Annual Report of Activities

October 1, 2017 to October 22, 2018

Weir and fish ladder at Nimbus Fish Hatchery on the Lower American River below Nimbus Dam.

Photo credit: Spencer Marshall, Sarah Perrin, and Zarela Guerrero, USBR

American River Group (ARG)

November 2018

Acronyms and Abbreviations

ARG	American River Group
BiOp	Biological Opinion
cfs	Cubic Feet Per Second
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CDFW	California Department of Fish & Wildlife
CWP	Coldwater Pool
FMS	Flow Management Standard
LAR	Lower American River
MRR	Minimum Release Requirements
NMFS	National Marine Fisheries Service
Reclamation	U.S. Bureau of Reclamation
RM	River Mile
RPA	Reasonable and Prudent Alternative
RTDOT	Real-Time Drought Operations Management Team
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	Thousand Acre-Feet
TCD	Temperature Control Device
USFWS	U.S. Fish & Wildlife Service

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Chapter 1 – Background

1.1 American River Geographic Orientation

The American River is the second largest tributary to the Sacramento River located in California's Central Valley. The North, Middle, and South forks of the American River originate in the Sierra Nevada range and then flow into Folsom Reservoir, approximately 25 miles east of the City of Sacramento, California. Folsom Dam and Reservoir as well as Nimbus Dam and Lake Natoma are features of the Central Valley Project (CVP) operated by the U.S. Bureau of Reclamation (Reclamation). The lower American River (LAR) reach begins at Nimbus Dam, approximately river mile (RM) 23, and continues downstream until its confluence with the Sacramento River. Figure 1 illustrates the LAR and surrounding features.

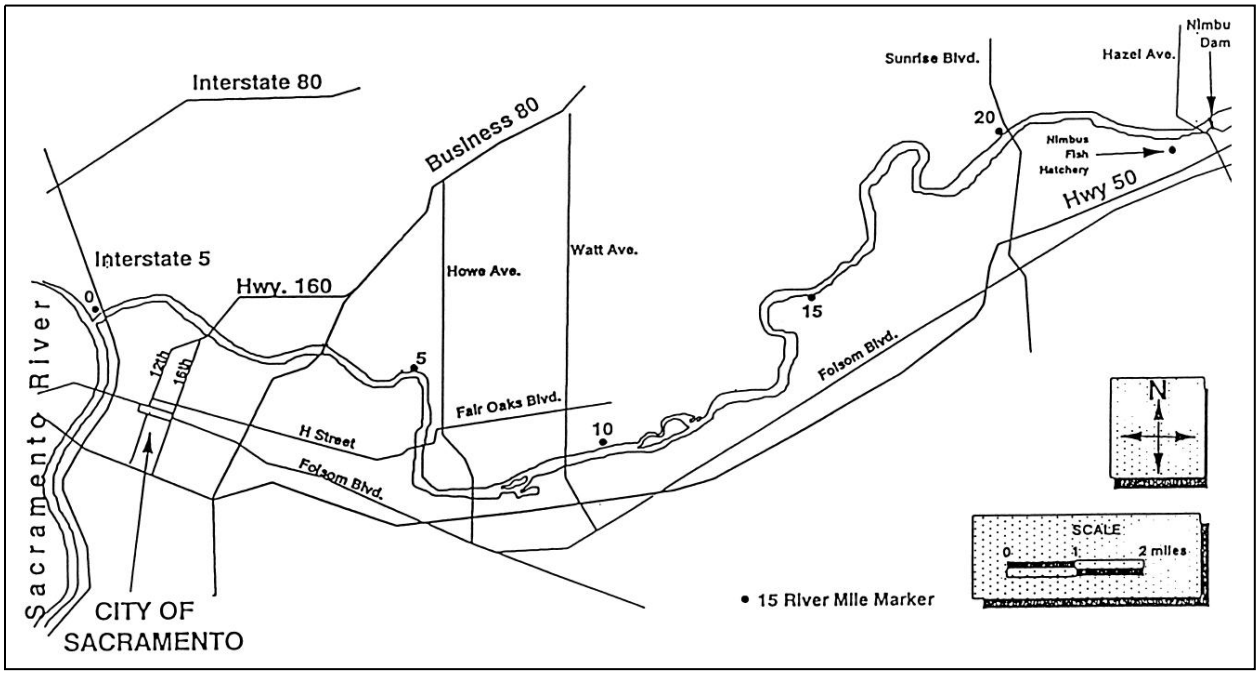

Figure 1. The lower American River between Nimbus Dam and the Sacramento River

1.2 Lower American River Historical Background

The LAR is a significant resource of considerable interest and provides water supply to urban and agricultural uses, flood control, fish and wildlife protection, recreational opportunities, hydroelectric power generation, and protects conditions in the Sacramento-San Joaquin Delta. The regulating facilities of the Folsom/Nimbus Dam complex include Folsom Dam, Reservoir and Powerplant, Nimbus Dam and Powerplant, and Lake Natoma. Releases from Folsom Dam are re-regulated approximately seven miles downstream by Nimbus Dam. Nimbus Dam creates Lake Natoma, which serves as a forebay for the diversions to the Folsom South Canal. Additional facilities include the Nimbus Fish Hatchery, at Nimbus Dam, owned by Reclamation and operated by the California Department of Fish and Wildlife (CDFW).

Reclamation operates Folsom/Nimbus Dam under a state water right permit and fish protection requirements that were adopted in 1958 as the State Water Resources Control Board (SWRCB) Decision 893 (D-893). This decision allows flows at the mouth of the American River to fall as low as 250 cubic feet per second (cfs) from January through mid-September, with a minimum of 500 cfs required between mid-September through December 31. The flow operations based on D-893 may not optimize the habitat protection. Since 1958, additional SWRCB Decisions, Congressional Acts (i.e. Central Valley Project Improvement Act (CVPIA), and a Federal Biological Opinion (BiOp) Reasonable and Prudent Alternative (RPA) (NMFS 2009 BiOp, Appendix 2D and 2011 RPA amendment), have changed the regulatory landscape for the State and Federal Water Projects.

The Water Forum, comprised of local American River stakeholders, has successfully joined together water purveyors, environmentalists, agriculturalists, business leaders, along with city and county governments in Sacramento, El Dorado and Placer counties in an agreement to secure Sacramento region water supply through the year 2030. The Water Forum has promoted operational changes with coequal objectives: "to provide a reliable supply for planned development to the year 2030, and to preserve the Sacramento region's environmental crown jewel, the lower American River". The Water Forum, in cooperation with Reclamation, National Marine Fisheries Service (NMFS), Untied States Fish and Wildlife Service (USFWS), and CDFW developed a draft Flow Management Standard (FMS) for the LAR to potentially improve the conditions of aquatic resources in the LAR. The FMS design is to improve habitat conditions for fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) fish in the LAR by enhancing minimum flows and water temperature, establishing a formal management process, and facilitating coordinated monitoring, and evaluation and reporting (Water Forum 2006).

The FMS was included in the NMFS 2009 BiOp on the Long-Term Operations of the CVP and State Water Project (SWP) RPA (Appendix 2D and 2011 RPA amendment). The FMS flow criteria have been tracked since 2006 and implemented, per the NMFS 2009 BiOp RPA action, since 2009. Reclamation continues to work with the Water Forum, NMFS, CDFW, USFWS, and other interested parties to integrate a revised flow management standard for the LAR into CVP operations and associated water rights.

The FMS is designed to integrate temperature performance capability for management of the downstream habitat. The NMFS 2009 BiOp also adopted components of the FMS temperature management process. Because water temperature control operations in the LAR are affected by many factors and operational

tradeoffs, ideal downstream temperature targets are sometimes infeasible (particularly with multiple years of below normal or dry conditions). The factors include available cold water resources, Nimbus release schedules, annual hydrology/snow pack, Folsom power penstock shutter management flexibility, Folsom Dam Urban Water Supply Temperature Control Device (TCD) management, power generation, and Nimbus Fish Hatchery operations and maintenance. Two structural devices provide downstream temperature management: (1) the Folsom Shutters and (2) the TCD. These devices control the desired downstream temperature by selecting the elevation where the water is withdrawn from the reservoir. In addition to accessing cooler water using the shutter elevations, a blending operation can also be employed where shutters at differing elevations are mixed or blended for temperature management. Lastly, when temperature operations exhaust the reservoir's coldwater pool past the lowest shutter locations prior to the fall, Reclamation has the ability to bypass the Folsom Shutters (power generation) to release the coolest water from the river outlets, the lowest elevation outfall in Folsom Dam, to maintain targeted temperatures in the LAR.

Reclamation established a working group to coordinate fishery and operational requirements for the LAR, known as the American River Group (ARG), in 1996. Reclamation is the lead coordinator of the ARG, bringing together those who have either a legislated or resources-specific interest in the operation of Folsom Dam and Reservoir, and the LAR. Agencies with trust responsibilities for the water resources in the LAR and the surrounding areas participate in the ARG. Members of the public and other agencies may attend ARG meetings and comment on matters under consideration by the ARG. The ARG convenes monthly or more frequently, if needed, to provide updates on water operations, fisheries, and other environmental concerns. Reclamation considers the provided information when making management decisions regarding temperatures and flows necessary to sustain fish resources in the LAR.

Chapter 2 – Reasonable and Prudent Alternative (RPA) Actions (NMFS 2009 BiOp)

2.1 Summary of RPA Actions

On June 4, 2009, NMFS issued the BiOp and Conference Opinion on the Long-Term Operations of the CVP and SWP that included RPA actions for the LAR (Table 1). The ARG was included amongst the four fisheries and operations technical teams whose function is to make recommendations for adjusting operations to meet contractual obligations for water delivery and to minimize adverse effects on listed anadromous fish species (see Section 11.2.1.1, NMFS 2009 BiOp).

There are several RPA actions that discuss minimal flow requirements and temperature objectives for the LAR: Action II.1.; "Lower American River Flow Management", Action II.2; "Lower American River Temperature Management", and Action II.4; "Minimize Flow Fluctuation Effects" (NMFS 2009 BiOp, Appendix 2D, and 2011 RPA amendment). The objectives of these RPA actions are to provide minimum flows for all stages of steelhead and to maintain suitable temperatures to support over-summer rearing of juvenile steelhead. A Temperature Management Plan is prepared for NMFS' consideration in May of each year that takes into consideration actions under Reclamation's authority using iterative modeling

techniques (i.e. The iterative Coldwater Pool Management model-see NMFS 2009 BiOp, Appendix 2D). Since 2009 Reclamation and NMFS continue to work together to address all of the elements of the RPA actions.

Table 1. NMFS BiOp Reasonable and Prudent Alternative (RPA) actions, description, and page references in the 2009 BiOp with 2011 amendments[1] related to American River operations.

ACTION ID	Page #	RPA Action Name
Action II.1	612-614	Lower American River Flow Management
Action II.2	614-615	Lower American River Temperature Management
Action II.3	615-616	Structural Improvements
Action II.4	617	Minimize Flow Fluctuation Effects
Action II.5	617	Fish Passage at Nimbus and Folsom Dams
Action Suite II.6	617-619	Implement the Following Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations

Chapter 3 – Summary of ARG Discussions

The following agenda items were discussed at monthly ARG meetings from October 2017 through September 2018. Meeting notes and supplemental ARG documents were made available.

3.1 Monthly Discussion Topics

- **Lower American River Fisheries Monitoring**
    - The status of current fisheries monitoring activities provided by Reclamation, NMFS, USFWS, and CDFW, as well as planned future fisheries monitoring activities.
- **Water Operations and Water Quality**
    - Flows measured at Nimbus Dam, temperatures at Watt Avenue. See Chapter 4.
- **NMFS BiOp RPA Actions – American River Division:**
    - RPA Action II.1 – Lower American River Flow Management

      Goal: Implementation of flow schedule specified in the FMS, which is summarized in Appendix 2-D of the NMFS 2009 BiOp.

[1]The 2011 NMFS RPA adjustments are available online at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/040711_ocap_opinion_2011_amendments.pdf

Discussion: Reclamation convenes the ARG to make recommendations for management within the constraints of the FMS.

- RPA Action II.2 – Lower American River Temperature Management

  Goal: Maintain suitable temperatures to support over-summer rearing of juvenile steelhead in the LAR.

  Discussion: Reclamation convenes the ARG to make recommendations regarding cold water management alternatives to improve water temperature conditions for fish, including potential power bypasses.

- RPA Action II.4 – Minimize Flow Fluctuation Effects

  Goal: Reduce stranding and isolation of juvenile steelhead through ramping protocols.

  Discussion: Reclamation convenes the ARG to make recommendations regarding ramping protocols and monitoring activities to effectively adjust releases from Nimbus to reduce the risk of stranding and isolation of steelhead.

3.2 Other Discussion Topics

- **Central Valley Project Improvement Act**
  - LAR Gravel Augmentation Program

    Restore and replenish spawning and rearing habitat that was lost due to the construction and operation of the CVP. Spawning and rearing habitat restoration projects on the LAR are part of a continuing program under the CVPIA. This year's planned project is located at upper Sailor Bar, approximately one mile downstream of the Nimbus Dam. However, due to permitting delays this project will not begin in 2018.

  - LAR fall-run Chinook Carcass Survey

    Estimate the escapement of fall-run Chinook salmon in a 13.1 mile section of the LAR from Nimbus Hatchery weir downstream to the Watt Avenue Bridge. The objectives of the surveys are to: 1) estimate the population size of returning Chinook salmon spawning in a 13.1 mile section of the LAR; 2) determine the general age and sex of returning Chinook salmon; 3) determine pre-spawning mortality; and 4) determine the ratio of returning hatchery-reared, coded-wire tagged salmon. The 2017/18 preliminary escapement estimate of fall-run Chinook salmon for the LAR is 7,457 fish. The combined 2017 LAR fall-run Chinook salmon escapement estimate from the in-river survey, Nimbus Fish Hatchery and weir collections is 23,893 fish. The LAR escapement survey was conducted over 14 survey periods from October 17, 2017, to January 19, 2018.

Chapter 4 – Water Operations Summary

General Water Year Conditions and Operations

Water year 2018 had total precipitation slightly below the long-term average. The 40-30-30 index for the Sacramento Valley was below normal. American River operations were dominated by storage conservation operations from late December through June, 2018, with some small flood control releases at times.

Hydrologic Conditions – American River

Watershed runoff in California is typically driven by winter precipitation and spring snow-melt runoff and quantified as a late spring through summer inflow volume (April through July volume, in addition to a water year total volume). The American River watershed spring/summer forecasted inflow volume is fundamental in operational planning; this is product updated routinely by the Department of Water Resources (DWR) and the National Weather Service-California Nevada River Forecast Center (CNRFC), where uncertainty is represented by percent runoff exceedances. The initial April – July 90% (conservative volume) unimpaired runoff exceedance forecast volume (February) was estimated at 460 TAF, or 38% of the average 1,350 million acre feet (MAF) was projected for the water year. The actual full natural flow volume April –July in 2018, was 1,072 thousand acre feet (TAF) and 89% of the average (final water year volume was 2,351 MAF). Table 2 provides data and characteristics of water year 2018. Because operational planning is significantly influenced by future forecasts, these uncertainties and eventually modified decisions are translated into the performance and efficiency of the system-wide operation.

Table 2. 2018 Water Year Northern Sierra precipitation, American River Basin snowpack, and Sacramento Valley Index statistics by month.

Water Year 2018 Month	Northern Sierra 8-Station Precipitation (Cumulative water year in inches through month)	Northern Sierra 8-Station percentage of historic monthly average (for month)	American River Basin Snowpack (percent of April 1 average)	Sacramento Valley Index (40-30-30 Index 50% Exceedance)
November	11.9	168%	NA	NA
December	12.6	7%	NA	9.3
January	19.6	78%	4	8.1
February	21.3	20%	18	6.7
March	33.9	165%	13	6.0
April	38.7	126%	66	6.9
May	40.5	81%	14	7.2

(DWR 2018)

Operations – Lower American River

Operational decisions on the LAR are balanced with local, CVP and SWP system-wide multi-purpose objectives including those that are planned and uncertain. Many factors contribute to operational actions including, but not limited to: flood protection, forecasted inflows, facility maintenance schedules, physical/mechanical facility limitations, upstream operations, minimum in-stream flow criteria, downstream Delta regulatory requirements, Delta exports, power generation, recreation, fish hatchery accommodations, temperature management capabilities, and others. In addition, uncertain or unplanned events may also influence real-time operation decisions (e.g. additional flow reduction for debris removal prior to fish weir and picket installation for the Nimbus Fish Hatchery). Planned operational targets are regularly updated late winter through early summer (depending on hydrologic conditions) on Reclamation's website (http://www.usbr.gov/mp/cvo/) (Reclamation 2018).

Key decisions that influenced 2018 LAR operations:

- Minimum flow rate/FMS: While WY18 was a below normal water year, a series of small storms was sufficient to keep instream releases above the Minimum Release Requirements (MRR) flows for all but approximately the first three weeks in March. In May, releases were cut for several days. The conserved water volume was then available for release in a short pulse flows requested by the fisheries agencies to facilitate outmigration of hatchery fish into the river.
- Coldwater Pool (CWP): The coldwater pool was well developed by the end of May this water year (Table 3).
- Coldwater Pool Protection: the temperature shutters were operated in the all down position beginning the end of March to protect the coldwater pool (Table 3).
- Temperature Management Plan: At the end of April the Iterative Coldwater Pool Management Model (iCPMM) results indicated a feasible maximum mean daily temperature target at Watt Avenue Bridge of 65°F. Monthly modeling updates indicated a need to operate to a maximum

mean daily temperature target at Watt Avenue of 66°F. This was based on changing coldwater pool data and existing climatological conditions. The model also indicated the potential for a November temperature target of 59°F at Watt Avenue.

- Cold Water Bypass: Reclamation is evaluating the potential need for implementing cold water bypass this year as of this writing.

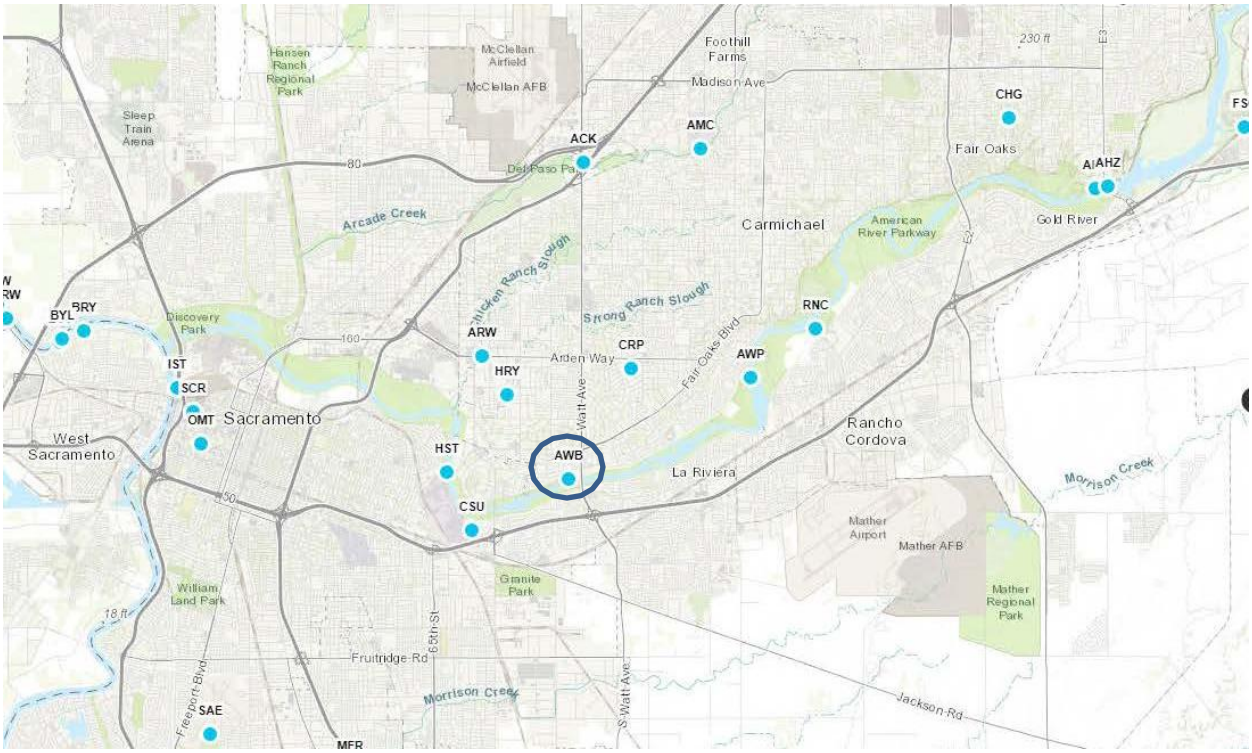

Figure 2. Location of temperature monitoring station at Watt Avenue

Table 3. Historical Folsom Reservoir Coldwater Pool dynamics.

Historical Conditions (2001-2018)						
Year	End of May		All Upper Shutters Lowered by	End of September		Watt Avenue Target (˚F)
	Storage (TAF)	CWP Volume < 58˚F (TAF)		Storage (TAF)	CWP Volume < 60˚F (TAF)	
2001	696	275	30 Mar	368	30	65-71
2002	822	455	04 Mar	510	50	65-69
2003	962	640	02 Apr	658	135	65-67
2004	635	300	05 Mar	376	30	69
2005	959	705	15 Mar	652	140	65
2006	928	670	29 Mar	639	125	65
2007	787	355	21 Mar	323	30	68
2008	617	250	None Lowered	270	25	69-70
2009	933	550	12 Mar	412	60	67
2010	905	580	14 Apr	624	130	66
2011	880 (960-July)	590	28 Mar	740	180	65
2012	926	536	29 Mar	450	60	65-66
2013	734	277	15 Apr	361	50	69
2014	548	200	None Lowered	345	35	70
2015	576	256	None Lowered	174	39	75
2016	826	421	23 Mar	306	27	68

2017	937	558	2 June	664	85	65
2018	955	622	28 Mar	467	56	66

4.1 RPA Action II.1 – Lower American River Flow Management

RPA Action II.1 is designed to provide minimum flow for all steelhead life stages, as specified by the FMS. These MRR are total releases measured at Nimbus Dam and are dependent on upstream storage and hydrologic conditions. The prescribed flows are minimums only and do not preclude Reclamation from making higher releases. Storage and flood control conditions are illustrated in Figure 2 which also includes inflow and releases October 2017 through October 2018.

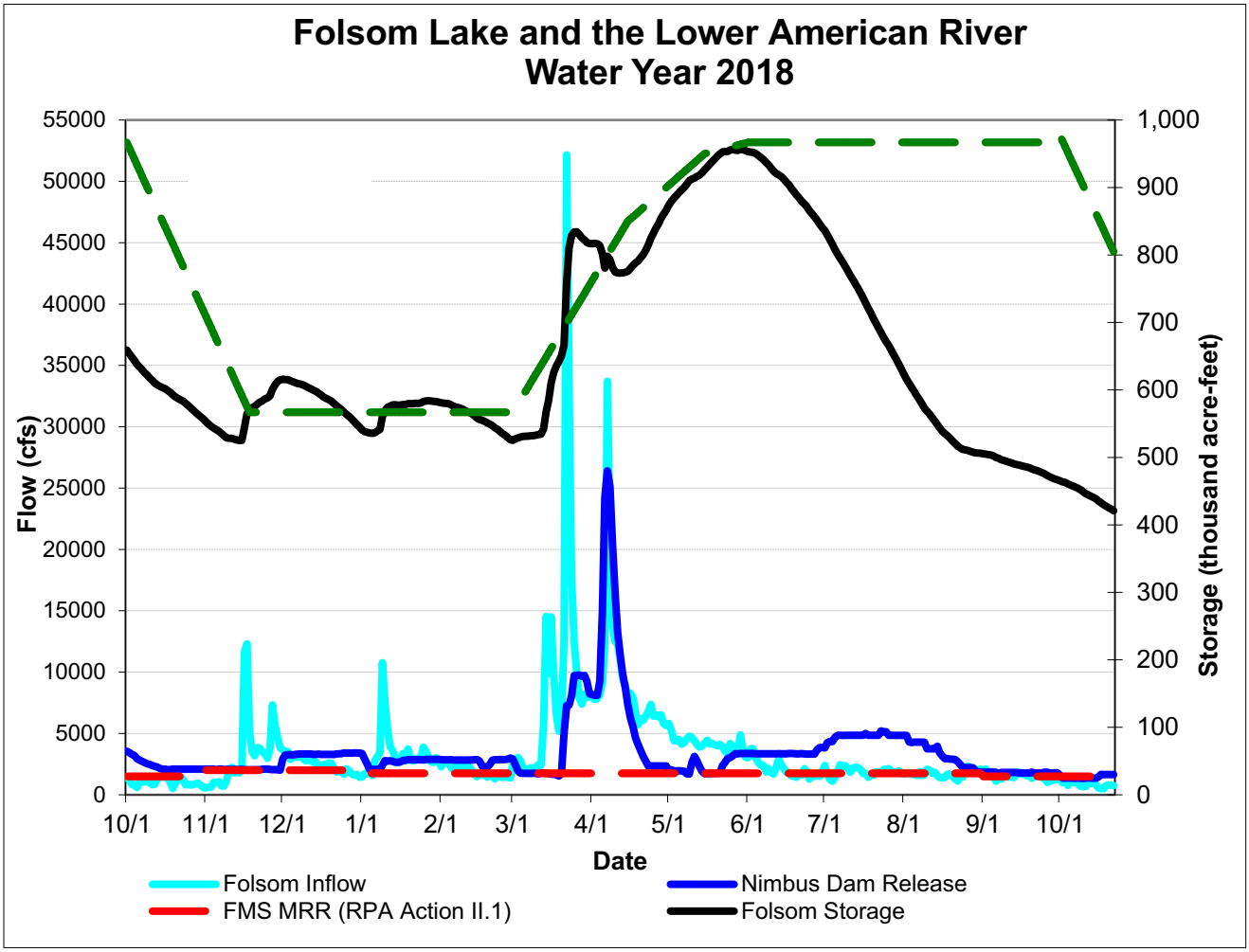

Figure 3. Summary of Folsom Reservoir Storage and Lower American River Flows[2]

[2] FMS MRR (RPA Action II.1) Conference/Off-Ramp Drought Operations were effective beginning March 2015 and terminated January 2016.

The Nimbus Dam releases to the LAR and the MRR prescribed by the FMS for water year 2018 are shown on Figure 3. In addition, the primary reasons for release changes to the LAR are identified on the figure. Folsom storage at the end of September was 467 TAF. The iCPMM model indicated a temperature target of 59°F beginning November 1 (not shown).

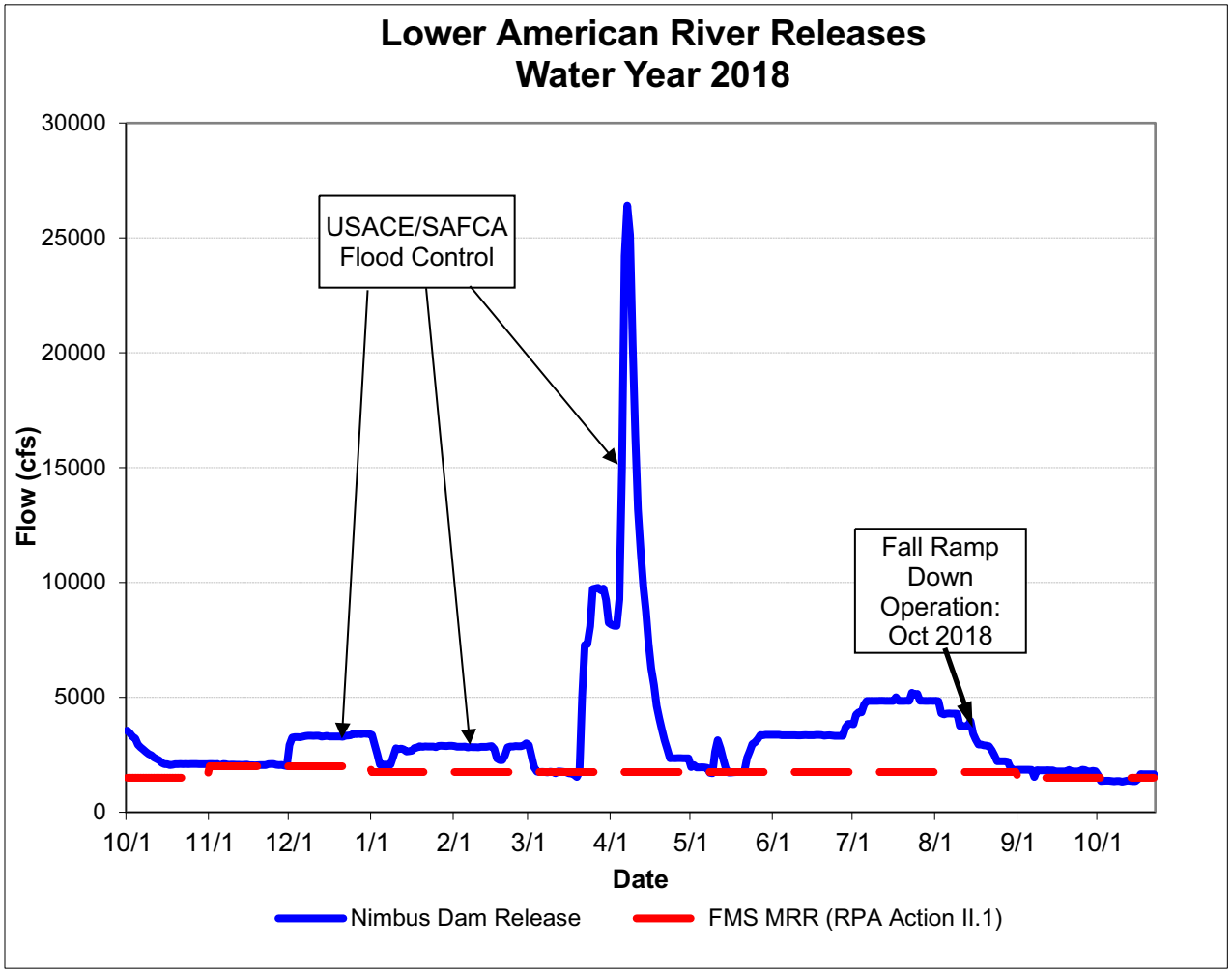

Figure 4. Summary of Lower American River Releases at Nimbus Dam

Table 4 contains a summary of operational release changes from Nimbus Dam. Flow management adjustments included flood control, storage conservation, fall-run Chinook salmon spawning, Delta needs and salinity management, and picket installation below Nimbus Dam.

Table 4. Release Changes at Nimbus Dam

Start Date	End Date	Release	To (cfs)	Comment
10/1/2017	10/4/2016	Decrease	3,000	Reducing flows for fall spawning
10/5/2017	10/14/2017	Decrease	2,000	Spawning flow
12/1/2017	12/1/2017	Increase	3,500	Storage management/flood control
1/1/2018	1/3/2018	Decrease	2,000	Storage management
1/9/2018	1/9/2018	Increase	3,000	Storage management
2/16/2018	2/17/2018	Decrease	2,400	Storage management
2/20/2018	2/20/2018	Increase	3,000	Delta needs
3/1/2018	3/1/2018	Decrease	2,500	Storage management/ramping to FMS
3/2/2018	3/3/2018	Decrease	1,750	Storage management/ramping to FMS
3/18/2018	3/19/2018	Increase	1,350	Storage management/ramping to FMS
3/19/2018	3/19/2018	Increase	1,750	Imminent flood control
3/20/2018	3/21/2018	Increase	7,500	Imminent flood control
3/24/2018	3/24/2018	Increase	10,000	Storage management
3/29/2018	3/31/2018	Decrease	8,300	Storage management/flood control
4/3/2018	4/3/2018	Hold	8,300	Storm expected at end of week
4/4/2018	4/4/2018	Increase	10,000	Storage management for imminent storm
4/5/2018	4/5/2018	Increase	20,000	Increase in forecasted Folsom inflows
4/6/2018	4/6/2018	Increase	25,000	Forecasted storm operations.
4/8/2018	4/8/2018	Decrease	20,000	Decreasing inflows
4/9/2018	4/18/2018	Decrease	5,000	Decreasing inflows
4/18/2018	4/23/2018	Decrease	2,500	Storage conservation
5/1/2018	5/1/2018	Decrease	2,000	Storage conservation
5/7/2018	5/14/2018	Decrease	1,750	Storage conservation for pulse flow later
5/22/2018	5/22/2018	Increase	2,500	Delta Salinity
5/24/2018	5/24/2018	Increase	3,000	Delta Salinity
5/26/2018	5/26/2018	Increase	3,500	Delta Salinity
6/28/2018	6/28/2018	Increase	4,000	Delta needs
7/2/2018	7/2/2018	Increase	4,500	Delta needs
7/5/2018	7/5/2018	Increase	5,000	Delta needs
8/2/2018	8/3/2018	Decrease	4,500	Storage conservation
8/9/2018	8/10/2018	Decrease	4,000	Reduced delta needs
8/14/2018	8/16/2018	Decrease	3,100	Reduced delta needs
8/23/2018	8/23/2018	Decrease	2,200	Reduced delta needs
8/28/2018	8/29/2018	Decrease	1,800	Reduced delta needs
9/6/2018	9/7/2018	Decrease	1,000	Fish picket installation
9/7/2018	9/7/2018	Decrease	700	Debris removal during picket installation
9/7/2018	9/7/2018	Increase	1,800	Picket installation complete
10/1/2018	10/1/2018	Decrease	1,500	October FMS

4.2 Action II.2 - Lower American River Temperature Management

RPA Action II.2 is designed to provide suitable temperatures to support over-summer rearing of juvenile steelhead in the LAR from May 15th through October 31st. Figure 4 is a summary of Reclamation's temperature operations, from October 2017 through October 2018, at the Watt Avenue Bridge (~RM 9) temperature compliance point. Each year available water resources and conditions are assessed to develop a temperature management plan. The iCPMM model tool is used to generate temperature modeling results which are one component that guides the decision making for the Temperature Management Plan. Model runs incorporate the latest operation's forecast (inflow, outflow and storage) and iteratively select a temperature target based on available resources and a pre-assumed habitat balance between steelhead and fall-run Chinook. The selected plan requires NMFS approval, with input from members of the ARG. The plan is reviewed for potential updates every month based on the latest hydrology and coldwater pool conditions. NMFS must concur on proposed deviations from the plan that may reduce the likelihood that the temperature objective would be met.

Reclamation submitted a Temperature Management Plan to NMFS on May 1, 2018, with the expectation that Folsom Reservoir storage conditions would fill to full capacity in the spring. The initial Plan in May included an iCPMM temperature model run with the objective to achieve a maximum temperature (mean daily) target at Watt Avenue Bridge of 65°F. Subsequent modeling later in May and June indicated a need to target a maximum daily average temperature of 65°F. Monthly modeling updates continued to prescribe a temperature target of 66°F through the summer months. The temperature target of 66°F at Watt Avenue was exceeded five times in July, 12 times in August, and two times in September. The exceedances in July were the result of needed reoperations owing to system effects from the Carr fire. In August, the river did not respond as rapidly as anticipated to release temperature changes, combined with seasonal heat. No exceedances have occurred since the end of September.

The FMS temperature management strategy and RPA acknowledge resource needs for the protection of Fall-run Chinook salmon spawning. The goal is to achieve cooler temperatures by November 1st, depending on the availability of remaining coldwater pool resources. The onset of seasonal fall cooling in most years occurs about the same time Folsom Lake becomes isothermal, near mid-November. As a result, many years continue active temperature management after RPA Action II.2's October 31st date. This is typically accomplished by releasing water from Folsom Dam's lower river outlet gates and at a cost to power generation. As of this writing, by-pass operations have not yet been required, but the potential need is being evaluated for November operations.

As has happened in most years, the temperature control operations are not complete prior to the required writing of the annual report. The previous Annual Reviews documented spring and summer actions well but were truncated ahead of the most difficult and critical period for temperature management in the fall. As a result of recent drought periods and heightened sensitivity of thermal influences on life stages, prudent efforts to accomplish critical review and efficacy of temperature management decision making for targeted species would capture the entire active selective withdraw period (lake stratification through de-stratification, typically April through the end of November or early December). Within season temperature targets, locations, metrics, and release decisions can significantly influence fall temperature performance. Water year 2018 was fortunate to have frequent smaller events leading to the ability to maximize capture of the storm events, and resulting in a nearly full Folsom reservoir by the end of May.

The water level aided in temperature management operation throughout the year. However, challenges are anticipated transitioning from the warm to cold water fishery habitat in the beginning of November.

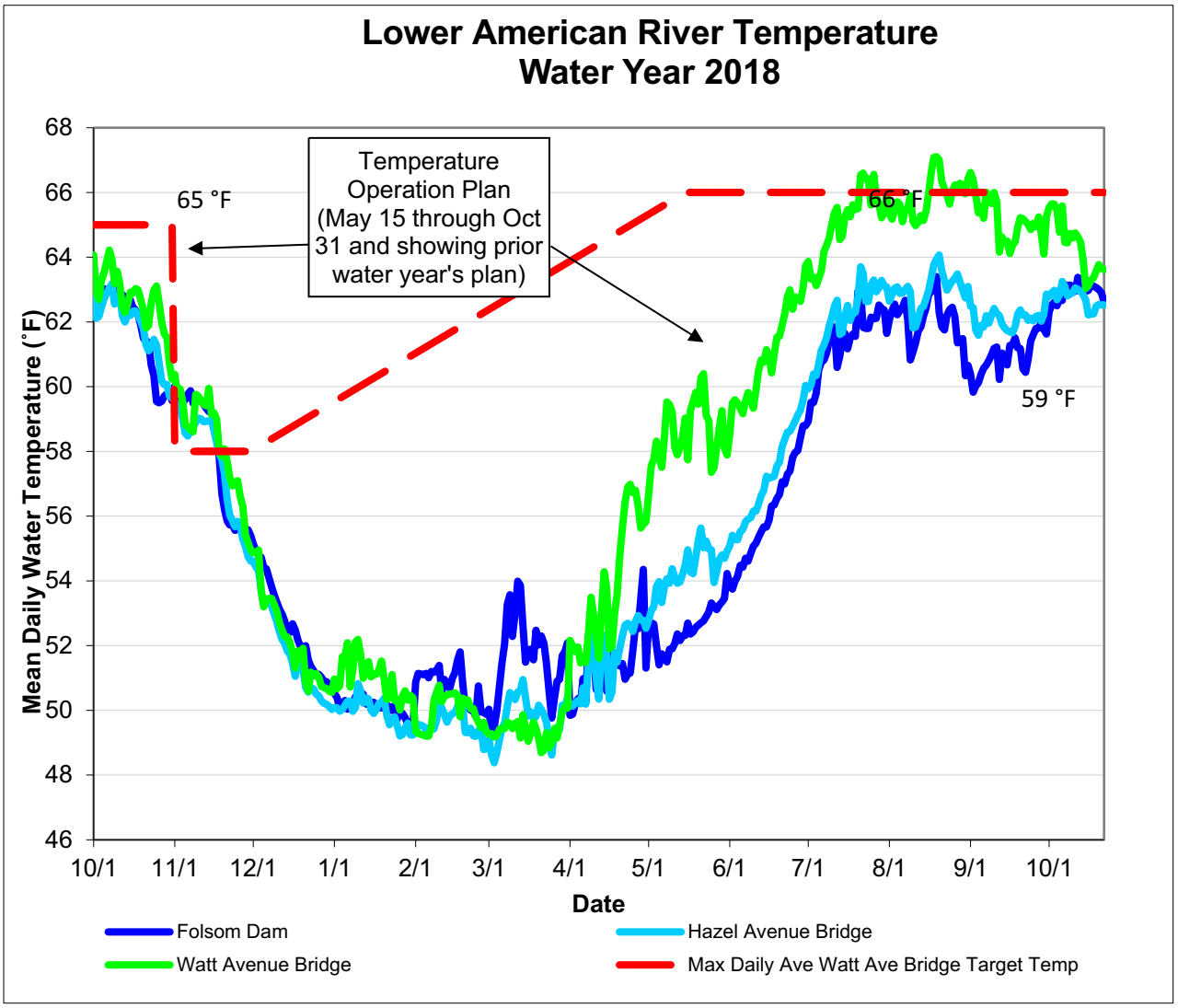

Figure 5. Summary of Temperature in the Lower American River

Table 5 is a list of Folsom Dam temperature shutter and power penstock blending operations taken to meet downstream temperature requirements.

Table 5. Folsom Dam Temperature Shutter and Bypass Operation

Date	Operation
10/19/2017	Beginning 10/19/2017 and until further notice, please operate Unit 1 at 100% and Unit 2 at 0% to blend for temperature objective at Fair Oaks Ave. Comment: Water temperature management to encourage spawning of Coleman Hatchery tagged fish at Nimbus Hatchery during remaining days of October.
10/20/2017	Please raise the Middle shutter on Unit 3 as early as possible on Friday October 20, 2017. Configuration after changes: Upper shutters - all up Middle shutters - all up Lower shutters - all down Comment: Water temperature management
10/20/2017	Beginning 10/20/2017 (after completion of the removal of the middle shutter on unit 3) and until further notice, please remove penstock priorities. Both units will be configured identically. Comment: Water temperature management to encourage spawning of Coleman Hatchery tagged fish at Nimbus Hatchery during remaining days of October.
10/23/2017	Beginning 10/23/2017 and until further notice, please run unit 1 at 30% and unit 3 at 70%. Comment: Targeting 60 degrees at Hazel Ave to encourage spawning of Coleman Hatchery tagged fish at Nimbus Hatchery during remaining days of October.
10/23/2017	Please raise the lower shutter on Unit 1 as early as possible on Monday October 23, 2017. Configuration after changes: Upper shutters - all up Middle shutters - all up Lower shutters - Unit 1 up, Units 2 and 3 down Comment: Water temperature management
10/26/2017	Beginning 10/26/2017 and until further notice, please run Unit 1 at 70%. Comment: Targeting 60 degrees at Hazel Ave to encourage spawning of Coleman Hatchery tagged fish at Nimbus Hatchery during remaining days of October.
11/02/2017	Please raise the lower shutter on Unit 2 on Thursday November 2, 2017. Configuration after changes: Upper shutters - all up Middle shutters - all up Lower shutters - Unit 1 and 2 up, Unit 3 out of operation Comment: Water temperature management
11/2/2017	Beginning 11/02/2017 remove unit priorities. Comment: All units are in the same shutter configuration.

02/7/2018	On Wed February 7, 2018 please install lower shutters and middle shutters on all 3 units. Configuration after changes: Upper shutters - all up Middle shutters - all down Lower shutters - all down Comment: Preparing for coldwater pool development
3/28/2018	Please install upper shutters on all 3 units placing them in configuration 1 on Wednesday March 28, 2018. If the work needs to be continued on Thursday, please coordinate with the CVO controllers to ensure coordination of power scheduling and unit outage. Configuration after changes: Upper shutters - all down Middle shutters - all down Lower shutters - all down Comment: Preparing for coldwater pool development
7/12/2018	On Thursday July 12, 2018, Please pull the upper shutter on Unit one. This will put Unit one in configuration 2. Units 2 and 3 will remain in configuration 1. If it is possible to do the shutter pull in the morning that would be preferable.
7/12/2018	Beginning Thursday July 12, 2018, please run unit 1 at 20%. This is for temperature blending after the upper shutter pull. Continue running Unit 1 at 20% until further notice.
7/16/2018	Effective as soon as possible, please run unit 1 at 20%. Continue at 20% until further notice. Note: temperature control in lower American River
7/23/2018	Effective as soon as possible, please run unit 1 at 35%. Continue at 35% until further notice. Note: temperature control in lower American River
7/30/2018	Effective as soon as possible, please run unit 1 at 45%. Continue at 35% until further notice. Note: temperature control in lower American River
7/31/2018	Effective as soon as possible, please maximize Unit 3 until further notice. Note: temperature control in lower American River
8/4/2018	Effective 8/4/2018 and until further notice, please utilize Unit #3 at approximately 40% daily blending rate. Note: temperature control to lower American River
8/8/2018	Effective 8/8/2018 and until further notice, please utilize Unit #3 at approximately 25% daily blending rate. Please make sure Unit 3 is always run together with another unit for temperature blending purposes. Note: temperature control to lower American River
8/9/2018	Please put Unit 3 in configuration 2 at approx 7:30 am on Thursday August 9, 2018. Configuration after changes: Upper shutters - Units 1, 2, and 3 up

	Middle shutters - all down Lower shutters - all down Comment: Temperature management in the Lower American River
8/9/2018	Effective 8/9/2018 and until further notice, all blending preferences are removed. Note: all 3 units are in the same temperature configuration
8/20/2018	Please put Unit 1 in configuration 3 at approx 7:30 am on Monday August 20, 2018. Configuration after changes: Upper shutters - Units 1, 2, and 3 up Middle shutters - Unit 1 up, Units 2 and 3 down Lower shutters - all down Comment: Temperature management in the Lower American River
8/20/2018	Effective 8/20/2018 and until further notice, please utilize Unit #1 at approximately 20% daily blending rate. Please make sure Unit 1 is always run together with another unit for temperature blending purposes. Note: temperature control to lower American River
8/22/2018	Effective 8/22/2018 and until further notice, please utilize Unit #1 at approximately 30% daily blending rate. Note: temperature control to lower American River
8/27/2018	Effective ASAP 8/27/2018 and until further notice, please utilize Unit #1 at approximately 50% daily blending rate. Note: temperature control to lower American River
8/28/2018	This is to document that Unit 2 was put in configuration 3 at approx 10 am on Tuesday August 28, 2018. Configuration after changes: Upper shutters - Units 1, 2, and 3 up Middle shutters - Unit 1 and 2 up, Unit 3 down Lower shutters - all down Comment: Temperature management in the Lower American River
8/28/2018	Effective ASAP 8/28/2018 and until further notice, please utilize Units 1 and 2 at a combined 50% daily blending rate. Note: temperature control to lower American River
8/30/2018	Effective ASAP 8/30/2018 and until further notice, please utilize Units 1 and 2 at a combined 75% daily blending rate. Note: temperature control to lower American River
9/1/2018	Effective 9/1/2018 at approximately 0930 hrs and until further notice, please maximize Unit 1 and Unit 2 and minimize Unit 3 as last on, first off. Note: Temperature control to lower American River
9/11/2018	This is to document that Unit 1 was put in configuration 4 at approx 10 am on Wednesday September 11, 2018. Configuration after changes: Upper shutters - Units 1, 2, and 3 up Middle shutters - Unit 1 and 2 up, Unit 3 down

	Lower shutters - Unit 1 up, Units 2 and 3 down Comment: Temperature management in the Lower American River
9/12/2018	Effective ASAP 9/12/2018 and until further notice, please utilize Units1 at 10% and 2 at 90% daily blending rate. Note: Unit 3 off-line for annual maintenance. Note: temperature control to lower American River
9/21/2018	Effective ASAP 9/21/2018 and until further notice, please utilize Unit1 at 25% and Unit 2 at 75% daily blending rate. Note: Unit 3 off-line for annual maintenance. Note: temperature control to lower American River
9/24/2018	Effective ASAP 9/24/2018 and until further notice, please utilize Unit1 at 15% and Unit 2 at 85% daily blending rate. Note: Unit 3 off-line for annual maintenance. Note: temperature control to lower American River
9/27/2018	Effective ASAP 9/27/2018 and until further notice, please utilize Unit1 and Unit 3 at a combined rate of 15% and Unit 2 at 85% daily blending rate. Note: Unit 3 off-line for annual maintenance but coming back soon and Unit 1 then going off-line. Note: temperature control to lower American River
9/27/2018	This is to document that Unit 3 was put in configuration 4 at approx 10 am on Thursday September 27, 2018. Configuration after changes: Upper shutters - Units 1, 2, and 3 up Middle shutters - Units 1, 2, and 3 up Lower shutters - Units 1 and 3 up, Unit 2 down Comment: Temperature management in the Lower American River
10/16/2018	Effective ASAP 10/16/2018 and until further notice, please utilize Unit 3 at a rate of 10 - 15%. Note: temperature control to lower American River

4.3 Action II.4 - Minimize Flow Fluctuation Effects

The goal of RPA Action II.4 (NMFS 2009 BiOp) is to reduce stranding and isolation of juvenile steelhead through ramping protocols, from January 1 through May 31; and to minimize the occurrence of flows exceeding 4,000 cfs throughout the year, except as necessary for flood control or in response to high inflow events. Owing to a steady series of smaller precipitation events over the American River Basin, and steady inflows into Folsom Reservoir, releases to the Lower American River were above 4,000 cfs for a limited amount of time from January 1, 2018, through May 31, 2018. Peak river releases for the year were 25,000 cfs on April 6-7, 2018.

Ramping protocols as specified under RPA II.4 were met from January 1 through May 31. Expedited ramping to install the Nimbus Fish Hatchery weir and picket infrastructure occurred on September 7, 2018, consistent with prior year operations.

Chapter 5 – Lower American River Monitoring

The monitoring activities described below are currently being implemented on the LAR and include actions which are either a requirement in the NMFS 2009 BiOp, assist Reclamation in meeting the NMFS 2009 BiOp RPA requirements, provide supplemental information, or are a CVPIA requirement.

5.1 RPA Monitoring Activities

5.1.1 Steelhead Spawning Surveys

NMFS RPA Actions II.1 – Lower American River Flow Management and II.4 - Minimize Flow Fluctuation Effects

Reclamation contracted with Cramer Fish Sciences (CFS) to conduct bi-weekly steelhead redd surveys from Nimbus Dam to Watt Avenue with the addition of Paradise Beach every other survey period, covering 18 river miles (Figure 5). The surveys began January 10th, 2018, and extended through May 14th, 2018. From January 10th to March 20th, 2018, a total of 85 new, clear salmonid and Lamprey redds were observed. Of the 85 new redds, 13 were identified as steelhead based on observations of adult steelhead redd occupation and 50 steelhead redds were classified to species using a discriminant function analysis (DFA). A total of four Chinook salmon (*Oncorhynchus tschawytscha*) redds were observed; these redds were identified using DFA. In addition, a total of 18 Pacific lamprey (*Entosphenus tridentatus*) redds and one Sacramento sucker (*Catostomus occidentalis*) redd were observed with a positively identified fish associated with it. Figure 6 shows the 2018 steelhead redd locations and their corresponding dates. Surveyed redds were recorded from a cataraft, raft or on foot and plotted using geographic positioning system (GPS) and biometric equipment. Updates were sent to NMFS bi-weekly to summarize the findings of the steelhead spawning survey.

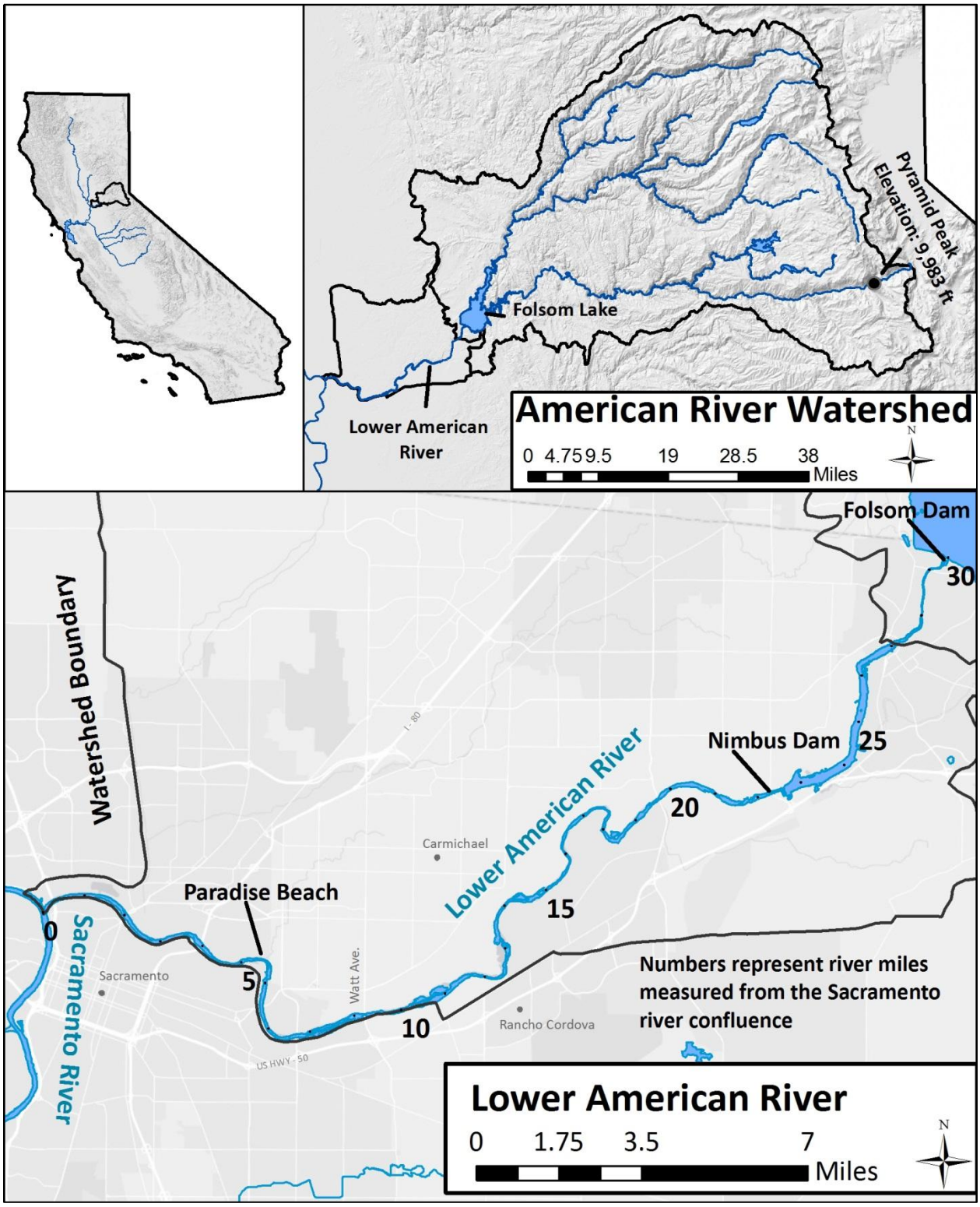

Figure 6. American River Steelhead redd survey area 2018.

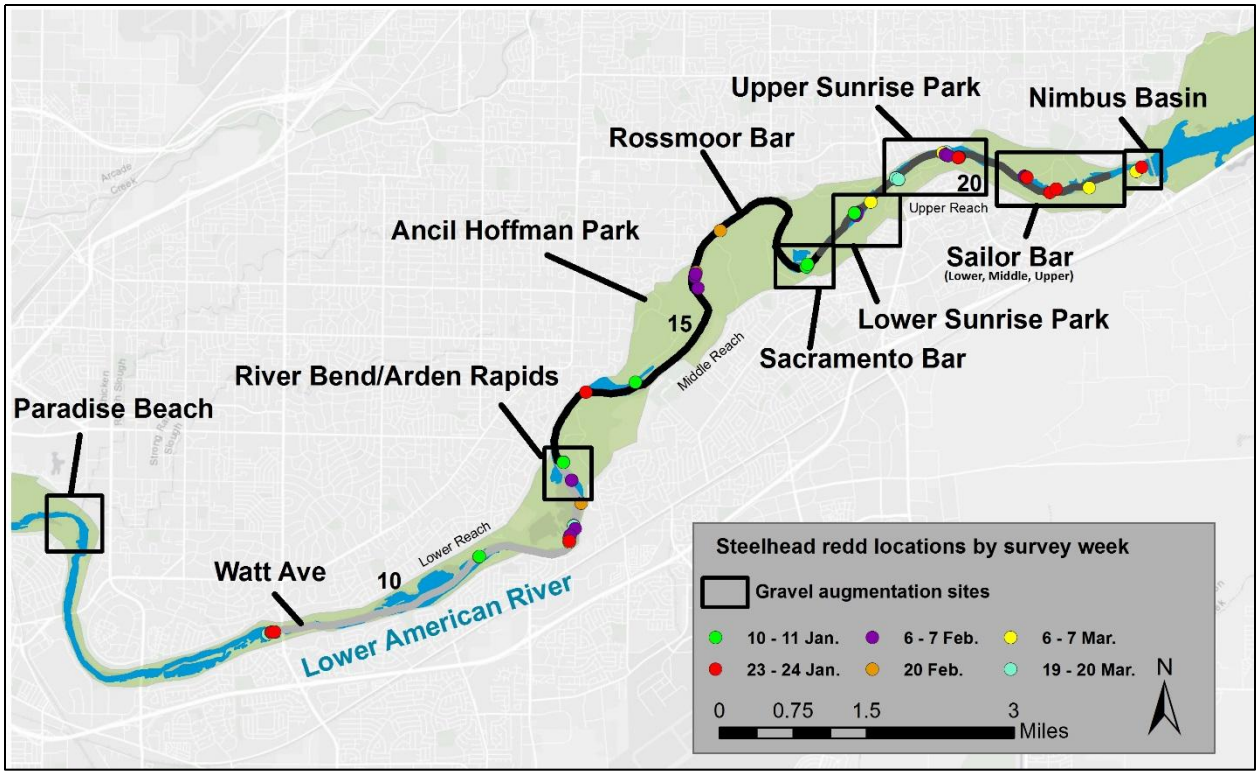

Figure 7. American River Steelhead redd distribution and timing in 2018.

5.1.2 Manual Temperature Profiles

RPA Action II.2 – Lower American River Temperature Management

Twice per month from April through October, Reclamation collects temperature profile data in Folsom Reservoir to assist in meeting RPA Action II.2 – Temperature Management. The temperature profile data are used to model downstream temperatures through the operation season so Reclamation can plan temperature shutter operations to meet the downstream temperature compliance point at Watt Avenue Bridge. Manual temperature profiles are taken at six locations in Folsom Reservoir.

5.1.3 Isolation Pool Monitoring

RPA Action II.4 – Minimize Flow Fluctuation Effects

Reclamation monitors flow fluctuations in the LAR to assess and reduce stranding and isolation of steelhead when ramping down flows and fluctuating flows above and below a threshold where elevation changes could lead to isolation of redds, fry and/or juvenile steelhead. Flow fluctuations in the LAR have been documented to result in steelhead redd dewatering and isolation, fry stranding, and fry and juvenile isolation. Habitat evaluations have identified several locations where isolation of salmonids and other fish species have been observed in the past coinciding with the reduction or fluctuation of flows.

LAR stranding surveys were performed on March 6-7, 19-20, April 12-13, 19, 23-24, May 1-2, and May 14, 2018. A maximum of 25,500 cfs and a minimum of 1,710 cfs were recorded on the LAR during the

monitoring season. Each stranding survey was performed following a reduction of flow on the LAR. The purpose of each survey was to determine if steelhead redds and/or juvenile salmonids were stranded in disconnected pools as a result of the flow reduction. CFDW staff accompanied CFS on each stranding survey.

Stranding surveys were performed along the LAR between Nimbus Dam and Paradise Beach (Figure 7). Crews searched for pools that had lost connectivity to the river due to reduced flow and determined if stranded salmonids were present. If juvenile salmonids were observed, the approximate number and size of fish in the pool were recorded. A beach seine was used to capture and release fish observed in pools back into the main channel. Some pools could not be seined due to dense vegetation. To estimate the pool area, a GPS polygon outlining the pool was recorded.

A total of 39 pools were observed in the LAR, covering an estimated area of 5,858 m^2 following flow reductions between January 10, 2018, and May 14, 2018. In some locations, the same pools were stranded multiple times as flows increased and receded. Within these stranding pools, 7,125 juvenile salmonids were observed; 370 of these were steelhead. Other fish species observed in stranding pools included Sacramento pikeminnow, Sacramento sucker, Pacific lamprey, three-spined stickleback (*Gasterosteus aculeatus*), largemouth bass (*Micropterus salmoides*), and sculpin (*Cottus* sp.). The areas with the largest stranding pools were Below San Juan Rapids (2,366 m^2 across 2 pools) and Lower Sunrise Side Channel Island (1,299 m^2 across 3 pools). The majority of stranding pool area from Below San Juan Rapids was from a single pool of 2,202m^2 that was too deep to effectively seine; based upon visual estimates, over 1,000 juvenile salmonids were in this pool; these numbers were not included because fish could not be identified to species due to pool depth and size. Stranding pools seined at the Lower Sunrise side channel island contained 4,043 juvenile salmonids (57% of season total) and 118 confirmed steelhead (32% of season total). The lower Sailor Bar side channel island stranded a total of 2,913 salmonids in early March; however, only one of these was a steelhead. There were several steelhead stranding areas in the lower river, below Riverbend (81 steelhead), below Rossmoor (59 steelhead), in the lower Riverbend side channel (39 steelhead), and below San Juan rapids (18 steelhead).

Bi-weekly updates were sent to NMFS describing isolation pool observations that coincided with steelhead spawning surveys.

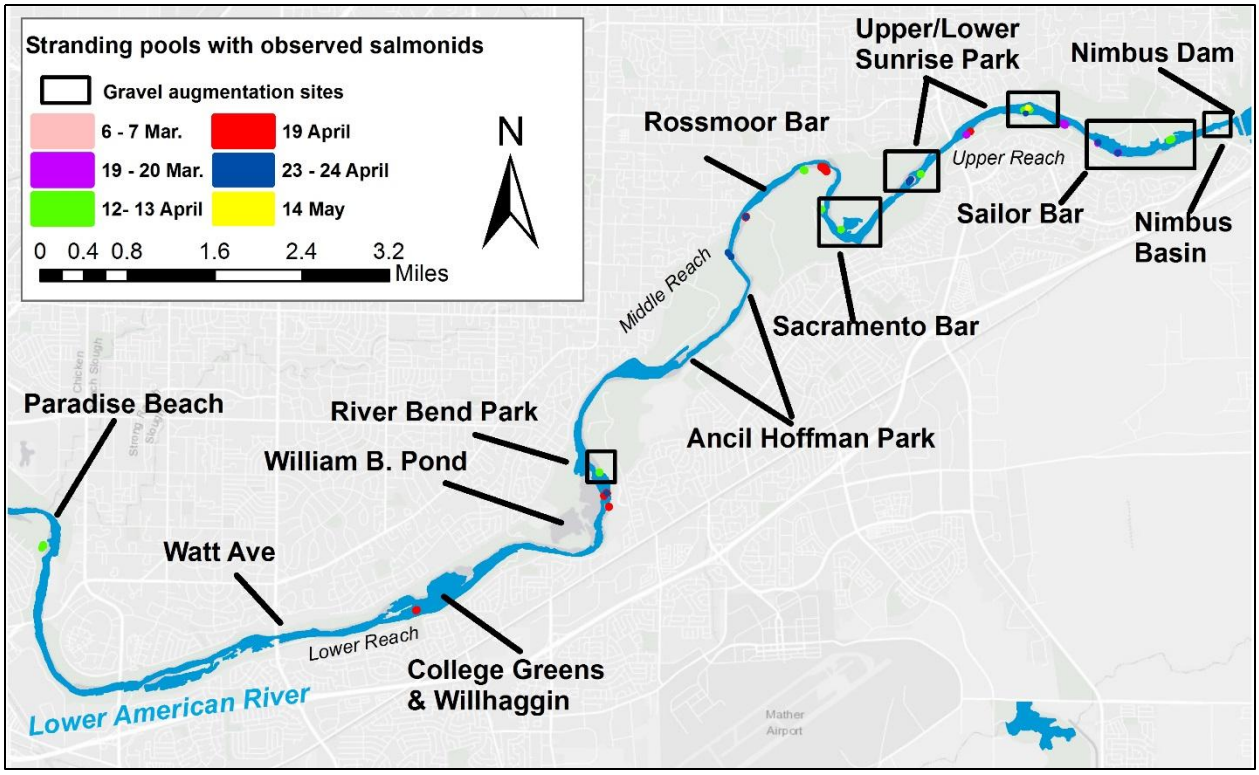

Figure 8. Locations of stranding areas on the Lower American identified March 7, March 19, April 12-13, April 19, April 23-24, and May 14, 2018. No stranding pools were observed on May 1-2.

5.1.4 Steelhead Redd Dewatering

During 2018, CDFW conducted five steelhead redd surveys to evaluate the impacts of planned flow fluctuations (Table 6). The objectives of this survey were to:

1. Ground truth Fair Oaks Stage height derived predictions of steelhead redd dewatering impacts with empirical data.
2. Evaluate overall steelhead redd dewatering impacts due to water operations on the LAR, and
3. Identify potential options to improve water operations to reduce redd dewatering impacts on steelhead.

The highest flow at which steelhead redds were established was 3,500 cfs during the month of December and the lowest flow at which redds were dewatered was 1,350 cfs (Table 6). The peak of steelhead spawning occurred during January and February at 3,000 cfs with egg incubation and emergence continuing through May. During this period, steelhead redds are subject to dewatering events due to fluctuations in in-river flows. The 1,350 cfs low flow represents a bottleneck of brood year 2018 steelhead in-river production. The 1,350 cfs low flow was initially scheduled to be reduced to 800 cfs on March 19th but due to high inflows and the need to manage for flood control, flows were then scheduled the same day to increase to 7,500 cfs. Because the 1,350 cfs low flow event was less than a day in duration, CDFW was unable to conduct redd dewatering surveys at this level and unable to determine the total impact of flow management on steelhead redd dewatering. However, the initial scheduled change to

800 cfs had the potential to result in significant impacts much of 2018 steelhead egg and embryo production.

Table 6. CDFW steelhead redd survey date, flow at Fair Oaks Bridge, observed redd dewatering, estimated potential redd dewatering, and reason for flow change. Lower American River, 2018.

Survey Date	Flow at Fair Oaks Bridge (cfs)	Estimated Potential Redd Dewatering	Observed Redd Dewatering	Water Operation Requirement
2/13/2018	3,000	Baseline survey	Baseline survey	Storage Management USACE Flood Curve
2/20/2018	2,400	2%	0%	Storage management USACE Flood Curve
2/27/2018	3,000	Baseline survey	Baseline survey	Delta salinity management
3/5/2018 3/12/2018	1,750	23%	8%	Storage management at MRR
3/19/2018[3]	1,350 800	32% 75%	No survey	Storage management at MRR

CDFW began conducting steelhead redd surveys on February 13, 2018, with flows at 3,000 cfs to determine which and how many redds would potentially be dewatered. Subsequent surveys were conducted through March 12, 2018, with releases from Nimbus ranging between 1,750 cfs and 3,000 cfs. Initial estimates of flow reduction from 3,000 cfs to 1,750 cfs indicated that there would be an approximate 27 cm drop in water surface elevation and approximately 23% of steelhead redds observed would be dewatered. Since the initial redd survey conducted on February 13 to the final survey conducted on March 12, 2018, observed water surface elevation change was recorded to be in the range of 0-56 cm in core spawning areas and 8% of observed redds were dewatered. The additional reduction from 1,750 cfs to 800 cfs estimated an additional 33 cm drop in water surface elevation and 75% of redds observed at 1,750 cfs would be dewatered. CDFW was unable to evaluate redd dewatering with flows at 1,350 cfs; therefore the true impact of redd dewatering during 2018 was not evaluated.

5.2 Other Monitoring Activities

5.2.1 Rotary Screw Trap

Rotary screw trap (RST) operations on the lower American River in 2018 are part of a collaborative effort by the U.S. Fish and Wildlife Service's Comprehensive Assessment and Monitoring Program (CAMP),

[3] CDFW was unable to conduct redd surveys on 3/19/2018 at the actual low flow of 1,350 cfs or the scheduled flow of 800 cfs due to the short duration <1 day of this low flow event.

Pacific States Marine Fisheries Commission, and the California Department of Fish and Wildlife and results are reported annually[4]. The primary objectives of the trapping operations were:

1. To collect fork length and weight data for juvenile salmonids.
2. To collect data that can be used to estimate the passage of juvenile fall-run Chinook salmon and quantify raw catch of steelhead/rainbow trout and three other runs of Chinook salmon.

A total of 90,104 fall-run Chinook salmon were captured. Four trap efficiency tests were used to estimate the passage of juvenile fall-run Chinook salmon. Trap efficiencies during these four tests ranged from 3.30% to 9.54%, with an average efficiency of 7.62%. Sampling occurred on 99 of the 131 days between January 12 and May 22. Based on USFWS' Comprehensive Assessment and Monitoring Program (CAMP) platform which is used to expand trap catches into passage estimates, the number of juvenile fall-run Chinook salmon that emigrated past the Watt Avenue trap site during the 2018 survey season was 1,287,000 individuals with 95% confidence intervals ranging from 1,245,000 to 1,426,000 individuals.

Sampling in 2018 was suspended due to high flows February 28 through March 4, March 20 through March 29, and April 5 through April 14 causing an unknown and potentially substantial percentage of the emigrating population to remain unobserved. Sampling was also suspended February 21 through February 25 due to Nimbus Fish Hatchery releasing 212,143 brood-year 2017 steelhead and again May 9 through May 14 when Nimbus Fish Hatchery released approximately 1,341,477 fall-run Chinook salmon. Sampling was again suspended May 18 through May 20 due to increased weekend recreational activities. Therefore, passage of juvenile fall-run Chinook salmon in 2018 is likely underestimated.

In total, 162 in-river produced steelhead and 336 hatchery origin steelhead were caught. Eleven winter-run Chinook salmon were captured. No spring-run Chinook salmon or late fall-run Chinook salmon were captured.

A total of 16,901 in-river produced, unmarked fall-run Chinook salmon were measured for fork length.

5.2.2 Chinook Escapement Survey

The 13.1-mile stretch of river from the Nimbus Weir downstream to Watt Avenue was divided into four sections and surveyed once during each survey week for salmon carcasses. The LAR escapement survey was conducted over 14 survey periods from October 17, 2017, to January 19, 2018. The objectives of the escapement survey are to:

1. Estimate the size of fall-run Chinook salmon escapement in the LAR;
2. Determine age class (adult or grilse) and sexual composition;
3. Determine the female egg retention; and
4. Estimate the number and origin of hatchery-reared, fall-run Chinook salmon in the LAR.

4 Hickey, K. and E. Bradbury. 2018. Draft - Juvenile Salmonid Emigration Monitoring in the Lower American River, California January – May 2018. Unpublished report prepared for the U.S. Fish and Wildlife Service and California Department of Fish and Wildlife, Sacramento, California. 68 pp.

The in-river fall-run Chinook salmon escapement estimate for the LAR is 7,457. In addition to the in-river estimates, 10,573 carcasses were trapped at the Nimbus Fish Hatchery, and 3,989 were collected above the weir by Nimbus Fish Hatchery staff. The combined 2017 LAR fall-run Chinook salmon escapement estimate is 23,893.

Coded wire tagged carcasses (adipose fin clipped) comprised 22% of the total fresh carcasses observed. Based on the practice of constant fractional marking of 25% of the total fall-run, Chinook salmon production expansion of the coded wire tagged carcasses number indicated 88% of the total in-river spawning population. Preliminary coded wire tag data recovered from carcasses processed during the survey revealed that approximately 34% originated at Coleman National Fish Hatchery, 24% from Nimbus Fish Hatchery, 19% from Mokelumne River Fish Installation, 4% from Feather River Fish Hatchery, and 2% from Merced River Fish Facility. Coded wire tags were either not recovered or unreadable for 19% of the adipose fin-clipped carcasses processed.

5.2.3 Other Monitoring

Additional project specific fisheries monitoring is being conducted to evaluate spawning and rearing habitat restoration projects. This monitoring includes river-wide Chinook salmon redd surveys, ground based redd surveys at project sites, an assessment of juvenile use of various types of habitat structure, an evaluation of egg incubation survival, evaluation of measured intragravel conditions for egg incubation, and comparisons of habitat availability before and after projects. A structured decision making process is being used to determine future project types and identify monitoring needs.

References

California Department of Fish and Wildlife (CDFW). 2018. a) Lower American River Fall-run Chinook Salmon Escapement Survey, 2017-2018; b) Lower American River Steelhead Redd Dewatering Survey, 2017-2018; c) Lower American River Rotary Screw Trap Survey, 2017-2018.

California Department of Water Resources (DWR) 2018. California Department of Water Resources, California Data Exchange Center. 8-Station Precipitation Index http://cdec.water.ca.gov/cgi-progs/queryMonthly?s=8si&d=today

Cramer Fish Sciences. 2018. 2018 Steelhead (Oncorhynchus mykiss) Spawning and Stranding Surveys, Central Valley Project, American River, California.

National Marine Fisheries Service (NMFS). 2009. Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project.

NMFS. 2011. 2011 Amendments to the National Marine Fisheries Service Operations Criteria and Plan Reasonable and Prudent Alternatives.

State Water Resources Control Board (SWRCB) 2016. State Water Resources Control Board Order WR 2015-0043. In the Matter of Specified License and Permits of the Department of Water Resources and the U.S. Bureau of Reclamation for the State Water Project and the Central Valley Project regarding the Executive Director's February 3, 2015 Order and Subsequent Modifications to that Order.

U.S. Bureau of Reclamation (Reclamation). 2018. Central Valley Operations Office: Operations Analysis and Accounting: Water Operations Analysis (Monthly PDF). http://www.usbr.gov/mp/cvo/

Water Forum. 2006. Draft: Lower American River Flow Management Standard.