Annual Report of Activities

October 1, 2015 to November 20, 2016

The 2016 Lower American River Sacramento Bar Gravel Restoration Project. Left photo is prior to work and right photo is the morning after the side channel was opened.

Photo: John Hannon

American River Group (ARG)

November 2016

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
FMS	Flow Management Standard
LAR	Lower American River
MRR	Minimum Required Release
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.

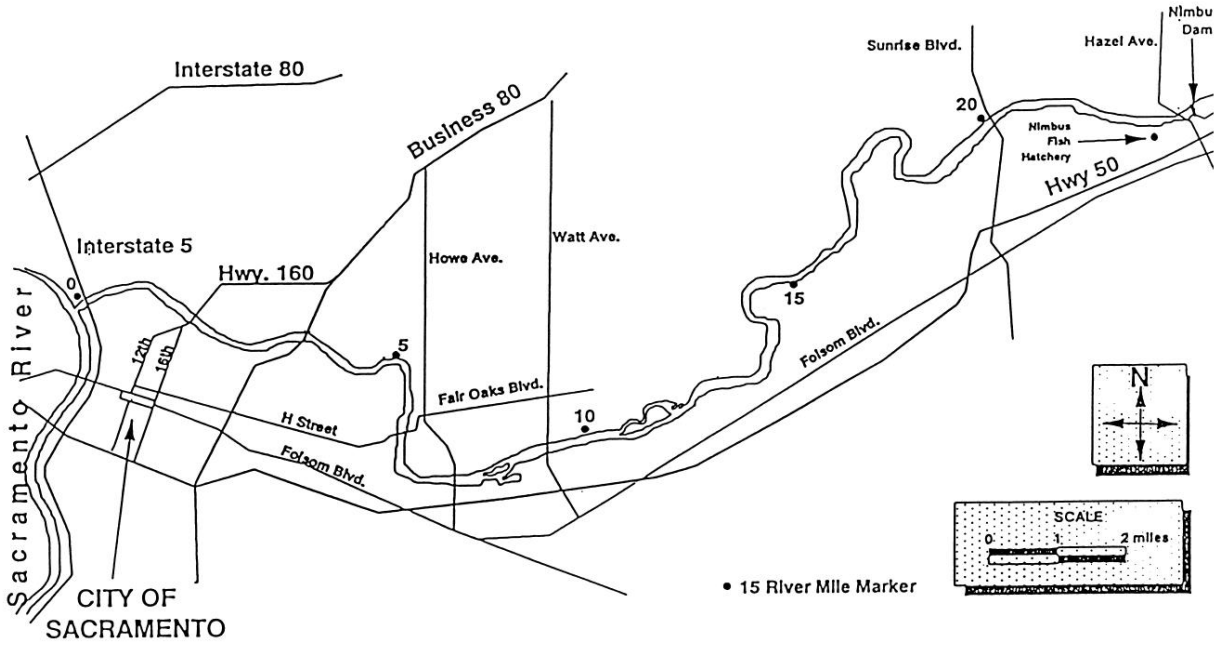

Figure 1. The lower American River between Nimbus Dam and the Sacramento River.

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. However, many recognize D-893 flows do not provide comprehensive 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. Members of the public and other agencies may attend ARG meetings and are encouraged to comment on matters under consideration by the ARG. The ARG convenes monthly or more frequently, if needed, with the purpose of providing fishery updates and reports to help inform 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 its BiOp and Conference Opinion on the Long-Term Operations of the CVP and SWP that included RPA actions for the LAR. 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.

Chapter 3 – Summary of ARG Discussions

The following agenda items were discussed at monthly ARG meetings from October 2015 through September 2016. 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.

      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. The 2016 project is located at

Sacramento Bar, approximately one mile downstream of the Sunrise Boulevard Bridge. This project will increase the available spawning area from two acres to over five acres, as well as create a new 1,200ft side channel for rearing. Gravel projects have increased the density of fish in side channel habitat's on the LAR from less than 3 juvenile fish per 25m^2 to more than 82 juvenile salmon per 25 m^2.

- **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 2015/16 preliminary escapement estimate of fall-run Chinook salmon is approximately 13,000. The survey began in October 19th and ran for fourteen weeks. Peak carcass detection occurred during the second week of December, about two weeks later than normal. Adult/grilse ratios and pre-spawning mortalities were within the normal limits, although, the proportion of ad-clipped fish seemed to be low, less than 20 percent.

Chapter 4 – Water Operations Summary

General Water Year Conditions and Operations

Water year 2016 offered some hydrologic relief to recent drought conditions in California and the American River watershed. Statewide precipitation measured 110%, runoff 95% and reservoir storage at 85% of average through the end of July (DWR 2016). Despite more favorable hydrologic events including flood risk management and flood control operations, reservoir storage recovery and the consequences of prolonged drought on fisheries still influenced year 2016 activities. In mid-December 2015, and a corrected version released in mid-January 2016, the California State Water Resources Control Board issued "Order WR 2015-0043" to address drought preparation and state-wide project operations. Although rain and snow-melt runoff conditions significantly improved in the spring, NMFS and SWRCB requirements to balance resources with the Sacramento River to protect endangered species resulted in significant impacts to Folsom Reservoir and the American River.

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 exceedences. The initial April – July 90% (conservative volume) unimpaired runoff exceedence forecast volume (February) was estimated at 750 TAF, or 61% of the average (1.825 MAF was projected for the water year, lower than the average water year volume of 2.683 MAF.). The actual full natural flow volume April –July in 2016, was 913 TAF and 74% of the average (final water year volume was 2.595 MAF). Despite favorable overall precipitation and runoff statistics, the timing of events and drier watershed conditions yielded early spring storm event driven runoff and poorer runoff during the typical May through July time-frame. The following table provides data and characteristics of water year 2016 (Table 1). 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 1. 2016 Water Year Northern Sierra precipitation, American River Basin snowpack, and Sacramento Valley Index statistics by month.

Water year 2016 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% Exceedence)
November	4.9	59	NA	NA
December	16.7	140	NA	5.3
January	32.8	179	47	5.8
February	35.5	34	83	6.5
March	51.9	238	81	6.1
April	54.7	72	89	7.3
May	56.9	105	39	7.1

(DWR 2016)

Operations – Lower American River

Operational decisions on the LAR are influenced by local and 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 can 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 in 2013). 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 2016).

Key decisions that influenced 2016 LAR operations:

- Minimum flow rate/FMS: As a result of reaching record low storage conditions at Folsom Dam in December 2015 (135.6 TAF), releases downstream in the lower American River remained low to protect water supply. Flow criteria were developed with consideration for low storage/low precipitation conditions that address the objectives to meet future in-stream temperature objectives and water supply needs. As a result of extremely poor hydrology and low storage conditions, both the "Off-Ramp" and "Conference Year" criteria were triggered in 2015. The

regular FMS Minimum Release Requirements (MRR) criteria resumed in January 2016 when storage conditions recovered. The "Off-Ramp" criteria again was triggered in September 2016 as a result of low storage conditions. Releases were reduced for October 2016 below the FMS MRR to protect water supply and temperature management in the next water year.

- Sacramento River fishery protection priority: Due to prior prolonged critical drought conditions in the Sacramento River, NMFS extended priority protections to winter-run Chinook salmon and the SWRCB ordered Shasta Lake actions for temperature management purposes. This resulted in limited summer Keswick releases (June through September) to protect Shasta Lake storage for temperature management. The tradeoff was increased American River water releases as required to meet SWRCB Delta water quality requirements concurrent with reduced project export pumping. In turn, higher than anticipated American River releases, lower than anticipated Folsom Lake storage conditions, and higher than expected downstream temperature performance occurred.
- Folsom storage conservation targets of end of October 2016 of 200 TAF or greater: The SWRCB ordered minimum storage conditions to "ensure adequate supplies for municipal uses going into the 2017 water year." (SWRCB, 2016).
- Reduced CVP Deliveries: The CVP reduced water allocations to the following groups:
    - South of Delta Agricultural Contractors to 5%, and
    - South of Delta Municipal and Industrial Contractors to 55% (of historical use)
- Reduced CVP Delta project pumping during the summer months.
- Cold Water Pool (CWP): The historical conditions of the CWP volume is recorded in Table 2 for comparison.
- Cold Water Pool Protection: Flood control release actions in late February and early March preferred spill through the Folsom main spillway radial gates (the warmer upper elevations of the reservoir) to preserve the development of the cold water pool at lower elevations.
- Temperature Management Plan: At the end of April the Iterative Cold-Water Pool Management Model (iCPMM) results indicated a feasible maximum mean daily temperature target at Watt Avenue Bridge of 65°F. In June, after subsequent coordination with the Sacramento River to protect Winter Run Chinook, modeling results indicating a feasible maximum mean daily temperature target at Watt Avenue of 68°F. The temperature target was adjusted with concurrence from NMFS. Modeling updates in August also suggested increasing the maximum daily temperature target at Watt Ave. to 69°F for the month of August and 68°F in October. ARG recommended a daily average target of 58°F at Watt Ave. in November for Fall-run Chinook spawning. The temperature target, based on feedback from NMFS and ARG, was not adjusted further. All information was communicated to NMFS, updated monthly, and discussed with the ARG.
- Cold Water Bypass: Reclamation released a cold-water bypass (foregoing power generation), from the deepest elevation in Folsom Reservoir to manage fall Nimbus Dam release temperatures and protect fall-run Chinook salmon.

Table 2. Historical Folsom Reservoir Cold Water Pool dynamics.

Historical Conditions (2001-2016)						
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

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 2015 through November 2016.

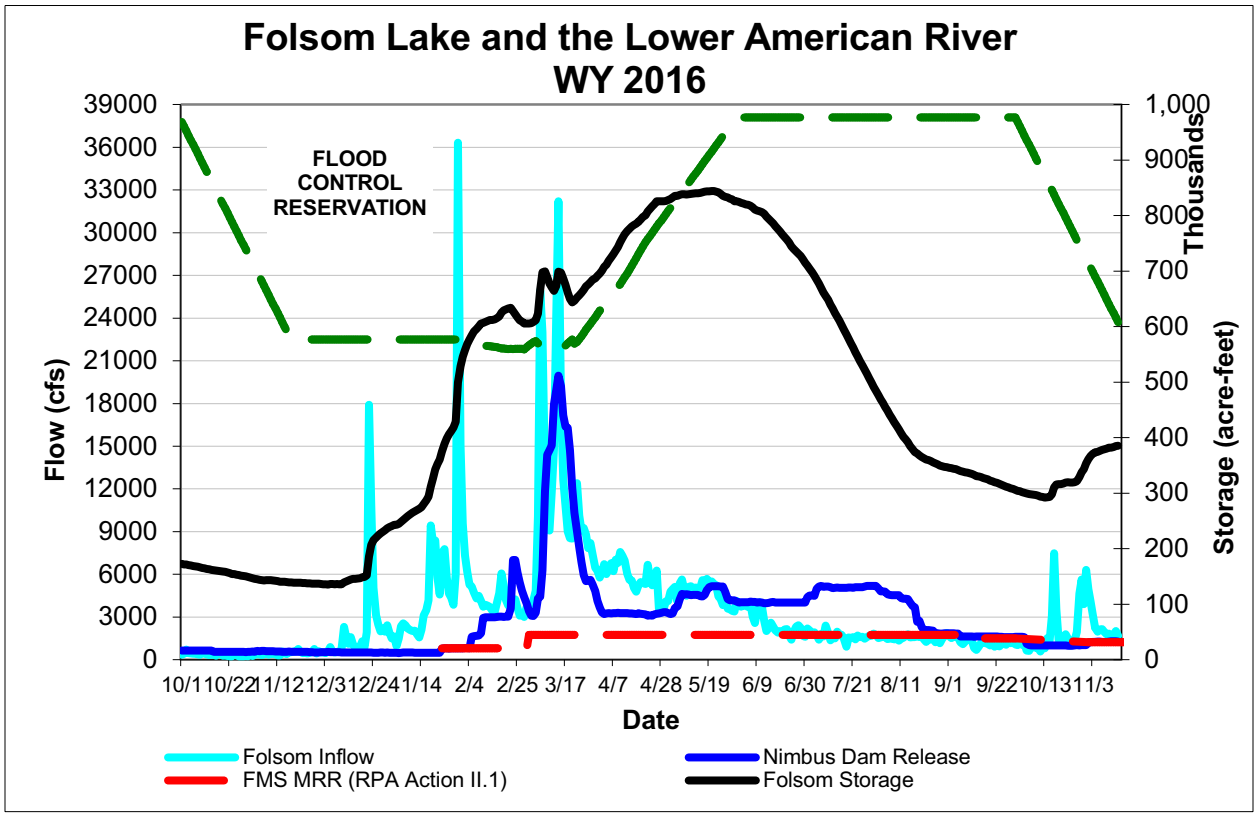

Figure 2. Summary of Folsom Reservoir Storage and Lower American River Flows[1]

The Nimbus Dam releases to the LAR and the MRR prescribed by the FMS for water year 2016 are shown on Figure 3. In addition, the primary reasons for release changes to the LAR are identified on the figure. Operational decisions were closely coordinated with agencies to offer protection to the Sacramento River fishery. Hydrologic conditions for both an "Off-Ramp" and "Conference Year" were satisfied in 2015 and carried into early 2016. During the fall and winter the FMS MRR operational decisions were outside "normal conditions" and were decided based on multi-agency input. Coordination occurred during ARG and Real-Time Drought Operations Management Team (RTDOT) meetings. RTDOT is a multi-agency team created in response to a State Water Resources Control Board Order dedicated to resolve real-time operational issues. In January 2016 "Off-Ramp" and "Conference Year" criteria were lifted when storage conditions recovered and the FMS MRR criteria resumed. Strong spring

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

storm events resulted in flood control management operations in February and March. This was followed by higher than expected releases to protect Sacramento River fishery and meet Delta flow/salinity requirement obligations May through August. Forecasted reservoir conditions in September indicated low Folsom storage (below 200 TAF projected for January 2017) for the drier 90% runoff exceedence hydrology. Discussions with ARG resulted in an action to reduce flows for the month of October to satisfy "Off-Ramp" conditions. October 2016 precipitation and runoff were above normal and regular release operations were resumed in November.

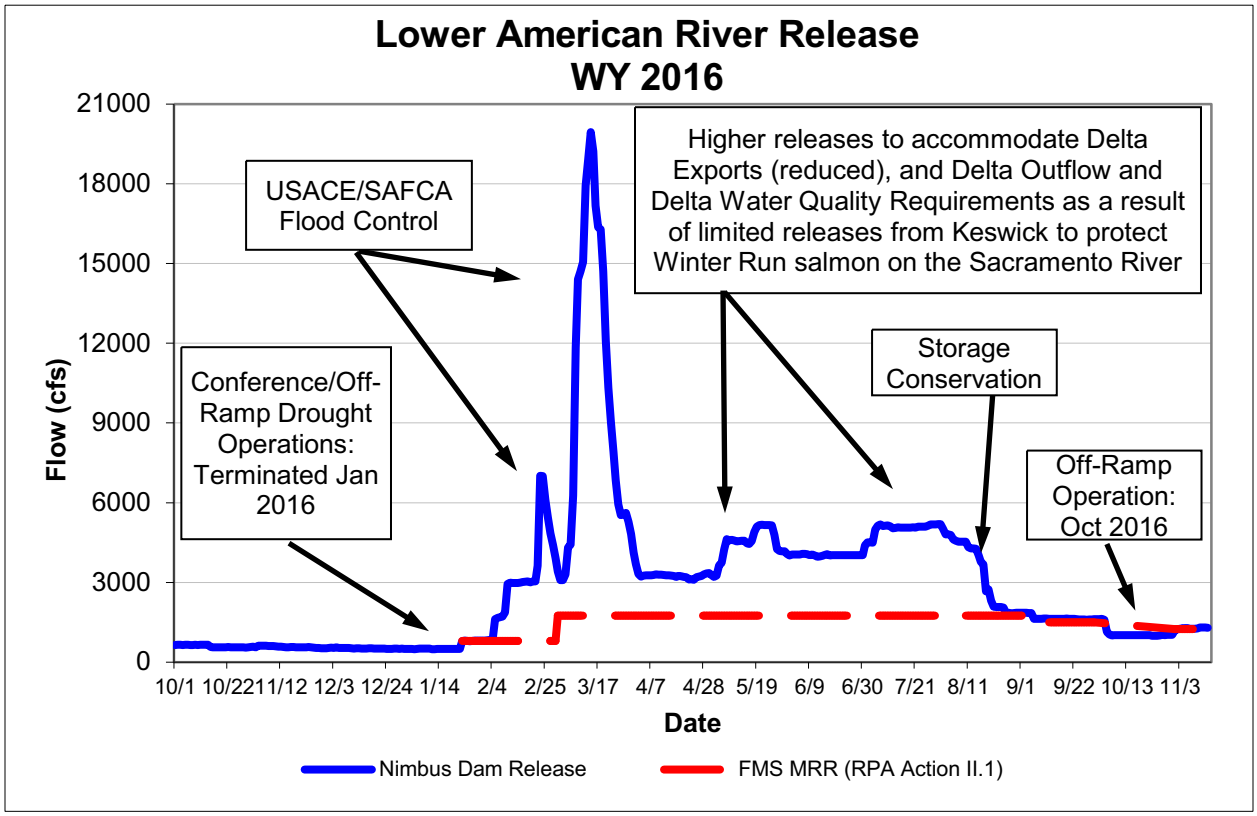

Figure 3. Summary of Lower American River Releases at Nimbus Dam

Table 3 contains a summary of operational release changes from Nimbus Dam. Flow management adjustments included flood control, storage conservation, and Delta management.

Table 3. Release Changes at Nimbus Dam

Start Date	End Date	Release	To (cfs)	Comment
10/1/2015	10/1/2015	Decrease	600	Storage conservation
10/15/2015	10/15/2015	Decrease	500	Storage conservation
1/23/2016	1/23/2016	Increase	800	Storage improvement
2/5/2016	2/5/2016	Increase	1,750	Storage management
2/9/2016	2/9/2016	Increase	3,000	Storage management/flood control. Start date Monday due to storm event potential for following weekend
2/22/2016	2/23/2016	Decrease	7,200	Ramp down - storage management/flood control
2/24/2016	3/2/2016	Decrease	3,000	Ramp down - storage management/flood control
3/4/2016	3/4/2016	Increase	4,550	Storage management/flood control
3/7/2016	3/7/2016	Increase	8,000	Storage management/flood control
3/8/2016	3/8/2016	Increase	15,000	Storage management/flood control
3/12/2016	3/12/2016	Increase	20,000	Storage management/flood control
3/16/2016	3/16/2016	Decrease	15,950	Ramp down storage management/flood control
3/19/2016	3/21/2016	Decrease	9,350	Ramp down storage management/flood control
3/22/2016	3/22/2016	Decrease	8,150	Ramp down storage management/flood control
3/23/2016	3/25/2016	Decrease	5,450	Ramp down storage management/flood control
3/29/2016	4/2/2016	Decrease	3,000	Ramp down storage management/flood control
5/4/2016	5/4/2016	Increase	3,500	Delta outflow requirements
5/5/2016	5/5/2016	Increase	4,000	Delta outflow requirements
5/6/2016	5/6/2016	Increase	4,500	Delta outflow requirements
5/18/2016	5/18/2016	Increase	5,000	Delta outflow requirements
5/26/2016	5/27/2016	Decrease	4,000	Delta requirements
7/1/2016	7/1/2016	Increase	4,500	Delta requirements and export
7/5/2016	7/5/2016	Increase	5,000	Delta requirements and export
8/1/2016	8/1/2016	Decrease	4,750	Conserve storage
8/5/2016	8/5/2016	Decrease	4,500	Conserve storage
8/11/2016	8/11/2016	Decrease	4,250	Conserve storage
8/15/2016	8/16/2016	Decrease	3,750	Conserve storage
8/18/2016	8/18/2016	Decrease/Increase	1000-3250	Facilitate picket installation at fish weir
8/19/2016	8/21/2016	Decrease	2,000	Storage Conservation
8/26/2016	8/26/2016	Decrease	1,750	Storage Conservation
9/6/2016	9/6/2016	Decrease	1,500	Storage Conservation
10/5/2016	10/5/2016	Decrease	1,000	Storage Conservation
11/1/2016	11/1/2016	Increase	1,250	Spawning flow

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 2015 through November 2016, 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 selects 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 cold-water pool conditions. NMFS must concur on proposed deviations from the plan that may reduce the likelihood that the temperature objective will be met.

Reclamation submitted a Temperature Management Plan to NMFS on May 10, 2016 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. The Plan was subsequently updated after multi-agency decisions were made to limit Sacramento River/Keswick flows for winter-run Chinook salmon protection. This resulted in increased projected spring and early summer American River releases for Delta regulatory requirements. In consequence, Folsom Reservoir storage conditions were projected lower than expected and anticipated temperature performance degraded to a maximum daily average target of 68°F. The Plan was updated on June 30, 2016 and concurred by NMFS after releases on the Sacramento River were finalized. In July, as a result of lower than expected storage conditions, the top set of temperature shutters were raised due to reservoir storage elevation/head requirement to protect the structural integrity of the shutters.

Further modeling updates on August 18, 2016 suggested increasing the maximum daily temperature target at Watt Ave to 69°F for the month of August and 68°F in October. Based on feedback and responses from ARG and NMFS, the temperature target was not increased, but Reclamation would operate with the understanding that temperature excursions at Watt Avenue Bridge greater than 68°F may occur. Between May 15th and October 31st a total of eleven days exceeded the daily average temperature target, all during periods where summer ambient air temperatures were the hottest, despite active operational blending changes.

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 cold-water-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. This year cold-water from the lower river outlets began on October 28th and was terminated November 24th when Folsom Lake reached isothermal conditions and resources were fully exhausted for active temperature management. A total volume of 24.5 TAF was bypassed. The

November desired daily average temperature target at Watt Ave. was 58°F. The cold-water-pool volume less than 58°F by the beginning of November was approximately 23 TAF. Strong October storms with warm ambient conditions likely contributed to these conditions. The average daily temperature at Watt Ave. during the bypass operation in November was approximately 58.5°F.

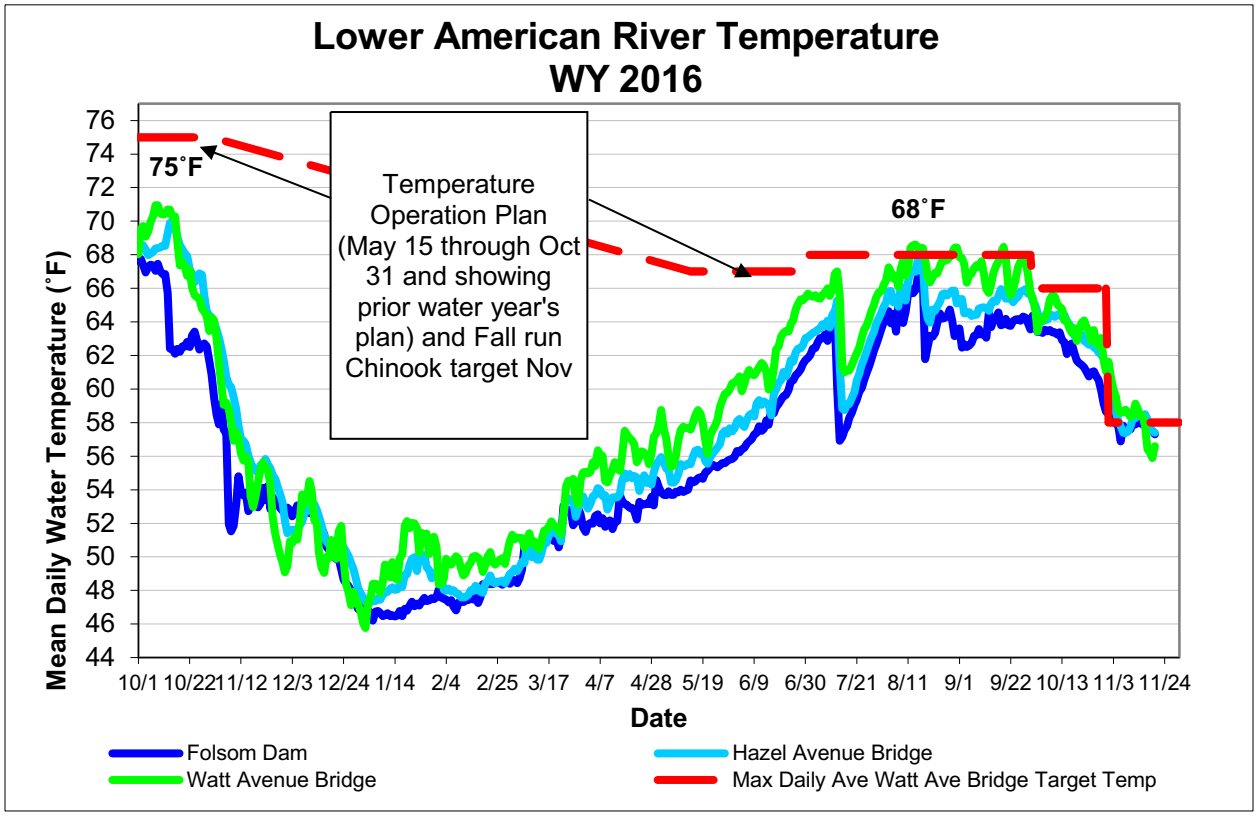

Figure 4. Summary of Temperature in the Lower American River

Table 4 is a list of Folsom Dam temperature shutter and power penstock blending operations taken to meet downstream temperature requirements.

Table 4. Folsom Dam Temperature Shutter and Bypass Operation

Date	Operation
10/8/2015	Target Unit 1 at approximately 15% of the daily load.
10/13/2015	Target Unit 1 at approximately 40% of the daily load.
10/14/2015	Target Unit 1 at approximately 100% of the daily load.
10/14/2015	Raise the Bottom (deganged 3 panels) set of temperature shutters on Folsom Penstock Unit 2
10/16/2015	Remove all blending preferences as a result of the shutter change.
10/29/2015	Bypass the following schedule through the lower-tier River Outlets 50 cfs
10/30/2015	Bypass the following schedule through the lower-tier River Outlets 100 cfs
10/31/2015	Bypass the following schedule through the lower-tier River Outlets 150 cfs.
11/2/2015	Bypass the following schedule through the lower-tier River Outlets 200 cfs.
11/6/2015	Bypass the following schedule through the lower-tier River Outlets 300 cfs.
12/4/2015	Terminate the bypass through the lower tier river outlets. Temperature operation supporting Fall Run Chinook spawning completed due to isothermal reservoir conditions.
2/9/2016	Work initiated the first week of February and completed Tuesday, 2/9/2016, the Bottom and Middle set of temperature shutters were lowered on Units 1 and 2, and the Middle set of temperature shutters were lowered on Unit 3.
2/22/2016	Preference spill through the Folsom Main Spillway Radial Gates if releases are greater than available penstock capacity.
3/23/2016	Work completed Wednesday, 3/23/2016, the Top set of temperature shutters were lowered on Units 1, 2, and 3.
7/13/2016	Raise the upper temperature shutters on Folsom Penstock Units 1, 2, and 3. Action due to elevation/head constraints on the upper shutters to protect structural integrity.
8/4/2016	Raise Unit #1 middle shutter.
8/8/2016	Maximize Unit 1, to blend for temperature target at Watt Ave. Comment: Temperature management blending.

Date	Operation
8/10/2016	Operate Unit 1 at about 45%, to blend for temperature target at Watt Ave.
8/10/2016	Operate Unit 1 at about 25%, to blend for temperature target at Watt Ave. Comment: Temperature management blending.
8/12/2016	Operate unit 1 at about 35%, to blend for temperature target at Watt Ave. Comment: Temperature management blending.
8/15/2016	Operate to maximize Unit 1.
8/16/2016	Raise the Middle set of temperature shutters on Unit 2.
8/17/2016	Until further notice, as a result of the shutter change, maximize Unit 1 and 2.
8/17/2016	Raise the Bottom set of temperature shutters on Unit 2.
8/17/2016	Remove all previous blending preferences. Beginning 08/17/2016, and until further notice, target Folsom Unit 2 at approximately 20% of the daily load and minimize load on Folsom Unit 3.
8/19/2016	Beginning 08/19/2016, and until further notice, please target Folsom Unit 2 at approximately 15% of the daily load.
8/19/2016	The Middle set of temperature shutters on Unit 3 were raised.
8/19/2016	Remove all previous blending preferences on Unit 3.
8/22/2016	Target Folsom Unit 2 at approximately 10% of the daily load.
8/25/2016	Target Folsom Unit 2 at approximately 15% of the daily load.
8/29/2016	Target Folsom Unit 2 at approximately 25% of the daily load.
8/31/2016	Target Folsom Unit 2 at approximately 35% of the daily load.
9/2/2016	Target Folsom Unit 2 at approximately 45% of the daily load.
9/4/2016	Target Folsom Unit 2 at approximately 55% of the daily load.
9/7/2016	Target Folsom Unit 2 at approximately 45% of the daily load.
9/10/2016	Target Folsom Unit 2 at approximately 55% of the daily load.
9/13/2016	Target Folsom Unit 2 at approximately 45% of the daily load.
9/15/2016	Target Folsom Unit 2 at approximately 55% of the daily load.
9/18/2016	Target Folsom Unit 2 at approximately 65% of the daily load.
9/23/2016	Target Folsom Unit 2 at approximately 75% of the daily load.
9/23/2016	Raise the Bottom set of temperature shutters on Unit 3.
9/28/2016	Target Folsom Unit 2 at approximately 85% of the daily load.
9/30/2016	Target Folsom Unit 2 at approximately 95% of the daily load.
10/3/2016	Remove all Unit blending priority preferences.
10/28/2016	Please bypass the following schedule through the lower-tier River Outlets: 50 cfs
10/29/2016	Bypass the following schedule through the lower-tier River Outlets: 150 cfs
10/30/2016	Bypass the following schedule through the lower-tier River Outlets: 250 cfs

Date	Operation
10/31/2016	Bypass the following schedule through the lower-tier River Outlets: 350 cfs
11/1/2016	Bypass the following schedule through the lower-tier River Outlets:450 cfs
11/2/2016	Bypass the following schedule through the lower-tier River Outlets: 500 cfs
11/24/2016	Discontinue power bypass. Cold-water-pool exhausted.

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. Late February and mid-March storm events required flood control releases with a maximum release of 20,000 cfs. Releases were also at or greater than 4,000 cfs in early May through mid-August to meet SWRCB Delta regulatory requirements as a result of fishery protections on the Sacramento River.

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 August 18, 2016 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 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. The surveys began January 7th, 2016, and extended through March 4th, 2016. From January 8th to April 14th, 2016, a total of 81 new, clear salmonid and Lamprey redds were observed. Of the 81 new redds, 8 were identified as steelhead based on observations of adult steelhead redd occupation, 11 were confirmed as Chinook Salmon and 1 was confirmed as Pacific Lamprey. The remaining 61 redds were initially classified as "unknown" because no fish were observed on the redd and Chinook Salmon and Lamprey were present in the system, producing similarly constructed redds. Further categorization based on a discriminant function analysis (DFA) led us to designate 45 unknown redds as steelhead, for a total of 53 total steelhead redds. The remaining 16 unknown redds were classified as Chinook Salmon redds. Figure 6 shows the 2016 steelhead redd locations (following DFA analysis) and their corresponding dates. Surveyed redds were recorded from a cataraft, raft or on foot and plotted using GPS and biometric equipment. Updates were sent to NMFS bi-weekly to summarize the findings of the steelhead spawning survey.

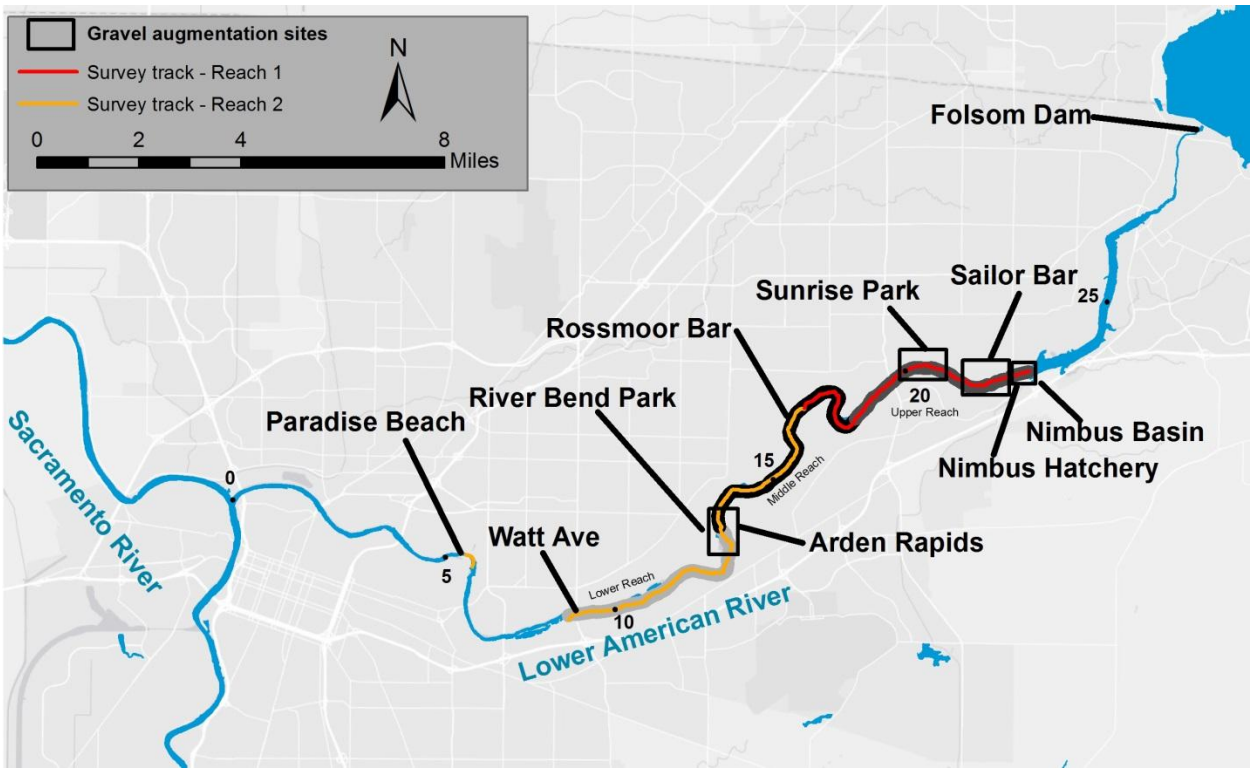

Figure 5. American River Steelhead redd survey area 2016.

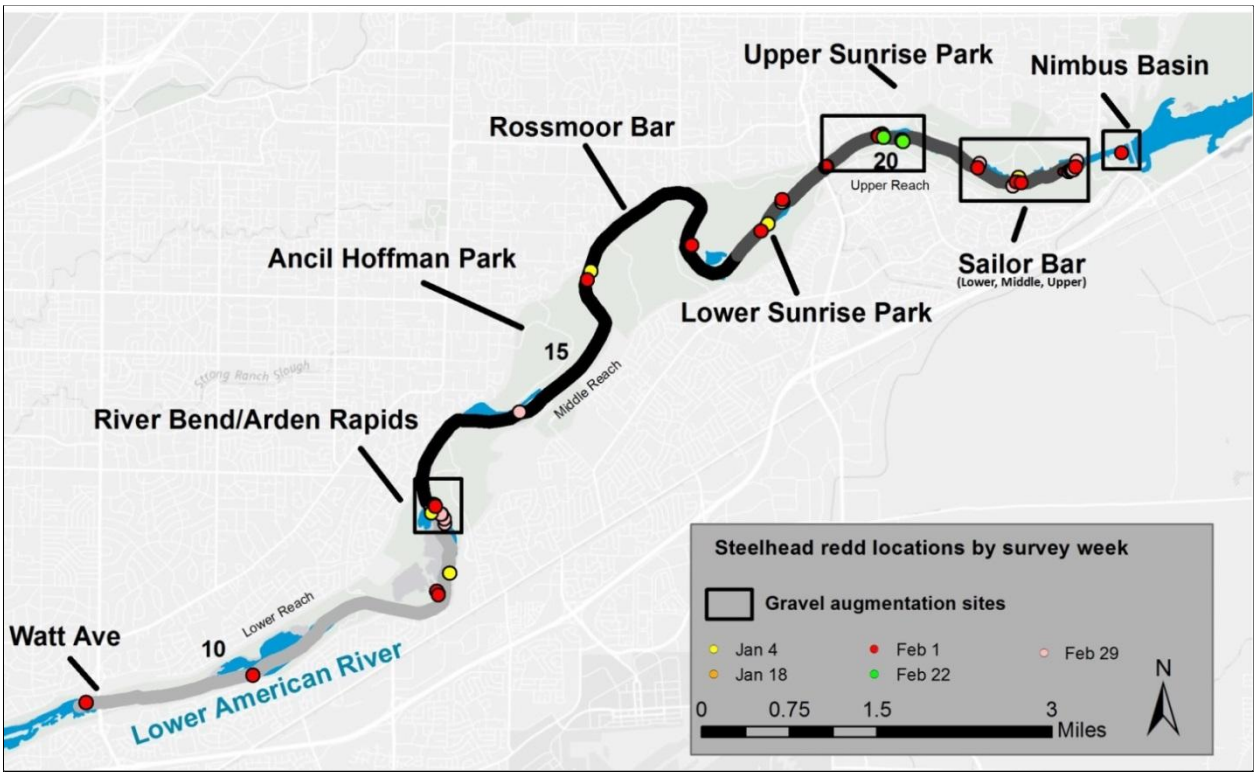

Figure 6. American River Steelhead redd distribution and timing in 2016.

5.1.2 Manual Temperature Profiles

RPA Action II.2 – Lower American River Temperature Management

Twice per month from May through November, 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 (see Chapter 4, Section 4.2).

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 elevations 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.

Lower American River stranding surveys were performed during three periods of flow reductions during late March/early April, mid-April, and late May. Based on walking surveys between Nimbus Dam and Watt Avenue and Paradise Beach, an estimated total of 1450 stranded juvenile salmonids between March 30th and April 1st following a 15,000 cfs flow reduction following a period of flood release (20,000 cfs to 5,000 cfs). An estimated 100 stranded juvenile salmonids were observed between April 13th and 14th following a flow reduction of 1,900 cfs (5,000 cfs to 3,100 cfs). On May 27th following a flow reduction of 1000 cfs approximately 45 juvenile salmonids were observed. CDFW was able to successfully relocate this group to the main channel. Most of the stranded juvenile salmonids were observed in pools located in floodplains or on top of gravel islands that had been inundated during the flood releases. Figure 7 shows the locations of all identified stranding pools.

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

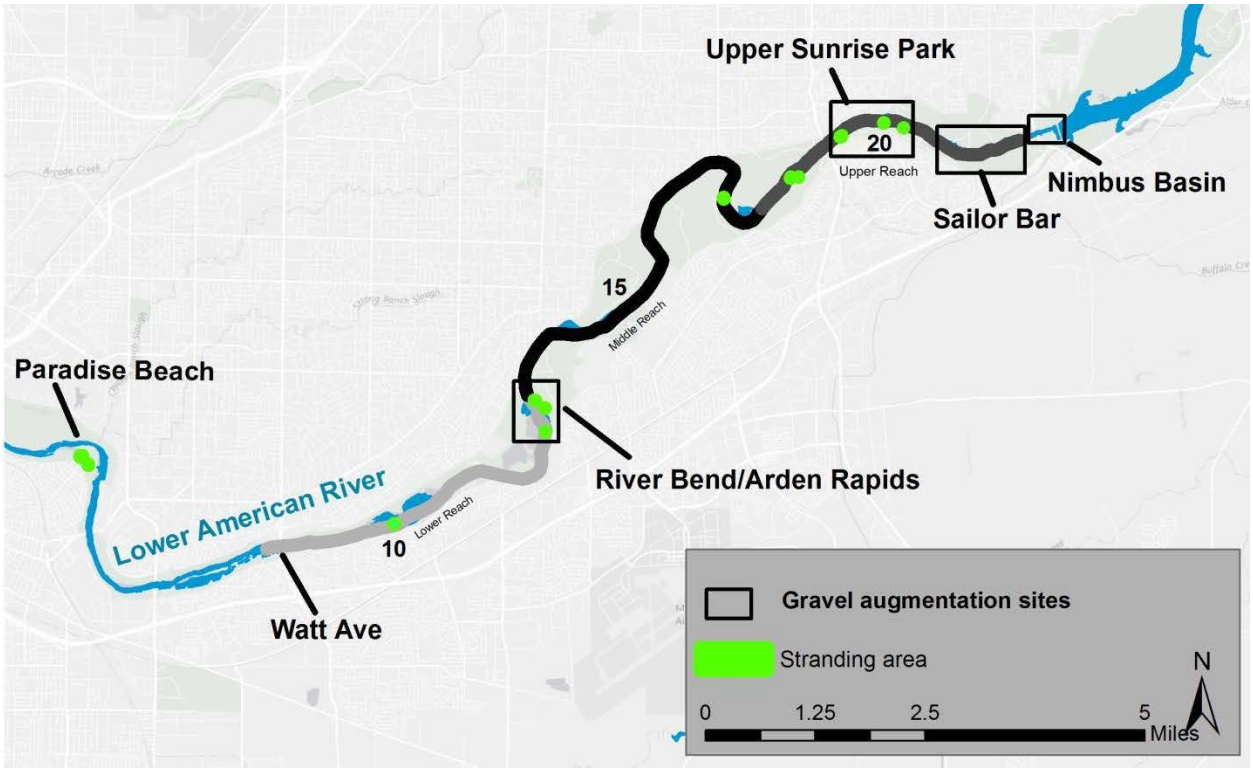

Figure 8. Locations of stranding areas on the Lower American identified March 30th – April 1st, April 13th and 14th, and May 27th.

5.2 Other Monitoring Activities

5.2.1 Rotary Screw Trap

Rotary screw traps were deployed 1/8 mile downstream of the Watt Avenue Bridge on the LAR in Sacramento County, California, for 69 days between January 12, 2015 and April 4th, 2015. The traps were not operational during high flow flood release from March 8th to March 21st. The primary objective of the trapping operations is to gather juvenile Chinook salmon and steelhead data pertaining to fish size, weight, life stage, and abundance/production. Secondary objectives of the trapping operations focus on collecting data on non-salmonid fish species, and gathering data pertaining to salmonid size, temporal presence, and abundance as they relate to environmental factors.

During the 2016 field season, two traps were deployed in one of the two river channels below the Watt Avenue Bridge. The raw catch data for juvenile salmonids collected are based on length-at-date criteria. The application of these criteria on the American River may over estimate the number of spring-run Chinook salmon that are caught. Many of the spring-run salmon will likely be reclassified as fall-run Chinook salmon after genetics analyses are complete. A total of 80,278 fall-run, 93 spring-run, 3 winter-run, and 255 late-fall-run juvenile Chinook salmon were captured. In addition, 331 juvenile steelhead/rainbow were captured. The 2016 field season was

terminated on April 4, 2016 because trapping exceeded a National Marine Fisheries Service steelhead take limit.

5.2.2 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.

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