ANNUAL SHASTA RIVER TMDL MONITORING REPORT 2023

PPREPARED AND SUBMITTED BY

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Shasta Valley Resource Conservation District

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SHASTA VALLEY
RESOURCE CONSERVATION DISTRICT

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INTRODUCTION

The North Coast Regional Water Quality Control Board (NCRWQCB) lists the Shasta River in the Shasta Total Max Daily Load (TMDL) for high temperature and low dissolved oxygen (DO). The NCRWQCB identifies agricultural activities (livestock impacts, impoundments, and diversions) as sources contributing to these impairments (NCRWQCB 2007). Surface water diversions from the Shasta River and tailwater, or excess irrigation return flows, to the river system degrade water quality and impact the *beneficial uses*, which include: 1) cold freshwater habitat (COLD) that supports migration, spawning and rearing (MIGR, SPWN) of salmonids including Chinook, steelhead and state and federally ESA-listed coho (RARE), 2) drinking water (MUN), 3) recreation (REC-1 & 2), 4) agricultural supply (AGR) and 5) groundwater recharge (GWR) (NCRWQCB 2007).

Under the protocols established in the Monitoring Plan, Quality Assurance Project Plan (QAPP) and Project Assessment and Evaluation Plan (PAEP) approved by the State Water Resource Control Board (SWRCB), the Shasta Valley Resource Conservation District (SVRCD) is monitoring water quality on the Shasta River and its tributaries. The goals of this monitoring effort are to assess progress in meeting TMDLs (temperature and DO) by monitoring Shasta River water quality and to identify locations where the restoration or alteration of riparian habitat, land management actions, and land management practices would likely improve water quality in the Shasta River and its tributaries.

This report summarizes and discusses meteorological data and the impact on the Shasta River watershed, as well as temperature and DO monitoring data at 28 sites (twelve sites measured DO and temperature) on the Shasta River and tributaries Parks Creek and Yreka Creek. Access to monitoring locations was acquired from private landowners through landowner agreements.

TEMPREATURE TMDL

The Shasta River TMDL temperature load allocation sources are riparian vegetation (shade), tailwater return flows, and surface water flow. The temperature water quality compliance scenario, as modeled by the NCRWQCB, included increased riparian shade to represent site potential riparian conditions on a river-reach scale, modified temperature regime of tailwater return flows such that return flows do not cause heating of the receiving water, Big Springs Creek temperatures reduced by 4°C from baseline, Parks Creek temperatures reduced by 2°C from baseline, and fifty percent (50%) increase in Shasta River flows downstream of the Big Springs Creek confluence, an increase of 45 ft^3/second (cfs) (NCRWQCB, 2006).

Juvenile salmonids are known or suspected to rear in the following reaches of the Shasta River: Grenada Irrigation District pumps to Highway A-12, near Breceda Lane, and in the Shasta River canyon at a side channel known as “Salmon Heaven”. Based on this information, the following locations are considered temperature compliance locations, as they are at or near the downstream end of these critical summer rearing locations (NCRWQCB, 2006). The name and River Mile (RM) are:

- “Salmon Heaven”, RM 5.6
- Montague-Grenada Road, RM 15.5
- Highway A-12, RM 24.1

For the modeled water quality compliance scenario, reductions in maximum water temperatures compared to the August baseline water temperatures at RM 5.6, RM 15.5, and RM 24.1 are 4.82°C, 4.92°C, and 4.71°C, respectively. The 5-day average daily maximum temperatures for the compliance scenario at RM 5.6, RM 15.5, and RM 24.1 are 18.9°C, 17.5°C, and 16.7°C, respectively (NCRWQCB, 2006).

For a full analysis and description of the load allocations, model conditions, calibration data, and modeled scenario outputs, please refer to the 2006 *Staff Report for the Action Plan for the Shasta River Watershed Temperature and Dissolved Oxygen Total Maximum Daily Loads*.

DISSOLVED OXYGEN TMDL

The dissolved oxygen water quality compliance scenario was developed using a process that separately evaluated components identified in the dissolved oxygen source and linkage analysis that affect dissolved oxygen concentrations in the Shasta River. They include photosynthetic and respiration rates, sediment oxygen demand rates, dissolved oxygen and nitrogenous oxygen demand concentrations of Lake Shastina outflow, key tributaries, and tailwater return flows, riparian shade, and Shasta River flow. The water quality compliance scenario consists of the baseline condition with key modifications including, reduced photosynthetic and respiration rates, reduced sediment oxygen demand (SOD) behind minor impoundments, reduced nitrogenous oxygen demand (NBOD input concentrations, modified dissolved oxygen concentrations at key locations, increased riparian shade (represented as decreased percent transmittance on a river reach scale), and increased Shasta River flow. and appears to result in attainment of the Basin Plan biostimulatory substances objective, as nutrient load reductions result in attainment of dissolved oxygen objective and non-nuisance level growth of aquatic plants, (NCRWQCB, 2006).

For a full analysis and description of the load allocations, model conditions, calibration data, and modeled scenario outputs, please refer to the 2006 *Staff Report for the Action Plan for the Shasta River Watershed Temperature and Dissolved Oxygen Total Maximum Daily Loads*.

MONITORING LOCATIONS

Temperature and DO were measured from April 1st through October 1st, 2023 at 28 locations on the Shasta River and its tributaries (Table 1), including year round at six DO and Temperature sites, and two year round temperature sites. The study area spans approximately 40 river miles from Dwinnell Reservoir to the mouth of the Shasta River at its confluence with the Klamath River (Figure 1).

TABLE 1. REACH, SITE ID, RIVER MILE, EQUIPMENT, AND MEASURED METRICS DURING THE 2023 IRRIGATION SEASON.

Reach	Reach Description	Site ID	River Mile	Equipment	Measurement
6	Dwinnell Reservoir Outlet to Parks Creek	105SRHVRPOD	39.1	TidbiTs®	Temperature
		105SRHVSPL	38.1	TidbiTs®	Temperature
		105SRHVRALC	37.9	TidbiTs®	Temperature
		105SRU1DO	37.9	Onset DO Logger	DO/Temperature
		105SRHVDSSPG	37.8	TidbiTs®	Temperature
		105SRU0IT	37.7	TidbiTs®	Temperature
		105SR7163DS	36.9	TidbiTs®	Temperature
		105SRHIGF	36.6	TidbiTs®	Temperature
5	Parks Creek to Big Springs Creek	105SRP1DO*	SR 33.9; PC 0.04**	InSitu AquaTroll	DO/Temperature
		105PCFPDO*	SR 33.9; PC 7.3**	Onset DO Logger	DO/Temperature
		105PCAFPT*	SR 33.9; PC 9.3**	TidbiTs®	Temperature
		105PCBMDT*	SR 33.9; PC 10.9**	TidbiTs®	Temperature
		105PCB1DO*	SR 33.9; PC 11.7**	Onset DO Logger	DO/Temperature
4	Big Springs Creek to Willow Creek	105SRN1DO	30.9	D-Opto	DO/Temperature
		105SRV1DO	26.0	D-Opto	DO/Temperature
		105SRV4AT	25.2	TidbiTs®	Temperature
		105SRV4BT	24.3	TidbiTs®	Temperature
3	Willow Creek to Little Shasta River	105SRT1DO	23.0	D-Opto	DO/Temperature
		105SRS1DO	16.7	D-Opto	DO/Temperature
2	Little Shasta River to Yreka Creek	105SRM1DO	14.6	D-Opto	DO/Temperature
		105SR400T	12.3	TidbiTs®	Temperature
		105SRA1DO	11.8	Onset DO Logger	DO/Temperature
		105SRA01T	10.2	TidbiTs®	Temperature
		105SRG01T	8.2	TidbiTs®	Temperature
1	Yreka Creek to Shasta River Mouth	105YCA01T*	SR 7.3; YC 0.6**	TidbiTs®	Temperature
		105SRTM01DO	5.3	D-Opto	DO/Temperature
		105SRP01T	3.0	TidbiTs®	Temperature
		105SRL1DO	0.6	Onset DO Logger	DO/Temperature

* Site was located on tributary to Shasta River
** River miles are provided both for where the tributary meets the mainstem as well as tributary river mile for the monitoring site.

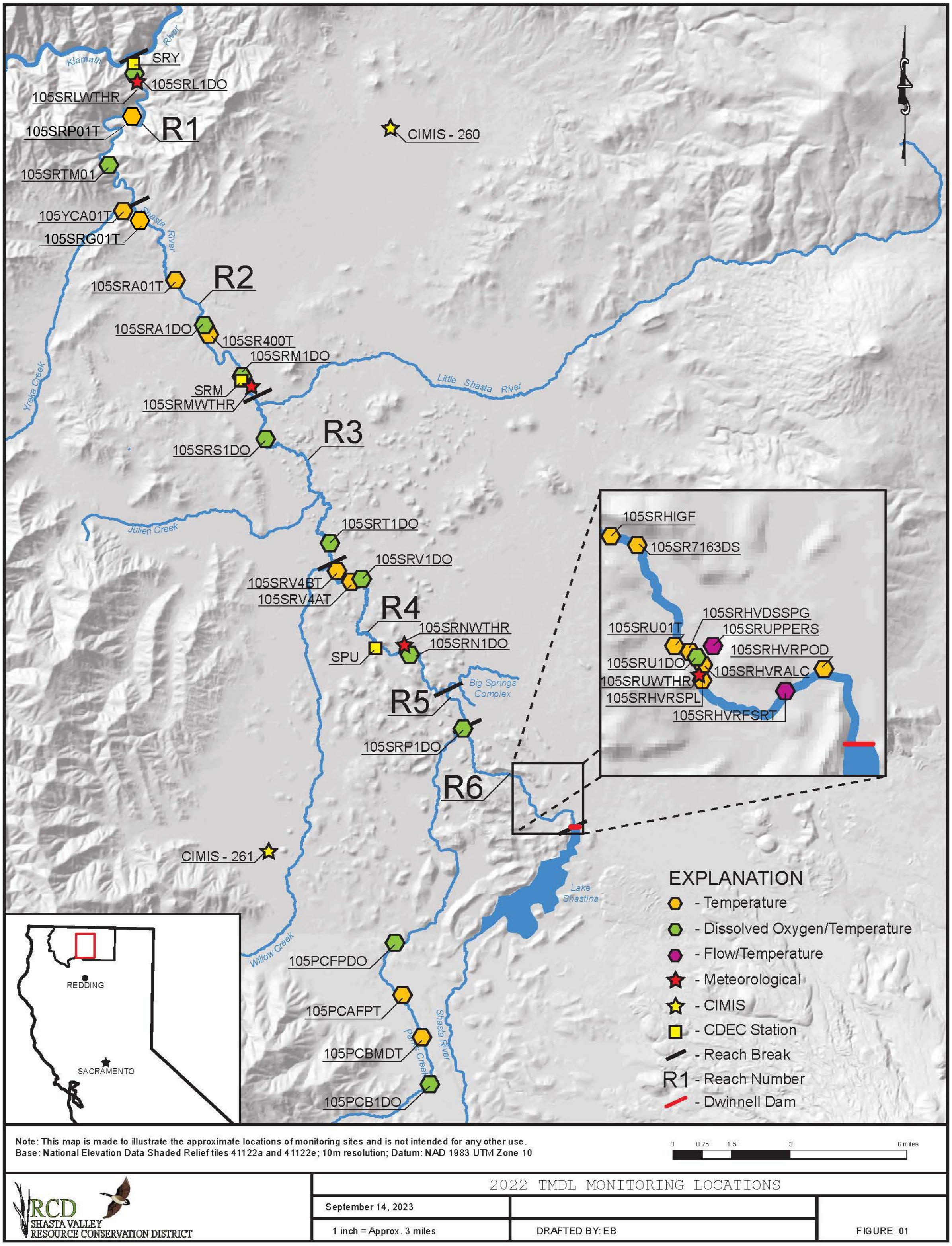

FIGURE 1. MAP OF 2022 TEMPERATURE, DO, FLOW, METEOROLOGICAL AND CDEC MONITORING LOCATIONS.

METHODS

Dissolved oxygen Sampling

Dissolved Oxygen (DO) and temperature were measured at twelve sites (Table 1; Figure 1) using a combination of ZebraTech D-Opto Loggers, InSitu AquaTroll 600, and Onset HOBO U26 Dissolved Oxygen Loggers. All three sensor types use optical fluorescence sensing elements to measure DO in liquids. These DO loggers were housed in custom made canisters designed to suspend the logger above sediment in the benthic zone, and to maintain a stationary position in the river in high flow.

Where possible, DO loggers were placed in runs or pool tail-outs and within the thalweg or deepest part of the cross-section. D-opto loggers were downloaded, cleaned of bio-fouling and re-calibrated per manufacturer specifications every three weeks. Intervals of more than three weeks may have increased the risk of optical lens bio-fouling that may have caused the logger to record inaccurate measurements. AquaTroll 600 and HOBO U26 loggers were calibrated immediately prior to deployment and initialization of the RDO Cap, which expires seven months after initialization. HOBO U26 loggers were downloaded and cleaned of bio-fouling every three weeks. Independent measurements of DO and temperature were made at the monitoring locations each time the sensors were downloaded.

Temperature Sampling

Temperature loggers were deployed at 14 sites (Table 1; Figure 1) in sets of two (paired for quality control) and housed in custom made canisters to protect them from direct sunlight. Where possible, temperature loggers were placed in runs or pool tail-outs and within the thalweg or deepest part of the channel cross-section.

In 2023, temperatures were recorded at 15-minute intervals (D-Opto loggers, U26 loggers, AquaTroll 600, and Onset Tidbits) at temperature monitoring locations as identified in Table 1 and on Figure 1. The 7-day average daily maximums (7-DAD Max) were calculated as the 7-day running average of daily maximum temperatures. Dates reported correspond with the middle date of this running average.

In addition to the 7-DAD Maximum temperature graphs are an analysis of the Maximum Weekly Average Temperatures (MWAT) and Maximum Weekly Maximum Temperatures (MWMT) for each site. The use of MWAT values was first proposed by the National Academy of Sciences (NAS) in 1972 as a long-term standard for preventing chronic sub-lethal effects for a variety of fish species. However, the MWAT is not calculated consistently by all researchers and agencies. The MWAT, as reported by Carter (2005), is the highest single value of the seven-day moving average temperature. Likewise, the MWMT is the highest seasonal or yearly value of the daily maximum temperatures over a running seven-day consecutive period. This methodology for calculating MWAT and MWMT was followed in this report and calculated for the entire irrigation season. The absolute maximum is calculated as the highest daily maximum temperature for the entire irrigation season.

The objective of the MWAT index is to provide an upper temperature standard that is protective of juvenile salmonids during the summer rearing period. The MWAT is a common measure of chronic (i.e. sub-lethal) exposure, the absolute maximum is a measure of acute (i.e. lethal) exposure, and the MWMT is a common measure of both chronic and acute effects (Carter 2005). The MWMT describes the maximum temperatures in a stream, but the value is not overly influenced by the maximum temperature of a single day. Table 2 describes the MWMT for the Shasta River during various life stages of coho salmon (Carter 2005). Refer to Carter (2005) for additional information regarding temperature effects on various life stages of Chinook and steelhead salmonids.

TABLE 2. MWMT FOR DIFFERENT LIFE STAGES OF COHO SALMON (REPRODUCED FROM CARTER 2005).

Coho Life Cycle						
	Adult Migration	**Spawning**	**Egg Incubation**	**Fry Emergence**	**Juvenile Rearing**	**Juvenile Out-migration**
Coho Periodicity	Sept 15 – Jan 31	Nov 1 – Jan 31	Nov 1 – Mar 31	Feb 1 – Apr 15	Jan 1 – Dec 31	Feb 15 – July 15
MWMT Criterion (°C)	20	13	13	13	18	18

In addition to water temperature and dissolved oxygen sampling, meteorological and discharge data were collected and used to inform and evaluate water temperature and dissolved oxygen sampling. ambient air temperature, precipitation, and solar radiation data were retrieved from four field meteorological stations, located along the Shasta River between Dwinnell Reservoir and the Klamath River, to inform water temperature and DO results in this study.

RESULTS AND DISCUSSION

METEOROLOGICAL CONDITIONS

Meteorological data is measured at several locations throughout the Shasta River watershed. Regional snowpack and snow water content are measured annually as part of the Department of Water Resources Statewide Monitoring Network, which partners with more than 50 state, federal, and private agencies. The cooperating agencies take snow and water content measurements in January, February, and March. The USFS continues to collect monthly data for April and May. Results from each monthly survey at a given site are tabulated and form an average of a regions annual snowpack and water content, which gives forecasters and resource managers the ability to make important management decisions. These data are also compared against a running historical average for the site for the given month. Regional data are summarized annually by the US Forest Service Shasta-Trinity National Forest, and presented in Table 3. For the last several years, the region has received significantly less water in the upper watershed.

TABLE 3. REGIONAL SNOW DEPTH AND WATER CONTENT FOR THE MONTH OF APRIL OF 2023, 2022, AND 2021.

Course	Elevation (ft. asl)	2023 Snow (in)	2023 Water (in)	2022 Snow (in)	2022 Water (in)	2021 Snow (in)	2021 Water (in)	Historic Avg Snow (in)	Historic Avg Water (in)
Little Shasta*	6200	73	20	17	7	n/a	n/a	14.6	n/a
Horse Camp	7900	156.5	46.5	30	13	68.5	26.5	116.89	52
Sand Flat	6800	110	25	9.5	4	63.5	26.5	96.85	40.04
North Fork	6900	111	40	0	0	42.5	22.0	59.17	23.96
Grey Rocks	6200	138	37	23.5	10.5	73.0	52.5	103.72	45.13
Sweetwater	5850	74	26.5	5.5	2.5	44.5	10.5	37.17	13.55
Parks Creek	6700	120	45	22	10	66.5	25.5	86.19	34.32
Deadfall Lakes	7200	111	41	19.5	8.4	55.0	22.0	73.63	31.38
Average of Courses Sampled (in)		**117**	**37.3**	**16**	**6.9**	**59.1**	**26.5**	**81.9**	**34.3**
Percent of Historic Average		**143%**	**109%**	**19%**	**20%**	**72%**	**76%**		

*Little Shasta site is managed by the Goosenest Ranger District, Klamath National Forest, and is not part of the average or percent of historic average calculation of all courses.
Note: Sites within Shasta River watershed are highlighted in light blue

In 2019, the SVRCD utilized Prop 1 funds through the DWR Sustainable Groundwater Planning (SGWP) grant program to implement two Hydrologic Data Acquisition System (HyDAS) stations in the upper Shasta River watershed. The stations are located on the north flank of Mt. Shasta, and the Goosenest. These stations provide snow depth and snow water content in real time. However, as of yet these stations do not have established snow courses and their small sample size prevents a comparison to an historical site average.

The SVRCD also utilized SGWP funds in 2019 to implement two California Irrigation Management Information System (CIMIS) stations. CIMIS stations collect and utilize meteorological data to provide accurate estimates of Evapotranspiration (ET) for a reference crop like alfalfa or grass. Through 2021, the SVRCD staff maintained the CIMIS station on a monthly basis. In addition to cooperating the CIMIS stations, the SVRCD cooperated and maintained four meteorological stations donated by the North Coast Regional Water Quality Control Board (NCRWQCB). These stations are located within the riparian corridor of the Shasta River between Dwinnell Reservoir and the confluence with the Klamath River. These four stations are not used to estimate ET, and are primarily used to record accurate air temperature and precipitation measurements adjacent to the Shasta River. Where available, annual precipitation and ET totals from the CIMIS stations, and precipitation totals from the NCRWQCB meteorological stations are presented for 2023 and the 2023 irrigation season in Table 4.

TABLE 4 . METEOROLOGICAL TOTALS FOR SVRCD COOPERATED CIMIS AND WEATHER STATIONS.

Station ID	Station Name or Reach	Elevation (ft. asl)*	2023 Total Precip (in)	2023 Total ET (in)	4/1/23 - 9/30/23 Total Precip (in)	4/1/23 - 9/30/23 Total ET (in)
105SRLWTHR	Reach 1	2050	n/a	n/a	n/a	n/a
260	Montague	2265	12.2	47	5.2	36.98
105SRMWTHR	Reach 2	2465	11.2	n/a	4.71	n/a
105SRNWTHR	Reach 4	2555	n/a	n/a	n/a	n/a
105SRUWTHR	Reach 6	2665	4.24	n/a	1.72	n/a
261	Gazelle	2745	9.6	48.61	4.9	37.60

*WGS-84 Datum
Note: CIMIS Stations are highlighted in light blue

Ambient air temperatures recorded at the CIMIS and NCRWQCB meteorological stations were examined to assist with analysis of seasonal and inter-annual river temperature and dissolved oxygen trends. As air temperatures increase into the summer, water temperatures in the Shasta River generally increase while dissolved oxygen levels decrease. An exception to this trend is in the upper Shasta River and Big Springs Creek where extensive macrophyte growth during mid and late summer minimizes increases in water temperature (Jeffres et al. 2009), although it is not clear if this exception is dependent on a normal water year. Additionally, tailwater returns to the river via overland flows are greatly affected by air and ground surface temperatures, and can subsequently have an impact on instream temperature and dissolved oxygen demands.

Temperature, rainfall, and reference evapotranspiration data from CIMIS station 260 – Montague is shown in Figure 2, and CIMIS station 261 – Gazelle in Figure 3. Meteorological data display warm-dry weather during the summer season and cooler temperatures and increased precipitation during the winter months, typical of a Mediterranean climate. Evapotranspiration is limited in the winter months when cloud cover is heavy and prevalent, and days are shorter. During the summer months higher evapotranspiration is coincident with longer days and increased daily maximum air temperatures. Precipitation data values for each day have been summed and multiplied by 100 for graphical purposes. Precipitation events at these locations demonstrate the large variability in seasonal precipitation and microclimates within the Shasta Valley.

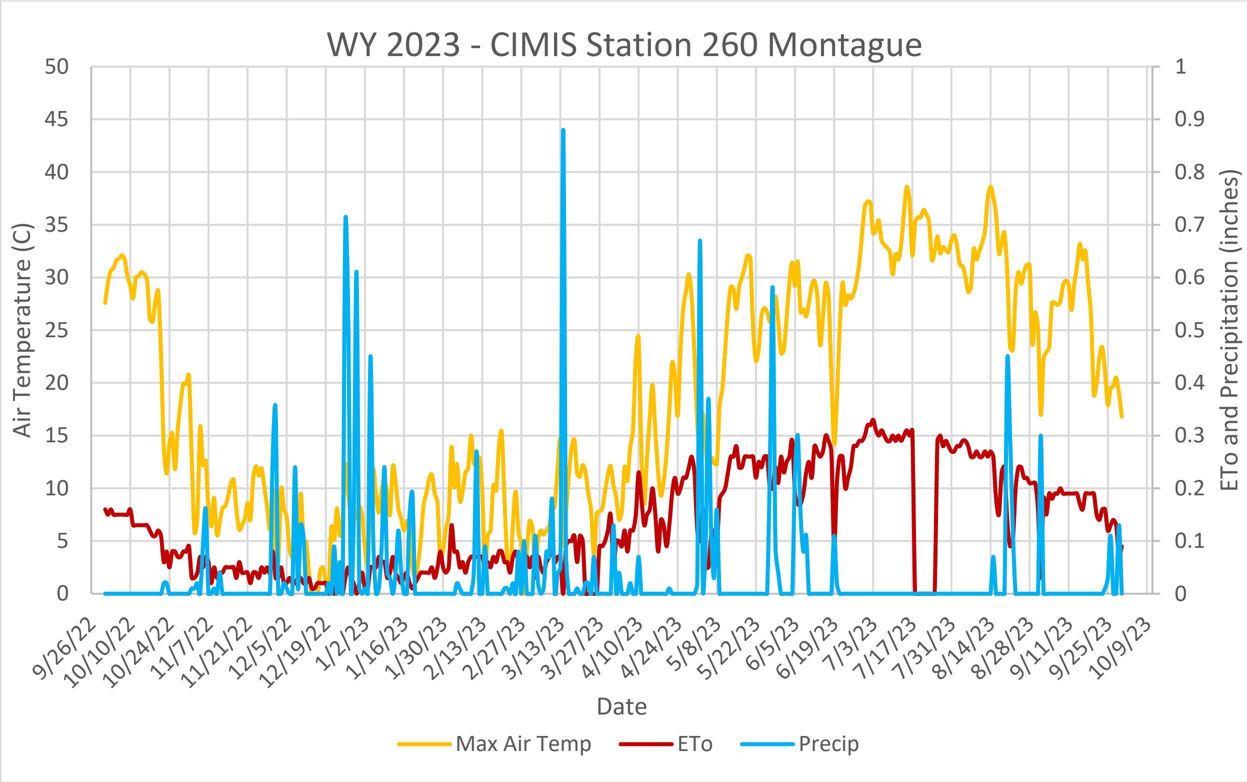

FIGURE 2. DAILY MAX AIR TEMP, ET, AND PRECIP FOR CIMIS STATION 260 – MONTAGUE FOR WY 23.

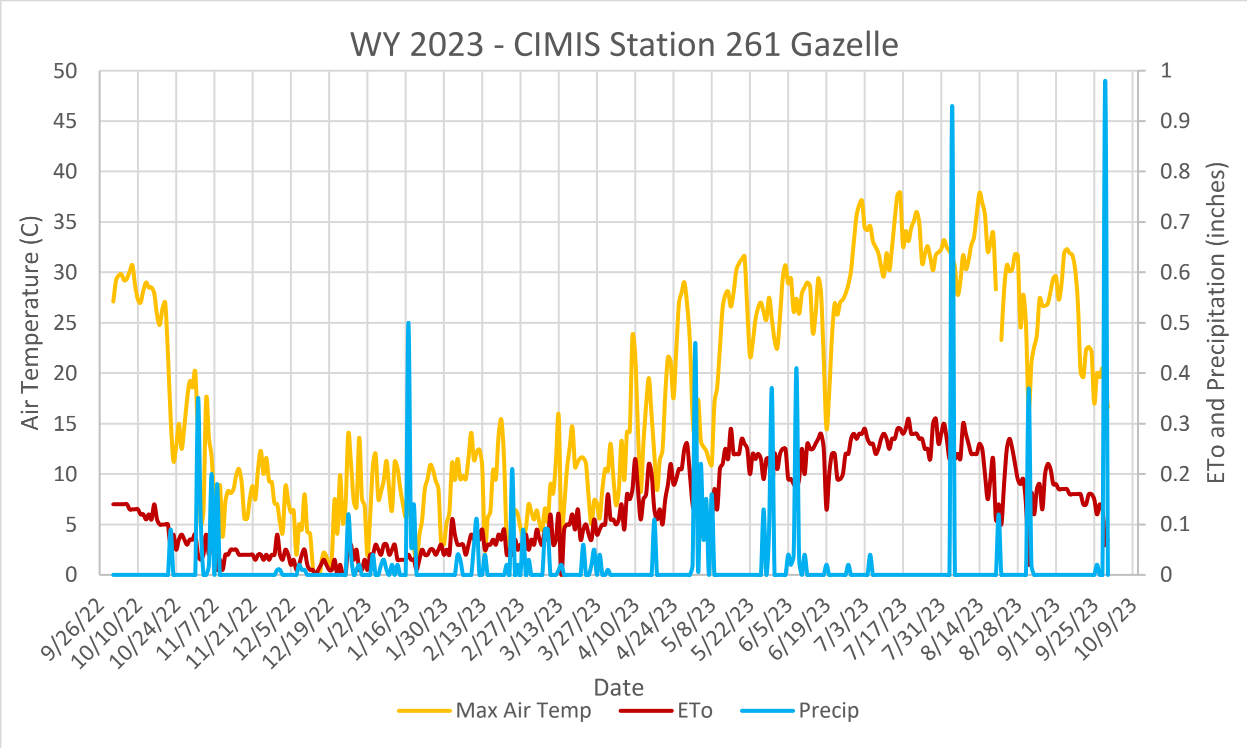

FIGURE 3. DAILY MAX AIR TEMP, ET, AND PRECIP FOR CIMIS STATION 261 – GAZELLE FOR WY 23.

SHASTA RIVER FLOW

Publicly available flow data recorded at fifteen-minute intervals at US Geologic Survey rated stream gauge sites near the cities of Montague and Yreka, and Department of Water Resources rated stream gauge downstream of Big Springs Creek (see Figure 1) is shown in Figure 4 and displays discharge of the Shasta River in cubic feet per second. Due to persistent drought conditions within the region, on May 10, 2021 California Governor Gavin Newsome declared a drought emergency for 41 counties, including Siskiyou County. Despite voluntary reductions in water use by stakeholders within the Shasta Valley, on August 17, 2021 the State Water Board adopted an emergency regulation which became effective on August 30, 2021. On June 21, 2022 the State Water Board readopted emergency instream flow requirements with modified flow levels which became effective on July 29, 2022. This emergency legislation establishes emergency drought minimum flows in the Shasta River watershed as measured at the Shasta River gauge near Yreka. The corresponding monthly emergency flow volume is shown in Figure 4 as a red line, and given in Table 5. In order to meet the emergency drought minimum flow volumes set forth in the legislation, certain water rights are being curtailed by the State Water Board.

TABLE 5. SHASTA RIVER EMERGENCY DROUGHT MINIMUM MONTHLY FLOW REQUIREMENTS FOR SRY, WY 2023.

Shasta River Emergency Drought Minimum Flow Requirements													
JAN	FEB	MAR 1-24	MAR 25-31	APR	MAY	JUN	JUL	AUG	SEP 1-15	SEP 16-30	OCT	NOV	DEC
~~135~~ 125	~~135~~ 125	~~135~~ 125	105	70	50	50	50	50	50	75	~~125~~ 105	~~150~~ 125	~~150~~ 125

Note: Values are in cubic feet per second and measured at the Shasta River Gauge near Yreka. Values with strikethroughs are 2021 emergency flow targets. 2022 emergency flow targets are underlined below.

Typically, between the months of October through March, the SRY gauge consistently records greater discharge than the SRM gauge. Between the months of April through September, this relationship inverts and the SRM gauge consistently reports higher flows than the SRY gauge. Though summers are warm and dry, significant reductions in flow volumes at both SRM and SRY gauges occurs on April 1 coinciding with the onset irrigation season and surface water diversion. Flow volumes typically increase significantly on October 1, coinciding with the end of irrigation season and the return of cooler days and increased precipitation. However, in 2022 flow volumes were slow to rebound. Flow volumes both in and outside of irrigation season are markedly lower than in previous years, and emergency flow targets were difficult to meet even after irrigation ceased. This is likely due to the compounding effects of continued drought and limited water supplies in the upper watershed.

According to USGS data, flows at SRY reached an annual low of 19.0 cfs on August 3, 2023, and an annual high of 472 cfs on March 15, 2023. Total discharge measured at the Shasta River gauges near Montague, Yreka, and downstream of Big Springs Creek is presented in Table 6.

TABLE 6. SHASTA RIVER ANNUAL DISCHARGE AND IRRIGATION SEASON DISCHARGE TOTALS FOR WY 2023.

Gauge	Total Discharge 10/1/22 – 9/30/23	Total Discharge 4/1/23 – 9/30/23	Total Emergency Minimum Discharge 10/1/22 – 9/30/23	Total Emergency Minimum Discharge 4/1/23 – 9/30/23
SPU	85,023 af	41,387 af	n/a	n/a
SRM	71,554 af	23,782 af	n/a	n/a
SRY	80,993 af	26,228 af	63,716 af	20,073 af

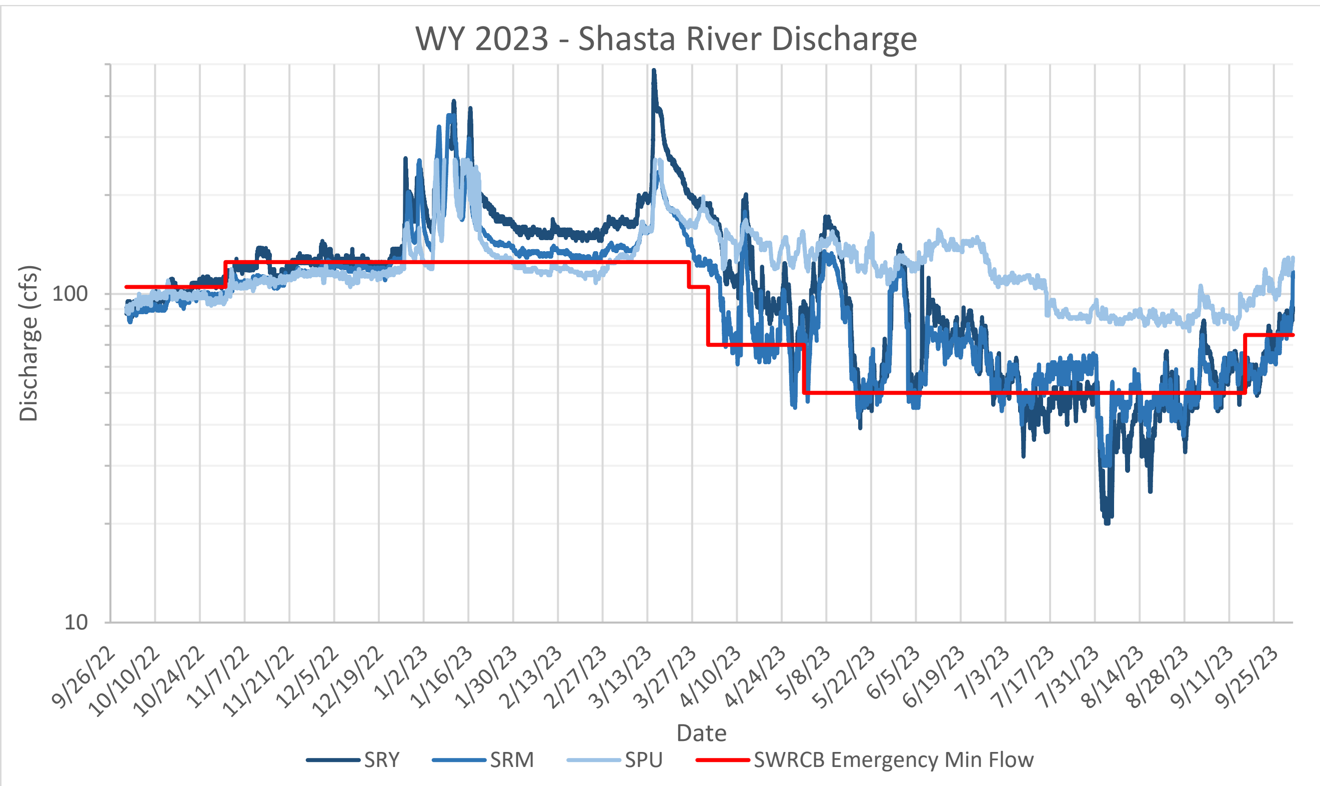

FIGURE 4. WY 2023 CONTINUOUS SHASTA RIVER DISCHARGE AND SWRCB MINIMUM INSTREAM FLOW CRITERIA.

TEMPERATURE RESULTS

Temperature was measured at 28 sites on the Shasta River and its tributaries in 2023. Temperatures in the Shasta River and its tributaries fluctuate daily and are moderate in comparison to air temperatures due to the high specific heat capacity of water.

Table 7 summarizes 2023 MWMT, MWAT, Absolute Maximum temperatures recorded over the course of the period monitored at each site in the Shasta River, Parks Creek, and Yreka Creek. A percentage has been calculated for each site corresponding to the number of days where the site exceeded the juvenile coho criterion of 18°C. The general trend of 7-DAD Max temperatures among all sites measured is a continuous rise that appears to correlate with seasonal warming, and late season decreases that correlate with cooling temperatures and decreased solar radiation from regional wild fires and/or increased instream vegetation. All sites saw a peak in 7-DAD Max temperatures during the month of July.

TABLE 7. 2023 SHASTA RIVER MWMT, MWAT, ABSOLUTE MAX TEMP, AND PERCENT OF DAYS EXCEEDED 18°C.

Site ID	Reach	MWMT (°C)	MWAT (°C)	Abs. Max Temp (°C)	% Days Exceeded 18°C
105SRHVRPOD	6	21.39	18.60	21.84	48
105SRHVRSPL	6	23.05	19.15	23.71	70
105SRHVRALC	6	14.76	13.83	14.90	0
105SRU1DO	6	21.33	18.17	21.88	29
105SRHVDSSPG	6	20.01	17.00	20.27	23
105SRU0IT	6	20.78	17.61	21.03	62
105SR7163	6	22.20	18.59	22.49	71
105SRHIGF	6	22.22	18.62	22.54	70
105PCB1DO	5	25.75	21.35	26.32	58
105PCBMDT	5	23.28	19.81	23.86	56
105PCAFPT	5	25.46	21.09	26.524	59
105PCFPDO	5	28.59	22.84	29.90	74
105SRP1DO	5	26.00	22.65	26.84	52
105SRN1DO	4	23.12	18.98	23.67	66
105SRV1DO	4	21.25	19.69	21.7	55
105SRV4AT	4	21.46	20.48	21.99	61
105SRV4BT	4	21.99	20.73	23.04	58
105SRT1DO	3	22.62	20.92	24.16	58
105SRS1DO	3	25.15	22.34	27.55	74
105SRM1DO	2	24.62	22.74	25.42	75
105SR400T	2	25.28	23.38	25.99	74
105SRA1DO	2	25.36	23.40	26.14	74
105SRA01T	2	26.36	23.88	27.38	61*
105SRG01T	2	26.12	24.17	26.62	75
105YCA01T	1	21.02	19.84	22.08	39
105SRTM01	1	26.28	24.11	27.12	60
105SRP01T	1	26.55	24.37	27.36	75
105SRL1DO	1	27.02	25.09	28.02	75

*Site 105SRA01T is missing key data from August and September, reducing the percentage of days monitored where the juvenile coho criterion was exceeded.

LONGITUDINAL ANALYSIS

Longitudinal MWMT data from 2017 to 2023 is shown below. In 2022, the sensor at 105SR400T was buried and data subsequently omitted as it did not accurately record the MWMT. In 2021, 105SRN1DO was not monitored, and data is not reported for that year. Additionally, in 2019, the data from points 105SRTM01DO and 105SRS1DO is not available.

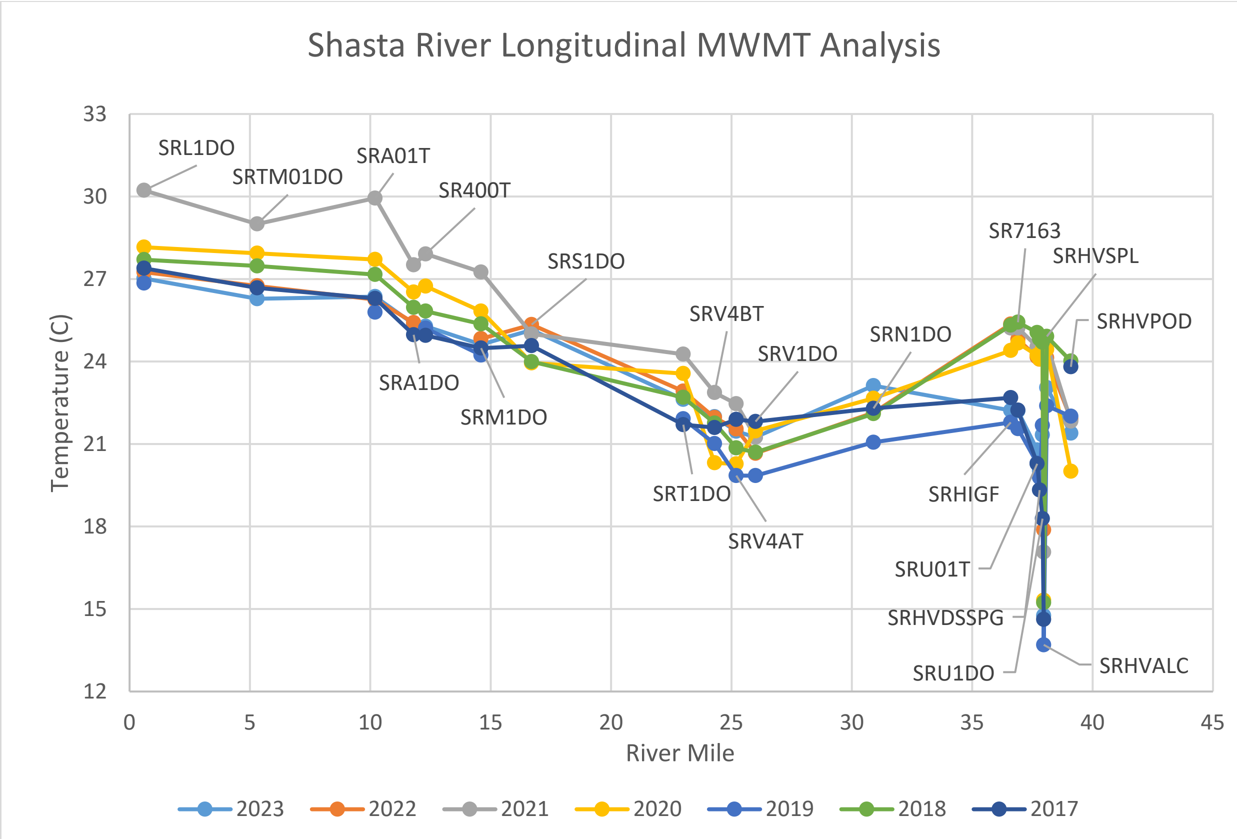

FIGURE 5. LONGITUDINAL MWMT DATA FOR LONG TERM SHASTA RIVER TEMPERATURE SITES BETWEEN 2017-2023.

Longitudinal MWAT data from 2017 to 2023 is shown below. In 2022, the sensor at 105SR400T was buried and subsequent data was omitted as it did not accurately record the MWAT. In 2021, 105SRN1DO was not monitored. Additionally, in 2019, the data from sites 105SRTM01DO and 105SRS1DO are not available because they were not monitored.

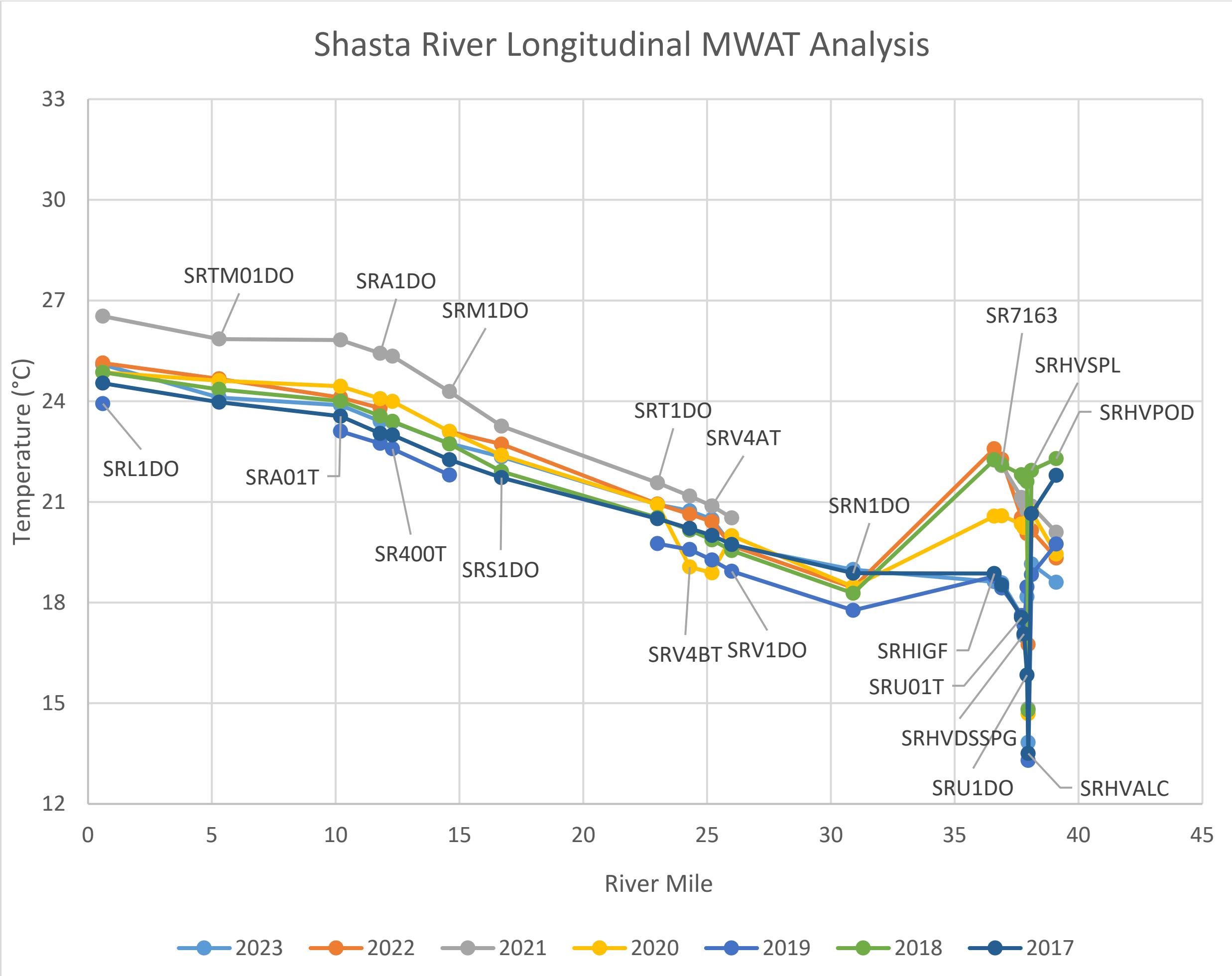

Figure 6. Longitudinal MWAT data for long term Shasta River temperature sites between 2017-2023.

Longitudinal Max Temp Data from 2017 to 2023 is shown below. In 2022, the sensor at 105SR400T was buried and subsequent data was omitted as it did not accurately record the Absolute Max temperature. In 2021, 105SRN1DO was not monitored. Additionally, in 2019, the data from sites 105SRTM01DO and 105SRS1DO are not available because they were not monitored.

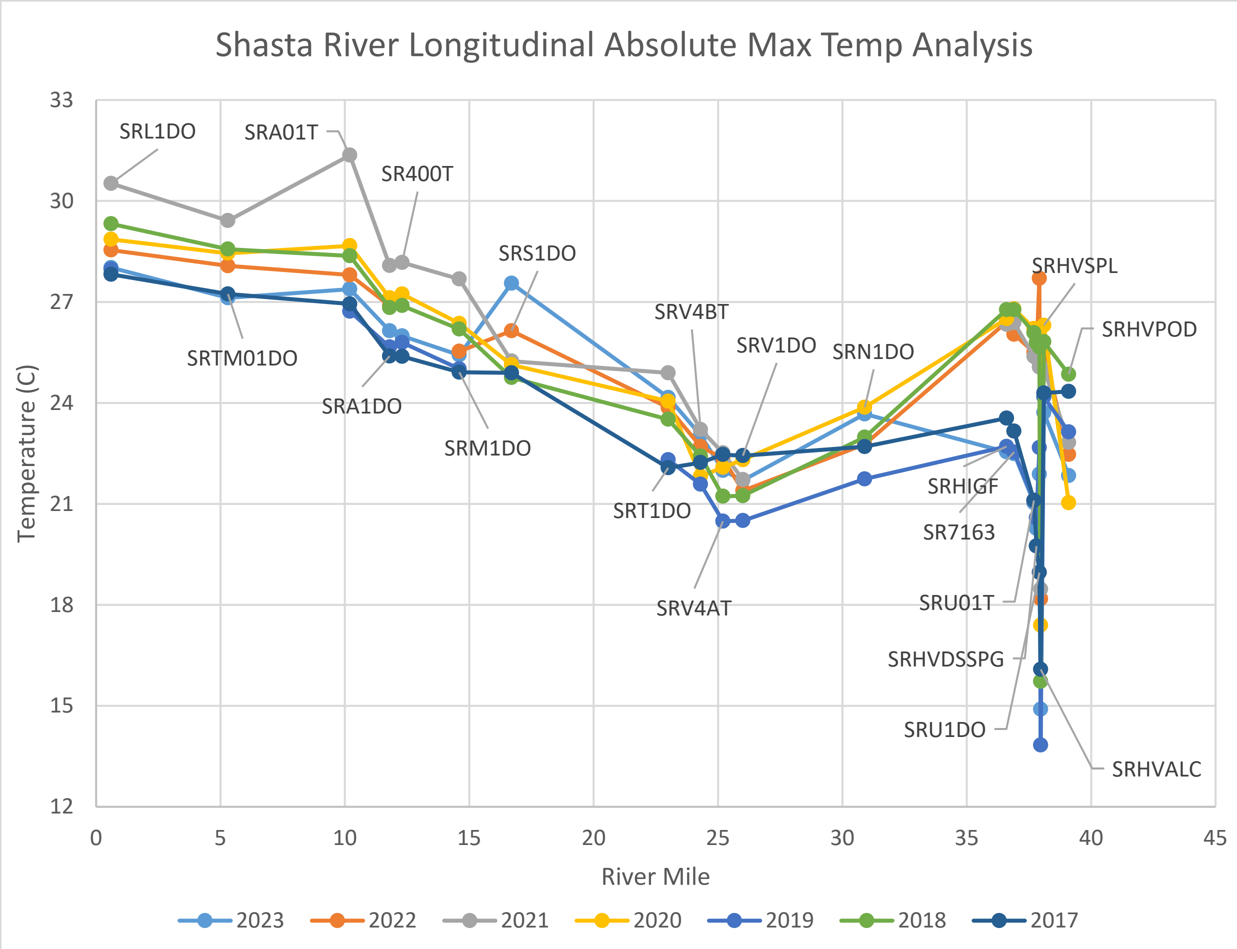

FIGURE 7. LONGITUDINAL ABSOLUTE MAX TEMPS FOR LONG TERM SHASTA RIVER TEMPERATURE SITES 2017-2023.

REACH 1

Figure 8 displays MWMT criterion for juvenile coho salmon rearing and 7-DAD Max water temperatures at a site within the tributary Yreka Creek (105YCA01T) and sites downstream of the confluence of Yreka Creek within Shasta River Reach 1. In WY 2023, temperature and DO data were collected year-round at 105SRL1DO, and an additional temperature monitoring site was added within this reach (105SRP01T). Missing data at site 105SRL1DO between Jan 25, and Feb 5, 2023 is the result of an expired RDO sensor cap. 7-DAD Maximum temperatures at Yreka Creek are consistently cooler than all other sites within Reach 1 throughout the monitored period. The temperature gap between Yreka Creek and the Shasta River in Reach 1 widens substantially from mid-May through mid-August when Reach 1 7-DAD Maximum temperatures reach their highest levels. Despite the overall increase in 7-DAD max temperatures throughout summer, 7-DAD Maximum temperatures at 105SYCA01T exceeds juvenile coho criterion for a sustained period of approximately four weeks, or roughly half the time of the Shasta River mainstem. 7-DAD Maximum temperatures throughout Reach 1 are generally consistent with each other, increasing only slightly in the downstream direction.

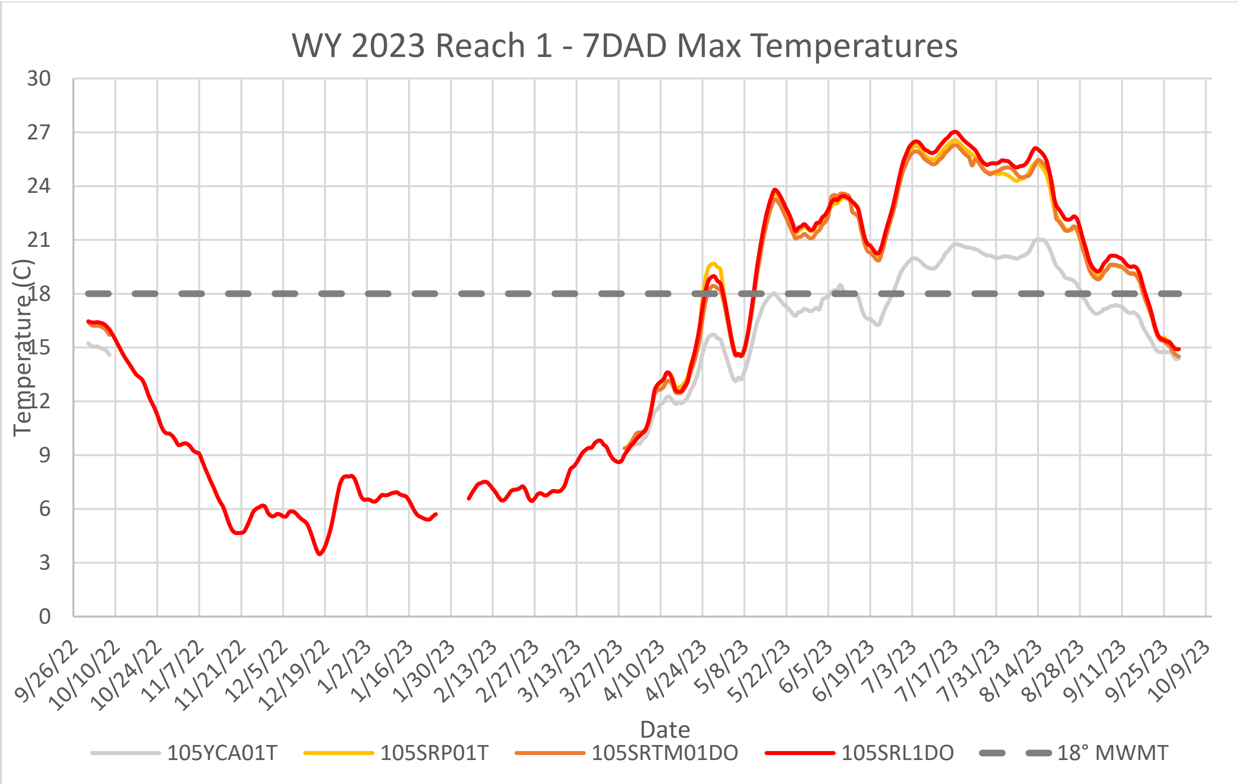

FIGURE 8. WY 2023 7DAD MAXIMUM TEMPERATURES AT REACH 1 (SHASTA RIVER AND YREKA CREEK SITES).

REACH 2

Figure 9 displays MWMT criterion for juvenile coho salmon rearing and 7-DAD Maximum water temperatures at sites within Shasta River Reach 2. These sites are located on the mainstem of the Shasta River between the confluences of Little Shasta River and Yreka Creek. In WY 2023, temperature and DO data were collected year around at 105SRM1DO, and an additional temperature monitoring site was added within this reach (105SRG01T). Missing data at site 105SRM1DO between Dec 5, 2022 and Jan 21, 2023 is the result of lost power during deployment. Missing data at site 105SRA01T between Aug 5-18, 2023 and Sep 7-21, 2023 is the result of the sensor being removed from the stream. 7-DAD Maximum temperatures at all sites within Reach 2 are generally consistent with one another with 7-DAD Maximum temperatures increasing slightly in the downstream direction.

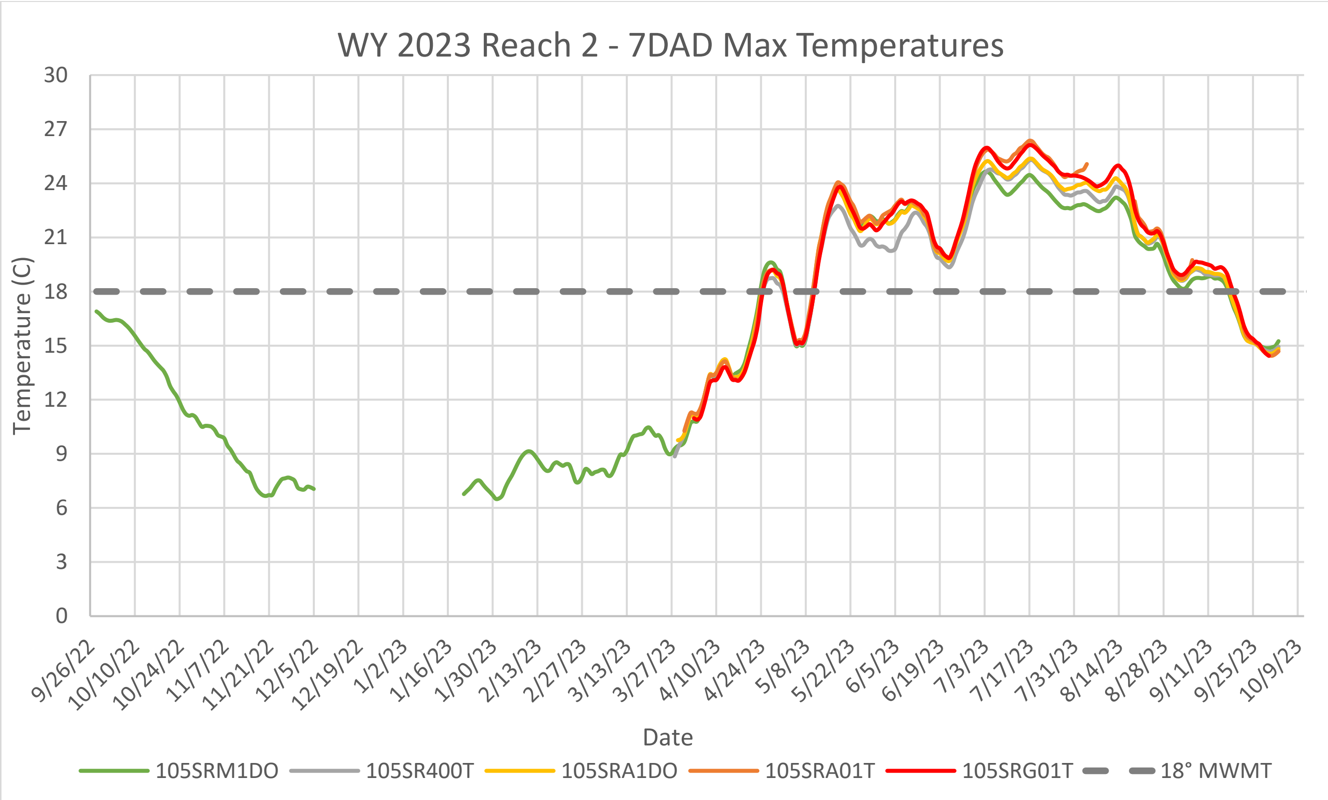

FIGURE 9. WY 2023 7-DAD MAXIMUM TEMPERATURES FOR REACH 2, SHASTA RIVER.

REACH 3

Figure 10 displays MWMT criterion for juvenile coho salmon rearing and 7-DAD Maximum water temperatures at sites within Shasta River Reach 3. These sites are located on the mainstem of the Shasta River between the confluences of Willow Creek and Little Shasta River. In WY 2023, temperature and DO data were collected year-round at 105SRT1DO. Missing data at 105SRT1DO between Dec 5, 2022 and Jan 17, 2023 is the result of loss of power during deployment. 7-DAD Maximum temperatures increased in the downstream direction through all sites in this reach. During the warmest part of the year, 7-DAD Maximum temperatures were nearly 3°C between the upstream and downstream sites. Despite exceeding the MWMT criterion for juvenile coho salmon for a sustained period at approximately the same time in mid-May, 7-DAD Maximum temperatures at 105SRT1DO drop below the criterion nearly two weeks sooner than the downstream site within this reach.

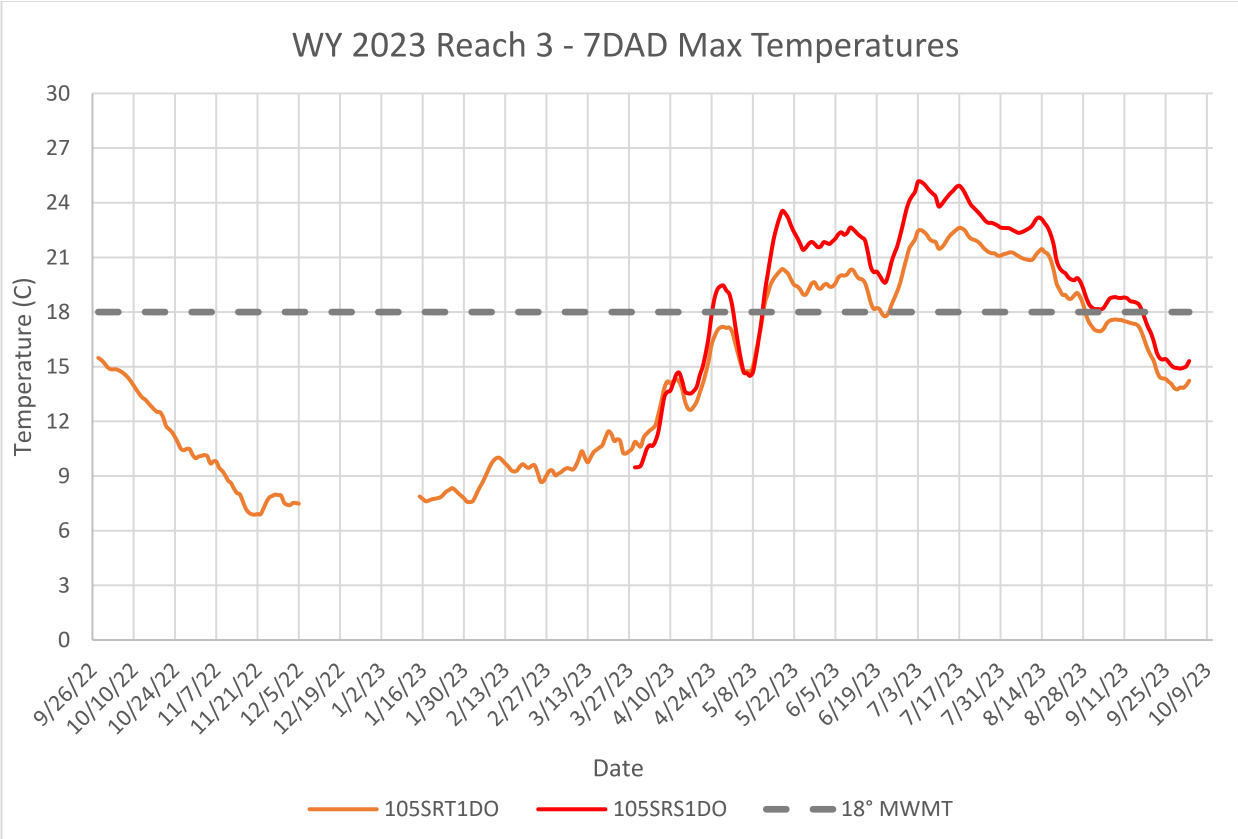

Figure 10. 2023 7-DAD Max temperatures for Shasta River, Reach 3.

Reach 4

Figure 11 displays MWMT criterion for juvenile coho salmon rearing and 7-DAD Maximum water temperatures at sites within Shasta River Reach 4. These sites are located on the mainstem of the Shasta River between the confluences of Big Springs Creek and Willow Creek. In WY 2023, temperature and DO data were collected year-round at all sites within Reach 4. Big Springs Creek adds a large volume (52 cfs average during July and August) of cold water to the Shasta River (Nichols et al. 2010). Consequently, 7-DAD Maximum water temperatures within this reach are consistently cooler throughout irrigation season than in all other reaches within the Shasta River. 7-DAD Maximum temperatures at the farthest upstream site, while still relatively cool, are consistently warmer than the next downstream site. Similar to previous years, a downstream warming trend forms at all sites except the farthest upstream site, beginning in early-July until the end of the irrigation season. 7-DAD Maximum temperatures exceed the MWMT juvenile coho criterion for a sustained period beginning in mid-May through mid-late August.

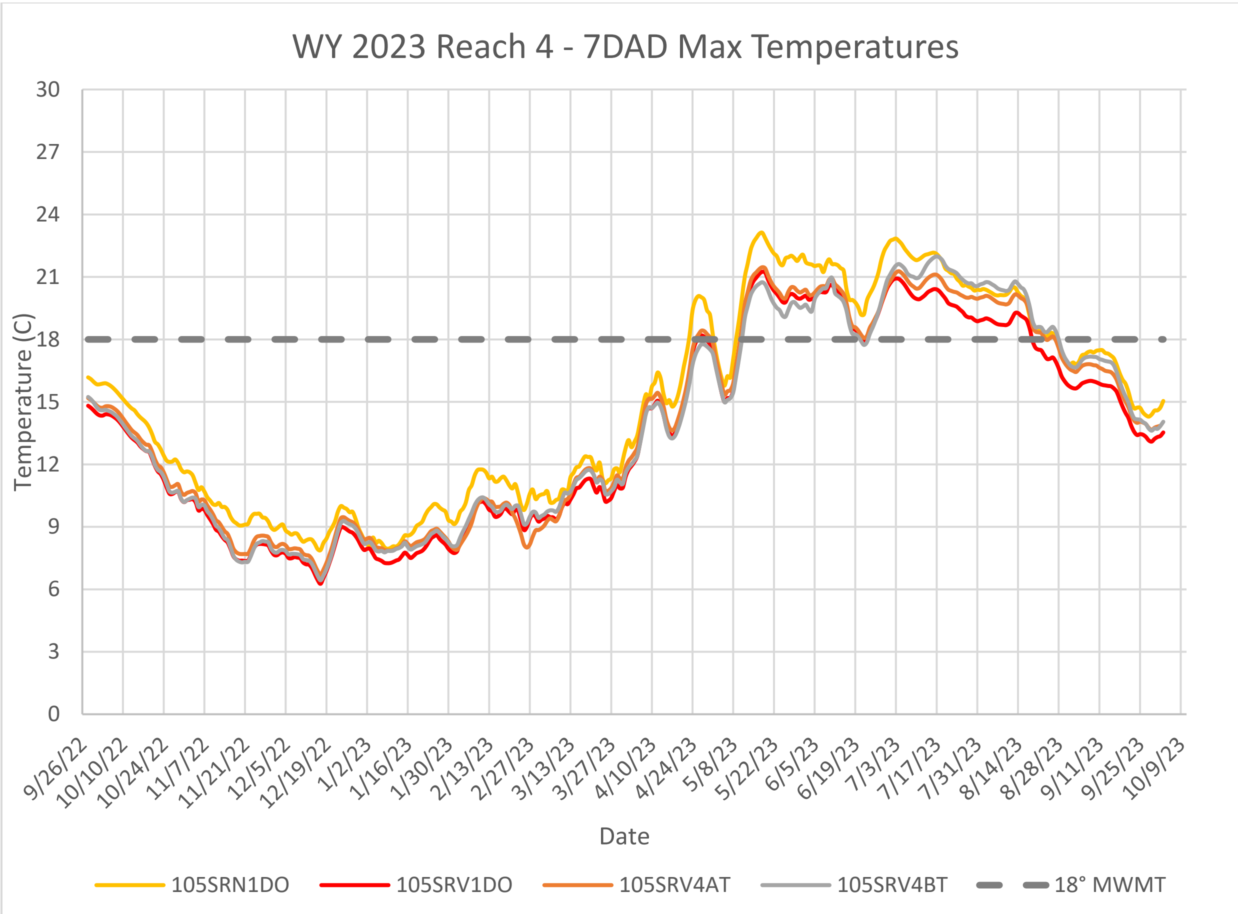

FIGURE 11. 2023 7-DAD MAX TEMPERATURES FOR SHASTA RIVER, REACH 4.

REACH 5

Figure 12 displays MWMT criterion for juvenile coho salmon rearing and 7-DAD Maximum water temperatures at sites within Shasta River Reach 5. Reach 5 spans the mainstem of the Shasta River between the confluences of Parks Creek and Big Springs Creek, and includes sites located on Parks Creek. In WY 2023, temperature and DO data were collected year-round at site 105SRP1DO. The Shasta River in Reach 5 is supplemented by flows from Parks Creek and Hole in the Ground Creek in Reach 5. Coho salmon utilize Parks Creek for migration, spawning and juvenile rearing (Chesney et al. 2009). Recent projects on Parks Creek, including the SVRCD's completion of the Parks Creek Fish Passage Project at the Interstate-5 bridge and the Parks Creek Riparian Improvement Project upstream of the Interstate-5 bridge, are expected to improve water quality, habitat, and the mobility of aquatic species. Monitoring sites on Parks Creek span nearly twelve river-miles. 7-DAD Maximum temperatures demonstrate a downstream warming trend across the entire creek until early July. 7-DAD Maximum temperatures at 105PCB1DO may be impacted changing flow regimes through the braided channel at this site. Several springs may influence temperatures between 105PCFPDO and 105SRP1DO.

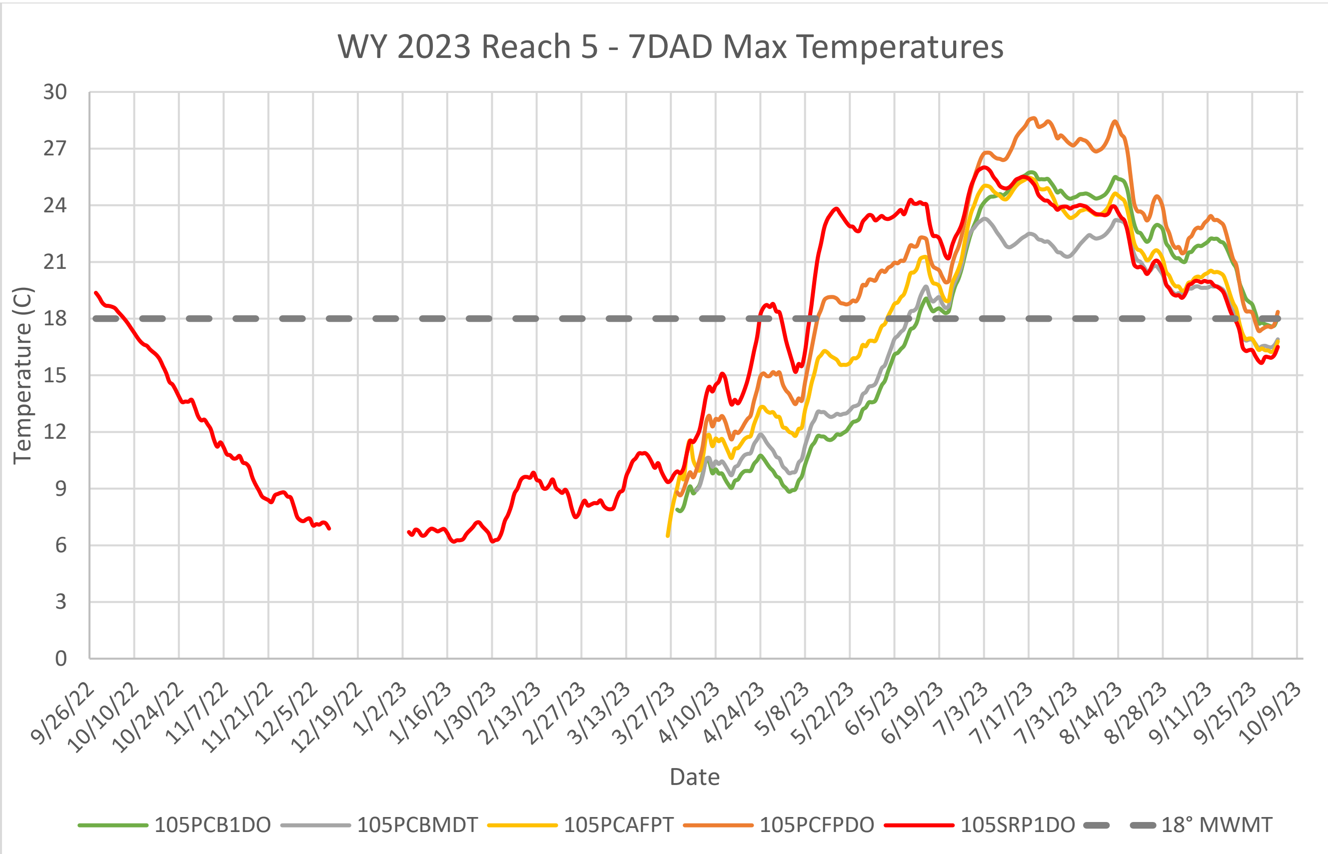

Figure 12. 2023 7-DAD Max temperatures at Parks Creek Reach 5. All sites are on Parks Creek.

Reach 6

Figure 13 displays MWMT criterion for juvenile coho salmon rearing and 7-DAD Maximum water temperatures at sites within Shasta River Reach 6. These sites are located on the mainstem of the Shasta River between Parks Creek and the outlet of Dwinnell Reservoir. Long term temperature and DO data at 105SRU1DO should be closely reviewed as the sensor regularly captures data from two separate flow regimes, one is dominated by subsurface inflows from an adjacent cold spring, and the second is Shasta River water released from Dwinnell Reservoir. Additionally, WY 2023 was cool and wet and provided enough precipitation over the winter that a springwater pipeline connection project could be operated, the outlet of which flows into the Shasta River at 105SRU1DO. 7-DAD Maximum temperatures at most sites consistently exceeded the MWMT juvenile coho criterion beginning mid-May through mid-September. 7-DAD Maximum temperatures generally increased in the downstream direction in this reach, with the exception of 105SRHVRALC which is located adjacent to a cold spring and likely records subsurface cold-water inputs to the Shasta River. All 7-DAD Maximum temperatures at sites downstream of the spring pipeline connection project are cooler than the 7-DAD Maximum temperature at the site immediately upstream of it.

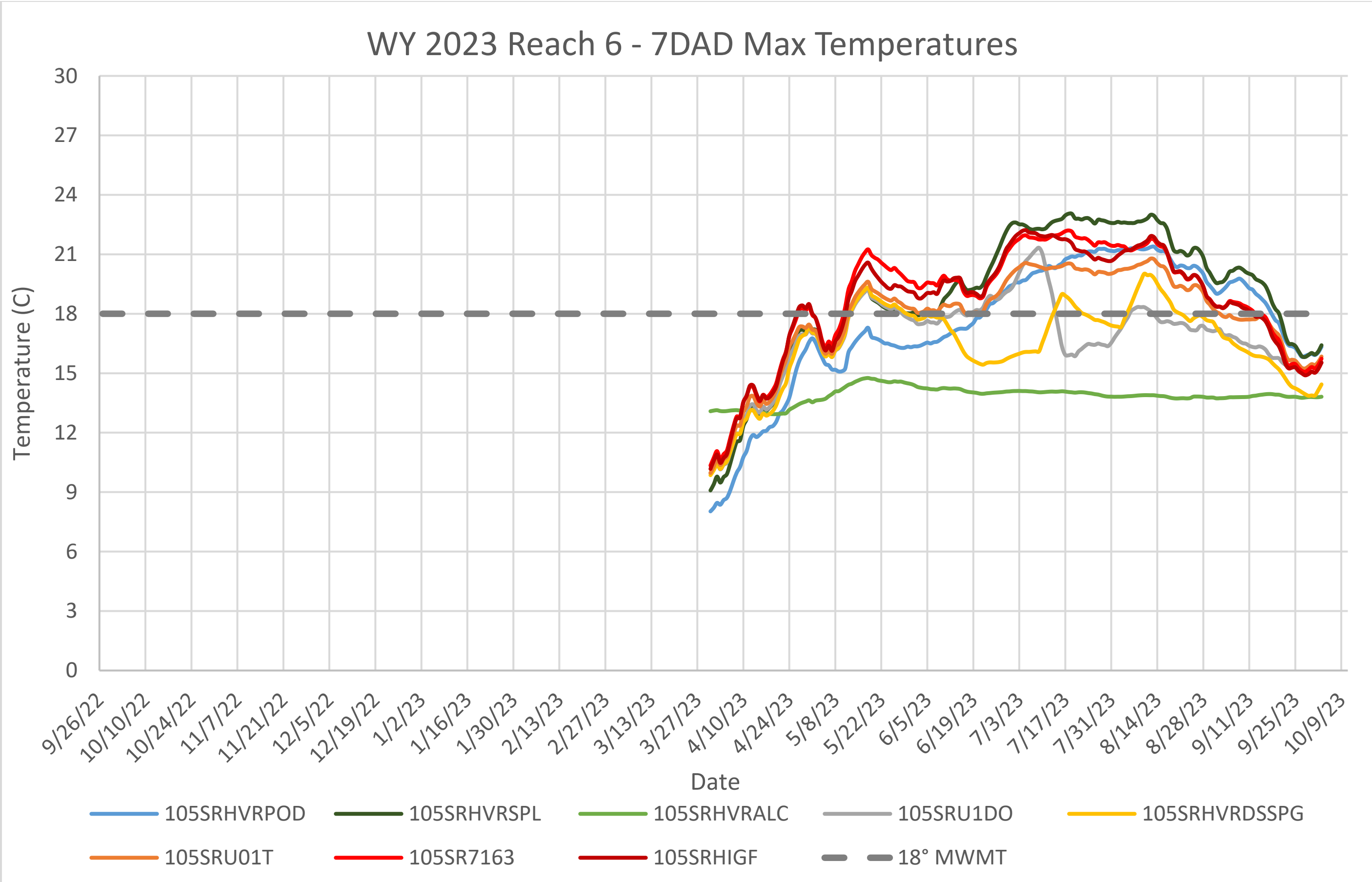

FIGURE 13. 2023 7-DAD MAX TEMPERATURES AT MONITORING LOCATIONS IN THE SHASTA RIVER AT REACH 6.

DISSOLVED OXYGEN RESULTS

Dissolved oxygen (DO) levels in surface waters are not constant, but change throughout the day as oxygen is added (by photosynthesis and reaeration) and removed (by carbonaceous and nitrogenous deoxygenation, sediment oxygen demand, and respiration) from the water. Salmonids such as coho and Chinook salmon are particularly sensitive to low DO concentrations as DO regulates metabolic activity in these and many fish species (Fry 1971). The 2015 North Coast Water Quality Control Plan states that the minimum dissolved oxygen concentration in the Shasta River should not fall below 6 mg/L.

Diurnal DO fluctuations were recorded at nine monitoring sites on the Shasta River and its tributaries. Lowest DO concentrations were between 23:00 and 7:00 when respiration occurs without photosynthesis, while the highest concentrations of DO were between 12:00 and 15:00 when peak photosynthesis occurs.

Figure 13 and Figure 14 display daily minimum dissolved oxygen measurements for WY 2023 at all sites on the Shasta River and Parks Creek, respectively. The general trend among all Shasta River sites measured was an increase in DO at all sites with maximums occurring around December and January followed by a continuous reduction in the daily minimum DO from early April through late July due to seasonal warming and associated increased Biological Oxygen Demand (BOD). This general trend is also observed in all Parks Creek sites, with a slight increase in daily minimum DO from the beginning of the period of record through the end of April. The slight increase is likely from decreased temperatures and reduced BOD. This peak around December and January is followed by a steep reduction in the daily minimum DO level from the end of April through late July and August due to seasonal warming and increased BOD. Noteworthy is the reduction in daily minimum DO decline at sites farther upstream on Parks Creek. More upstream monitoring sites on Parks Creek are likely less nutrient rich and have proportionately less BOD. General trends for all Shasta River and Parks Creek sites are characterized by increasing DO levels from late July and August through early October due to cooling temperatures, decreased solar radiation from regional wild fires, and increased production of instream vegetation (e.g., macrophytes).

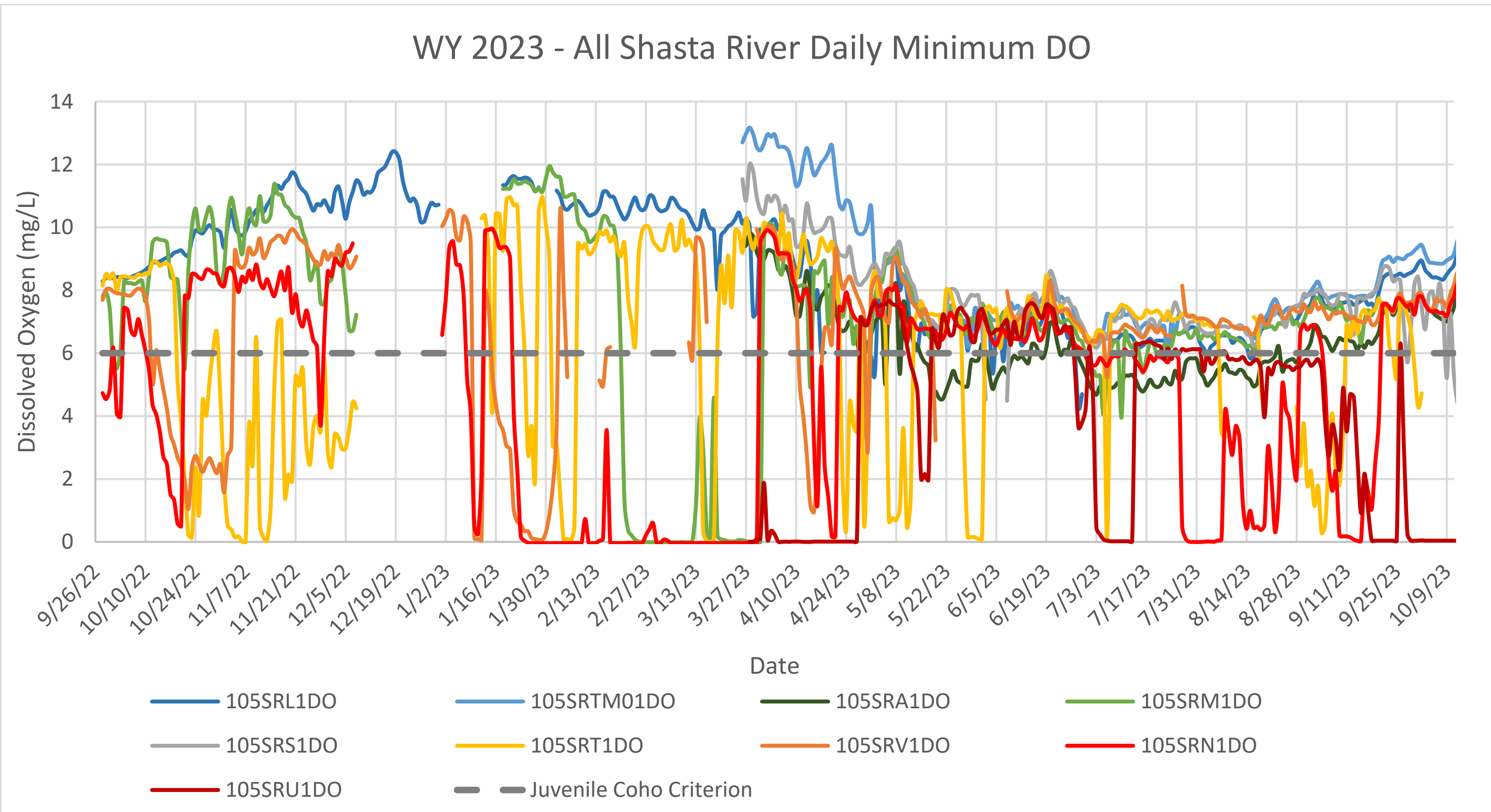

FIGURE 14. WY 2023 DAILY MINIMUM DO AT ALL SHASTA RIVER SITES.

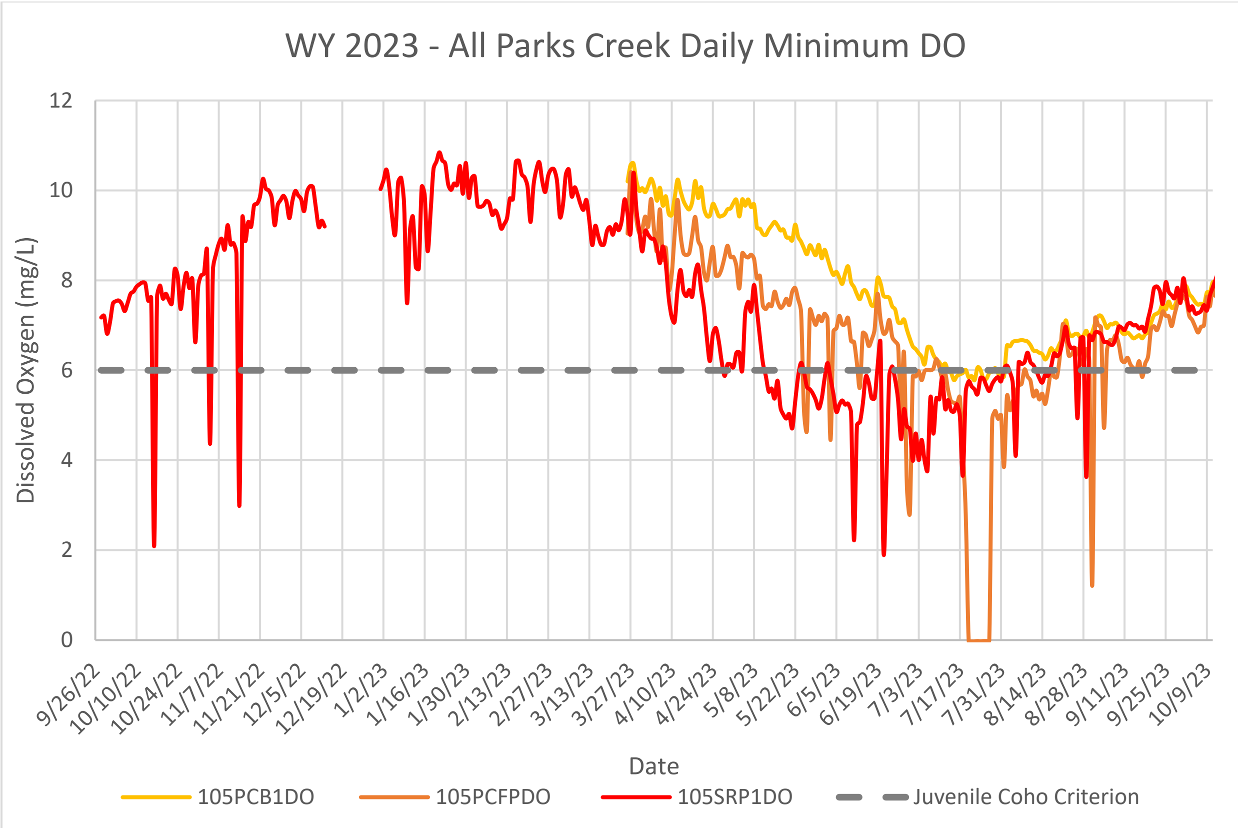

FIGURE 15. WY 2023 DAILY MINIMUM DO AT ALL PARKS CREEK SITES.

Table 8 displays the percentage of days that each site fell below the TMDL (6 mg/L) during the 2023 irrigation season. Upstream sites on the Shasta River (105SRU1DO) and Parks Creek (105PCB1DO, 105SRP1DO) experienced a high percentage of days below the TMDL. Middle River site (105SRA1DO) also experienced a significant percentage of days below the TMDL. Persistent drivers of dissolved oxygen demand within the Shasta River Watershed are all exacerbated by drought conditions.

TABLE 8. PERCENTAGE OF DAYS MONITORED WHERE DO LEVELS FELL BELOW 6 MG/L.

Reach	DO Monitoring Site	Percentage of Days DO Fell Below Juvenile Coho Criterion *	Days Site Occupied	Days of Quality Data
1	105SRL1DO	19.1	183	183
	105SRTM01DO	11.5	183	183
2	105SRA1DO	53.0	183	183
	105SRM1DO	8.2	183	183
3	105SRS1DO	4.9	183	183
	105SRT1DO	31.1	183	183
4	105SRV1DO	19.1	183	183
	105SRN1DO	44.8	183	183
5	105SRP1DO	48.1	183	183
	105PCFPDO	54.0	183	183
	105PCB1DO	8.7	183	183
6	105SRU1DO	58.5**	183	183

*Percentage is calculated from the total number of days in the irrigation season (183) and quality data days at a site

** DO levels at this site are heavily impacted by a nearby groundwater spring inflow, which is typically oxygen depleted, and beaver dams impounding water and is likely not representative of the reach.

Reach 1

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRL1DO is shown in Figure 16. DO and temperature equipment were deployed for 371 days, between September 28, 2022 and October 3, 2023. Missing DO data between January 29 and February 1, 2022 is due to an expired RDO cap. DO levels fell below the juvenile coho DO criterion of 6 mg/L in 37 of the 371 days for which quality DO data was recorded during WY 2023, and 35 of the 183 days for which quality data was recorded during the 2023 irrigation season.

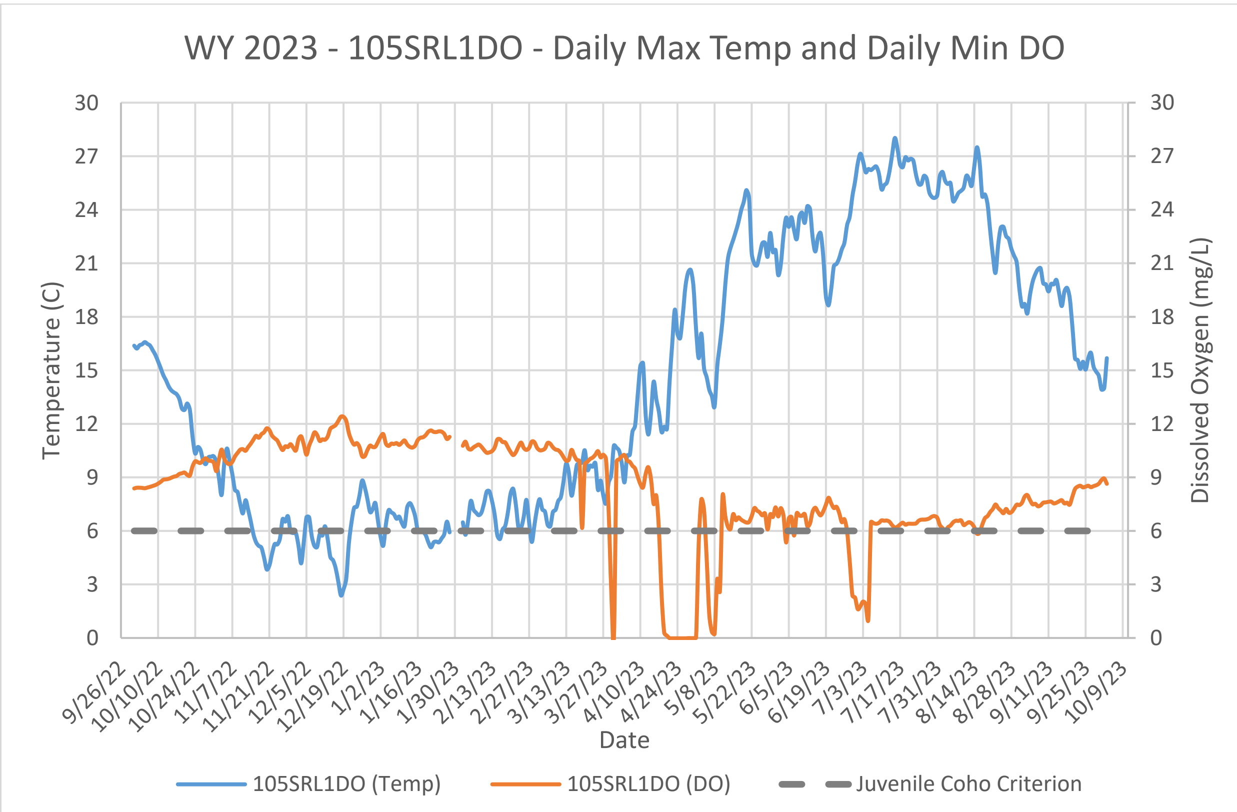

Figure 16. 2023 daily maximum temperature and daily minimum DO at 105SRL1DO, Shasta River.

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRTM01DO is shown in Figure 17. DO and temperature equipment were deployed for 208 days, between March 26 and October 19, 2023. Missing DO data between July 26 and August 16, 2023 is due to a corrupted file damaged during the download process. DO levels fell below the juvenile coho DO criterion of 6 mg/L in 1 of the 208 days for which quality was recorded, and 1 of the 183 days for which quality DO data was recorded during the 2023 irrigation season.

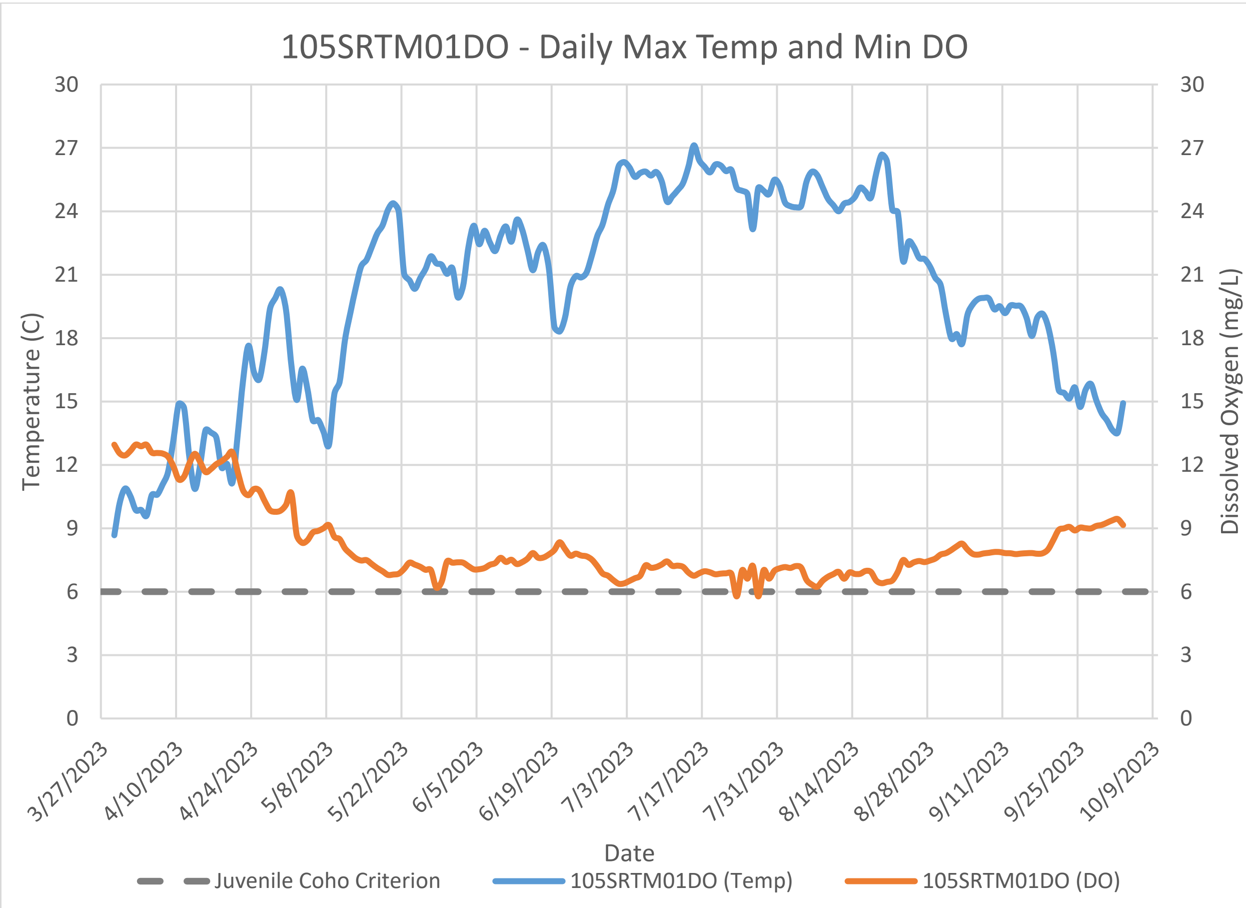

FIGURE 17. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105SRTM01DO, SHASTA RIVER.

REACH 2

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRA1DO is shown in Figure 18. DO and temperature equipment were deployed for 207 days, between March 26 and October 18, 2023. DO fell below the juvenile coho DO criterion of 6 mg/L in 97 of the 207 for which quality DO data was recorded during the 2023 irrigation season.

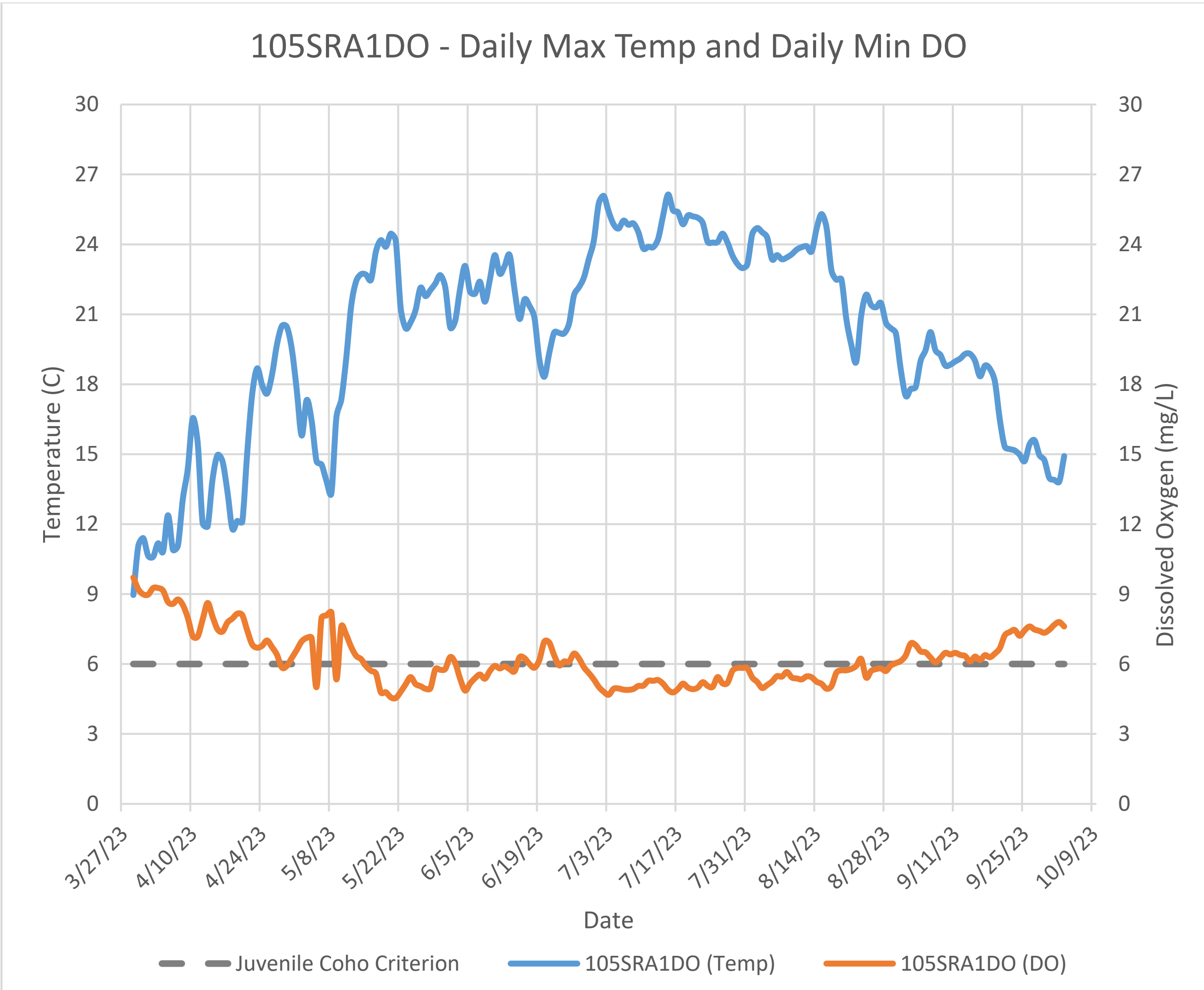

FIGURE 18. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105SRA1DO, SHASTA RIVER.

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRM1DO is shown in Figure 19. DO and temperature equipment were deployed for 371 days between September 28, 2022 and October 3, 2023. DO and temperature data are missing from December 9, 2022 to January 17, 2023 due to power failure while equipment was deployed. DO fell below the juvenile coho DO criterion of 6mg/L in 58 of the 331 days for which quality DO data was recorded during WY 2023, and 15 of the 183 days for which quality DO data was recorded during the 2023 irrigation season.

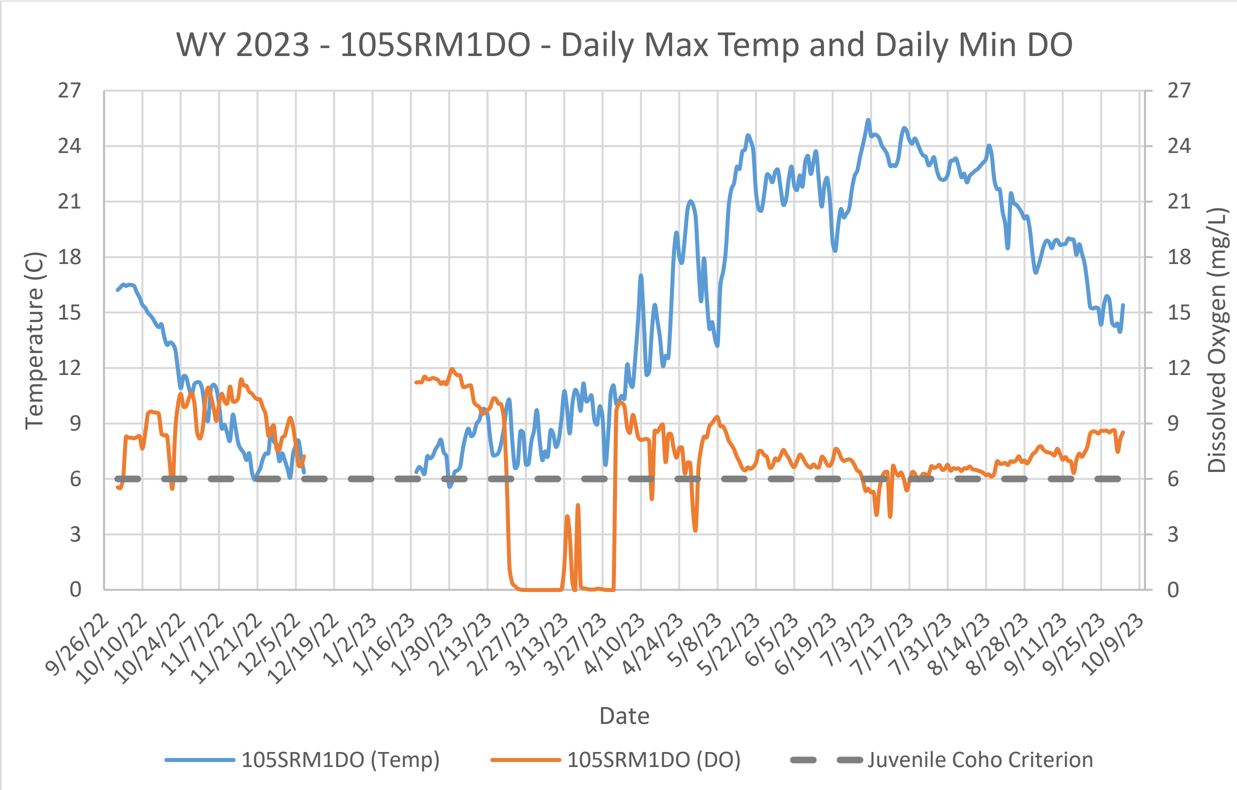

FIGURE 19. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105SRM1DO, SHASTA RIVER.

REACH 3

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRS1DO is shown in Figure 20. DO and temperature equipment were deployed for 215 days between March 26 and October 26, 2023. DO fell below the juvenile coho DO criterion of 6 mg/L in 9 of the 183 days for which quality DO data was recorded during the 2023 irrigation season,

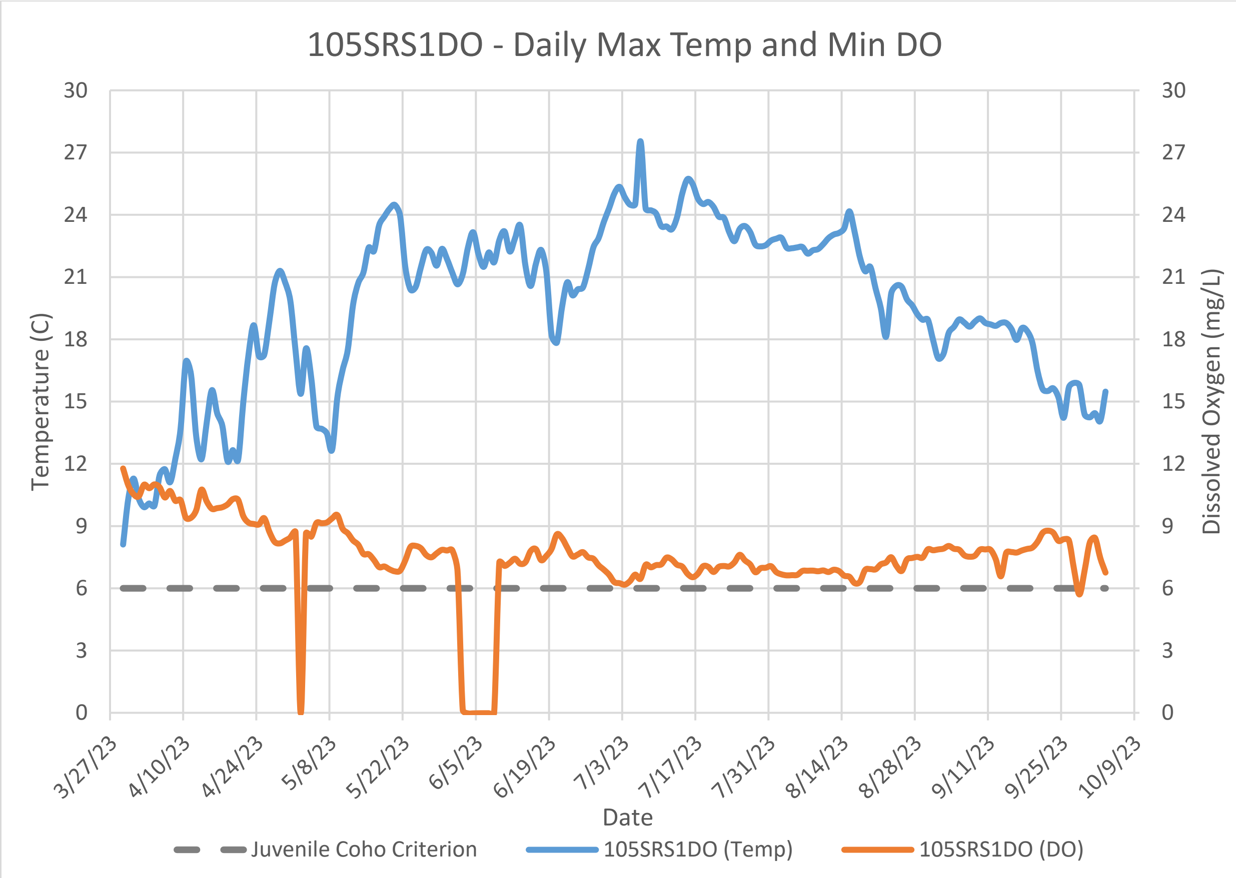

FIGURE 20. 2023 DAILY MAXIMUM TEMPERATURE DAILY MINIMUM DO AT 105SRS1DO, SHASTA RIVER.

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRT1DO shown in Figure 21. DO and temperature equipment were deployed for 371 days between September 28, 2022 and October 3, 2023. DO and temperature data are missing from December 9, 2022 to January 11, 2023 due to power failure while equipment was deployed. DO fell below the juvenile coho DO criterion of 6mg/L in 118 of the 357 days for which quality DO was recorded during WY 2023, and 57 of the 183 days for which quality DO data was recorded during the 2023 irrigation season.

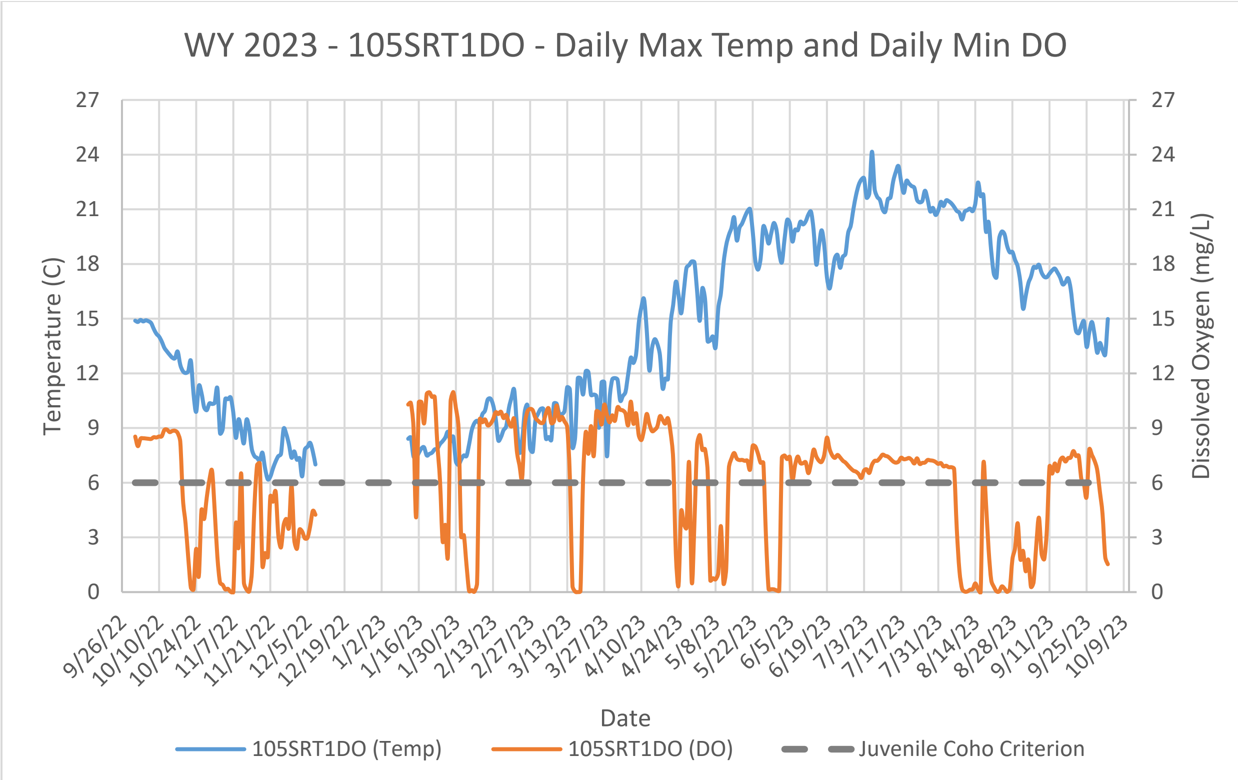

FIGURE 21. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105SRT1DO, SHASTA RIVER.

REACH 4

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRV1DO are shown in Figure 22. DO and temperature equipment were deployed for 371 days between September 27, 2023 and October 3, 2023. High turbidity during winter obscured data on numerous occasions and is thought to be responsible for the numerous dips during this time period. DO levels fell below the juvenile coho DO criterion of 6 mg/L in 129 of the 365 days for which quality DO data was recorded during WY 2023, and 35 of the 183 days for which quality data was recorded during the 2023 irrigation season.

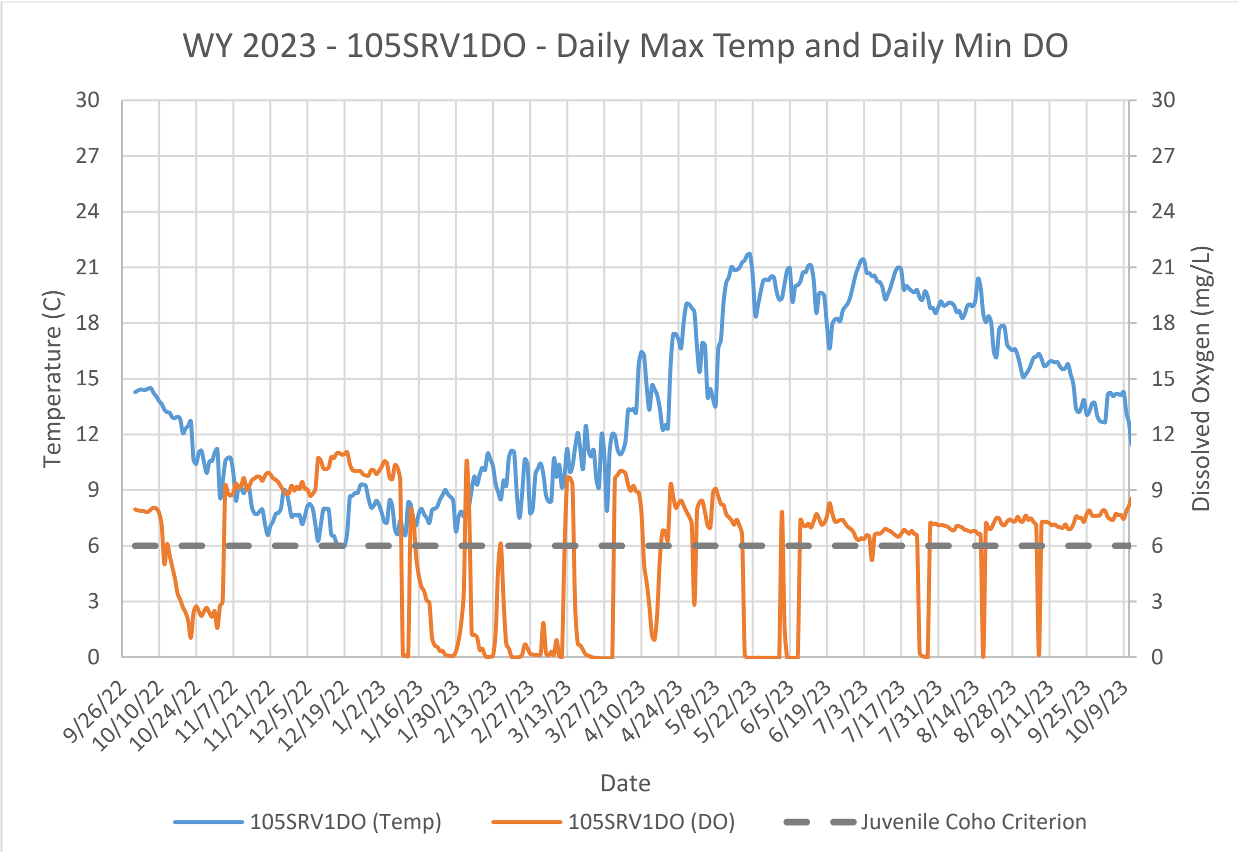

FIGURE 22. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105SRV1DO, SHASTA RIVER.

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRN1DO are shown in Figure 23. DO and temperature equipment were deployed for 371 days between September 27, 2022 and October 3, 2023. High turbidity during winter obscured data on numerous occasions and is thought to be responsible for the numerous dips during this time period. DO levels fell below the juvenile criterion DO criterion of 6 mg/L in 175 of the 365 days for which quality data was recorded during WY 2023, and 82 of the 183 days for which quality DO data was recorded during the 2023 irrigation season.

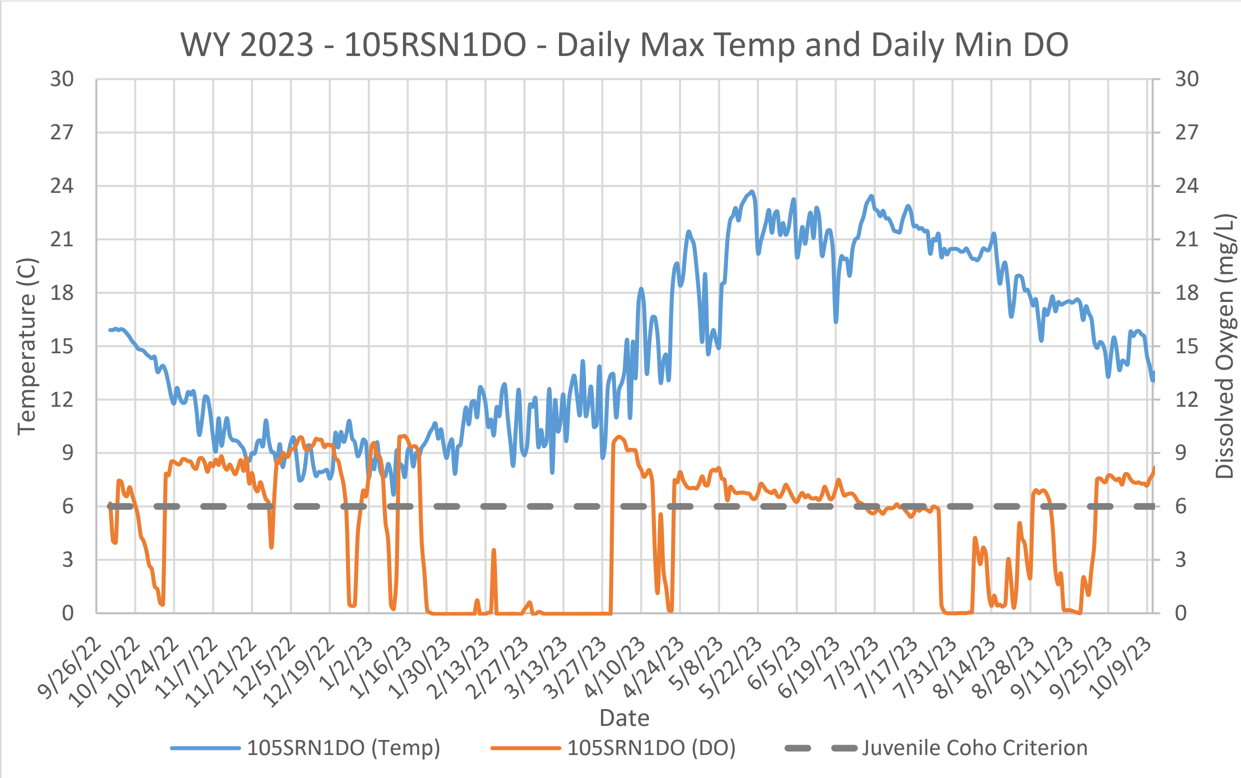

FIGURE 23. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105SRN1DO, SHASTA RIVER.

REACH 5

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRP1DO are shown in Figure 24. DO and temperature data were deployed for 371 days from September 27, 2022 to October 3, 2023. DO data is missing from December 14, to December 31, 2022 due to power failure while equipment was deployed. DO levels fell below the juvenile coho DO criterion of 6 mg/L in 91 of the 347 days for which quality DO data was recorded during WY 2023, and 88 of the 183 days for which quality DO data was recorded during the 2023 irrigation season.

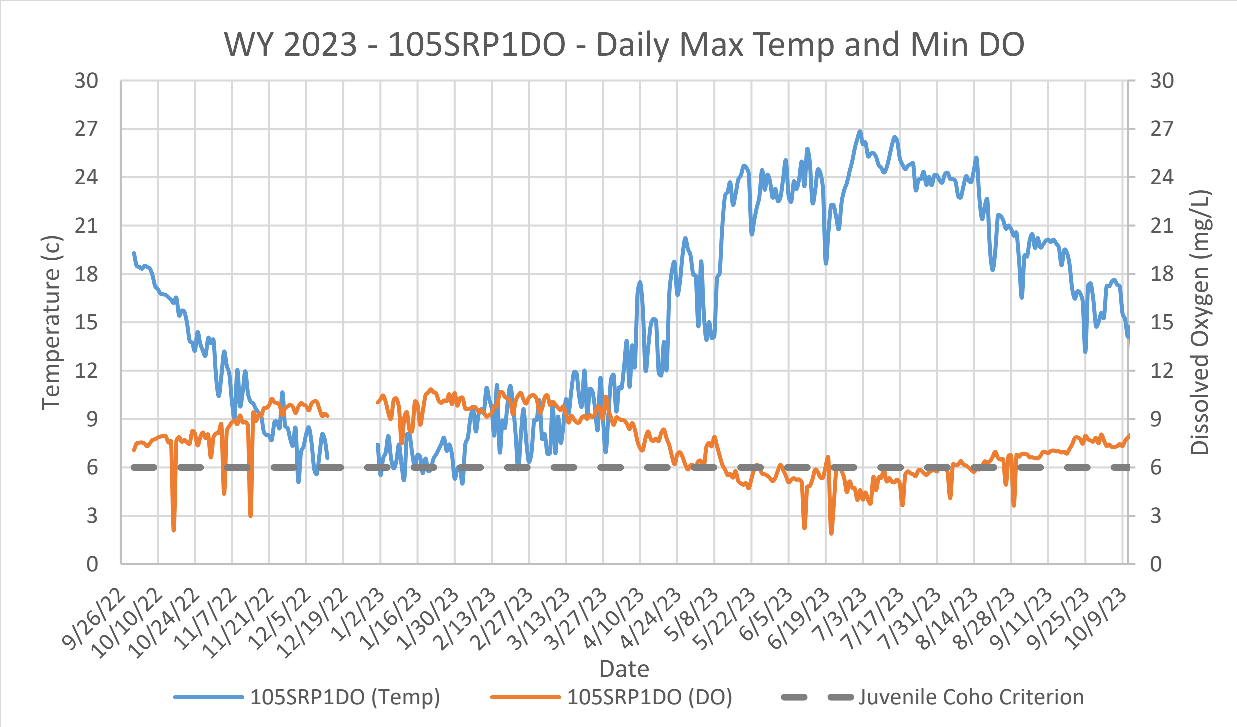

FIGURE 24. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105SRP1DO, PARKS CREEK.

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105PCFPDO are shown in Figure 25. DO and temperature equipment were deployed for 216 days from March 26 to October 27, 2023. DO levels fell below the juvenile coho DO criterion of 6 mg/L in 54 of the 183 days for which quality DO data was recorded during the 2023 irrigation season.

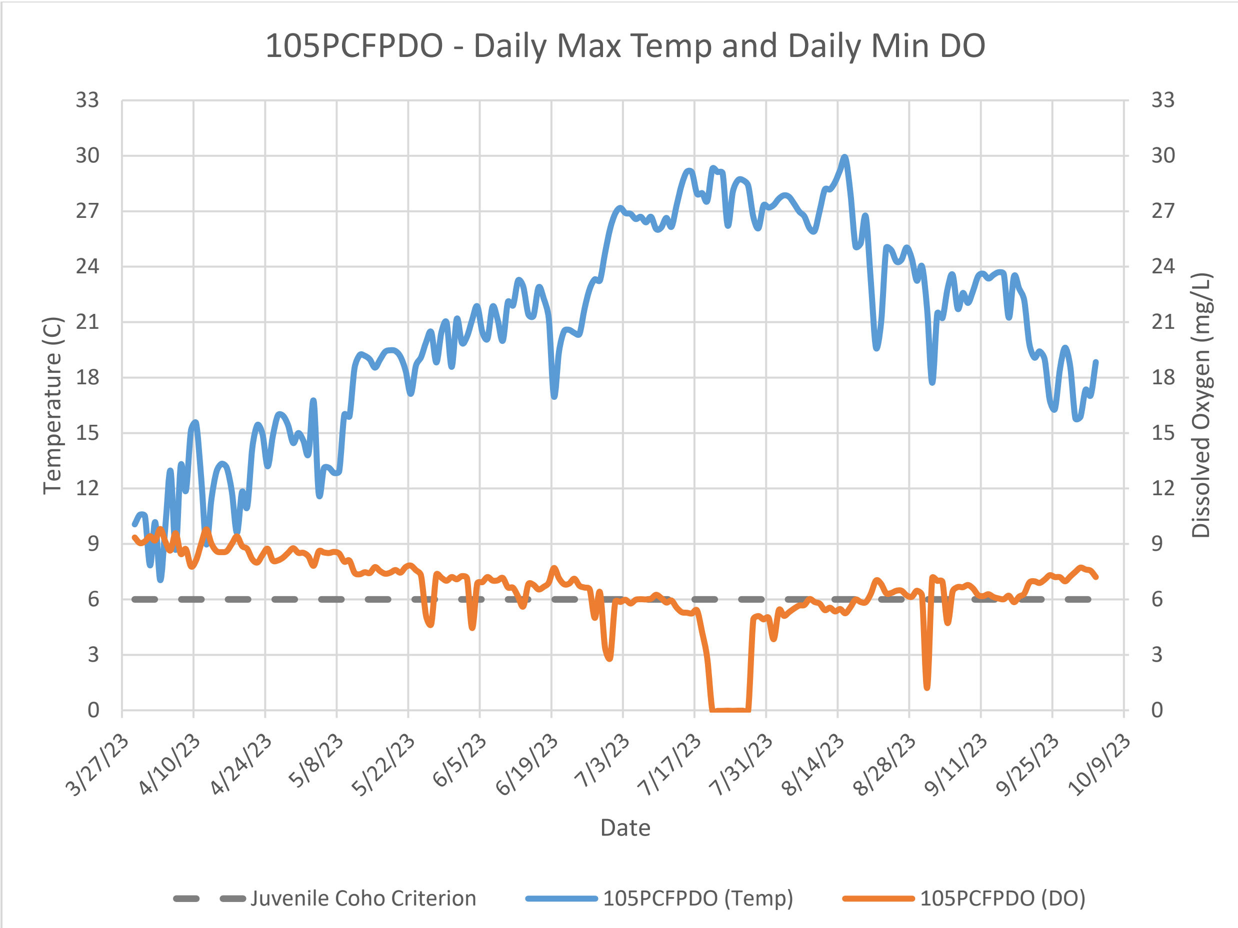

FIGURE 25. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105PCFPDO, PARKS CREEK.

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105PCB1DO is shown in Figure 26. DO and temperature equipment was deployed for 216 days from March 26 to October 27, 2023. Large gravels to cobbles make up the substrate at this site and the braided channel morphology becomes isolated pools in the latter part of the summer, with limited flow percolating through the large rocky substrate. DO fell below the juvenile coho DO criterion of 6 mg/L in 16 of the 183 days for which quality DO data was recorded during the 2023 irrigation season.

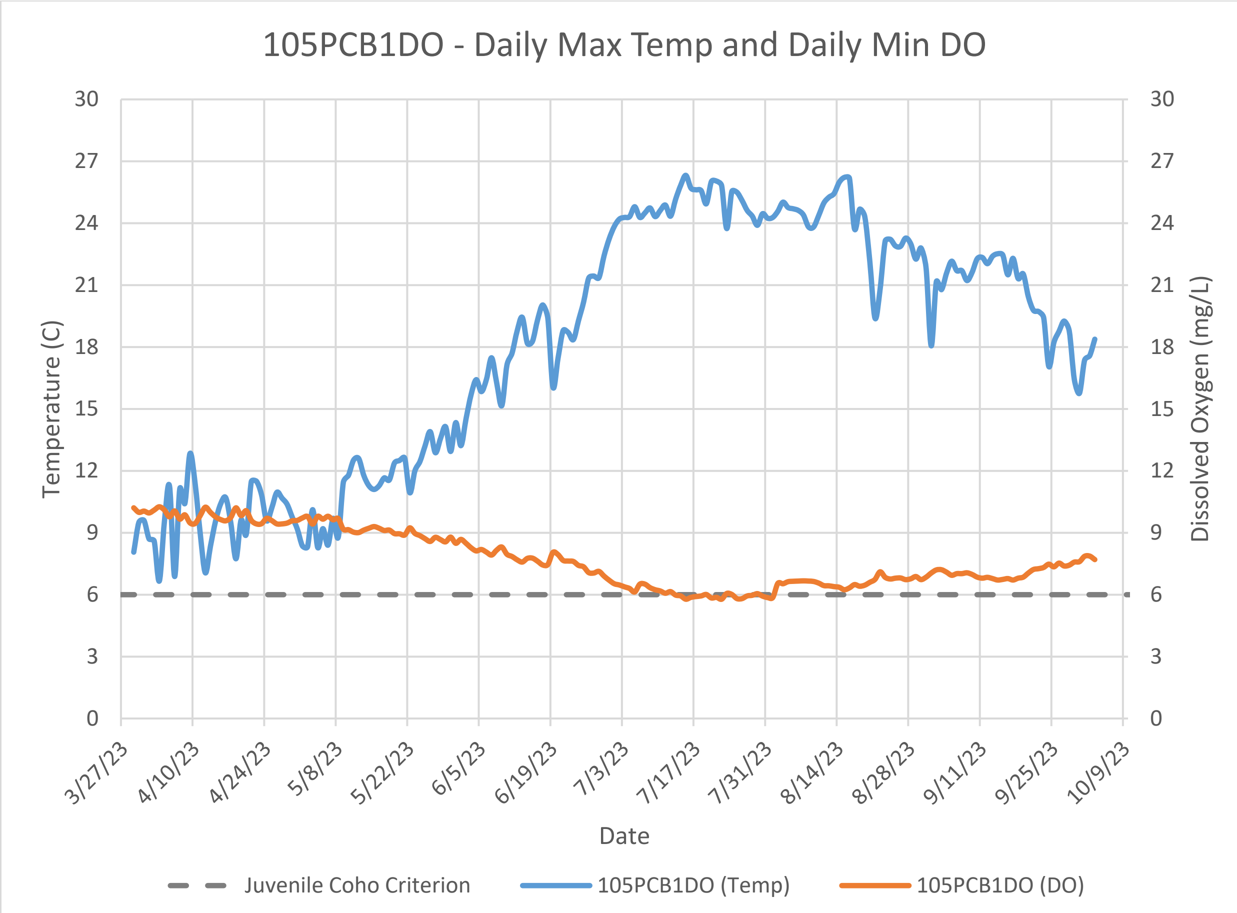

FIGURE 26. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105PCB1DO, PARKS CREEK.

REACH 6

Daily maximum temperature, daily minimum DO, and the juvenile coho DO criterion for site 105SRU1DO are shown in Figure 27. DO and temperature equipment were deployed for 212 days from March 28 to October 25, 2023. Significant incursions in daily minimum DO occur at the beginning of the season, between March 28 to April 27, 2023, between June 27 to July 13, 2023, and from August 9 until equipment was pulled on October 25, 2023. Long term DO data at 105SRU1DO should be closely reviewed as the sensor regularly captures data from two separate flow regimes, one is dominated by subsurface inflows from an adjacent cold spring, and the second is Shasta River water released from Dwinnell Reservoir. Additionally, WY 2023 was cool and wet and provided enough precipitation over the winter that a springwater pipeline connection project could be operated, the outlet of which flows into the Shasta River at 105SRU1DO. Additionally, the presence of nearby beaver dams have reduced flow velocities and increased fine sediment deposition which can increase sediment oxygen demand (SOD). DO levels fell below the juvenile coho DO criterion of 6 mg/L in 107 of the 183 days for which quality DO data was recorded during the 2023 irrigation season.

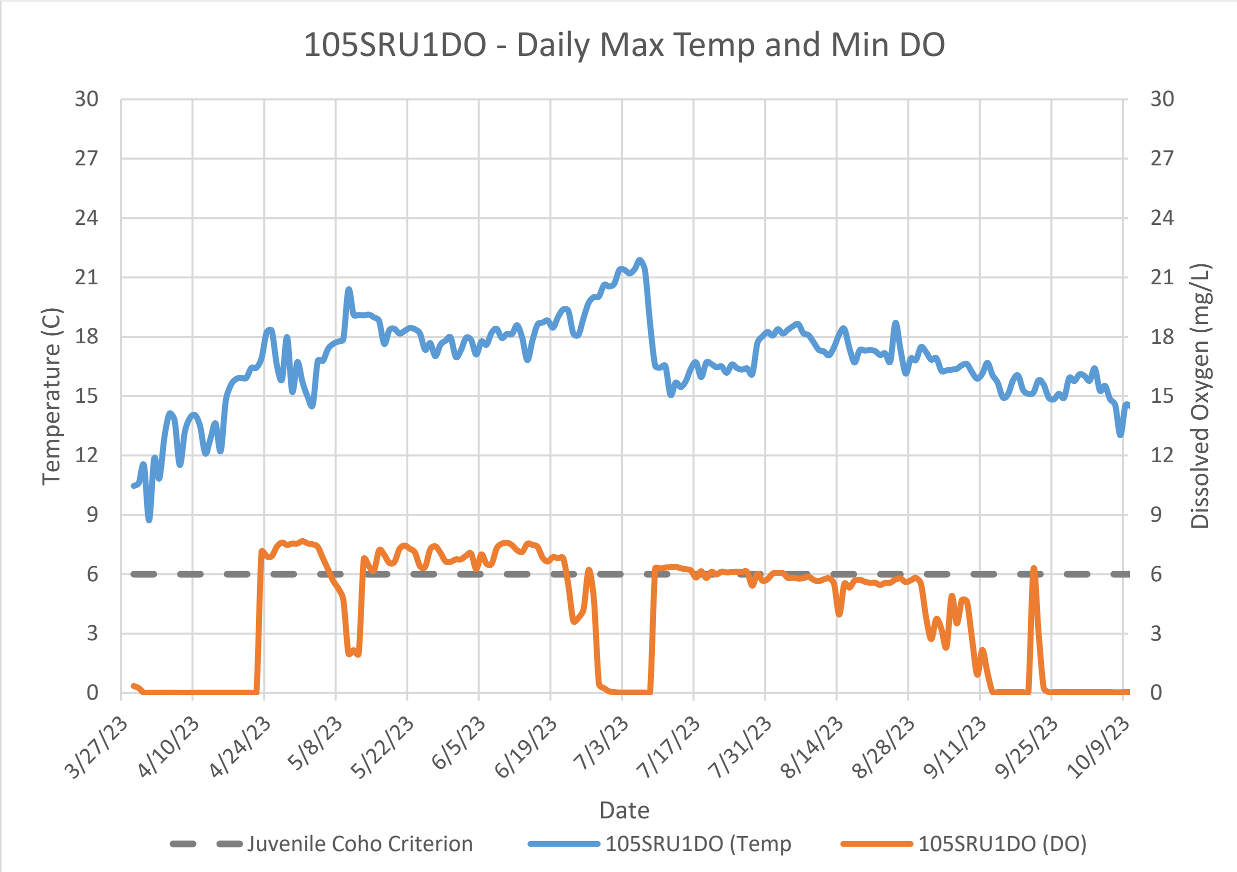

FIGURE 27. 2023 DAILY MAXIMUM TEMPERATURE AND DAILY MINIMUM DO AT 105SRU1DO, SHASTA RIVER.

SUMMARY OF MANAGEMENT ACTIONS

The Governor's emergency drought declaration for Siskiyou County brought minimum instream flow requirements for the Shasta River. Marking the second full year of emergency instream required flows, 2023 saw nearly twice the volume of water move through the mainstem of the Shasta River during the irrigation season compared to non-curtailed years, particularly between Big Springs Creek and the confluence with the Klamath River. Using the water rights established in the Shasta River Decree as a guide when local collaboration did not achieve the required flows, curtailment of diversions from the Shasta River were enforced until the minimum required flow target was met, as measured at the Shasta River gauge near Yreka (see Table 5).

Water Year 2023, while a slightly above average water year, saw significantly more precipitation, much of which was in the form of snow, throughout the upper watershed. As a result, spring production was increased and certain projects that directly pipe cold springwater directly to the Shasta River were operable. In addition to WY 2023 being cooler and wetter than previous years, these infrastructure improvement projects help further improve water quality conditions for the benefit of salmonids at all life stages.

The ongoing drought, emergency minimum instream flow requirements and dam removal present major changes to the Shasta River watershed management. These large-scale management changes make evaluation of progress of individual projects and changes to ranch management particularly challenging, but the multi-year longitudinal analysis of MWMT, MWAT, and Absolute Max temperatures is helpful in understanding year to year trends. A multi-year analysis between any two consecutive water quality monitoring sites in the proximity of known habitat restoration, water conservation, or changes to on-farm management projects is needed to fully assess efficacy of related actions. Looking at relative changes between two consecutive points on the river eliminates differences resulting from air temperatures, which are known to be the predominant driver of instream temperatures. Additionally, increased spatial resolution of water temperature and dissolved oxygen data, as well as spatial, temporal, and quantity of cold groundwater and spring water inputs would be helpful to better understand specific actions or changes in management within a given reach.

IMPACT ON WATER QUALITY

Water temperatures coinciding with increased flow volumes during the 2023 irrigation season generally corroborate the RMS model assumptions in the 2006 *Staff Report for the Action Plan for the Shasta River Watershed Temperature and Dissolved Oxygen Total Maximum Daily Loads*. Specifically, the 50% flow increase model scenario and the water quality compliance model scenario were broadly reproduced through the enforced diversion curtailment of BSID and diverters downstream of Big Springs Creek. Increased flow in an open channel increases stage which can have an insulating effect on water temperatures and increase habitat connectivity. The magnitude of this impact is variable and is highly dependent on channel morphology. Greater flow volume has a more pronounced effect on flow velocity. Because ambient air temperature is the single greatest driver of changes to surface water temperatures in the Shasta River, increased velocity has the effect of moving water more quickly through the system, increasing negative advection of heat, thereby attenuating maximum water temperatures. Despite this, water temperatures in the Shasta River still exceeded TMDL and MWMT objectives during the 2023 irrigation season at all monitoring sites that were not directly measuring spring inflows.

Increased flow volumes attenuate the magnitude of diurnal fluctuation of dissolved oxygen levels within the Shasta River by diluting the impact oxygen demand and oxygen production has on a given volume of water.

CONCLUSIONS

The compounding effects of ongoing drought, significant reaches lacking continuous riparian shade, and warm tailwater inputs continue to impact water temperatures in the Shasta River. Water temperatures and DO levels exceeded TMDL and MWMT objectives during the 2023 irrigation season at all monitoring sites that were not directly measuring spring inflows.

While comparisons and multi-year analysis of data have been made and presented, additional data and analysis is needed in order to make direct comparisons to the modeled water quality compliance scenario, including:

- Improved meteorological understanding of air temperature and annual precipitation within the upper watershed and valley floor.
- Improved understanding of site potential shade and channel width on expected temperature allocation
- Analysis of all temperature data using 5-DAD maximum temperatures.
- And improved data resolution around TMDL temperature and DO compliance point at RM 5.6.

Coordination with NCRWQCB staff is needed to ensure monitoring parameters, locations, and data processing methods allow for comparison to modeled TMDL goals and compliance scenarios.

Additional coordination with other entities involved in preparing integrated hydrologic models for the Shasta River Watershed would also be beneficial. These include the Siskiyou County Flood Control and Water Conservation District and their agents as well as the State Water Resources Control Board and the California Department of Fish and Wildlife.

Continued efforts to identify high quality water within the watershed while also improving infrastructure and on farm practices to leverage and increase the impact of improved water quality remain the SVRCDs top priority.

The SVRCD looks forward to working with agencies and stakeholders to support them in adapting to broader changes to resource management within our district.

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APPENDIX

Public Data Access

California Irrigation Management Information System (CIMIS)

- Station 260 – Montague
- Station 261 – Gazelle

https://cimis.water.ca.gov/

California Data Exchange Center (CDEC)

- Hydrologic Data Acquisition System (HyDAS)
    - Station SVG – Goosenest
        - https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=SVG
    - Station SVB – Bolam
        - https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=SVB

California Data Exchange Center (CDEC)

- Shasta River Discharge and Stage
    - Station SRM – Near Montague
        - https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=SRM
    - Station SRY – Near Yreka
        - https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=SRY