Russian River Water Quality Summary for the 2021/2022 Temporary Urgency Change

Sonoma Water

July 2022

American Disabilities Act Compliance

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1.0 Introduction

On 17 November 2021, the Sonoma County Water Agency (Sonoma Water) filed Temporary Urgency Change Petitions (TUCPs) with the State Water Resources Control Board (SWRCB) for modifications to water right Permits 12947A, 12949, 12950, and 16596 that would implement an alternative hydrologic index based on Lake Mendocino storage values starting December 11, 2021. These changes were necessary to ensure that the water supply condition and corresponding minimum instream flow requirements in the Russian River watershed are aligned with actual watershed hydrologic conditions. This is essential to maintain sustainable reservoir/river operations to protect municipal water supply and listed salmon species in the Russian River. On December 10, 2021, the State Water Resources Control Board (SWRCB) Order was issued approving Sonoma Water's petition.

In summary, the SWRCB approved the following temporary changes to the Decision 1610 (D1610) instream flow requirements from 11 December 2021 through 9 June 2022 to the following:

(1) The minimum instream flow requirements for the Upper Russian River, the Lower Russian River, and Dry Creek will be established using a hydrologic index based on water storage in Lake Mendocino. For the purposes of the requirements in Term 20 of Permit 12947A, Term 17 of Permit 12949, Term 17 of Permit 12950, and Term 13 of Permit 16596, the following definitions shall apply:

   a. Dry water supply conditions exist when storage in Lake Mendocino is less than:
      i. 40,000 acre-feet as of January 1
      ii. 59,000 acre-feet as of February 1
      iii. 68,000 acre-feet as of March 1
      iv. 69,500 acre-feet as of March 16
      v. 71,000 acre-feet as of April 1
      vi. 70,000 acre-feet as of April 16
      vii. 69,000 acre-feet as of May 1
      viii. 67,500 acre-feet as of May 16
      ix. 65,000 acre-feet as of June 1
   b. Critical water supply conditions exist when storage in Lake Mendocino is less than:
      i. 31,000 acre-feet as of January 1
      ii. 36,000 acre-feet as of February 1
      iii. 52,000 acre-feet as of March 1
      iv. 53,000 acre-feet as of March 16
      v. 54,000 acre-feet as of April 1
      vi. 53,000 acre-feet as of April 16
      vii. 52,000 acre-feet as of May 1
      viii. 51,000 acre-feet as of May 16
      ix. 50,000 acre-feet as of June 1
   c. Normal water supply conditions exist in the absence of defined dry or critical water supply conditions.

This temporary change was requested in response to the current extremely dry conditions, severely low storage levels in Lake Mendocino and Lake Sonoma, and the current hydrologic index not aligning with

observed hydrologic conditions in the Russian River Watershed. The proposed change was also requested in response to the reported failure of the transformer bank of the Potter Valley Project (PVP) hydroelectric plant in October 2021 that would likely continue to result in a significant reduction in the inter-basin transfers of Eel River water into the Russian River Watershed.

2.0 2022 Russian River Flow Summary

In early January 2022, following a series of storms in October through December 2020, water storage levels in Lake Mendocino rose above 41,000 acre-feet, which is similar to storage levels experienced in 2016, a normal water year. However, storage declined through the month of February due to less than normal rainfall, and remained below 45,000 acre-feet through the month of March (Figure 2-1). Storage did increase in Lake Mendocino through May due to a late season storm event in April, as well as from higher inflow rates from Potter Valley than outflow rates through the reservoir, and peaked in early June at just over 50,600 acre-feet, where it remained relatively stable through the term of the Order (Figure 2-1).

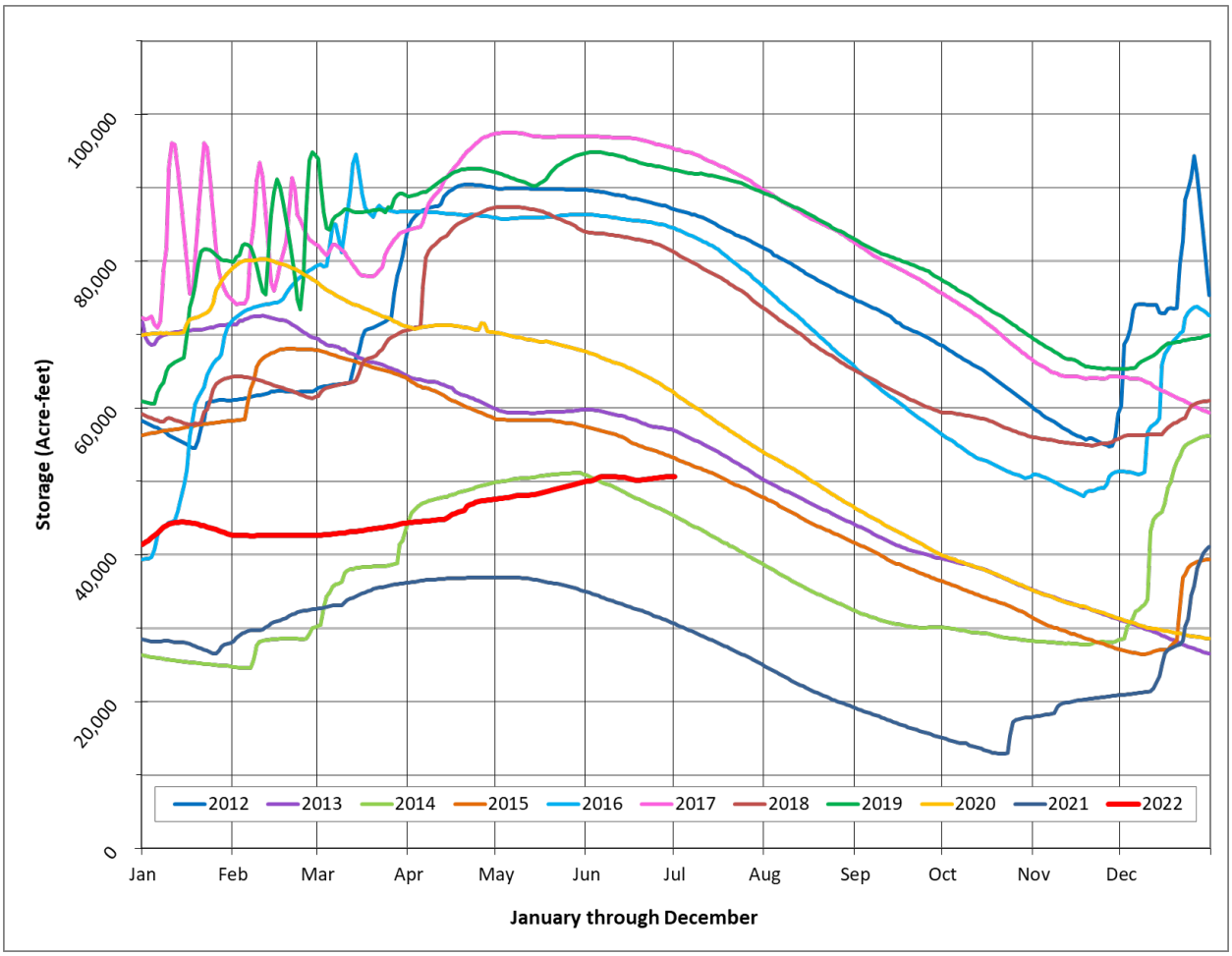

Figure 2-1. Lake Mendocino water storage levels, in acre-feet, from 2012 through 2022.

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

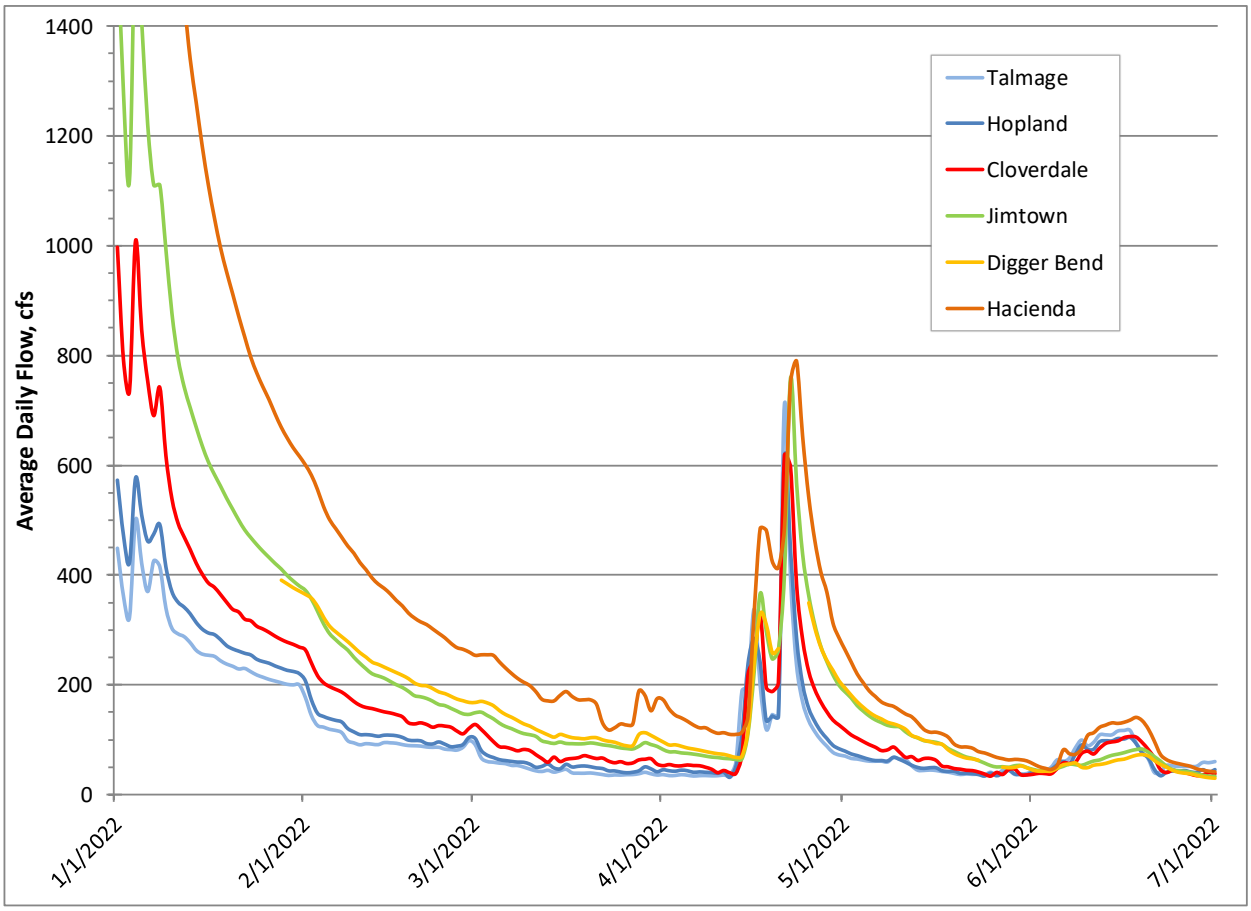

Figure 2-2. 2022 average daily flows in the Russian River as measured at U.S. Geological Survey (USGS) gages in cubic feet per second (cfs). Flow rates are preliminary and subject to final revision by USGS.

The changes in upper Russian River minimum instream flow requirements authorized by the Order generally allowed flows to decline below D1610 minimum instream flows of 150 cfs beginning in February and continuing through June. (Figure 2-3). Flows briefly increased above the D1610 minimum flow in mid-April during late season storm events, but quickly declined to flows below the D1610 minimum, but not below TUC minimum flows. Overall, flows did not decline below the TUC minimum daily average flows in the upper Russian River during the term of the Order (Figure 2-3).

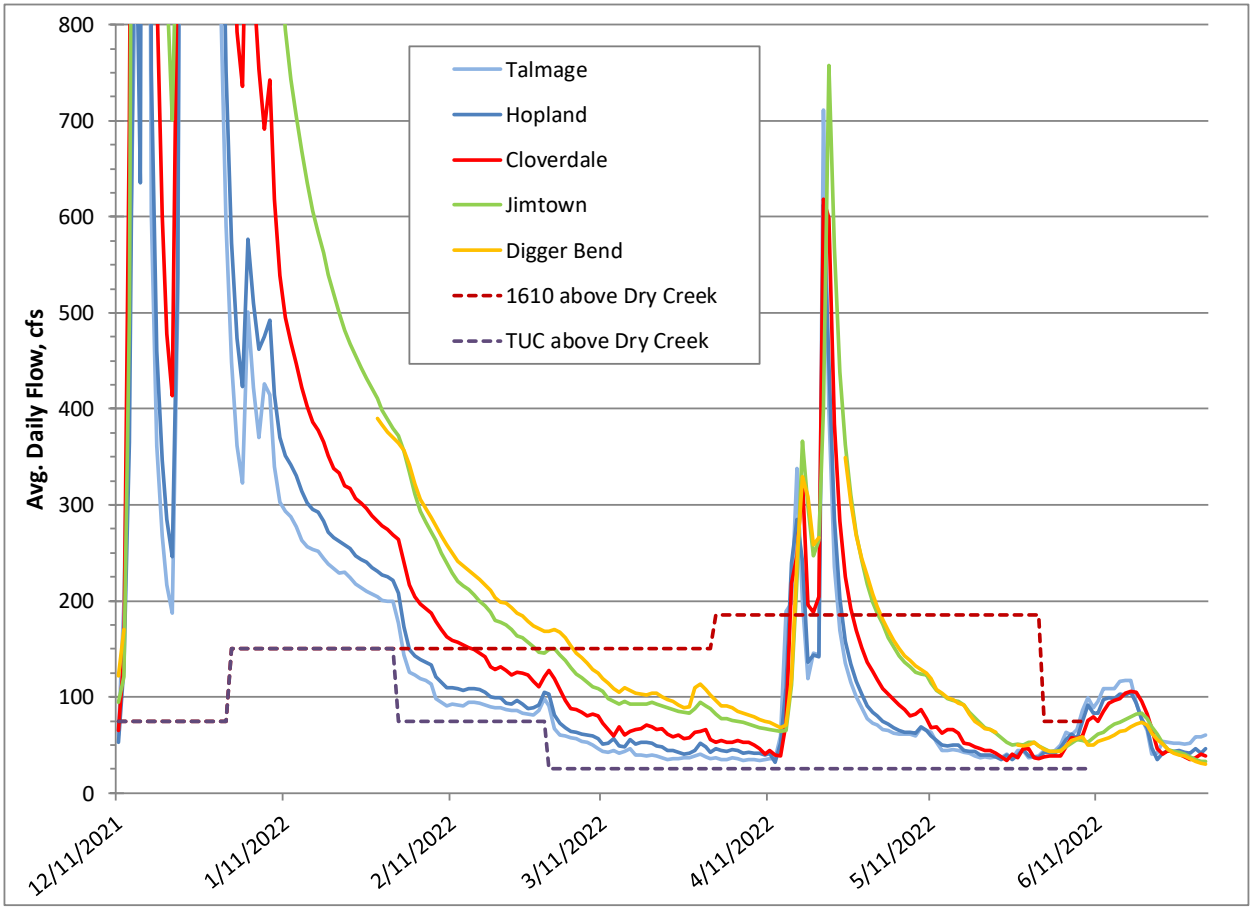

Figure 2-3. December 2021 through June 2022 average daily flows in the upper Russian River as measured at USGS gages above the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

The changes in lower Russian River minimum instream flow requirements authorized by the Order allowed flows at Hacienda to decline below D1610 minimum instream flows of 125 cfs briefly in early April and again in mid-May through the end of the Order (Figure 2-4). However, lower Russian River flows did not decline below the TUC minimum daily average flows authorized by the Order (Figure 2-4).

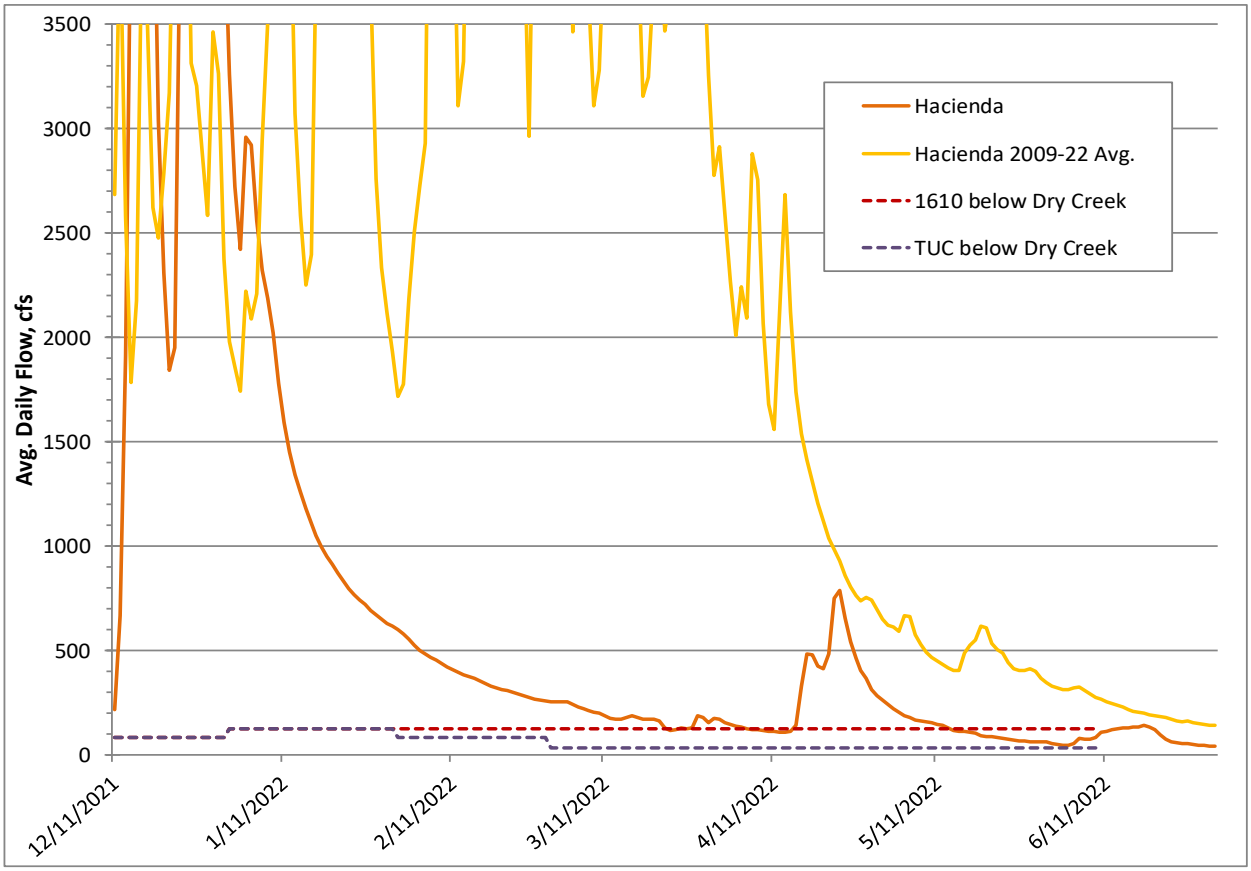

Figure 2-4. December 2021 through June 2022 average daily flows in the lower Russian River as measured at USGS gages below the Dry Creek confluence in cubic feet per second. Flow rates are preliminary and subject to final revision by USGS.

3.0 Water Quality Monitoring

Water quality data was collected at the USGS maintained gages to monitor TUC flows for potential effects to recreation and available aquatic habitat for salmonids. Datasonde data, including temperature and dissolved oxygen measurements, were collected at these and other stations 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. Analysis and discussion of the flow data and datasonde data for potential effects to aquatic habitat for salmonids is presented in Section 4.0 below.

4.0 Additional Monitoring

4.1 Sonoma Water and USGS Permanent and Seasonal Datasondes

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

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

The data collected by the sondes described above are evaluated in Section 4.2 in response to the terms of the SWRCB TUC Order to evaluate whether and to what extent the reduced flows authorized by the Order caused any impacts to water quality or availability of aquatic habitat for salmonids.

Figure 4-1 Sonoma Water and USGS Russian River Permanent and Seasonal Datasonde Monitoring Stations

NORTH

0 1.25 2.5 5 Miles

Sonoma Water

4.2 Aquatic Habitat for Salmonids

4.2.1 Introduction

In Term 7 of the Temporary Urgency Change Order (Order) the State Water Resource Control Board (SWRCB) tasked Sonoma Water with evaluating impacts associated with reductions in minimum instream flows authorized by the Order to water quality and the availability of aquatic habitat for Russian River salmonids. This section of the report summarizes temperature and dissolved oxygen (DO) conditions in the Russian River during the Order and relates these conditions to fisheries monitoring data collected by Sonoma Water.

4.2.2 Russian River Salmonid Life Stages

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

Coho Timing and Distribution

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

the Order; therefore, only temperature and DO data relating to these life stages will be analyzed for this report. There is limited coho spawning habitat upstream of Healdsburg therefore only the Hacienda and Digger bend sites will be summarized for coho.

Steelhead Timing and Distribution

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

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

The steelhead smolt migration in the Russian River begins at least as early as March and continues through June, with most steelhead emigrating from March through May (SCWA unpublished data, Martini-Lamb and Manning 2011). Temperature and DO data related to Russian River steelhead adult, juvenile, and smolt life stages are summarized for this report as these life stages are present in the mainstem during the Order.

Chinook Timing and Distribution

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

4.2.3 Methods

Sonoma Water uses underwater video, downstream migrant traps, and water quality data collected in the Russian River to depict water quality conditions when salmonids where present. To estimate the number of adult Chinook that return to the Russian River upstream of the Mirabel inflatable dam,

Sonoma Water typically operates an underwater video camera in the fish ladder located at the dam. Sonoma Water also operates downstream migrant traps to enumerate salmonid smolts. USGS stream gages and a Sonoma Water operated data sonde were used to provide water quality data in the mainstem Russian River.

Physical and water quality conditions (flow, water temperature, and DO) were collected at multiple sites in the Russian River. USGS stream gages located on the Russian River at Hacienda, Digger Bend, Jimtown, and Hopland provided flow, water temperature, and DO data. A data sonde operated by Sonoma Water collected temperature and DO data in the east fork Russian River 0.5 km downstream of Coyote Valley Dam, near Ukiah, CA. Water quality conditions at these sites were compared to literature-based thresholds then used to construct temperature and DO criteria for Russian River salmonids (Tables 4-1 through Table 4-4).

Table 4-1. Adult salmonid water temperature (°C) thresholds used for migration when describing water quality conditions during the term of the Temporary Urgency Change Order. Criteria are from SCWA (2016).

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

Table 4-2. Juvenile salmonid rearing temperature (°C) thresholds used for describing water quality conditions during the term of the Temporary Urgency Change Order. Criteria are from SCWA (2016).

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

Table 4-3. Salmonid smolting temperature (°C) thresholds used for describing water quality conditions during the term of the Temporary Urgency Change Order. Criteria are from SCWA (2016).

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

Table 4-4. Dissolved oxygen (mg/L) thresholds for all salmonid life stages used for describing water quality conditions during the term of the Temporary Urgency Change Order. Criteria are from SCWA (2016).

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

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

4.2.4 Results

Flow

The winter 2021 TUCO went into effect on December 11, 2021, and expired 180 days later on June 9, 2022. During that period, average daily flow at Hacienda ranged from a high of 18,820 cfs on December 16, 2021, to a low of 45 cfs on June 4, 2022. Flow during the Order was typically between 141 cfs and 1,375 cfs (25th and 75th percentiles of the daily average flow at Hacienda). During the Order, the Russian River was generally influenced by tributary in-flow early in the winter and in April following rain events.

Temperature

Adult Salmonid Migration

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

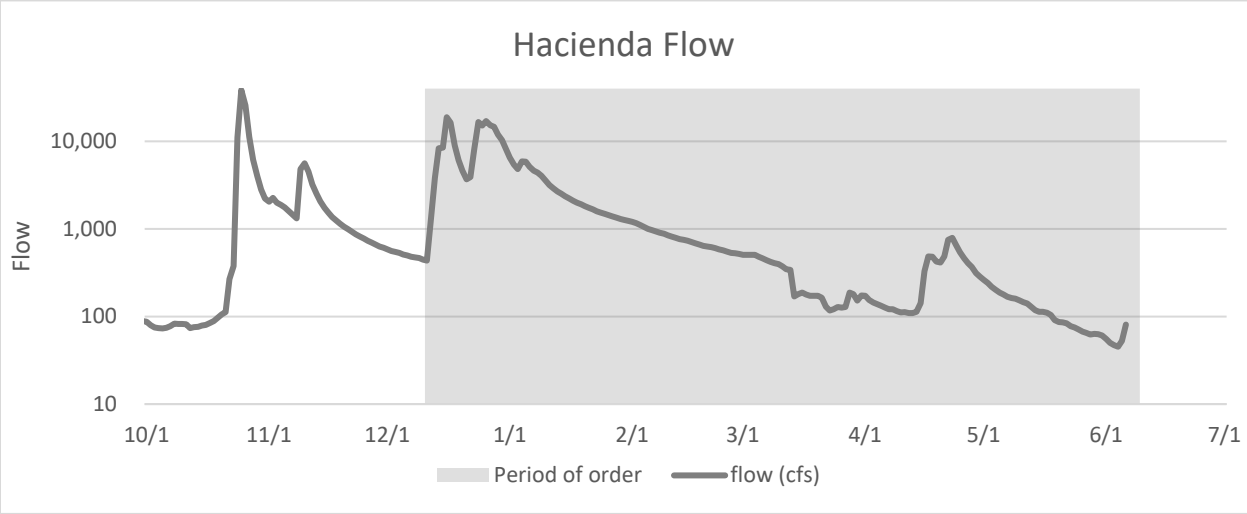

Figure 4-1. Flow in the Russian River at the USGS Hacienda stream gage (11467000).

Chinook

Water temperatures for Chinook salmon were favorable during the period of the order when Chinook are typically observed in the Russian River. Temperature was optimal for adult salmonids (based on the criteria in Table 4-1 and Figures 4-2 through 4-5).

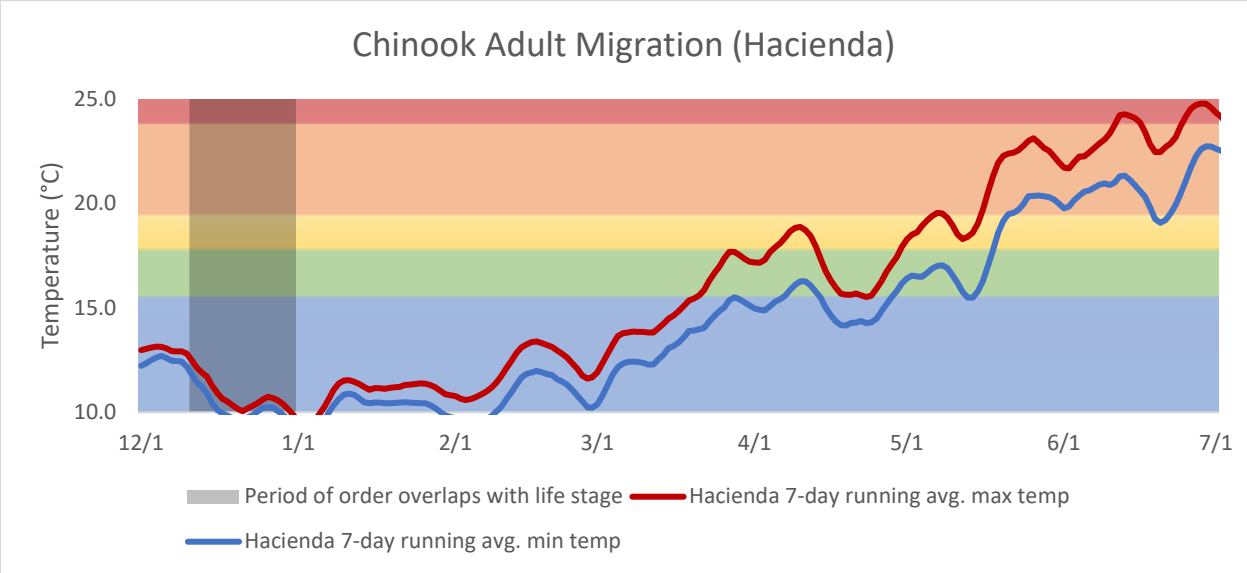

Figure 4-2. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000. Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult Chinook based on Table 4-1.

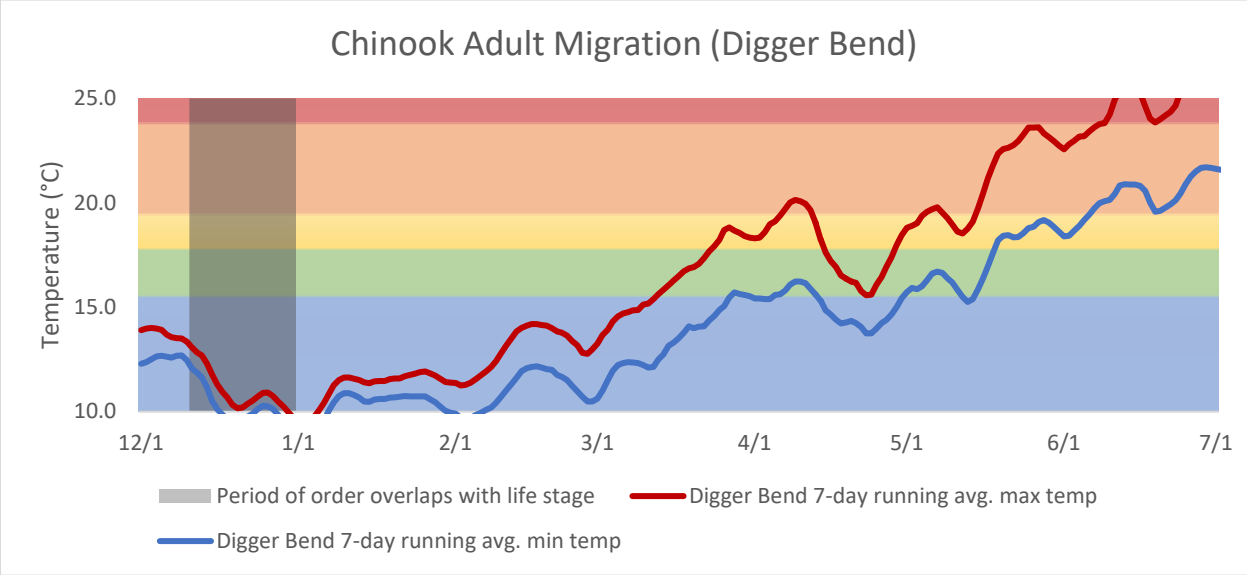

Figure 4-3. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

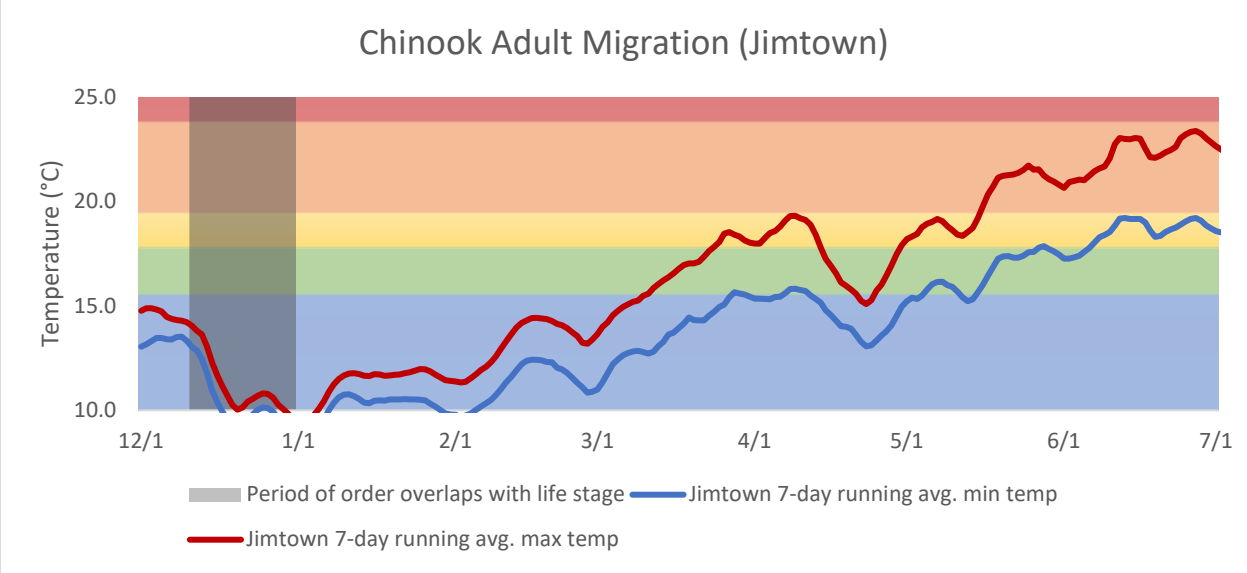

Figure 4-4. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

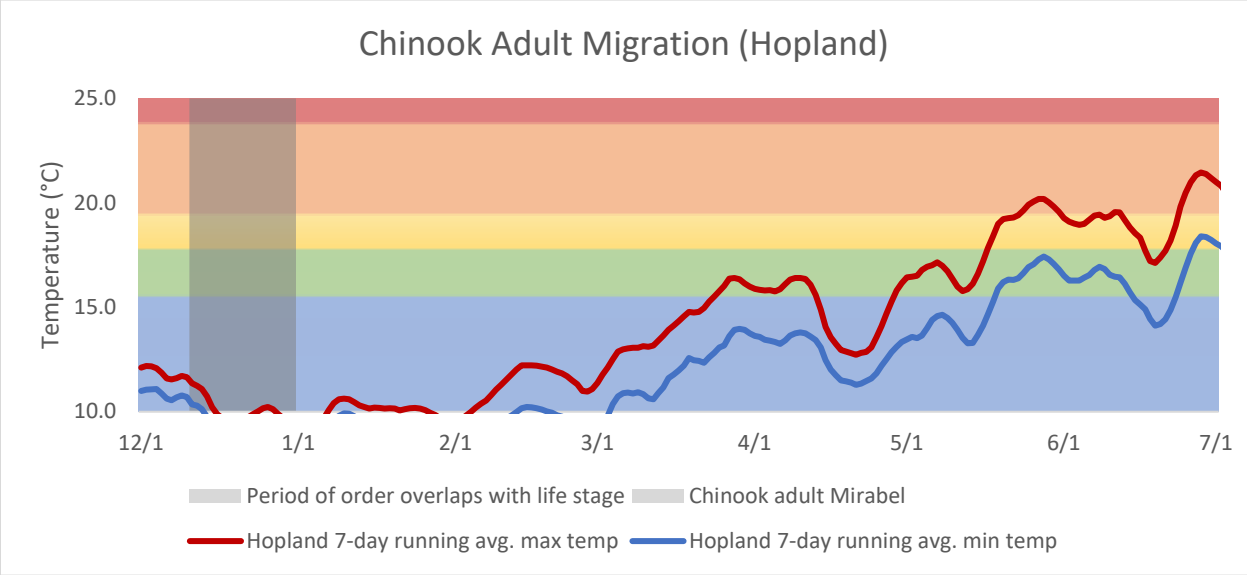

Figure 4-5. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook adult migration based on Table 4-1.

Coho

Water temperature for coho was generally favorable during the portion of the Order that overlaps with coho adult migration (December through March). At the Hacienda gage and at the Digger Bend gage temperature was mainly in the optimal and suitable range for adult coho (based on the criteria in Table 4-1, and Figure 4-6 and Figure 4-7).

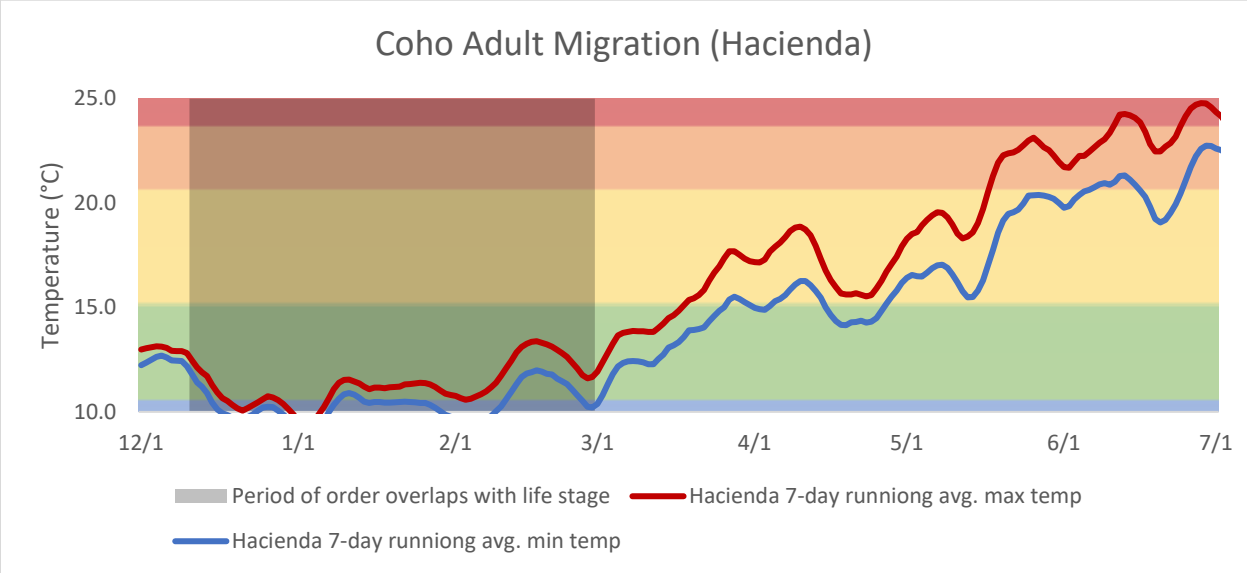

Figure 4-6. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000). Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult coho based on Table 4-1.

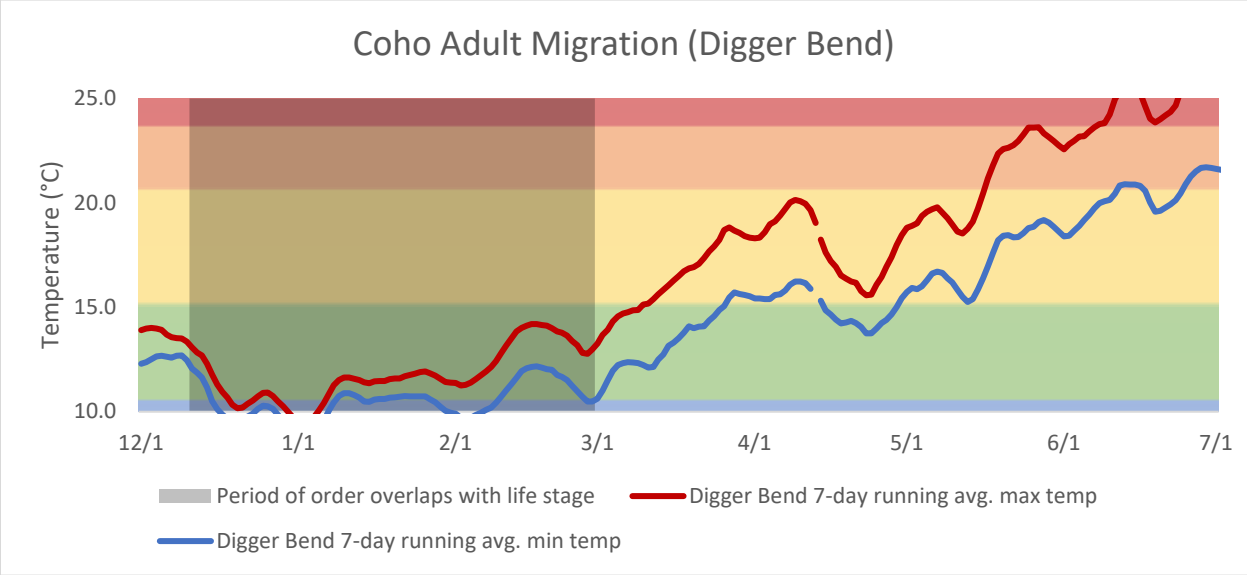

Figure 4-7. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for coho adult migration based on Table 4-1.

Steelhead

Water temperatures for steelhead were favorable during the portion of the Order that overlaps with the steelhead adult migration (December through March). Temperature was optimal to suitable for adult steelhead based on our criteria (Table 4-1 and Figure 4-9 through 4-12).

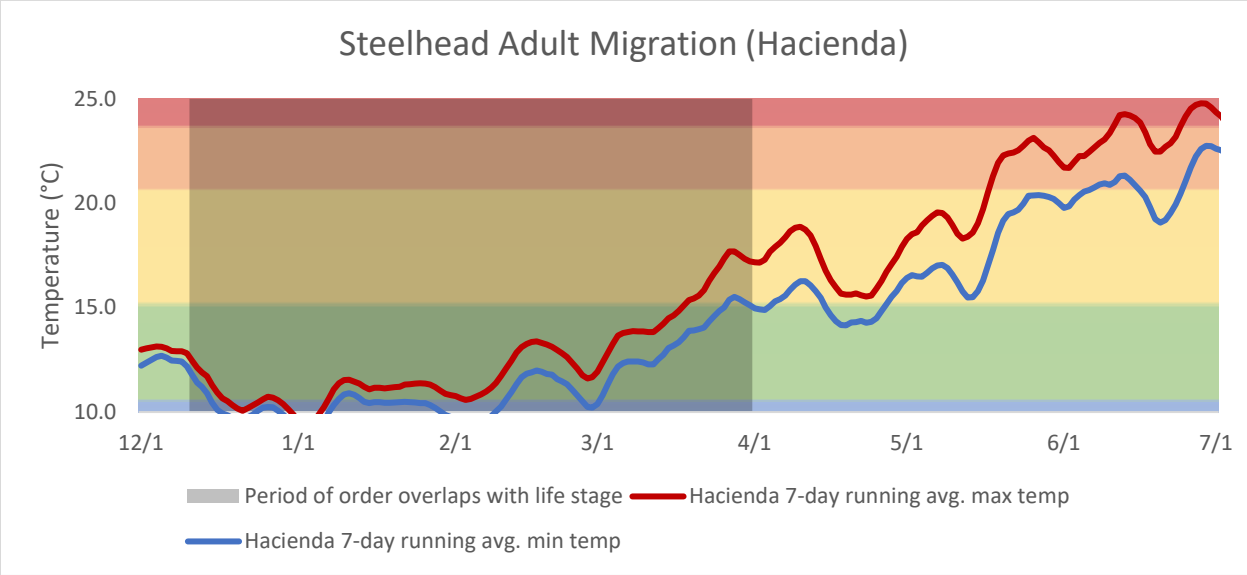

Figure 4-8. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000). Also show are optimal, suitable, stressful, acutely stressful, and lethal water temperature zones for adult steelhead based on Table 4-1.

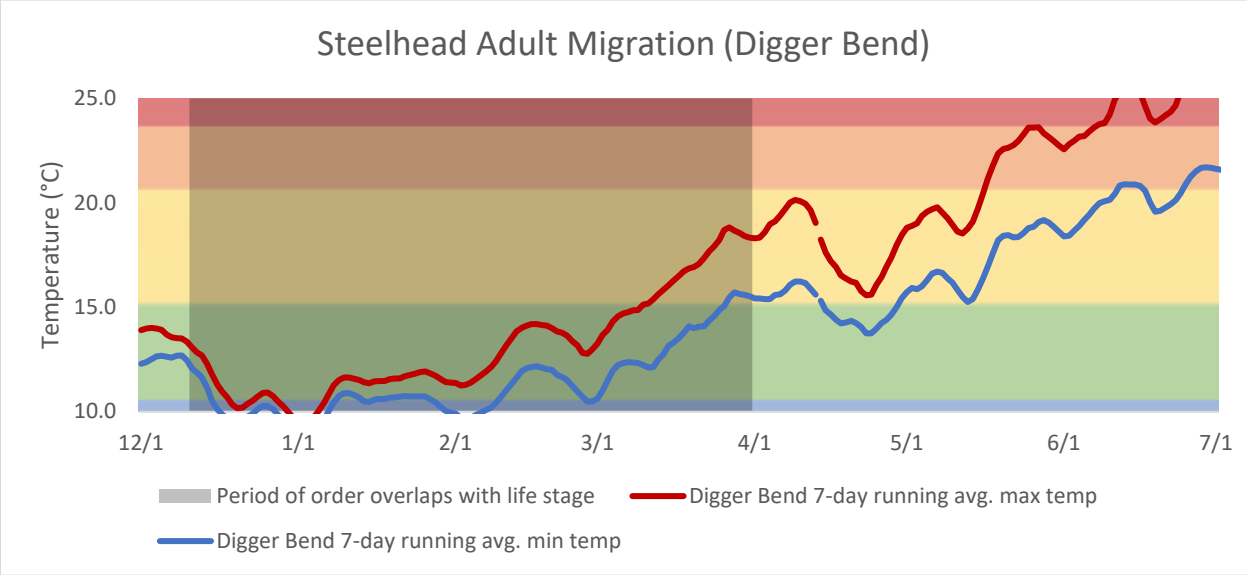

Figure 4-9. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

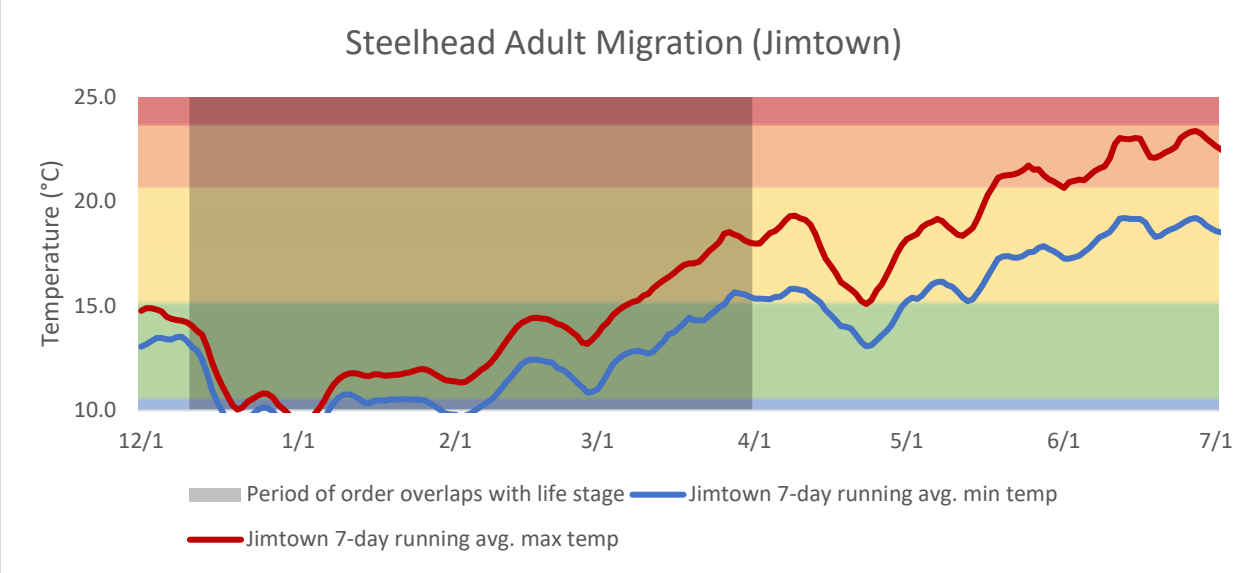

Figure 4-10. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

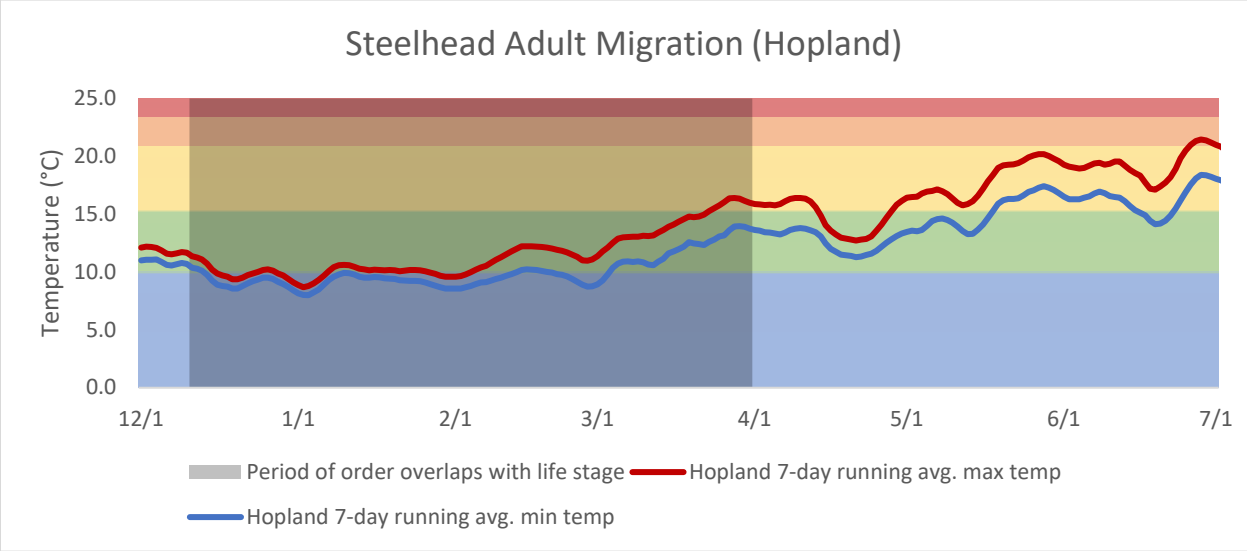

Figure 4-11. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

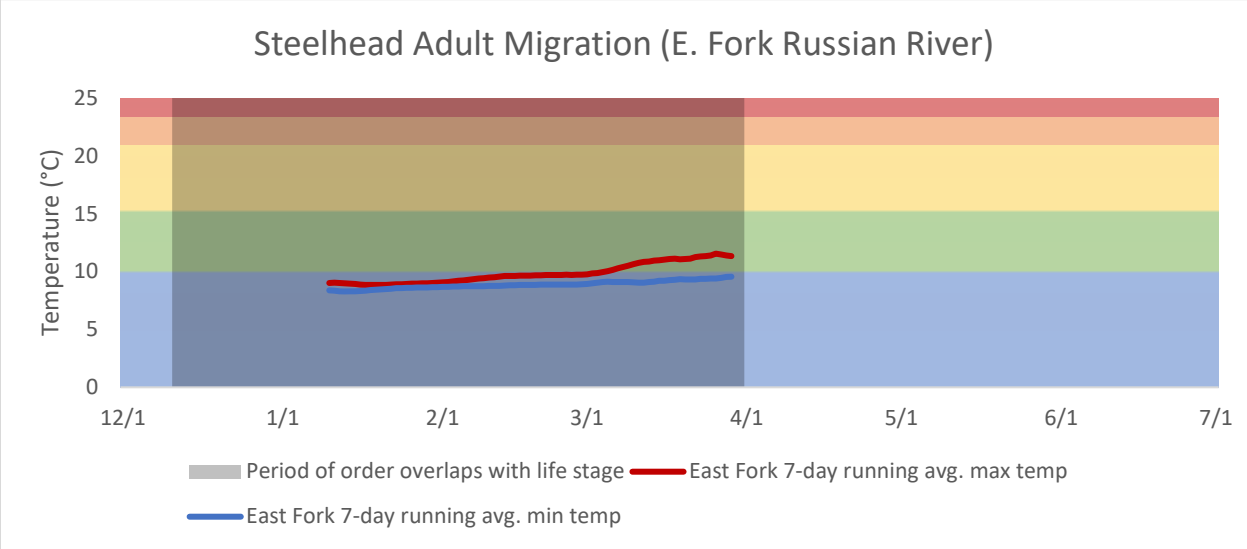

Figure 4-12. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water in the east fork Russian River 0.5 km downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead adult migration based on Table 4-1.

Salmonid Rearing

Salmonids must cope with water temperatures found at their rearing sites. In the Russian River basin much of the salmonid rearing habitat is in tributaries to the Russian River including Dry Creek, but Chinook and steelhead rear in the mainstem Russian River as well. Chinook emerge from redds constructed in the upper Russian River in the early spring and begin rearing in the shallow portions of the stream margins. In the mainstem Russian River, Chinook finish rearing in the early spring when water temperatures are still relatively cool. As a result, Chinook rear at more locations in the mainstem, but for a shorter time than steelhead. Therefore, we relate water temperature at several mainstem

Russian River sites to Chinook water temperature criteria. Steelhead rear in freshwater for one or more years and are primarily restricted to the tributaries of the Russian River and to the portion of Russian River where water released from the cold-water pool (the bottom portion of the lake) in Lake Mendocino has the greatest cooling effect on mainstem rearing habitat near Coyote Valley Dam. This cooling effect has largely diminished by the time water reaches Cloverdale approximately 50 km downstream. We relate steelhead water temperature criteria to water temperature collected in the east fork of Russian River downstream of Coyote Valley Dam and at Hopland as these sites are within the section of the Russian River that can provide year-round rearing opportunities for juvenile steelhead. Juvenile coho salmon do not rear in the mainstem of the Russian River.

Chinook

During 2021, water temperatures for rearing Chinook ranged from optimal to acutely stressful depending on the site and time period within the Chinook rearing season (Figures 4-13 through 4-19). However, it is important to note that Chinook in the Russian migrate downstream and out to sea in the spring thus avoiding high temperatures and by June the majority of Chinook smolts have emigrated from the Russian River (see Salmonid Smolt Outmigration).

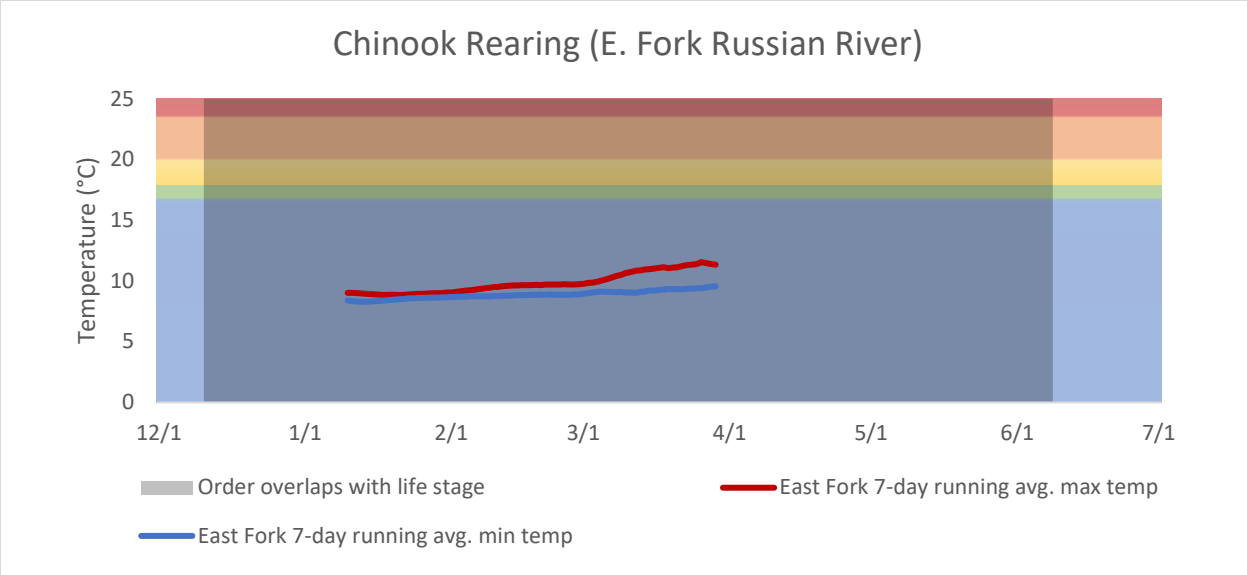

Figure 4-13. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water in the east fork Russian River 0.5 km downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based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

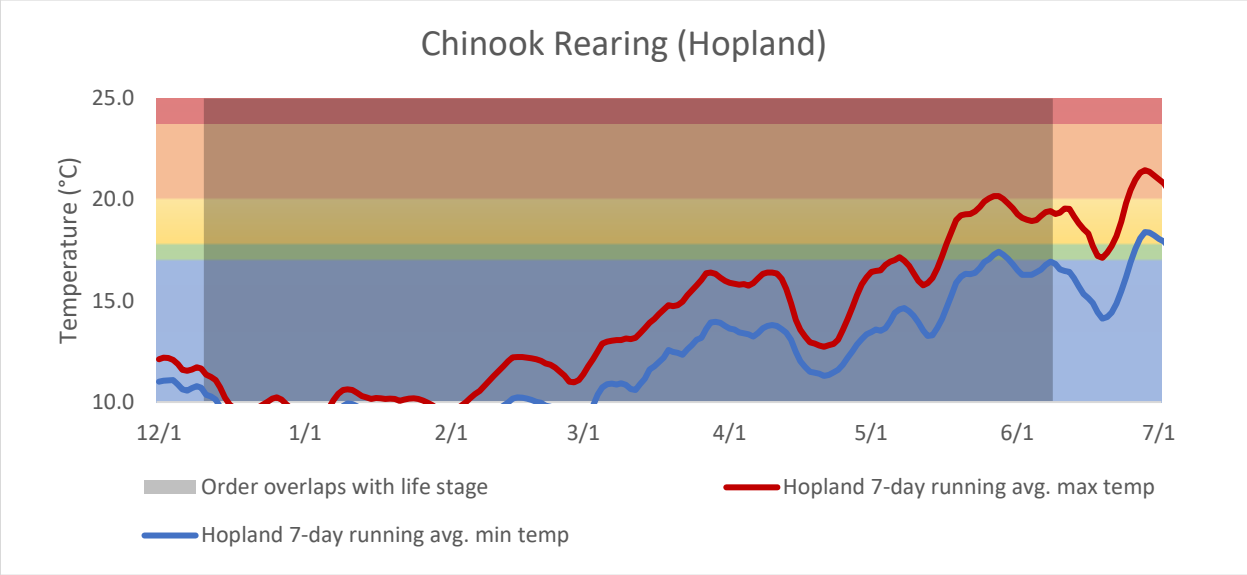

Figure 4-14. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hopland (11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

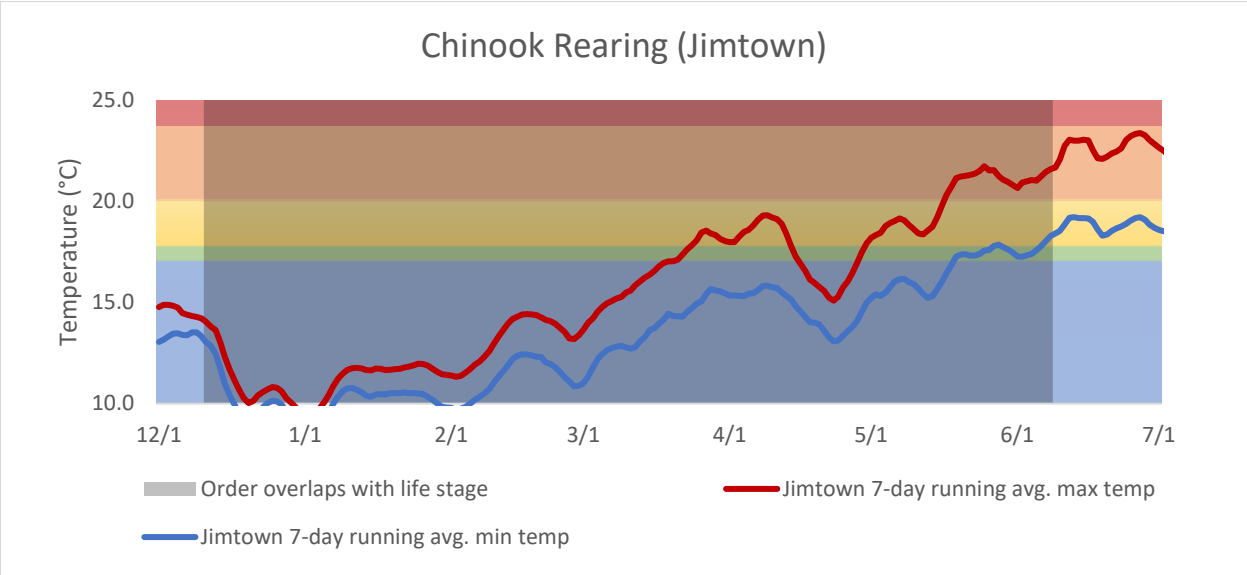

Figure 4-15. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Jimtown (USGS gage number 11463682) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

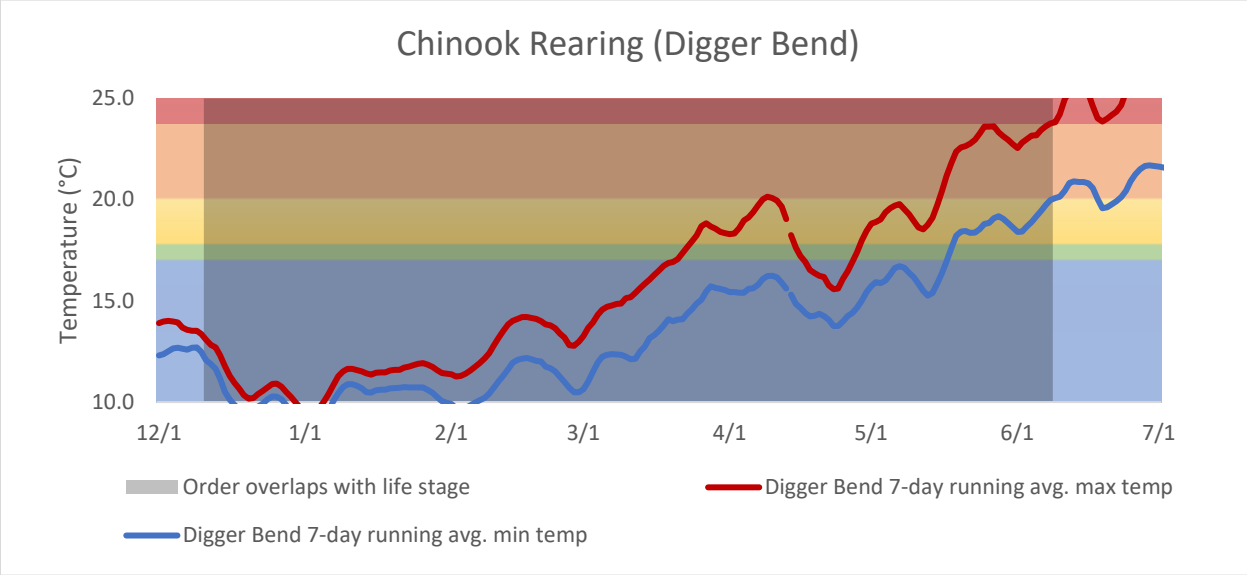

Figure 4-16. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Digger Bend (11463980) shown with the optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

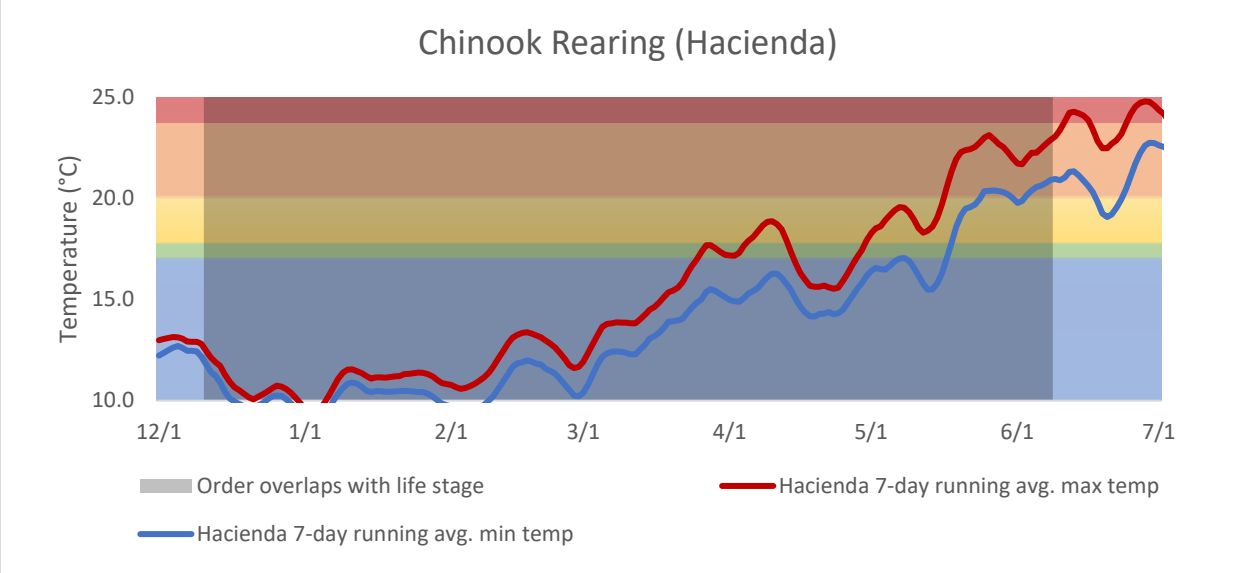

Figure 4-17. The 7-day running average of the minimum and maximum water temperatures collected at the USGS stream gage at Hacienda (gage number 11467000) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook rearing based on Table 4-2.

Steelhead

Steelhead parr rear year-round in the upper Russian River. During the Order water temperature in the east fork of the Russian River downstream of Coyote Valley Dam was optimal during the period that data was collected at this site (Figure 4-18). At the USGS stream gage at Hopland, water temperature was generally optimal to suitable for steelhead rearing (Figure 4-19).

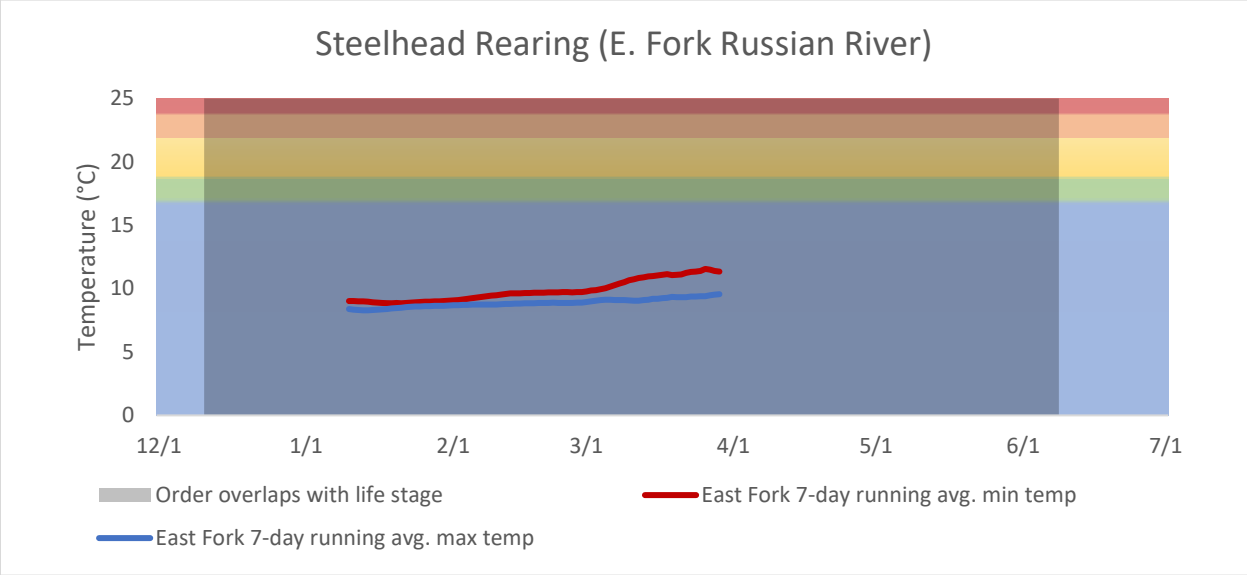

Figure 4-18. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water at the east fork Russian River downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead parr based on Table 4-2.

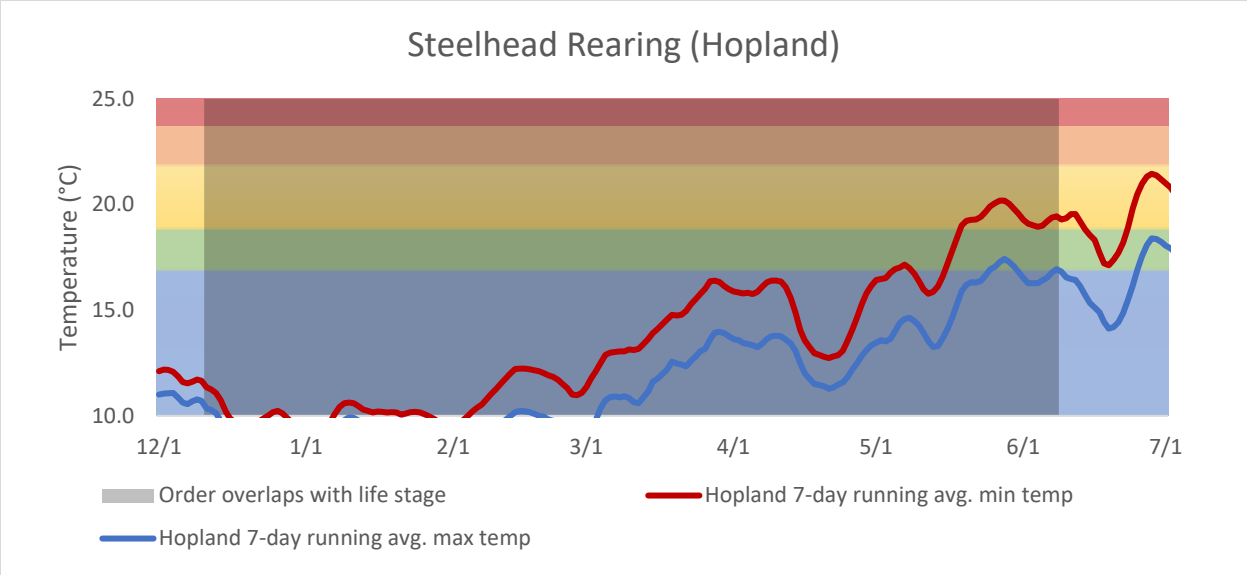

Figure 4-19. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead parr based on Table 4-2.

Salmonid Smolt Outmigration

For smolts produced in the upper portion of the watershed, we summarized Russian River water temperature for the east fork Russian River downstream of Coyote Valley Dam, Hopland, Jimtown, Digger Bend, and Hacienda gages and show these temperatures with water temperature criteria for Chinook and Steelhead smolts. For coho smolts we summarized water temperature for the Digger Bend,

and Hacienda gages since there is little coho spawning habitat upstream of Maacama Creek. Catches of Chinook, steelhead, and coho smolts from the Mirabel downstream migrant trap are shown with the Hacienda temperature data since the Hacienda gage is located near the Mirabel downstream migrant trap. The Mirabel downstream migrant trap was installed on April 7, 2022, and fished through July 7, 2022.

Chinook

Water temperature in the upper Russian River near the Coyote Valley Dam was not collected during the smolt outmigration period (April through June). Water temperature was generally favorable at the Hopland gage, however the seven-day running average of the maximum water temperature became stressful near the end of the smolt migration period. Water temperature became stressful to acutely stressful at sites located downstream of Hopland (Figure 4-20 through Figure 4-23). It is important to note that Chinook have evolved to emigrate during the spring before water temperatures become lethal that many Chinook were captured at the Mirabel fish trap emigrated before water temperature became acutely stressful (Figure 4-23).

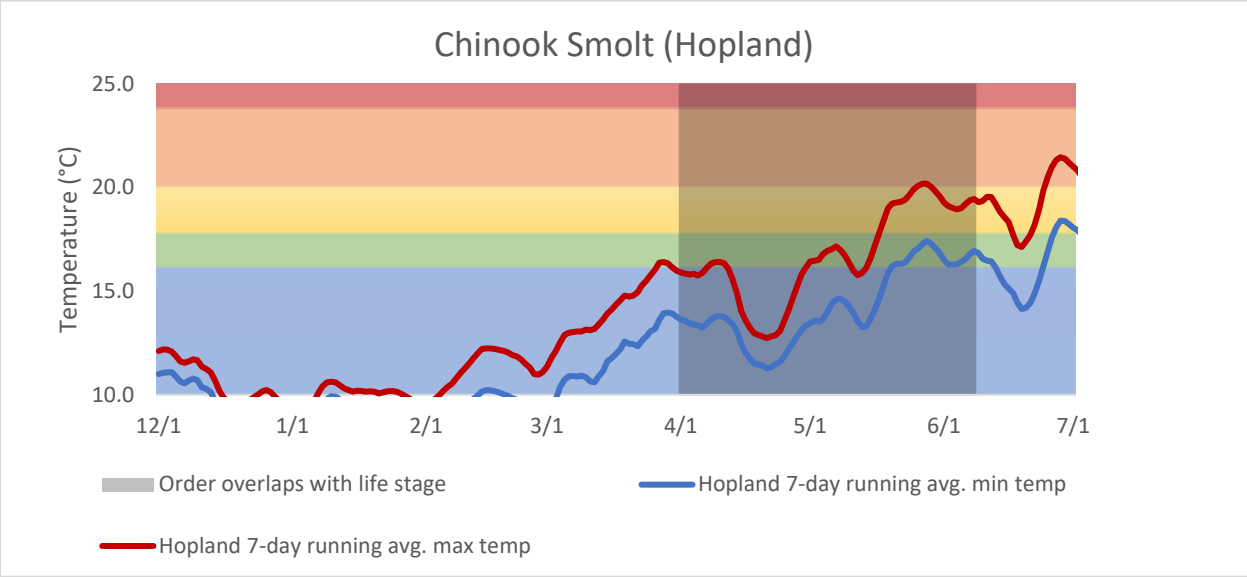

Figure 4-20. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). Shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

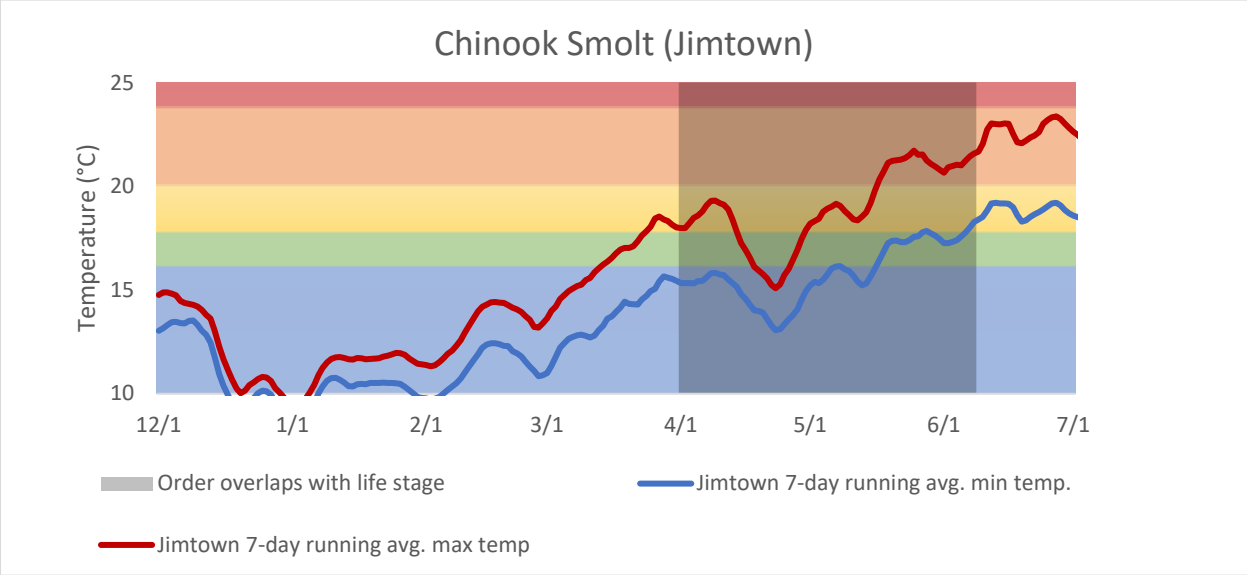

Figure 4-21. The 7-day running average of the minimum and maximum water temperatures collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

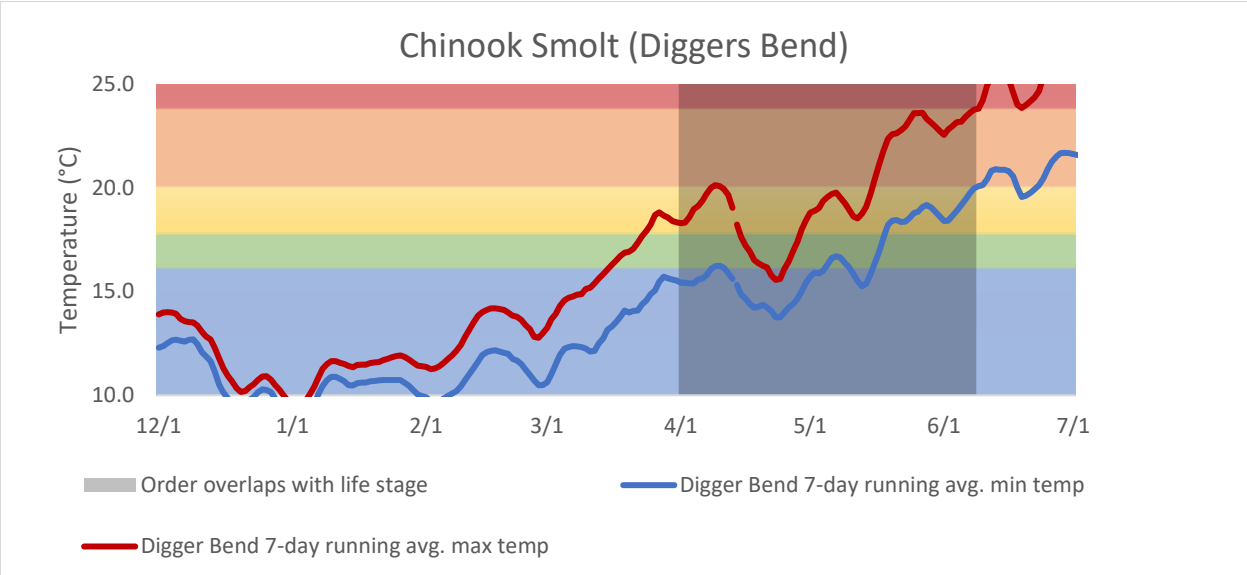

Figure 4-22. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

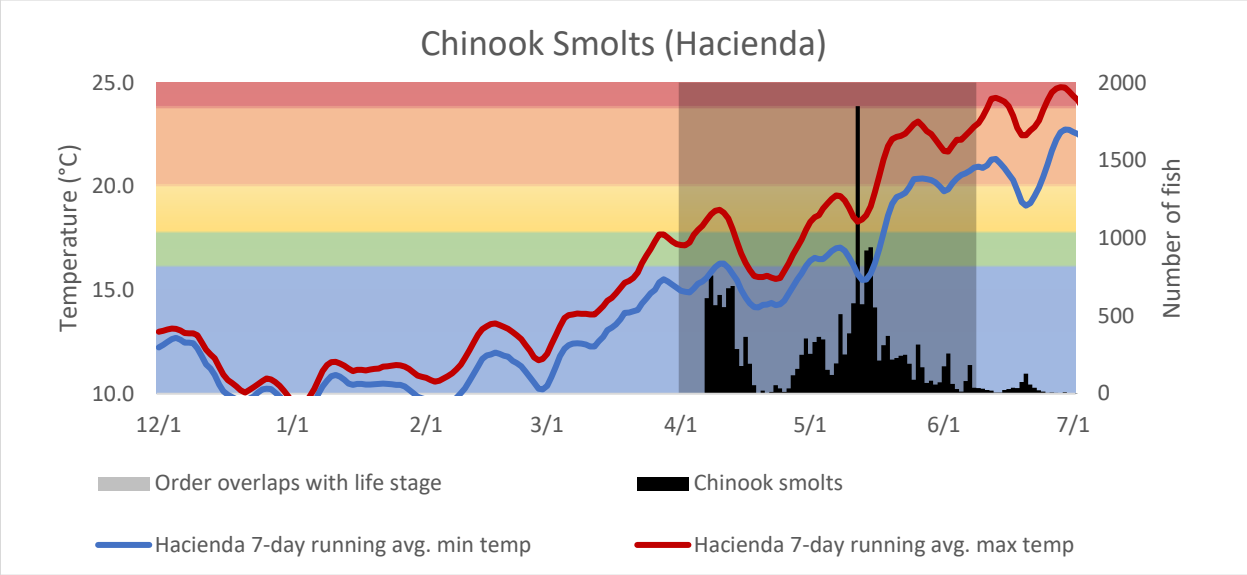

Figure 4-23. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook smolt catch from the Mainstem Russian River near Mirabel and optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Chinook smolts based on Table 4-3.

Coho

Water temperature in the Russian River near Digger Bend and Hacienda ranged from suitable to acutely stressful with early months of the coho smolt emigration period being more favorable (Figure 4-24 and Figure 4-25). It is important to note that coho have evolved to emigrate during the spring before water temperatures become lethal and that many coho were captured at the Mirabel fish trap emigrated before the 7-day running average of the minimum daily water temperature became acutely stressful (Figure 4-25).

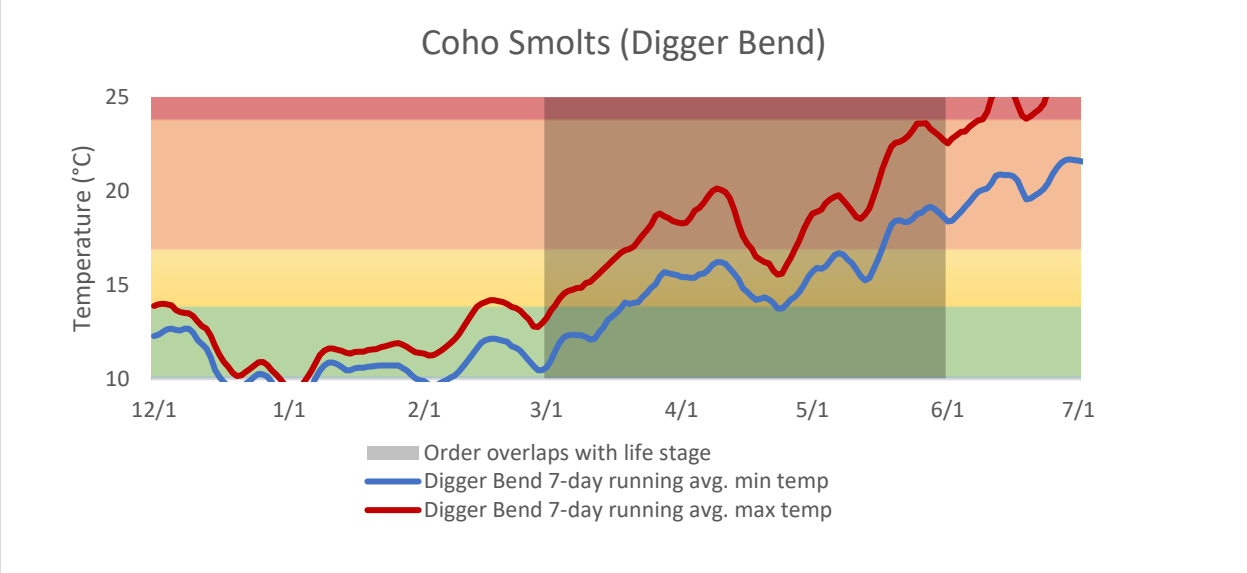

Figure 4-24. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for Coho smolts based on Table 4-3.

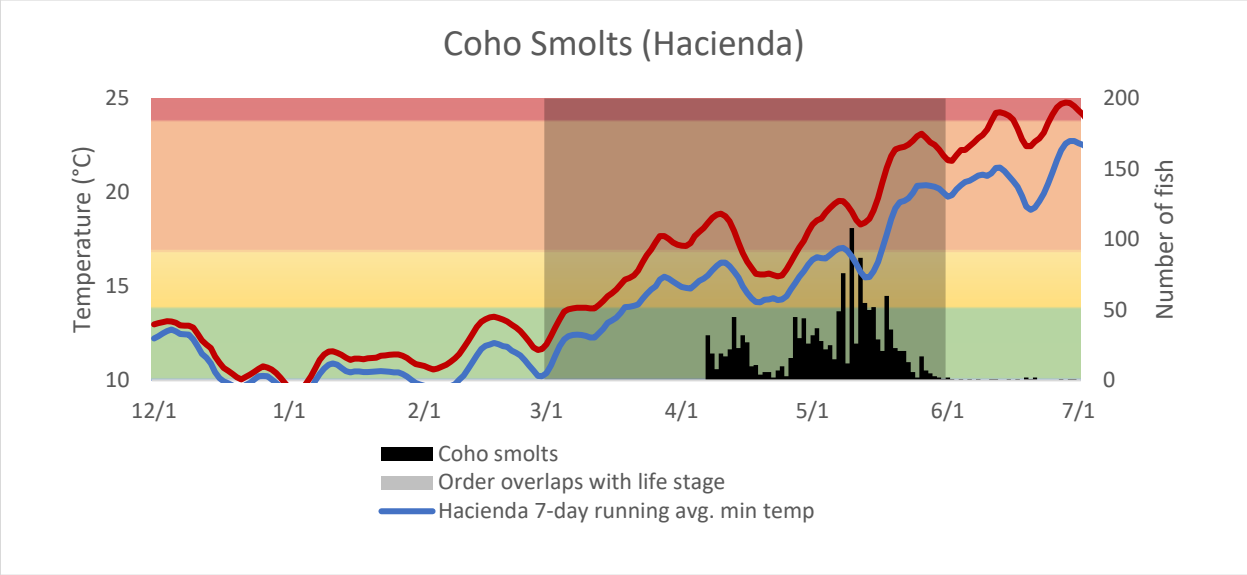

Figure 4-25. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook smolt catch from the Mainstem Russian River near Mirabel and optimal, suitable, stressful, acutely stressful and lethal water temperature zones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

Steelhead

Water temperature in the upper Russian River near the Coyote Valley Dam was generally favorable for steelhead smolts during the period that steelhead smolts are expected to emigrate and when data was available (March through April, Figure 4-26). However, water temperature became stressful to acutely stressful at sites located downstream of Hopland (Figure 4-27 through Figure 4-30). It is important to note that steelhead have evolved to emigrate during the spring before water temperatures become lethal and that many steelhead were captured at the Mirabel fish trap emigrated before water temperature became acutely stressful (Figure 4-30).

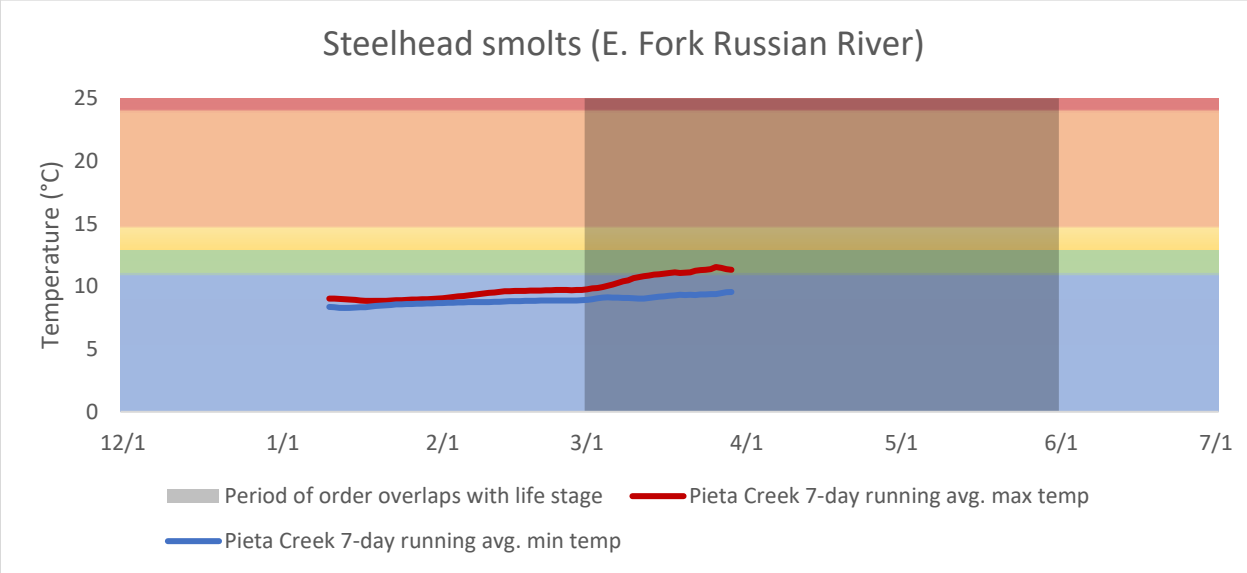

Figure 4-26. The 7-day running average of the minimum and maximum water temperatures collected by Sonoma Water at the east fork of the Russian River downstream of the Coyote Valley Dam. Shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead smolts based on Table 4-3.

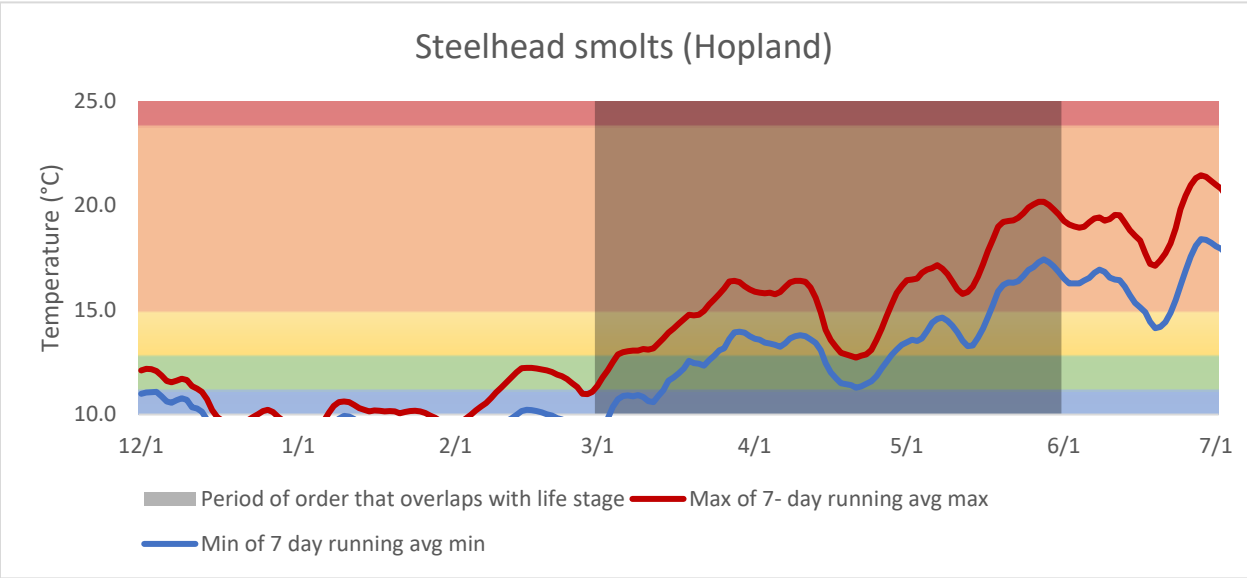

Figure 4-27. The 7-day running average of the minimum and maximum water temperatures collected at Hopland (USGS stream gage number 11462500). Shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead smolts based on Table 4-3.

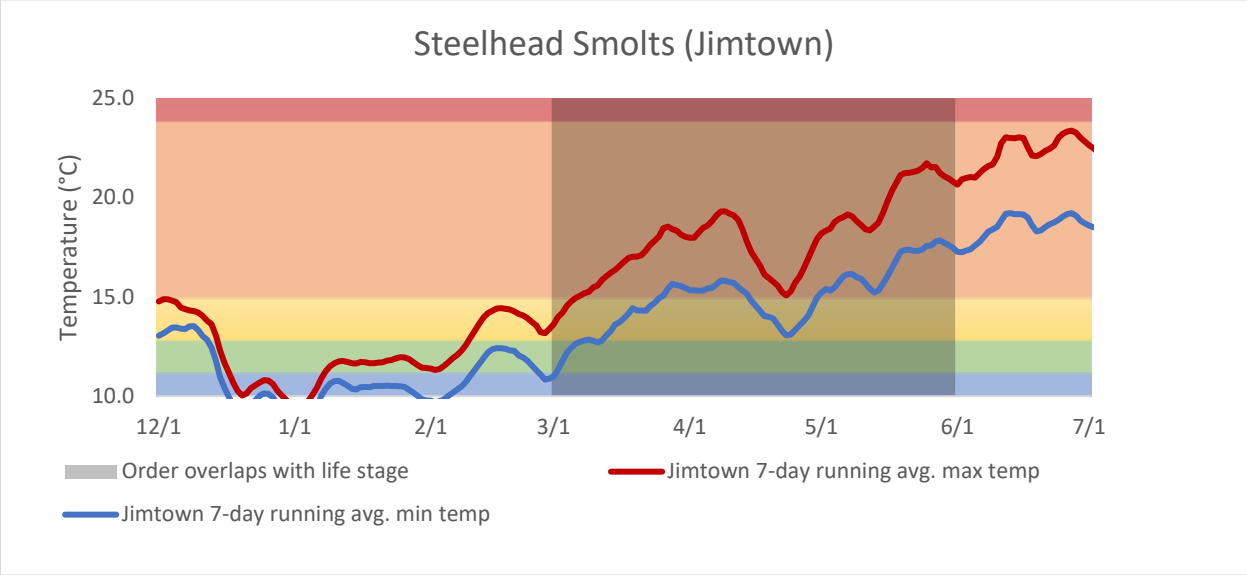

Figure 4-28. The 7-day running average of the minimum and maximum water temperatures collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead smolts based on Table 4-3.

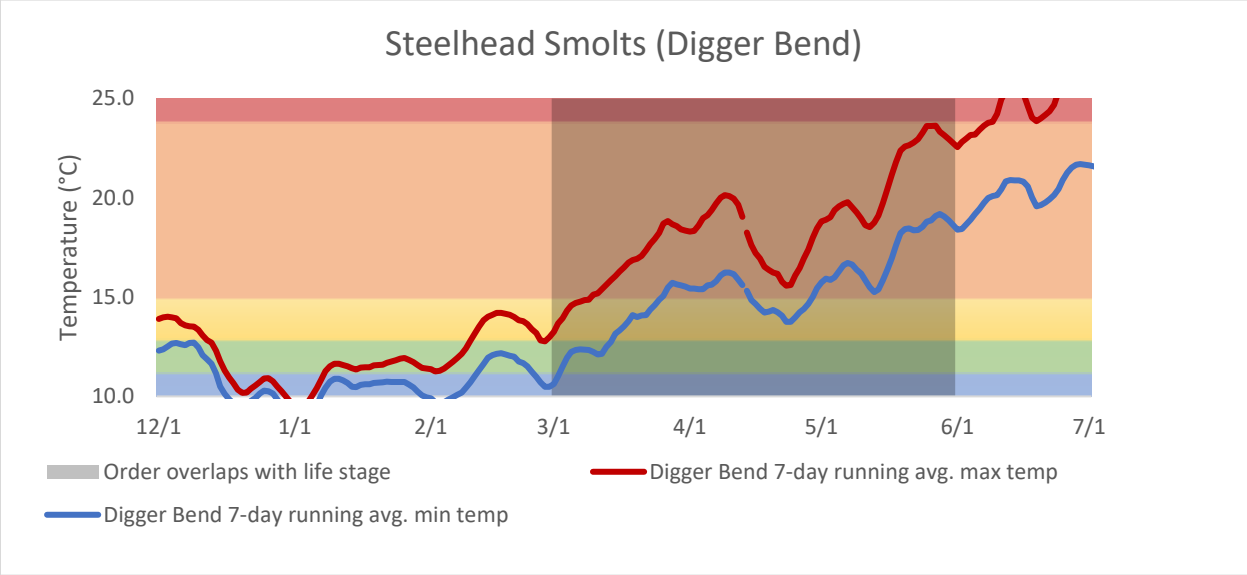

Figure 4-29. The 7-day running average of the minimum and maximum water temperatures collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead smolts based on Table 4-3.

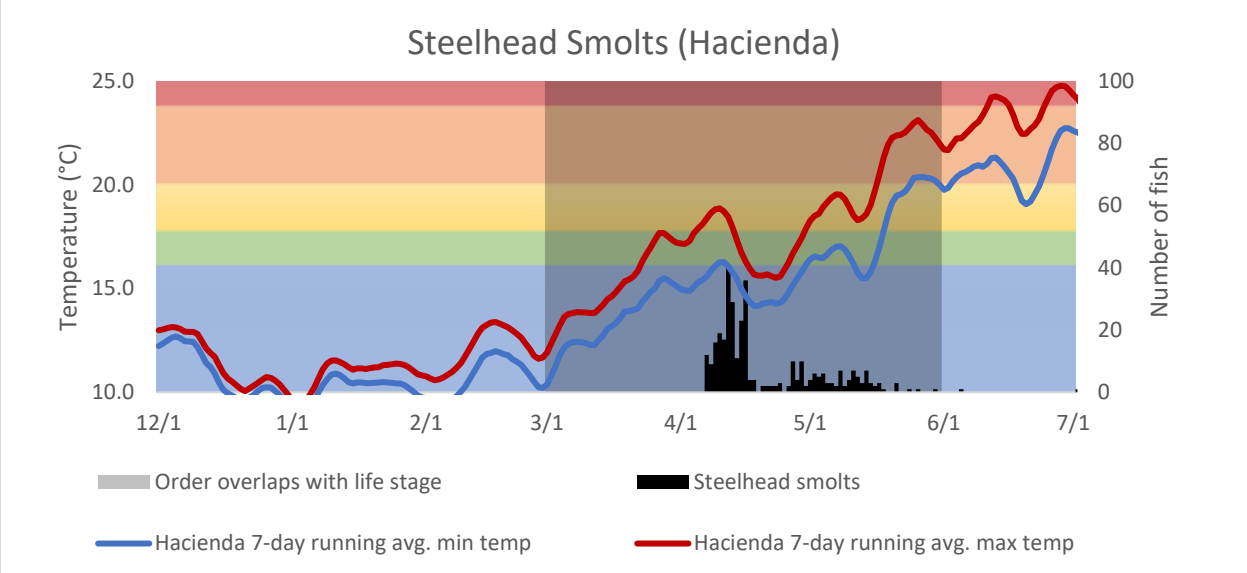

Figure 4-30. The 7-day running average of the minimum and maximum water temperatures collected at Hacienda (USGS gage number 11467000) shown with the Chinook smolt catch from the Mainstem Russian River near Mirabel and optimal, suitable, stressful, acutely stressful and lethal water temperature zones for steelhead smolts based on Table 4-3.

Dissolved Oxygen

At most sites, dissolved oxygen generally ranged from optimal to suitable for salmonids in the Russian River throughout the Order. In the east fork Russian River dissolved oxygen was favorable based on the limited data that was available for that site (Figure 4-31). At Hopland dissolved oxygen was generally favorable (Figure 4-32). However, dissolved oxygen became stressful at Jimtown, particularly later in the season (Figure 4-33). At Digger Bend and at Hacienda dissolved oxygen was generally favorable during the order (figure 4-34 and Figure 4-35).

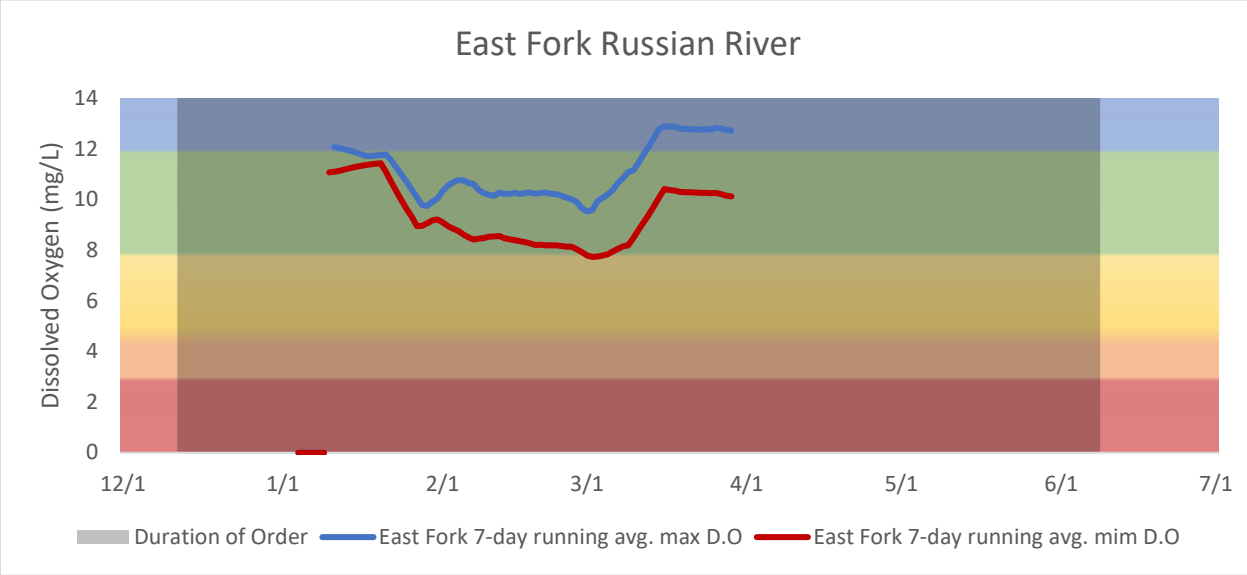

Figure 4-31. The 7-day running average of the minimum and maximum dissolved oxygen collected by Sonoma Water in the east fork of the Russian River downstream of Coyote Valley Dam shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

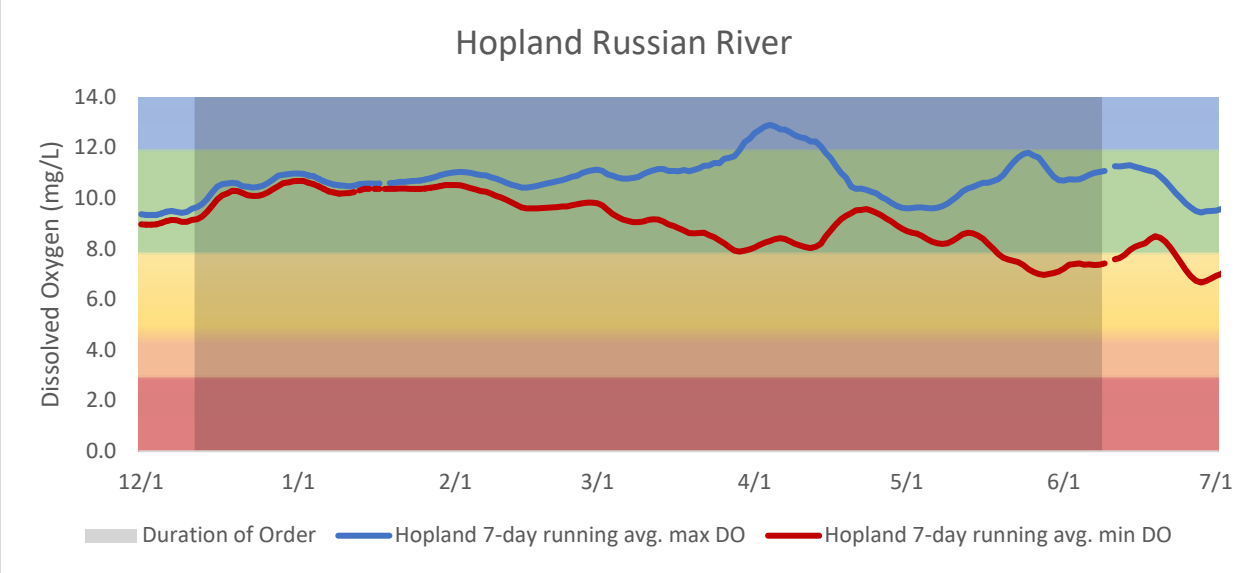

Figure 4-32. The 7-day running average of the minimum and maximum dissolved oxygen collected at Hopland (USGS stream gage number 11462500) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

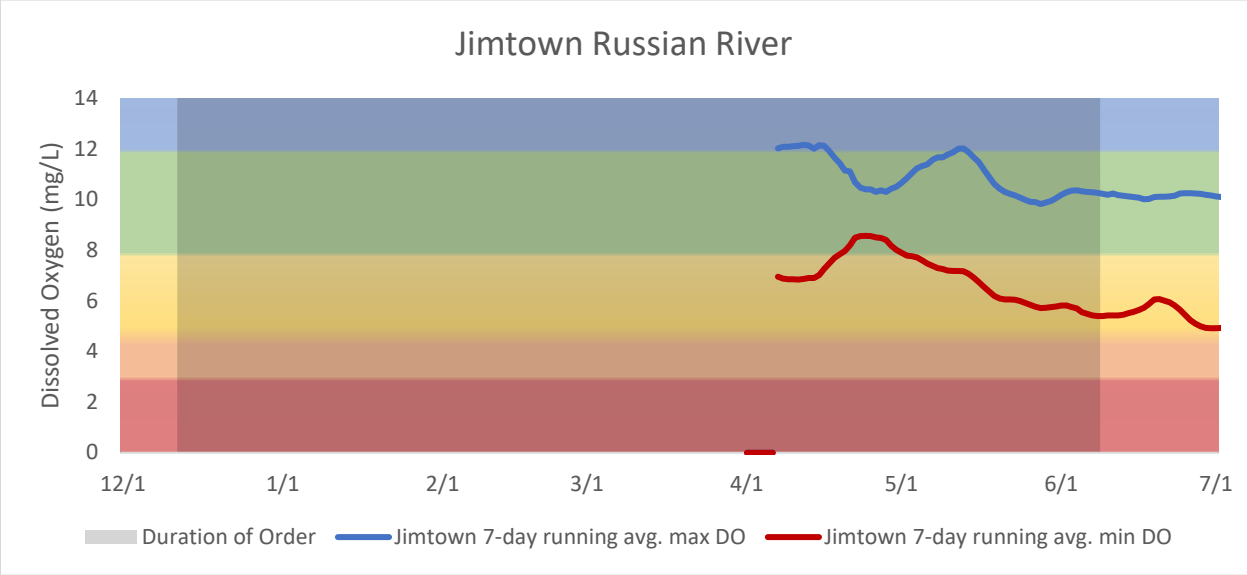

Figure 4-33. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Jimtown USGS stream Gage (1146382) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

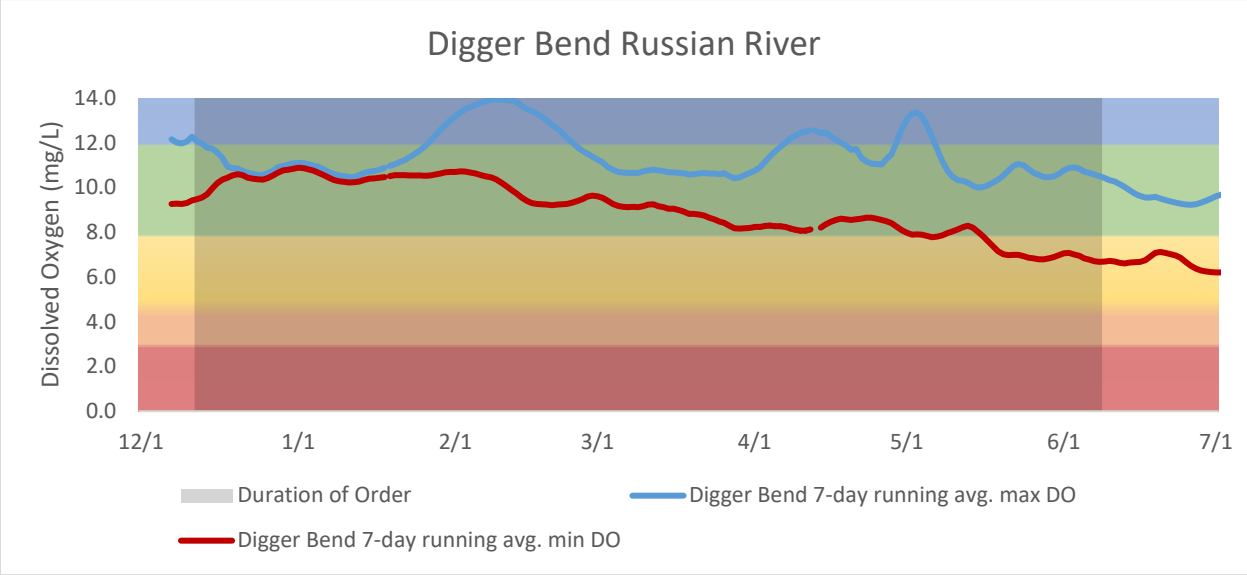

Figure 4-34. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Digger Bend USGS stream gage (11463980) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

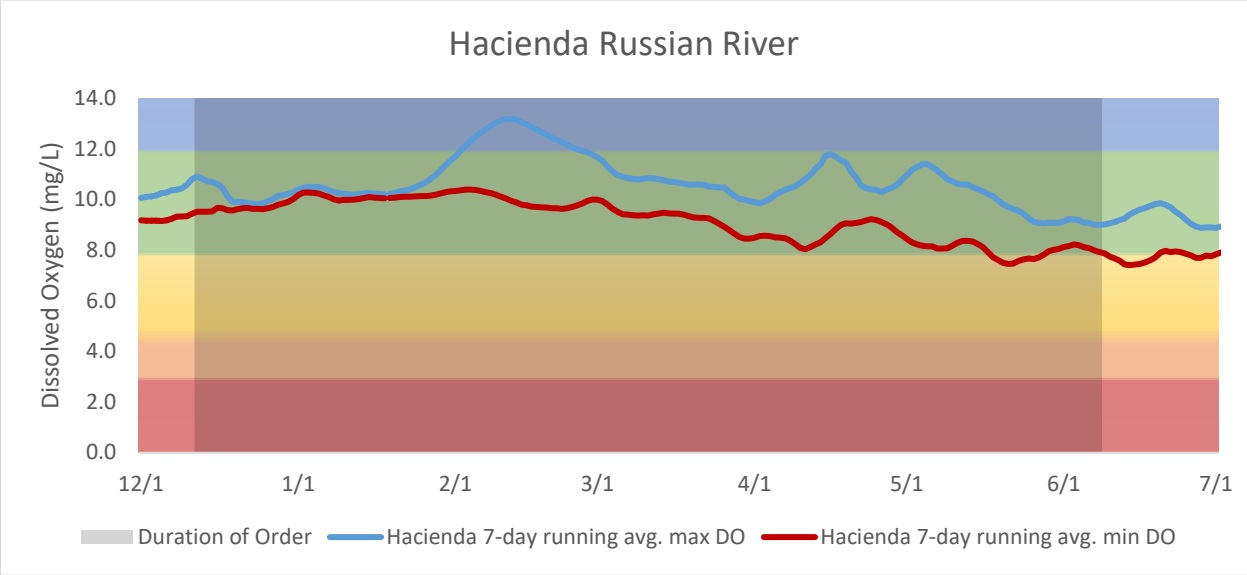

Figure 4-35. The 7-day running average of the minimum and maximum dissolved oxygen collected at the Hacienda USGS stream gage (1146700) shown with optimal, suitable, stressful, acutely stressful, lethal dissolved oxygen zones based on criteria in Table 4-4.

4.2.5 Summary

Water temperatures were generally favorable for salmonids during the Order since the Order spanned from the winter to late spring. However, some salmonids did experience unfavorable conditions near the end of their migration and rearing periods. Water temperature is mainly dependent on air temperature and varies thought the year with cooler temperature in the winter when air temperature is relatively cool and warmer temperatures in the summer when air temperature is warm. Cold water reservoir releases made from deep in the lakes provide cool water habitat immediately downstream of the Coyote Valley and Warm Springs dams and this habitat can remain cool despite warm air temperatures. Salmonids have adapted to cope with seasonally warm water temperatures by occupying the river at a time of year when water temperatures are favorable or in the case of rearing steelhead by occupying sections of the river that have cooler water temperatures from reservoir releases.

Water temperature was generally favorable for adult salmonids. During the time period that the Order was in effect and that adult Chinook were expected to be migrating upstream water temperature was optimal. For coho adults water temperature was in the optimal to suitable range during the portion of their migration period that overlapped with the Order. Adult steelhead return to the Russian River later in the winter than Chinook or coho. As a result, they must cope with slightly warmer temperatures near the end of their migration period. Water temperature for adult steelhead was generally optimal to suitable with temperatures reaching stressful levels by the end of the migration season. While temperatures were occasionally unfavorable for adult salmonids it is important to note that (1) these fish have evolved to cope with seasonally warm water temperatures by returning to the river during a time of year when water temperatures are cool and (2) most adult salmonids return to the Russian River during a time of year when water temperatures in the river are favorable.

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

For steelhead rearing, water temperature in the east fork Russian River was optimal during the time period that data was available. At Hopland, water temperature for steelhead rearing was generally optimal during the Order with a brief period near the end of the Order where the 7-day running average of the average maximum daily temperature was stressful.

Chinook salmon smolts experienced optimal to suitable conditions with stressful water temperatures occurring later in the migration period. However, the bulk of Chinook smolts emigrate from the Russian River when water temperatures are more favorable. In 2022, over 78% (15,205) of the Chinook smolts captured at the Mirabel downstream migrant trap (not adjusted for trap efficiency) were captured before the 7-day average of the maximum daily water temperature reached acutely stressful levels.

Dissolved oxygen was generally suitable for salmonids during the Order. Dissolved oxygen in the east fork of the Russian River was optimal to suitable, although limited data that was available. The 7-day running average of the minimum dissolved oxygen was generally suitable for salmonids at Hopland, Digger Bend, and Hacienda with a period of stressful conditions near the end of the Order. Limited data was available for Jimtown early in the season; however the 7-day running average of the minimum dissolved oxygen was stressful for salmonids from early May to the end of the Order at this site.

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