KINGS RIVER FISHERIES MANAGEMENT PROGRAM
ANNUAL TECHNICAL REPORT
Water Year 2019-2020

Kings River
FISHERIES MANAGEMENT PROGRAM

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EXECUTIVE SUMMARY

The Kings River Water Association, Kings River Conservation District, and California Department of Fish and Wildlife have jointly implemented habitat and trout population enhancement projects and conducted a series of monitoring programs in the lower Kings River and Pine Flat Reservoir. These habitat enhancement projects have been implemented over the past eighteen years in response to the Kings River Fisheries Management Program (KRFMP) Framework Agreement, which was approved on May 28, 1999, with the financial commitment extended for another ten-year period on June 26, 2009, and again on May 28, 2019. The Framework Agreement includes actions designed to protect and enhance fishery habitat within the lower Kings River and in Pine Flat Reservoir. The Technical Steering Committee is responsible for implementing the actions authorized under the agreement and approved by the Executive Policy Committee. The scope of activities undertaken as part of the KRFMP between October 2019 and September 2020 described in this annual technical report includes: a compilation and synthesis of information regarding habitat enhancements, trout population enhancements, and monitoring activities conducted as part of the KRFMP. Report timeline for activities includes Water Year 2020 (October 2019- September 30, 2020) and CDFW stocking activity for Calendar year 2020.

Key Elements of the program in recent years includes:

- Most instream flow targets met as outlined in the Framework Agreement, with most days greatly exceeding these targets;
- Kings River Fisheries Management Program website improved and maintained;
- Incubated 331,000 rainbow trout eggs in the incubator building;
- Continued implementation of a supplemental Rainbow Trout stocking plan in addition to CDFW annual budgeted stocking program;
- Received final report integrating green- LiDAR with 2-D hydrologic and Habitat modelling. *Lower Kings River Habitat Characterization and Identification for habitat Enhancement Opportunities* – Cramer Fish Sciences;

1.0 INTRODUCTION

The Kings River Water Association (KRWA), Kings River Conservation District (KRCD), and California Department of Fish and Wildlife (CDFW) have jointly implemented habitat and trout population enhancement projects and conducted a series of monitoring programs in the lower Kings River and Pine Flat Reservoir. These habitat enhancement projects have been implemented over the past twenty years in response to the Kings River Fisheries Management Program (KRFMP) Framework Agreement, which was approved on May 28, 1999. The Framework Agreement includes actions designed to protect and enhance fishery habitat within the lower Kings River and in Pine Flat Reservoir. The Technical Steering Committee (TSC) is responsible for implementing the actions authorized under the agreement and approved by the Executive Policy Committee. The scope of activities undertaken as part of the KRFMP between October 2019 and September 2020 and CDFW stocking in 2020 described in this annual technical report includes:

• Monitoring hydrology and operations including inflow to Pine Flat Reservoir, reservoir storage, reservoir releases, operation of remote sensing telemetry systems, turbine bypass operation, and activities to implement enhanced winter flows for fishery habitat as outlined in Exhibits C and D of the Framework Agreement;

• Monitoring water quality including water temperature and dissolved oxygen within Pine Flat Reservoir and the lower Kings River, compliance with dissolved oxygen requirements within the lower river, and planning and monitoring water temperature conditions at the completion of the irrigation season;

• Routine fish stocking by the CDFW, KRFMP supplemental stocking, and continued contributions of rainbow trout fry produced from the incubator building.

The annual report provides a project management structure for reviewing and prioritizing existing and proposed activities, fish stocking, and implementation of other elements contained in the Framework Agreement. Results of the fishery and habitat monitoring program are intended to provide a technical and scientific framework for identifying design criteria and priorities for determining the appropriate scale and location of habitat enhancement projects, linkages among potential projects to maximize biological benefits and reduce cost, identify priorities for habitat enhancement project locations, and identify potential opportunities for expanding enhancement projects through funding augmentation from collaborative grant applications from state, federal, and private funding sources. In addition, one of the key objectives of the annual report improves coordination and communication among the parties involved in implementing various elements of the Framework Agreement, and to facilitate a process for reviewing and evaluating the performance of management actions in achieving the overall goals of the KRFMP.

1.1 ADMINISTRATIVE ACTIVITIES

Along with the financial commitment, in-kind support from KRFMP agencies are estimated below. In-kind support may include staff time for data collection, weir management, analysis, reporting, water operations, meetings, and other administrative activities which vary by agency. The following tables show estimates of agency in-kind support for October 1, 2019 through September 30, 2020; KRWA (Table 1-1), KRCD (Table 1-2), CDFW (Table 1-3). Estimated in-kind support from agencies for the KRFMP was 5,164 hours or about 2.48 Full-Time Equivalent (FTE). Additionally, volunteers involved with assisting the KRFMP are vital for the program success, providing approximately 638 hours of service (Table 1-4).

The in-kind support does not account for CDFW fish stocking or the loss of water supply and storage loss for temperature control pool management. Section 5 outlines stocking activities related to the KRFMP. In 2020, the CDFW allotment for the Kings River included approximately $168,805 or 34,450 pounds of catchable size rainbow trout to the Lower Kings River, Avocado Lake, and Pine Flat Reservoir. Fish stocking by CDFW also included approximately $29,442 or 6,008.5 pounds of fish in sub-catchable, fingerling, and super-catchable trout. Section 2 outlines hydrologic conditions for Water Year 2020. The temperature control pool has been maintained above 100,000 acre-feet, a storage volume unavailable to water users. For Water Year 2020, water made available specifically for KRFMP requirements as releases from Pine Flat and target minimum flows at locations below Pine Flat Dam were approximately 26,000 acre-feet.

Table 1-1: Estimate of KRWA In-Kind Support for the KRFMP, October 1, 2019 - September 30, 2020

KRFMP Support Activity	Hours/Year	Days/Year	FTE
Weir Management (Dennis Cut)	117	14.6	0.06
Weir Management (Fresno Weir)	130	16.3	0.06
Fall Electrofishing Survey	120	15.0	0.06
River Operations	364	45.5	0.18
Reservoir Operations	78	9.8	0.04
Internal Water Accounting	104	13.0	0.05
Administrative Activities	594	74.3	0.29
Total In-Kind Support	1507	188.4	0.72

Table 1-2: Estimate of KRCD In-Kind Support for the KRFMP, October 1, 2019 -September 30, 2020

KRFMP Support Activity	Hours/Year	Days/Year	FTE
Administrative	1870	233.8	0.90
Education Outreach	11	1.4	0.01
Fall Electrofishing Survey	355	44.4	0.17
Fishing Access Maintenance	12	1.5	0.01
Incubator Fry Release	71	8.9	0.03
Incubator Maintenance	1	0.1	0.00
Incubator Operation	628	78.5	0.30
Pine Flat Reservoir Profile	86	10.8	0.04
Public Relations/Outreach	12	1.5	0.01
Snorkel Survey	24	3.0	0.01
Sub-Catchable Stocking	3	0.4	0.00
Total In-Kind Support	3073	384.1	1.48

Table 1-3: Estimate of CDFW In-Kind Support for the KRFMP, October 1, 2019 - September 30, 2020

KRFMP Support Activity	Hours/Year	Days/Year	FTE
Fall Electrofishing Survey	200	25	0.10
Administrative Activities	384	48	0.18
Total In-Kind Support	584	73	0.28

Table 1-4: Estimate of Volunteer Hours for the KRFMP, October 1, 2019 -September 30, 2020

KRFMP Support Activity	Hours/Year	Days/Year	FTE
Fall Electrofishing Survey	300	37.5	0.14
Incubator Fry Release	102	12.8	0.05
Incubator Operation	142	17.8	0.07
Public Advisory Group	79	9.9	0.04
Sub-Catchable Stocking	15	1.9	0.01
Total In-Kind Support	638	79.8	0.31

1.2 ANNUAL TECHNICAL REPORT

Interested parties and stakeholders, including the KRFMP Executive Policy Committee (ExCom), KRFMP Public Advisory Group (PAG), resource and water agencies, local angling groups, and others have expressed interest in the information being collected as part of the KRFMP's monitoring program. Preparation and distribution of an Annual Technical Report has been identified as a useful method of conveying information regarding the program status and monitoring results to interested parties.

2.0 HYDROLOGY AND OPERATIONS

2.1 RESERVOIR INFLOW

Daily average inflow into Pine Flat Reservoir from hydrologic year 2020, October 1, 2019 through September 30, 2020, are shown in Figure 2-1. Inflow into Pine Flat Reservoir is characterized by high seasonal and inter-annual variability reflecting variation in precipitation, snowpack, and runoff within the watershed. Kings River basin discharge averaged 1,257 cfs, ranging from 150 to 8,656 cfs. Table 2-1 shows the Kings River calculated annual runoff and the corresponding percent water year for the past 20 years; years included in this report are in bold text.

Table 2-1: Kings River basin calculated annual runoff by Water Year, October-September

Water Year (Oct-Sept)	Annual Runnof (TAF)	Percent Water Year
2000	1,534	91%
2001	1,010	60%
2002	1,141	67%
2003	1,426	84%
2004	1,050	62%
2005	2,531	149%
2006	2,952	174%
2007	679	40%
2008	1,216	72%
2009	1,348	80%
2010	2,062	122%
2011	3,318	196%
2012	826	49%
2013	691	41%
2014	537	32%
2015	361	21%
2016	1,253	74%
2017	4,096	242%
2018	1,275	75%
2019	2,177	171%
2020	**913**	**54%**

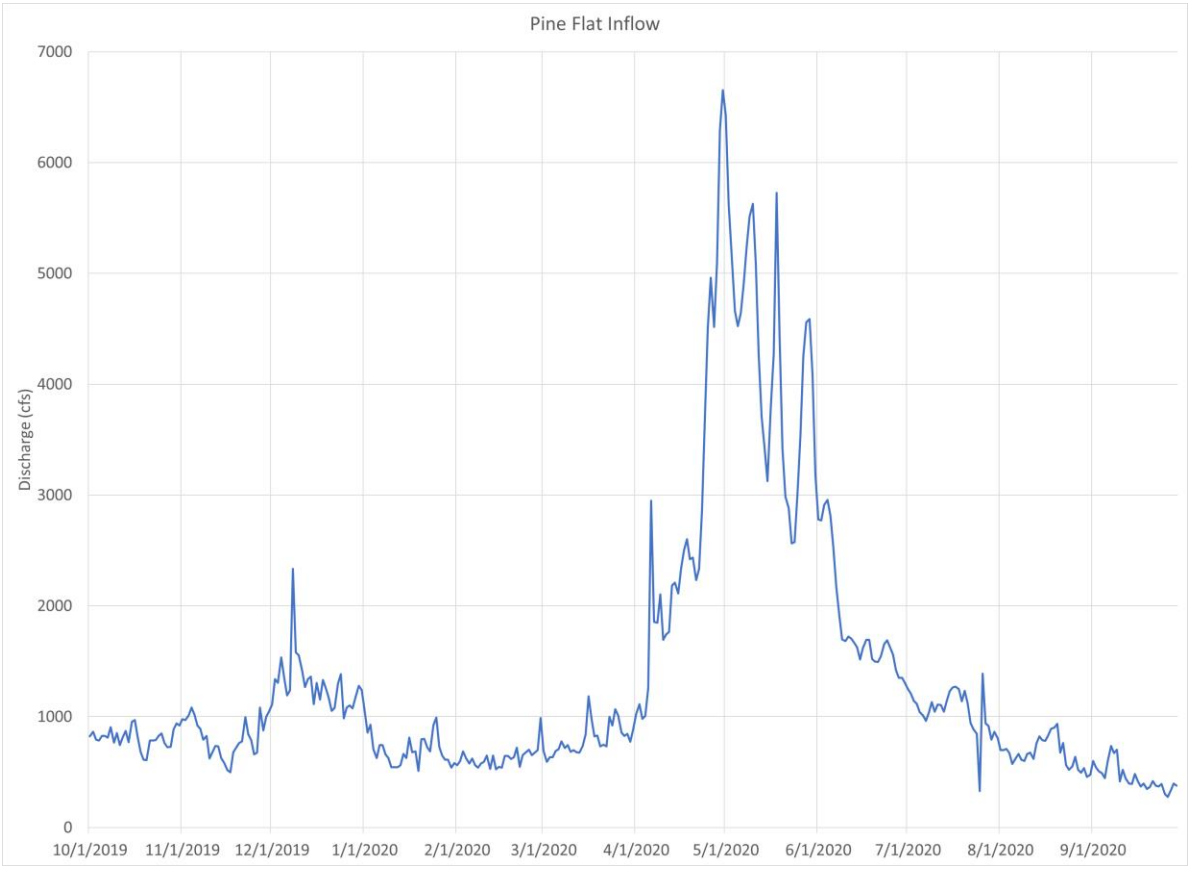


Figure 2-1: The annual inflow into Pine Flat Reservoir from October 1, 2019 through September 30, 2020

2.2 RESERVOIR STORAGE

Daily reservoir water storage volume in Pine Flat Reservoir from October 1, 2019 through September 30, 2020 is shown in Figure 2-2. Reservoir storage reflects the combined effects of reservoir inflow, releases from Pine Flat Reservoir to the lower Kings River, and evaporation. As part of the Framework Agreement, a voluntary 100,000 acre-feet temperature control pool was established. Pine Flat reservoir storage was maintained above the temperature control pool during this report period.

Figure 2-2: Average daily storage in Pine Flat from October 1, 2019 through September 30, 2020

2.3 RESERVOIR RELEASES

Framework Agreement established minimum instream Exhibit C and Exhibit D flow releases from Pine Flat Reservoir (Figure 2-3), flow at Piedra (Figure 2-4), in Dennis Cut (Figure 2-5), at Fresno Weir (Figure 2-6) and below Fresno Weir (Figure 2-7) to support resident fish populations in the lower river (Table 2-2).

Water discharge from Pine Flat Reservoir to the lower Kings River show high variability within the year as shown in Figure 2-3. Average daily discharge from Pine Flat in the lower Kings River from October 1, 2019 through September 30, 2020 ranged from 54 to 6,652 cfs, all above target flows. Average discharge from Pine Flat was 1,798 cfs during the report period.

Daily average Kings River flow at Piedra from October 1, 2019 through September 30, 2020 ranged from 131 to 6,501 cfs, all above target flows. Flow at Piedra averaged 1,768 cfs during the report period.

Daily average flow at Dennis Cut from October 1, 2019 through September 30, 2020 demonstrated two slight departures from the 5 cfs target as outlined in the Framework Agreement, 2-days occurred with daily average flow of 4 cfs (Figure 2-5). These occurred

on November 28, 2019 and January 21, 2020 and adjustments were made to meet or exceed targets. Flow at Dennis Cut averaged 59 cfs during the report period, ranging from 4 to 189 cfs.

Target flow at Fresno Weir included increases for 'Exhibit D' flow schedule in WY 2020, due to preceding year conditions in WY 2019. Daily average Kings River flow at Fresno Weir from October 1, 2019 through September 30, 2020 was 1,505 cfs, ranging from 101 to 5,709 cfs (Figure 2-6). Several departures from target flows occurred in WY 2020. On December 24, 2019, outflow sources at Pine Flat shifted and were also being adjusted for unregulated flow from Mill and Hughes creek, resultant daily average flow at Fresno Weir was 249 cfs. Five days, January 30 - February 3, 2020 had slight departures at Fresno Weir, where 249 cfs was at Fresno Weir. At that time, an additional 1 cfs was diverted at Dennis Cut, which had 6 cfs instead of 5 cfs, and minimum air temperatures, ranging 27-39 degrees F, likely influenced unregulated river pumping for frost protection. Two additional departures from the target flow at Fresno Weir occurred for fish survey efforts on December 2 and 5, 2019, with 223 cfs and 238 cfs respectively. At the direction of the KRFMP Executive Policy Committee a departure from the flow requirements was allowed to facilitate safe river access during fish surveys. Outflow from Pine flat was ramped down and up daily to allow survey crews to sample fish populations. During the 'Exhibit D' enhanced flow period, water orders over Fresno Weir often exceeded the minimum target requirement at Fresno Weir.

Daily average flow below Fresno Weir from October 1, 2019 through September 30, 2020 ranged from 35 to 2,960 cfs (Figure 2-7). Flow below Fresno Weir averaged 672 cfs during the report period.

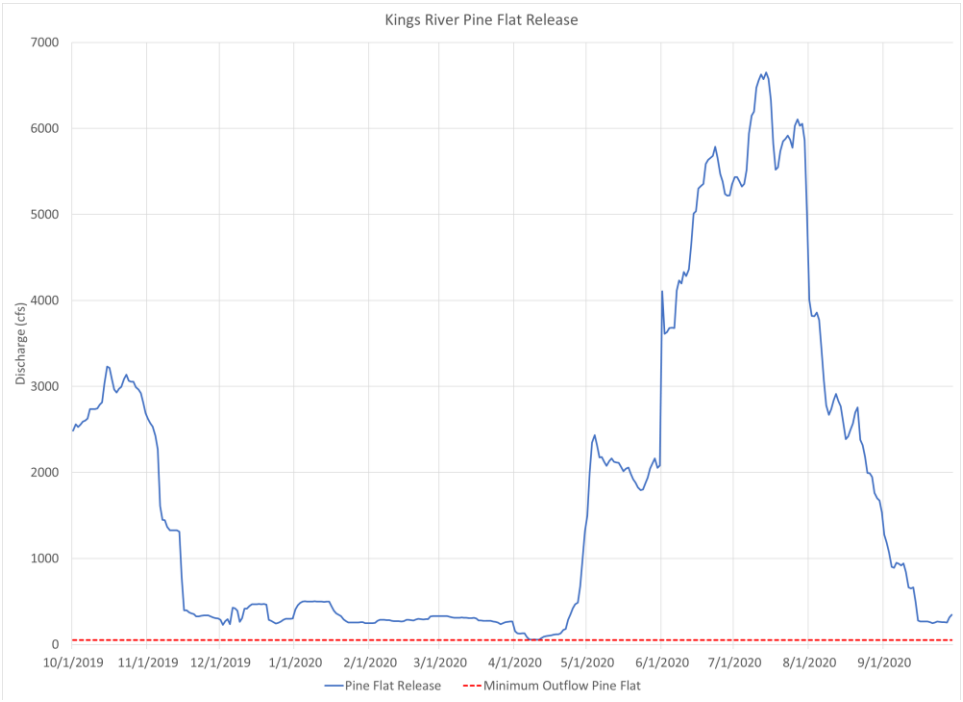


Figure 2-3: Average daily discharge from Pine Flat into the Kings River from October 1, 2019 through September 30, 2020

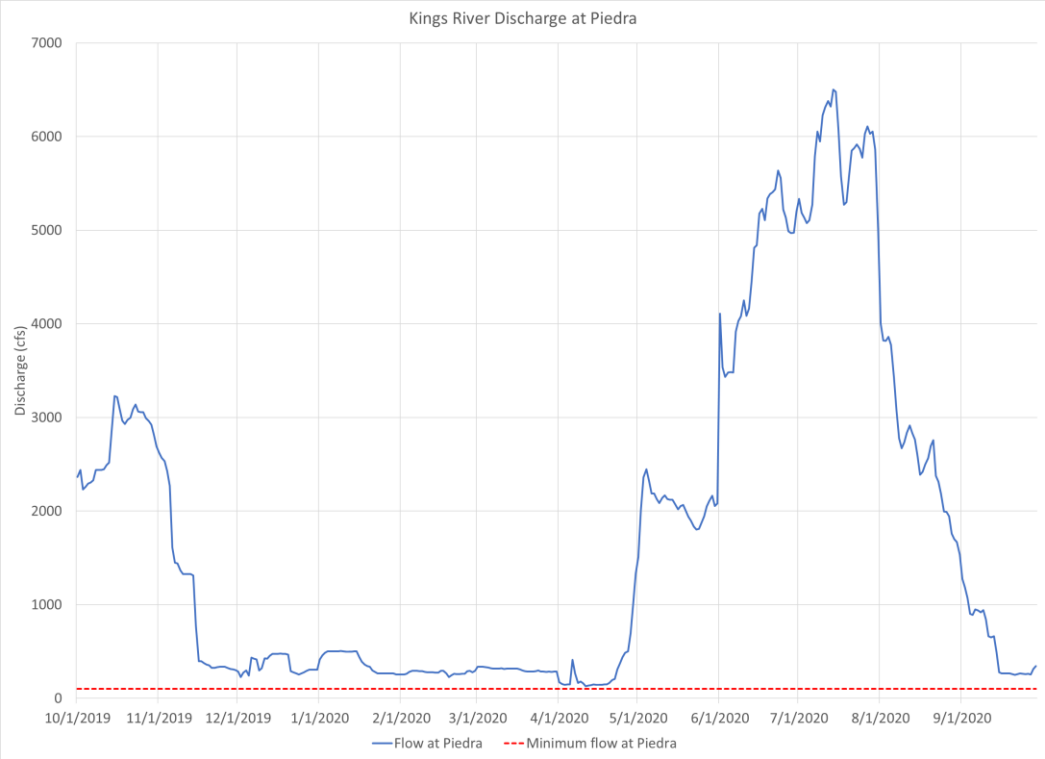


Figure 2-4: Average daily flow of Kings River at Piedra from October 1, 2019 through September 30, 2020

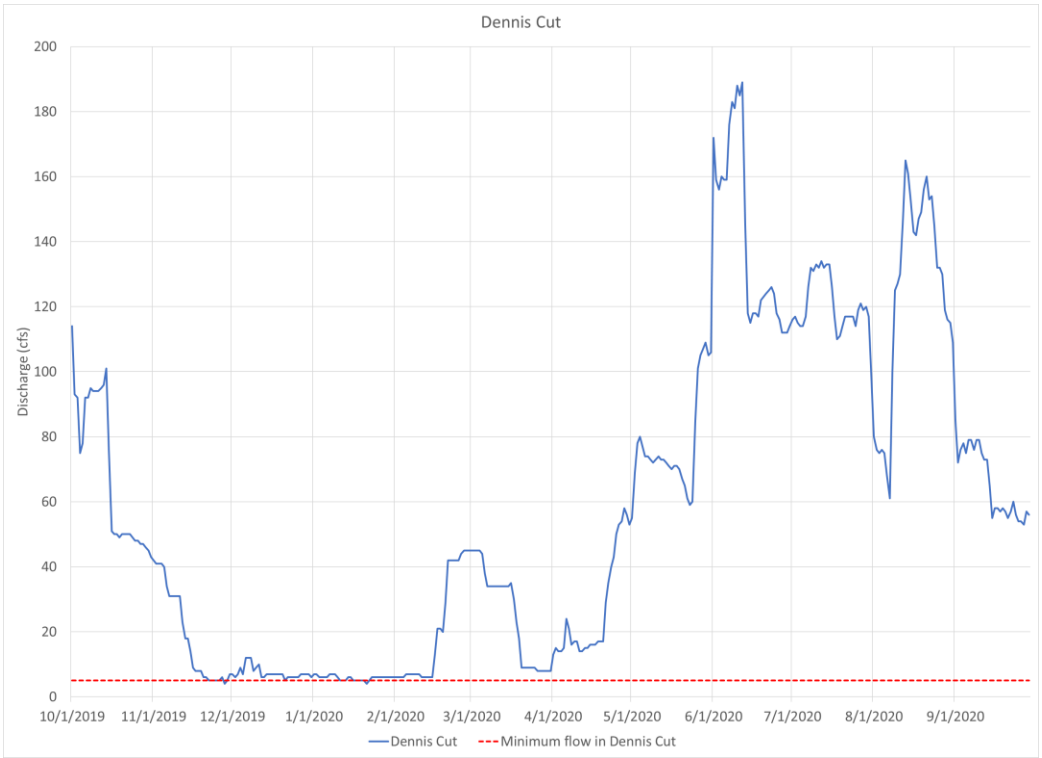


Figure 2-5: Average daily flow in Dennis Cut from October 1, 2019 through September 30, 2020

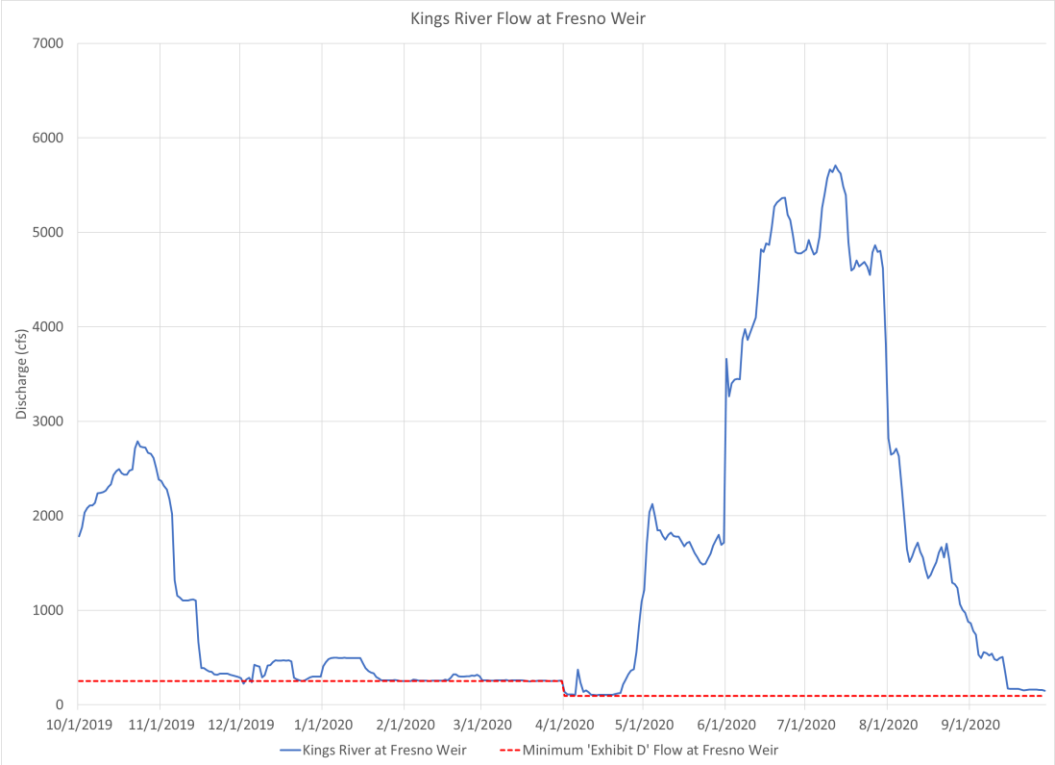


Figure 2-6: Average daily flow of Kings River at Fresno Weir from October 1, 2019 through September 30, 2020

Figure 2-7: Average daily flow of Kings River below Fresno Weir from October 1, 2019 through September 30, 2020

2.4 TELEMETRY SYSTEM

Use of real-time flow monitoring stations below Fresno Weir and at Dennis Cut continued. These systems provide data that supports informed decisions on water temperature and flow management after completing the irrigation and delivery season when elevated water temperatures may affect habitat quality for trout within the lower river. The real-time water temperature monitoring system complements temperature monitoring at fixed locations within the river (Section 3.1.2) for use in evaluating factors affecting habitat conditions and the potential health and condition of biota within the river.

2.5 EXHIBIT C AND D FLOWS

Minimum flow targets are dependent on prior water year volumes. Exhibit "D" flows were provided when irrigation demand became less than 250 cfs until March 31, 2020. These flows were triggered by the wetter than normal Water Year in October 2018 – September 2019, with approximately 2,177,000 acre feet of runoff, 171% of normal. Exhibit "D" flow requirements are observed when the preceding water year exceeds 1,555,000 acre feet. The minimum flow targets also increase when the preceding water year runoff exceeds 2,100,000 acre feet. The "enhanced minimum flow period" at Fresno Weir (250 cfs at Fresno Weir) for Water Year 2020, October 1, 2019 through September 30, 2020, began when the minimum flow to Fresno Weir would otherwise have fallen below 250 cfs through March 31, 2020. On April 1, 2020 target flows reverted to 'Exhibit C' flows for the remainder of the Water Year (Table 2-2).

Table 2-2. 'Exhibit C' target flows (cfs) from the Framework Agreement.

Exhibit C flows	Oct 1 - Nov 15	Nov 16 - Mar 31	Apr 1 - Sept 30
Required from Pine Flat	50	50	50
Total flow at Piedra	100	100	100
Minimum in Dennis Cut	5	5	5
Minimum to Fresno Weir	95	95	95
Water divertible to China Slough	10	5	15
Required over Fresno Weir	40	45	35

2.6 SUMMARY

Hydrologic conditions, Pine Flat Reservoir operations and flows within the lower river during Water Year 2020 are characterized by high seasonal variability characteristic of the Kings River watershed and water supply operations. Findings and recommendations regarding hydrology and operations for this reporting period include:

- Pine Flat Reservoir operations were successful in maintaining the temperature control pool in the reservoir above the minimum level specified in the Framework Agreement;
- Daily average discharge from Pine Flat, Kings River flow at Piedra, and Kings River flow below Fresno Weir demonstrated 100% compliance with the instream flow targets as outlined in the Framework Agreement, with most days greatly exceeding these targets;
- A real-time telemetry system provided information on flow at Fresno Weir and Dennis Cut that is available for monitoring and managing conditions within the lower river as part of the fishery program;
- Flows levels representing Exhibit "D" flow schedule was observed during WY 2020, however, water orders during the enhanced flow period often exceeded these requirements;
- Dennis Cut and King River at Fresno Weir flow showed slight departures from target instream flow as outlined in the Framework Agreement, with most days greatly exceeding these flow targets.

3.0 WATER QUALITY

Water quality monitoring as part of the KRFMP has focused on measurements of water temperature and dissolved oxygen concentrations that directly affect habitat quality for fish and macroinvertebrates within Pine Flat Reservoir and the lower Kings River.

3.1 RESERVOIR WATER QUALITY

Reservoir temperature and dissolved oxygen measurements are monitored monthly throughout the year. Reservoir profile data are used in temperature control pool management during the fall months after completion of the irrigation season to provide suitable temperature conditions for trout and other fish species within Pine Flat Reservoir and the lower river. Water temperature at each outlet (dam and power plant) are used on a real-time basis for use in evaluating water temperature released from the reservoir into the lower Kings River. On September 4, 2019 water releases began from the low-level sluices as well as the turbine bypass. By taking advantage of blending colder water from the lower levels of the reservoir with well oxygenated water from the turbine bypass, conditions within the tailrace could be maintained lower than would have occurred otherwise. Water was either blended through these two levels or was released solely through the low-level sluices for the remainder of the water year.

Vertical profiles in Pine Flat Reservoir of temperature and dissolved oxygen are collected on a regular basis. An example reservoir profile is presented in Figure 3-1. Appendix A includes monthly vertical reservoir temperature and dissolved oxygen profile measurements during the reporting period October 2019 – September 2020. A characteristic seasonal pattern of thermal stratification beginning in the spring includes formation of a reservoir hypolimnion (cold water layer near the bottom) and epilimnion (warmer water layer near the surface), which increases through the summer months. In the late fall and winter, the water temperature in the reservoir becomes almost uniform. Reservoir profiles indicate thermal stratification occurred in October, and June through September (Appendix A). Destratification began in November and temperatures were nearly isothermal through March (Appendix A). In many water bodies, turnover occurs during late fall and winter when cold air temperatures cool the upper layer of water so that the epilimnion is colder than the hypolimnion. Pine Flat Reservoir did not experience turnover in this reporting period. Due to the COVID-19 (coronavirus) pandemic, social distancing guidelines, and the "Stay at Home" order issued by Governor Newsome on March 19 in the effort to further contain and control the pandemic within California, reservoir profiles did not occur in April and May. Temperature sensors on the face of the dam indicated temperatures within the reservoir during these months were good, with the low-level sluices measuring near 9.5˚C, the penstocks and mid-level sluices measuring between 10˚C and 10.5˚C. Reservoir profiles also indicated dissolved oxygen levels greater than 7.0 mg/L occurred throughout the reservoir January through March. In June levels remained greater than 6.0 mg/L, but steadily dropped until only water within the epilimnion contained dissolved oxygen levels exceeding 3.0 mg/L at the end of September.

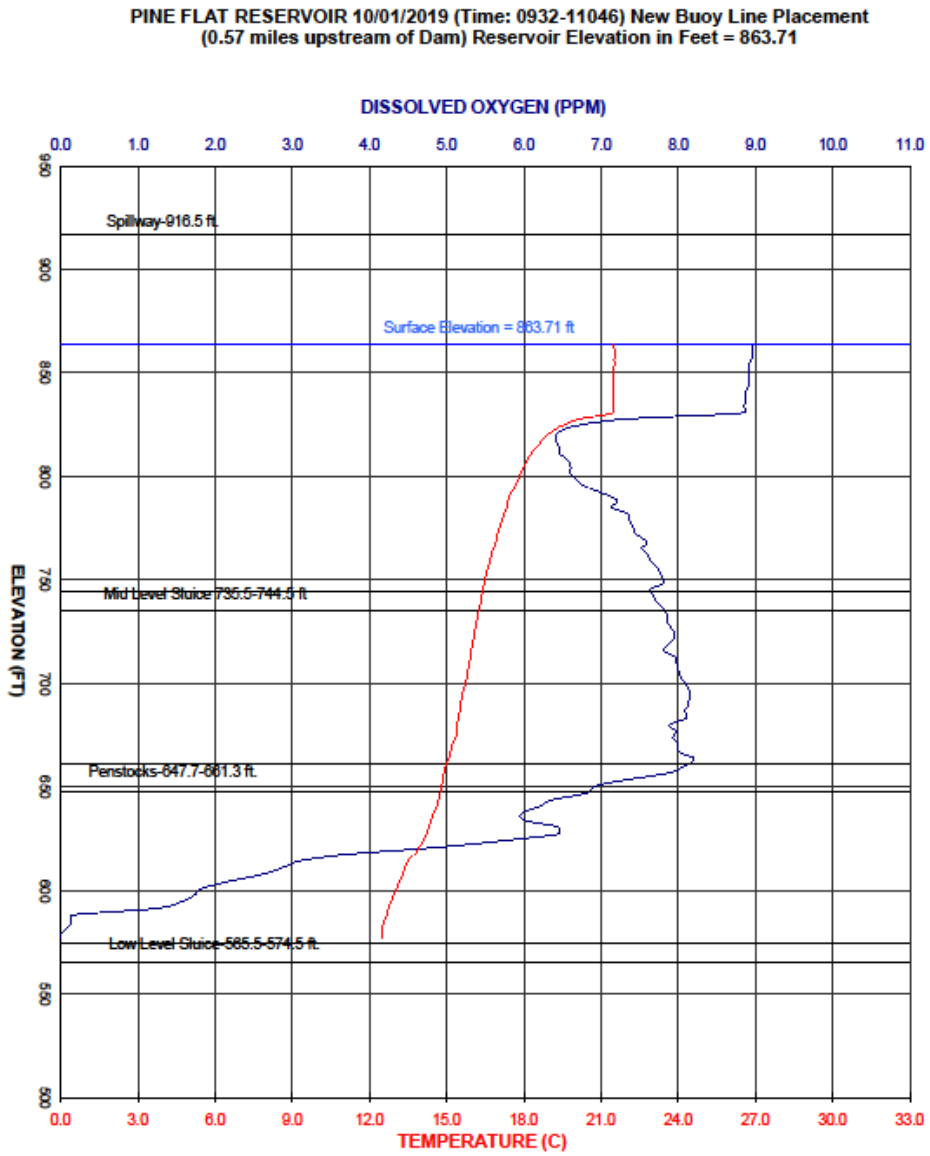


Figure 3-1: Pine Flat Reservoir profile taken 10/01/2019

3.2 RIVER WATER QUALITY

Water temperature and dissolved oxygen concentrations within the lower Kings River are monitored at the Army Corps of Engineers (ACOE) Bridge, which is located 0.6 miles downstream of Pine Flat Dam. From October 01, 2019 through May 22, 2020, a Hydrolab DataSonde, mounted to the weir, recorded water temperature and dissolved oxygen levels every 10 minutes. On May 22, 2020, the DataSonde was replaced with a Eureka Manta which continuously sampled water temperature and dissolved oxygen levels for the remainder of the reporting period. Water

temperature is also measured at Fresno Weir at the stilling well in the weir pool. Although not ideal for measurement of main current temperature, these locations allow for real-time data collections throughout the season.

Average daily water temperature in the lower Kings River are shown for ACOE Bridge (Figure 3-2) and Fresno Weir (Figure 3-3). The daily minimum, maximum, and average water temperatures recorded at the ACOE Bridge were 9.9˚C, 20.6˚C, and 13.5˚C respectively. The daily minimum, maximum, and average temperatures recorded at Fresno Weir were 10.5˚C, 23.0˚C, and 15.1˚C. Throughout the season, daily average water temperature at Fresno Weir were approximately 1.6 ˚C higher than at ACOE Bridge. However, Fresno Weir daily average water temperature at Fresno Weir were recorded as much as 10.0 ˚C higher and 1.5 ˚C lower than at ACOE Bridge. Efforts were made to keep temperatures below Pine Flat Dam suitable for the tailwater trout fishery. Water releases which blended cold water from the low-level sluices with the turbine bypass was initiated on September 4 and continued through September 14 when a decrease in the downstream water order allowed for a switch to the low-level sluices. By September 22, the water order again increased and blending of the low-level sluices with the turbine bypass was reinstated through the remainder of the water year. By blending water from the low-level sluices, release temperatures were initially reduced from 20.5˚C to 18.0˚C. Upon switching entirely to the low-level sluice, release temperatures fell to 14.2˚C. A moderate increase in temperature to 15.0˚C occurred upon resumption of blending with the turbine bypass.

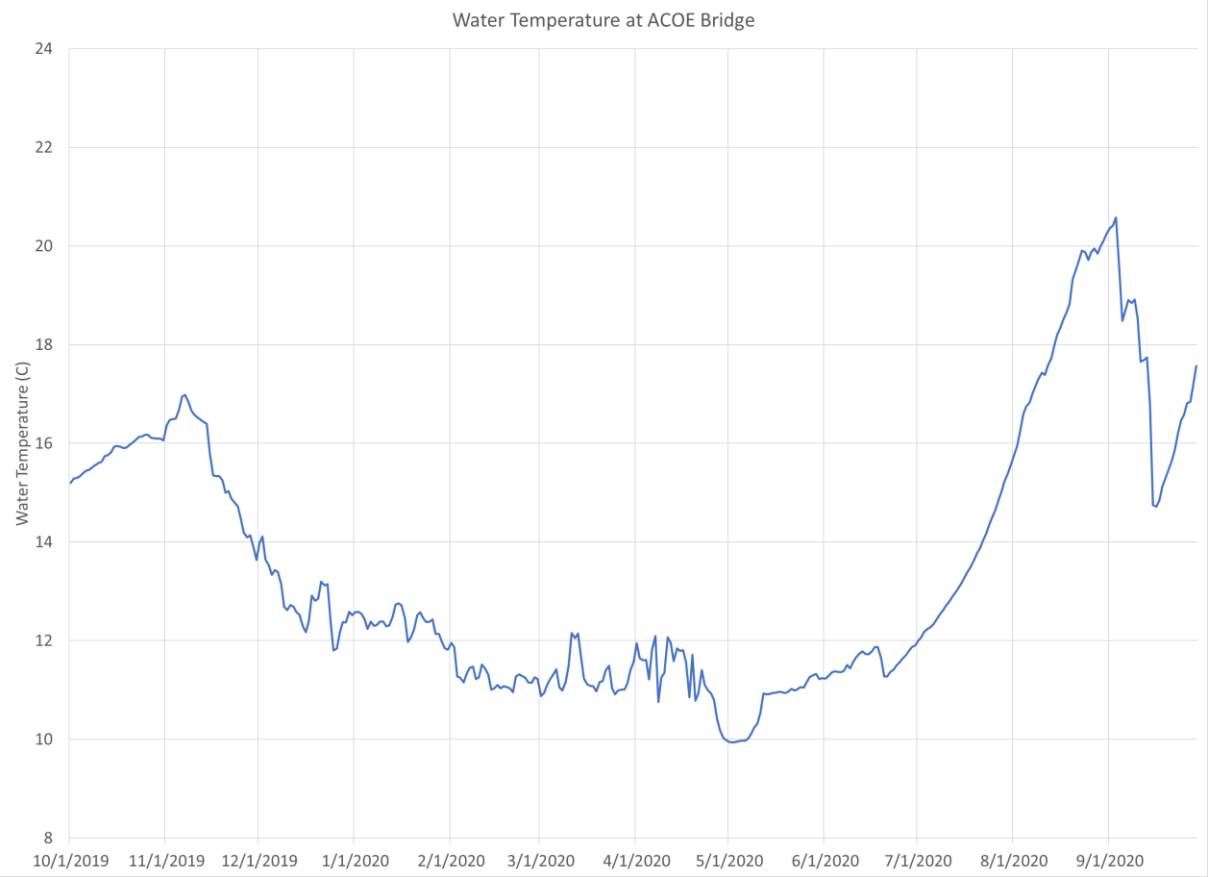


Figure 3-2: Daily average water temperature at the ACOE Bridge October 1, 2019 through September 30, 2020.

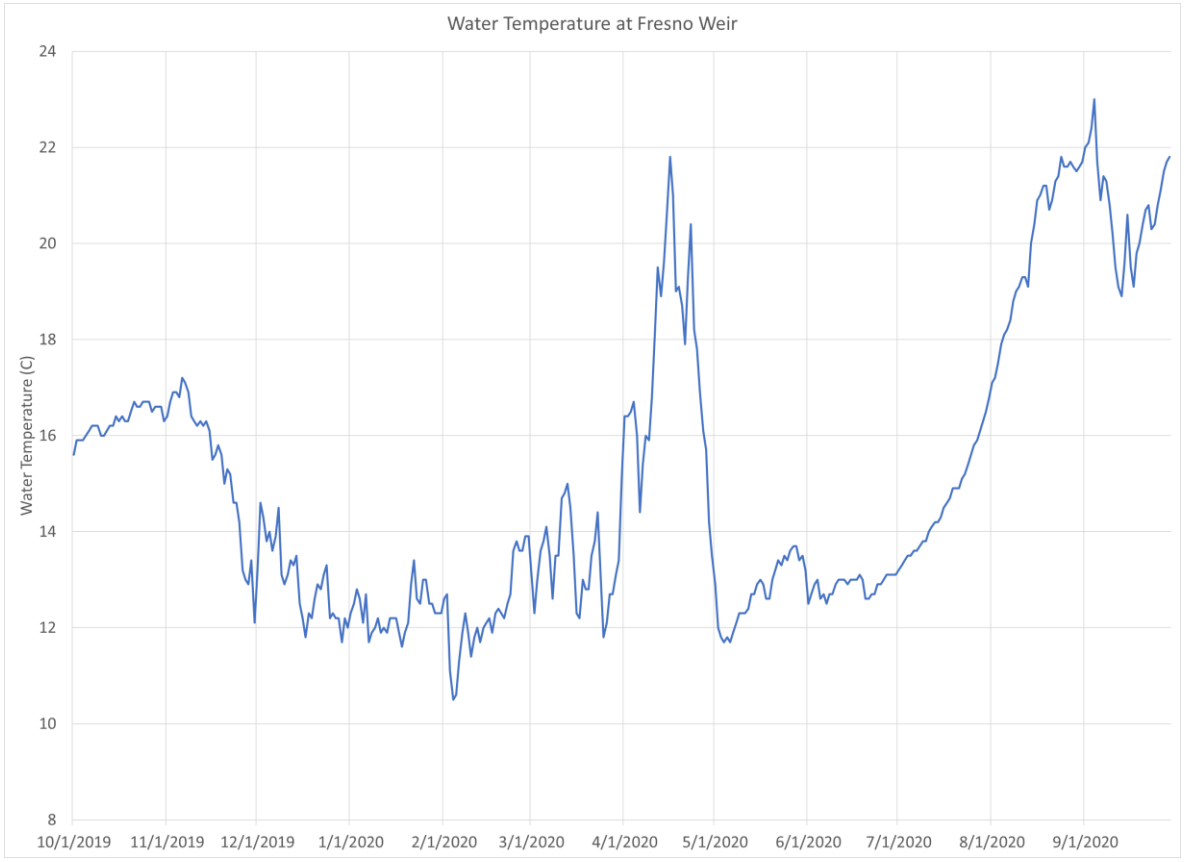


Figure 3-3: Daily average water temperature at Fresno Weir October 1, 2019 through September 30, 2020

Temperatures within the river have a seasonal pattern, with lowest temperatures occurring during the winter and early spring and increasing during the spring and summer months, with the greatest increase in seasonal temperatures occurring during the late summer and early fall after completion of the irrigation season. For much of the year, the diel temperature variation (difference between the maximum and minimum daily temperature) is typically lowest immediately downstream of Pine Flat Dam with diel temperature variation increasing as a function of distance downstream within the lower river. However, as atmospheric conditions cool in the fall and early winter, a reverse temperature gradient is observed, and cooler temperatures are recorded at Fresno Weir than at the ACOE Bridge.

During the 2019-2020 reporting period, dissolved oxygen concentrations within the lower Kings River remained within the range considered suitable for various fish and macroinvertebrate species that occur in this section of the river. The daily average dissolved oxygen concentration at the ACOE Bridge from October 2019 through September 2020 is presented in Figure 3-4. The DataSonde dissolved oxygen meter used for monitoring has an accuracy of ± 0.2 mg/L, while the Manta has an accuracy of ± 0.1 mg/L. Minimum and maximum dissolved oxygen content recorded during this reporting period was 6.8 mg/L and 11.2 mg/L respectively. The daily average dissolved oxygen content exceeded 7.4 mg/L throughout this reporting period, with an annual average of 9.1 mg/L.

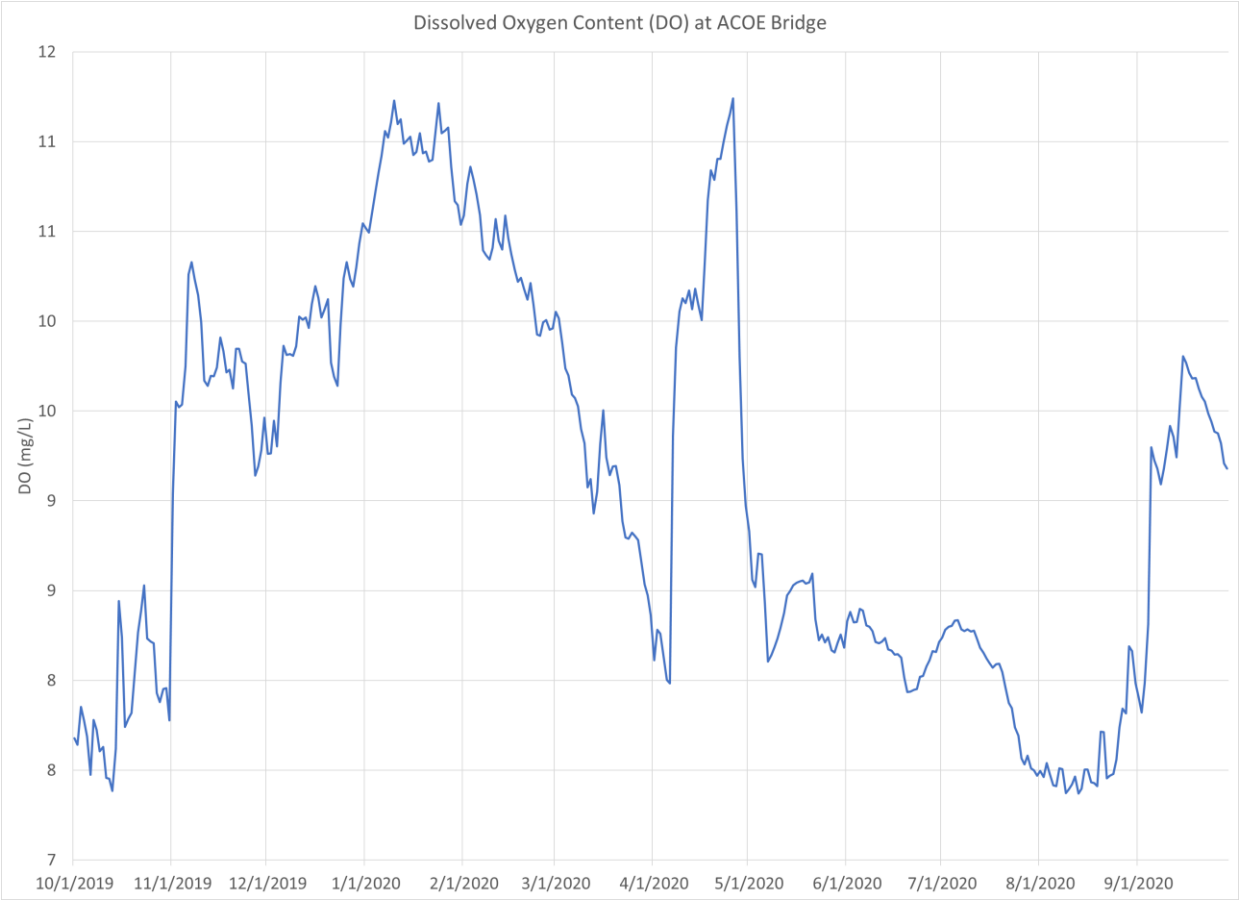


Figure 3-4: Daily average dissolved oxygen content at the ACOE Bridge October 1, 2019 through September 30, 2020.

As a condition of the Federal Energy Regulatory Commission (FERC) Project License P-2741 license, KRCD is required to maintain a minimum dissolved oxygen concentration at the ACOE Bridge of 7.0 mg/L for the protection of fish and other aquatic organisms inhabiting the lower Kings River when the power plant is in operation. KRCD met its license operating and monitoring requirements for the duration of this reporting period, except for two days when the dissolved oxygen concentration immediately below Pine Flat Power Plant did briefly drop below 7.0 mg/L (Table 3-1). During the August 20 low dissolved oxygen event the operator noticed that the level was fluctuating erratically and immediately began taking corrective action. This event was likely triggered due to environmental conditions within the reservoir (Appendix A, Profile for August 5) and was not a response to any actions taken at the power plant. The event on August 24 was triggered when the Unit 2 turbine was taken out of service for the season. In both instances, KRCD power plant operators immediately took corrective action to increase the dissolved oxygen level by increasing spill via available dam outlets and the turbine bypass until dissolved oxygen levels in the river could be maintained at or above 7.0 mg/L.

Table 3-1. Dissolved oxygen events < 7.0 mg/L for Pine Flat Power Plant (Project No. 2741) in 2020.

Date	Reporting Periods D.O. < 7.0 mg/L	Duration of Event[1] (minutes)	Minimum D.O. (mg/l)	Average D.O. Over Duration (mg/L)
August 20	1	30	6.9	7.0
August 22	4	60	6.8	6.9

[1] Duration includes the ten-minute interval just prior to the low value, through interval it remains greater than or equal to 7.0 mg/L.

3.3 SUMMARY

Several tools for managing water temperature in the lower river include cooperation from the ACOE in allowing the use of the lower sluice gates to release cold water during critical periods, and improved flexibility in managing water temperatures by using the turbine bypass. Water quality monitoring within Pine Flat Reservoir and the lower Kings River during Water Year 2020 have shown:

- Pine Flat Reservoir can become stratified during late spring, summer, and fall showing a characteristic pattern of warmer water near the surface (epilimnion) and colder water with reduced dissolved oxygen concentrations near the bottom of the reservoir (hypolimnion). Reservoir profile water temperature becomes almost uniform in the late fall and winter. During the 2019-2020 water year reservoir profiles indicate thermal stratification occurred in the early fall and summer months. Destratification began in November and occurred throughout the winter into early spring. Pine Flat Reservoir did not experience lake turnover during the reporting period. Reservoir profiles also indicated dissolved oxygen levels greater than 7.0 mg/L occurred throughout the reservoir during the winter. In June levels remained greater than 6.0 mg/L, but steadily dropped until only the epilimnion contained dissolved oxygen levels exceeding 3.0 mg/L by the end of the water year.

- The temperature of water released from the reservoir into the lower river can be managed through selective operation of different outlet works, including the turbine bypass. The ability to manage water temperatures is limited by the availability of cold water in Pine Flat Reservoir at release points during critical times. The program successfully utilized releases from the low-level sluices for the benefit of the tailwater trout fishery beginning in early September. Cooler water provided by these releases was successful in maintaining temperatures in the upper portion of the tailwater below 20˚C for the remainder of the water year.

- Water temperatures are variable along a longitudinal gradient downstream of Pine Flat Dam. During much of the year the coldest temperatures are immediately downstream of the dam and temperatures typically increase with distance downstream. During the fall and winter, as atmospheric temperatures cool, a reverse temperature gradient may be observed with temperatures decreasing as a function of distance downstream.

- Aeration and mixing of water released from the reservoir are effective in maintaining suitable temperature and dissolved oxygen concentrations within the lower river. The daily average dissolved oxygen level exceeded 7.0 mg/L throughout the year.

- KRCD power plant operators monitor conditions throughout the year to ensure that dissolved oxygen levels do not fall to or remain below 7.0 mg/L for an extensive period. On August 20 and 24 dissolved oxygen levels were briefly recorded as less than 7.0 mg/L. Upon dropping below this threshold, KRCD power plant operators immediately took corrective action to increase the dissolved oxygen level; spill was increased via available dam outlets and the turbine bypass.

4.0 HABITAT ENHANCEMENT

One goal of the KRFMP is to enhance the quality and availability of habitat for a variety of fish and macroinvertebrates within Pine Flat Reservoir and the lower Kings River. A brief description of the habitat enhancement projects planned and/or implemented as part of the KRFMP during 2020 is summarized below.

4.1 RIVER

Cramer Fish Sciences was contracted in 2018 to create a 2D hydrologic model, quantify the seasonal availability of spawning and rearing habitat by flow rate, locate and identify locations for future habitat enhancement projects and create weighted habitat suitability models. The final report was submitted to the KRFMP in September 2019. The document is anticipated to serve as a tool to direct future habitat enhancement projects within the tailwater fishery for rainbow trout. Findings indicated a substantial lack of spawning sized gravel in areas of seasonal inundation, channelization, fewer than optimal pool to riffle habitat transitions and a deficit in available habitat for young of the year. Upon approval by the Executive Committee (ExCom) in early 2020 the Technical Steering Committee (TSC) was tasked with reviewing the habitat enhancement projects proposed in the report, and to make a recommendation back to the ExCom as to which project or projects should be pursued. Discussions remained ongoing throughout this reporting period, and a recommendation expected to be presented to the ExCom during the 2020-2021 reporting period.

4.2 PINE FLAT RESERVOIR

The KRFMP budgets for projects to enhance and/or benefit the fishery created within Pine Flat Reservoir. The Pine Flat ACOE staff has been instrumental in helping the program discern the size, type, and locations of such projects. In addition, the ACOE has provided the necessary personnel and logistic resources needed to ensure project completion. In 2020 the ACOE determined improvement of the fishing access below Pine Flat Dam took precedence over in-reservoir habitat enhancement projects. The KRFMP plans to continue working with the ACOE through the foreseeable future.

5.0 FISH STOCKING

CDFW transitioned from stocking triploid rainbow trout into the lower Kings River in favor of diploid rainbow trout at the start of 2018. In 2020, sub-catchable, catchable and super-catchable rainbow trout and catchable brook trout were planted in the Lower Kings River. Catchable rainbow trout, sub-catchable brown trout and fingerling Chinook salmon were planted in Pine Flat Reservoir. Avocado Lake received a catchable allotment of rainbow trout. In addition, rainbow trout eggs were incubated by KRCD and released in the lower river. The supplemental rainbow trout stocking program initiated by the KRFMP in the fall of 2018 was continued during this reporting period.

5.1 SUPPLEMENTAL STOCKING

In 2017 the KRFMP developed a supplemental rainbow trout stocking plan for the tailwater fishery below Pine Flat Dam. The plan focuses on stocking only diploid trout with increased stocking in the fall and winter months when river flows and temperature are best for angler success. The intent is to provide a population of hatchery-produced catchable sized trout capable of sustaining the current level of angler pressure in both the put-and-take and catch-and-release zones. Additionally, the reinstitution of stocking diploid trout provides the potential for holdover trout to spawn and contribute to the resident population when and where conditions are suitable. The plan was fully approved in May 2018 and Calaveras Trout Farm, a private aquaculture facility in Snelling, CA was awarded a 3-year renewable contract to provide the KRFMP 30,000 (10,000 lbs) to 50,000 (16,600 lbs) of diploid rainbow trout between October and March each year. In the summer of 2019 the KRFMP was informed by Calaveras Trout Farm that they would not be able to meet their contractual obligation due to the malfunction of a component of the Merced Irrigation dam which resulted in fish kill and subsequent closure due to loss of fish stock. Fortunately, the CDFW was able to step in and cover supplemental stocking for the 2019-2020 season. A 5-year contract signed with the KRFMP in July 2018 was in place which could serve as a back-up for supplemental stocking. According to representatives of the CDFW supplemental trout measured 9" or smaller in fork length and weighed anywhere from 2 to 4 fish per pound, with an average weight of 3 fish per pound. Supplemental stocking by the CDFW began in October 2019, providing weekly plantings through April. Representatives of CDFW estimated distribution of supplemental trout was 77% into the Put & Take Zone (Reach 1) and 23% into the Catch & Release Zone (Reach 2) (Table 5-1).

Table 5-1: Summary of 2019-2020 supplemental stocking by the California Department of Fish and Wildlife. All fish are catchable size, 9" or smaller and weighed 2 to 4 fish per pound on delivery.

Month	# Lbs	# Fish	# Fish/Lb
October	3,200	12,240	3.83
November	3,200	9,440	2.95
December	3,000	7,360	2.45
January	3,100	10,560	3.41
February	3,300	10,270	3.11
Total	15,800	49,870	3.16

5.2 INCUBATOR BUILDING

The incubator building has run seasonally since November 2012. Maintenance has been facilitated by KRCD staff as well as volunteers interested in the fishery and the Kings River. During the 2019 – 2020 program year diploid rainbow trout eggs were purchased from Cold Springs Trout Farm, with three incubation periods completed. Table 5-2 summarizes the incubation periods, number of eggs incubated, estimated hatch rate, estimated number of fry released, and the percentage of fry released into both the Put & Take and Catch & Release Zones. When trout fry reached the button up stage (about 1" long) they were released at multiple locations within the fishery management area. These activities were conducted under SE4 and P1 of the 2019 Annual Implementation Plan.

Table 5-2: Incubator building activity 2019 – 2020. Number of eggs incubated per rearing period, estimated hatch rate, estimated number of fry released, and percentage released in both the Put & Take and Catch & Release Zones.

Incubation Period	Number of Eggs Incubated	Estimated Hatch Rate	Estimated Fry Released	Put & Take Zone	Catch & Release Zone
10/29/2019-12/18/2019	105,000	71%	38,000	33%	67%
01/06/2020-02/26/2020	126,000	94%	87,000	52%	48%
02/28/2020-04/15/2020	100,000	94%	77,000	49%	51%

During the first (October 29, 2019 to December 18, 2019) and final (February 28, 2020 to April 15, 2020) rearing periods water temperature is believed to be a contributing factor to the observed high mortalities during the rearing season. In the case of the October through December rearing period the hatch rate was only 71% (Table 5-2). Daily average water temperatures within the incubator during the first seventeen days of the rearing period were within the range considered lethal (>15.5˚C) by Woynarovich et al. (2011) for the incubation of rainbow trout eggs and sac-fry. On five of those days, minimum temperatures were also greater than 15.5˚C. On November 12, fifteen days after the initiation of this rearing period the sac-fry were observed transitioning to the swim-up stage, with transition complete by November 18, twenty-one days after incubation was initiated. In the days immediately prior to initiation of the transition from the sac-fry stage to the swim-up stage mortalities were daily estimated to be several thousand but once all fry reached the swim-up stage the daily fry mortalities were greatly reduced. This was likely due in-part to both the greater thermal tolerances of swim-up fry (Woynarovich et al. 2011) and the seasonal cooling occurring in the tailrace (Figure 3-2). In the case of the February through April rearing period the hatch rate was 91% and would likely have been higher if two of the shipping trays upon arrival to the incubator had not already begun hatching. Daily average water temperatures within the incubator remained within the range Woynarovich et al. (2011) consider optimal (7˚C-12.5˚C) for the incubation of rainbow trout eggs and sac-fry as well as for swim-up fry (7˚C-20˚C). Fry mortalities throughout most of this rearing period were low, with anywhere from 50 to 400 reported daily. In the final nine days of this rearing period daily mortalities began numbering in the thousands despite water temperatures still being within the range Woynarovich et al. (2011) considers optimal for fry in the swim-up stage. However, a number of quick temperature increases which the fry may not have been able to acclimate to may have been a contributing factor to those losses. On April 7, the daily average temperature was 2.33˚C warmer than the previous day and was followed by a day where the average temperature was 1.28˚C warmer. On April 11, the average temperature was again another 1.53˚C over the previous day. Additionally, carrying capacity limits within the raceways may have been met as warmer water contains less oxygen, thus

supporting fewer fish. Outflows through Pine Flat Dam were reduced to near 50 cfs beginning on April 7, and largely remained steady until again increasing on April 12 to around 100 cfs for the remainder of the rearing period. When flows from the dam are near 50 cfs water in the incubator is found to often be one to two degrees warmer or cooler, depending on ambient air temperature, from that of releases from the dam and flow into the incubator intake pool is visibly lacking. This temperature is likely due in part to a combination of the decreased outflow and the river morphology. The placement of boulders immediately upstream of the intake pool may further reduce flow into the pool.

In order to reduce future losses of fry during the initial rearing period it is recommended that future trout rearing seasons either 1) consider eliminating the run which is initiated in the fall or 2) wait until the middle of November to begin incubation after lethal water temperatures for trout eggs and sac-fry have passed. For Option 1 the benefit would be reducing scheduling challenges inherent with the need to acquire volunteers not only for the normal weekend coverage but also those able to take over the daily care of fry during the six days of electrofishing and the long Thanksgiving weekend. The obvious disadvantage with a reduction to two rearing periods annually is the reduction in the number of fry available for release into the river annually. For Option 2 the benefits would be a greater number of fish would survive the egg and sac-fry stage for release into the river while maintaining the same number of annual rearing periods as in previous years. The disadvantage for this option is the scheduling challenges which occur due to the need to acquire volunteers in addition to the normal weekend coverage on an additional six weekdays during the fall electrofishing survey and the additional coverages required during the fall and winter holidays. To reduce fry losses during any rearing period the KRFMP should consider the use of a chiller system to ensure water temperatures in the raceways never reach lethal levels. There are benefits and disadvantages to each of these options. A benefit of using a chiller would be the ability to maintain water temperatures within a range suitable for survival of eggs and sac-fry. There are however numerous disadvantages associated with this option, 1) determining the appropriate chiller to install, 2) refrigeration equipment is costly (Nickerson 2011) and for the KRFMP purposes would typically only be needed for a few weeks of any rearing period, 3) chiller barrels are designed for a specific minimum flow rate which must be maintained as equipment failure is possible with variable flows (Nickerson 2011), 4) there may be inadequate heat recovery if a heat exchanger is being utilized which will affect the efficiency of the chiller (Nickerson 2011), 5) the proper compressor must be installed to handle seasonal variations in ambient temperatures (Nickerson 2011), 6) staff and volunteers would need to recognize problems with the system, and staff would need to learn how to troubleshoot and maintain the system appropriately.

Losses due to carrying capacity issues because of increased water temperature may have been reduced if flows in the raceways had been increased concurrent with flows decreasing in the tailrace as temperatures warmed. Leitritz and Lewis (1976) recommend minimum flows, when hatchery operations are under 1,000', of 7.6 GPM when water temperature reaches 13˚C and upward of 15 GPM when water temperature reaches 18˚C. This increased flow would have allowed for more rapid oxygen exchange throughout the raceway, thus providing increased support to carrying capacity in the raceways. One must be careful not to set the flow too high or fry may exhaust themselves swimming against the current leading to further mortality. Flows in the incubator were around 7.5 GPM per raceway at the time large losses were initially reported on April 11 by KRCD staff. KRCD staff reported on April 7, when tailrace flows were reduced to around 50 cfs, the raceways were receiving 8.5 GPM. KRCD staff increased on April 11, back to

8.5 GPM per raceway and were raised on April 13 to 11 GPM per raceway, which met the minimum recommended flow by Leitritz and Lewis (1976) for a water temperature of 16˚C, which was the average water temperature on that day. Additionally, as the water warmed, energetic needs of the fish would have increased. Energetic needs of salmonids are affected by fish size, water temperature, and food availability (Elliott 1994). Food availability had been increased over the final week the fry were rearing in the incubator, and appeared to be sufficient based on observations of some uneaten food remaining in the raceways between daily cleanings by KRCD staff. Above 18˚C there is a decrease in maximum energy uptake (Elliott 1994). On April 11 and April 12 maximum temperatures of 18.46˚C and 18.91˚C were recorded, with daily average on April 12 being 18.05˚C.

5.3 CDFW STOCKING

The CDFW annual stocking between January-December 2020 are summarized here. CDFW provided hatchery grown salmonids in several different size categories to the Kings River below Pine Flat Reservoir (88,361 fish, 29,160 pounds), Pine Flat Reservoir (107,560 fish, 13,049 pounds), and Avocado Lake (9,270 fish, 5,700 pounds). These numbers do not include the supplemental fish provided for the KRFMP. Details for each size class are summarized below.

5.3.1 Fingerlings

Pine Flat Reservoir received approximately 382.5 pounds of fingerling salmon (74,970 fish) in 2019. Table 5-3 details stocking of fingerling size fish.

Table 5-3: CDFW salmonid fingerlings planted in Pine Flat Reservoir or the Kings River below Pine Flat 2020.

Water	Species	Fingerlings	
		Year	
		2020	
		# Trout	Pounds
Pine Flat Reservoir			
	Chinook Salmon	74,970	382.5
Total		74,970	382.5

5.3.2 Sub-Catchable Trout

Sub-catchable rainbow trout stocked by CDFW are generally 4-6 inches long. Table 5-3 details stocking of sub-catchable trout. A total of 3,460 pounds (34,031 fish) of sub-catchable rainbow trout were stocked in the lower Kings River as part of the put-and-grow program during 2019. Pine Flat reservoir received a total of 666 pounds (9,990 fish) of sub-catchable brown trout during this same period.

Table 5-4: CDFW sub-catchable trout stocked 2020.

Water	Species	Sub-Catchables	
		Year	
		2020	
		# Trout	Pounds
Kings River below Pine Flat Reservoir			
	Rainbow Trout	34,031	3,460
Pine Flat Reservoir	Brown Trout	9,990	666
Total		44,021	4,126

5.3.3 Catchables

Catchable trout (2 fish per pound) are stocked either once or twice per week during the non-irrigation period (roughly October through March) and once each week during the irrigation season when flows are high. Table 5-5 details stocking of catchable size trout. A total of 24,200 pounds (53,635 fish) of catchable size rainbow trout were stocked in the lower Kings River during 2019. Pine Flat received a total of 12,000 pounds (22,600 catchable rainbow trout) and Avocado Lake received a total of 5,700 pounds (9,270 catchable rainbow trout) during this same period.

Table 5-5: CDFW catchable sized trout stocked 2020.

Water	Species	Catchables	
		Year	
		2020	
		# Trout	Pounds
Kings River below Pine Flat Reservoir	Brook Trout	15,025	7,450
	Rainbow Trout	38,610	16,750
Pine Flat Reservoir	Rainbow Trout	22,600	12,000
Avocado Lake	Rainbow Trout	9,270	5,700
Total		70,480	34,450

5.3.4 Super Catchables

Super-catchable size trout are defined as trout greater than one pound. Table 5-6 details stocking of super-catchable size trout. Kings River below Pine Flat Reservoir received a total of 1,500 pounds of super-catchable trout (695 rainbow and brook trout) in 2020.

Table 5-6: CDFW super-catchable sized trout stocked 2020.

Water	Species	Super-Catchables	
		Year	
		2020	
		# Trout	Pounds
Kings River below Pine Flat Reservoir			
	Rainbow Trout	695	1,500.0
Total		695	1,500.0

5.3.5 Trophy Trout

Beginning December 2005, CDFW implemented a trophy trout stocking program in the put-and take section as well as the catch-and-release section. Trophy trout are designated as trout greater than 2.99 pounds each. No trophy trout were planted in 2020.

6.0 MONITORING

Section G (1)(k) of the Framework Agreement "Development of Criteria/Monitoring" calls for the agencies to carry out a monitoring program to determine the effects of various elements of the KRFMP and the overall status of the fishery. Water temperature and dissolved oxygen monitoring remain a priority. The KRFMP is also dedicated to continuing its annual fish population surveys in the fall.

6.1 ANNUAL FISH POPULATION SURVEYS IN THE LOWER KINGS RIVER

Long-term annual baseline trout fisheries monitoring within the lower Kings River is being conducted as part of the KRFMP to determine (1) the assemblage, abundance and condition of the fish community inhabiting the lower Kings River; (2) overall biomass; (3) hatchery and "wild" rainbow trout abundance and distribution; (4) overwintering survival, size and age structure of rainbow trout populations. Surveys are completed with KRFMP agency staff and the assistance of local volunteers and college students.

Electrofishing is performed at sampling sites within each of the three uppermost management reaches of the lower Kings River (Figure 6-1). Reach One which consists of the section of river between Pine Flat Dam and Alta (Cobbles) Weir is managed as a put-and-take trout fishery, permitting take of up to five trout daily, between the ACOE Bridge and Alta (Cobbles) Weir. The area above the ACOE Bridge has been closed to fishing by order of Homeland Security since September 2001. Additionally, within Reach One, the Thorburn Channel and a 200' radius from the channel exit are also closed to fishing by CDFW regulations. Both Reach Two and the upper portion of Reach Three are managed as a catch-and-release trout fishery, with special regulations permitting zero take of trout and prohibitions on the use of bait and barbed hooks between Alta (Cobbles Weir) and the Highway 180 crossing. Reach Two is located between Alta (Cobbles) Weir and Fresno Weir while Reach Three consists of the portion of river from Fresno Weir to the Reedley Narrows gauging station. This reach is an opportunistic trout fishery as water temperatures downstream of Fresno Weir may not remain suitable for trout in some years.

Surveys are conducted at the same sampling sites each year for use in establishing an abundance index, and for determining trends in abundance of trout and other fish species. Sampling is conducted using a block net on the upper end and lower end of the sample reach and backpack electro-fishers. Electrofishing surveys have been conducted over a period of 36 years (since 1983) in the Kings River by KRCD and CDFW biologists. In 2007, the KRFMP began to use a multi-pass depletion technique. This allowed for more rigorous sampling and provided a more complete assessment of the species composition and abundance found in the sample site. Data collected during the survey include species to the lowest practical taxon, (Table 6-1), total length measured to the nearest mm, fork length is measured for trout, and weight measured to the nearest tenth of a gram. Rainbow trout are classified as either hatchery rainbow trout or "wild" rainbow trout based on characteristics observed while in hand. Rainbow trout of moderate to deep olive coloration, typically with heavy spotting throughout the body, and with worn down or missing fins are categorized as hatchery rainbow trout. Rainbow trout of any size, which exhibit silver to moderate coloring, light to moderate spotting or parr marks, and have fins in excellent condition are classified as "wild" rainbow trout. This group of rainbow trout is assumed to have originated via natural in-river reproduction, from the KRFMP incubator facility, or via recruitment through Pine Flat Dam. This data can then be used to determine trends in the populations and condition of sampled fish species. Sampling sites are 300 feet in length and are sampled using backpack electro-fishers. The final reports are available on the KRFMP website: http://krfmp.org/resources/reports-documents/.

During this reporting period electrofishing surveys were conducted at five of the six designated study sites in 2019. Due to heavy rainfall on December 4 sampling at the Alta e-fishing site was canceled due to unsafe site conditions. The survey was not rescheduled due to water deliveries scheduled for Kings River water users after the e-fishing sampling window of December 2 through December 10 closed. Due to the Exhibit D flows mandated by the KRFMP Framework Agreement and water deliveries in the Kings River, river flow was higher than permissible for electrofishing. To allow for sampling to occur in 2019 flows were pulsed during the electrofishing period following the ramping schedule outlined in the Framework Agreement (KRFMP 1999) to prevent negative impacts on the fishery, releases from the dam were ramped down at a predetermined time so that target flows at the sampling site could be met by the time surveyors needed to enter the water. Releases were then ramped up again daily to meet water delivery needs in the afternoon of sampling. This ramping cycle allows for surveyors to safely enter the water and complete the sampling effort while still meeting the KRWA's obligation to its water users.

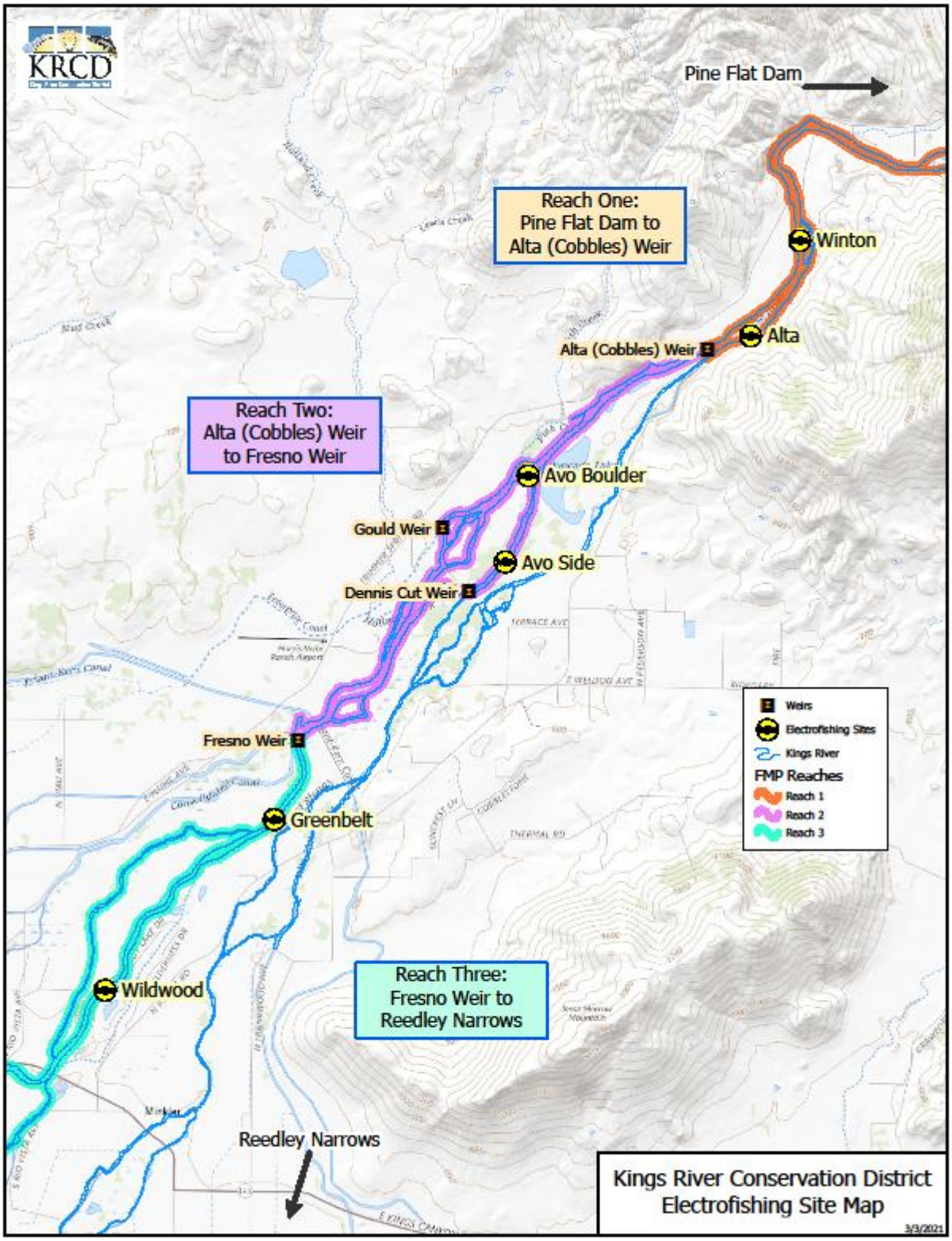


Figure 6-1: Electrofishing sites in the Kings River and their respective FMP management zones.

Table 6-1: Fish species, number collected, and percentage of total catch during the annual fish population survey in 2019. NS indicates the site was not sampled in 2019.

December 2019								
	Winton	Alta	Avo Boulder	Avo Side	Greenbelt	Wildwood	Total	% of Total
California Roach	0	NS	11	25	8	84	**128**	**7.3%**
Catfish sp.	3	NS	0	2	1	0	**6**	**0.3%**
Lamprey sp.	4	NS	5	166	2	8	**185**	**10.5%**
Rainbow Trout - "Wild"	1	NS	3	10	0	0	**14**	**0.8%**
Rainbow Trout - Hatchery	0	NS	26	8	0	0	**34**	**1.9%**
Sacramento Pikeminnow	23	NS	6	4	21	8	**62**	**3.5%**
Sacramento Sucker	44	NS	174	155	53	158	**584**	**33.1%**
Sculpin sp.	339	NS	67	168	69	68	**711**	**40.3%**
Three-spine Stickleback	8	NS	13	9	5	5	**40**	**2.3%**
Total Fish Captured	**422**	**0**	**305**	**547**	**159**	**331**	**1,764**	
% of Total	**24%**	**0%**	**17%**	**31%**	**9%**	**19%**		**100%**

Table 6-2: 2019 Estimate of fish species per-mile in the lower Kings River tailwater fishery.

2019 Species Per-mile Estimate	
California Roach	451
Catfish sp.	21
Lamprey sp.	651
Rainbow Trout - "Wild"	49
Rainbow Trout - Hatchery	120
Sacramento Pikeminnow	218
Sacramento Sucker	2,056
Sculpin sp.	2,503
Three-spine Stickleback	141

6.2 2019 FISH POPULATION SNORKEL SURVEY

In The fall of 2019 the KRFMP contracted with FishBio to conduct a snorkel survey within the 11.2-mile reach of the Kings River between the ACOE Bridge and Greenbelt County Park. This allowed for sampling a greater extent of river as well as sampling in areas with greater habitat diversity (greater depths and velocities) than is possible with the annual Fall electrofishing survey. The primary objective of the survey was to characterize the size distribution and size class of trout in the river. Presence of other fish species within survey reaches was also documented.

Snorkel surveys were conducted on November 19-21 with outflows from Pine Flat Dam ranging between 313 cfs-367 cfs. Sampling occurred in habitat units identified as riffles, runs, and pools which were selected via a random number generator for each habitat type. A sub-sample of surveyed habitat units was randomly selected for calibration of dive counts. Habitat units were generally sampled in a downstream direction, although wider sites required divers swim upstream along on the edges after completing the downstream count. Depending on the width of the sampling site, three or more divers were required for each count.

Thirty habitat units were sampled by FishBio. Sixteen habitat units (4 pools, 5 riffles, 7 runs) were above Alta Weir while the remaining fourteen habitat units (3 pools, 6 riffles, 5 runs) were below. They sampled a total of 19.1% of the 11.2 miles between the ACOE Bridge and Greenbelt County

Park. Additionally, they surveyed 19.1% of each reach both above and below Alta Weir. Nine species were observed during the survey. Native species observed included rainbow trout, Sacramento sucker, Sacramento pikeminnow, California Roach, sculpin sp., and three-spine stickleback. Non-native species observed included white catfish, bluegill sunfish, and bass sp.

Species abundance could only be estimated for Sacramento sucker and rainbow trout due to patchy abundance of other species. Sacramento suckers were estimated at 4,494 for the 11.2-mile reach, with 1,897 estimated above Alta Weir and 2,597 estimated below. A total of 127 rainbow trout were directly observed during the snorkel survey, leading to an estimation of 1,625 rainbow trout (145 fish/mile) within the 11.2-mile section of river sampled. Of these trout, it was estimated 549 (109 fish/mile) were in the 5 miles above Alta Weir and the remaining 1,076 (174 fish/mile) in the 6.2 miles below. Most rainbow trout were observed in runs (55%) and riffles (38%). FishBio estimated for each of the habitat units 830 trout in riffles, 745 in runs, and 50 in pools. It was also noted by FishBio, the smallest size class (<150 mm) was the least abundant (estimated 144), followed by the largest size class (>300 mm, estimated 607), with the medium size class (150-300 mm) most abundant (estimated 874).

To FishBio, this skewed size class data suggests this reach of the Kings River has poor natural recruitment, limited survival of early life stages, or increased stocking of larger sized trout. While the snorkel survey did not distinguish between trout of hatchery or "wild" origin, due to the difficulties a snorkel survey presents in making that determination, FishBio does note that natural populations are typically dominated by smaller size classes with decreasing abundance as fish age increases. Also, considering the quantity of stocking occurring within the sampled reach of the Kings River, density and abundance estimates were relatively low suggesting high harvest pressure and/or emigration and/or entrainment from the study reach.

6.3 Lower Kings River Angler Creel Survey

CDFW conducted an angler survey on the Kings River, below Pine Flat Reservoir from January 2020 through March 2020. The surveyed reach started at the ACOE bridge and extended downstream to the Greenbelt parking lot. The reach was divided into 3 sections: Section 1 – ACOE bridge downstream to Piedra Bridge. Section 2 – Piedra Bridge downstream to Cobbles (Alta) Weir. Section 3 – Cobbles (Alta) Weir downstream to Greenbelt parking lot. Sections 1 and 2 are the traditional put-and-take reach and Section 3 is the catch-and-release reach. The three sections surveyed are historical sections used in past angler surveys. Results were compared to past KRCD and CDFW surveys to evaluate the effectiveness of the supplemental stocking program.

Catch-per-unit effort (CPUE), January – March 2020 was 0.51 fish/hour and was substantially higher than 0.088 – 0.33 CPUE reported from 1990 – 2001 (KRCD) and the 0.18 CPUE reported by CDFW (2006). Analysis of stocking density verses CPUE shows a positive relationship with higher stocking densities producing higher CPUEs. Angler satisfaction with the fishery, in 2020, was high (4.5, Scale = 1 – 5). Angler use, in 2020, declined from the high numbers of anglers observed in 2006 and was slightly higher than the angler numbers observed by KRCD from 1990 – 2001. The decline in angler numbers between the 2020 and 2006 surveys may be attributed to the absence of trophy trout in 2020. Angler demographics were similar to past surveys. Fresno, Madera, Kings and Tulare Counties accounted for 95% of the anglers fishing the lower Kings River.

The supplemental stocking program is achieving its goal of increasing angler success (CPUE) and has created a fast action fishery in the process. CDFW defines a fast action fishery as a catch rate of 0.5 or greater (CPUE). Catch rates were high across all three sections surveyed indicating that the distribution strategy for put-and-take (75%) and catch-and-release (25%) areas are providing a balanced fishery, while providing diverse angling opportunities.

7.0 PUBLIC EDUCATION AND OUTREACH

7.1 WEBSITE

KRCD staff has maintained and updated the website throughout 2020. The site contains a photo album, contact page, volunteer site, access to program reports and documents, projects, and links to resources: http://krfmp.org/.

7.2 HYDROLOGY AND TEMPERATURE REPORT

For operations, KRWA uses a real-time telemetry system for monitoring water temperature and streamflow at Fresno Weir. Typically, during the summer and fall of dry hydrologic years, information collected on the lower Kings River is compiled in weekly reports and distributed by KRWA to members of the PAG and other interested parties to provide current information on environmental conditions that would affect habitat quality. These reports have provided information on flows in the lower river and tributary streams as well as a summary of flow and temperature trends. Copies of these reports remain on file at KRWA. Hydrologic and Climate Summary Reports were circulated August 1, 2018 – November 17, 2019 a timeframe when reservoir outflow was being reduced from high irrigation levels and temperature blending of reservoir releases was used to provide flows to the lower Kings River. By November 17, 2019 no blending was occurring.

7.3 EDUCATIONAL TOURS

7.3.1 Incubator Building

Multiple tours were hosted at the incubator during the 2019-2020 rearing period (Table 7-1) prior to March 19 when Governor Newsom issued the “Stay at Home” order in the effort to control the COVID-19 (coronavirus) pandemic. As a result of this order all remaining tours of the incubator were canceled for the rest of the trout rearing season. Topics covered during tour events include a general overview of the purpose and history of the trout rearing program, the trout lifecycle, and the role of trout in the local ecosystem.

Table 7 - 1: Organizations and school groups provided with tours of the KRFMP Trout Incubator during the 2019-2020 season.

Date	Organization
11/25/19	Reedley College - Watershed Class
12/14/19	Girl Scouts - Clovis Troop #5004
01/22/20	Sanger Unified School District - Teachers & Administrators
01/30/20	Scout Island Outdoor Education Center - Director
02/07/20	Fresno Unified School District - Science Teachers
02/08/20	Boys & Girls Club - Orange Cove Chapter
02/12/20	Chaffee Zoo - Education Department
02/25/20	Kings River & Taft High Schools, Community Day School - Art & Science Students

8.0 MAINTENANCE ACTIVITIES

8.1 THORBURN CHANNEL

KRCD staff periodically cleared the headgate of accumulated debris. However, additional routine maintenance activities of the channel, roadways, and trail did not occur during the program year.

8.2 INCUBATOR BUILDING

While in service, daily operation and maintenance of the incubator facility is performed by KRCD Environmental staff Monday thru Friday. Volunteers care for the trout fry in the facility most weekends and holidays during incubator operation. Volunteers are also utilized to assist with planting of trout fry into the river. The total number of individuals who volunteered time to assist with either daily operation of the incubator building or with fry release are summarized in table 8-1. Volunteer assistance to the incubator was greatly reduced during the final rearing period due to the worldwide COVID-19 (coronavirus) pandemic. After March 19, when Governor Newsom issued a "Stay at Home" order the KRCD Environmental staff directed all volunteers to immediately cease participation with the trout incubator facility until further notice. As a result, KRCD staff took over weekend coverage of trout fry and the final fry release of the season. During this reporting period no building or equipment maintenance utilizing staff from the KRCD Pine Flat Power Plant was required.

Table 8 - 1: Number of volunteers and amount of time dedicated to the KRFMP Trout Incubator during the 2019-2020 season.

Incubation Period	Volunteers (#)	~ Time (Hours)
10/29/2019-12/18/2019	27	118
01/06/2020-02/26/2020	55	109
02/28/2020-04/15/2020	9	17

9.0 DEVELOPMENT OF A LONG-TERM IMPLEMENTATION PLAN

Section G(1) of the Framework Agreement includes elements addressing adaptive management (Section 1b); stream temperature monitoring (Section 1d); funding for habitat enhancement projects (Section 1f); enforcement, education, and awareness program (Section 1i); stocking program (Section 1j); development of criteria/monitoring (Section 1k); and access (Section 1p). The Annual Implementation Plan helps to provide guidance, prioritize activities and the allocation of expenditures, and coordinate among the parties to facilitate efficient implementation of these elements of the Framework Agreement. The Long Term Implementation Plans (formerly 10 Year Plans): (1) provide a project management structure for reviewing and prioritizing proposed habitat enhancement activities, fish stocking, and other elements of the Framework Agreement; (2) identify the objectives and methods to be used to assess the overall response of trout and other species for use in evaluating achievement of the Kings River aquatic resource goals as identified in Section 1a of the Framework Agreement; and (3) provide a framework for the experimental design and evaluation of specific enhancement activities (e.g., enhancement projects funded under the Framework Agreement, fish stocking and supplementation, pulse flows for temperature management, etc.) within the context of the overall goals and activities being implemented through the Framework Agreement. Results of monitoring and evaluation activities serve, in part, as the basis for the adaptive management element of the Framework Agreement (Section 1b) and for identifying changes in program priorities, or the allocation of resources from one program element to another. The Long-Term Implementation Plan is a "living plan" that is reviewed by the TSC, Public and ExCom on an annual basis and revised as projects and elements of the program are implemented and as new scientific information becomes available.

REFERENCES

Elliott, J. M. 1994. Quantitative Ecology and the Brown Trout. R. M. May and P. H. Harvey, eds. Oxford Series in Ecology and Evolution. Oxford University Press. New York, NY. 286 pp.

Hellmair, M., J. Guignard, and J. Montgomery. 2020. Lower Kings River 2019 Fish Population Survey. FishBio. May 2020. https://krfmp.org/webpages/wp-content/uploads/2021/03/2019-Snorkel-Survey_FINAL_May-2020.pdf

Johnson, K. 2020. 2020 Lower Kings River angler survey downstream Pine Flat Dam to Greenbelt Parking Lot, Fresno County, California. California Department of Fish and Wildlife.

Kings River Conservation District (KRCD). 2020. Lower Kings River Annual Trout and non-game Fish Population Survey: Kings River Conservation District 2019 Electrofishing Results. Kings River Conservation District Environmental Resource Division. In-House Report. http://krfmp.org/webpages/wp-content/uploads/2020/03/2019-Population-Survey.pdf

Kings River Fisheries Management Program (KRFMP). 1999. Kings River Fisheries Management Program Framework Agreement. http://krfmp.org/_pdf_fmp/FMP_FrameworkAgreement1999.pdf

Leitritz, E., and R. C. Lewis. 1976. Trout and Salmon Culture (Hatchery Methods): California Department of Fish and Game. Fish Bulletin 164.

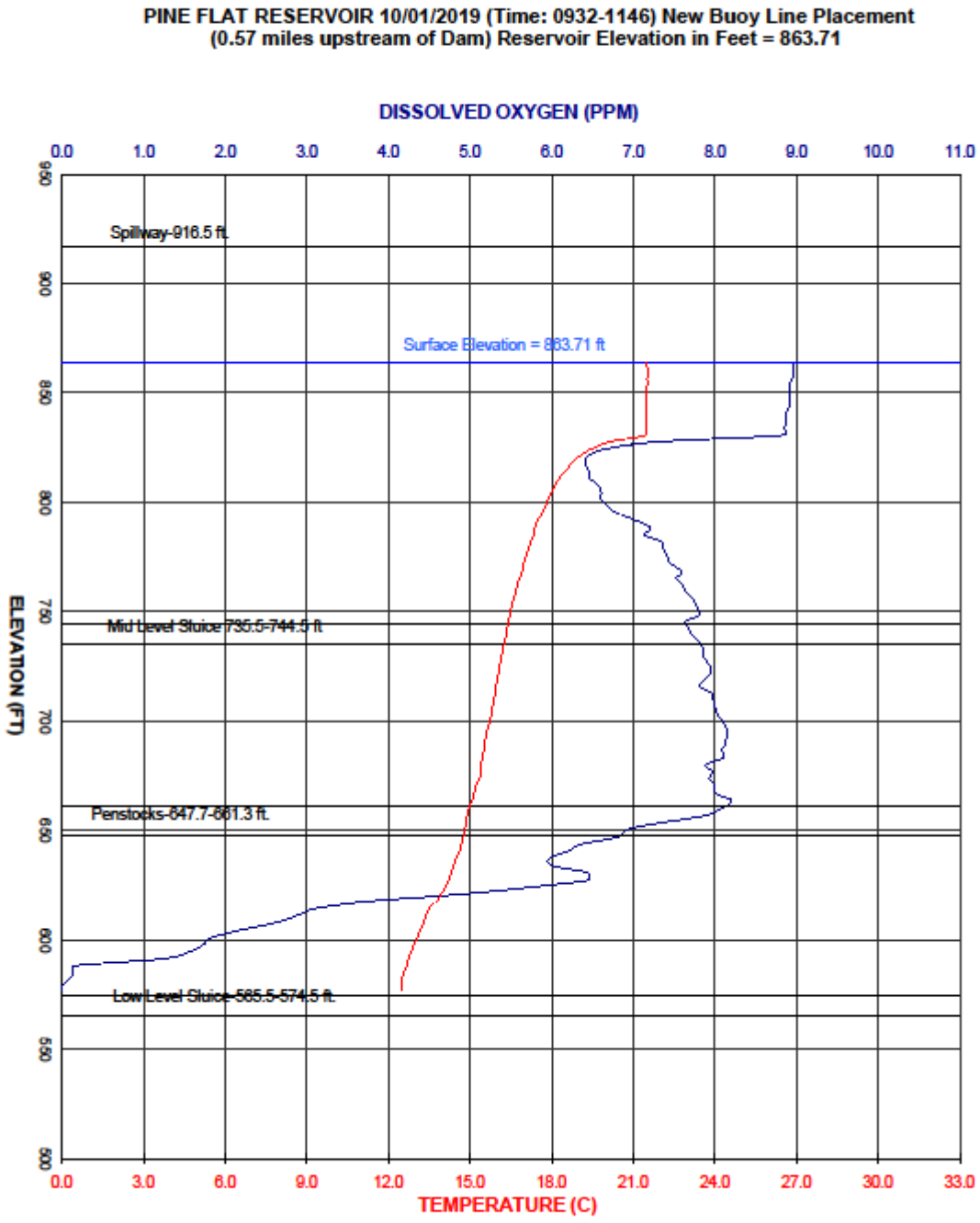
Moyle, P. B. 2002. Inland Fishes of California: Revised and Expanded. University of California Press. Berkeley, California. 502 pp.

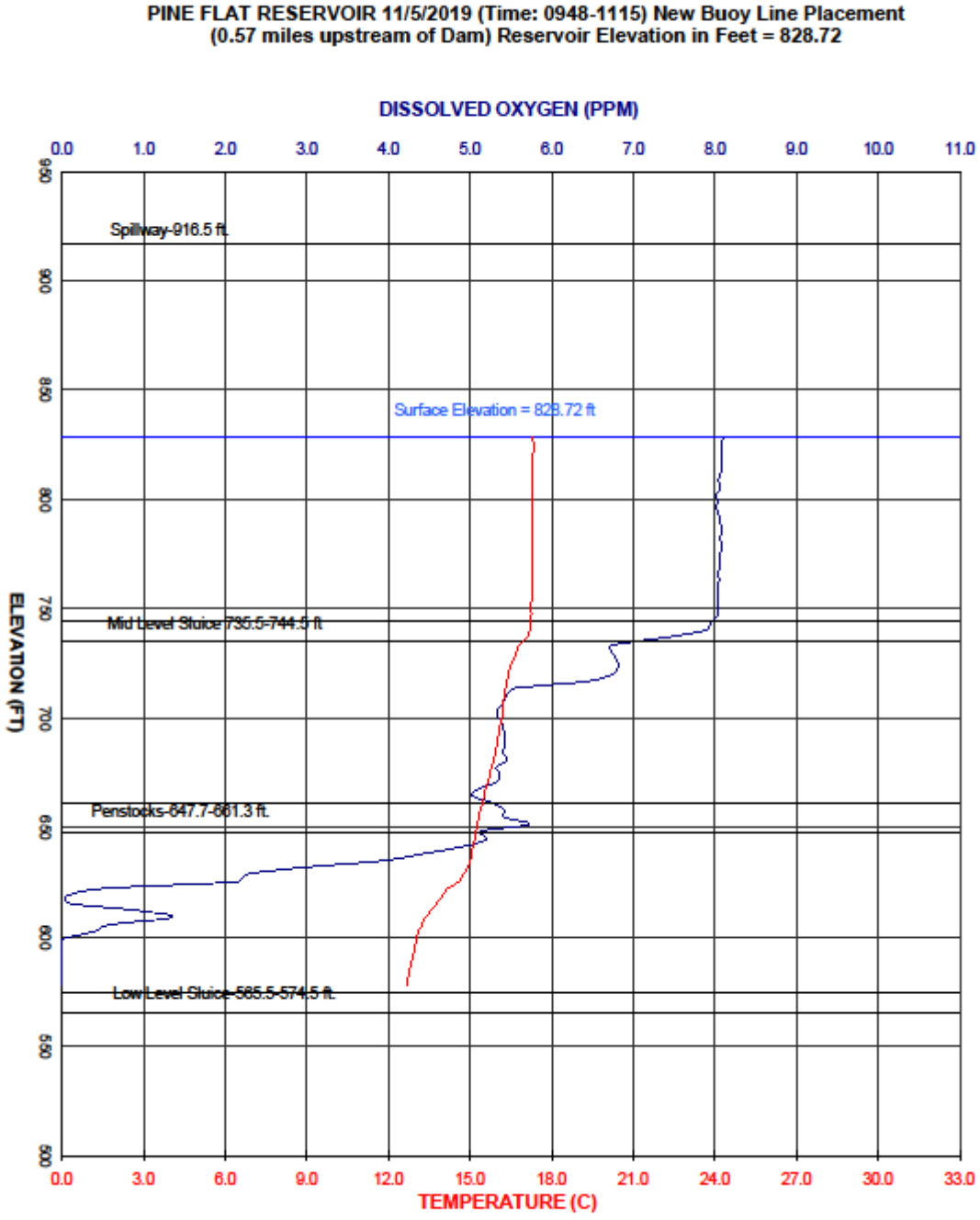
Nickerson, Philip. P.Eng. 2011. Avoid Water Chiller Errors. Global Aquaculture Advocate. November/December 2011.

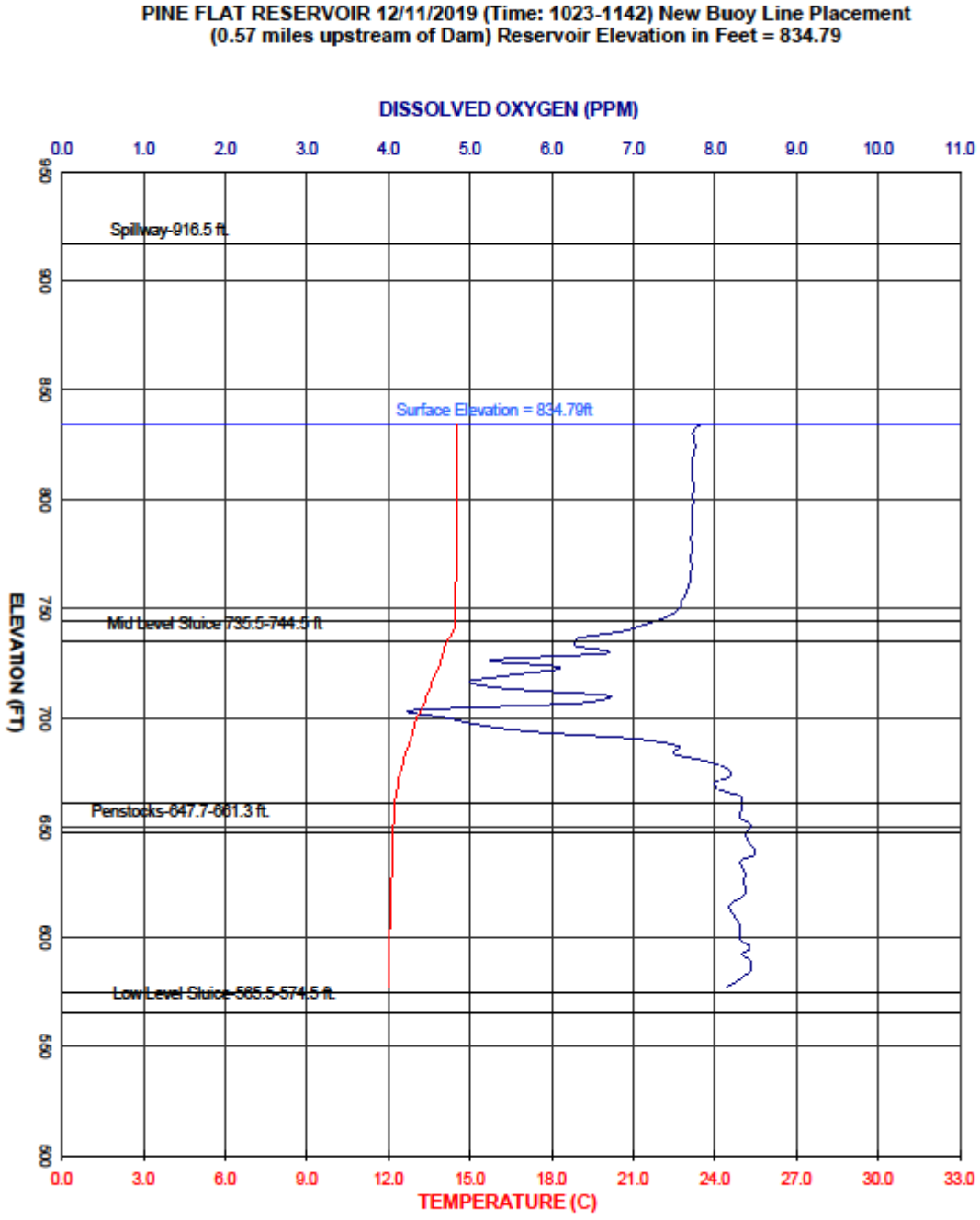
Woynarovich, A., G. Hoitsy, and T. Moth-Poulsen. 2011. Small-scale rainbow trout farming. FAO Fisheries and Aquaculture Technical Paper 561.

Appendix A

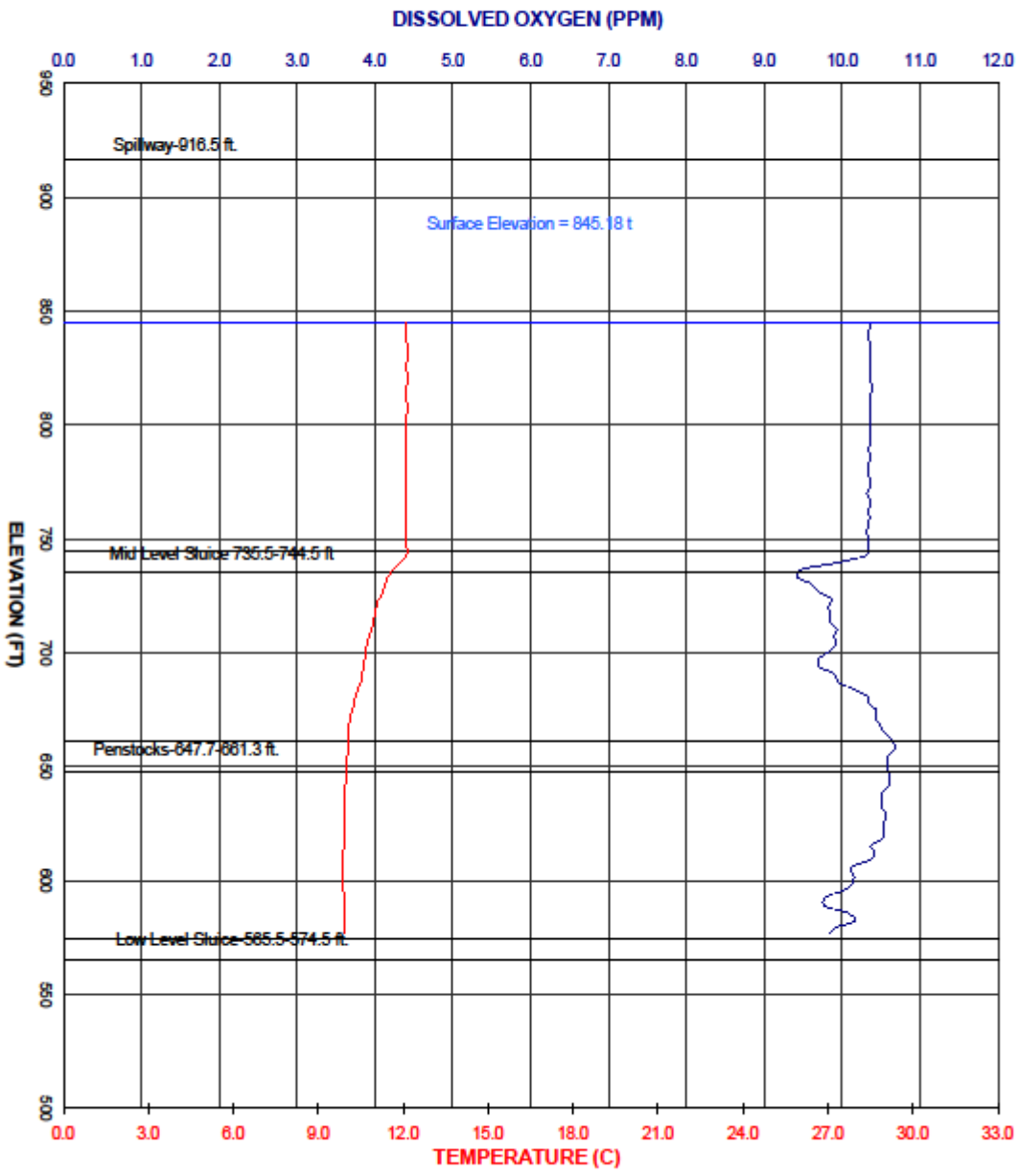
Pine Flat Reservoir Temperature and Dissolved Oxygen Profiles
October 2019 – September 2020


PINE FLAT RESERVOIR 10/01/2019 (Time: 0932-1146) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 863.71
DISSOLVED OXYGEN (PPM)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
Spillway-916.5 ft.
Surface Elevation = 863.71 ft
Mid Level Sluice-735.5-744.5 ft.
Penstocks-647.7-661.3 ft.
Low Level Sluice-565.5-574.5 ft.
ELEVATION (FT)
950
900
850
800
750
700
650
600
550
500
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
27.0
30.0
33.0
TEMPERATURE (C)

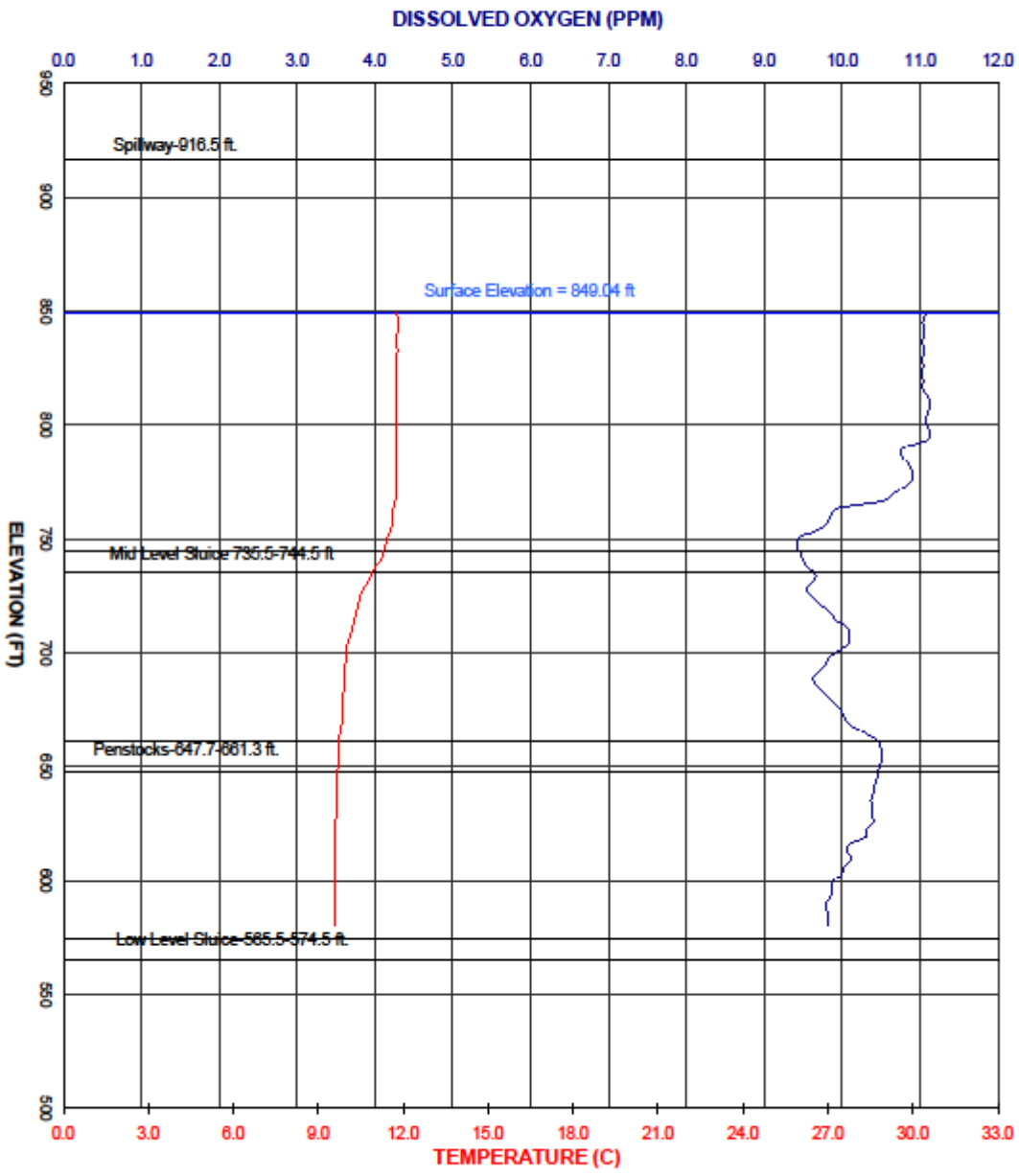

PINE FLAT RESERVOIR 11/5/2019 (Time: 0948-1115) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 828.72
DISSOLVED OXYGEN (PPM)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
Spillway-916.5 ft.
Surface Elevation = 828.72 ft
Mid Level Sluice-735.5-744.5 ft.
Penstocks-647.7-661.3 ft.
Low Level Sluice-565.5-574.5 ft.
ELEVATION (FT)
950
900
850
800
750
700
650
600
550
500
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
27.0
30.0
33.0
TEMPERATURE (C)


PINE FLAT RESERVOIR 12/11/2019 (Time: 1023-1142) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 834.79
DISSOLVED OXYGEN (PPM)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
Spillway-916.5 ft.
Surface Elevation = 834.79ft
Mid Level Sluice-735.5-744.5 ft.
Penstocks-647.7-661.3 ft.
Low Level Sluice-565.5-574.5 ft.
ELEVATION (FT)
950
900
850
800
750
700
650
600
550
500
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
27.0
30.0
33.0
TEMPERATURE (C)

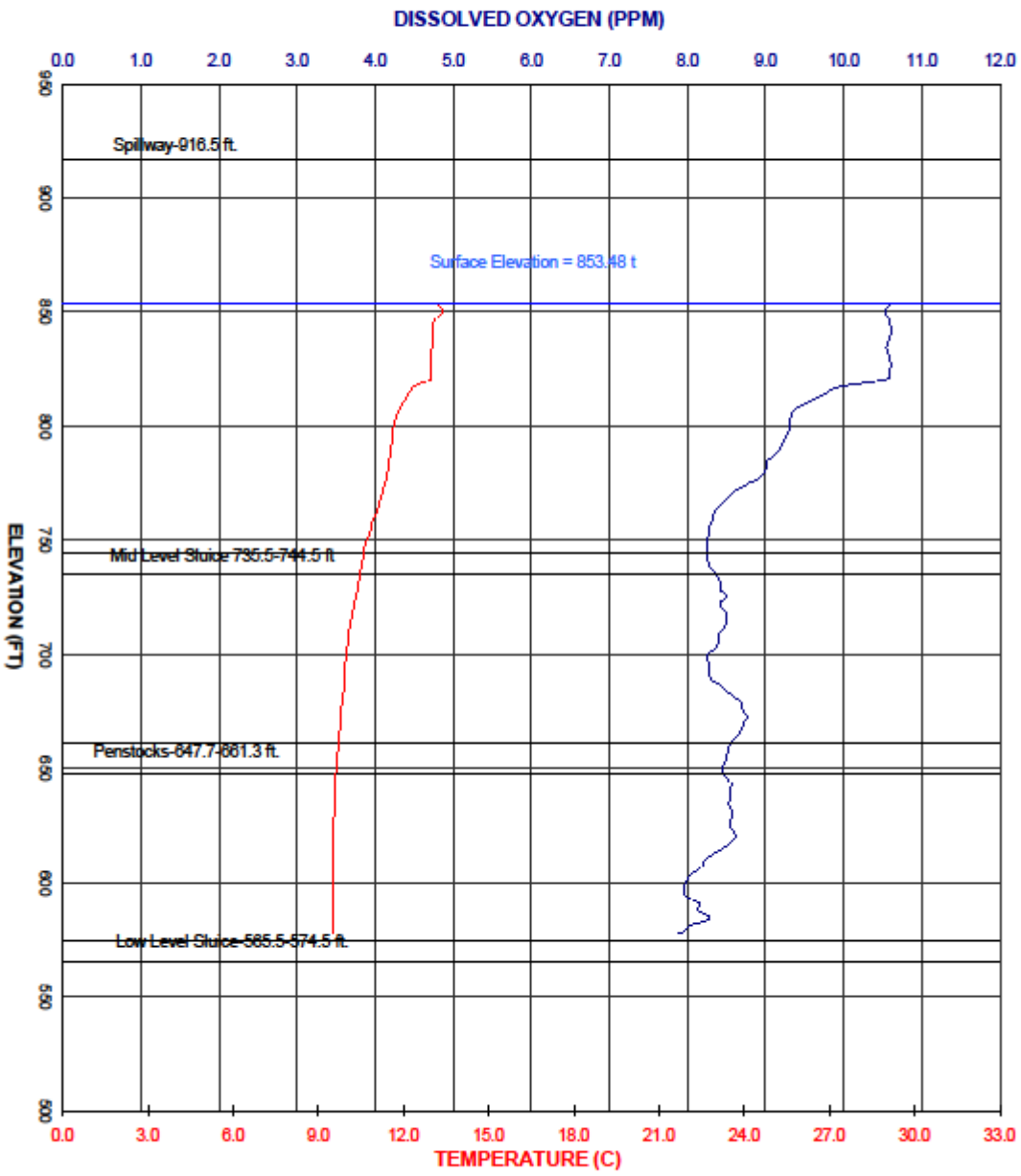
PINE FLAT RESERVOIR 01/14/2020 (Time: 0956-1056) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 845.18



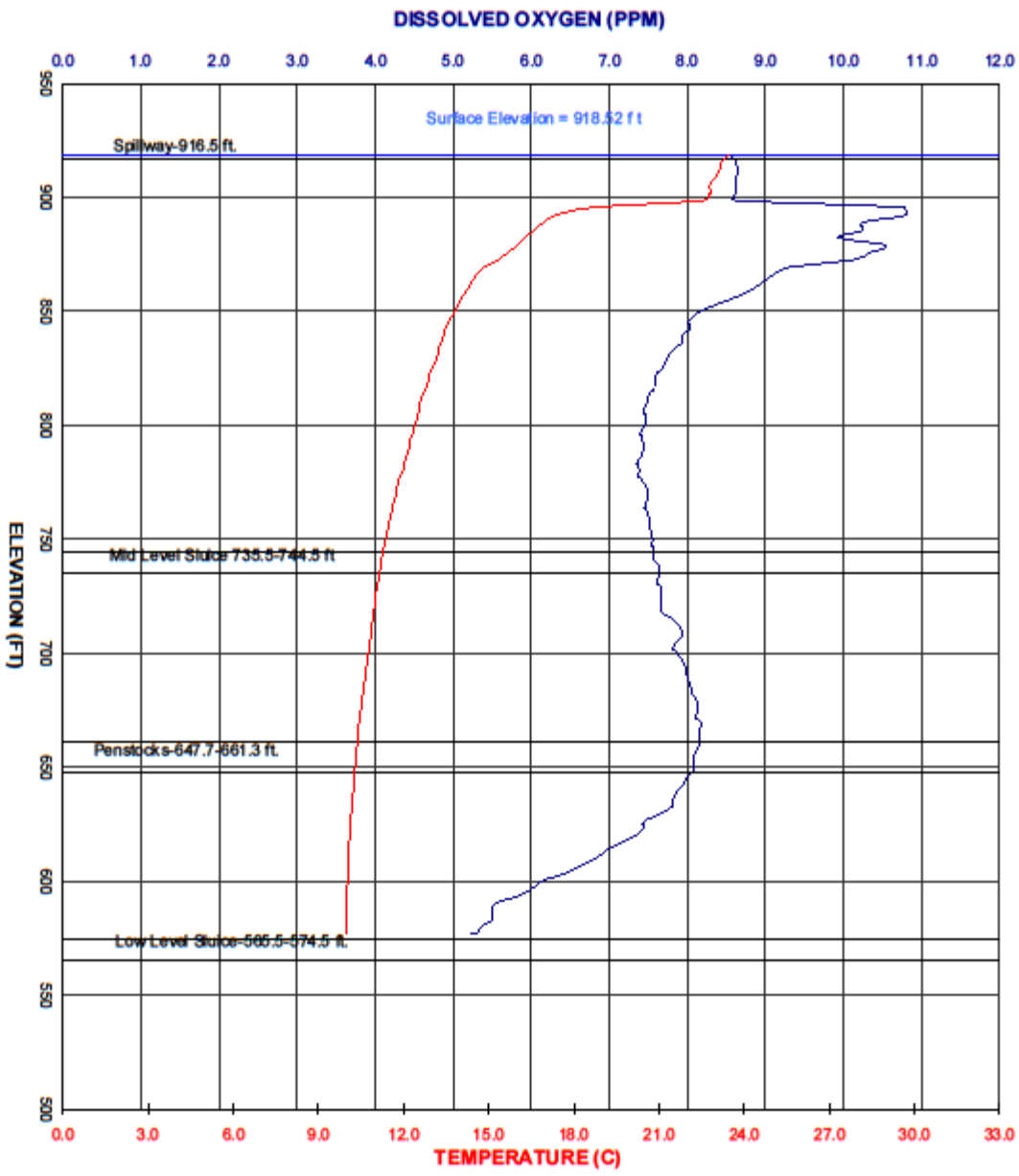
PINE FLAT RESERVOIR 02/04/2020 (Time:1015-1105) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 849.04



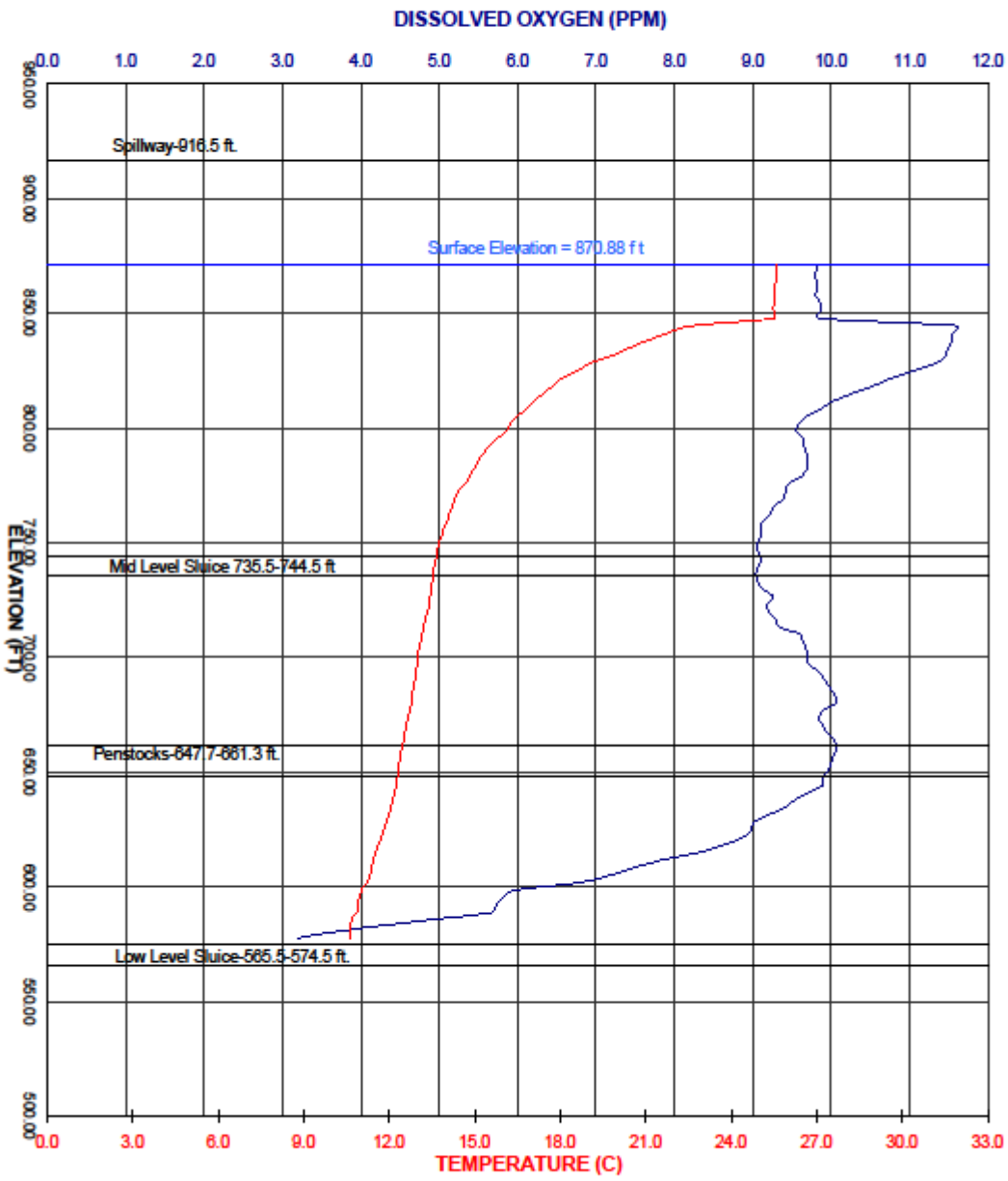
PINE FLAT RESERVOIR 03/03/2020 (Time: 1020-1214) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 853.48



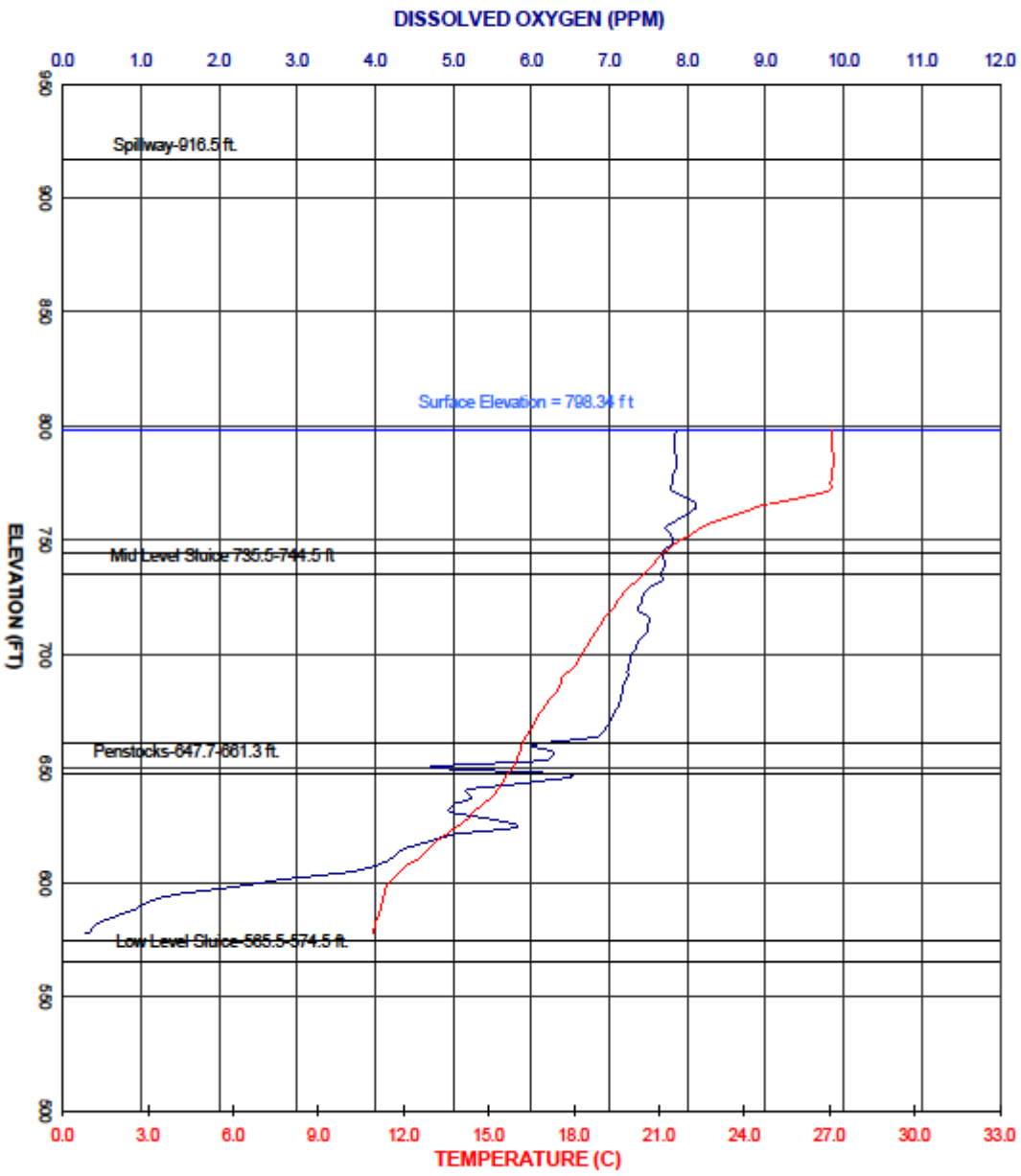
PINE FLAT RESERVOIR 06/02/2020 (Time: 1041-1203) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 918.52



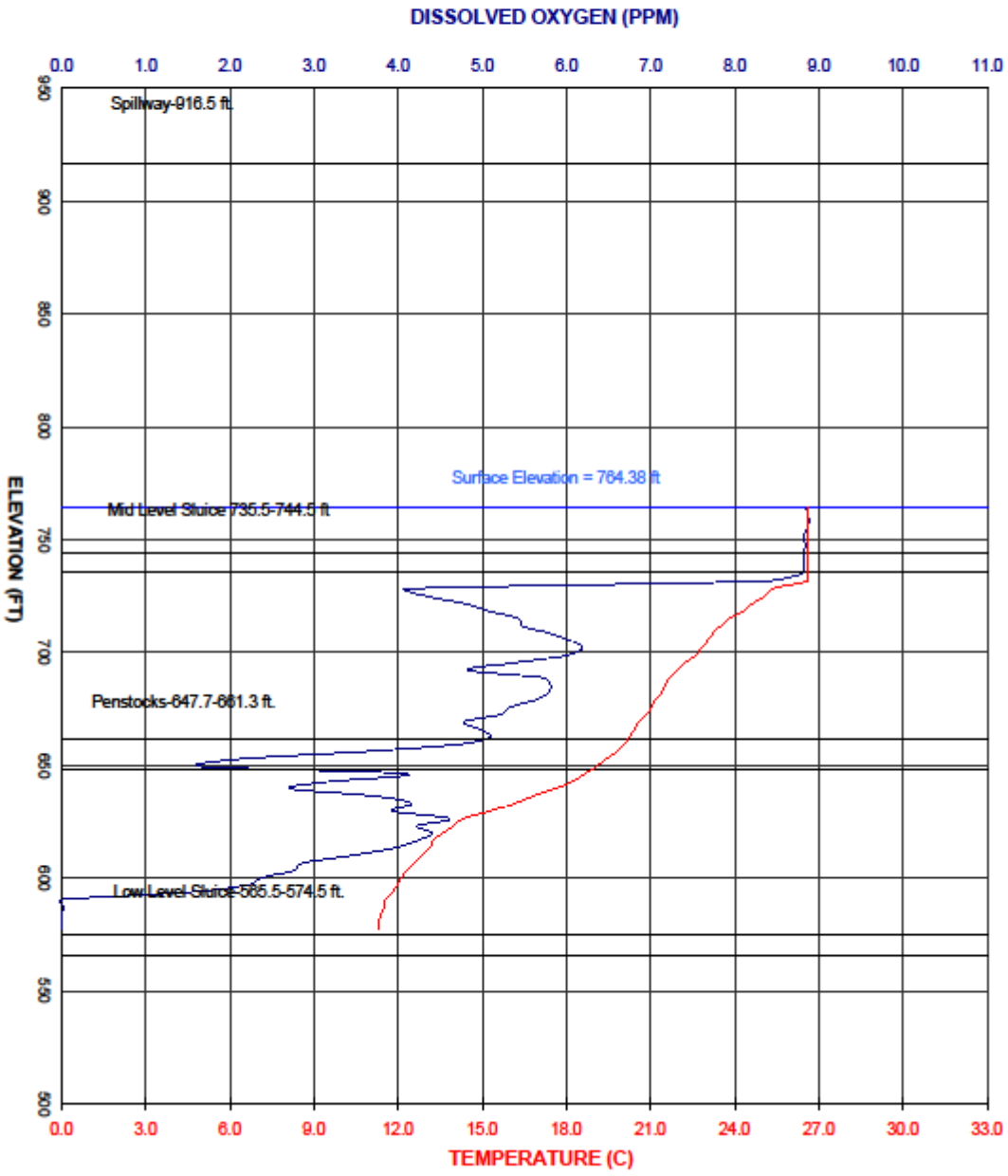
PINE FLAT RESERVOIR 07/07/2020 (Time: 0915-1005) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 870.88



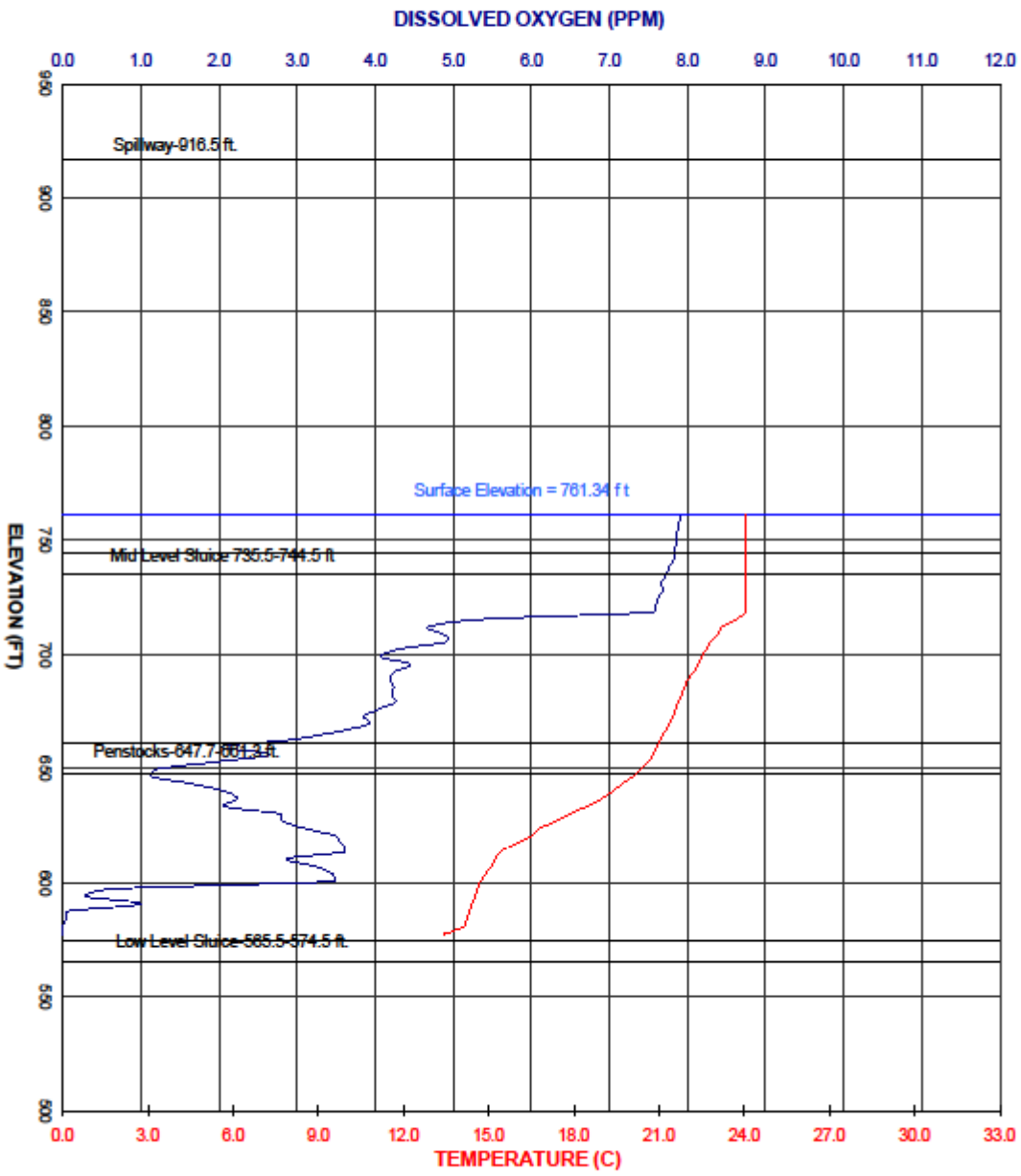
PINE FLAT RESERVOIR 08/05/2020 (Time: 1021-1102) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 798.34



PINE FLAT RESERVOIR 09/02/2020 (Time: 0904-0955) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 764.38



PINE FLAT RESERVOIR 09/16/2020 (Time: 1032-1133) New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 761.34



PINE FLAT RESERVOIR 09/30/2020 (Time: 1040-1122 New Buoy Line Placement
(0.57 miles upstream of Dam) Reservoir Elevation in Feet = 762.17