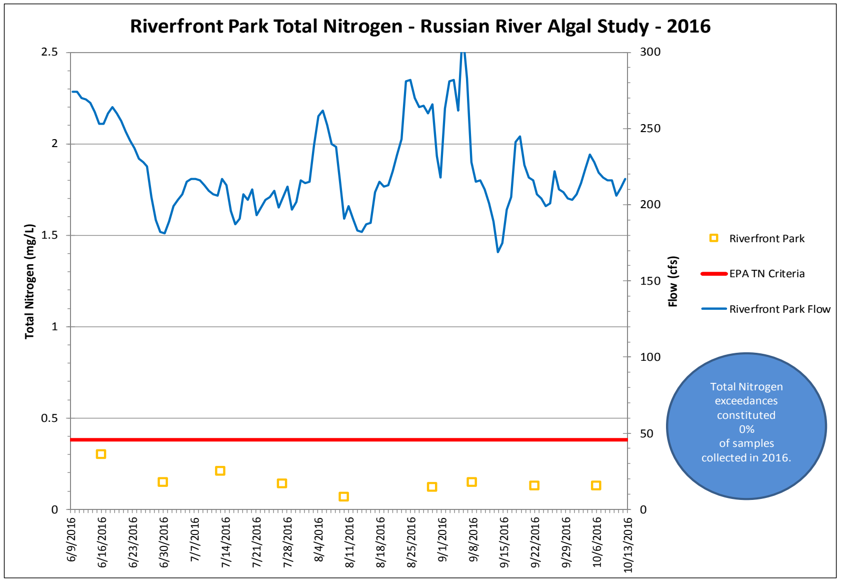


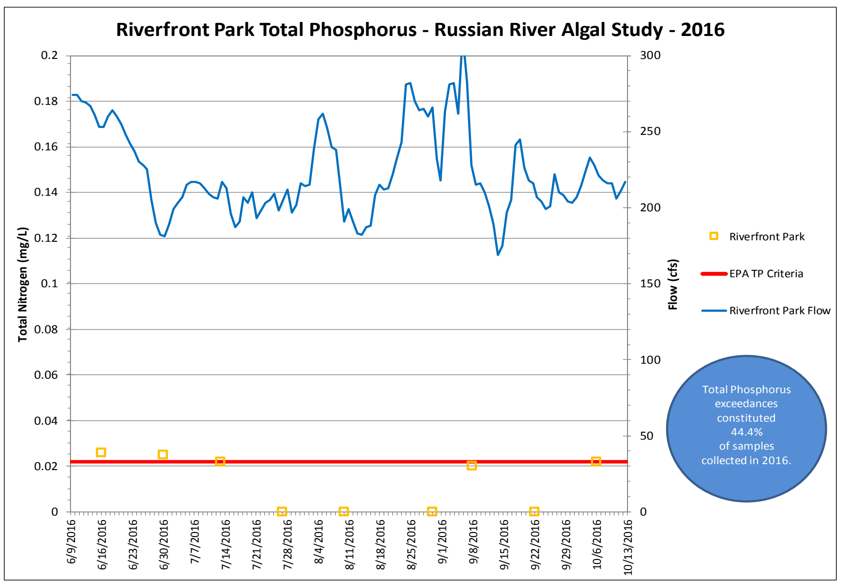




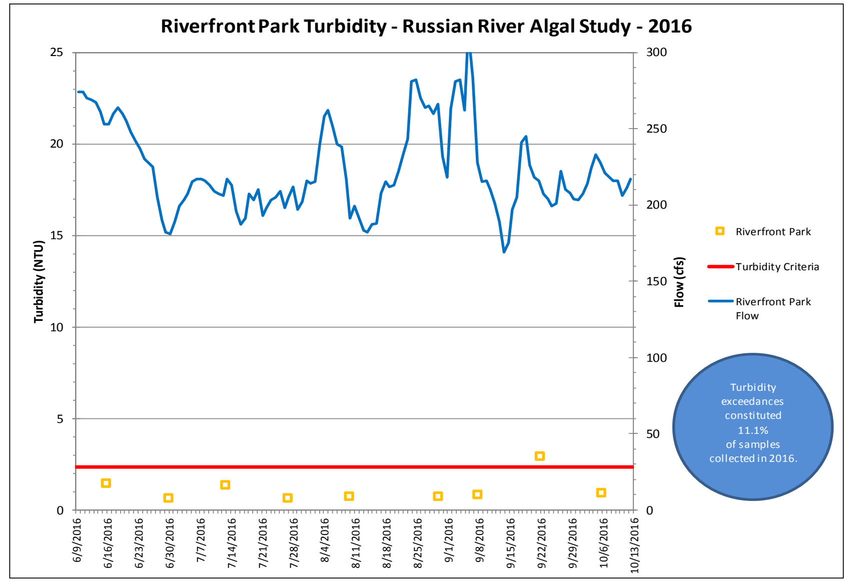
Figures 3-5 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Jimtown in 2016.

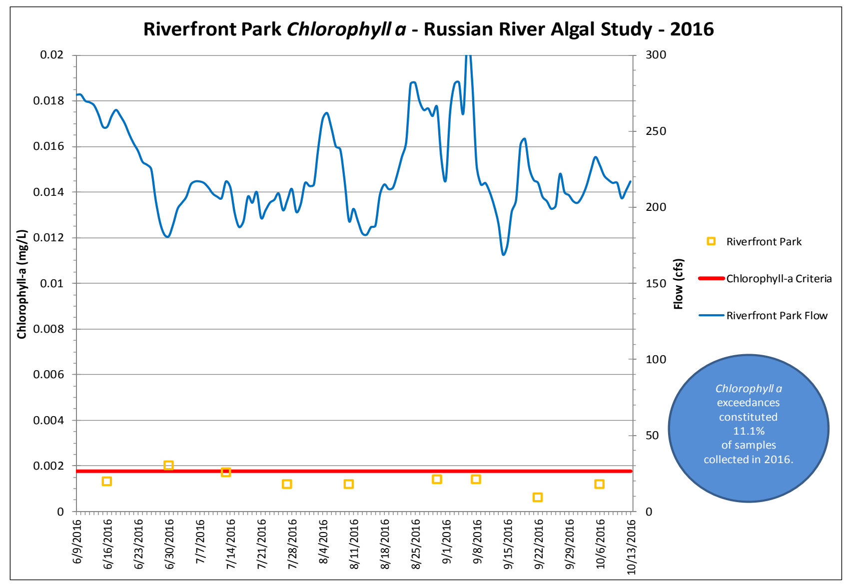
Figures 3-5 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll-a* Results from Jimtown in 2016.



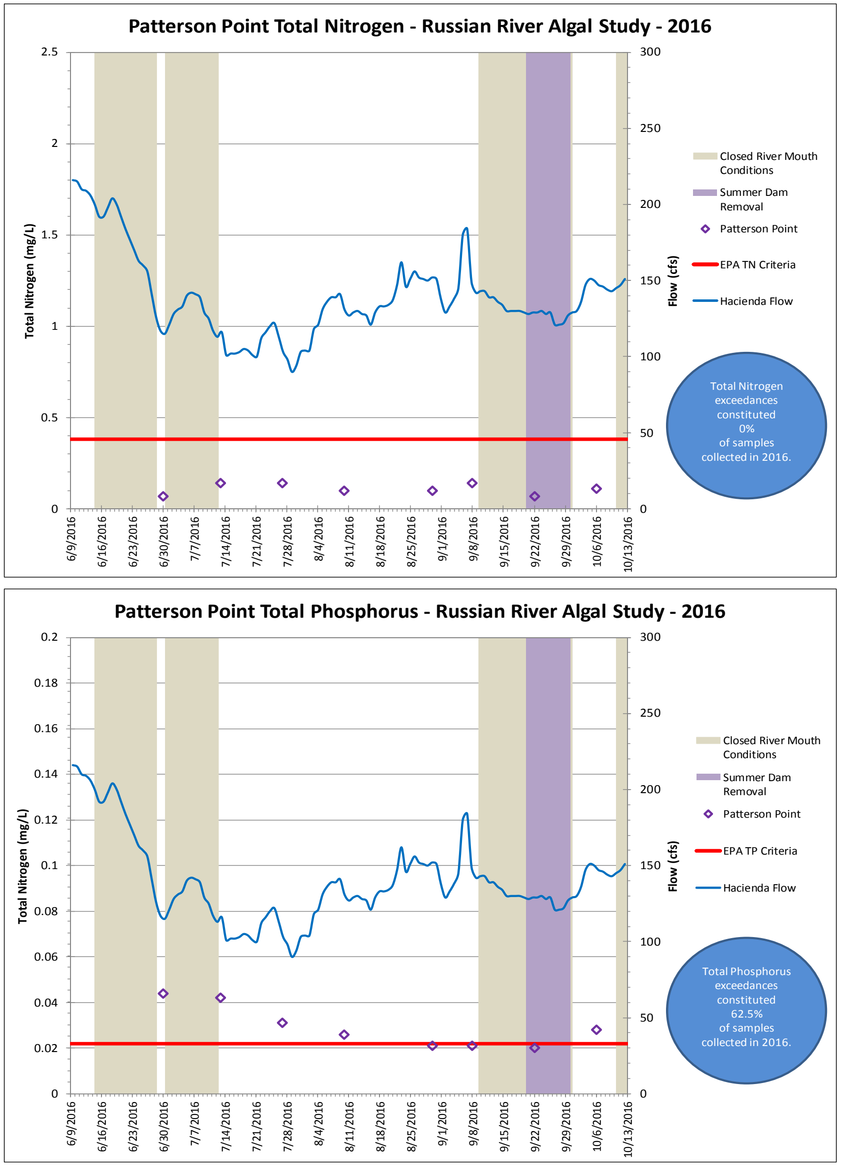


Figures 3-6 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Riverfront Park in 2016.

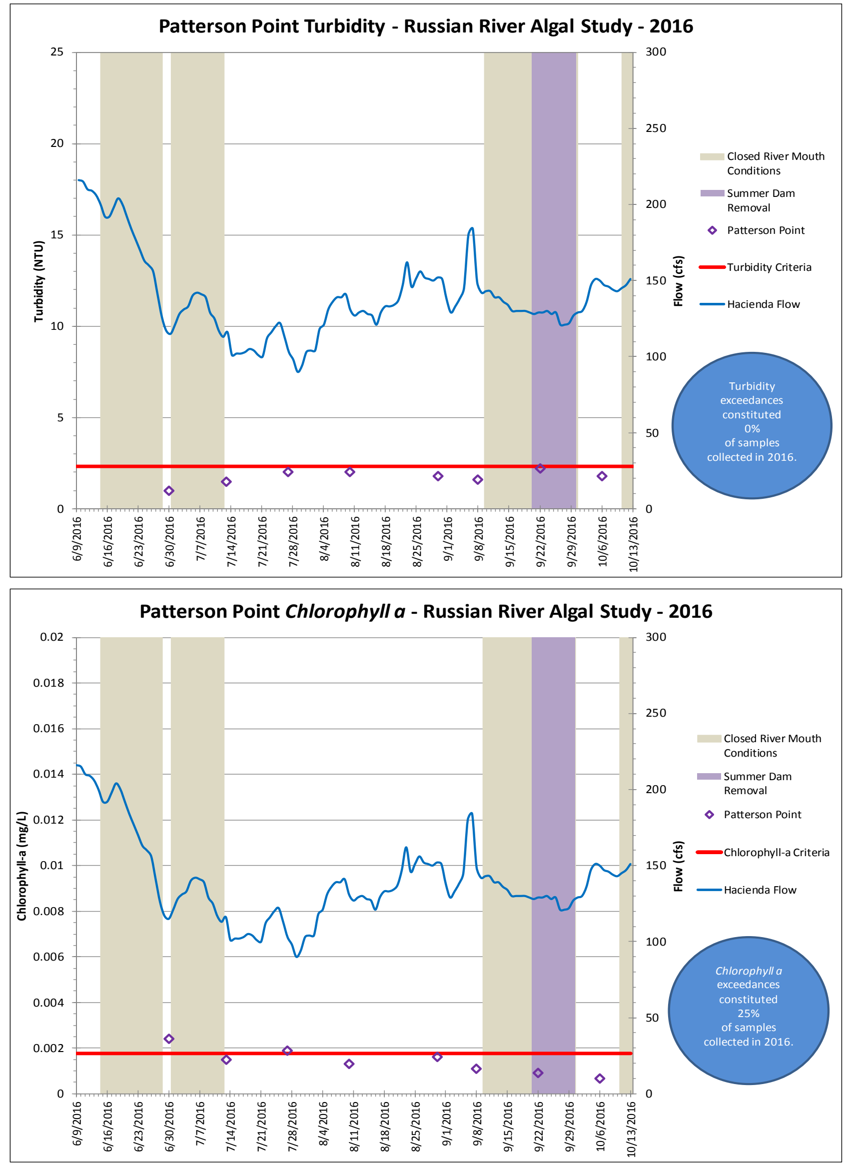




Figures 3-6 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll- a* Results from Riverfront Park in 2016.



Figures 3-7 a and b. Water Agency Seasonal Mainstem Russian River Grab Sampling Total Nitrogen and Total Phosphorus Results from Patterson Point in 2016.



Figures 3-7 c and d. Water Agency Seasonal Mainstem Russian River Grab Sampling Turbidity and *Chlorophyll-a* Results from Patterson Point in 2016.

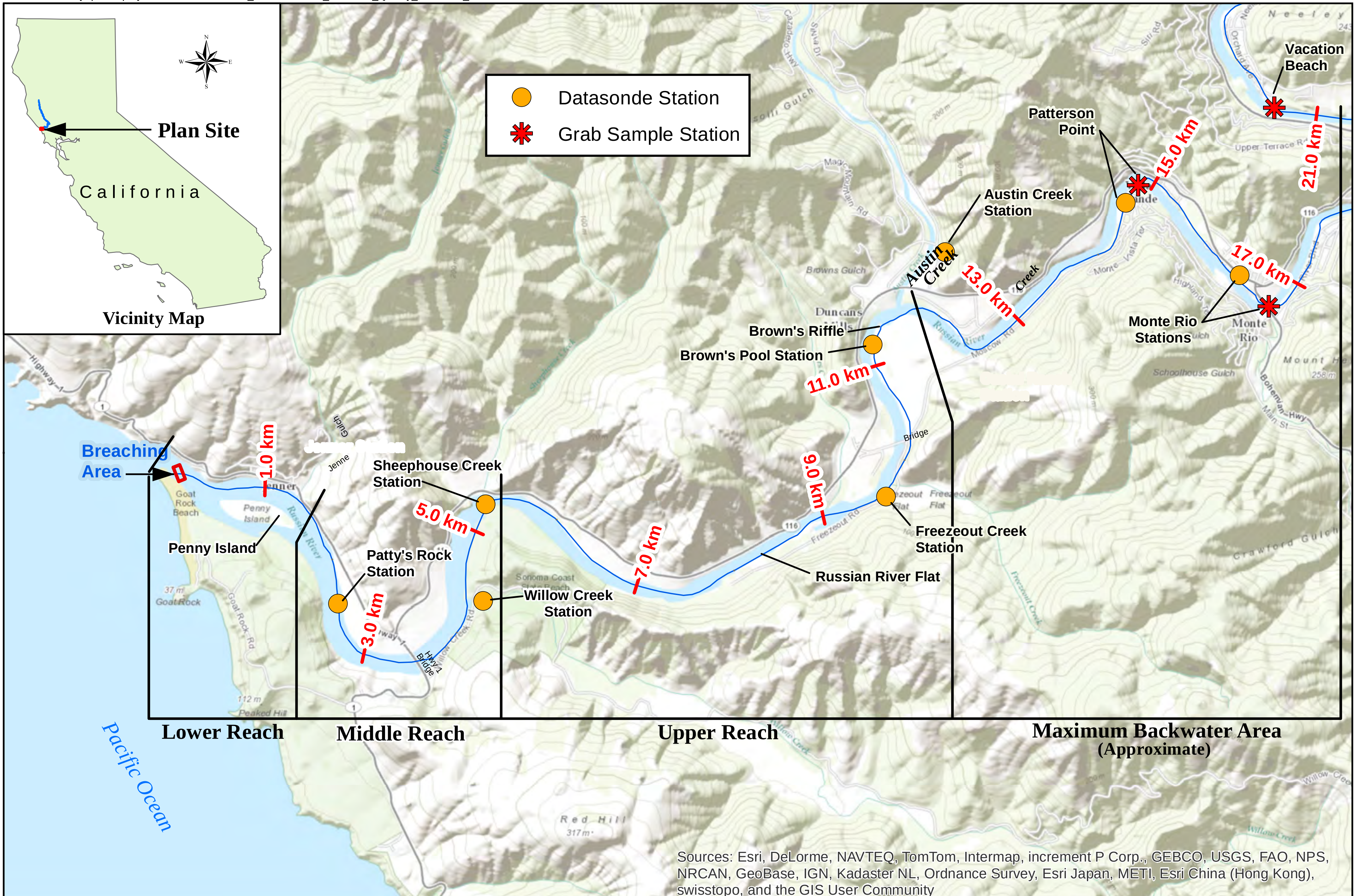
3.2 Water Agency Russian River Estuary Water Quality Monitoring

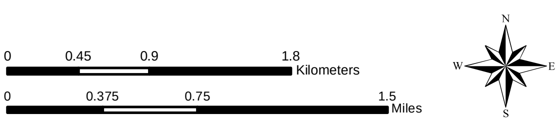
Flows in the lower Russian River at Hacienda (downstream of the confluence with Dry Creek) dropped below D1610 minimum flow requirement of 125 cfs during the month of July, but did not drop below the TUC five-day running average of 70 cfs or the instantaneous minimum flow of 60 cfs while the Order was in effect from 1 May through 27 October (Figure 2-4). Long-term water quality monitoring and weekly grab sampling was conducted in the lower, middle, and upper reaches of the Russian River Estuary and the upper extent of inundation and backwatering during lagoon formation, between the mouth of the river 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 2016 monitoring season (Figure 3-8). Data was not collected at the Sheephouse Creek station in 2016 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 2016 is currently being compiled and will be discussed in the "Russian River Biological Opinion Status and Data Report Year 2016-17" due to be released in June 2017. The annual report will be available on the Water Agency's website: http://www.scwa.ca.gov/bo-annual-report/.

Water Agency staff conducted weekly grab sampling from 10 May to 18 October at three stations in the lower mainstem Russian River, including: Vacation Beach, Monte Rio, and Patterson Point (Figure 3-8). 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 3-5 through 3-7 and Figures 3-9 and 3-10. Samples collected for *Enterococcus* were undiluted only and results are included in Tables 3-5 through 3-7 and Figure 3-11. 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 3-9 and 3-10 utilize undiluted sample results unless the reporting limit has been exceeded, at which point the diluted results are utilized.





Russian River Estuary
Water Quality Monitoring Stations

This Map is for general reference only.

Figure 3-8

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 3-8, and the results are summarized in Tables 3-5 through 3-10 and Figures 3-9 through 3-15. 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 no exceedances of the recommended EPA Recreational Water Quality Criteria (RWQC) for Total Coliform at the monitoring stations (Figure 3-9). However, the Monte Rio station was observed to have two exceedances of the RWQC for *E. coli*, one during estuary closure in June with Hacienda flows at 170 cfs, and the other during estuary closure and summer dam removal in September with flows at 122 cfs (Table 3-6 and Figure 3-10). Several exceedances of the *Enterococcus* RWQC were observed early in the season at all three monitoring stations during closed estuary conditions, with Hacienda flows ranging from 170 to 259 cfs (Tables 3-5 through 3-7). Later in the season, Monte Rio was observed to have two *Enterococcus* exceedances; one during estuary closure and summer dam removal with Hacienda flows of 122 cfs, and the other during estuary closure as flows increased from approximately 150 cfs to 240 cfs (Table 3-6 and Figure 3-11). Patterson Point was also observed to have an exceedance of the *Enterococcus* RWQC during an estuary closure event in July with Hacienda flows at 113 cfs (Table 3-7 and Figure 3-11). External factors including estuary closures and the removal of two summer dams in Guerneville at the end of September likely had an effect on increasing bacterial concentrations observed during the 2016 monitoring season (Figures 3-9 through 3-11).

Table 3-5. 2016 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)
5/10/2016	11:30	17.3	8.1	1299.7	1723	13.2	10	<10	468
5/17/2016	11:30	20.5	8.0	727.0	677	5.2	10	3.1	377
5/24/2016	12:20	18.6	8.1	387.3	529	8.6	<10	2.0	343
5/31/2016	11:50	21.0	8.0	686.7	816	16.6	<10	5.1	277
6/2/2016	14:20	22.9	8.2	461.1	670	9.6	<10	30	259
6/7/2016	10:40	20.9	8.1	980.4	1333	30.9	30	40.2	224
6/14/2016	11:10	20.8	8.2	1553.1	4674	17.3	20	**141**	202
6/21/2016	10:20	21.8	8.1	>2419.6	2359	95.8	75	**248.9**	186
6/23/2016	11:10	22.9	8.1	>2419.6	4106	57.1	63	**95.9**	170
6/28/2016	12:40	24.3	8.1	>2419.6	2603	16.9	<10	41.4	127
7/5/2016	10:00	21.9	8.0	>2419.6	2755	24.6	10	47.4	140
7/7/2016	12:20	23.1	8.0	1986.3	2909	13.5	10	7.4	141
7/12/2016	9:40	23.3	8.1	>2419.6	4884	5.1	20	32.0	113
7/19/2016	9:40	23.3	8.0	>2419.6	3076	4.1	<10	6.3	104
7/26/2016	9:40	23.5	7.9	1732.9	3255	22.8	31	31.3	113
8/2/2016	9:40	23.5	7.9	412.0	2382	15.8	10	44.3	104
8/9/2016	10:50	22.5	7.9	1732.9	2613	25.9	20	8.6	141
8/16/2016	11:10	22.5	7.9	>2419.6	2064	18.3	20	7.3	121
8/23/2016	11:30	21.8	7.9	1299.7	1145	9.7	<10	9.7	162
8/30/2016	11:40	21.5	7.8	920.8	932	<10	<10	10.9	152
9/6/2016	11:00	21.2	8.0	866.1	1396	5.2	10	3.0	181
9/13/2016	11:20	20.2	7.9	1119.9	860	3.1	20	5.1	140
9/15/2016	12:10	20.0	7.9	1046.2	933	20.1	41	2.0	136
9/20/2016	11:20	20.9	7.8	1119.9	1063	26.2	41	9.7	129
9/22/2016	10:50	19.6	7.7	1732.9	1291	17.5	31	12.8	130
9/27/2016	10:20	19.6	7.8	1553.1	1019	27.5	41	41.6	121
9/29/2016	12:50	20.0	7.7	980.4	1187	7.5	31	5.2	122
10/4/2016	11:10	16.9	7.7	1046.2	1112	20.3	41	14.4	147
10/11/2016	11:00	17.2	7.8	980.4	1050	32.3	31	40.4	142
10/18/2016	0:00	16.3	7.7	1732.9	934	65	85	22.8	240

* 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 3-6. 2016 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)
5/10/2016	11:10	15.6	7.9	908.4	1376	16.0	<10	<10	468
5/17/2016	11:10	19.8	7.8	866.4	857	4.1	20	1.0	377
5/24/2016	12:00	17.9	8.0	488.4	529	6.3	10	3.1	343
5/31/2016	11:30	21.0	7.9	770.1	1187	14.6	30	5.2	277
6/2/2016	14:00	22.4	8.0	1203.3	822	48.0	52	**228**	259
6/7/2016	10:20	21.9	8.2	>2419.6	1314	204.6	109	**387.3**	224
6/14/2016	10:50	21.4	8.1	1119.9	1178	13.4	20	**63**	202
6/21/2016	10:10	21.5	8.0	>2419.6	2909	69.7	51	**62.4**	186
6/23/2016	10:50	22.9	8.1	>2419.6	3784	**261.3**	**241**	**179.2**	170
6/28/2016	12:20	24.0	7.8	>2419.6	4106	16.9	<10	5.2	127
7/5/2016	9:40	21.9	7.9	>2419.6	4106	22.4	10	12.8	140
7/7/2016	12:00	23.3	7.9	>2419.6	3076	18.7	63	14.4	141
7/12/2016	9:20	23.4	7.8	2419.6	4106	33.2	41	26.2	113
7/19/2016	9:20	23.1	7.9	>2419.6	3255	12.1	20	7.4	104
7/26/2016	9:20	23.8	7.9	2419.6	2909	2.0	<10	14.5	113
8/2/2016	9:25	23.2	7.8	571.7	1354	4.1	<10	7.2	104
8/9/2016	10:20	22.4	7.8	1553.1	1178	13.2	20	5.2	141
8/16/2016	10:50	22.3	7.8	1299.7	1198	7.5	20	<1.0	121
8/23/2016	11:05	21.6	7.8	1732.9	1076	21.6	10	4.1	162
8/30/2016	11:20	21.1	7.8	1203.3	959	41	41	7.4	152
9/6/2016	10:50	20.8	7.9	1553.1	1187	16.7	20	6.2	181
9/13/2016	11:00	19.8	7.8	816.4	1126	8.6	10	3.1	140
9/15/2016	11:50	19.9	7.8	980.4	657	20.1	10	3.0	136
9/20/2016	10:50	21.1	7.8	1986.3	2187	104.3	121	52.0	129
9/22/2016	10:40	20.1	7.8	1956.3	1860	72.7	110	53.7	130
9/27/2016	10:00	19.8	7.7	1413.6	2187	99.0	41	43.1	121
9/29/2016	12:30	20.0	7.7	>2419.6	4611	**980.4**	**884**	**290.9**	122
10/4/2016	10:50	16.8	7.6	1203.3	933	8.5	10	13.5	147
10/11/2016	10:40	17.1	7.8	1119.9	1050	14.6	31	11.9	142
10/18/2016	10:20	16.7	7.7	1986.3	1670	77.1	97	**61.7**	240

* 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 3-7. 2016 Patterson Point bacteria concentrations for samples collected by the Water Agency. This site experiences freshwater conditions.

Patterson Point	Time	Temperature	pH	Total Coliforms (Colilert)	Total Coliforms Diluted 1:10 (Colilert)	E. coli (Colilert)	E. coli Diluted 1:10 (Colilert)	Enterococcus (Enterolert)	USGS 11467000 RR near Guerneville (Hacienda)***
MDL*				20		20		2	Flow Rate****
Date		°C		MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	MPN/100mL	(cfs)
5/10/2016	11:00	16.6	7.9	686.7	908	12.1	<10	<10	468
5/17/2016	10:50	20.1	7.9	648.8	670	10	31	1.0	377
5/24/2016	11:40	18.1	8.0	547.5	455	8.4	<10	1.0	343
5/31/2016	10:50	21.4	8.0	1119.9	1178	18.9	<10	3.1	277
6/2/2016	13:40	22.6	8.1	866.4	744	22.8	41	10	259
6/7/2016	10:00	21.7	8.1	1553.1	2014	35.0	30	44.1	224
6/14/2016	10:30	21.3	8.1	1732.9	1119	22.3	10	**63**	202
6/21/2016	9:40	21.5	8.2	>2419.6	2282	25.6	63	47.0	186
6/23/2016	10:10	22.6	8.1	>2419.6	4611	43.2	74	28.2	170
6/28/2016	11:50	23.7	7.8	>2419.6	3873	13.4	20	7.4	127
7/5/2016	9:20	21.7	7.9	>2419.6	2098	44.3	31	15.8	140
7/7/2016	11:10	22.6	7.9	>2419.6	4352	43.2	41	21.3	141
7/12/2016	8:50	23.1	7.9	>2419.6	3448	16.9	52	**73.3**	113
7/19/2016	9:00	22.2	7.8	1986.3	2613	1.0	<10	2.0	104
7/26/2016	9:00	23.0	7.6	2419.6	4106	6.3	10	14.5	113
8/2/2016	9:00	22.7	7.8	>2419.6	1956	29.9	41	21.6	104
8/9/2016	9:50	22.1	7.8	1732.9	2481	9.7	<10	10.8	141
8/16/2016	10:30	21.9	7.8	1413.6	1450	18.5	<10	4.1	121
8/23/2016	10:10	21.7	7.9	1299.7	1250	17.1	10	2.0	162
8/30/2016	10:40	21.2	8.1	1203.3	1236	12.0	20	3.1	152
9/6/2016	10:30	20.8	8.0	1046.2	1145	16.1	20	5.2	181
9/13/2016	10:30	19.8	7.8	727.0	884	14.8	41	8.6	140
9/15/2016	11:00	20.0	7.8	816.4	1374	15.8	31	17.3	136
9/20/2016	10:30	20.8	7.8	1203.3	1723	34.5	52	16.0	129
9/22/2016	10:10	20.0	7.7	1732.9	134	67.9	109	54.4	130
9/27/2016	9:40	20.3	7.8	>2419.6	1789	66.3	41	39.9	121
9/29/2016	12:00	20.4	7.9	1986.3	1396	38.9	52	18.3	122
10/4/2016	10:20	16.8	7.5	1119.9	932	8.5	10	7.4	147
10/11/2016	10:10	17.2	7.9	547.1	399	25.0	20	6.3	142
10/18/2016	9:50	16.6	7.7	1299.7	1658	61.7	97	48.8	240

* 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

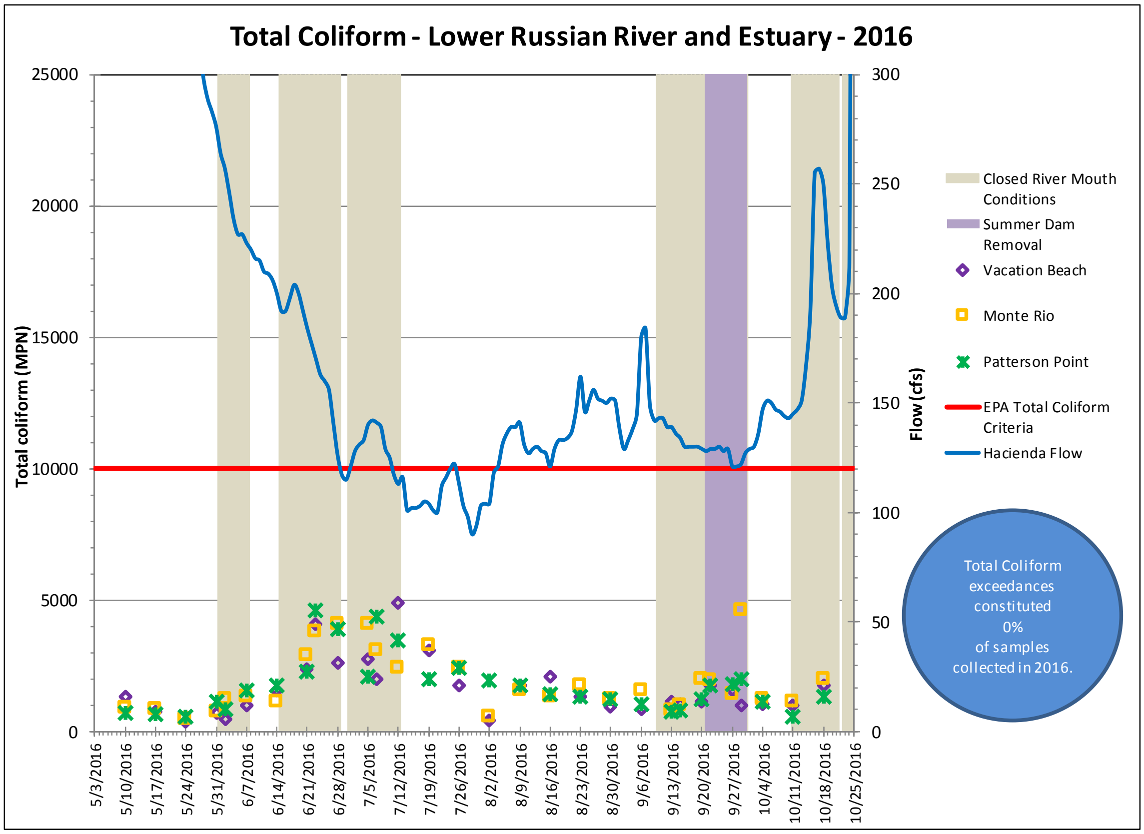


Figure 3-9. Total Coliform results for the Russian River from Vacation Beach to Patterson Point in 2016.

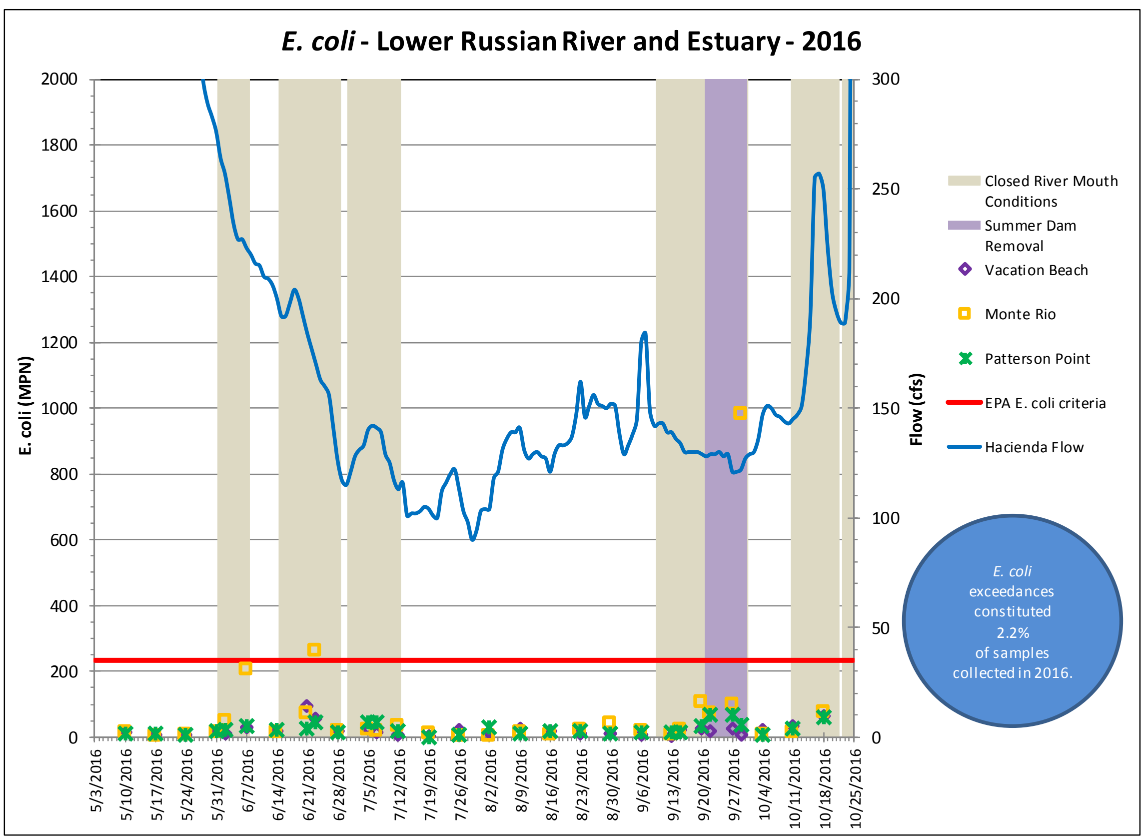


Figure 3-10. *E. coli* results for the Russian River from Vacation Beach to Patterson Point in 2016.

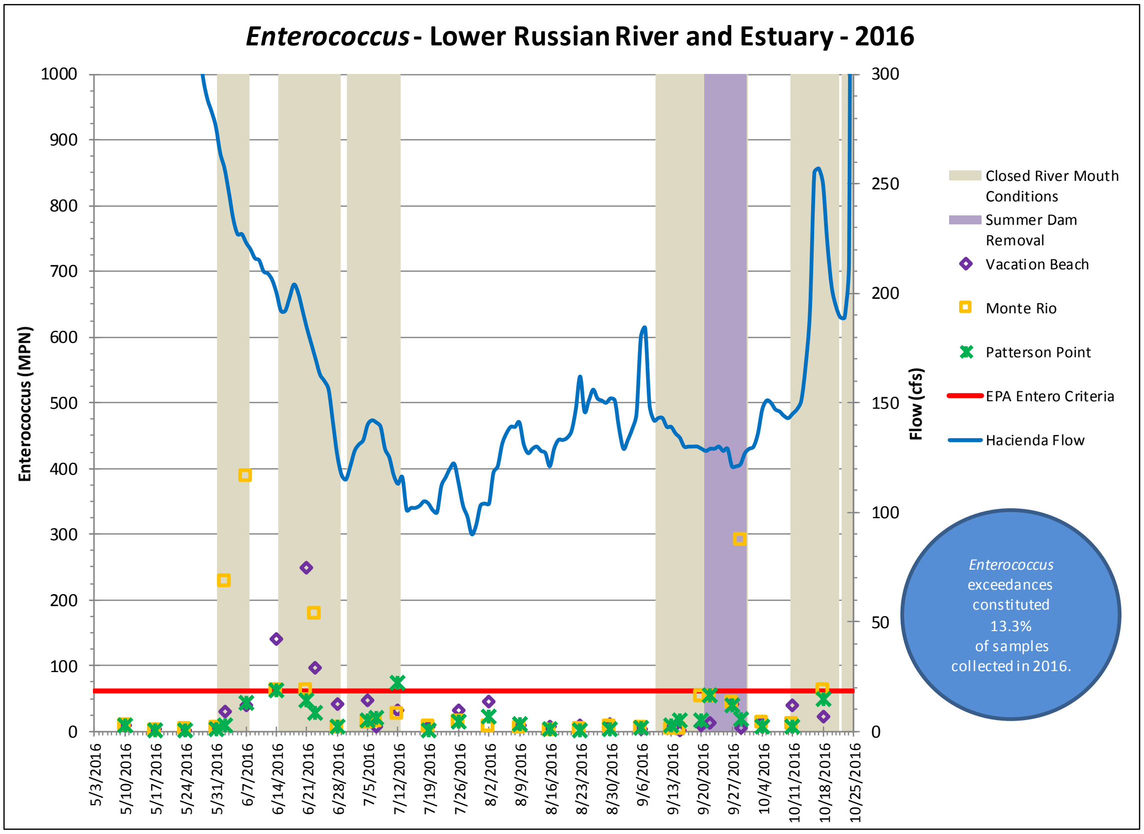


Figure 3-11. *Enterococcus* results for the Russian River from Vacation Beach to Patterson Point in 2016.

The EPA criteria for Total Nitrogen was exceeded twice at the Vacation Beach and Monte Rio stations and three times at Patterson Point with Hacienda flows ranging from 343 cfs to 468 cfs (Tables 3-8 through 3-10). All exceedances were observed to occur during open estuary conditions at the beginning of the season (Figure 3-12). In contrast, all three stations predominantly exceeded the EPA criteria for Total Phosphorous during the term of the Order and under Hacienda flows that ranged from 104 cfs to 468 cfs, continuing a trend of consistent exceedances observed in previous years (Tables 3-8 through 3-10). Interestingly, all three stations had concentrations below the EPA criteria for Total Phosphorus at least twice during the months of August and September, with open and closed estuary conditions and Hacienda flows ranging from 129 cfs to 181 cfs (Figure 3-13).

The EPA criteria for Turbidity was exceeded periodically at Vacation Beach throughout the season, and three times each at Monte Rio and Patterson Point (Tables 3-8 through 3-10). Exceedances were observed to occur during open and closed estuary conditions with Hacienda flows ranging from 104 cfs to 377 cfs (Figure 3-14). 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 104 cfs to 468 cfs (Tables 3-8 through 3-10 and Figure 3-15). 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 3-15).

Table 3-8. 2016 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)
5/10/2016	11:30	17.3	8.1	ND	ND	ND	0.29	ND	ND	**0.46**	**0.036**	0.069	1.32	1.92	180	2.2	**0.0051**	468
5/17/2016	11:30	20.5	8.0	1	ND	ND	0.21	0.061	1	**1.3**	**0.034**	0.078	1.46	1.86	190	**2.6**	**0.0029**	377
5/24/2016	12:20	18.6	8.1	ND	ND	ND	0.16	ND	ND	0.3	**0.033**	0.083	0.81	1.14	170	1.6	0.0010	343
5/31/2016	11:50	21.0	8.0	ND	ND	ND	0.15	0.061	ND	0.35	**0.036**	0.062	1.43	1.85	170	1.8	**0.0023**	277
6/2/2016	14:20	22.9	8.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	259
6/7/2016	10:40	20.9	8.1	ND	ND	ND	0.077	ND	ND	0.25	**0.031**	0.052	1.44	1.90	140	1.4	**0.0020**	224
6/14/2016	11:10	20.8	8.2	ND	ND	ND	0.05	ND	ND	0.22	**0.034**	0.05	1.87	2.13	170	1.3	**0.0024**	202
6/21/2016	10:20	21.8	8.1	ND	ND	ND	0.045	ND	ND	0.15	**0.031**	0.071	1.61	2.30	170	1.2	**0.0050**	186
6/23/2016	11:10	22.9	8.1	ND	ND	ND	ND	ND	ND	0.18	**0.031**	0.06	1.36	2.11	180	**2.4**	**0.0034**	170
6/28/2016	12:40	24.3	8.1	ND	ND	ND	ND	ND	ND	0.18	**0.028**	0.068	1.61	2.23	160	2.0	**0.0034**	127
7/5/2016	10:00	21.9	8.0	ND	ND	ND	ND	ND	ND	0.14	**0.037**	0.063	1.96	2.30	150	**2.9**	**0.0024**	140
7/7/2016	12:20	23.1	8.0	ND	ND	ND	ND	ND	ND	0.1	**0.029**	0.031	1.82	1.77	180	**2.5**	**0.0026**	141
7/12/2016	9:40	23.3	8.1	0.24	ND	ND	ND	ND	0.24	0.24	**0.030**	0.050	1.64	1.91	150	2.0	0.0009	113
7/19/2016	9:40	23.3	8.0	ND	ND	ND	ND	ND	ND	0.14	**0.030**	0.058	1.72	2.07	150	2.0	**0.0022**	104
7/26/2016	9:40	23.5	7.9	ND	ND	ND	ND	ND	ND	0.14	**0.029**	0.049	1.62	2.31	150	1.8	0.0011	113
8/2/2016	9:40	23.5	7.9	ND	ND	ND	ND	ND	ND	0.14	**0.031**	0.072	1.58	2.14	140	2.1	**0.0020**	104
8/9/2016	10:50	22.5	7.9	ND	ND	ND	ND	ND	ND	0.14	**0.023**	0.046	1.45	2.22	140	2.2	0.0012	141
8/16/2016	11:10	22.5	7.9	ND	ND	ND	ND	ND	ND	0.14	**0.025**	0.059	1.65	2.19	250	1.7	0.0017	121
8/23/2016	11:30	21.8	7.9	ND	ND	ND	ND	ND	ND	0.1	0.021	0.054	1.20	0.96	140	2.0	0.0014	162
8/30/2016	11:40	21.5	7.8	ND	0.1	0.0029	ND	ND	ND	0.1	ND	0.055	1.48	2.03	140	1.4	0.0007	152
9/6/2016	11:00	21.2	8.0	ND	ND	ND	ND	ND	ND	0.18	ND	0.05	1.88	2.13	120	**2.7**	0.0005	181
9/13/2016	11:20	20.2	7.9	ND	ND	ND	ND	ND	ND	0.1	0.021	0.056	1.63	2.18	150	1.6	0.00064	140
9/15/2016	12:10	20.0	7.9	ND	ND	ND	0.022		ND	0.092	0.020	0.034	1.59	2.33	140	**2.4**	0.00032	136
9/20/2016	11:20	20.9	7.8	ND	ND	ND	ND	ND	ND	0.14	0.021	0.037	1.49	1.84	120	2.0	0.0003	129
9/22/2016	10:50	19.6	7.7	ND	ND	ND	ND	ND	ND	0.1	**0.024**	0.054	1.67	1.89	130	2.1	0.0011	130
9/27/2016	10:20	19.6	7.8	ND	ND	ND	ND	ND	ND	0.10	**0.022**	0.06	1.73	1.79	140	**3.5**	0.0005	121
9/29/2016	12:50	20.0	7.7	ND	ND	ND	ND	ND	ND	0.10	**0.026**	0.083	1.48	1.77	130	**2.7**	0.0007	122
10/4/2016	11:10	16.9	7.7	ND	ND	ND	ND	ND	ND	0.14	**0.027**	0.041	1.70	1.89	120	**2.7**	0.0010	147
10/11/2016	11:00	17.2	7.8	ND	ND	ND	ND	ND	ND	0.10	**0.023**	0.056	1.74	1.96	130	**3.8**	**0.0020**	142
10/18/2016	0:00	16.3	7.7	ND	ND	ND	0.1	ND	ND	0.21	**0.050**	0.11	2.80	3.92	3500	**3.6**	**0.0018**	240

* 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 3-9. 2016 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)
5/10/2016	11:10	15.6	7.9	0.21	ND	ND	0.29	0.057	0.21	**0.56**	**0.040**	0.081	1.53	1.94	180	1.7	**0.0063**	468
5/17/2016	11:10	19.8	7.8	ND	ND	ND	0.21	0.06	ND	**0.44**	**0.037**	0.078	1.49	1.90	180	**2.4**	**0.0033**	377
5/24/2016	12:00	17.9	8.0	ND	ND	ND	0.16	ND	ND	0.34	**0.040**	0.091	0.86	1.12	180	1.8	0.0015	343
5/31/2016	11:30	21.0	7.9	ND	ND	ND	0.14	0.061	ND	0.34	**0.036**	0.058	1.64	1.86	160	1.4	**0.0022**	277
6/2/2016	14:00	22.4	8.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	259
6/7/2016	10:20	21.9	8.2	ND	ND	ND	ND	ND	ND	0.14	**0.026**	0.059	1.53	1.96	150	1.1	**0.0035**	224
6/14/2016	10:50	21.4	8.1	ND	ND	ND	0.049	ND	ND	0.15	**0.027**	0.046	1.48	2.22	170	1.5	0.0017	202
6/21/2016	10:10	21.5	8.0	0.21	ND	ND	ND	ND	0.21	0.21	**0.034**	0.047	1.48	2.27	170	1.1	**0.0060**	186
6/23/2016	10:50	22.9	8.1	ND	ND	ND	0.04	ND	ND	0.22	**0.035**	0.067	1.46	2.14	160	1.9	**0.0035**	170
6/28/2016	12:20	24.0	7.8	ND	ND	ND	ND	ND	ND	0.07	**0.049**	0.100	1.52	2.21	160	1.9	0.0017	127
7/5/2016	9:40	21.9	7.9	ND	ND	ND	ND	ND	ND	0.1	**0.039**	0.067	1.91	2.32	150	2.2	**0.0040**	140
7/7/2016	12:00	23.3	7.9	ND	ND	ND	0.041	ND	ND	0.15	**0.032**	0.042	1.64	1.87	170	1.7	**0.0028**	141
7/12/2016	9:20	23.4	7.8	ND	ND	ND	ND	ND	ND	0.14	**0.035**	0.065	1.62	1.91	150	1.4	**0.0022**	113
7/19/2016	9:20	23.1	7.9	ND	ND	ND	ND	ND	ND	0.1	**0.032**	0.078	1.97	2.01	150	**2.6**	**0.0022**	104
7/26/2016	9:20	23.8	7.9	ND	ND	ND	ND	ND	ND	0.17	**0.039**	0.061	1.81	2.19	170	2.0	0.0016	113
8/2/2016	9:25	23.2	7.8	ND	ND	ND	ND	ND	ND	0.21	**0.032**	0.061	1.77	2.20	140	1.8	0.0016	104
8/9/2016	10:20	22.4	7.8	ND	ND	ND	ND	ND	ND	0.07	**0.027**	0.050	1.44	2.20	140	2.0	0.0013	141
8/16/2016	10:50	22.3	7.8	ND	ND	ND	ND	ND	ND	0.14	**0.029**	0.055	1.39	1.60	220	1.1	0.0012	121
8/23/2016	11:05	21.6	7.8	ND	ND	ND	ND	ND	ND	0.14	ND	0.039	1.13	1.08	140	1.3	0.0014	162
8/30/2016	11:20	21.1	7.8	ND	ND	ND	ND	ND	ND	0.14	**0.029**	0.055	1.46	2.13	140	1.0	**0.0019**	152
9/6/2016	10:50	20.8	7.9	ND	ND	ND	ND	ND	ND	0.07	0.021	0.054	1.61	2.16	110	1.8	0.0010	181
9/13/2016	11:00	19.8	7.8	ND	ND	ND	ND	ND	ND	0.1	**0.022**	0.052	1.68	2.33	140	1.2	0.00096	140
9/15/2016	11:50	19.9	7.8	ND	ND	ND	ND	ND	ND	0.18	**0.025**	0.042	1.88	2.50	150	2.0	0.00096	136
9/20/2016	10:50	21.1	7.8	ND	ND	ND	ND	ND	ND	0.18	**0.024**	0.048	1.74	1.86	130	1.4	0.0003	129
9/22/2016	10:40	20.1	7.8	ND	ND	ND	ND	ND	ND	0.07	**0.024**	0.038	1.48	1.87	150	0.7	0.00060	130
9/27/2016	10:00	19.8	7.7	ND	ND	ND	ND	ND	ND	0.07	**0.022**	0.056	1.72	2.07	140	1.7	0.0005	121
9/29/2016	12:30	20.0	7.7	ND	ND	ND	ND	ND	ND	0.1	**0.030**	0.067	1.78	1.94	130	1.3	0.0002	122
10/4/2016	10:50	16.8	7.6	ND	ND	ND	ND	ND	ND	0.19	**0.039**	0.087	1.53	2.05	130	1.3	0.0003	147
10/11/2016	10:40	17.1	7.8	ND	ND	ND	0.14	ND	ND	0.18	**0.030**	0.060	1.55	1.97	130	**2.5**	0.0016	142
10/18/2016	10:20	16.7	7.7	ND	ND	ND	0.11	ND	ND	0.28	**0.072**	0.180	3.26	3.92	170	1.5	0.0014	240

* 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 3-10. 2016 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)
5/10/2016	11:00	16.6	7.9	0.21	ND	ND	0.29	ND	0.21	**0.5**	**0.040**	0.081	1.55	1.97	180	2.1	**0.0041**	468
5/17/2016	10:50	20.1	7.9	ND	ND	ND	0.21	0.06	ND	**0.44**	**0.047**	0.074	1.46	1.86	180	1.8	0.0014	377
5/24/2016	11:40	18.1	8.0	0.32	ND	ND	0.17	ND	0.32	**0.49**	**0.031**	0.083	0.93	1.24	180	1.4	0.0007	343
5/31/2016	10:50	21.4	8.0	ND	ND	ND	0.15	0.061	ND	0.31	**0.036**	0.062	1.46	1.89	170	2.2	**0.0021**	277
6/2/2016	13:40	22.6	8.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	259
6/7/2016	10:00	21.7	8.1	ND	ND	ND	0.065	ND	ND	0.24	**0.024**	0.055	1.61	1.89	150	2.1	**0.0058**	224
6/14/2016	10:30	21.3	8.1	0.24	ND	ND	0.058	ND	0.24	0.31	**0.026**	0.054	1.57	2.44	170	1.4	**0.0024**	202
6/21/2016	9:40	21.5	8.2	ND	ND	ND	ND	ND	ND	0.1	**0.036**	0.051	1.40	2.38	170	1.0	**0.0039**	186
6/23/2016	10:10	22.6	8.1	0.21	ND	ND	ND	ND	0.21	0.21	**0.035**	0.067	1.52	2.25	160	1.7	**0.0027**	170
6/28/2016	11:50	23.7	7.8	0.24	ND	ND	ND	ND	0.24	0.24	**0.043**	0.096	1.65	2.27	160	2.2	**0.002**	127
7/5/2016	9:20	21.7	7.9	ND	ND	ND	0.04	ND	ND	0.18	**0.036**	0.09	1.79	2.24	150	2.1	0.0015	140
7/7/2016	11:10	22.6	7.9	ND	ND	ND	ND	ND	ND	0.14	**0.037**	0.073	1.75	1.89	160	1.6	**0.0035**	141
7/12/2016	8:50	23.1	7.9	ND	ND	ND	ND	ND	ND	0.18	**0.038**	0.069	1.57	1.92	140	2.2	**0.0024**	113
7/19/2016	9:00	22.2	7.8	ND	ND	ND	0.041	ND	ND	0.22	**0.034**	0.086	1.89	2.04	170	**3.0**	0.0011	104
7/26/2016	9:00	23.0	7.6	ND	ND	ND	ND	ND	ND	0.17	**0.035**	0.068	1.77	2.12	170	**2.40**	0.0013	113
8/2/2016	9:00	22.7	7.8	0.21	ND	ND	ND	ND	0.21	0.24	**0.033**	0.068	1.47	2.19	140	**2.4**	0.0012	104
8/9/2016	9:50	22.1	7.8	ND	ND	ND	ND	ND	ND	0.1	**0.027**	0.065	1.35	2.31	140	2.2	0.0015	141
8/16/2016	10:30	21.9	7.8	ND	ND	ND	ND	ND	ND	0.070	**0.026**	0.059	1.40	1.52	240	1.2	0.0012	121
8/23/2016	10:10	21.7	7.9	ND	ND	ND	ND	ND	ND	0.1	0.021	0.05	1.13	1.27	150	1.8	0.0014	162
8/30/2016	10:40	21.2	8.1	ND	ND	ND	ND	ND	ND	0.1	0.021	0.055	1.17	2.05	140	1.8	0.0016	152
9/6/2016	10:30	20.8	8.0	ND	ND	ND	ND	ND	ND	0.21	ND	0.058	1.60	2.01	130	1.6	0.0012	181
9/13/2016	10:30	19.8	7.8	ND	ND	ND	ND	ND	ND	0.10	0.021	0.05	1.67	2.40	170	1.0	0.00080	140
9/15/2016	11:00	20.0	7.8	ND	ND	ND	ND		ND	0.1	**0.022**	0.042	1.60	2.56	570	1.50	0.00064	136
9/20/2016	10:30	20.8	7.8	0.24	ND	ND	ND	ND	0.24	0.24	**0.024**	0.048	1.56	1.87	130	2.00	0.00060	129
9/22/2016	10:10	20.0	7.7	ND	ND	ND	ND	ND	ND	0.07	0.020	0.042	1.49	1.94	130	1.2	0.00090	130
9/27/2016	9:40	20.3	7.8	ND	ND	ND	ND	ND	ND	0.14	**0.025**	0.052	1.55	2.05	140	1.4	0.0012	121
9/29/2016	12:00	20.4	7.9	ND	ND	ND	ND	ND	ND	0.10	**0.026**	0.13	1.62	1.77	130	1.2	0.00050	122
10/4/2016	10:20	16.8	7.5	ND	ND	ND	ND	ND	ND	0.08	**0.030**	0.041	1.47	2.08	84	1.2	ND	147
10/11/2016	10:10	17.2	7.9	ND	ND	ND	0.14	ND	ND	0.21	**0.027**	0.068	1.56	2.16	130	1.9	0.0012	142
10/18/2016	9:50	16.6	7.7	ND	ND	ND	0.079	ND	ND	0.15	**0.065**	0.17	2.36	3.59	160	1.0	0.00089	240

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

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

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

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

Recommended EPA Criteria based on Aggregate Ecoregion III

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

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

Total Nitrogen: 0.38 mg/L

Turbidity: 2.34 FTU/NTU

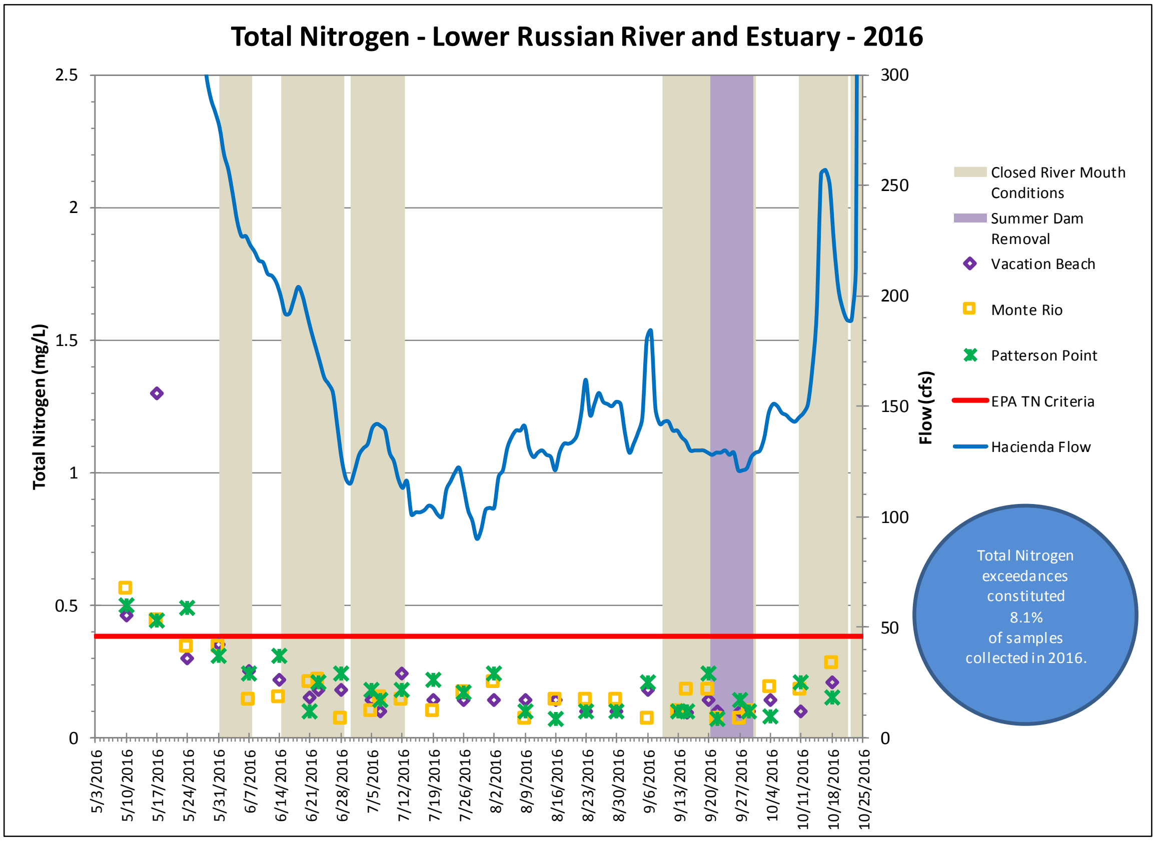


Figure 3-12. Total Nitrogen results for the Russian River from Vacation Beach to Patterson Point in 2016.

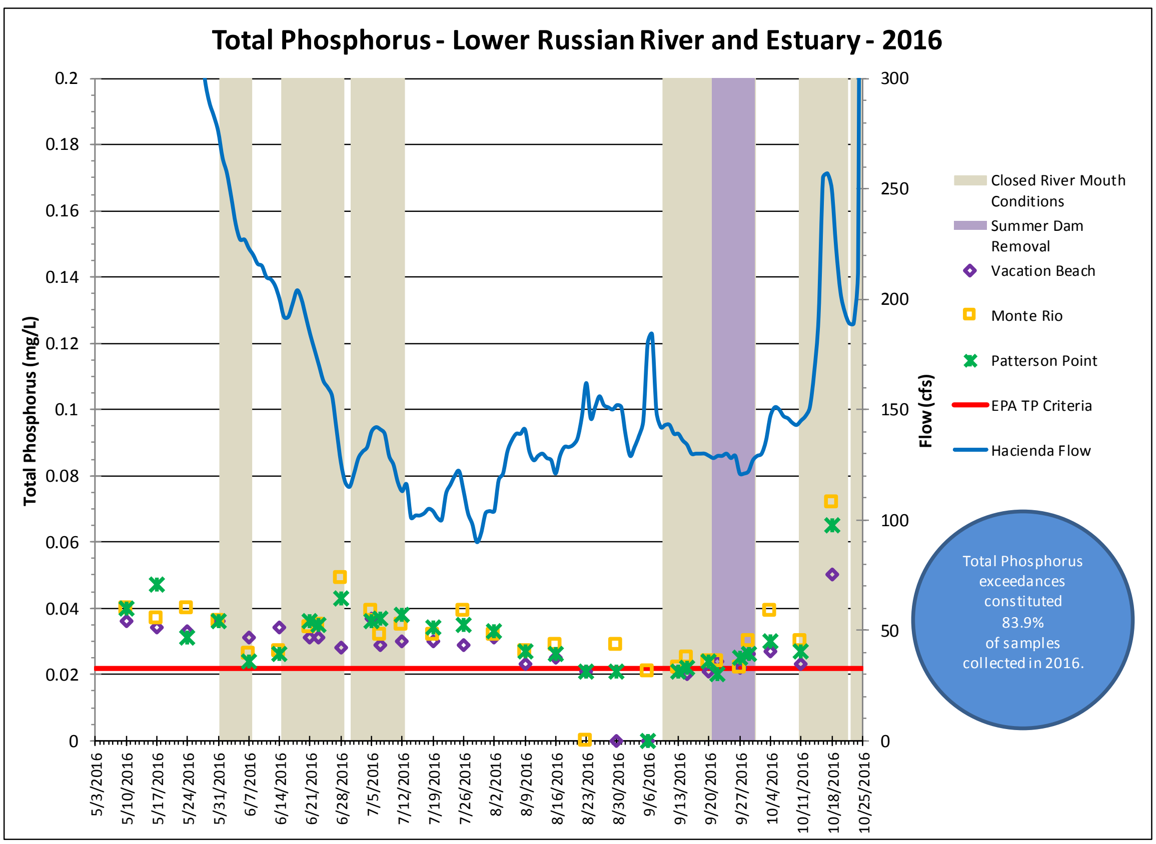


Figure 3-13. Total Phosphorus results for the Russian River from Vacation Beach to Patterson Point in 2016.

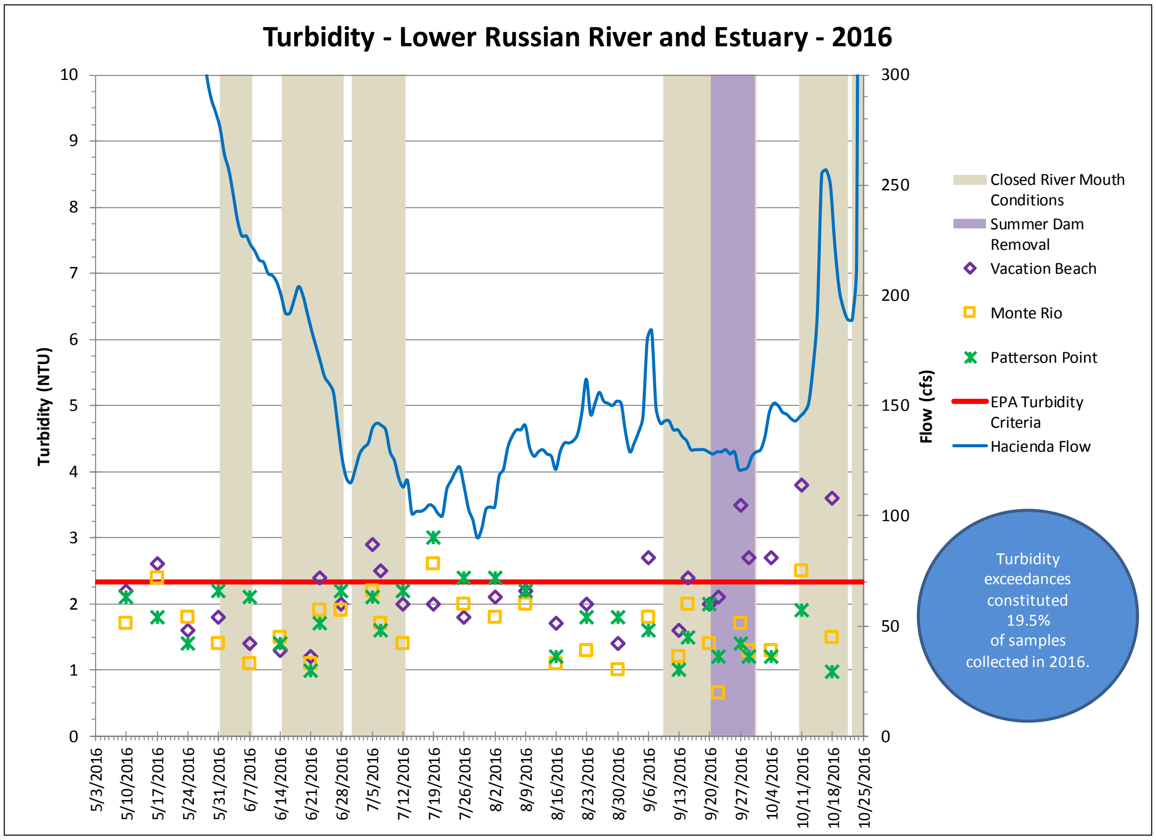


Figure 3-14. Turbidity results for the Russian River from Vacation Beach to Patterson Point in 2016.

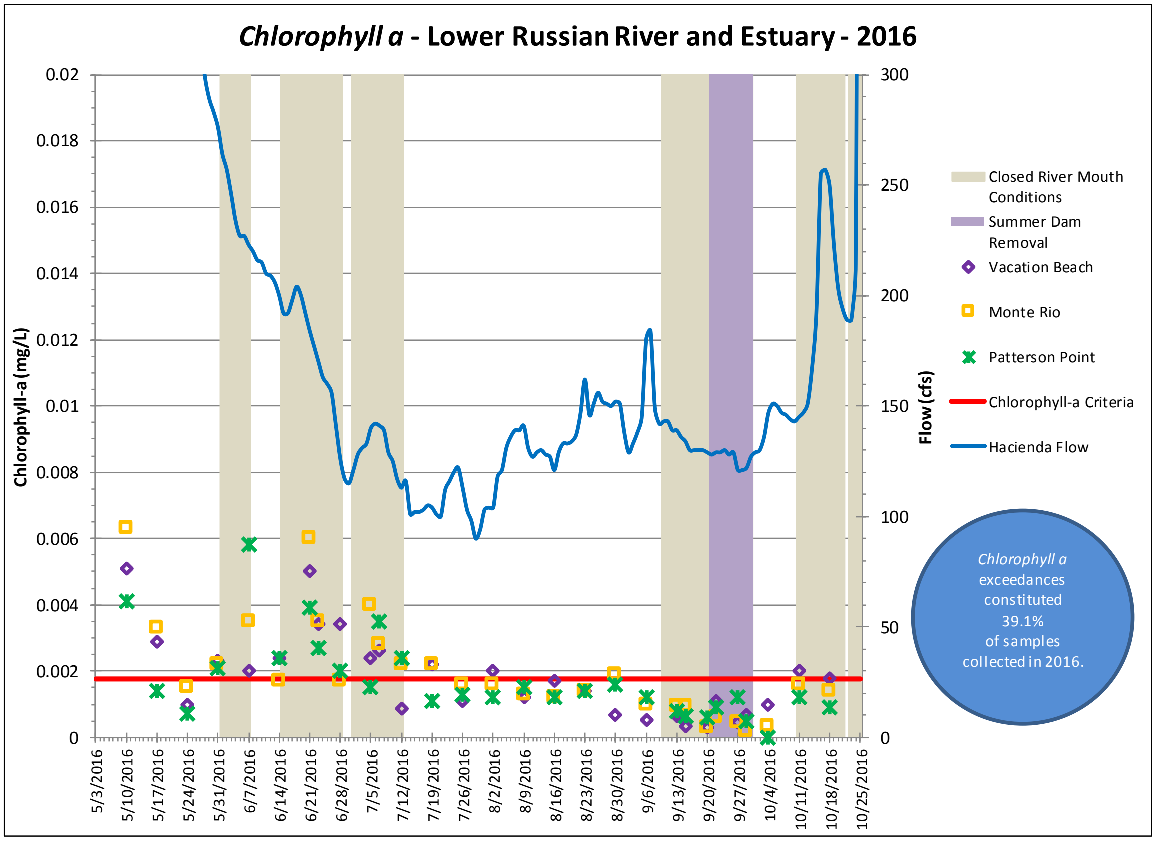


Figure 3-15. *Chlorophyll a* results for the Russian River from Vacation Beach to Patterson Point in 2016.

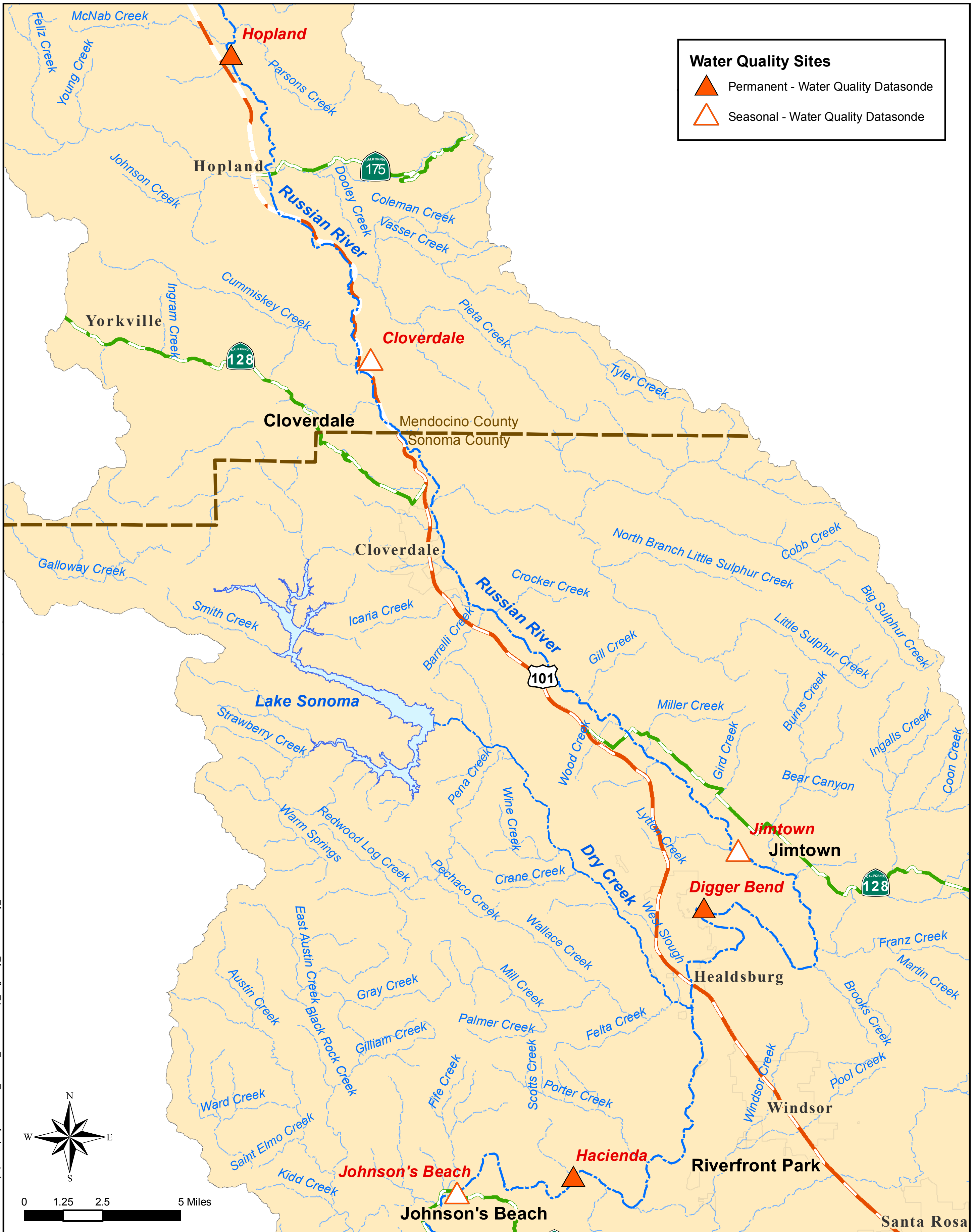
4.0 Additional Monitoring

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 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 2016 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/.



\\SD-DATA\Proj\special projects\7323_RRIFR_D1610\Temp_Urgency_WaterQuality_2014a.mxd

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

This Map is for general reference only.

Figure 4-1

4.2 Aquatic Habitat for Salmonids

4.2.1 Introduction

In Term 6(b) of the Temporary Urgency Change Order (Order), the State Water Resource Control Board (SWRCB) tasked the Water Agency with evaluating the effects of reductions in minimum instream flows authorized by the Order on 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 water temperature and dissolved oxygen (DO) changes at multiple life stages. The Russian River supports three species of salmonids: coho salmon (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and Chinook salmon (*Oncorhynchus tshawytscha)*. These species follow a similar life history pattern. 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 that remain in the redd for several weeks before hatching. After hatching, the larval fish remain in the gravel for several more weeks before emerging. After emerging from the gravel these young salmonids are identified first as fry and then later as parr once they have undergone some freshwater growth. Parr rear for a few months (Chinook salmon) to 2 years (steelhead) in freshwater before undergoing a physiological change identified as smoltification. At this stage fish, 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 water temperature, and DO. While all three species follow a similar life history, each species tends to spawn and rear in different locations and are present in the Russian River watershed at slightly different times. These subtle, but important, differences may expose each species to a different set of freshwater conditions.

Coho Timing and Distribution

Wild coho salmon have become scarce in the Russian River watershed and monitoring data relies mainly on fish released from the hatchery at the Warm Springs Dam as part of the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP). Data collected on the Water Agency's Mirabel inflatable dam underwater video camera system from 2011 through 2013 indicate that the adult coho salmon run may start in late October and continue through at least January. The bulk of adult coho salmon migrate through the river from November through February. In 2013, 97% of coho were observed after 20 November (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 smolts 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. The water temperature and DO data relating to juvenile coho salmon rearing and smolt life stages will be analyzed in this report as these are the life stages likely to be present in the Russian River during the time period governed by the Order (1 May through 27 October, 2016).

Steelhead Timing and Distribution

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

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). 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). 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 (Lake Mendocino) and Hopland. 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 steelhead rearing and smolt life stages will be analyzed in this report.

Chinook Timing and Distribution

Based on video monitoring at the Water Agency's Mirabel inflatable dam, adult Chinook salmon 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. For this report we have defined the adult Chinook migration period as October through December because generally the bulk of Chinook salmon pass the Mirabel inflatable dam from October through December. Chinook salmon are mainstem spawners and deposit their eggs into the stream bed of the mainstem Russian River and in Dry Creek (a tributary to the Russian River near Healdsburg) 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 salmon smolt out-migration occurs from April through June. The adult and smolt life stages are present in the mainstem Russian River during the time period covered by the Order. Therefore, water temperature and DO data relating to the Chinook salmon adult and smolt life stages 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 evaluate Russian River water quality conditions when salmonids where 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 Water Agency-operated data sondes were used to provide water quality data in the mainstem Russian River and In Dry Creek.

To estimate the number of adult Chinook salmon that return to the Russian River the Water Agency typically operates underwater video cameras in two fish ladders located on the east and west banks of the Russian River at Mirabel. However, a continuing construction project to improve fish passage at the Mirabel inflatable dam in 2016 created challenges in operating a video camera system at this site. In 2016 we experimented with one camera in the newly constructed fish ladder on the west bank, but were unable to operate a camera in the existing fish ladder on the east bank of the Russian River. In addition to the Mirabel camera system, the Water Agency counted adult salmon at a DIDSON at Dry Creek. 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, however fish can often be identified to the family lever (i.e. salmonidae). In addition to operating a DIDSON at Dry Creek the Water Agency experimented with an underwater video camera in a fish ladder at Memorial Beach near Healdsburg. This site is located on the mainstem Russian River upstream of Dry Creek. Data from these monitoring sites were used to determine when adult salmonids were present in the Russian River during 2016.

Physical habitat conditions (flow, water temperature, and DO) were collected at multiple sites in the Russian River. USGS (United States Geological Survey) stream gages located on the Russian River at Hacienda and Hopland provided flow, 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 water temperature (°C) thresholds used for migration when describing water quality conditions during the term of the May 2016 temporary urgency change order. Criteria is from SCWA (2016).

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

Table 4-2. Juvenile salmonid rearing temperature (°C) thresholds used for describing water quality conditions during the term of the May 2016 temporary urgency change order. Criteria is from SCWA (2016).

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

Table 4-3. Salmonid smolting temperature (°C) thresholds used for describing water quality conditions during the term of the May 2016 temporary urgency change order. Criteria is from SCWA (2016).

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

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

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

Salmonid counts are used to relate water quality conditions to the timing and magnitude of salmonid migrations. We compared fish counts with water quality information only where water quality stations were in close proximity to fish counting station. The timing and magnitude of salmonid migrations and the water quality conditions these fish likely experienced can be understood by displaying water quality information with salmonids counts. Adult count data collected at Mirabel are paired with water quality data collected at Hacienda. Adult counts collected at the Healdsburg fish ladder are paired with water quality data from the USGS stream gage at Digger Bend. Dry Creek DIDSON adult counts are paired with water quality data collected in Dry Creek at the USGS stream gage at Lambert Bridge. The majority of steelhead rearing habitat in the mainstem Russian River occurs upstream of Hopland. For steelhead rearing in the mainstem Russian River his report presents the water quality data from the USGS Hopland gaging station and from the East Fork Russian River. Dry Creek is also used as rearing habitat by steelhead juveniles and steelhead rearing criteria is displayed with water quality data collected from the USGS stream gage at Lambert Bridge in Dry Creek. Smolts moving downstream out of Dry Creek first pass the Dry Creek downstream migrant trap then pass the Hacienda USGS stream gage before entering the ocean. Therefore Dry Creek salmonid smolt data has been paired with Dry Creek and Hacienda water quality data to describe the conditions these fish likely experienced as they migrated downstream out of Dry Creek and the lower Russian River.

4.2.4 Results

Flow

During the Order period from May 1 to October 27, 2016, flow in the Russian River at Hacienda ranged from a low of 90 cfs in July high of over 900 cubic feet per second (cfs) during a storm in late October. Flows at Hacienda during the Order were typically between 129 cfs and 222 cfs (25^{th} and 75^{th} percentiles of the instantaneous flow from the USGS stream gage at Hacienda (gage number 11467000). The Russian River was influenced by tributary in-flow until July, and was generally controlled by reservoir releases from July through early-October, and again by tributary inflow in late October.

During the period of the Order, 1,642 adult salmonids were observed at the Mirabel, Dry Creek and Healdsburg counting stations. However, some adult salmon may have been double counted since individuals counted at Healdsburg or Dry Creek would have first passed and may have been counted at Mirabel. At Mirabel, 826 Chinook salmon, 7 fish that had coho salmon characteristics, 2 adult steelhead, and 27 unidentified adult salmonids were observed during the Order. At Healdsburg, 241 Chinook, 2 fish that had coho characteristics, 1 steelhead adult, and 23 unidentified adult salmonids were observed during the Order. At the Dry Creek DIDSON, 513 adult salmonids were observed during the Order. The mouth of the Russian River was closed by a barrier beach for much of September (Figure 4-2). With the exception of 2 fish, all adult salmonids observed at our counting stations were observed after September 30, 2016. A barrier beach formed and closed the mouth of the Russian River on September 11, 2016, precluding fish entry, and remained intact until September 30, 2016.

Two significant rain events occurred in October 2016 that may have encouraged Chinook salmon to migrate upstream. The Russian River watershed received over 2 inches of rain between October 14 and October 16. In the 3 days following this rain event 415 adult salmonids were observed on video collected at Mirabel. The second rain storm delivered approximately 7 inches of rain between October 24 and October 31. We observed 100 adult Chinook at Mirabel on October 25, 2016, but many more likely passed undetected because water visibility was too poor to detect all fish passing Mirabel. Shortly after the Order expired the Mirabel dam was deflated in response to higher flows associated with a storm event. The deflation of the Mirabel dam allowed for many adult Chinook to pass Mirabel undetected.

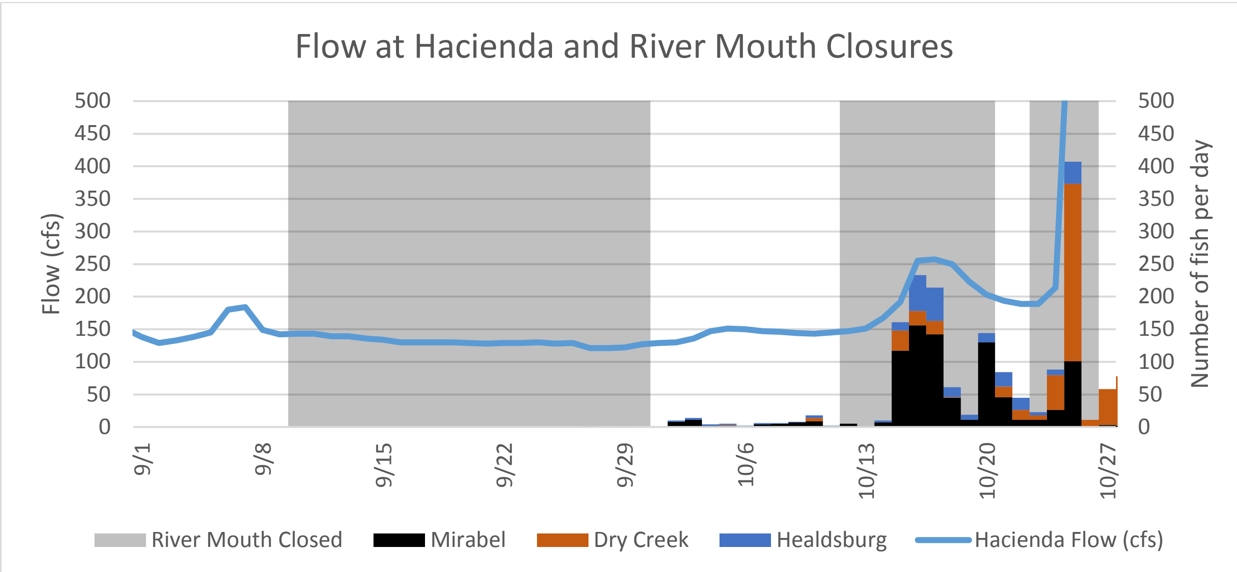


Figure 4-2. Flow in the Russian River at the USGS Hacienda stream gage (11467000) shown from 1 September 2016 to 27 October 2016. Times when the mouth of the Russian River was closed due to the formation of a barrier beach are shown as shaded areas. Also shown are the adult salmonid counts (the sum of adult Chinook, coho, steelhead, and unidentified salmonids) from underwater video collected at Mirabel and Healdsburg, and DIDSON collected on Dry Creek.

Temperature

Adult Salmonid Migration

During the Order we observed 563 adult salmonids that we were unable to identify to species, 1,067 adult Chinook, 9 fish that had coho characteristics, and 3 adult steelhead. It is important to note that the river mouth was closed for much of September and that the bulk of the adult salmonid run occurred after the end of the Order when water temperatures were suitable to optimal. Most of the unidentified adult salmonids observed on the Dry Creek DIDSON during the Order were likely Chinook based on run timing information from previous years of monitoring at Mirabel. After the Order expired many more adult salmonids were observed on the Dry Creek DIDSON. From 28 October 2016, to the end of December 2016, a total of 2,205 adult salmonids were observed on the Dry Creek DIDSON.

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). However, on days when adult salmonids were observed at the Mirabel counting station the maximum and minimum daily water temperature were declining and generally fell within the suitable range (Figure 4-3). 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 4-3 through 4-7). Water temperatures in Dry Creek were optimal during the period of time that the Order overlaps with the adult Chinook migration (Figure 4-8).

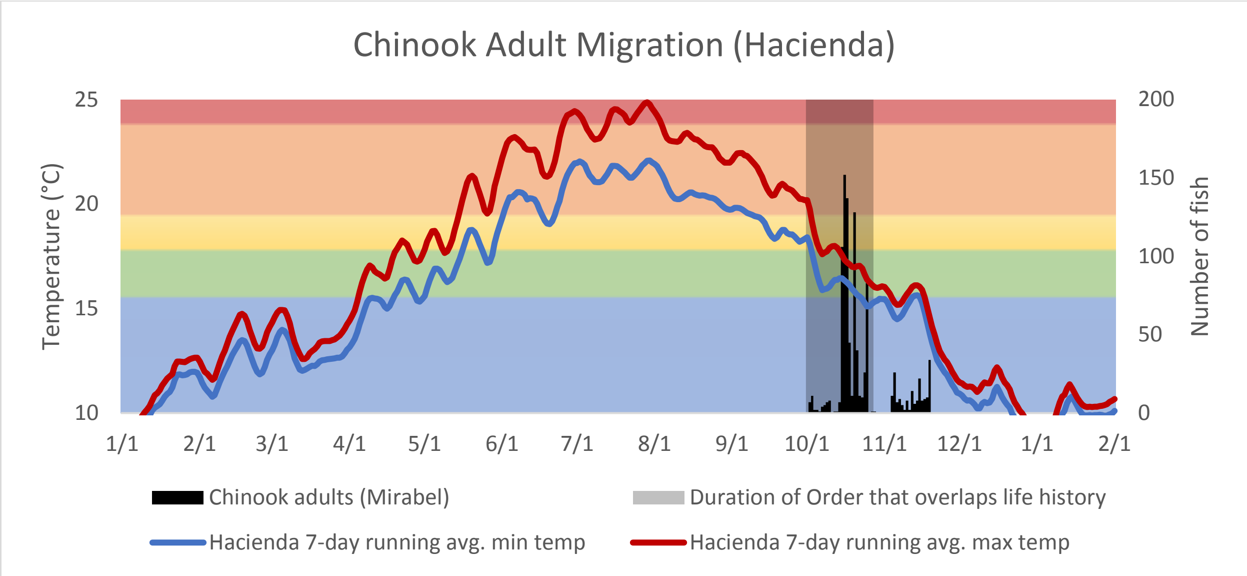


Figure 4-3. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook counts from the mainstem Russian River at Mirabel. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature thresholds for adult Chinook salmon based on Table 4-1.

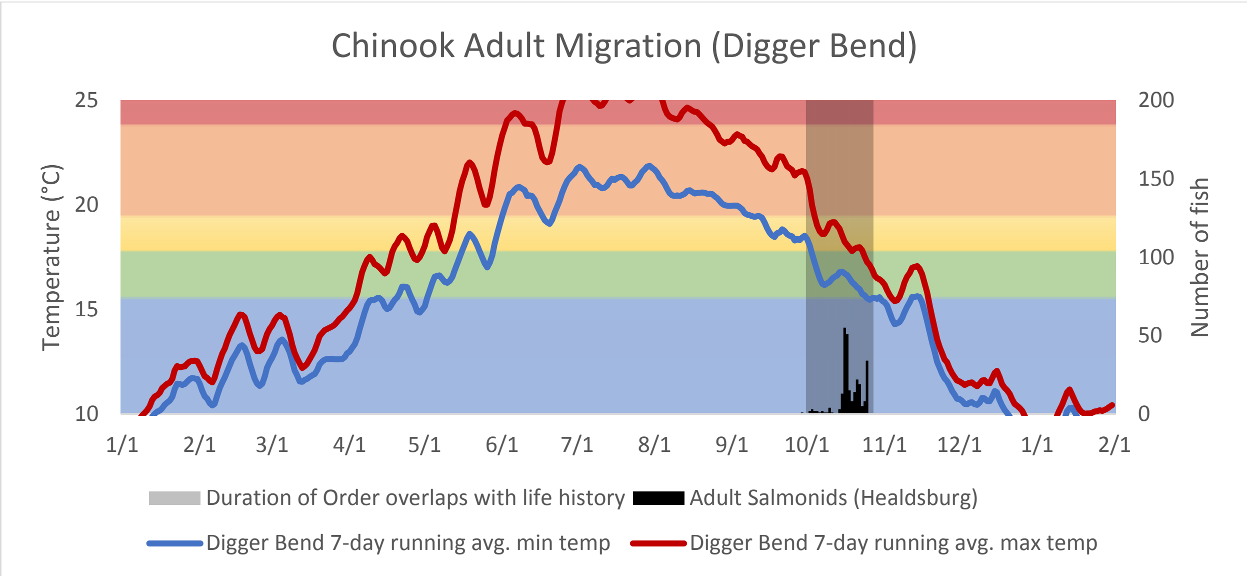


Figure 4-4. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook adult migration based on Table 4-1.

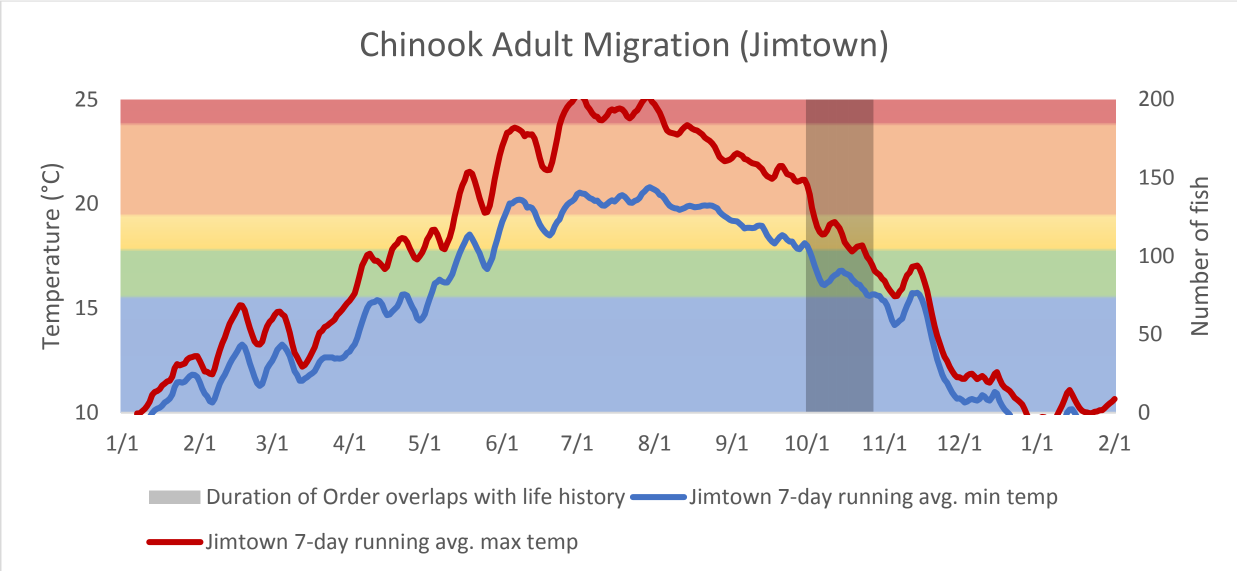


Figure 4-5. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook adult migration based on Table 4-1.

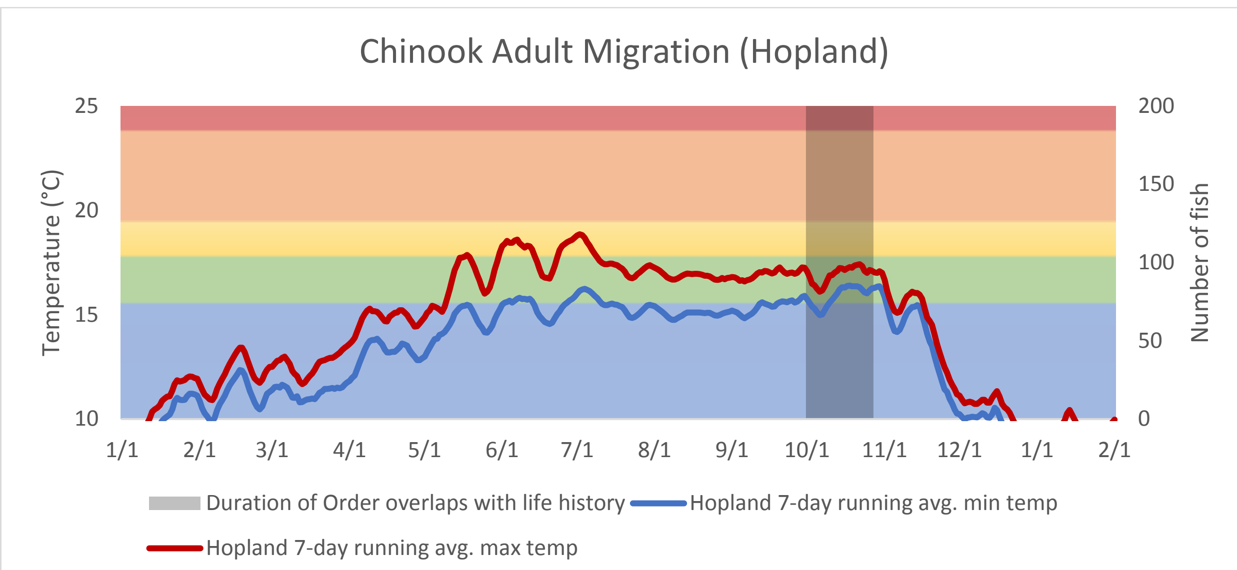


Figure 4-6. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook adult migration based on Table 4-1.

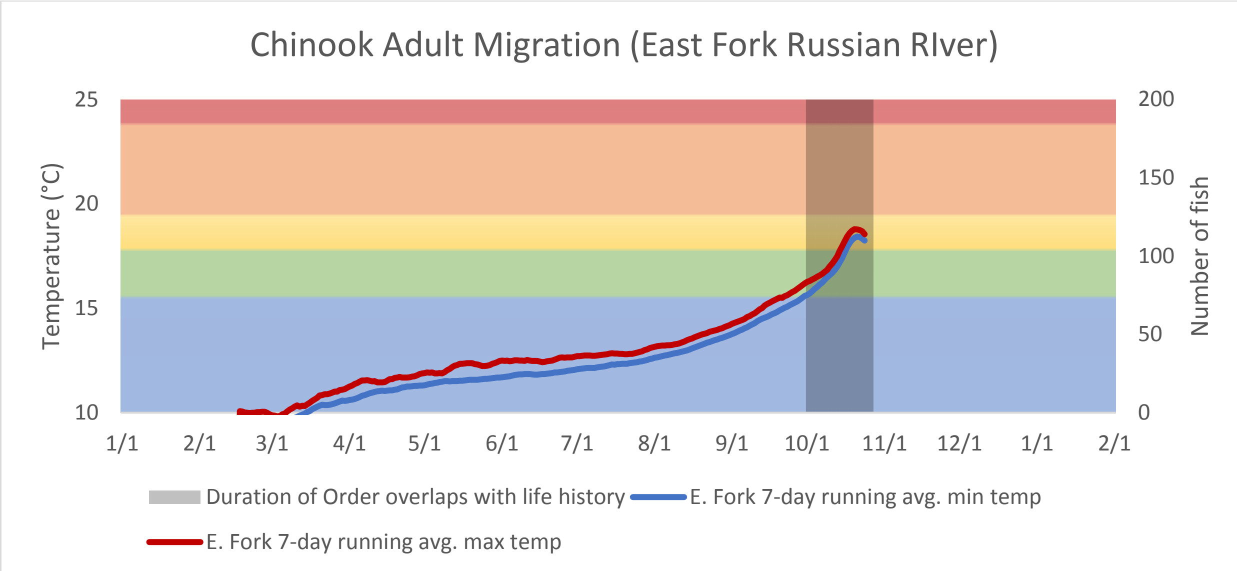


Figure 4-7. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River approximately 1/3 of a mile downstream of the Coyote Valley Dam shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook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

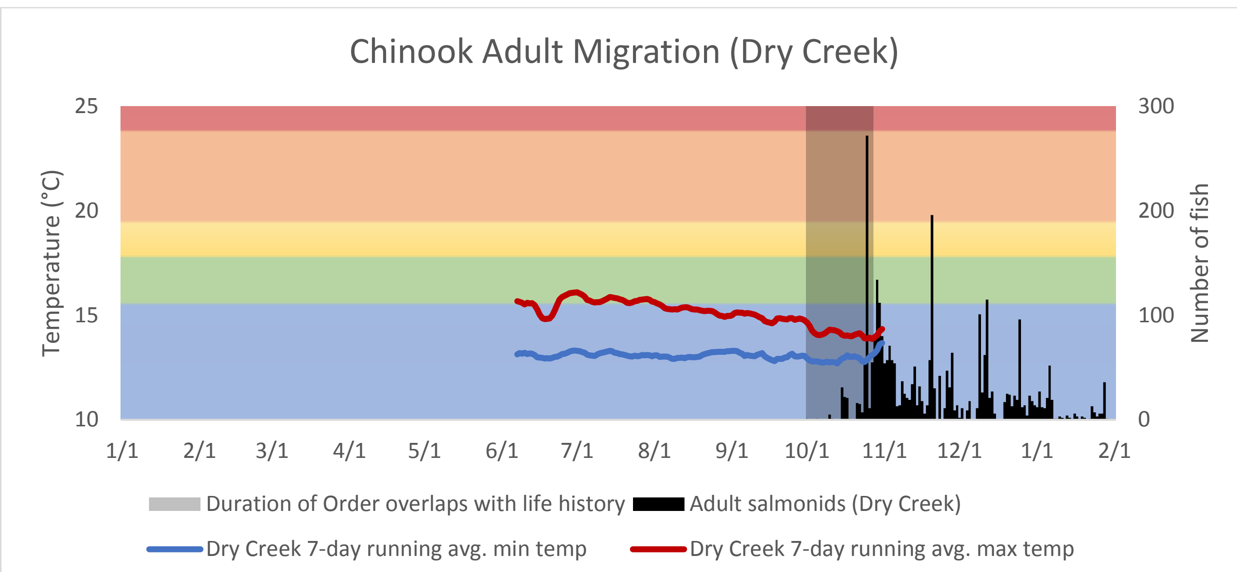


Figure 4-8. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Lambert Bridge (gage number 11465240) in Dry Creek shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-1.

Salmonid Rearing

In the Russian River watershed much of the salmonid rearing habitat is located in tributaries to the Russian River, including Dry Creek. Water temperatures from Dry Creek are shown with the temperature criteria for coho, Chinook, and steelhead as this is an important rearing area for these species. Coho typically emerge from the gravel and spend 1 year in fresh water before immigrating to sea in the early spring. During this freshwater rearing phase they require cold water. Because of this cold water rearing requirement coho are not thought to rear in the Mainstem Russian River. Instead the tributaries to the Russian River, including Dry Creek are important coho rearing habitat. For this report water temperature criteria for coho is related to water temperature data collected in Dry Creek at Lambert Bridge (USGS stream gage number 11465240). Chinook and steelhead rear in the mainstem Russian River as well as Dry Creek. Chinook emerge from redds 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 or Coho. 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 and Lake Sonoma has the potential to provide steelhead with cold water rearing habitat through the summer. We relate steelhead water temperature criteria to water temperature collected in the East Fork Russian River, at Hopland, and in Dry Creek as these sites are within the section of the Russian River and Dry Creek that can provide year-round rearing opportunities for juvenile steelhead.

Chinook

During 2016 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 4-9 and Figure 4-10). 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 (Figure 4-11 through Figure 4-13). It is important to note that this change in water temperature suitability was not due to the implementation of the Order and resultant changes in minimum instream flow, but due to warming air temperature. At Jimtown and Digger Bend the maximum daily water temperature first became acutely stressful in mid-May, but flows remained above minimum instream flows outlined by Decision 1610 (185 cfs) until early to mid-June depending on the site. At Hacienda the maximum daily water temperature first became acutely stressful in mid-May, but flows remained above minimum instream flows outlined by D1610 (125 cfs) until late June. Furthermore, Chinook have adapted to local conditions and migrate downstream and out to sea in the spring to avoid rearing at high temperatures. In Dry Creek water temperatures are optimal during the Chinook rearing period (Figure 4-14).

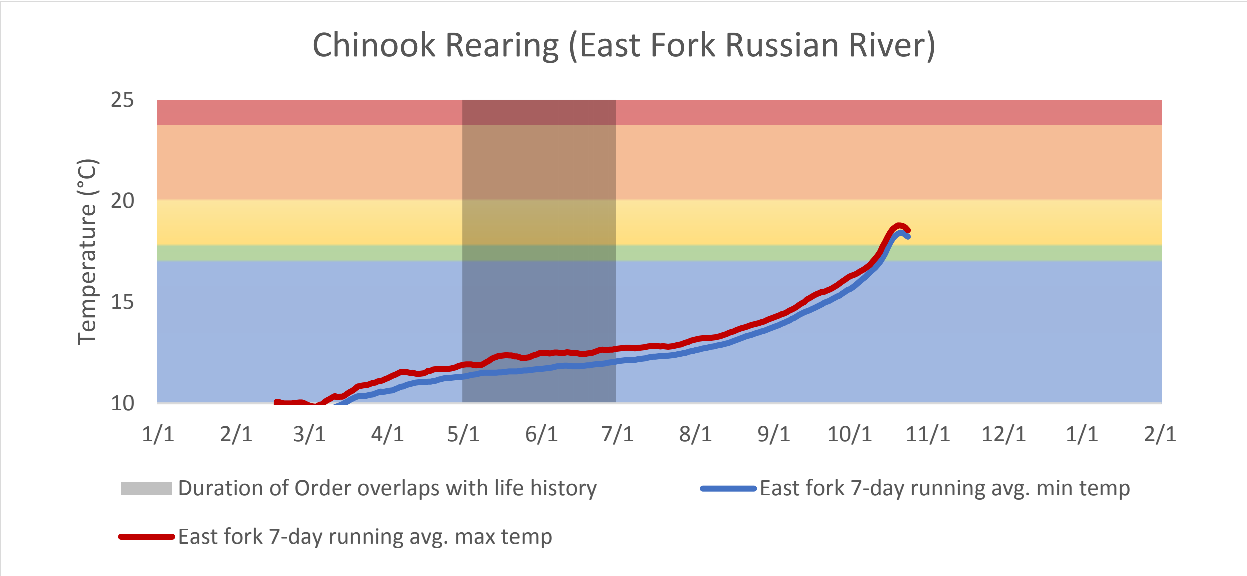


Figure 4-9. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River approximately 1/3 of a mile downstream of the Coyote Valley Dam shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

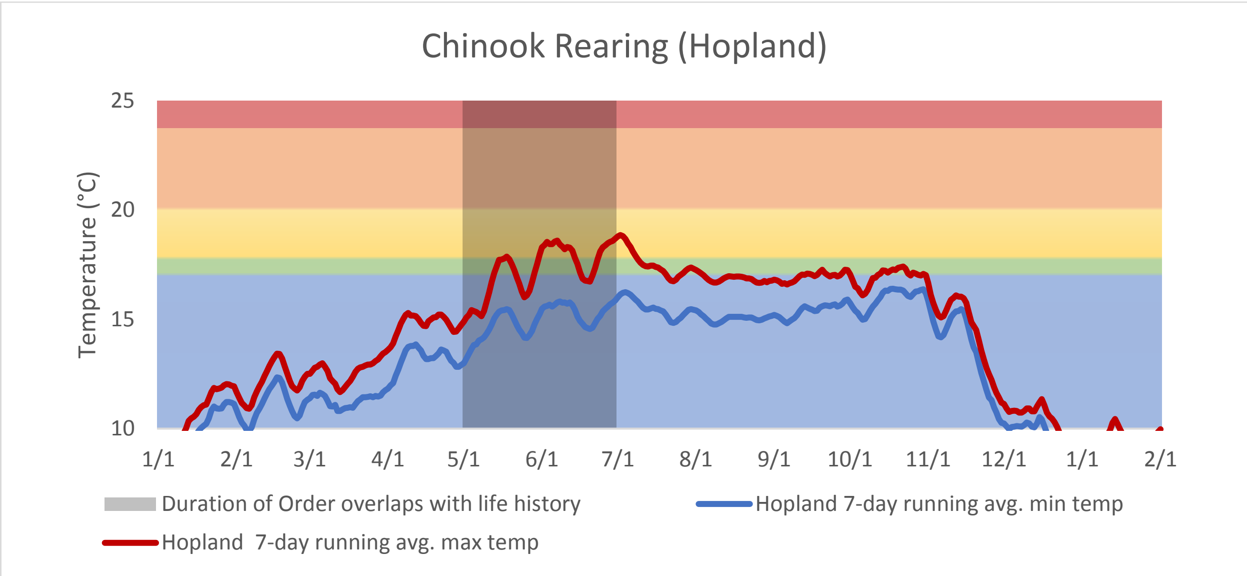


Figure 4-10. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

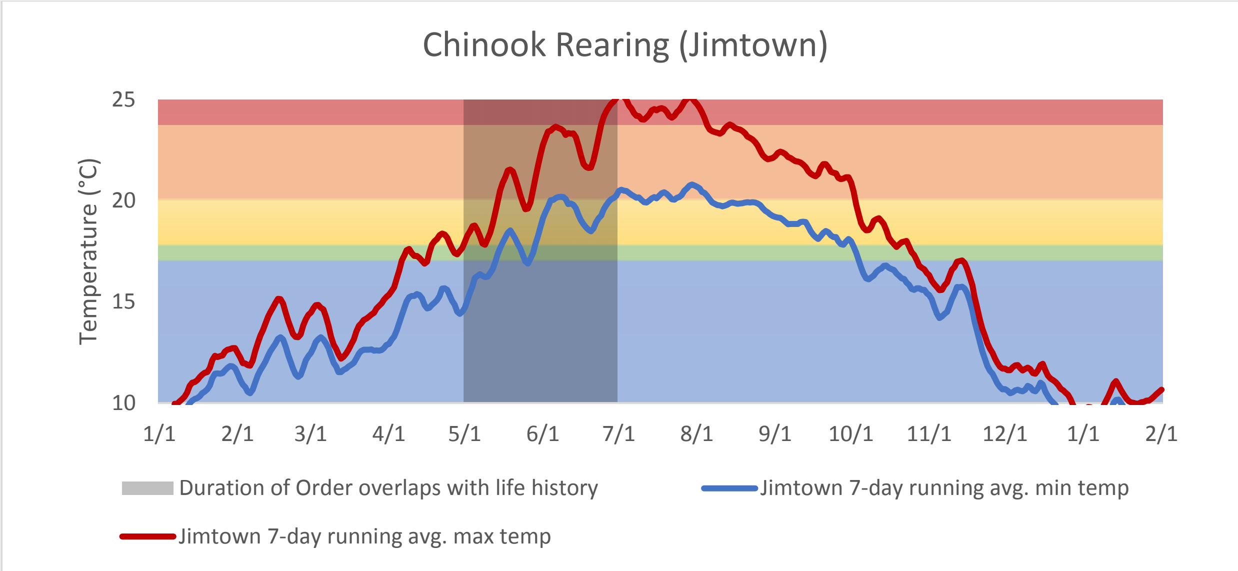


Figure 4-11. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

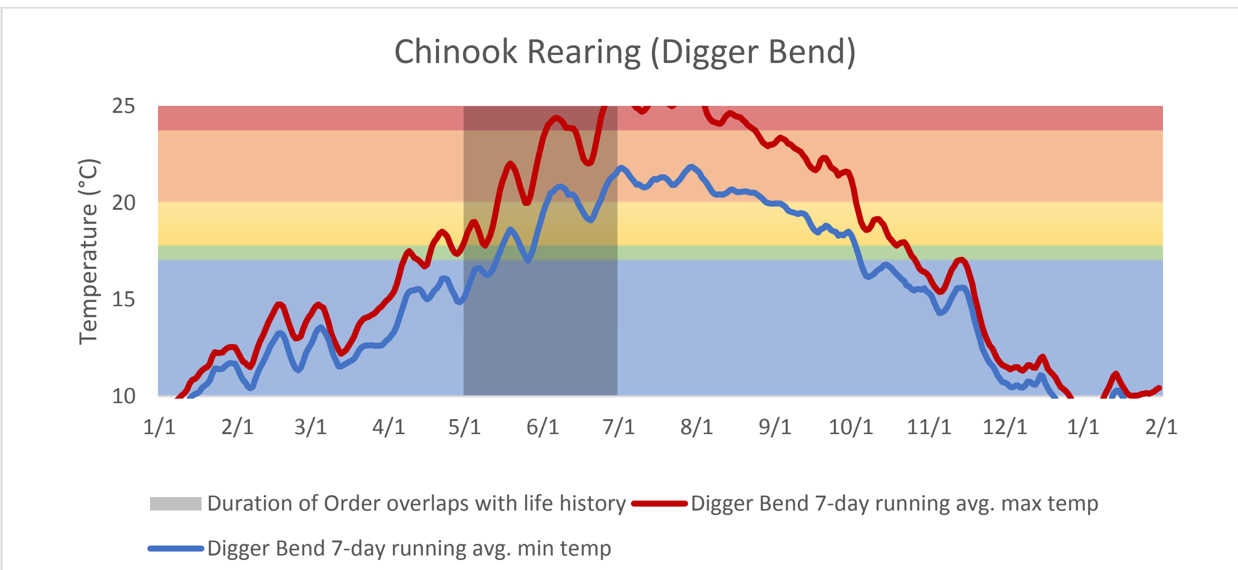


Figure 4-12. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

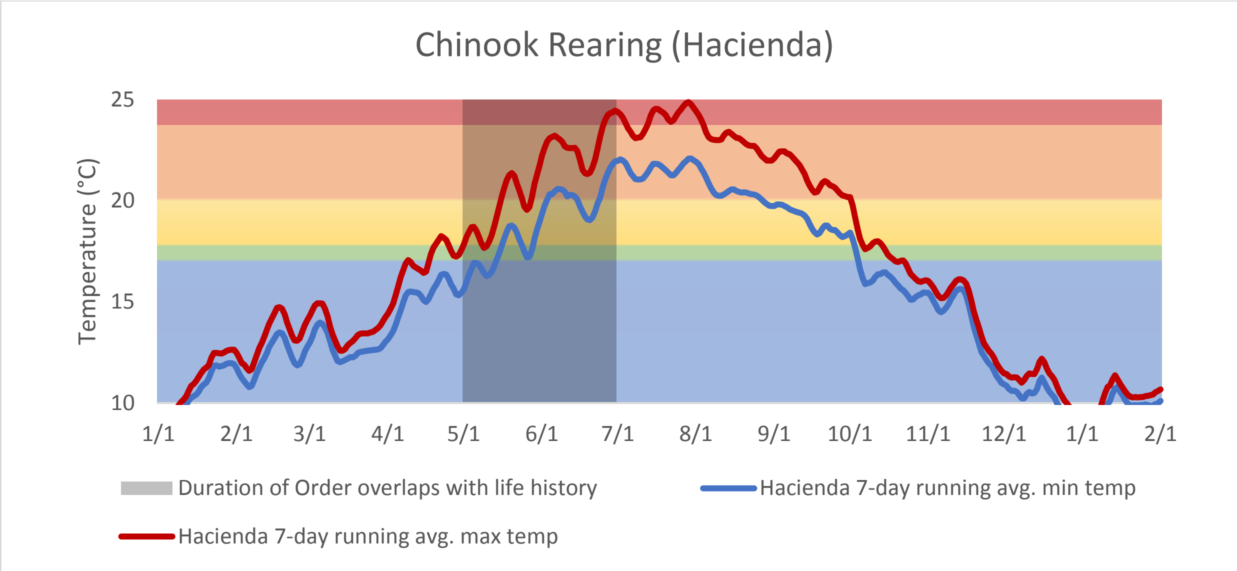


Figure 4-13. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hacienda (gage number 11467000) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

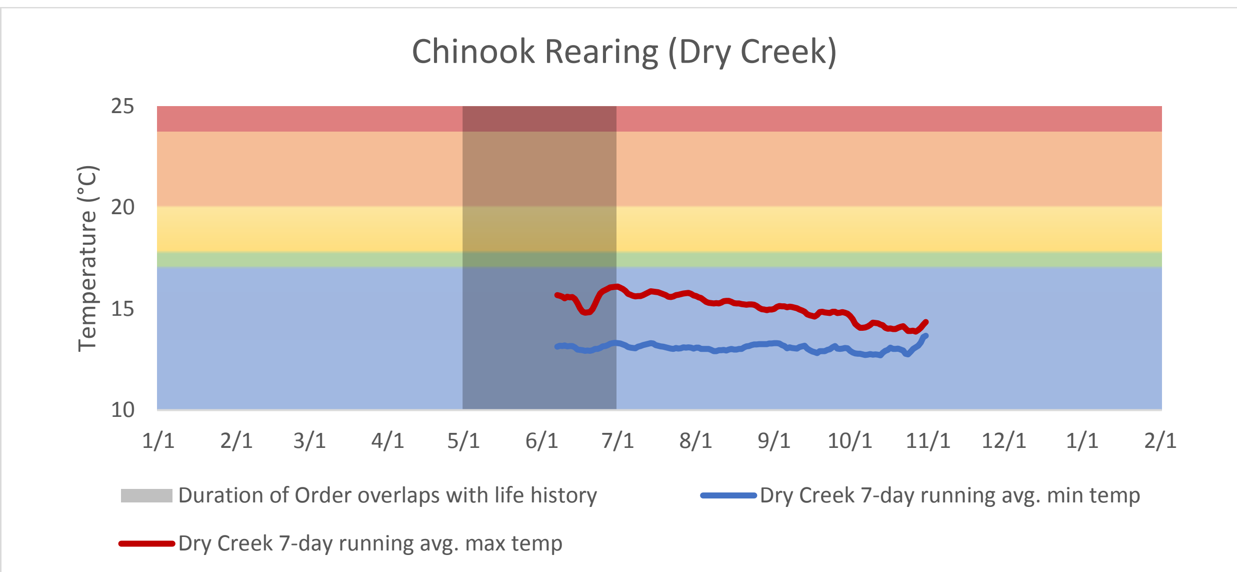


Figure 4-14. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Lambert Bridge (gage number 11465240) in Dry Creek shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based on Table 4-2.

Coho

Water temperatures were favorable for coho rearing in Dry Creek. Releases from Warm Spring Dam provide cold water for coho rearing in Dry Creek. Water temperatures were optimal to suitable in Dry Creek (Figure 4-15). The mainstem Russian River is not considered rearing habitat for coho.

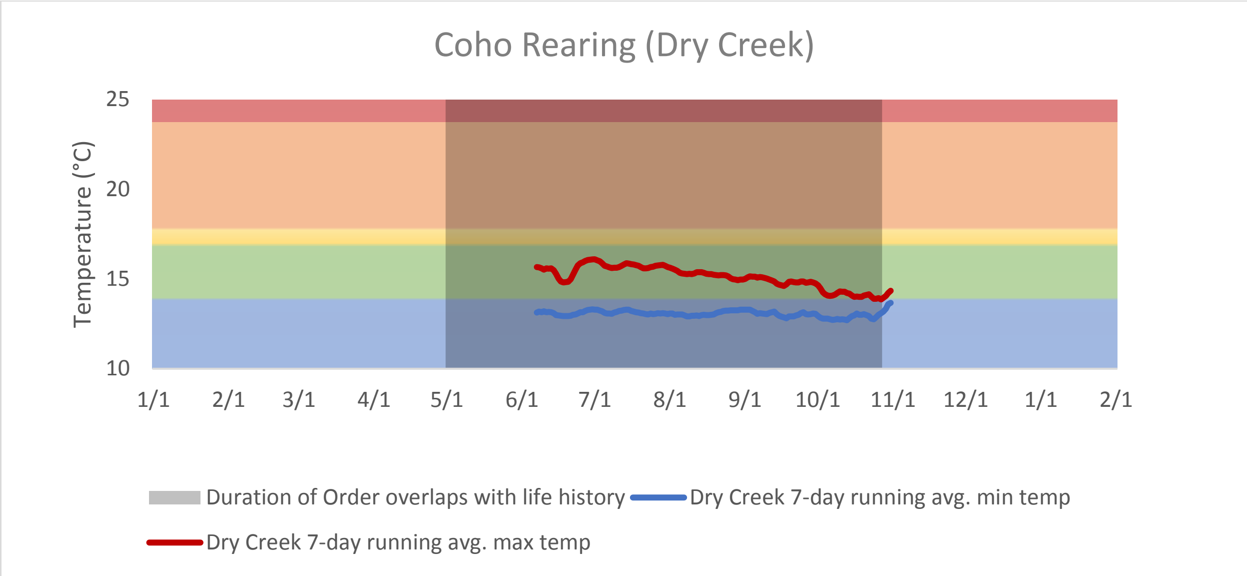


Figure 4-15. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Lambert Bridge (gage number 11465240) in Dry Creek shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook rearing based 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 4-16). During the Order water temperature at the USGS stream gage at Hopland mainly fell in the optimal to suitable range for steelhead parr (Figure 4-17). Water temperatures were optimal for steelhead raring in Dry Creek (Figure 4-18).

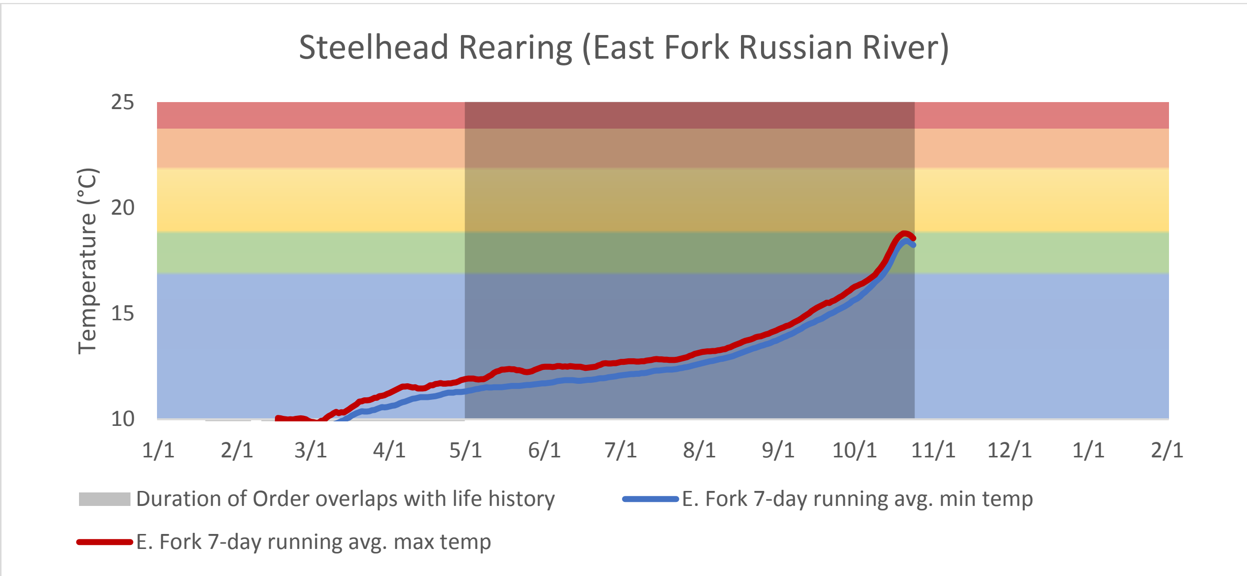


Figure 4-16. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River. The optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead parr based on Table 4-2 are also shown.

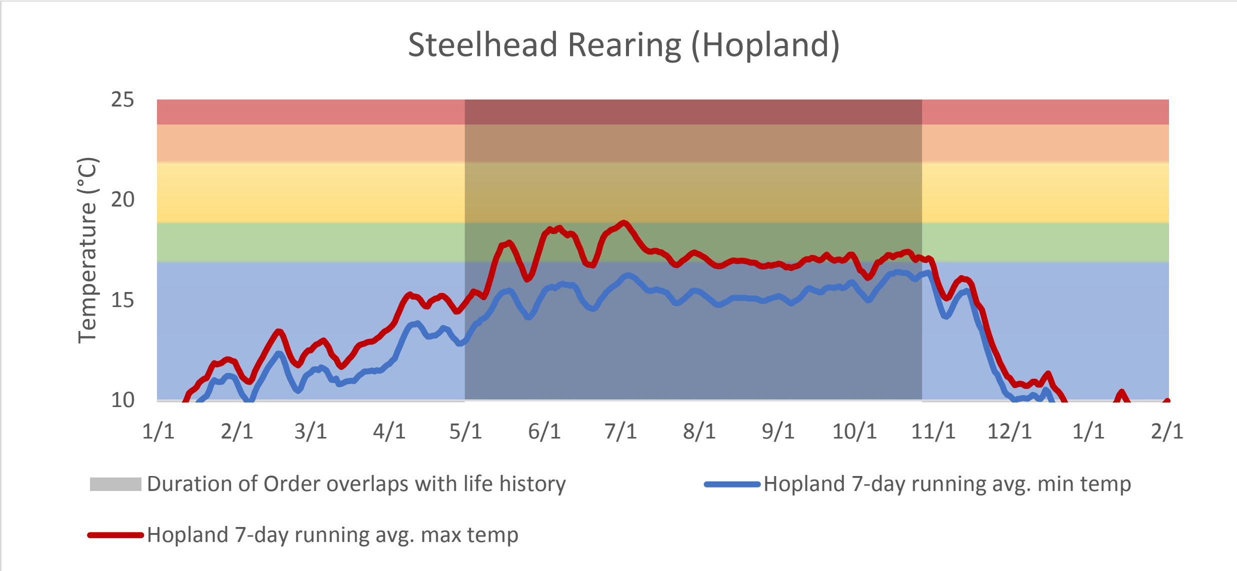


Figure 4-17. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). The optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead parr based on Table 4-2 are also shown.

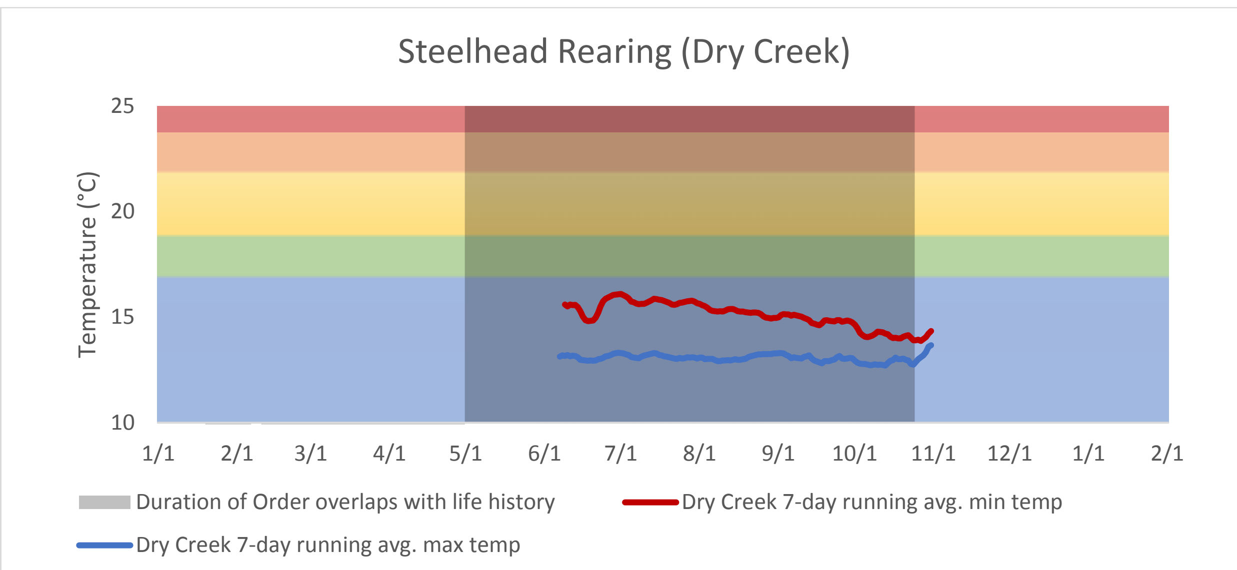


Figure 4-18. The 7-day running average of the minimum and maximum water temperatures collected in Dry Creek at Lambert Bridge (USGS stream gage number 11465240). The optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead parr based on Table 4-2 are also 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 14, 2016, until July 31, 2016. During the Order we captured 9,823 Chinook salmon smolts, 259 coho salmon smolts and 126 wild and hatchery 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 Dry Creek 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 portion of the Russian River (April through June, Figure 4-19 and Figure 4-20). However, water temperature became less favorable in the later part of the migration at sites located downstream of Hopland (Figure 4-21 through Figure 4-23). It is important to note that Chinook have evolved to emigrate during the spring before water temperatures become lethal. Trap catches at Chalk Hill (located on the mainstem Russian River approximately 10 miles upstream of Healdsburg and 5.5 miles upstream of Digger Bend) show that Chinook smolt counts peak before water temperatures reach the acutely stressful levels (Figure 4-21). Water temperatures in Dry Creek were favorable for Chinook smolts (Figure 4-24).

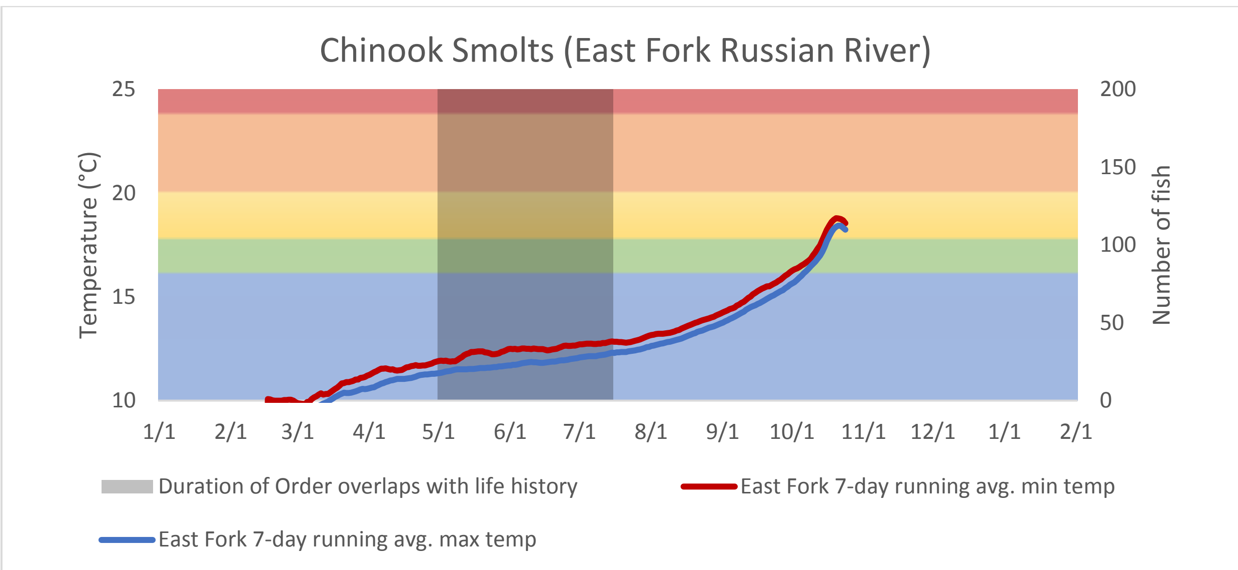


Figure 4-19. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

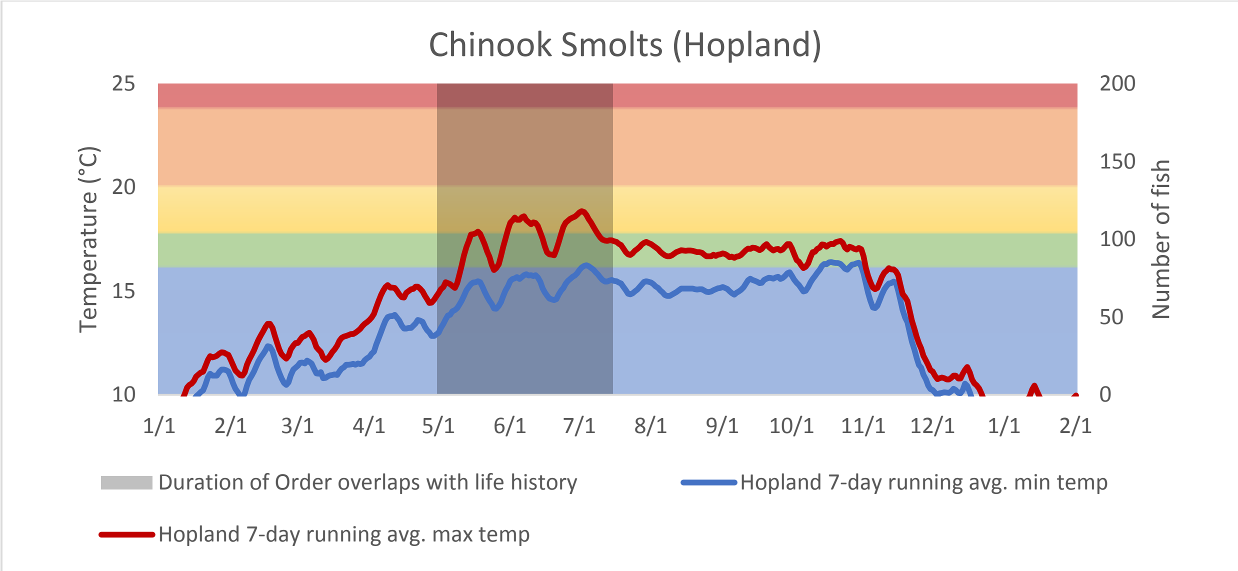


Figure 4-20. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). Shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

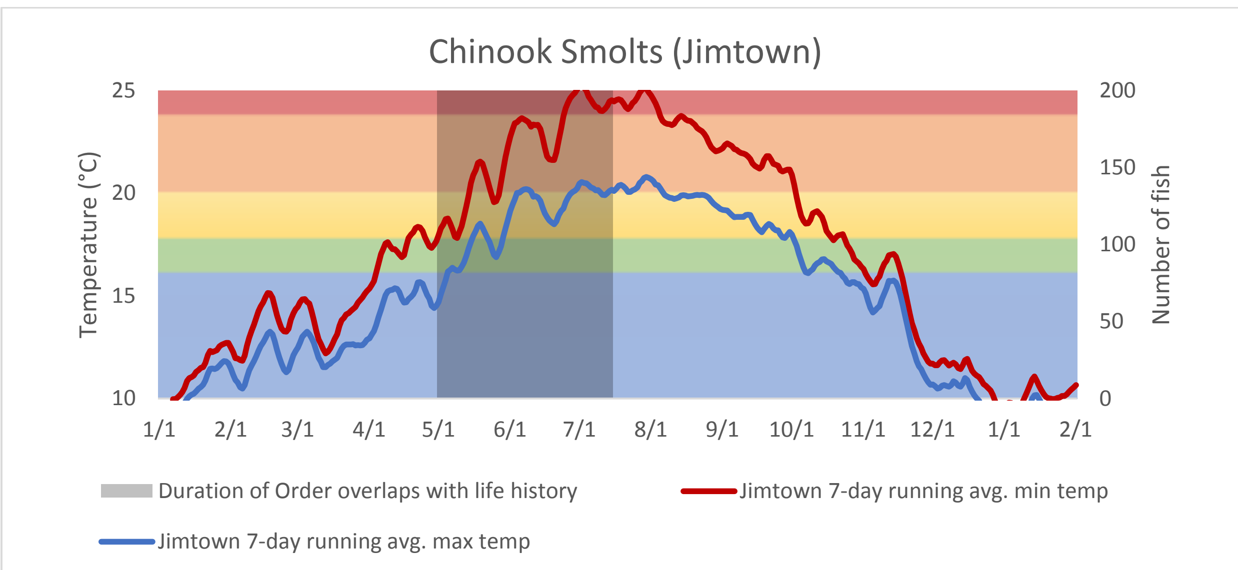


Figure 4-21. The 7-day running average of the minimum and maximum water temperatures collected at the Jimtown USGS stream Gage (1146382) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

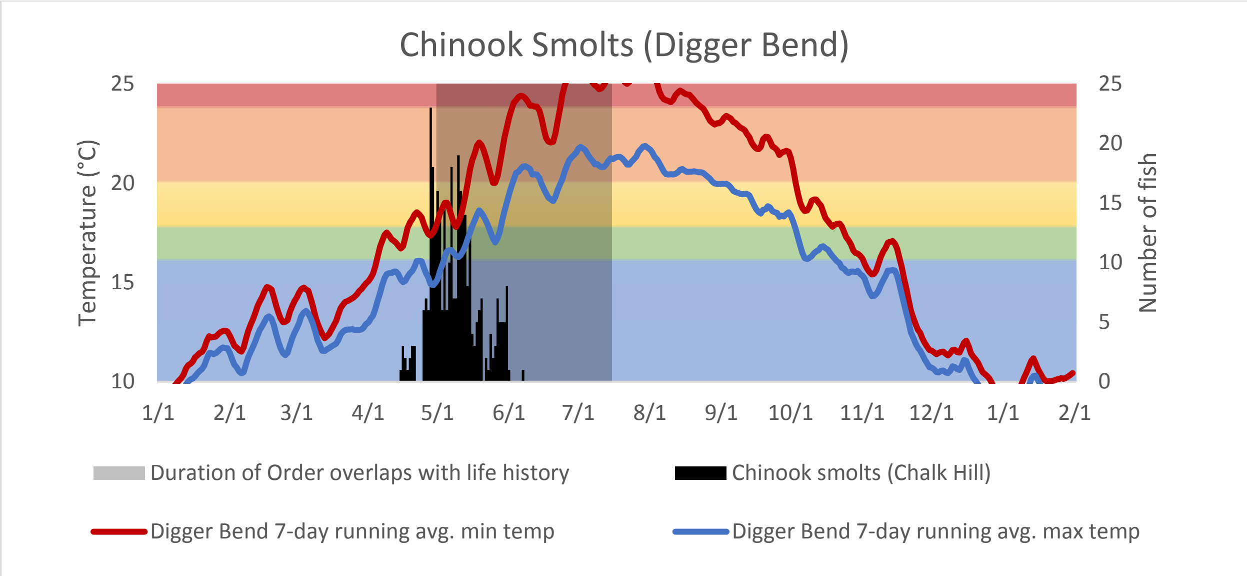


Figure 4-22. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) shown with the daily Chinook smolt catch from a fish trap located at Chalk Hill approximately 5 miles upstream of Digger Bend. Also show are the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

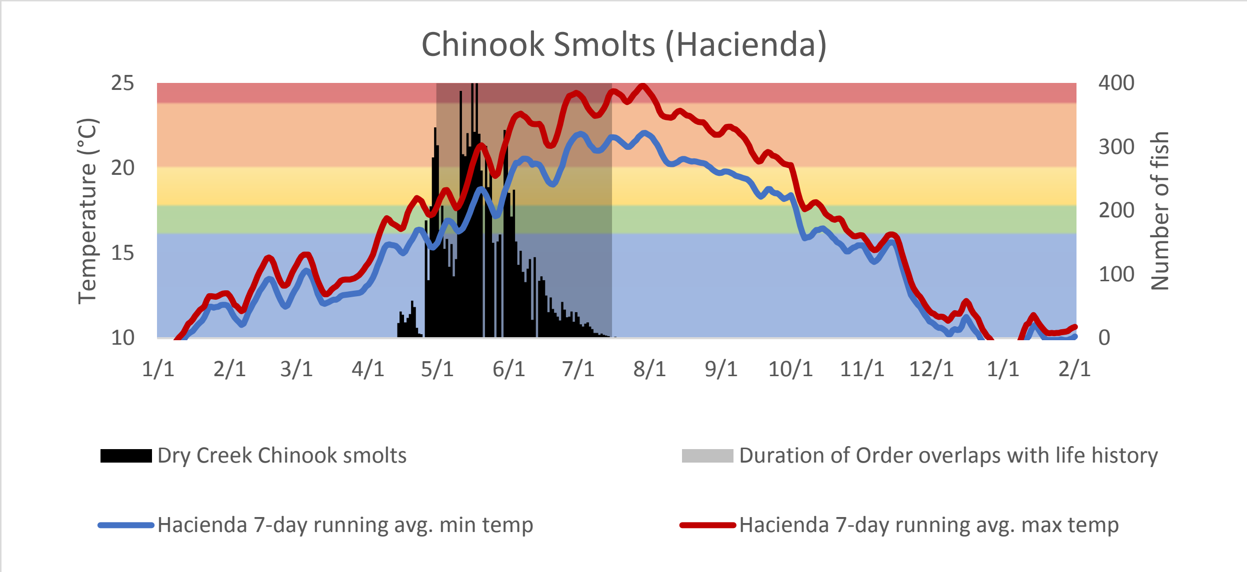


Figure 4-23. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook smolt catch from Dry Creek. Also show are the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

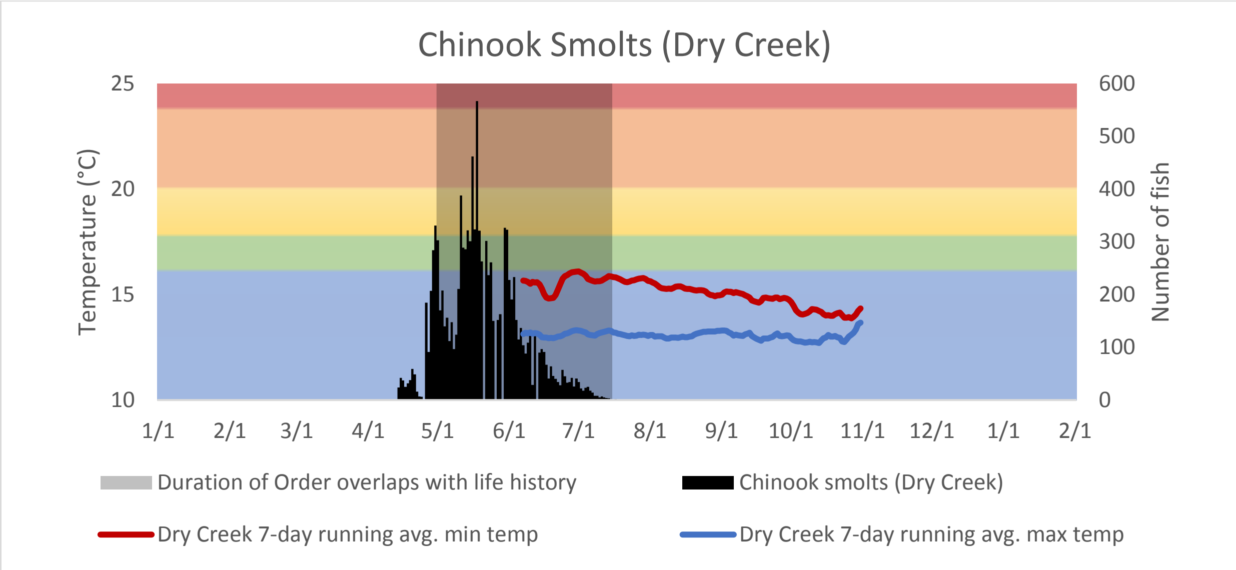


Figure 4-24. The 7-day running average of the minimum and maximum water temperatures collected at the Lambert Bridge USGS stream Gage (11463980) in Dry Creek shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for Chinook smolts based on Table 4-3.

Coho

A total of 259 coho salmon smolts were captured at the downstream migrant trap from April 16 until July 28, 2016; however, only eight individuals were captured after May 31, 2016. In Dry Creek water temperatures were not collected during the coho smolt period. The water temperature at Hacienda ranged from 17.1°C to 24.3°C during the time we captured coho smolts at Dry Creek. For coho smolts the observed water temperatures were in the suitable through lethal range. 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 4-25).

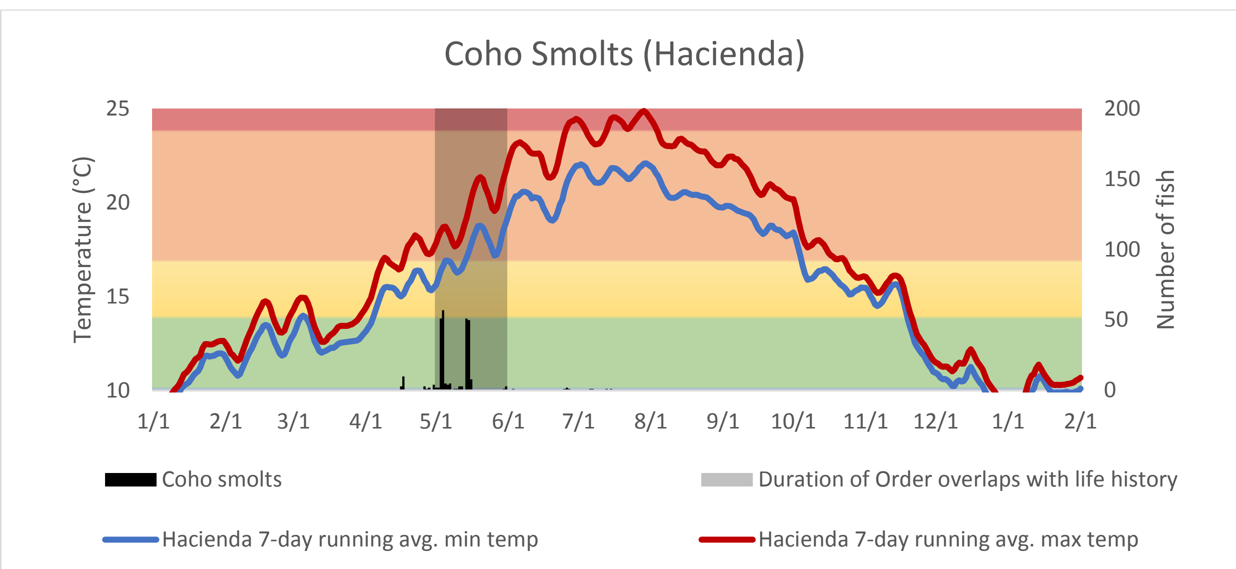


Figure 4-25. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the coho smolt catch from Dry Creek. Also show are the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for coho smolts 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 4-26). At Hopland water temperatures for smolting steelhead were stressful to acutely stressful (Figure 4-27). At Jimtown water temperatures were acutely stressful (Figure 4-28). At Digger Bend water temperatures were acutely stressful to lethal (Figure 4-29). We captured steelhead smolts at the downstream migrant trap from April 17, until July 30, 2016. 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 4-30). However, most steelhead smolts likely leave much earlier in the year when water temperatures are cooler. At Dry Creek water temperatures were not collected during the steelhead smolt period.

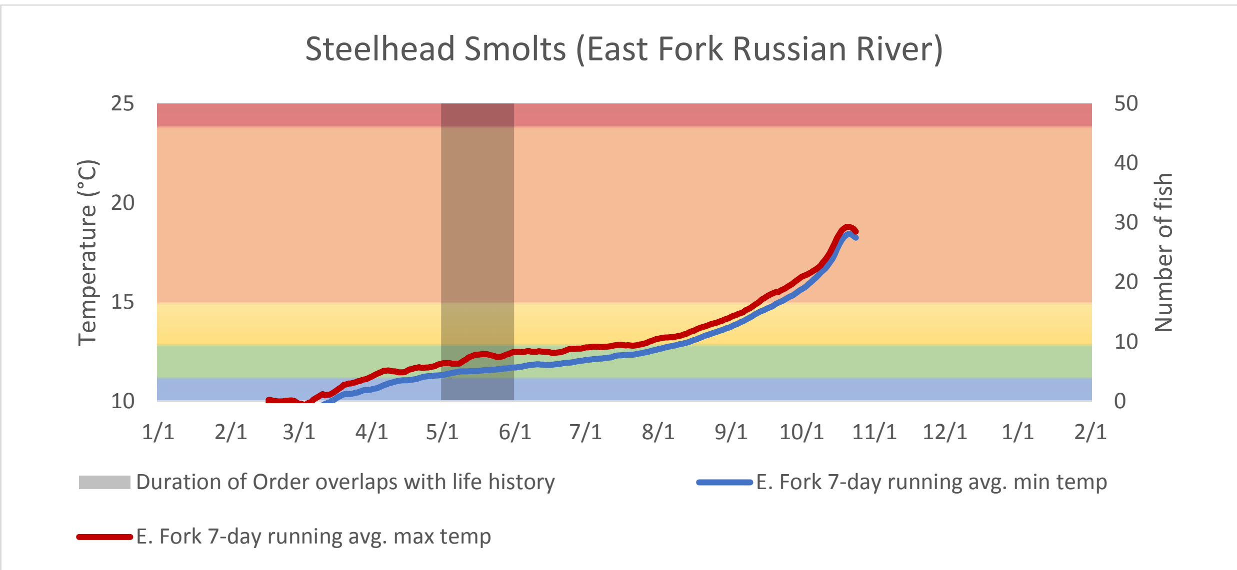


Figure 4-26. The 7-day running average of the minimum and maximum water temperatures collected in the East Fork Russian River shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

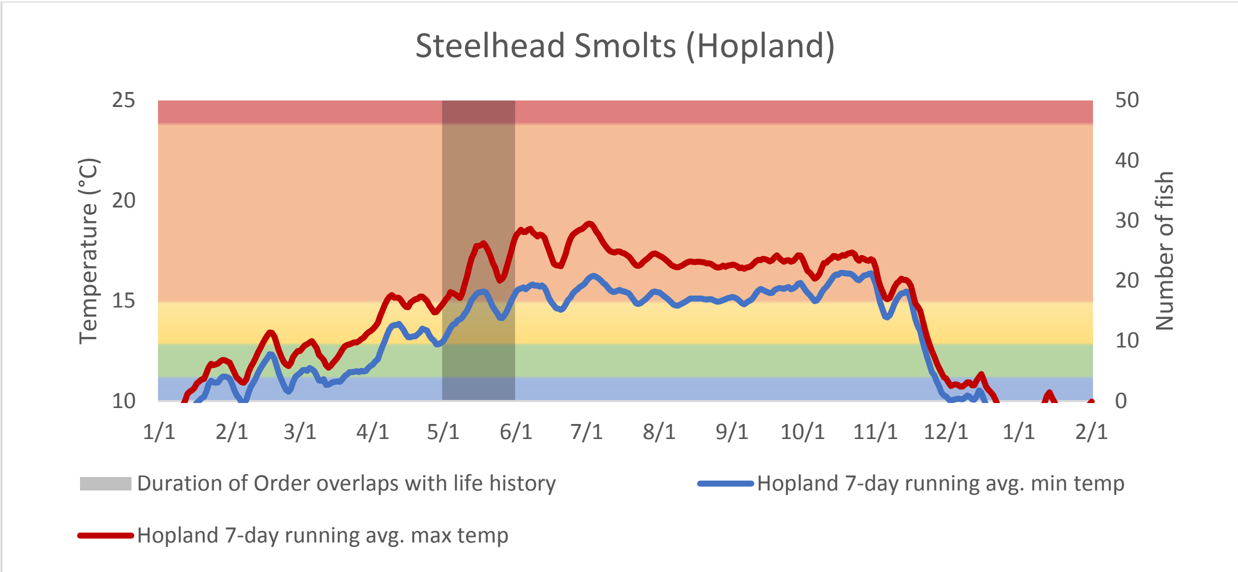


Figure 4-27. The 7-day running average of the minimum and maximum water temperatures collected at the USGS gage at Hopland (gage number 11462500) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

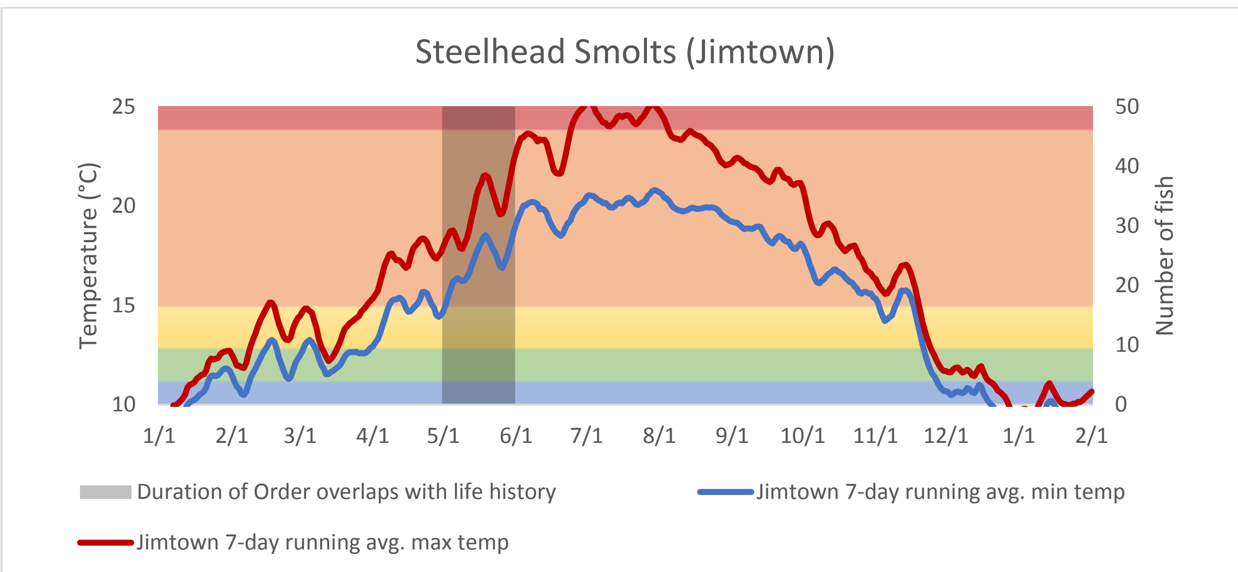


Figure 4-28. The 7-day running average of the minimum and maximum water temperatures collected at the USGS gage at Jimtown (USGS gage number 11463682) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

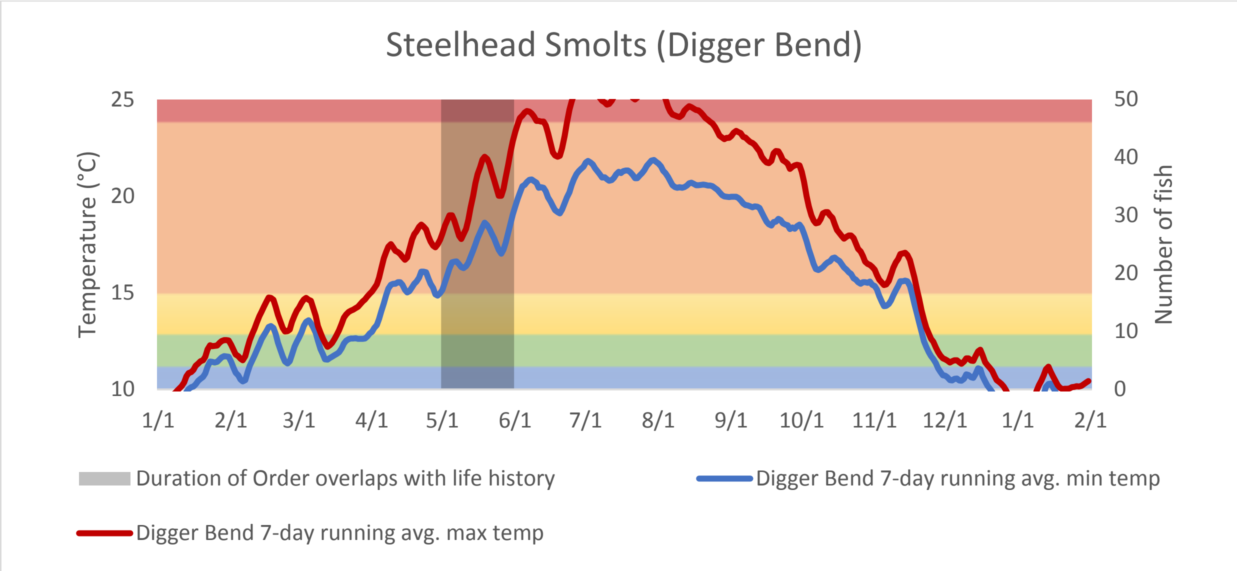


Figure 4-29. The 7-day running average of the minimum and maximum water temperatures collected at the USGS gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead smolts based on Table 4-3.

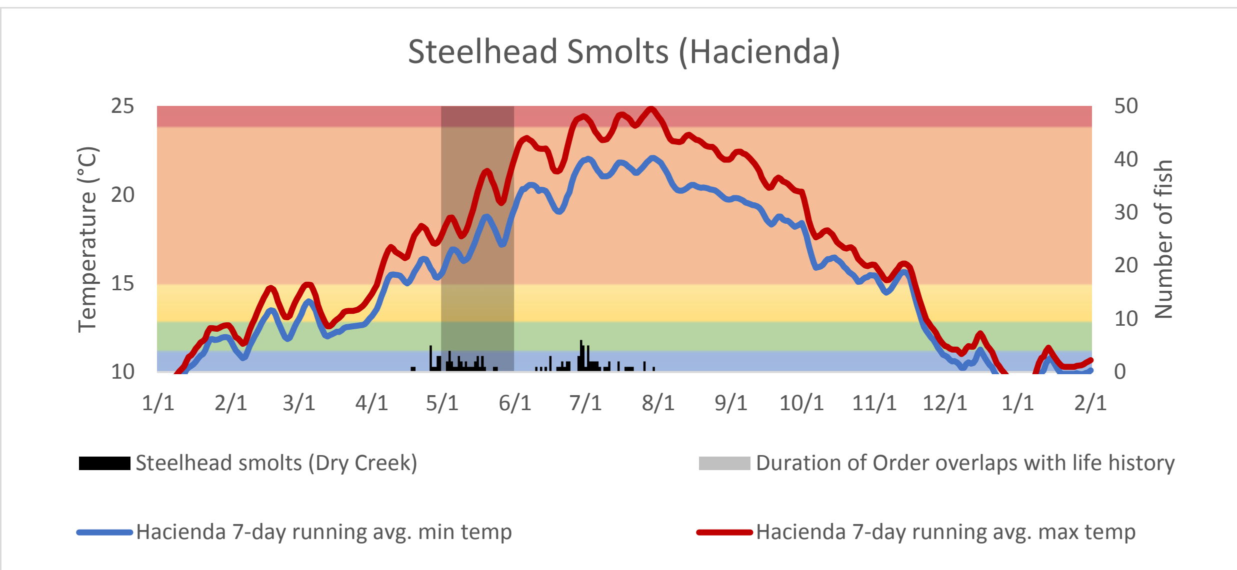


Figure 4-30. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the steelhead smolt catch from Dry Creek. Also show are the optimal, suitable, stressful, acutely stressful and lethal water temperature thresholds for steelhead 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 Russian River to a level that was very poor for salmonids (Figure 4-31). This is due to water with low dissolved oxygen being released from Lake Mendocino. In the summer Lake Mendocino stratifies with a layer of warmer less dense water laying on top of a cooler denser layer of water. The intake for the release point in Lake

Mendocino is located near the bottom of the lake. Dissolved oxygen near the bottom of the lake declines throughout the summer. In the fall dissolved oxygen recovers when stratification in the lake breaks down and oxygenated water mixes thought the lake. This pattern is fairly typical for Lake Mendocino and has been observed in previous years. In previous years dissolved oxygen in the East Fork Russian River recovers at the confluence with the West Fork Russian River about 1 mile downstream of Coyote Valley Dam. 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).

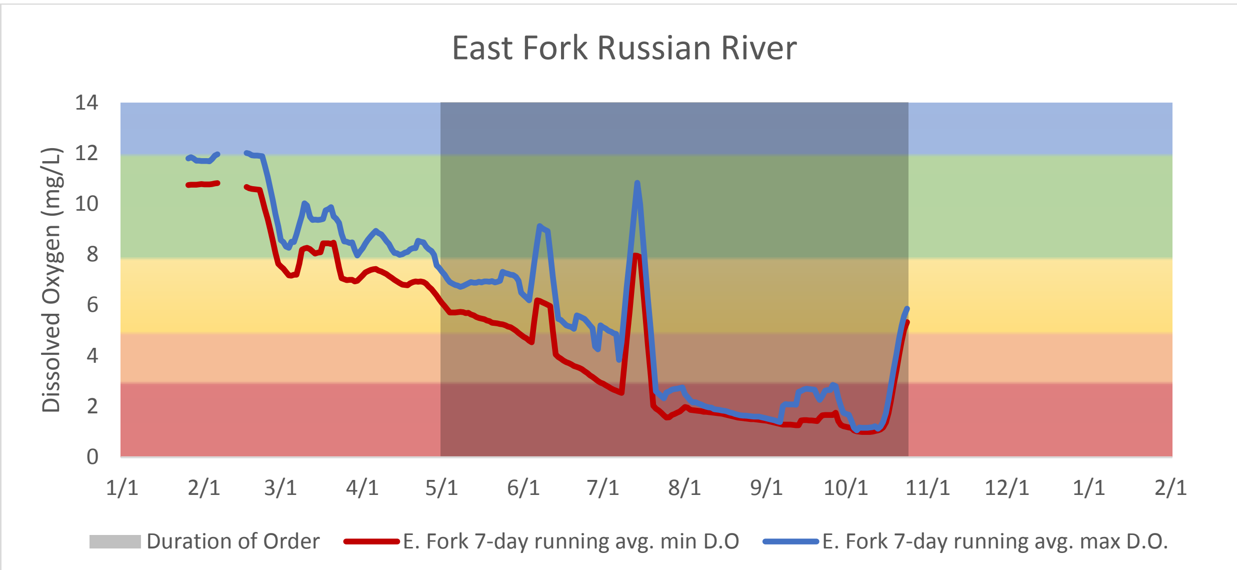


Figure 4-31. The 7-day running average of the minimum and maximum dissolved oxygen collected in the East Fork Russian River approximately 1/3 mile downstream of the Coyote Valley Dam. Shown with the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria.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

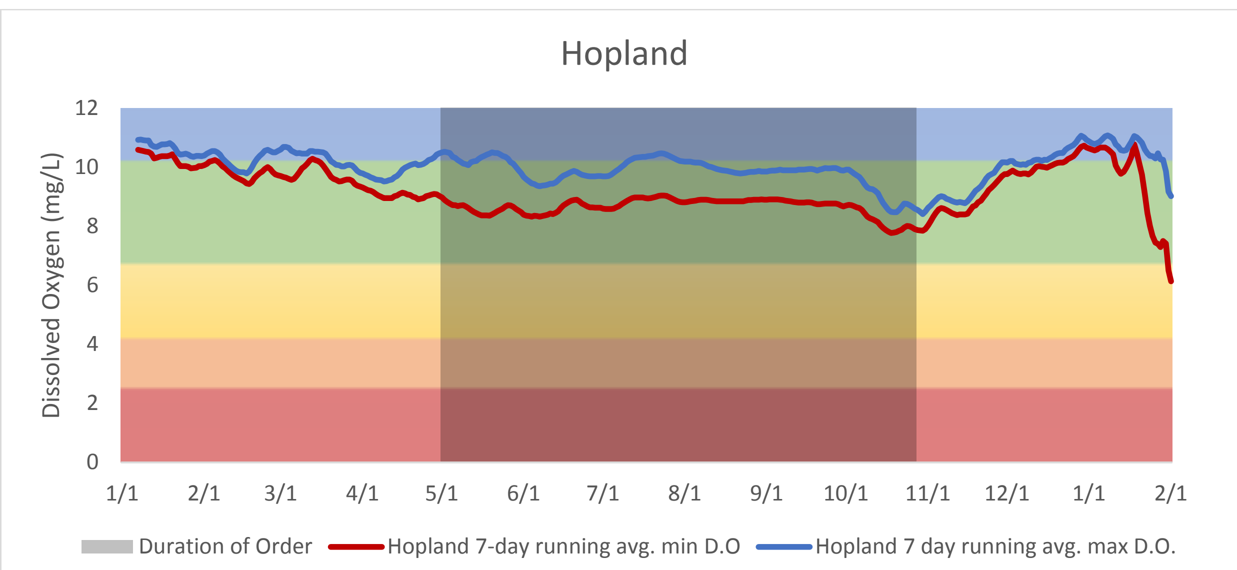


Figure 4-32. The 7-day running average of the minimum and maximum dissolved oxygen collected at Hopland (USGS stream gage number 11462500). Also shown are the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 4-4 for a description of water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

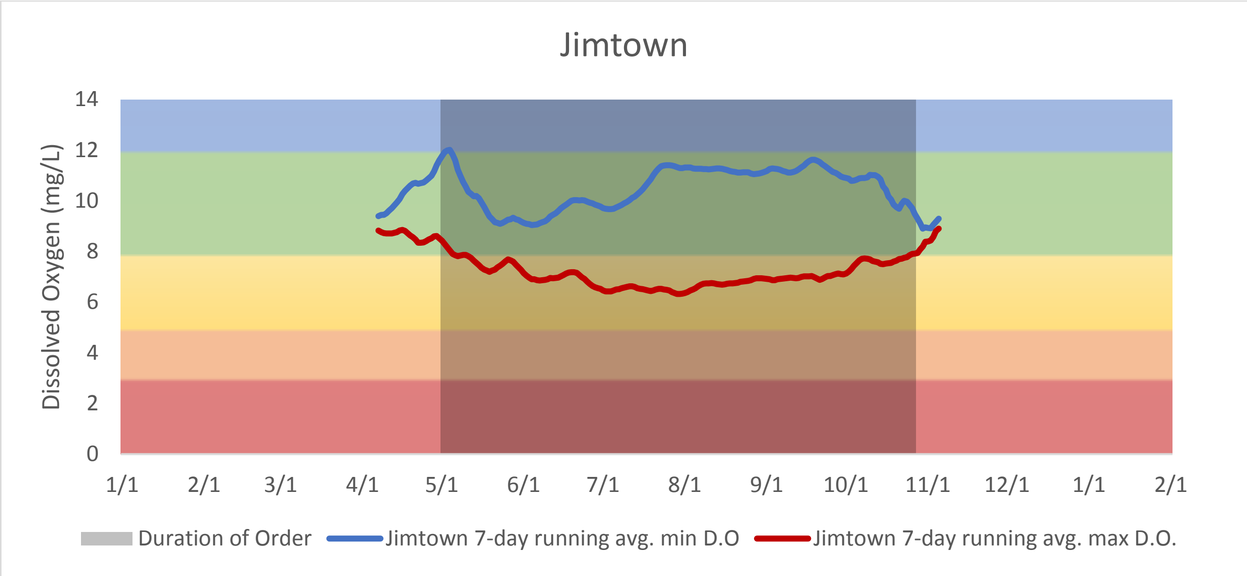


Figure 4-33. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Jimtown USGS stream Gage (1146382). Also shown are the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 4-4 for a description of water quality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

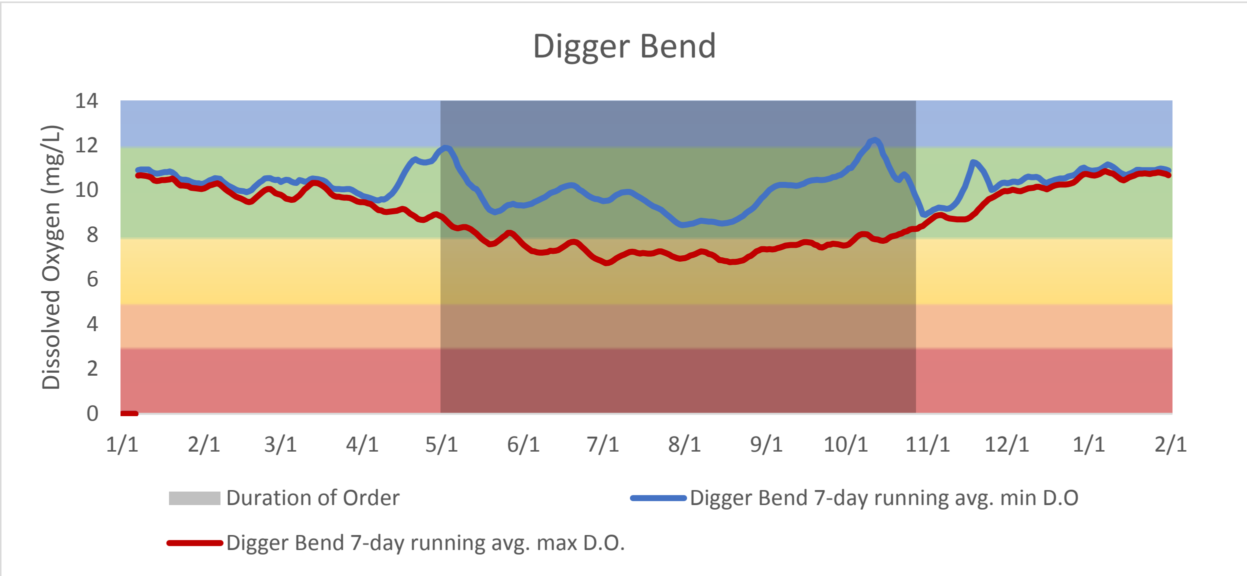


Figure 4-34. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Digger Bend USGS stream gage (11463980). Also shown are the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 4-4 for a description of water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

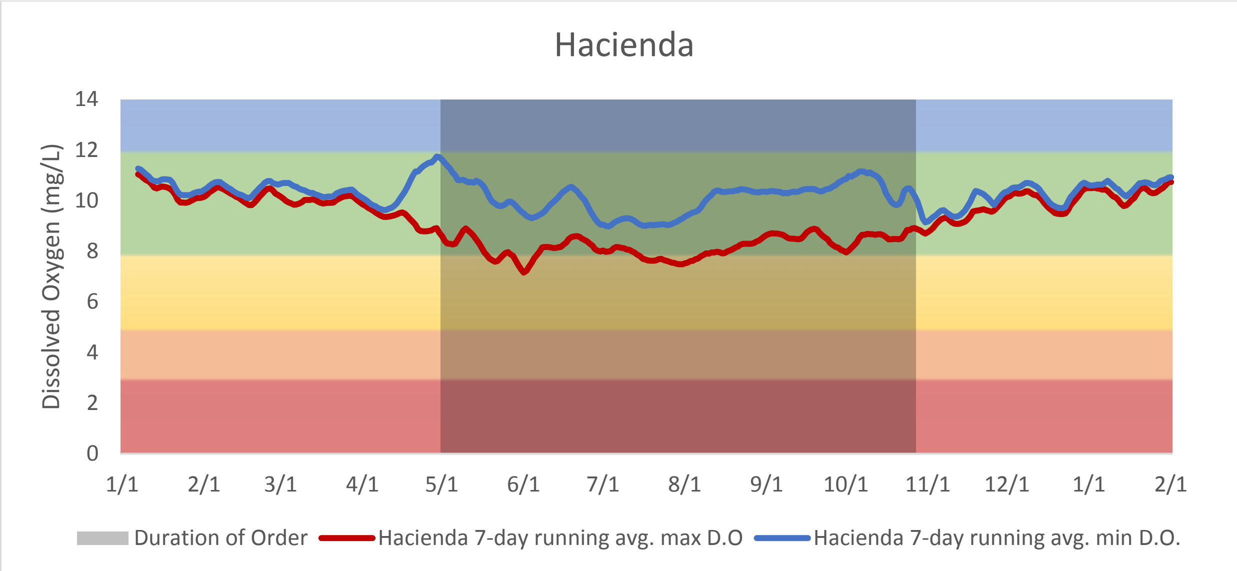


Figure 4-35. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Hacienda USGS stream gage (1146700). Also shown are the optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on our criteria. See Table 4-4 for a description of water quality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

4.2.5 Summary

Compared to the last few years of significant drought flows were higher in the Russian River during the spring, summer, and fall in 2016. Adult fish moved past Mirabel during the Order. However, like in previous years, a barrier beach that formed at the mouth of the river limited fish from entering the river during September. Significant rain events in October likely helped motivate adult Chinook to migrate upstream. When Chinook first began migrating upstream in 2016 water temperature at Hacienda was stressful to acutely stressful, but quickly improved 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 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 October 1 when water temperatures in the river are becoming favorable.

For Chinook smolts water temperature was favorable for rearing in the early spring and at most sites became unfavorable by the end of the rearing season. Water temperature 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 would encounter 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 rearing in Dry Creek in 2016. 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 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 (located on the mainstem Russian River approximately 10 miles upstream of Healdsburg and 5.5 miles upstream of Digger Bend) 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 be 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 watershed (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 2016, 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 2017). 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 when compared to the section of the river occupied by rearing steelhead. 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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