SHASTA RIVER MONITORING REPORT
AGREEMENT NO. 16-049-110

ANNUAL MONITORING REPORT FOR 2018

PREPARED AND SUBMITTED BY

Shasta Valley Resource Conservation District

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RCD
SHASTA VALLEY
RESOURCE CONSERVATION DISTRICT

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INTRODUCTION

The Shasta River is listed in the Shasta TMDL for high temperature and low dissolved oxygen (DO). Agricultural activities (livestock impacts, impoundments, and diversions) have been identified as the main source of these impairments (NCRWQCB 2007). Sizable diversions of water from the Shasta River and excessive irrigation return flows, or tailwater, returns 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, QAPP and PAEP approved by the SWRCB, the SVRCD and AquaTerra Consulting are monitoring water quality on the Shasta River (and selected springs and 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 future project locations that would improve water quality in the Shasta River.

This report summarizes temperature and DO monitoring data at 27 sites (nine sites that have DO) on the Shasta River and tributaries Parks Creek and Yreka Creek. Access to monitoring locations was acquired from private landowners through landowner agreements.

MONITORING LOCATIONS

Temperature and DO were measured from April 1st through October 1st, 2018 at 27 locations on the Shasta River and several tributaries and springs (Table 1). 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 DEPLOYED AND MEASURED METRICS DURING THE 2017 IRRIGATION SEASON (LISTED IN ORDER FROM UPSTREAM AT THE OUTLET OF DWINNELL RESERVOIR TO DOWNSTREAM AT THE MOUTH OF THE SHASTA RIVER). TAILWATER AND SPRING SITES ARE LISTED IN PARENTHESES.

Reach	Reach Description	Site ID	River Mile	Equipment	Measurement
6	Dwinnell Outlet to Parks Creek	105DRE	39.8	DWR Gage	Dwinnel Reservoir Storage
		105SRXQ	39.8	DWR Gage	Discharge Into Shasta R.
		105DFBQ	39.8	DWR Gage	Discharge Into Shasta R.
		105SRHVRPOD	39.1	TidbiTs®	Temperature
		(105SRUPPERS)*	NA	Hach A-V + TidbiTs®	Discharge/Temperature
		105SRHVSPL	38.1	TidbiTs®	Temperature
		105SRHVRALC	37.9	TidbiTs®	Temperature
		105SRU1DO	37.9	D-Opto	DO/Temperature
		105SRHVDSSPG	37.8	TidbiTs®	Temperature
		105SRU0IT	37.7	TidbiTs®	Temperature
		105SR7163DS	36.9	TidbiTs®	Temperature
		105SRHIGF	36.6	TidbiTs®	Temperature
Parks Creek	Parks Creek	(105SRP1DO)*	SR 33.9 (PC 0.04)**	D-Opto	DO/Temperature
	Parks Creek	(105PCFP)*	SR 33.9 (PC 7.3) **	TidbiTs®	Temperature
5	Parks Creek to Big Springs Creek	(105SRPCO) *	SR 33.1 (PCO 0.04)**	TidbiTs®	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
		105SR5007DS	20.1	TidbiTs®	Temperature
		105SRS1DO	16.7	D-Opto	DO/Temperature
		105SRM1DO	14.6	D-Opto	DO/Temperature
		105SR400T	12.3	TidbiTs®	Temperature
		105SRA1DO	11.8	D-Opto	DO/Temperature
		105SRA01T	10.2	TidbiTs®	Temperature
Yreka Creek	Yreka Creek	(105YCA01T)*	SR 7.3 (YC 0.6)**	TidbiTs®	Temperature
1	Yreka Creek to Shasta River Mouth	105SRTM01	5.3	TidbiTs®	Temperature
		105SRL1DO	0.6	D-Opto	DO/Temperature

* Parentheses indicate site was located on tributary to Shasta River

** Tributary river miles are provided both for where the tributary meets the mainstem as well as tributary river mile

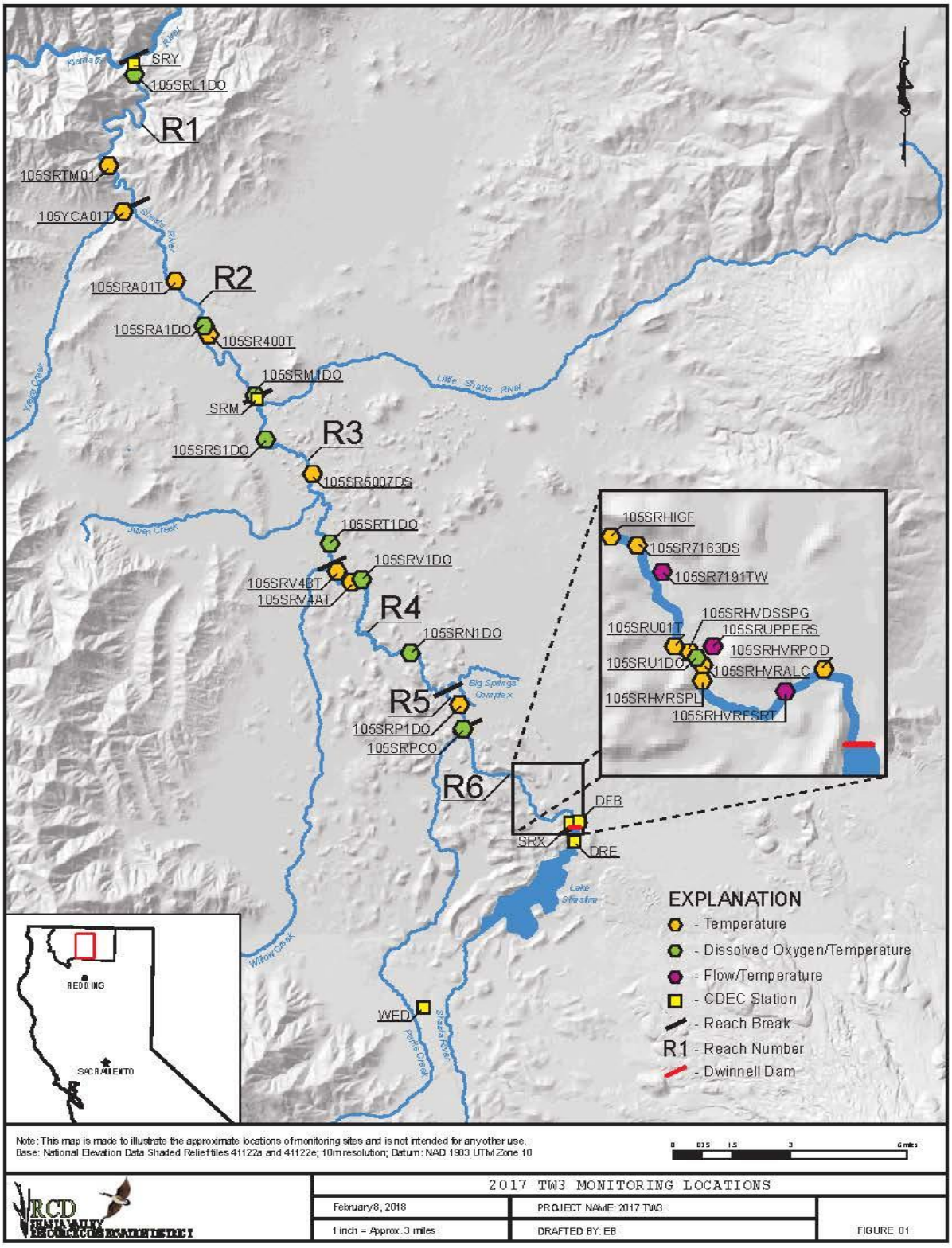

FIGURE 1. MAP OF 2018 TEMPERATURE, DO, FLOW AND CDEC MONITORING LOCATIONS.

METHODS

DISSOLVED OXYGEN (W/TEMPERATURE) SAMPLING

Dissolved Oxygen (DO) and temperature were measured at nine sites (Table 1; Figure 1) with ZebraTech D-Opto Loggers, which 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.

TEMPERATURE SAMPLING

Temperature loggers were deployed at 15 sites in the Shasta River 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 cross-section.

In 2017, temperatures were recorded at 15-minute increments (D-Opto loggers 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 last 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. Additionally, 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 collection, ambient air temperature (as well as rainfall and solar radiation) data were retrieved from Weed Airport (CDEC Station ID-WED) to inform water temperature and DO results in this study.

WATER QUALITY – NUTRIENT SAMPLING

Water samples were collected at four locations that were in the immediate vicinity of existing temperature/DO monitoring sites: 105SRHVRPOD, 105SRP1DO, 105SRM1DO and 105SRL1DO. These sites were chosen to provide a snapshot of water quality conditions representative of upstream, midstream and downstream locations.

Samples were collected using a pole-sampler in locations where the stream visually appeared to be completely mixed. Field personnel used discreet containers provided by Basic Laboratories (Redding, CA) to obtain samples from as close to the centroid of the stream and water column as possible.

After samples were obtained, containers were properly labeled with date, time and site information, and directly placed into a cooler with ice per instructions by Basic Laboratories. Samples were collected on August 22, 2018 and were transported to Basic Laboratories for analysis of the following analytes: Nitrate as N (NO_3^--N), Nitrite as N (NO_2^--N), Total Kjeldahl Nitrogen (TKN), Ammonia as N (NH_3-N), Total Phosphorus as P (TP -P).

RESULTS AND DISCUSSION

TEMPERATURE RESULTS

Temperature was measured at 27 sites on the Shasta River and its tributaries in 2018. Temperatures in the Shasta River and its tributaries fluctuate daily and are moderated in comparison to air temperatures due to the high specific heat capacity of water.

For this report, a comparison of 2017 and 2018 temperatures is presented for Reach 6. Please refer to the Shasta River Watershed Stewardship Report for a comprehensive year-to-year comparison of temperatures and DO at all sites.

Table 3 includes seasonal MWMT, MWAT, seasonal absolute maximum temperature and percentage of days each site exceeded the TMDL or MWMT limit of 18 °C.

TABLE 3. 2018 SHASTA RIVER MWAT, MWMT, ABSOLUTE MAX. TEMPERATURE AND PERCENTAGE OF DAYS TMDL WAS EXCEEDED. ALL REACH 5 SITES ARE LOCATED PARKS CREEK. 105YCA01T IS LOCATED ON YREKA CREEK.

Site ID	Reach	MWMT (°C)	MWAT (°C)	Abs. Max Temp (°C)	% Days Exceeded TMDL
105SRHVRPOD	6	24.01	22.28	24.85	67
105SRHVRSPL	6	24.91	21.94	25.82	75
105SRHVRALC	6	15.23	14.79	15.72	0
105SRU1DO	6	24.70	21.60	25.66	74
105SRDSSPG	6	24.82	21.70	25.79	74
105SRU0IT	6	25.05	21.81	26.09	74
105SR7163DS	6	25.43	22.11	26.77	78
105SRHIGF	6	25.32	22.26	26.77	78
105SRPCFP	5	30.97	24.07	32.28	82
105SRP1DO	5	27.86	23.40	29.55	84
105SRPCO	5	30.81	24.26	32.51	88
105SRN1DO	4	22.10	18.28	22.98	64
105SRV1DO	4	20.70	19.55	21.24	51
105SRV4AT	4	20.86	19.87	21.22	54
105SRV4BT	4	21.76	20.16	22.42	54
105SRT1DO	3	22.69	20.53	23.51	63
105SR5007DS	3	23.78	21.16	25.16	69
105SRS1DO*	3	23.99	21.91	24.75	91
105SRM1DO	2	25.36	22.73	26.19	74
105SR400T	2	25.83	23.40	26.89	75
105SRA1DO	2	25.97	23.56	26.83	71
105SRA01T	2	27.16	24.00	28.37	75
105YCA01T	1	22.01	20.24	22.75	48
105SRTM01	1	27.47	24.35	28.57	85
105SRL1DO	1	27.70	24.86	29.32	73

* 105SRS1DO includes data recorded April 1 through September 1, 2018. Equipment malfunction caused the discontinuation of this site after September 1.

REACH 1 TEMPERATURE RESULTS

Figure 2 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. 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-June through mid-August when Reach 1 7-DAD Maximum temperatures reach their maximums. Despite the cool water input from Yreka Creek, its flows are minimal, ranging from 2-5 cfs during the summer. 7-DAD Maximum temperatures throughout Reach 1 are generally consistent with each other, increasing only slightly in the downstream direction.

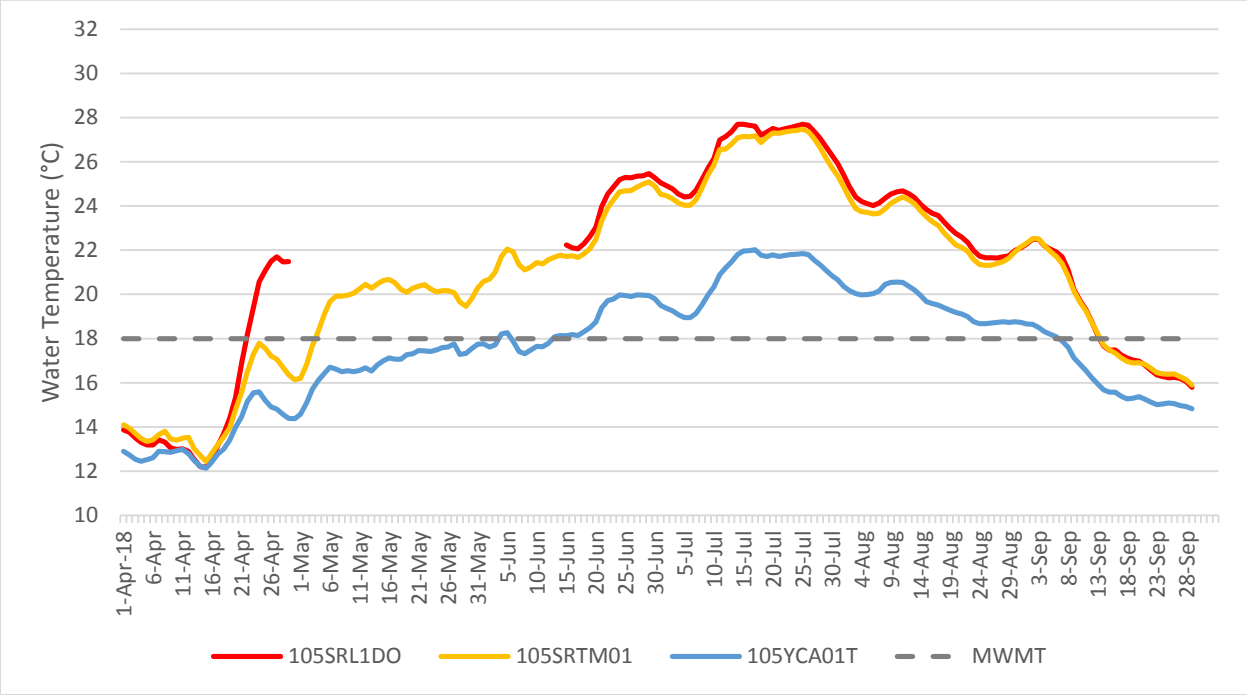

FIGURE 2. 2018 7-DAD MAXIMUM TEMPERATURES AT REACH 1 (SHASTA RIVER AND YREKA CREEK SITES).

REACH 2

Figure 3 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 downstream of the USGS operated Montague Weir. 7-DAD Maximum temperatures at all sites within Reach 2 are generally consistent with one another with 7-DAD Maximum temperatures increasing in the downstream direction. Data indicate a cooling trend in July and August that can be explained by the presence of heavy smoke from regional wildfires that led to reduced solar radiation.

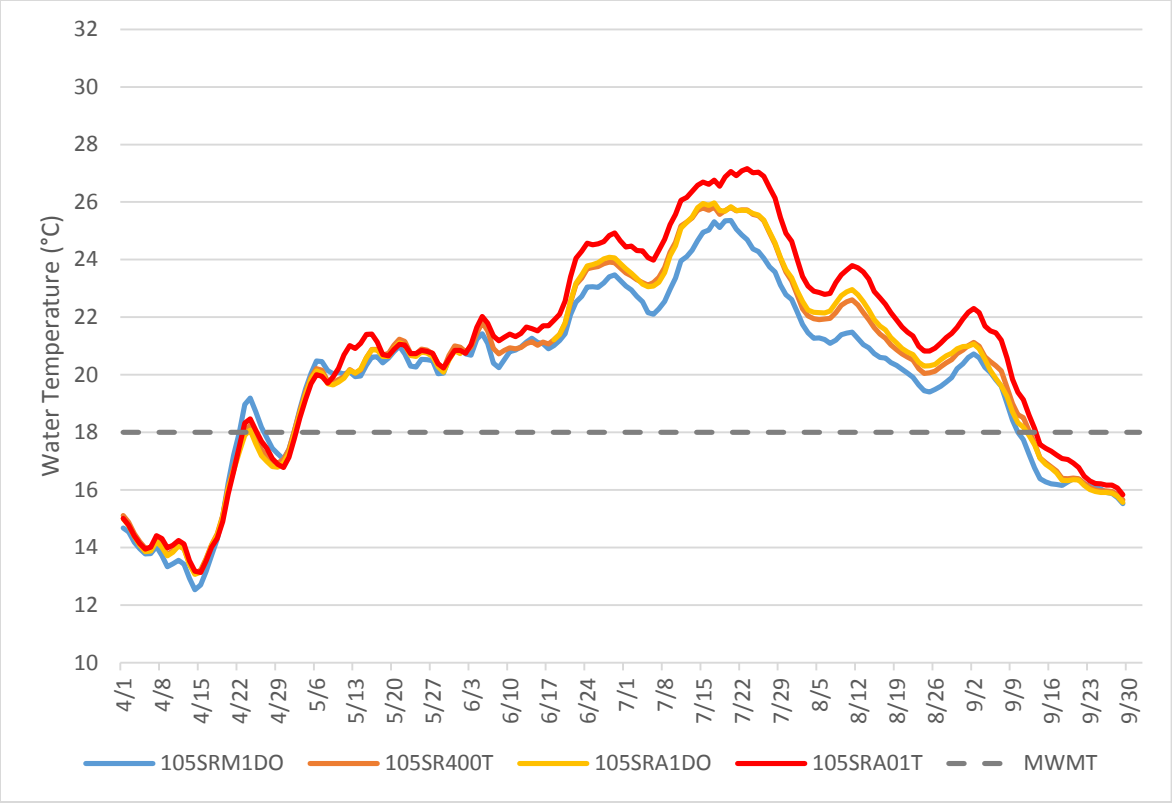

FIGURE 3. 2018 7-DAD MAXIMUM TEMPERATURES FOR REACH 2, SHASTA RIVER.

REACH 3

Figure 3 displays MWMT criterion for juvenile coho salmon rearing and 7-DAD Maximum river temperatures at sites within Shasta River Reach 3. 7-DAD Maximum temperatures increased in the downstream direction through all sites in this reach.

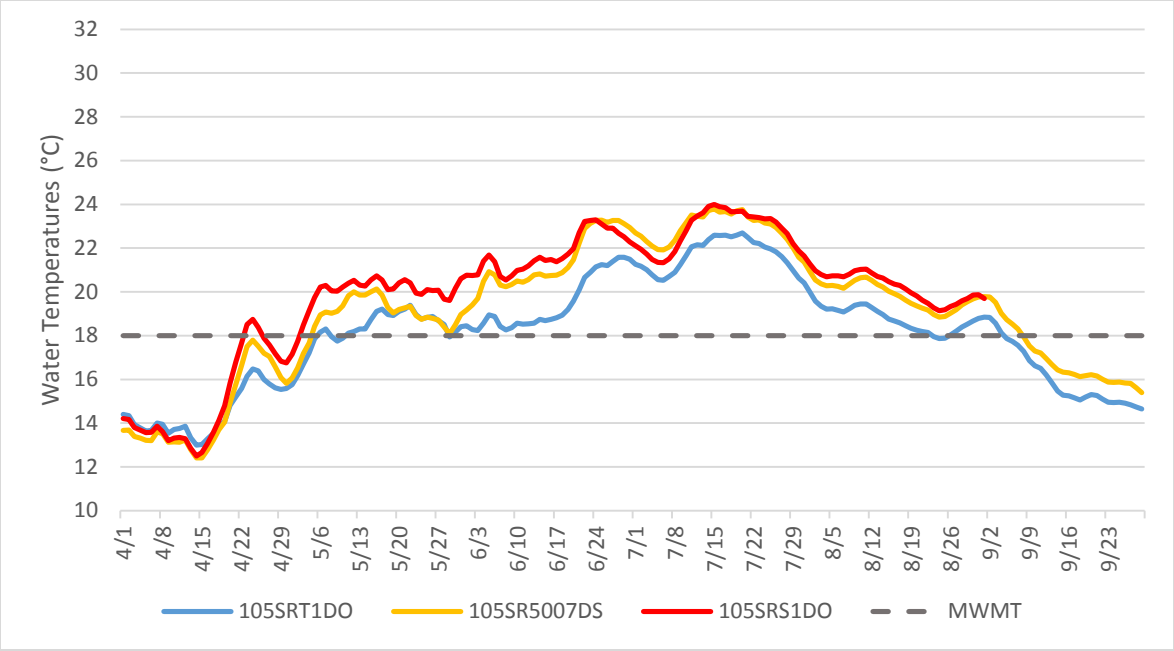

FIGURE 4. 2018 7-DAD MAX TEMPERATURES FOR SHASTA RIVER, REACH 3.

REACH 4

Figure 5 displays 7-DAD Maximum water temperatures at sites within Shasta River Reach 4 and MWMT criterion for juvenile coho salmon rearing. These sites are located downstream of the Big Springs Creek confluence, which adds a large volume (53 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. Regardless, 7-DAD Max temperatures at all sites within this reach exceeded 18 °C May 5 through August 1, 2018.

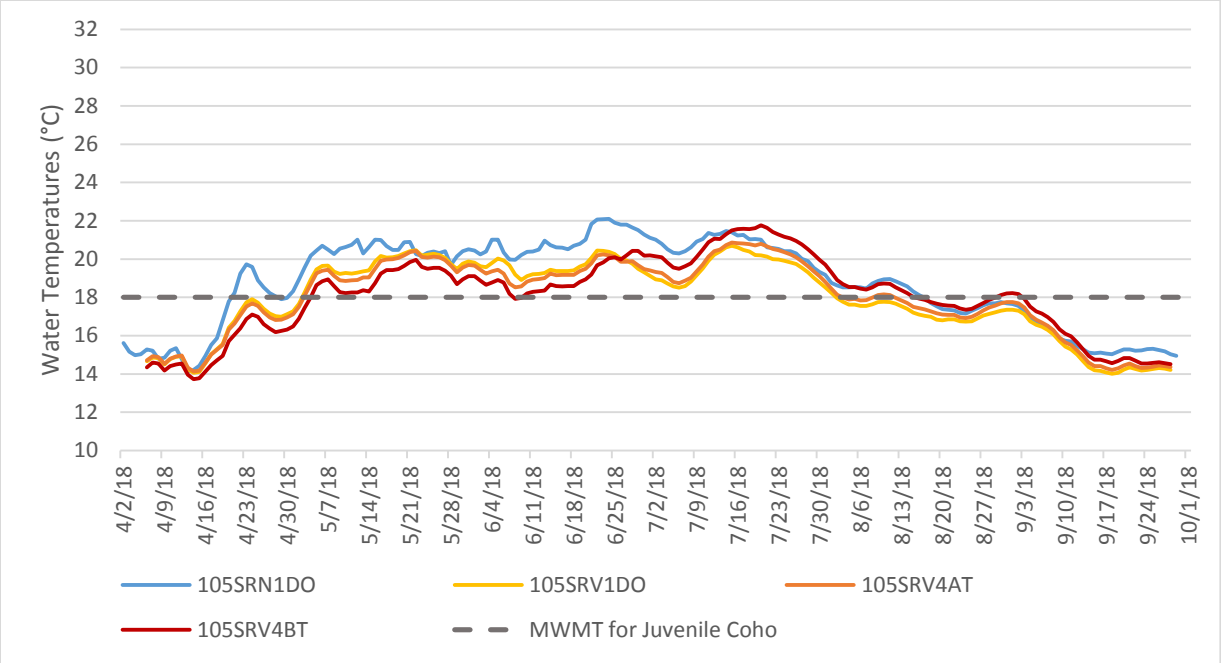

FIGURE 5. 2018 7-DAD MAX TEMPERATURES FOR SHASTA RIVER, REACH 4.

REACH 5

In Reach 5, the Shasta River is supplemented by flows from Parks Creek (105SRP1DO), Hole in the Ground Creek (not measured), and Parks Creek overflow (105SRPCO). Coho salmon utilize Parks Creek for migration, spawning and juvenile rearing (Chesney et al. 2009). Parks Creek overflow is the historic Parks Creek channel, which primarily collects a mix of tailwater from one ranch and small ephemeral spring water inputs. The overflow is only connected to Parks Creek during high flow events, usually winter or early spring. This flow enters the Shasta River just north (downstream) of the Parks Creek confluence with the Shasta River. During irrigation season, Parks Creek overflow discharges up to 5 cfs into the Shasta River.

7-DAD Maximum temperatures from Parks Creek were typically 2-3°C warmer than upstream Shasta River sites. Depending on flow rates, these warm inflows may increase water temperatures in the Shasta River. Inflow from Big Springs Creek reduces temperatures considerably at the bottom of Reach 5.

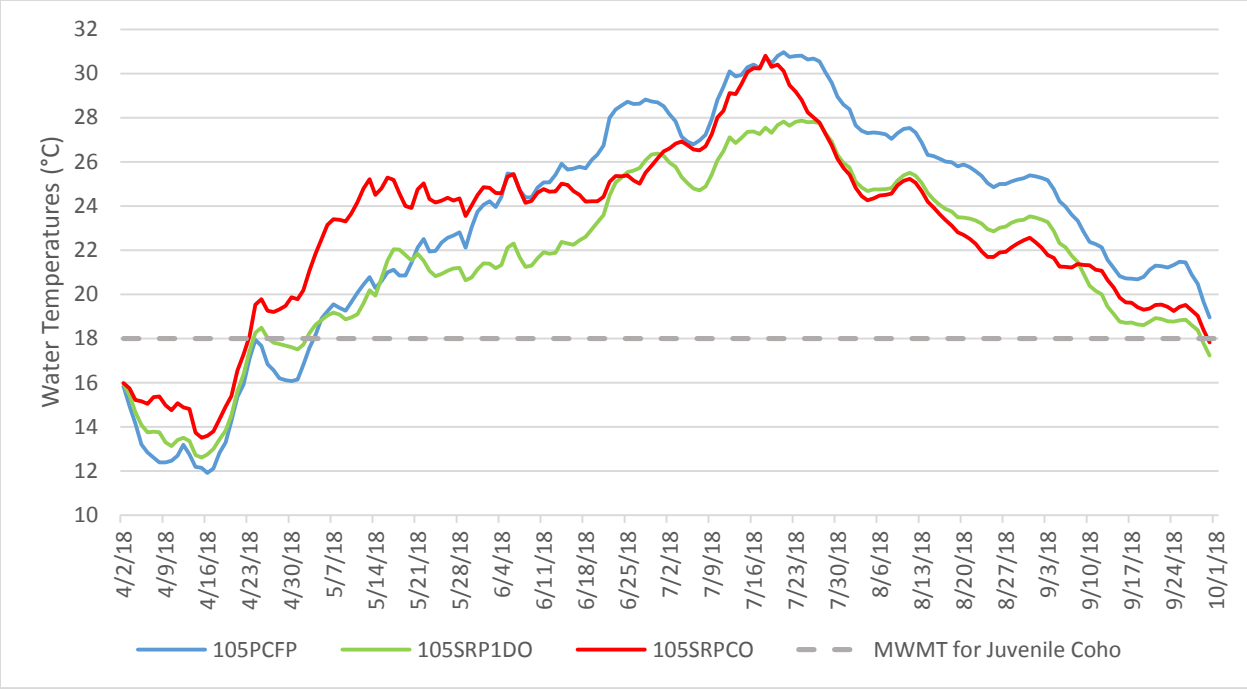

FIGURE 6. 2018 7-DAD MAX TEMPERATURES AT SHASTA RIVER REACH 5. ALL SITES ARE ON PARKS CREEK, TRIBUTARY OF SHASTA RIVER.

REACH 6

In 2018, drought-like conditions and less than average winter snow pack at high elevations in the Shasta River Watershed led to decreased flows in the Shasta River and surrounding springs, which contributed to higher water temperatures in the Shasta River in Reach 6 when compared to 2017 (Figure 7 & Figure 8). In addition, a spring pipeline designed to convey cold spring water into the Shasta River was minimally used during 2018 due to low flow at the source spring (Figure 9) and in the upper Shasta River in general. Temperatures at most sites exceeded the Shasta River TMDL (18 °C) by the end of the first week in May and remained above the TMDL until mid-September in 2018 (Figure 7). In contrast, cold water contributions from the Upper Spring Pipeline in 2017 kept overall temperatures below the TMDL limit at most sites until the third week in June, and created a small area of cold water refugia (temperatures below 18 °C) near the spring pipeline outlet for all of 2017. Moreover, no site exceeded 24 °C in 2017, whereas more than half the sites exceeded 25 °C in 2018.

Temperatures varied little from most upstream sites to most downstream sites at HVR in 2018, and showed a modest increasing trend in the downstream direction. Exceptions are at the HVR point of diversion (105SRHVRPOD) where an abundance of vegetation (providing shade) and deeper positioning of the temperature canister allowed for cooler recorded temperatures; and at the alcove (105SRHVRALC) just below the south Spring Pipeline outlet where a small, consistent source of cold spring water allowed for cooler recorded temperatures (Figure 7).

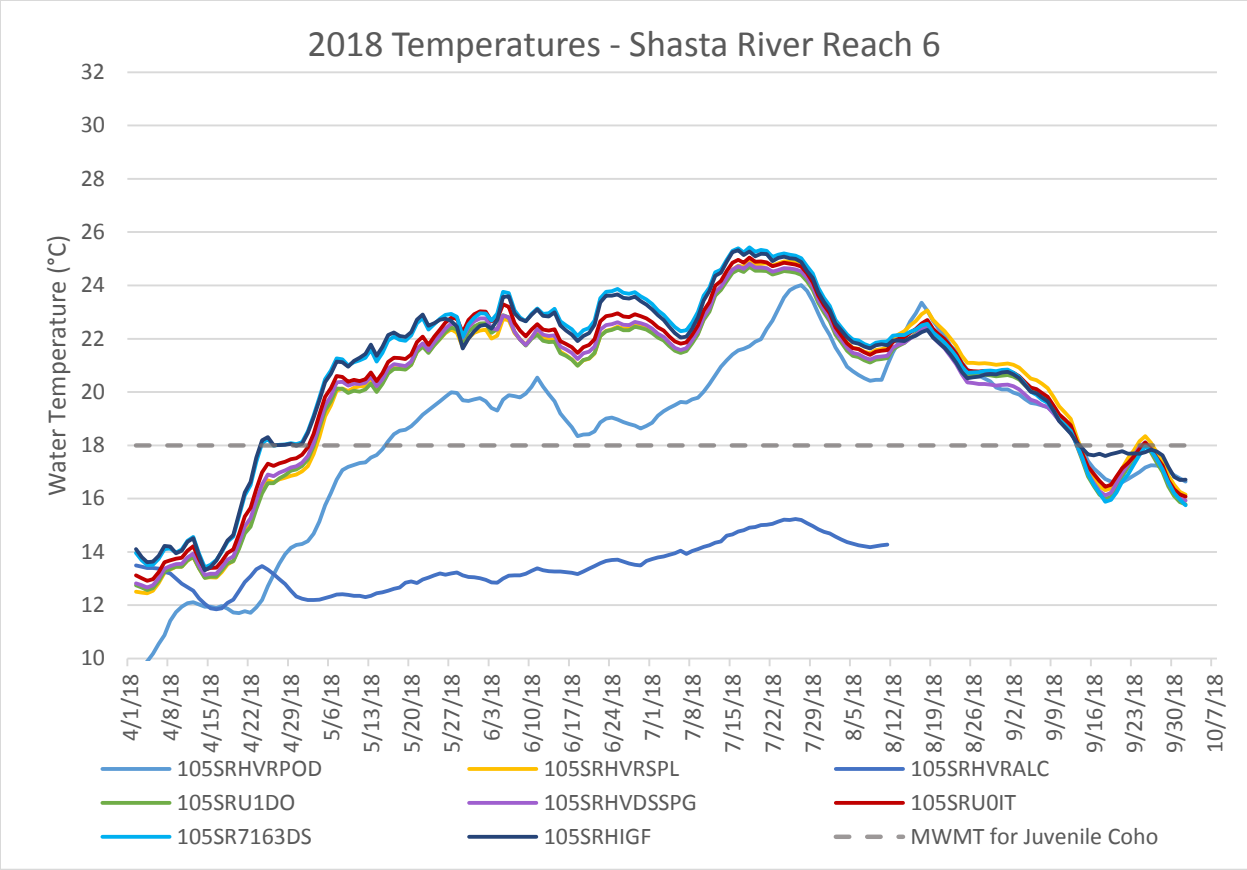

FIGURE 7. 2018 7-DAD MAX TEMPERATURES AT MONITORING LOCATIONS IN THE SHASTA RIVER AT REACH 6.

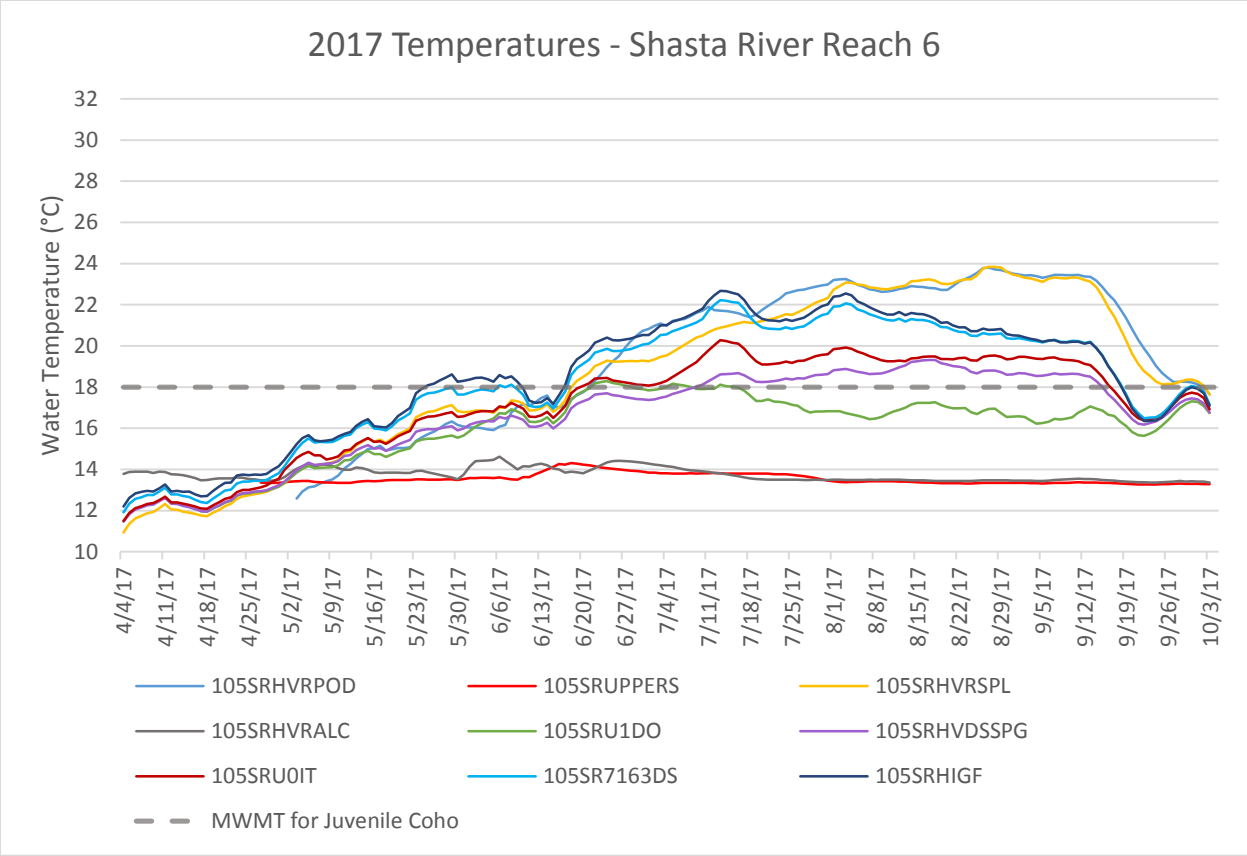

FIGURE 8. 2017 7-DAD MAX TEMPERATURES AT SHASTA RIVER REACH 6.

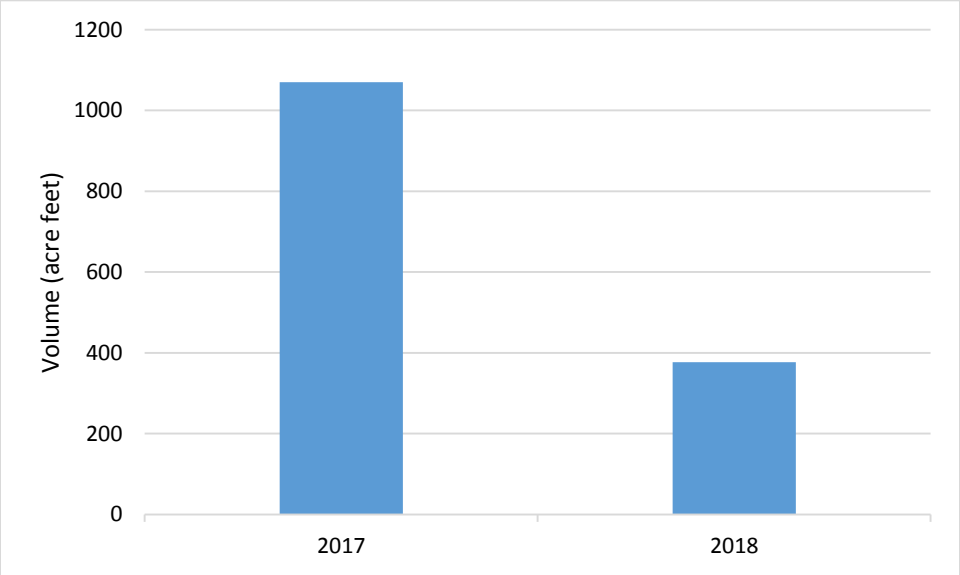

FIGURE 9. VOLUME OF WATER THROUGH THE UPPER SPRING CULVERT IN 2017 AND 2018.

DISSOLVED OXYGEN

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.

DISSOLVED OXYGEN RESULTS

Figure 10 displays 2018 daily minimum dissolved oxygen measurements at all sites on the Shasta River and Parks Creek. The general trend among all sites measured was a continuous reduction in the daily minimum DO from early April through late July due to seasonal warming, followed by increasing DO through early October due to cooling temperatures, decreased solar radiation from regional wild fires and increased production of instream vegetation (e.g., macrophytes).

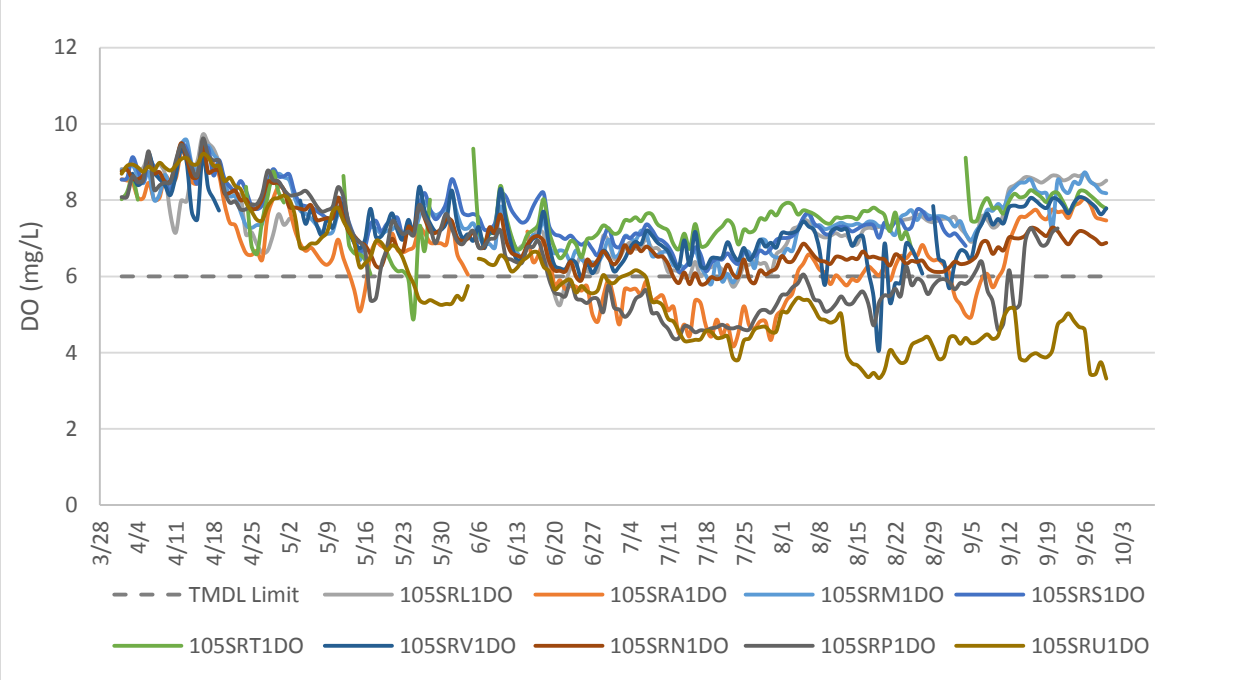

FIGURE 10. 2018 DO MINIMUM AT ALL SITES, SHASTA RIVER AND PARKS CREEK.

Table 4 displays the percentage of days that each site fell below the TMDL (6 mg/L) during the 2018 irrigation season. Upstream site 105SRU1DO experienced the highest percentage of days below the TMDL due to low water yields from nearby springs that, when flowing at optimal levels, can increase DO with cold aerated water inputs to the Shasta River; and low inputs from Dwinnel Reservoir (except

during a late summer water release from the reservoir that sent warm, low-DO water into the Shasta River, exacerbating the problem).

TABLE 4. PERCENTAGE OF DAYS MONITORED WHERE DO LEVELS FELL BELOW THE TMDL OF 6 MG/L.

Reach	DO Monitoring Site	% Exceedance - TMDL (6 mg/L)
1	105SRL1DO	4
2	105SRA1DO	36
	105SRM1DO	1.6
3	105SRS1DO*	0
	105SRT1DO	1.4
4	105SRV1DO	4.8
	105SRN1DO	7.1
5 (Parks Ck Site)	105SRP1DO	48.9
6	105SRU1DO	60.1

* 105SRS1DO includes data recorded April 1 through September 1, 2018. Equipment malfunction caused the discontinuation of monitoring at this site after September 1.

Reach 1

DO in Reach 1 is displayed in Figure 11. Missing data in May due to equipment malfunction.

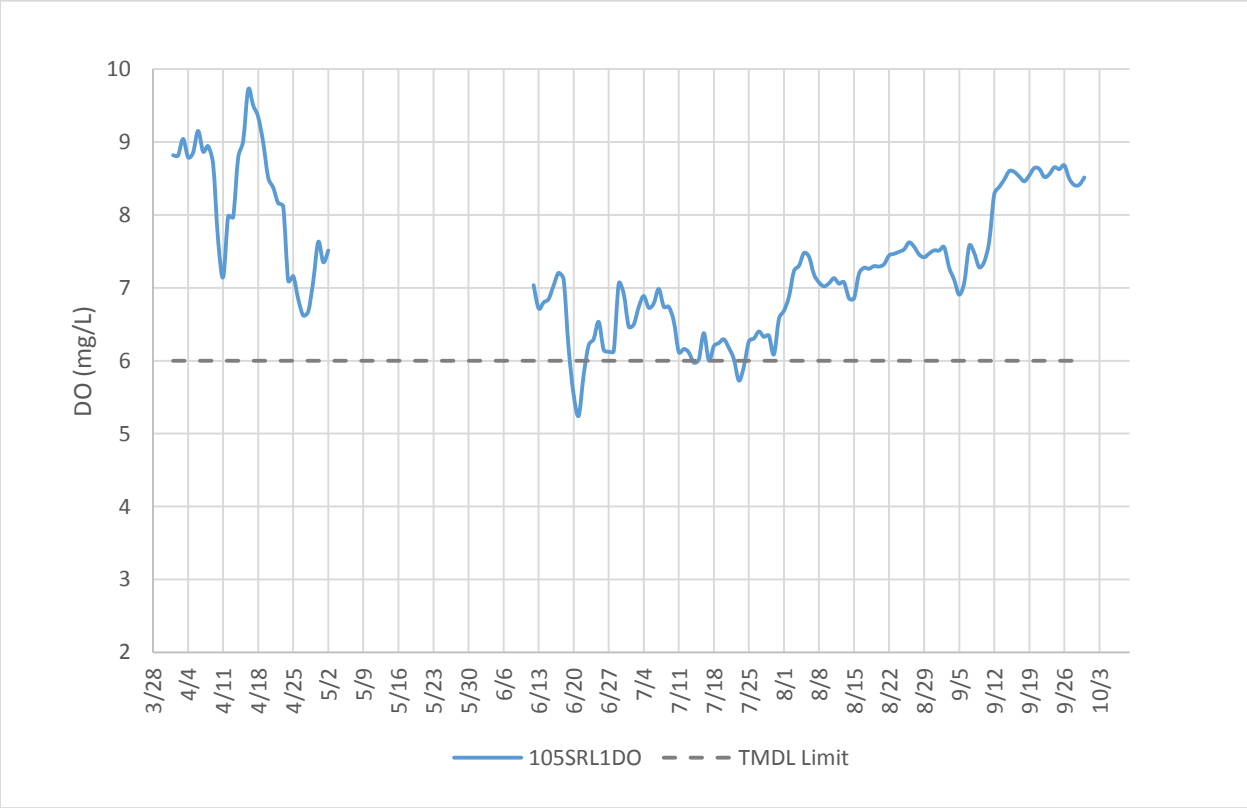

Figure 11. 2018 DO minimum at 105SRL1DO, Shasta River.

Reach 2

DO in Reach 2 at 105SRA1DO reached a low of 4.16 mg/l on July 23. Missing data on June 6-15 due to DO meter lens biofouling (Figure 12).

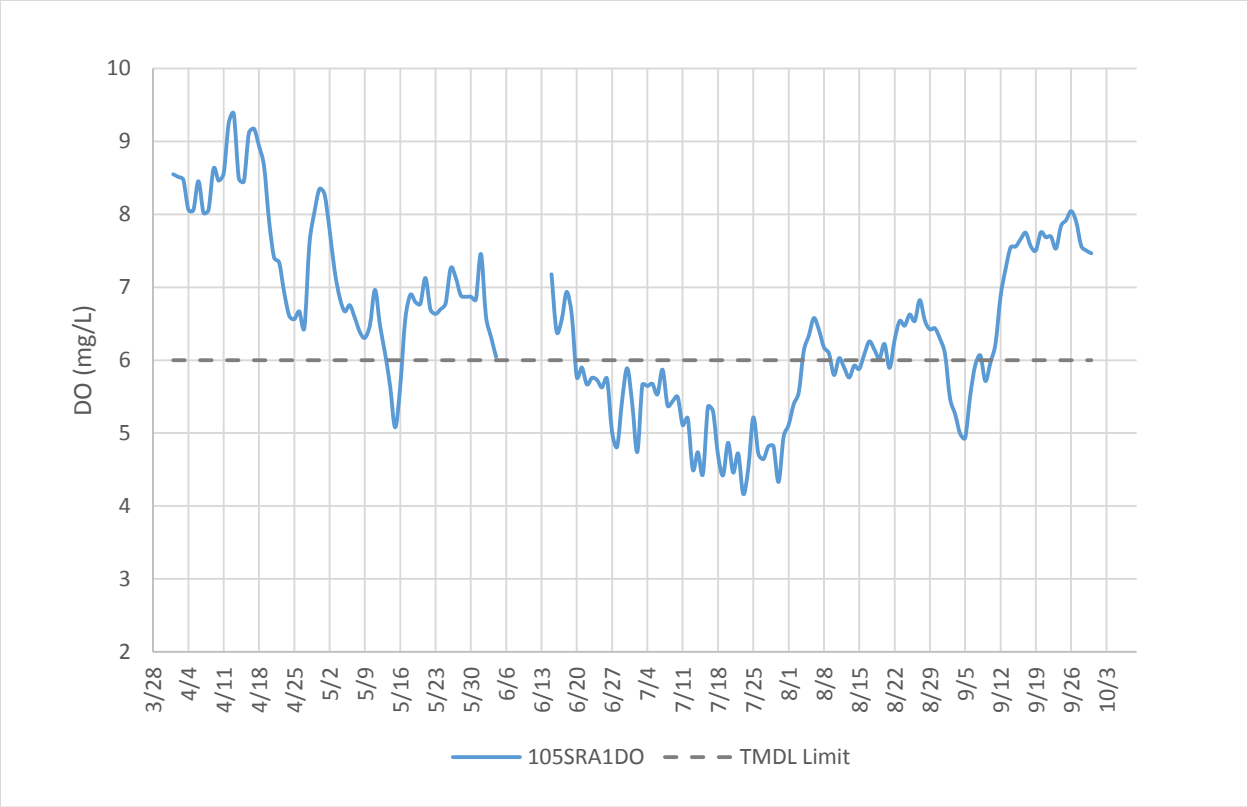

FIGURE 12. 2018 DO MINIMUM AT 105SRA1DO, SHASTA RIVER.

DO in Reach 2 at 105SRM1DO reached a low of 5.8 mg/L on July 19 but remained above the TMDL limit for most of the irrigation season (Figure 13).

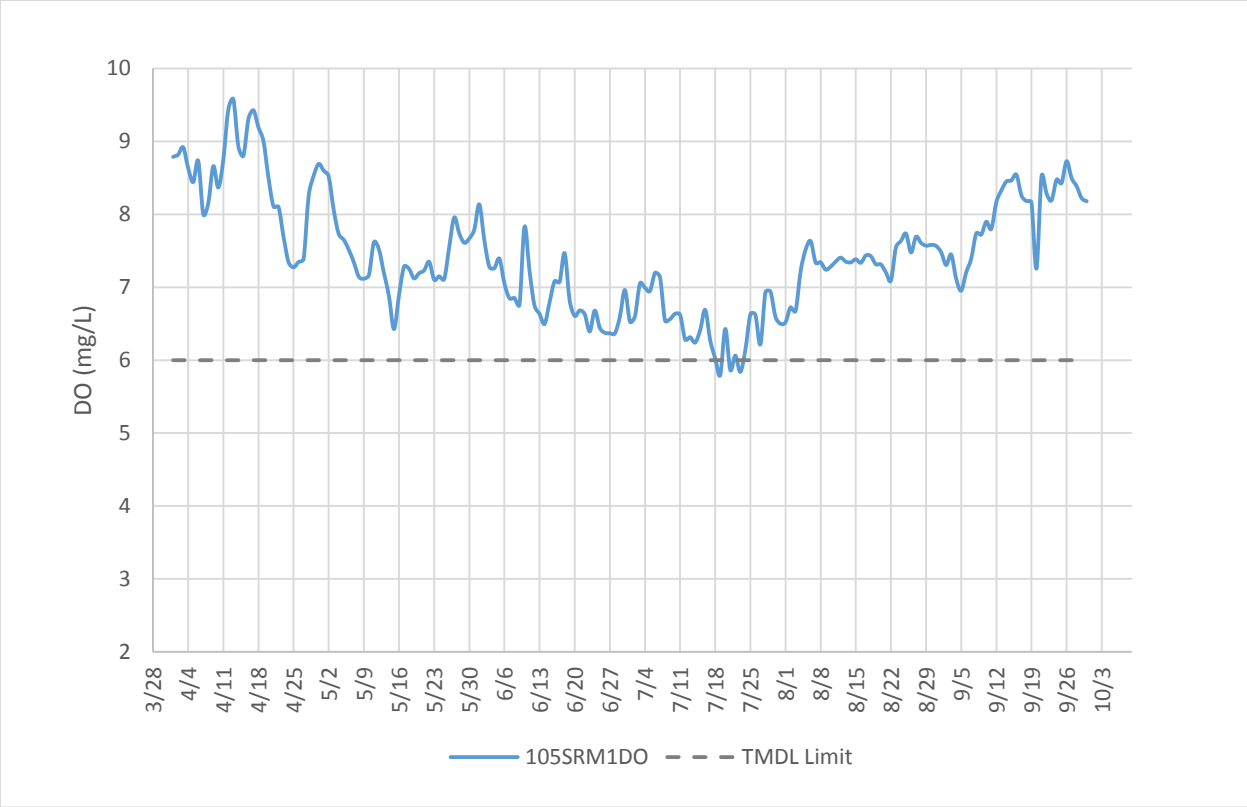

FIGURE 13. 2018 DO MINIMUM AT 105SRM1DO, SHASTA RIVER.

REACH 3

DO in Reach 3 at 105SRS1DO (Figure 14) did not fall below the TMDL limit on any days monitored in 2018 (September data missing due to equipment malfunction).

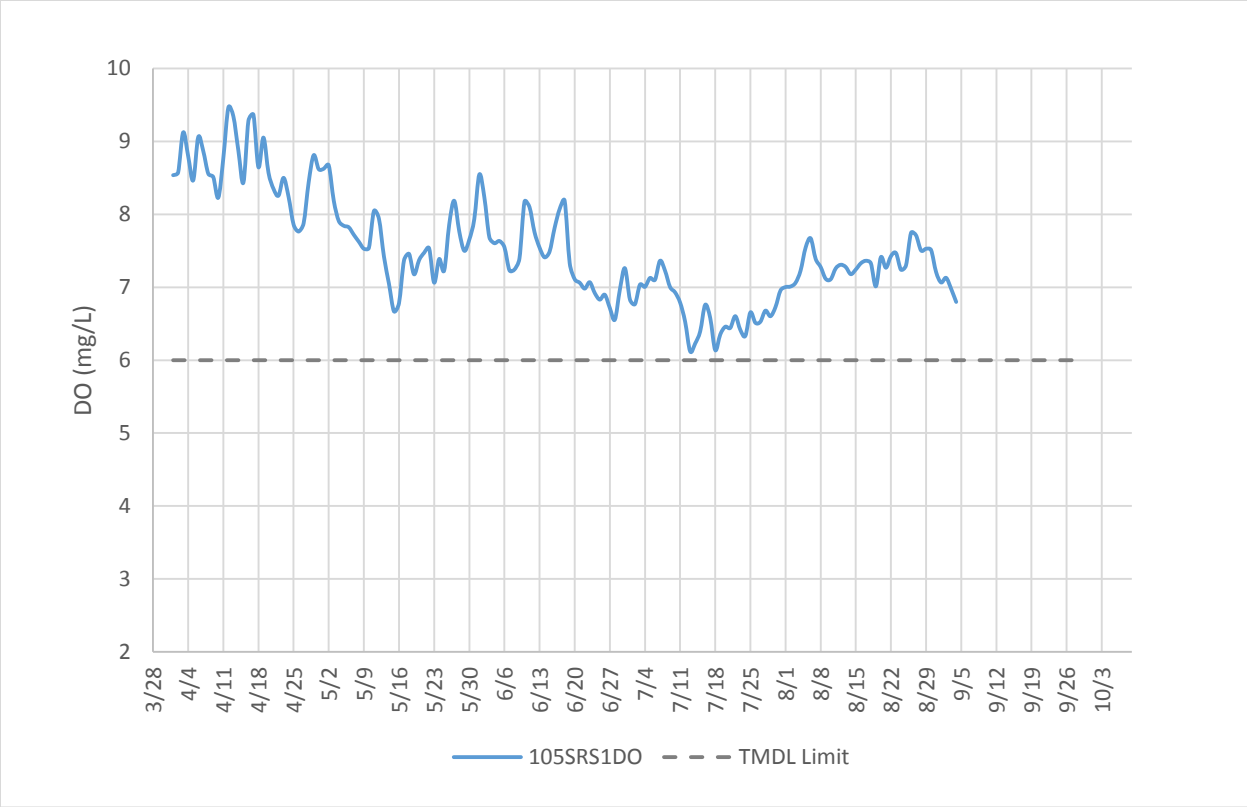

FIGURE 14. 2018 DO MINIMUM AT 105SRS1DO, SHASTA RIVER.

DO in Reach 3 at 105SRT1DO reached a low of 4.9 mg/L on May 25 (Figure 15). This site experienced more "crashes" in data than at other sites. Technician observations included the need for greater calibration of this instrument during monthly equipment download and re-calibration dates than at other sites. Crashes may have been due to frequent bio-fouling, age of equipment or a combination of both, as actual anoxic events were unlikely given the lack of evidence (e.g., fish kills, algae blooms and upstream/downstream signals at other sites).

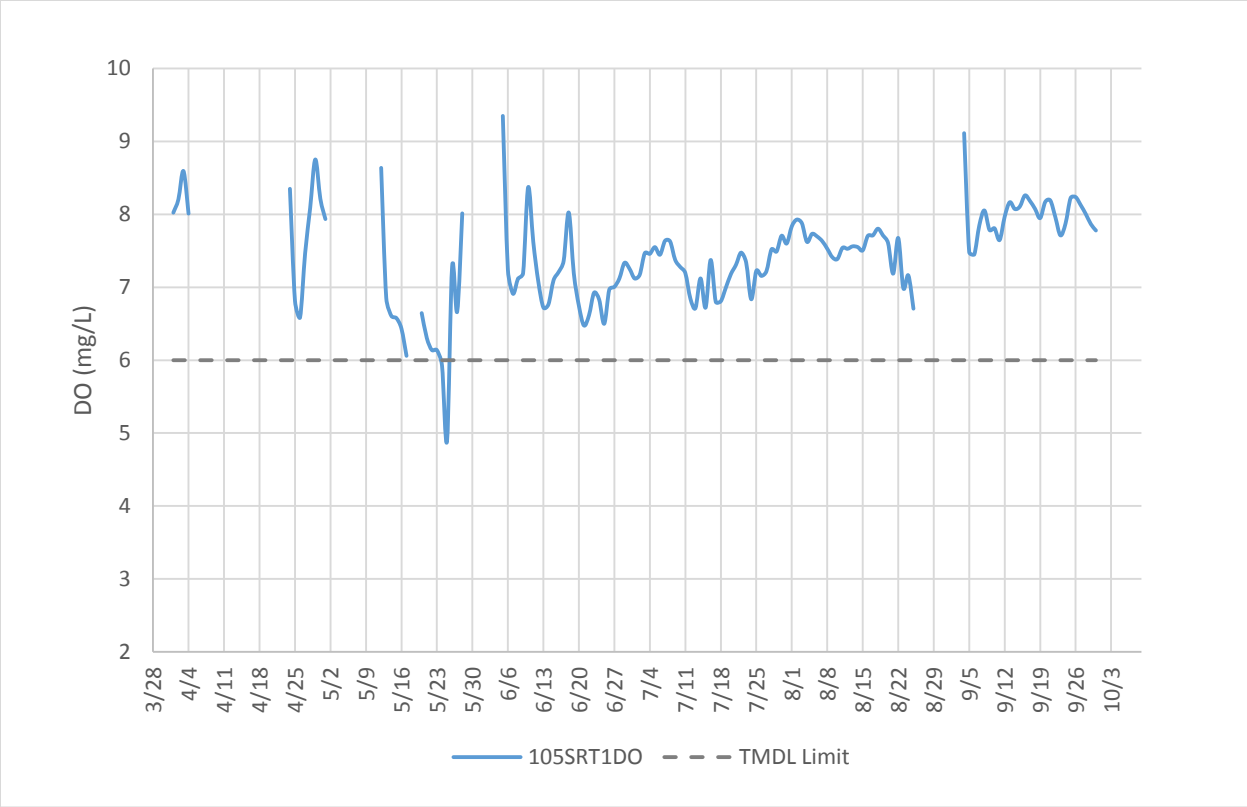

FIGURE 15. 2018 DO MINIMUM AT 105SRT1DO, SHASTA RIVER.

REACH 4

DO in Reach 4 at 105SRV1DO reached a low of 4.07 mg/L on August 9 but remained above the TMDL through most of the irrigation season (Figure 16).

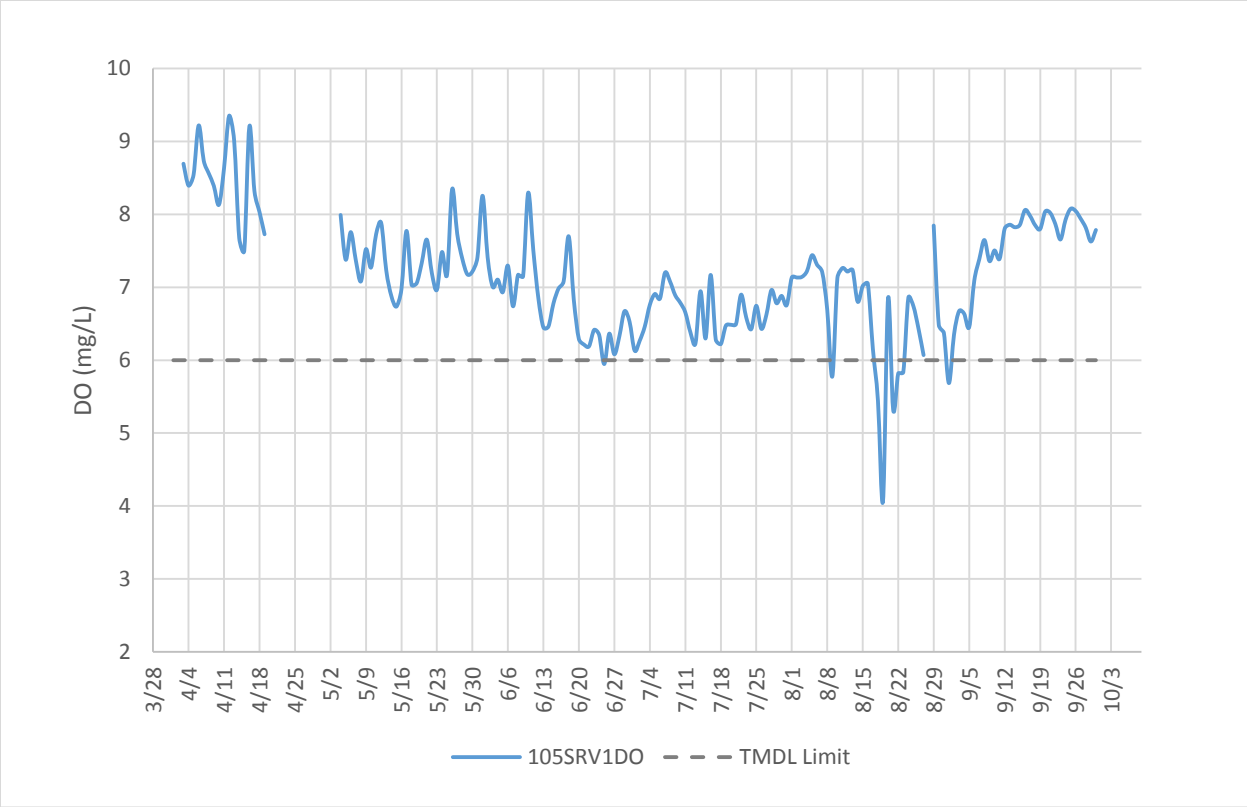

FIGURE 16. 2018 DO MINIMUM AT 105SRV1DO, SHASTA RIVER.

DO in Reach 4 at 105SRN1DO fell to a low of 5.82 mg/L on July 27, but remained above the TMDL for most of the irrigation season (Figure 17).

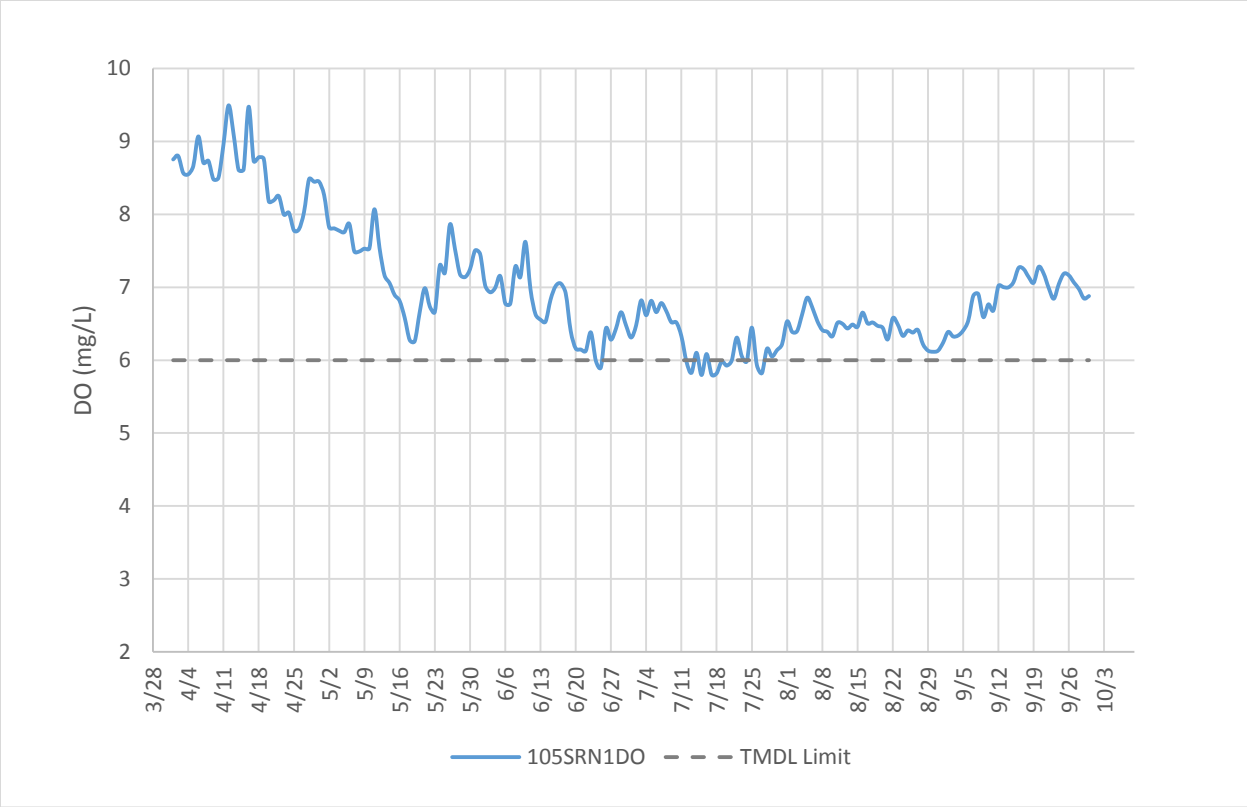

FIGURE 17. 2018 DO MINIMUM AT 105SRN1DO, SHASTA RIVER.

REACH 5

DO measured in the mouth of Parks Creek 105SRP1DO fell to a low of 4.38 mg/L on July 12 (Figure 18). The lack of cattle exclusion fencing, sediment and erosion issues, channel realignments, diversions and tailwater returns throughout lower Parks Creek have created conditions that consistently lead to poor DO readings.

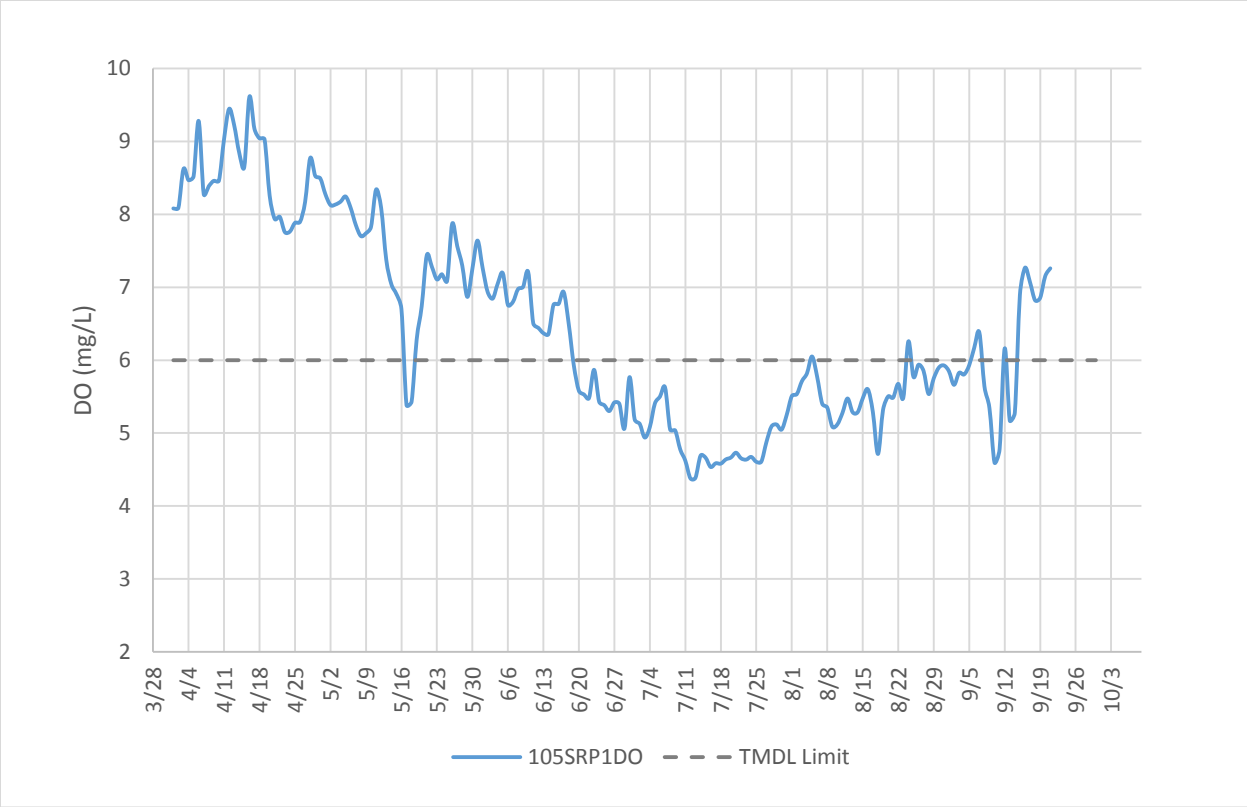

FIGURE 18. 2018 DO MINIMUM AT 105SRP1DO, SHASTA RIVER.

REACH 6

DO measured in Reach 6 at 105SRU1DO fell to a seasonal low of 3.32 mg/L on September 30 (Figure 19). The lower-than-normal water year in 2018 led to low flows, higher temperatures and low DO in Reach 6 in 2018. Moreover, high temperature, low DO water released from Dwinnel Reservoir (due to low water storage that created conditions for increased solar energy absorption) contributed to temperature and DO issues in this reach.

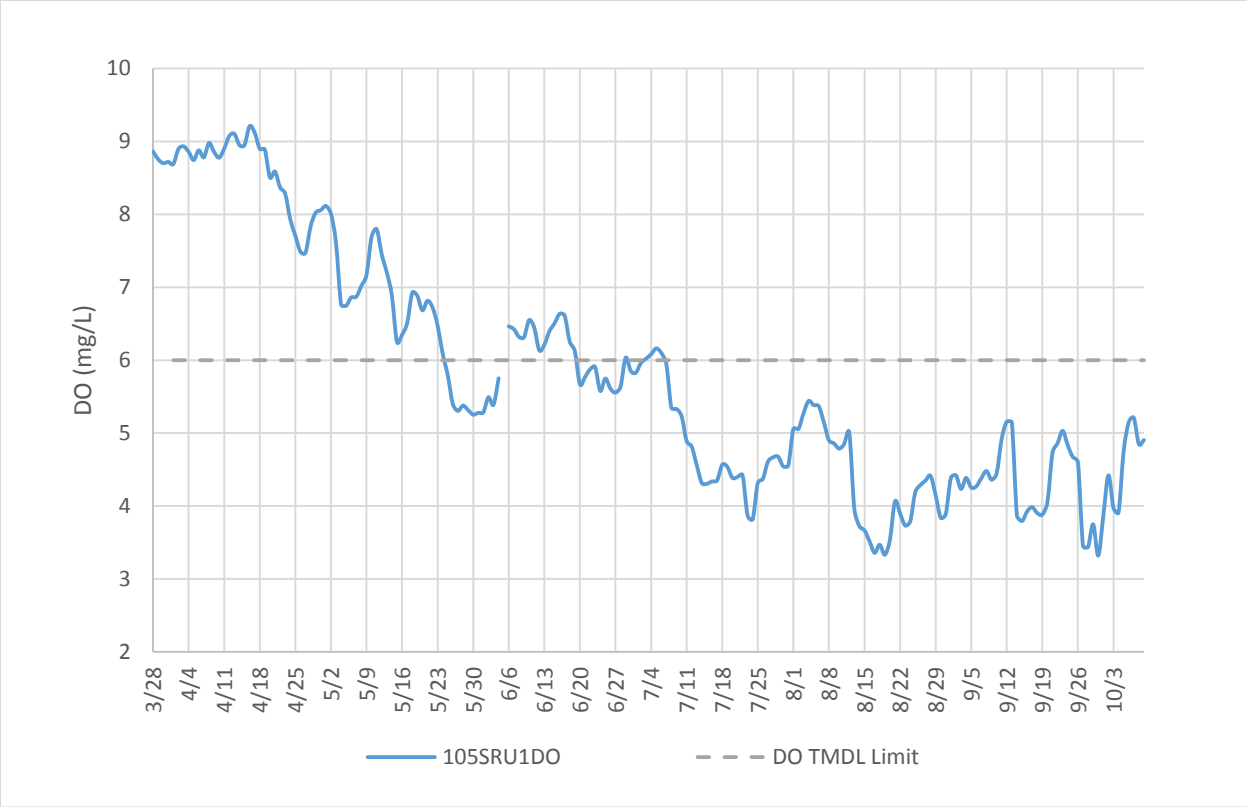

FIGURE 19. 2018 DO MINIMUM AT 105SRU1DO, SHASTA RIVER.

WATER QUALITY – NUTRIENTS

Table 5 and Figure 20 display water quality/nutrient sample results at four locations on the Shasta River. Samples were collected on August 22, 2018 and were transported to Basic Laboratories for analysis of the following analytes: Nitrate as N (NO_3^--N), Nitrite as N (NO_2^--N), Total Kjeldahl Nitrogen (TKN), Ammonia as N (NH_3-N), Total Phosphorus as P (TP -P).

Upstream sites contained higher levels of TKN and Nitrate than downstream sites. Upstream site 105SRHVRPOD was the only site with detections of Nitrite and Ammonia. Increased flow from Big Springs Creek as well as other downstream springs and seeps may contribute to the dilution of nutrients further downstream. A more extensive sampling scheme is recommended for replication and comprehensive analysis in future studies.

TABLE 5. WATER QUALITY SAMPLES AT SELECT SHASTA RIVER MONITORING SITES, 2018. "ND" IS NO DETECTION OF THIS NUTRIENT. 105SRP1DO SITE WAS COLLECTED 100 YARDS DOWNSTREAM OF DO SITE ON THE SHASTA RIVER JUST DOWNSTREAM OF THE CONFLUENCE WITH PARKS CREEK.

Analyte	105HVPOD	105SRP1DO	105SRM1DO	105SRL1DO
NO_3^-	0.4	0.11	ND	ND
NO_2^-	0.034	ND	ND	ND
TKN	0.78	0.4	0.22	0.35
NH_3	0.04	ND	ND	ND
Total P	0.149	0.149	0.158	0.167

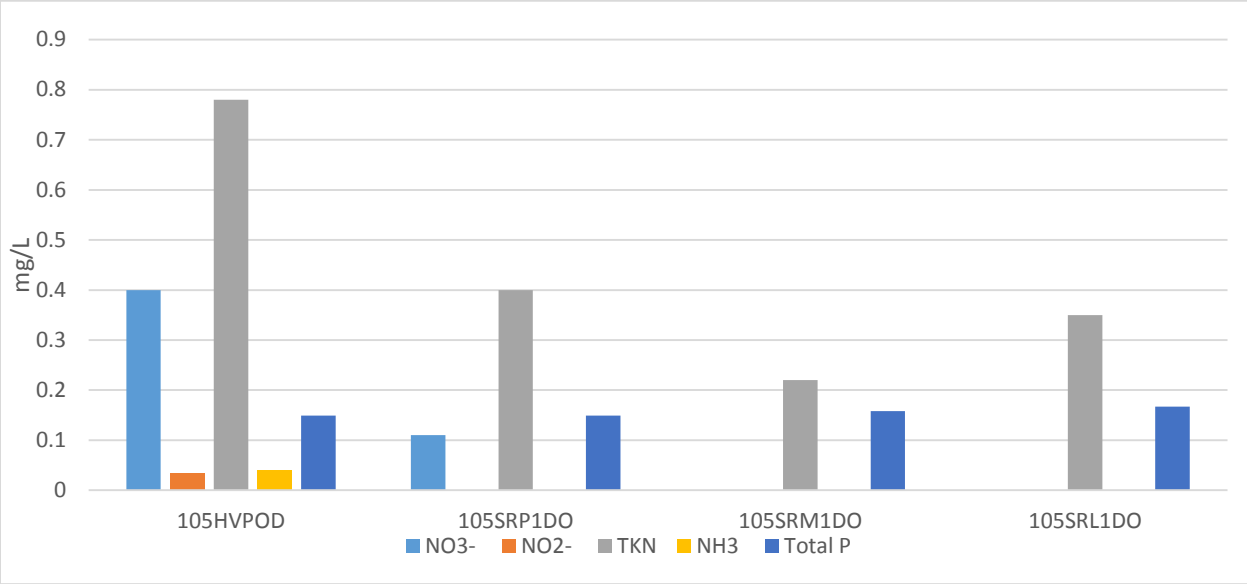

FIGURE 20. WATER QUALITY SAMPLES AT SHASTA RIVER MONITORING SITES, 2018.

CONCLUSION

In general, temperature on the Shasta River exceeded TMDL and MWMT objectives in 2018, while DO levels were above minimum objectives at most sites but fell below those objectives at others. These mixed results suggest that, in general, DO and especially temperature did not meet NCWQCP objectives in 2018, but long-term monitoring results have shown positive impacts of ongoing resource management and restoration projects on the Shasta River and its tributaries.

The results from this annual monitoring report, as well as a multi-year analysis of temperatures and DO on the Shasta River that can be found in the 2018 Shasta River Watershed Stewardship Report, support continued efforts (e.g. riparian planting, tailwater reduction, spring-connection/enhancement projects, and impoundment removal) to decrease water temperatures and improve DO conditions in the Shasta River.

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