



— BUREAU OF —
RECLAMATION

American River Group Summary of Activities for Water Year 2021

Central California Area Office, Folsom, CA
Interior Region 10- California-Great Basin



Distant view of Folsom Dam during morning quagga survey on Folsom Lake. Photo credit: Spencer Marshall, USBR.

Mission Statements

The Department of the Interior (DOI) conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

American River Group Summary of Activities for Water Year 2021

**Folsom Dam, CA
Interior Region 10- California-Great Basin**

prepared by

**Central California Area Office
7794 Folsom Dam Road
Folsom, CA 95630**

**Central Valley Operations Office
3310 El Camino Avenue, Suite 300
Sacramento, CA 95821**

**Bay Delta Office
801 I Street, Suite 140
Sacramento, CA 95814**

Acronyms and Abbreviations

ARG	American River Group
BiOp	Biological Opinion
cfs	Cubic Feet Per Second
CFS	Cramer Fish Sciences
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CDFW	California Department of Fish & Wildlife
DWR	Department of Water Resources
CWP	Cold Water Pool
FMS	Flow Management Standard
LAR	Lower American River
MRR	Minimum Release Requirement
NMFS	National Marine Fisheries Service
CNRFC	California Nevada River Forecast Center
Reclamation	U.S. Bureau of Reclamation
RM	River Mile
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	Thousand Acre-Feet
USFWS	U.S. Fish & Wildlife Service
WOMT	Water Operations Management Team
WY	Water-Year

Table of Contents

Chapter 1 – Introduction and Background	1
1.1 Introduction.....	1
1.2 American River Geographic Orientation.....	1
1.3 Lower American River Historical Background	1
1.4 Transition to February 2020 ROD	3
Chapter 2 – February 2020 ROD	5
2.1 Summary of February 2020 ROD.....	5
Chapter 3 – ARG Discussion Topics	7
3.1 Monthly Discussion Topics	7
3.2 Other Discussion Topics	8
Chapter 4 – Water Operations Summary	14
4.1 General Water Year Conditions and Operations	14
4.2 Hydrologic Conditions – American River	14
4.3 Operations – Lower American River.....	15
4.4 WY 2021 Operations Under February 2020 ROD	19
4.4.1 2017 Flow Management Standard Releases and Planning Minimum.....	19
4.4.2 Spring Pulse Flows.....	21

4.4.3	Temperature Management Plan	21
4.5	Summary of American River Operations to Meet Delta Requirements	27
Chapter 5	– Lower American River Biological Monitoring	28
5.1	Monitoring Activities.....	28
5.1.1	Steelhead Spawning Surveys	28
5.1.3	Stranding and Isolation Pool Monitoring.....	30
5.1.4	Steelhead Redd Dewatering.....	33
5.2	Other Monitoring Activities.....	33
5.2.1	Rotary Screw Trap	33
5.2.2	Chinook Escapement Survey	35
5.2.3	Other Monitoring	35
References	36
Attachment A	- American River 2017 Flow Management Standard, Planning Minimum & Spring Pulse Flow Guidance Document.....	A-Error! Bookmark not defined.
Attachment B	– American River Temperature Management Plan Guidance Document.....	B-Error! Bookmark not defined.
Attachment C	- Water Year 2021 Temperature Management Plan for the Lower American River...	C-Error! Bookmark not defined.
Attachment D	– American River Power Bypass Proposal, October 1, 2021 .	D-Error! Bookmark not defined.

Chapter 1 – Introduction and Background

1.1 Introduction

The Water Year (WY) 2021 Summary of Activities serves to summarize biological information, and operational discussions and decisions for the lower American River (LAR). Additionally, it serves to document implementation of Alternative 1 (Preferred Alternative) as described in the Final Environmental Impact Study and as analyzed in the 2019 National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) (NMFS 2019), adopted in the February 2020 Record of Decision (ROD) for the Coordinated Long-Term Operations of the Central Valley Project (CVP) and State Water Project (SWP) during WY 2021 (October 1, 2020 – September 30, 2021).

1.2 American River Geographic Orientation

The American River is located in California’s Central Valley. It is the second largest tributary to the Sacramento River below Shasta Dam. The North, Middle, and South forks of the American River originate in the Sierra Nevada range and 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 CVP operated by Reclamation. The 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.

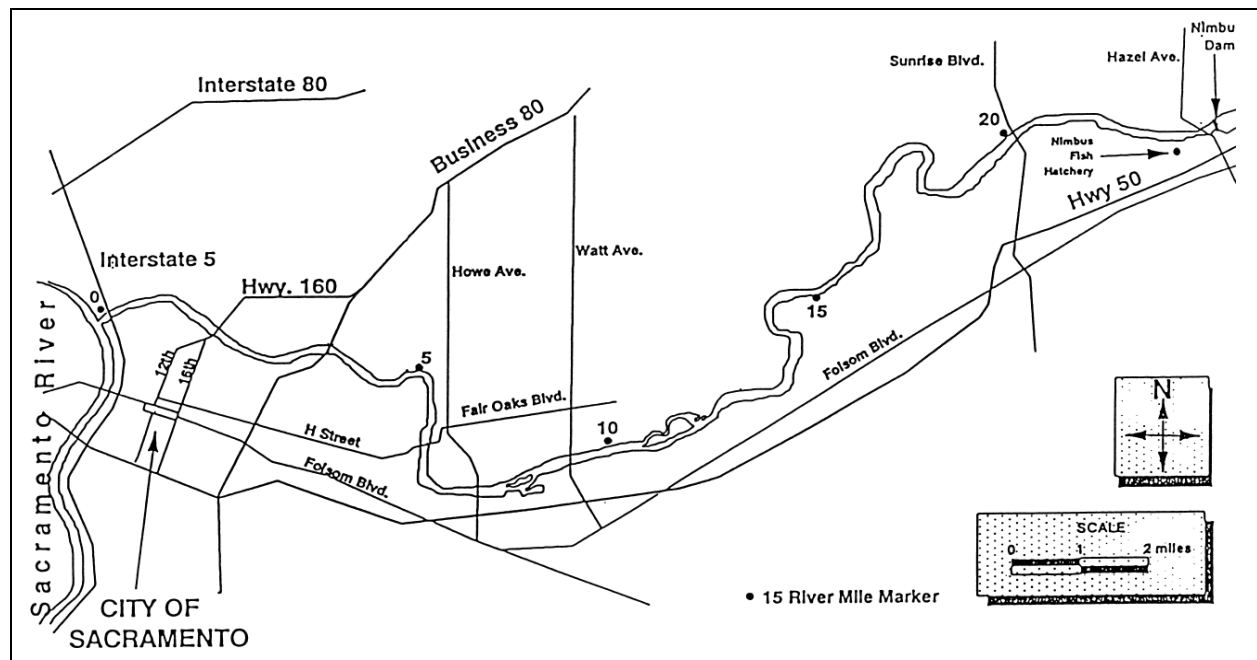


Figure 1. The Lower American River between Nimbus Dam and the Sacramento River

1.3 Lower American River Historical Background

The LAR provides water supply for urban and agricultural uses, flood control, fish and wildlife protection, recreational opportunities, hydroelectric power generation, and contributes to water quality conditions in the Sacramento-San Joaquin Delta. Reclamation is responsible for operating the Folsom/Nimbus Dam complex to meet local and downstream water demands, regulatory requirements, and fish habitat needs. 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 at Nimbus Dam include the Nimbus Fish Hatchery, which is owned by Reclamation and operated by the California Department of Fish and Wildlife (CDFW).

Reclamation operates Folsom and Nimbus dams 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 habitat protection given current water rights and fishery conditions. Since 1958, additional SWRCB Decisions and Congressional Acts [i.e. Central Valley Project Improvement Act (CVPIA)], and Endangered Species Act (ESA) requirements have changed the regulatory landscape for the State and Federal Water Projects, including operations on the LAR.

In 1996, Reclamation established a working group to coordinate fishery and operational requirements for the LAR, known as the American River Group (ARG). The ARG brings together stakeholders who have either a legislated or resources-specific interest in the operation of Folsom Dam and Reservoir and the LAR. Reclamation is the lead coordinator of the ARG. The formal members include agencies with trust responsibilities for fisheries resources in the LAR: Reclamation, the U.S. Fish and Wildlife Service (USFWS), NMFS, CDFW and Sacramento Water Forum (Water Forum). 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 discuss water operations, fisheries, and other environmental factors. Reclamation considers the information provided by the ARG when making management decisions regarding temperatures and flows necessary to sustain LAR fish resources.

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, NMFS, 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 was designed to

improve habitat conditions for fall-run Chinook salmon and steelhead 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 designed to integrate water temperature performance capability for management of the downstream habitat. The NMFS 2009 BiOp (NMFS 2009) also adopted components of the FMS temperature management process. Action II.2 of the NMFS 2009 BiOp states that “The priority for use of the lowest water temperature control shutters at Folsom Dam shall be to achieve the water temperature requirement for steelhead, and thereafter may also be used to provide cold water for fall-run Chinook salmon spawning.” While NMFS’s priority was temperature management for steelhead due to federal listing status, temperature management for fall-run Chinook salmon was also important. 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 water year type conditions). These factors include available cold-water resources, Nimbus Dam release schedules, annual hydrology/snowpack, Folsom power penstock shutter management flexibility, power generation, Nimbus Fish Hatchery operations and maintenance, and Delta needs.

The Folsom temperature shutters are structural devices at the Folsom Dam power unit intakes that provide downstream temperature management control. These devices help control the desired downstream temperature by selecting the elevation where water is withdrawn from the reservoir. The Folsom Shutters can be operated such that water from different reservoir elevations is accessed and blended, providing additional temperature management control. Lastly, when temperature operations exhaust the reservoir’s cold water pool (CWP) at the lowest shutter locations, Reclamation has the operational ability to release the coolest water from the river outlets at the lowest elevation outfall in Folsom Dam in effort to achieve targeted temperatures in the LAR to the extent physically controllable. Releases from the river outlets cannot be used to generate power and thus this operation is referred to as a “power bypass”.

1.4 Transition to February 2020 ROD

In 2009, NOAA Fisheries issued a BiOp to Reclamation that included an RPA to address the effects of the proposed action considered in the 2009 BiOp and how that action could be implemented in a manner that would avoid the likelihood of jeopardy to listed species or adverse modification of critical habitat. On April 7, 2011, NOAA Fisheries provided an RPA amendment (NMFS 2011), which, consistent with the Delta Stewardship Council’s Independent Review Panel (DSC 2010), corrected errors in the 2009 RPA and provided clarification.

On August 2, 2016, Reclamation, the federal action agency, and the California Department of Water Resources (DWR), the applicant, jointly requested the reinitiation of ESA consultation with the USFWS and NOAA Fisheries on the coordinated long-term operation of the CVP and SWP. NOAA Fisheries accepted the reinitiation request on August 17, 2016. On January 31, 2019, Reclamation transmitted their Biological Assessment (BA) to NOAA Fisheries and a revised BA (Reclamation 2019b) was submitted on October 21, 2019.

NOAA Fisheries finalized and issued its BiOp on the coordinated operations of the CVP and SWP on October 21, 2019. NOAA Fisheries concluded that Reclamation's proposed operations will not jeopardize threatened or endangered species, or destroy or adversely modify designated critical habitats.

The Bureau of Reclamation signed a ROD on February 18, 2020 to implement the preferred alternative as described in the Final EIS for the Reinitiation of Consultation on the Coordinated Long-Term Operation (ROC on LTO) of the CVP and SWP and evaluated in the 2019 USFWS and NMFS BiOps (Reclamation 2020; USFWS 2019).

Chapter 2 – February 2020 ROD

2.1 Summary of February 2020 ROD

Implementation of the February 2020 ROD began on February 19, 2020. The February 2020 ROD for American River operations includes commitments regarding flows and water temperature objectives, with some conservation measures related to habitat restoration and hatchery management (Table 1). Reclamation proposed to adopt the minimum flow schedule or Minimum Release Requirement (MRR) and approach developed by the Water Forum in 2017-2018 (Water Forum 2017). This approach also includes implementation of redd dewatering protective adjustments that restrict changes in the MRR between December and June and, under certain conditions, a spring pulse flow. Reclamation also proposed to continue summer and fall temperature management for the LAR.

Table 1. Components of the Proposed Action related to the American River system per Table 4-7 in Chapter 4 of the 2019 Biological Assessment.

Component	Page #
Seasonal Operations	4-23
2017 Flow Management Standard Releases and “Planning Minimum”	4-23
American River Pulse Flows	4-23
Spawning and Rearing Habitat Restoration	4-23
Nimbus Hatchery Genetic Management Plans	4-23
Drought Temperature Management	4-23
Yellow-billed Cuckoo Surveys	4-23

An overview of American River operations under the February 2020 ROD specific to the 2017 FMS planning minimum and spring pulse flow is provided in Attachment A. An overview of American River operations under the February 2020 ROD specific to water temperature management is provided in Attachment B. American River operations under the 2020 ROD continue to be coordinated through the ARG.

The following non-flow components of the February 2020 ROD are not discussed in this report as they have not been standing topics of discussion at ARG meetings during WY 2021.

- *Spawning and Rearing Habitat Restoration*
- *Hatchery Genetics Management Plans (HGMPs)*

- *Drought Temperature Management*
 - *Reclamation did degang the shutters of the Temperature Control Device during WY 2021, which allowed for the alternative shutter configurations proposed in this component of the 2020 ROD. Shutter configurations were reported out at the monthly ARG meetings.*
- *Yellow-billed Cuckoo Surveys*

Chapter 3 – ARG Discussion Topics

The following section outlines ARG discussion topics from the October 2020 through September 2021 monthly meetings. Meeting notes and supplemental ARG documents were made available to the ARG members and posted to the ARG Technical Group website¹. The ARG distribution list is maintained by the Central California Area Office (CCAO) Resources Management Division.

3.1 Monthly Discussion Topics

- **Lower American River Fisheries Monitoring**
 - The status of current and future fisheries monitoring activities were provided by Reclamation, NMFS, USFWS, CDFW, Cramer Fish Sciences (Cramer), and Pacific States Marine Fisheries Commission (PSMFC) (see Chapter 5).
- **American River System Reservoir Operations**
 - Monthly reservoir operations and hydraulic forecast updates provided by Central Valley Operations (CVO), Sacramento Municipal Utility District (SMUD), and Placer County Water Agency (PCWA).
- **Water Operations and Water Quality**
 - Reservoir storage, CWP volume, flows measured at Fair Oaks gage on the LAR, current temperature modeling results and water temperatures measured at Nimbus Dam, Fair Oaks gage, and Watt Avenue (see Chapter 4).
 - February 2020 ROD *2017 Flow Management Standard Releases and Folsom Planning Minimum*

The 2017 FMS in the February 2020 ROD was finalized in December 2018 and incorporated into the Proposed Action for ROC on LTO of the CVP and SWP. The 2017 FMS in the February 2020 ROD includes a minimum release requirement (MRR) with flows ranging from 500 to 2,000 cfs based on time of year and annual hydrology. The flow schedule is intended to improve CWP and habitat conditions for steelhead and fall-run Chinook salmon. Specific flows are determined using the American River and Sacramento River indices intended to define the current and recent hydrology.

The 2017 FMS in the February 2020 ROD includes an end-of-December storage planning minimum that aims to improve water supply reliability and help manage water temperatures in the LAR. The objective of incorporating the planning minimum into the forecasting process is to provide releases of salmonid-suitable temperatures to the LAR and reliable deliveries to American River water agencies that are

¹ The ARG Technical Team webpage can be found here: <https://www.usbr.gov/mp/bdo/american-river-group.html>

dependent on deliveries or releases from Folsom Reservoir.

- *Spring Pulse Flows*

The 2017 FMS in the February 2020 ROD includes a pulse flow component of about a four-week duration during March and April. This requires supplementing normal operational releases from Folsom Dam under certain conditions. Accommodations may be made for additional requests for spring pulse flows by re-shaping previously planned releases. The intent of the spring pulse flow is to provide a juvenile salmonid emigration cue before relatively low flow conditions and unsuitable thermal conditions occur later in spring.

- *Temperature Management Plan*

Reclamation will prepare a draft Temperature Management Plan by May 15 for the summer through fall water temperature management season using the best available information and decision support tools. The draft plan will contain: (1) forecasts of hydrology and storage; and (2) a modeling run or runs, using these forecasts, demonstrating what temperature compliance schedule can be attained. Reclamation will use an iterative approach, varying shutter configurations, with the objective to attain the best possible water temperature schedule for the compliance point at Watt Avenue Bridge (AWB²).

3.2 Other Discussion Topics

- **Central Valley Project Improvement Act (CVPIA)**

Reclamation's most recently completed restoration project took place in the fall of 2021 at Ancil Hoffman Park, adjacent to the Effie Yeaw Nature Center in Carmichael, California. Mobilization of construction equipment for the Ancil Hoffman Salmonid Restoration Project started on August 30, 2021. The construction was completed on October 1, 2021. The Ancil Hoffman Project focused on gravel sorting and placement for spawning adults; and floodplain rearing habitat for juveniles. Over 15,000 cubic tons of gravel was sorted and placed in the mainstem river. Gravel for the Ancil Hoffman restoration project was extracted from the Project site. Gravel was processed (sorted and cleaned) and stockpiled at the Project site before being delivered via dump truck to short-term areas adjacent to gravel augmentation sites within the Ancil Hoffman portion of the mainstem American River (Figure 2). The sorted gravel is ideal size for spawning fall-run Chinook and Steelhead. Floodplain habitat was created by creating a 1,000 ft alcove feature (Figure 3). Inundation of the rearing habitat can occur at flows of 800 cfs and greater.

Reclamation is working on permitting for additional habitat improvement sites at Lower Sailor Bar (Figure 4), including upper Sunrise Side Channel (Figure 5).

² Temperature data for the compliance point at Watt Avenue Bridge (AWB) can be found here: <https://cdec.water.ca.gov/webgis/?appid=cdecstation&sta=AWB>

Habitat improvement projects in the LAR are often led by or coordinated with the Water Forum.



Figure 2. A dump truck placing sorted gravel into the mainstem American River.

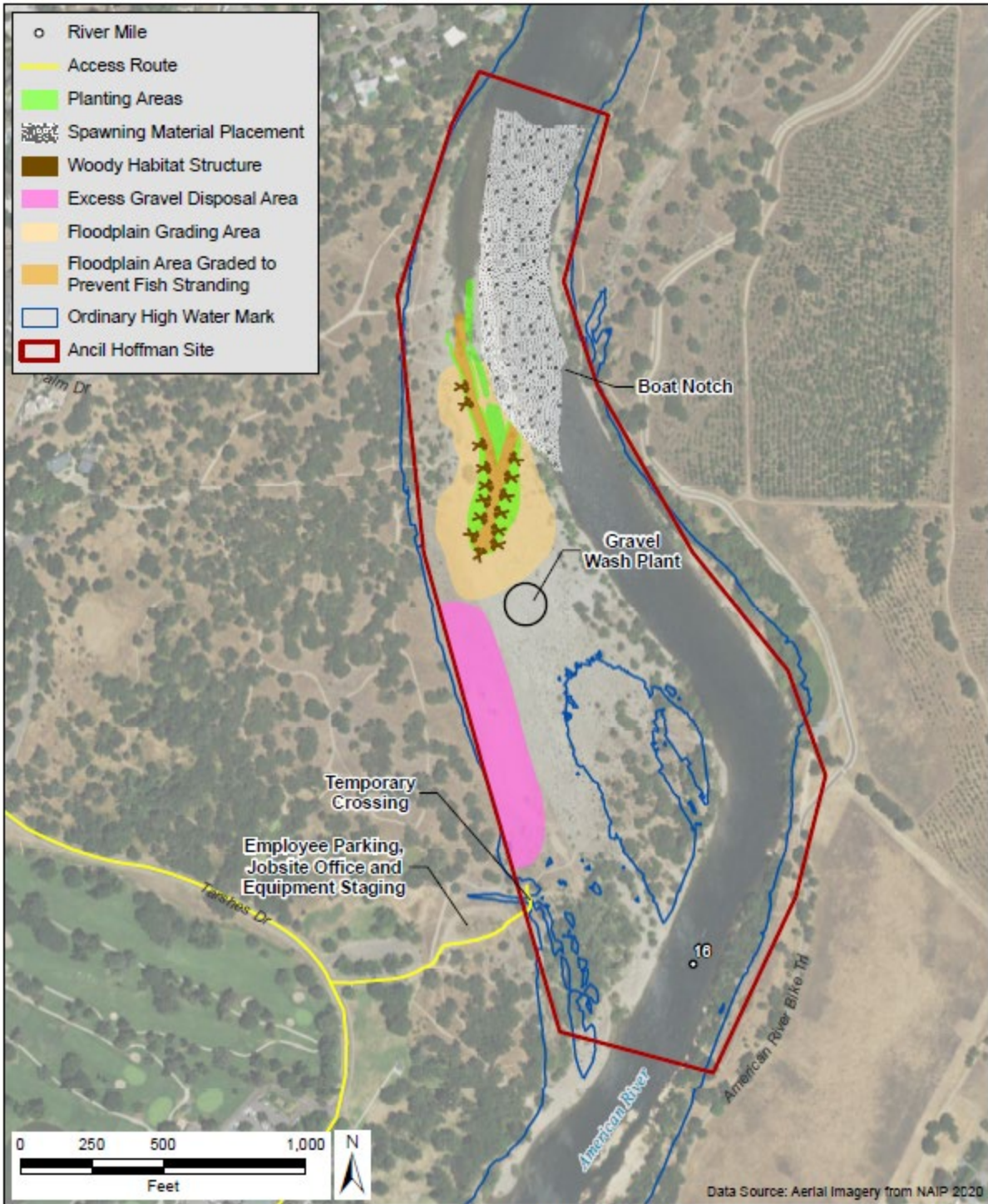


Figure Source: GEI Consultants, Inc. 2021.

Z:\Projects\2005215_CityOfSac_LowerAmericanRiver\2005215_G002_ProjectLocation_20210512.mxd
12May2021 RG/GI

Figure 3. Project design of the Ancil Hoffman Salmonid Restoration in the Lower American River. Project completed on October 1, 2021.



Figure 4. Future restoration site at Lower Sailor Bar (extent of project site, gravel augmentation and side channel area may not be current).

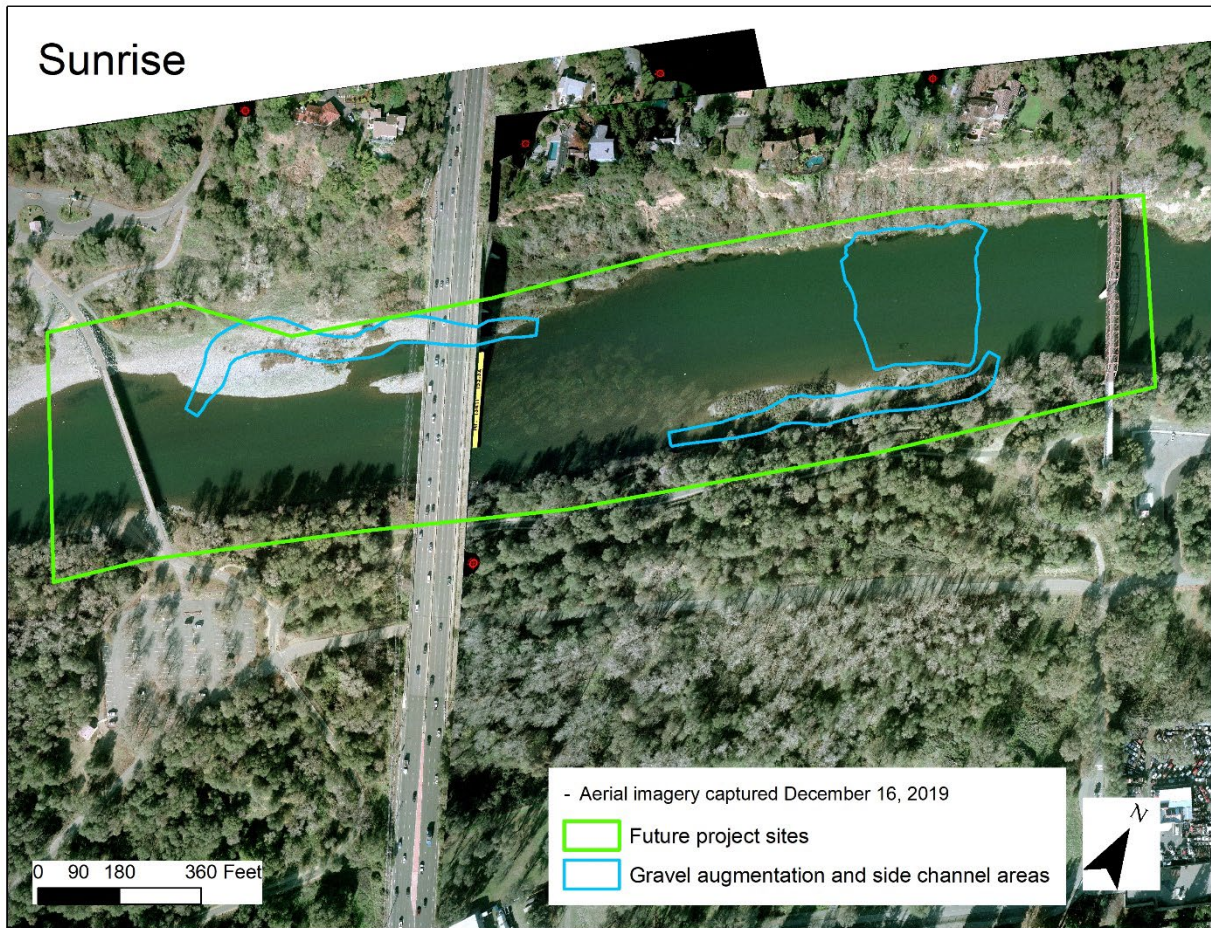


Figure 5. Future restoration site at Sunrise Side Channel (extent of project site, gravel augmentation and side channel area may not be current).

- **Power Bypass proposals**

- Group discussed power bypass options to achieve cooler fall temperatures for spawning fall-run Chinook salmon. A power bypass was approved by Reclamation for implementation during fall 2020. Another power bypass was discussed and proposed for fall 2021 and was also approved by Reclamation. The implementation of that power bypass began in October 2021 and thus occurred during WY 2022 (see Attachment D).

- **ARG Presentations**

- **Nimbus Fish Ladder (12/17/2020)** - John Hannon, Fish Biologist, Bay-Delta Office, Reclamation; shared photos of the new fish ladder in the Nimbus Basin.
- **Shining a Light on Harvest Management (1/21/2021)** – Dana Lee, Fisheries Biologist, FISHBIO; fall-run harvest management in the CV, importance of forecasts, harvest and escapement during the drought, status of hatcheries, possible

improvements to harvest management.

- **2017 FMS Refresher (2/18/2021)** - Jeff Weaver, HDR; summary of 2017 Flow Management Standard Minimum Releases Requirement (FMS calculation and application).
- **Sailor Bar: Tested Techniques & Innovative Ideas (3/18/2021)** - Avery Scherer, Cramer; results of monitoring at Sailor Bar restoration site following gravel augmentation and side channel construction.
- **Pre-spawn Mortality of Female Fall-run Chinook on the Lower American River (4/15/2021)** – Tracy Grimes, CDFW; presented data on prespawn mortality of Chinook salmon in the lower American River from carcass surveys between 2011-2020.
- **LAR RST Salmonid Data Analysis (7/15/2021)** - Olivia Mihok, a NOAA Hollings Scholar; presented her findings related to Lower American Rotary Screw Trap Data for Steelhead & Chinook salmon. Her research focused on analyzing catch patterns to better understand the cause and impacts of data gaps.

Chapter 4 – Water Operations Summary

4.1 General Water Year Conditions and Operations

The 40-30-30 index for the Sacramento Valley was ultimately characterized as “critical” for WY 2021, based on the May 50% exceedance forecast. American River operations were dominated by storage conservation operations from late December 2020 through September 2021.

4.2 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 runoff forecast is updated routinely by the DWR and the National Weather Service California Nevada River Forecast Center (CNRFC), where uncertainty is represented by percent runoff exceedances. The February 2021 initial unimpaired runoff 90% exceedance (conservative) forecast volume for April – July 2021 by DWR in their Bulletin 120 was 350 thousand Acre-Feet (TAF), or 50.0% of the average 370 TAF³. The actual full natural flow volume April – July in 2021 was 745 TAF, or 33% of the 15 year average (final WY 2021 actual inflow to Folsom volume October – September was 718.37 TAF).⁴ Table 2 provides precipitation data and characteristics for November to May of WY 2021. 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. 2021 Water Year Northern Sierra precipitation, American River Basin snowpack, and Sacramento Valley Index statistics by November 2020 through May 2021 (DWR Bulletin 120).

Water Year 2021	Northern Sierra 8- Station Precipitation (Cumulative inches through month) ⁵	Sacramento Valley Index (40-30-30 Index 50% Exceedance; year type) ⁶
November	3.49	N/A
December	7.11	5.9; Dry
January	13.98	5.3; Critical
February	18.02	5.0; Critical
March	22.08	4.6; Critical
April	22.83	4.4; Critical
May	23.01	4.0; Critical

³ <https://cdec.water.ca.gov/reportapp/javareports?name=b120feb21.pdf>

⁴ <https://cdec.water.ca.gov/dynamicapp/QueryMonthly?&s=AMF>

⁵ <https://cdec.water.ca.gov/reportapp/javareports?name=8STATIONHIST>

⁶ <http://cdec4gov.water.ca.gov/reportapp/javareports?name=WSI>

4.3 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 unplanned. 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, water 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 in late winter through early summer (depending on hydrologic conditions) on Reclamation’s website (<http://www.usbr.gov/mp/cvo/>).

Key factors that influenced WY 2021 LAR operations:

- Minimum flow rate/FMS: WY 2021 was a critical water year and there were no flood control releases required.
- LAR Flow Reduction Discussions: In addition to the monthly ARG meetings, several ARG calls were scheduled to discuss specifically the potential reduction of LAR flows due to current hydrologic conditions and poor outlooks. ARG members provided redd dewatering information to help understand potential redd dewatering impacts with LAR flow reductions. These discussions weighed the risk of reducing flows to increase storage and minimizing risk of redd impacts due to increased or fluctuating flows needed for flood management.
- Reservoir Storage: Reservoir storage peaked on May 15, 2021 at 398.78 TAF.
- Cold Water Pool (CWP): The CWP volume was lower than desirable by the end of May this water year (see historical end of May CWP volumes in Table 3). This was due to the lower reservoir storage that resulted from critical year hydrology.
- Temperature Management Plan (TMP): Based on various iCPMM and CE-QUAL-W2 modelling runs and given the current number of uncertainties with potential drought actions, inflow projections and operations forecasts, the LAR TMP goal was to target 71°F at Hazel (as measured at the American River at Fair Oaks - AFO gauge; see Figure 6) from June 6, 2021 to October 31, 2021 and target 58°F from November 1, 2021 until winter. Diminishing levels of precipitation and runoff in California resulted in the driest Water Year in a century. Extreme heat compounded the difficulty of meeting water temperature objectives over the summer months. Reclamation operated to 71°F at Hazel Avenue thru October 31, 2021. This decision, with agreement from the ARG, was made to conserve CWP resources to attempt to meet more suitable water temperatures in November than the temperature plan objective of 59°F at Hazel Ave. See Section 4.4.3 Temperature Management Plan for more details.
- October 2020 Hatchery Conditions: The water for the fish ladder was turned on October 30, 2020 to allow Chinook salmon to begin entering the ladder. Flows into the ladder

were set at 20 cfs for the entirety of the season. Flow was set using two staff gauges, one located within the fish ladder and the other located just downstream. Fall-run Chinook salmon brood stock collection began on November 2, 2020 and continued until January 26, 2021. In early October 2020, CDFW reported approximately 25,000 steelhead deaths in the Nimbus raceways, thought to be due to conditions (low dissolved oxygen and disease) exacerbated by very warm water temperatures. CDFW installed aerators and sourced medicated feed, which reduced deaths into the single digits daily. The Nimbus Dam Gate 18 was opened in November 2019 to address stagnant warmer water at the hatchery intake, but that was not possible in fall 2020 because of construction on the hatchery fish ladder directly downstream of the gate.

- October-November 2021 Folsom Power Bypass: On October 1, 2021, Reclamation received a Folsom Power Bypass proposal from CDFW on behalf of the state and federal fisheries agencies (see Attachment D). The proposal contains three bypass scenarios that would access Folsom's CWP below the power unit penstocks to reduce LAR water temperatures to benefit rearing steelhead and spawning fall-run Chinook salmon. Prior to submittal to USBR, this proposal was provided in Draft form to the ARG for review and comment. The proposal draws upon numerous Folsom power bypass and LAR temperature management discussions held at the monthly and ad hoc ARG meetings over the previous several months. The proposal was presented and discussed at the September 24, 2021 ARG ad-hoc meeting:
 - Scenario A: power bypass starting October 18 at 150 cfs and then increasing to 350 cfs on October 25 and continuing at 350 cfs until November 25 or a bypass is no longer needed
 - Scenario B: power bypass starting October 18 at 350 cfs and then continuing at 350 cfs until November 25 or a bypass is no longer needed
 - Scenario C: power bypass starting October 11 at 150 cfs and then increasing to 350 cfs on October 18 and continuing until November 25 or a bypass is no longer needed

On October 7, the Regional Director approved Scenario C but with the following characteristics:

- Start date of October 11 with 50 cfs and adding approximately 50 cfs per day for 3 days up to approximately 150 cfs (to avoid cold water shock to fish in Lake Natoma) with the goal of reaching a LAR daily average water temperature of 62° F measured at Hazel Avenue to limit pre-spawn mortality and limit induction of spawning
- Hold the approximately 62° F LAR daily average water temperature measured at Hazel Avenue (approximately 150 cfs and not to exceed 350 cfs of power bypass) through the month of October
- For comparison, Scenario C requested a power bypass volume and modeled temperatures resulting from that volume. The power bypass proposal did not target a particular temperature, but instead focused on a volume aimed to achieve the coldest temperature possible given the limited CWP.

- Starting around October 25 increase the bypass to no more than 350 cfs to target 56° F LAR daily average water temperature measured at Hazel Avenue (via approximately 100 cfs/day increments) by November 1.
- Continue with the maximum 350 cfs power bypass until ambient air temperatures make power bypass no longer necessary to maintain LAR daily average water temperature of 56° F measured at Hazel Avenue.

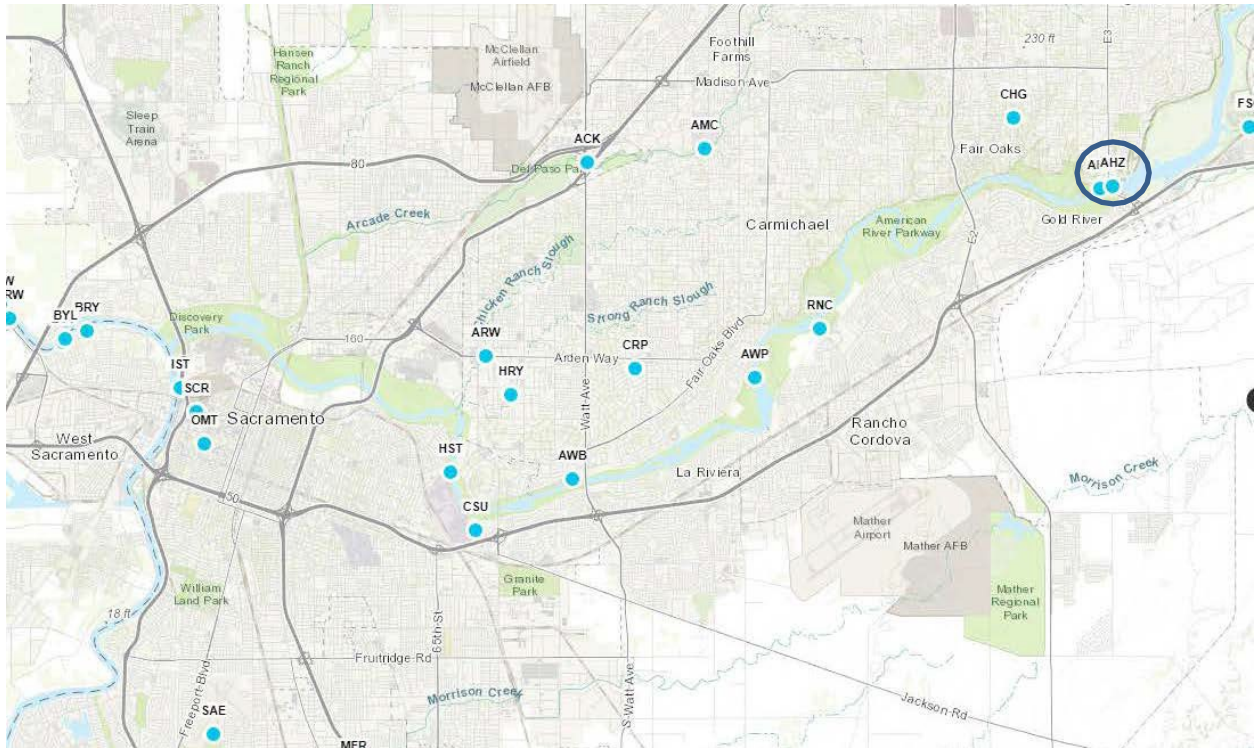


Figure 6. Location of water temperature monitoring station (AFO) at American River at Fair Oaks.

Table 3. Historical Conditions (2001-2021) Folsom Reservoir Cold Water Pool dynamics.

Year	End of May Storage (TAF)	End of May CWP Volume < 58° F (TAF)	All Upper Shutters Lowered by	End of September Storage (TAF)	End of September CWP Volume < 60° F (TAF)	Watt Avenue Target (°F)
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

Year	End of May Storage (TAF)	End of May CWP Volume < 58°F (TAF)	All Upper Shutters Lowered by	End of September Storage (TAF)	End of September CWP Volume < 60°F (TAF)	Watt Avenue Target (°F)
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
2019	935	605	26 Mar 5 Jun (unit 1 returned to service)	714	89	65
2020	790	366	21 Apr	423	60	68
2021	361	117	None Lowered	230	34	71 (at AFO)

From April through November, Reclamation collects temperature profile data in Folsom Reservoir twice a month (essentially every two weeks). For December through March, temperature profiles are taken one time per month at all six locations. The temperature profile data are used to model reservoir and downstream temperatures throughout the temperature control season. This allows Reclamation to determine feasible temperature objectives on the Lower American River. The temperature model is run for every new profile to be able to either confirm that the temperature objectives are still feasible or determine that a change to the temperature plan needs to be made. The temperature compliance location is at Watt Ave for May through October and shifts to the Hazel Ave Bridge location for November. However, during this critical year, the compliance location was moved to Hazel Ave Bridge.

4.4 WY 2021 Operations Under February 2020 ROD

4.4.1 2017 Flow Management Standard Releases and Planning Minimum

The February 2020 ROD is designed to provide minimum required flows for all steelhead life stages, as specified by the 2017 FMS Minimum Release Requirement (MRR). These MRRs are measured as total releases at Nimbus Dam. The 2017 FMS uses two hydrological indices to determine the MRR: American River Index (ARI) and Sacramento Index (SRI). The prescribed flows are minimums only, and do not preclude Reclamation from making higher releases.

Storage and flood control conditions for Folsom Lake are illustrated in Figure 7, which also includes inflow to Folsom Lake and releases at Nimbus Dam for October 2020 through October 2021. Folsom storage at the end of September was 230 TAF.

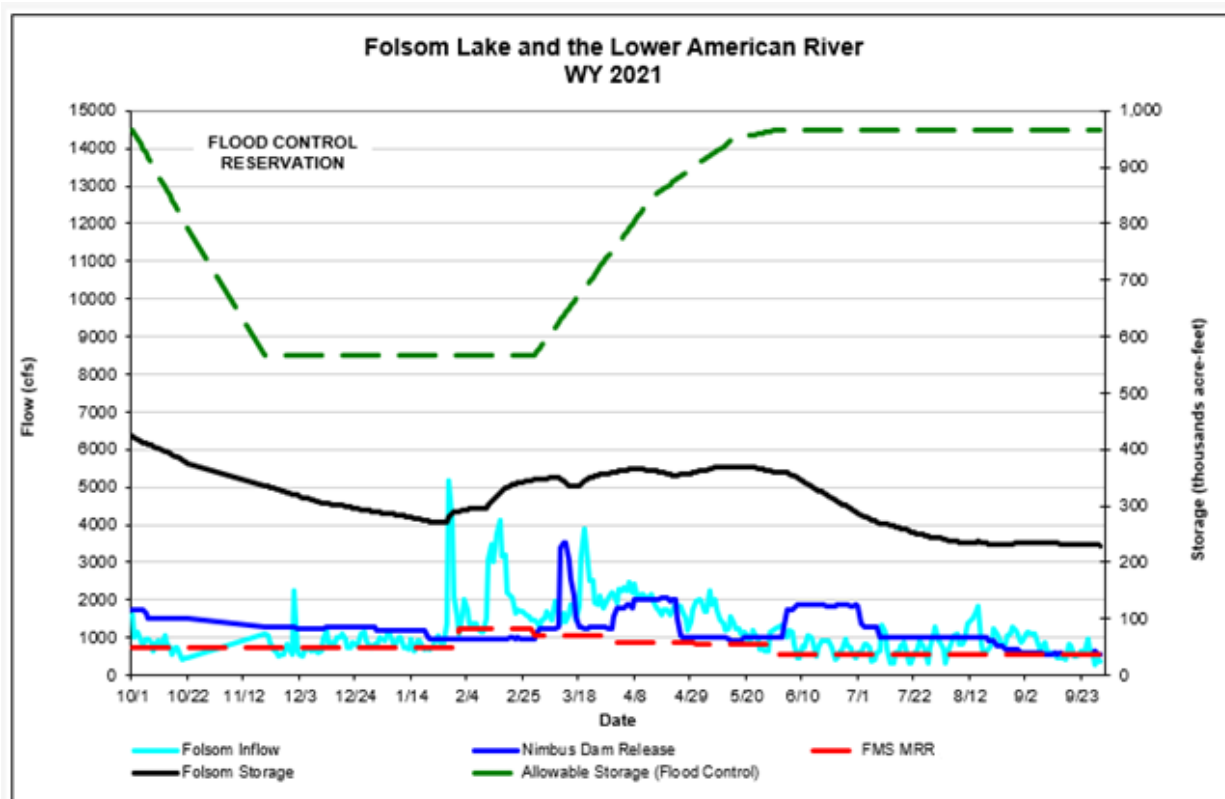


Figure 7. Summary of WY 2020 Folsom Reservoir Storage and Flow Releases from Nimbus Dam to the Lower American River.

The Nimbus Dam releases to the LAR and the prescribed MRRs for WY 2021 are shown in Figure 8.

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

below Nimbus Dam. Because of concerns about dry hydrology, Reclamation operated to a February 2021 Nimbus release of 950 cfs rather than the MRR of 1,246 cfs, as shown below in Figure 8.

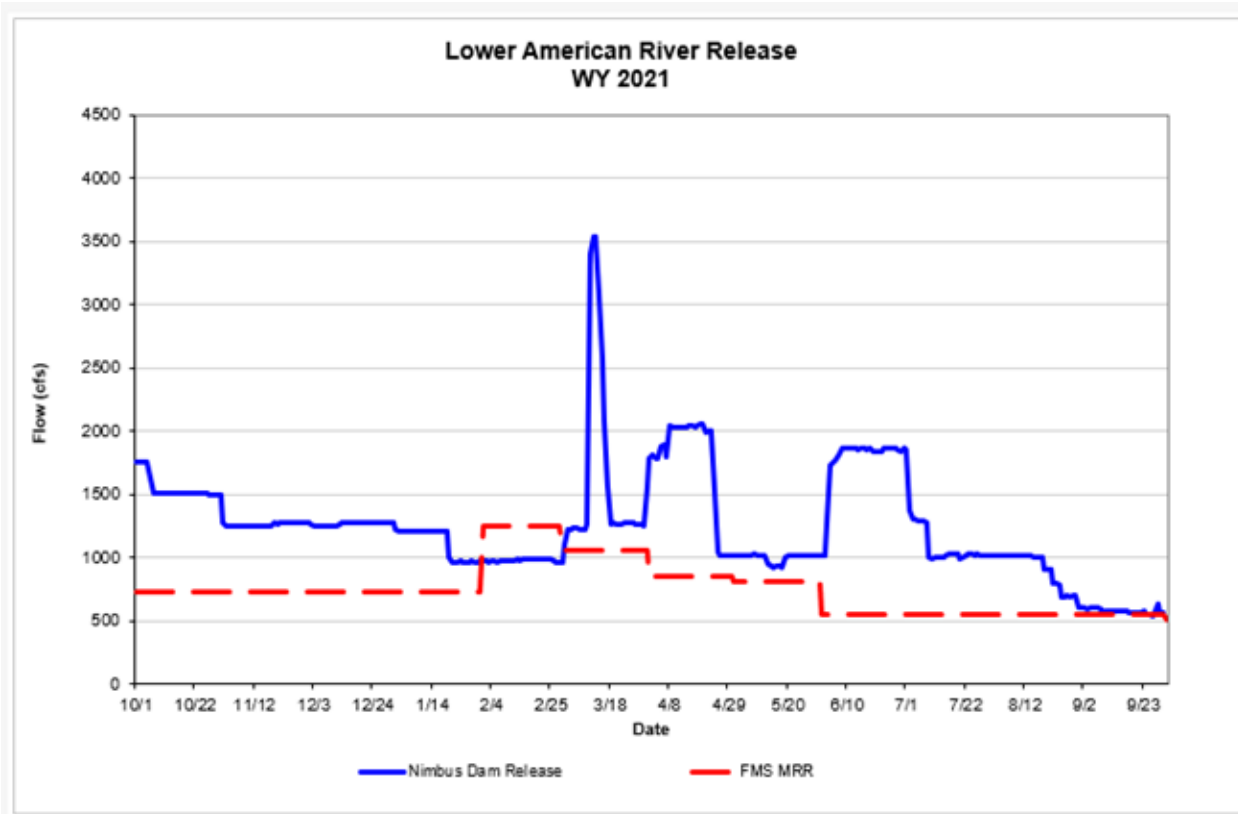


Figure 8. Summary of WY 2021 Nimbus Dam Releases to the Lower American River Releases.

Table 4. Reclamation’s WY 2021 Release Changes at Nimbus Dam

Start Date	Release	To (cfs)	Comment
11/1/2020	Decrease	1,250	Fall spawning flows
1/1/2021	Decrease	950	Storage Conservation
3/2/2021	Increase	1,200	Delta Needs
3/11/2021	Increase	3,500	SWRCB D-1461
3/14/2021	Decrease	3,000	SWRCB D-1461
3/15/2021	Decrease	2,500	SWRCB D-1461
3/16/2021	Decrease	2,000	SWRCB D-1461
3/17/2021	Decrease	1,500	SWRCB D-1461
3/18/2021	Decrease	1,200	SWRCB D-1461
3/31/2021	Increase	1,500	SWRCB D-1461 -- Delta Outflow
4/1/2021	Increase	1,750	SWRCB D-1461 -- Delta Outflow
4/8/2021	Increase	2,000	SWRCB D-1461 -- Delta Outflow
4/24/2021	Decrease	1,500	Conserve Storage
4/25/2021	Decrease	1,000	Conserve Storage
5/13/2021	Decrease	900	Conserve Storage

Start Date	Release	To (cfs)	Comment
5/19/2021	Increase	1,000	D-1641 Salinity
6/3/2021	Increase	1,250	Delta Outflow
6/4/2021	Increase	1,750	Delta Outflow
6/7/2021	Increase	1,850	Delta Outflow
7/2/2021	Decrease	1,300	Conserve Storage
7/9/2021	Decrease	1,000	Conserve Storage
8/19/2021	Decrease	900	Conserve Storage
8/22/2021	Decrease	800	Conserve Storage
8/25/2021	Decrease	700	Conserve Storage
8/31/2021	Decrease	600	Conserve Storage
9/9/2021	Decrease	550	Conserve Storage
*10/24/2021	Increase	2,500	Lake Natoma Reservoir Management
*10/25/2021	Decrease	550	Lake Natoma Reservoir Management

*Denotes release changes that occurred after WY 2021 for continuity of operations

4.4.2 Spring Pulse Flows

Spring pulse flows were not required or implemented in Water Year 2021 as part of the February 2020 ROD. Because this was an off-ramp year (i.e., Nimbus releases exceeded the spring pulse flow for more than two days between Feb 1 and March 15) there was no requirement for a separate pulse flow.

4.4.3 Temperature Management Plan

The temperature management plan component in the February 2020 ROD is designed to provide suitable temperatures to support over-summer rearing steelhead in the LAR from May 15 through October 31. Figure 9 is a summary of Reclamation’s water temperature operations, from October 2020 through November 2021, 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 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-determined habitat balance between steelhead and fall-run Chinook salmon. The selected plan is provided to ARG for comments and recommendations. After the ARG review of the Water Temperature Plan, Reclamation reviews the comments and determines the final plan. The plan is reviewed for potential updates every month based on the latest hydrology and CWP conditions.

Reclamation presented a draft Temperature Management Plan to ARG in May of 2021. On June 30, 2021, Reclamation finalized the WY 2021 Temperature Management Plan which included an iCPMM temperature model run with the objective to achieve a maximum temperature (mean daily) target at Hazel of 71°F. The temperature target of 71°F at Hazel was exceeded on two consecutive days in July. Extreme heat in July complicated efforts to control LAR temperatures. the heat waves were more durable and long lasting than the weather forecasts were able to

accurately predict. As a result, multiple changes to river releases (temperature blending) were made until control was re-gained of the LAR in-stream temperatures. As a result, multiple changes in TCD operations were made to regain LAR in-stream temperatures.

The 2017 FMS under the February 2020 ROD includes a temperature management strategy that acknowledges resource needs for the protection of fall-run Chinook salmon spawning. The goal is to achieve cooler water temperatures in October, depending on the availability of remaining CWP resources, and continue through November until active water temperature management is no longer necessary. The onset of seasonal fall cooling in most years occurs in mid-November due to ambient air temperature cooling and decreased day length. As a result, in many years, active temperature management continues after the October 31 end date of the juvenile steelhead temperature management period. After November, cooling the river to temperatures suitable for fall-run Chinook salmon spawning is typically accomplished by raising the lower shutter and releasing water through Folsom Dam’s power units. In some years, Reclamation may release water from the lower river outlet gates at a cost to power generation for additional river cooling. A summary of WY 2021 temperature shutter and power penstock blending operations, including power bypass, is provided in Table 5.

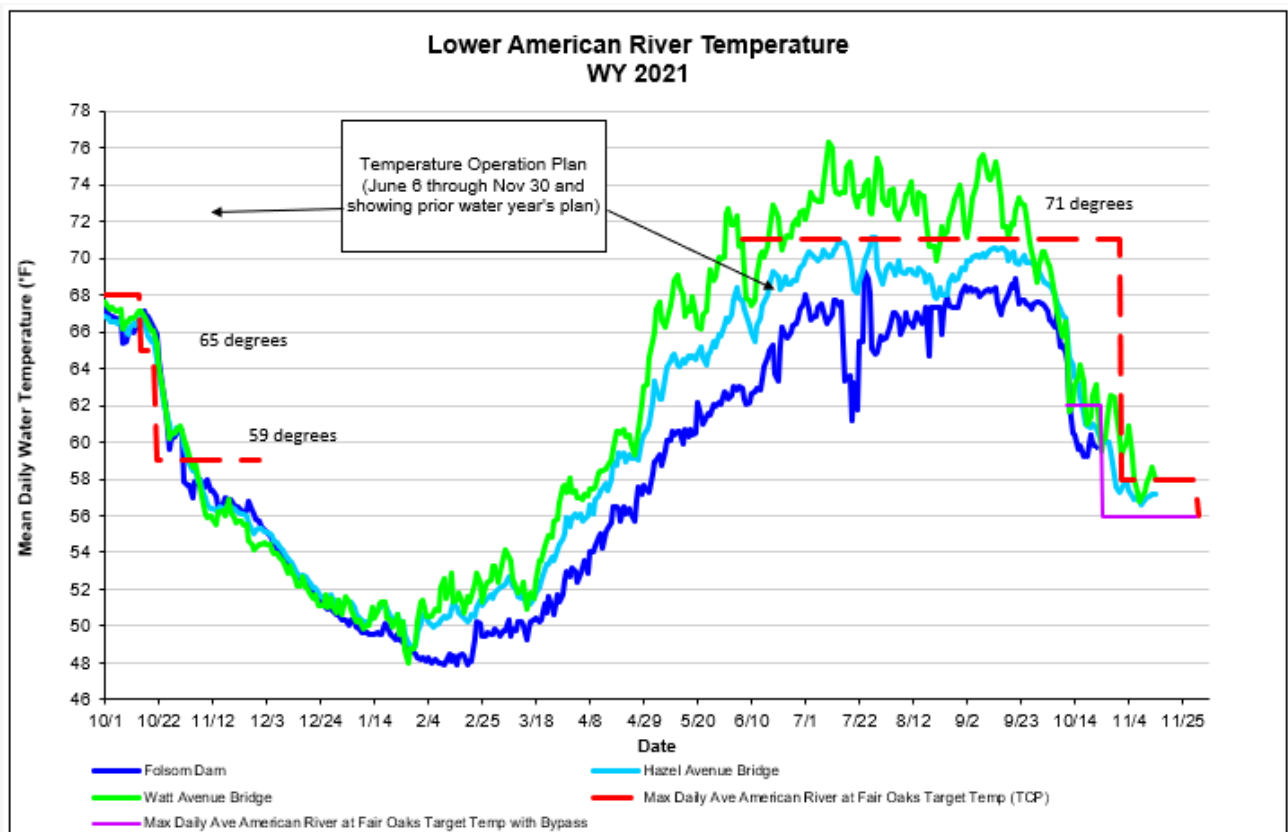


Figure 9. Summary of WY 2021 Water Temperatures in the Lower American River.

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

Date	Operation
10/13/2020	Effective ASAP please maximize Unit 2 (minimize Unit 1). Note: Temperature control at Watt Ave (decreasing from 68 degrees F to 65 degrees F on Thursday October 15, 2020).
10/14/20	Please schedule the following Shutter Pulls at Folsom Dam: On Wednesday October 14, 2020, please pull the middle shutter on Unit 1 putting it in Configuration 3. After this shutter pull is complete, all blending requirements are canceled. Shutter positions after change: Uppers: all up Middles: all up Bottom: all down Note: Temperature control at Watt Ave
10/19/20	Effective ASAP Monday October 19, 2020, please utilize Unit 1 at 50%. Note: Temperature control at Watt Ave.
10/21/20	Effective ASAP Wednesday Oct 21, 2020 please run Unit 1 at 75% blend. Note: Target 59 degrees F at Watt Ave per revised Temperature Control Plan
10/21/20	Please schedule the following Shutter Pull at Folsom Dam: On Wednesday October 21, 2020 at approximately 0700, please pull the bottom shutter on Unit 2 putting it in Configuration 4. Shutter positions after change: Uppers: all up Middles: all up Bottom: all up Note: Temperature control at Watt Ave, targeting 59 degrees F based on revised Temperature Control Plan.
10/21/20	Effective ASAP Thursday Oct 22, 2020 remove all blending requirements. Note: Target 59 degrees F at Watt Ave per revised Temperature Control Plan
10/28/20 0100 hr	Please make the following power bypass releases from the lower outlet tubes: 100 cfs
10/28/20 1300 hr	Please make the following power bypass releases from the lower outlet tubes: 200 cfs
10/29/20 0100 hr	Please make the following power bypass releases from the lower outlet tubes: 300 cfs
10/29/20 1300 hr	Please make the following power bypass releases from the lower outlet tubes: 400 cfs

Date	Operation
10/30/20 1300 hr	Please make the following power bypass releases from the lower outlet tubes: 500 cfs
10/30/20 0100 hr	Please maintain 500 cfs power bypass until further notice. Note: Implement Power Bypass Temperature Control Plan approved by RD
11/25/20 0100 hr	Please make the following power bypass reduction from the lower outlet tube: From (cfs) To (cfs) 500 250
11/26/20 0100 hr	Please make the following power bypass reduction from the lower outlet tubes: From 250 cfs to 0 cfs Note: Power Bypass Temperature Control Plan ends
2/22/21	On Monday, 02/22/2021, please lower all the Bottom and Middle set of temperature shutters on Penstock Units 1, 2, and 3. Folsom shutter status after changes: Top Shutters: Units 1, 2, & 3 - raised Middle Shutters: Units 1, 2, & 3 - lowered Bottom Shutters: Units 1, 2, & 3 - lowered Comment: Temperature Management
6/18/21	Unit 2 and 3 are deganged and top of the middle are out. Unit 3 has the uppers lifted up. • Unit 3 deganged and top of the middle out on June 18th
6/21/21	Unit 2 and 3 are deganged and top of the middle are out. Unit 3 has the uppers lifted up. • Unit 2 deganged and top of the middle out on the June 21st
6/22/21	Effective ASAP today, June 22, 2021, please run Unit 1 at 50% blend. Note: Target 71 degrees F at Hazel per Temperature Control Plan
6/23/2021	On Wednesday June 23, 2021, please raise the middle shutter on Unit 1. This will put Unit 1 in Configuration 3. Status after change: Upper gates - all up Middle Gates - Units 2 and 3 (Deganged): top panel up, lower panel down, Unit 1 up Lower Gates - all down Note: Elevation requirement
6/23/21	Effective ASAP Wednesday June 23, 2021 please minimize Unit 1 as much as possible. Note: conserving the coldest water by minimizing the coldest unit.
7/2/21	Effective ASAP Friday, July 2, 2021 please run Unit 1 at 20% blend. Note: Target 71 degrees F at Hazel Ave
7/3/21	On Saturday July 3, 2021, a call was made into the CVO control room to please run Unit 1 at a 50% blend. Note: conserving the coldest water by minimizing the coldest unit.

Date	Operation
7/8/21	<p>On Thursday July 8, 2021, please raise the middle lower shutter on Unit 2. This will put Unit 2 in Configuration 3.</p> <p>Status after change: Upper gates - all up Middle Gates - Units 3 (Deganged): top panel up, lower panel down, Unit 1 and Unit 2 up Lower Gates - all down Note: Temperature management</p>
7/8/21	<p>Effective ASAP Thursday, July 8, 2021 please run Unit 1 at 75% blend.</p> <p>Note: Target 71 degrees F at Hazel Ave</p>
7/9/21	<p>This order supersedes the last Folsom Blending order sent yesterday.</p> <p>Effective ASAP Friday, July 9, 2021 please run Unit 1 at 75% and Unit 2 at 25% blend.</p> <p>Note: Target 71 degrees F at Hazel Ave</p>
7/14/21	<p>Effective ASAP Wednesday, July 14, 2021 please run Unit 1 at 50% and Unit 2 at 10% blend.</p> <p>Note: Target 71 degrees F at Hazel Ave</p>
7/14/21	<p>Effective ASAP today, July 14, 2021, please minimize Unit 3 blending.</p> <p>Note: Target 71 degrees F at Hazel Ave</p>
7/16/21	<p>On Friday July 16, 2021, please raise the lower shutters on Unit 1. This will put Unit 1 in Configuration 4.</p> <p>Status after change: Upper gates - all up Middle Gates - Units 3 (Deganged): top panel up, lower panel down, Unit 1 and Unit 2 up Lower Gates - Unit 1 up, and Unit 2 and 3 down Note: Temperature management</p>
7/19/21	<p>On Monday July 19, 2021, please degange Unit 2 bottom shutters and remove the top 1 panel of the bottom shutters.</p> <p>Status after change: Upper gates - all up Middle Gates - Units 3 (Deganged): top panel up, lower panel down, Unit 1 and Unit 2 up Lower Gates - Unit 1 up, and Unit 2 (Deganged): top panel 1 up, lower 2,3,4 panels down, and Unit 3 down Note: Temperature management</p>
7/21/21	<p>On Wednesday July 21, 2021, please lower Unit 1 bottom shutters to configuration 3.</p> <p>Status after change: Upper gates - all up Middle Gates - Units 3 (Deganged): top panel up, lower panel down, Unit 1 and Unit 2 up Lower Gates - Unit 1 down, and Unit 2 (Deganged): top panel 1 up, lower 2,3,4 panels down, and Unit 3 down Note: Temperature management</p>

Date	Operation												
7/22/21	<p>Starting on Thursday, July 22, 2021, please run the Folsom units to this daily blending schedule: Unit 1 at 40% Unit 2 at 30% Unit 3 at 30% Note: Target 71 degrees F at Hazel Ave</p>												
7/26/21	<p>On Tuesday July 26, 2021, please lift bottom shutters on Unit 1 to configuration 4. Also please lift Middle shutters on Unit 3. Status after change: Upper gates - all up Middle Gates - all up Lower Gates - Unit 1 up (configuration 4), and Unit 2 (Deganged): top panel 1 up, lower 2,3,4 panels down, and Unit 3 down Note: Temperature management</p>												
7/27/21	<p>Starting on Tuesday, July 27, 2021, please run the Folsom units to this daily blending schedule: Unit 1 at 20% Unit 2 at 50% Unit 3 at 30% Note: Target 71 degrees F at Hazel Ave</p>												
8/8/21	<p>Starting on Sunday, Aug 8, 2021, please run the Folsom units to this daily blending schedule: Unit 1 at 25% Unit 2 at 60% Unit 3 at 15% Note: Target 71 degrees F at Hazel Ave</p>												
8/24/21	<p>Starting ASAP on Saturday, Aug 24, 2021, please run the Folsom units to this daily blending schedule: Unit 1 at 60% Unit 2 at 0% Unit 3 at 40% Note: Target 71 degrees F at Hazel Ave, Unit 2 minimized while exciter diagnosis/repair work is completed.</p>												
9/7/21	<p>Starting on Tuesday, September 7, 2021, please run the Folsom units to this daily blending schedule: Unit 1 at 10% Unit 2 at 40% Unit 3 at 50% Note: Target 71 degrees F at Hazel Ave</p>												
10/11/21	<p>Please make the following power bypass releases from the lower outlet tubes:</p> <table border="1" data-bbox="527 1627 1144 1753"> <thead> <tr> <th>Date</th> <th>Time</th> <th>cfs</th> </tr> </thead> <tbody> <tr> <td>10/11/21</td> <td>0100</td> <td>50</td> </tr> <tr> <td>10/12/21</td> <td>0100</td> <td>100</td> </tr> <tr> <td>10/13/21</td> <td>0100</td> <td>150</td> </tr> </tbody> </table> <p>Please maintain 150 cfs power bypass until further notice. Also, starting on October 11, 2021, please prioritize Unit 1 first, then Unit 3 second, and Unit 2 at last priority. Note: Implement Power Bypass approved by RD</p>	Date	Time	cfs	10/11/21	0100	50	10/12/21	0100	100	10/13/21	0100	150
Date	Time	cfs											
10/11/21	0100	50											
10/12/21	0100	100											
10/13/21	0100	150											

Date	Operation									
10/13/21	On Wednesday October 13, 2021, please lift Bottom shutters on Unit 3 to configuration 4. Also please lift Bottom shutters on Unit 2 to configuration 4 if time permit. Status after change: Upper Gates - all up Middle Gates - all up Lower Gates - all up Note: Temperature management									
10/25/21	Please make the following power bypass releases from the lower outlet tubes: <table data-bbox="527 594 1144 688" style="margin-left: 40px;"> <thead> <tr> <th>Date</th> <th>Time</th> <th>cfs</th> </tr> </thead> <tbody> <tr> <td>10/25/21</td> <td>0100</td> <td>250</td> </tr> <tr> <td>10/26/21</td> <td>0100</td> <td>350</td> </tr> </tbody> </table> Please maintain 350 cfs power bypass until further notice.	Date	Time	cfs	10/25/21	0100	250	10/26/21	0100	350
Date	Time	cfs								
10/25/21	0100	250								
10/26/21	0100	350								

4.5 Summary of American River Operations to Meet Delta Requirements

In the spring, Nimbus Dam (as measured at the AFO⁷ gauge on the LAR) releases are held steady (unless Shasta Reservoir is in flood control operations and thus can result in fluctuating demand on Folsom Reservoir) until flows are needed to support instream demands on the mainstem Sacramento River, Delta Outflow and other requirements (refer to Table 4 for Reclamation’s WY 2021 Release Changes at Nimbus Dam). CVP releases for Delta Outflow requirements are balanced between Shasta Reservoir and Folsom Reservoir. Shasta Reservoir and Folsom Reservoir are relied upon to meet in-river water temperature control requirements below Keswick Dam and Nimbus Dam later in the season, and both reservoirs need to substantially fill in the spring to fully meet these requirements. Therefore, releases must be carefully balanced to manage storage in each reservoir. An overarching goal for Reclamation when operating the CVP is to fill both reservoirs as much as possible by the end of the flood control season (end of May) while meeting all other authorized project purposes.

⁷ Temperature data for the Fair Oaks (AFO) gage can be found here:
<https://cdec.water.ca.gov/webgis/?appid=cdecstation&sta=AFO>

Chapter 5 – Lower American River Biological Monitoring

The monitoring activities described below are currently being implemented on the LAR and include actions which: represent requirements in the NMFS 2009 BiOp, NMFS 2019 BiOp, or 2020 ROD; assist Reclamation in implementing operations pursuant to the NMFS 2009 BiOp, NMFS 2019 BiOp, or 2020 ROD; provide supplemental information; or meet CVPIA specific requirements.

5.1 Monitoring Activities

5.1.1 Steelhead Spawning Surveys

Reclamation contracted with Cramer to conduct bi-weekly steelhead redd surveys. Redd surveys were conducted from Nimbus Dam to Watt Avenue, with the addition of surveys at Paradise Beach every other survey period, covering 18 river miles (Figure 10) (CFS 2021). Surveys began on January 6, 2021 and continued through April 15, 2021. No steelhead redds were observed on the final three surveys. From January 6 to April 15, 2021, a total of 101 new, clear salmonid and Pacific lamprey (*Entosphenus tridentatus*) redds were observed. When possible, redds were assigned to species based on observations of adults of these species within proximity of the redds. Of the 101 new redds, 10 were positively identified in the field as steelhead, and five as Chinook salmon. Of the remaining redds, 86 redds were initially classified as “unknown” because no fish were observed on the redd. Categorization by Discriminant Function Analysis (DFA) led to designation of 46 unknown redds as steelhead, for a total of 56 steelhead redds. Of the remaining 40 unknown redds, four were classified as Chinook salmon and 36 as Pacific lamprey.

Figure 11 shows the 2021 steelhead redd locations (following DFA) and their corresponding discovery dates by survey week. Overall, 11% of steelhead redds during the 2020 surveys were observed at gravel augmentation sites, which is the lowest percentage observed since Cramer began performing surveys in 2015. The percentage of steelhead redds observed at gravel augmentation sites had previously ranged from 27.2% to 50% since 2015. Surveyed redds were recorded from a cataraft, raft, or on foot and plotted using geographic positioning system (GPS) and biometric equipment. Bi-weekly reports summarizing the findings of the steelhead spawning survey were sent to NMFS and survey data were also reported at the monthly ARG meeting.

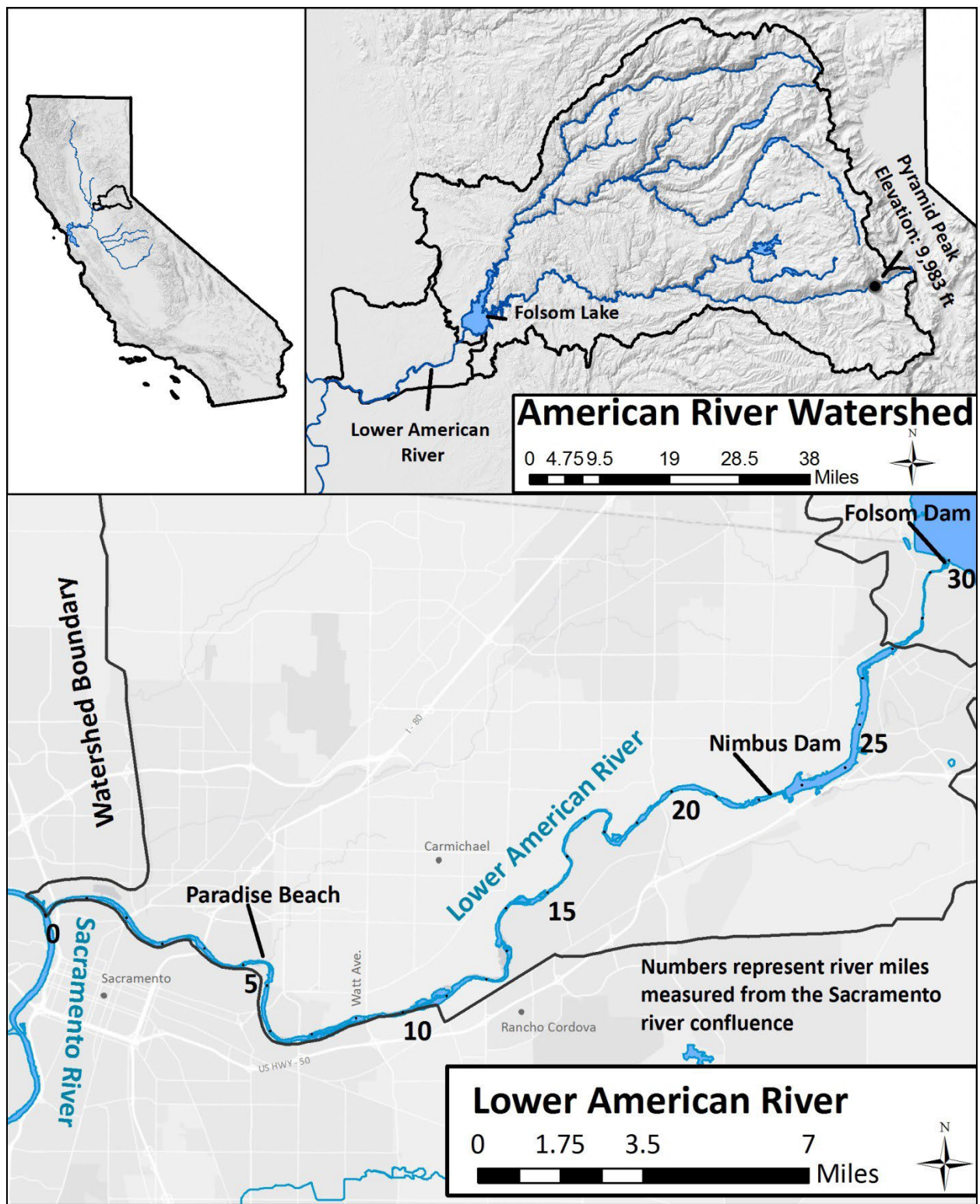


Figure 10. American River steelhead spawning survey reach.

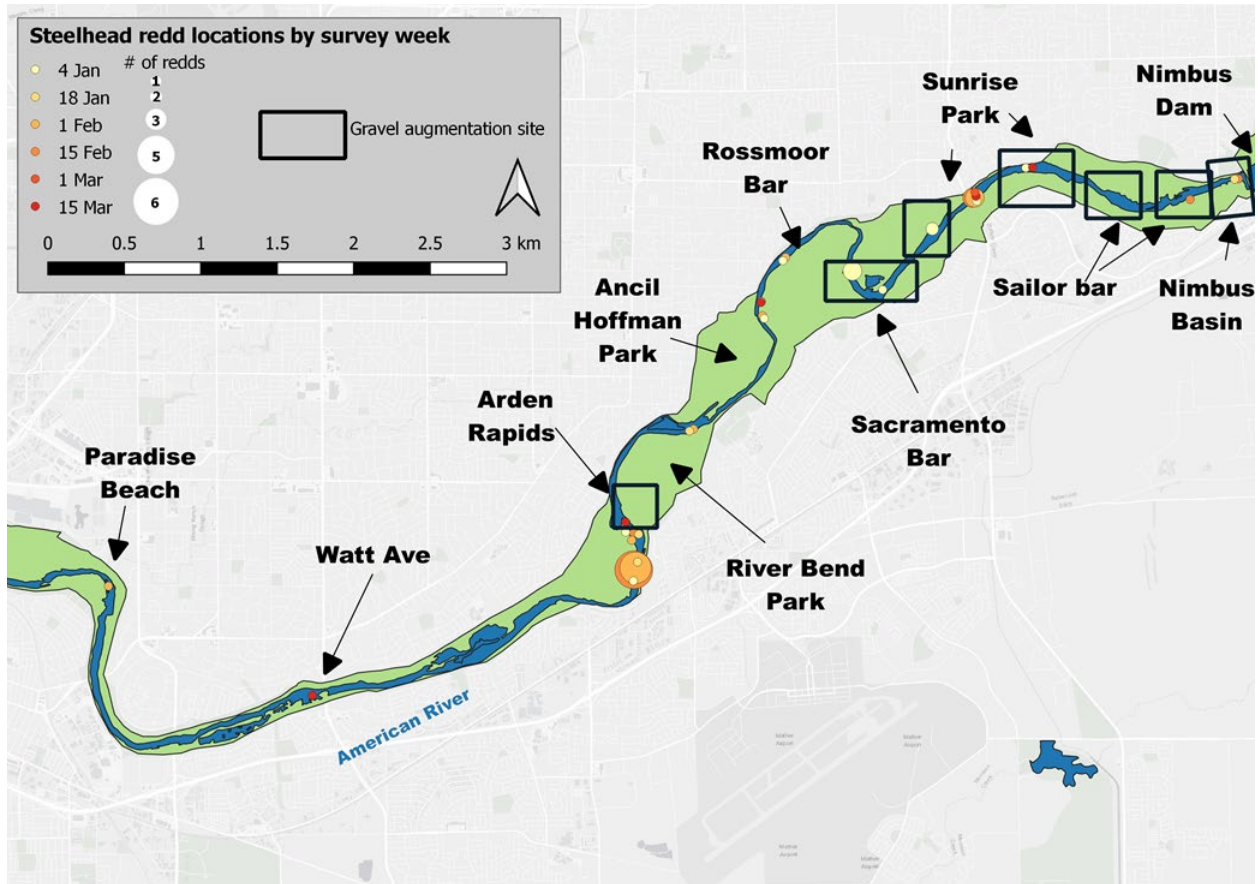


Figure 11. American River steelhead redd distribution and timing in 2021.

5.1.3 Stranding and Isolation Pool Monitoring

Reclamation monitors flow fluctuations in the LAR to assess and reduce dewatering of salmonid redds, and stranding and isolation of juvenile salmonids. Typically, stranding surveys occur under the following conditions: 1) when there is a flow reduction of more than 1,000 cfs when the initial flow is greater than 2,000 cfs or 2) when there is a flow reduction of 250 cfs if the final flow will be below 1,000 cfs. Stranding surveys may also be performed for smaller flow reductions, following discussion with Reclamation and other resource agencies. 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. 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 20 - 22 January, 18 - 19 March, and 26 - 27 April 2021 between Nimbus Dam and Paradise Beach (Figure 12). When juvenile salmonids were observed, the approximate number and size of fish in the isolated pool were recorded, along with species identification, when possible. Water temperature, dissolved oxygen (DO), and turbidity were recorded in isolated pools that contained stranded juvenile salmonids. A GPS polygon outlining the stranding pool was also recorded to estimate pool area. Survey crews looked for new stranding pools and revisited previous stranding locations during each survey. All fish were captured with a beach seine. All fish captured in the isolated pools were released back into the main channel with assistance from

CDFW. Occasionally some juveniles could not be captured due to dense vegetation, etc. In these cases, fish numbers were estimated visually. If the salmonids were captured with a beach seine they were identified to species. Table 6 summarizes salmonids captured, with steelhead numbers in parentheses. In cases where fish were observed but could not be captured by seine net they generally could not be accurately identified to species.

Table 6. Summary of stranded juvenile salmonids on the Lower American River observed during stranding surveys that occurred March 18-19 and April 26-27 2021. Values reported below are total salmonids; numbers in parentheses below salmonid counts are fish that were positively identified as steelhead.

Date	Categories	Nimbus, above hatchery weir (22)	Upper Sunrise above side channel (21)	Upper Sunrise side channel (21)	Lower Sunrise side channel (19)	Lower Riverbend Side Channel (13)	Below River Bend side channel (13)
18 - 19 March	# pools	0	1	1	1	2	0
18 - 19 March	total area (m ²)	0	466	2,332	16	564	0
18 - 19 March	total stranded salmonids (steelhead)	0	199 (18)	373	N/A ¹	327	0
26 - 27 April	# pools	1	1 ²	1 ²	0	1 ²	1
26 - 27 April	total area (m ²)	50	420	60	0	208	161
26 - 27 April	total stranded salmonids (steelhead)	1	7 (3)	548 (20)	0	31 (2)	5

Following flow reductions between January 16 and April 27, 2021, isolated pools were observed at six unique locations adjacent to the LAR, covering an estimated area of 3,636 m². Within these pools, 1,534 juvenile salmonids were observed; 43 of these were steelhead. Other fish species observed in pools included Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento Sucker (*Catostomus occidentalis*), Three-spined Stickleback (*Gasterosteus aculeatus*), Golden Shiner (*Notemigonus crysoleucas*), Western Mosquitofish (*Gambusia affinis*), Bluegill (*Lepomis macrochirus*), sculpin (*Cottus* sp.), bass (*Micropterus* sp.) and small unidentified Cyprinidae. CDFW staff accompanied Cramer during stranding surveys conducted on March 18-19 and April 26-27 and assisted Cramer with returning stranded salmonids to the LAR main channel on those survey dates. No stranded salmonids were observed during the January 20-22 surveys.

The majority of juvenile salmonid stranding occurred following a flow reduction of 2,550 cfs between 13 – 19 March (Table 6). The flow reduction in March accounted for 60% of all stranded salmonids observed in 2021 (42% of stranded steelhead; 18 total). The remaining 40% of the juvenile salmonid

stranding in 2021 occurred in late April following a flow reduction of 1,058 cfs, and 58% of all confirmed steelhead were stranded after this flow reduction.

In March, none of the observed stranding pools reached water temperatures considered to be stressful for juvenile salmonids (above 60.8°F, USEPA 2003; Table 7). However, in April, three stranding pools had stressful temperatures exceeding 60.8°F (Table 7). Two pools containing stranded salmonids were measured between 74.48°F and 79.88°F. Both of these pools were relatively small, shallow, and in an area exposed to direct sunlight for most of the day (Table 7). Additionally, in April one relatively small pool (60 m²) in the Upper Sunrise Side Channel had low DO conditions (3.02 mg/l), although water temperatures were not at stressful levels (14.1°C; Table 7). A total of 568 salmonids and high numbers of numerous other species were rescued from that pool; the low DO conditions were likely the result of crowded conditions in a small water body. No additional stranding surveys were conducted after April 27 because flows on the lower American River remained stable through the end of May.

Table 7. Summary of environmental data in the observed stranding pools containing stranded juvenile salmonids March 18-19 and April 26-27 2021. Numbers reported are averages across the pools observed within each location. Bolded numbers indicate stressful conditions for juvenile salmonids (USEPA 2003).

Date	Categories	Nimbus, above hatchery weir (22)	Upper Sunrise above side channel (21)	Upper Sunrise side channel (21)	Lower Sunrise side channel (19)	Lower Riverbend Side Channel (13)	Below River Bend side channel (13)
18 - 19 March	Temperature (°C)	N/A	12.7	13.8	14.8	12.05	N/A
18 - 19 March	Dissolved oxygen (mg/l)	N/A	10.79	11.26	9.06	11.43	N/A
18 - 19 March	Turbidity (ntu)	N/A	2.26	2.45	0.56	3.75	N/A
26 - 27 April	Temperature (°C)	26.6	17.3	14.1	N/A	14.1	23.6
26 - 27 April	Dissolved oxygen (mg/l)	12.9	9.36	3.02	N/A	8.43	9.05
26 - 27 April	Turbidity (ntu)	4.64	0.92	2.33	N/A	2.28	0.56

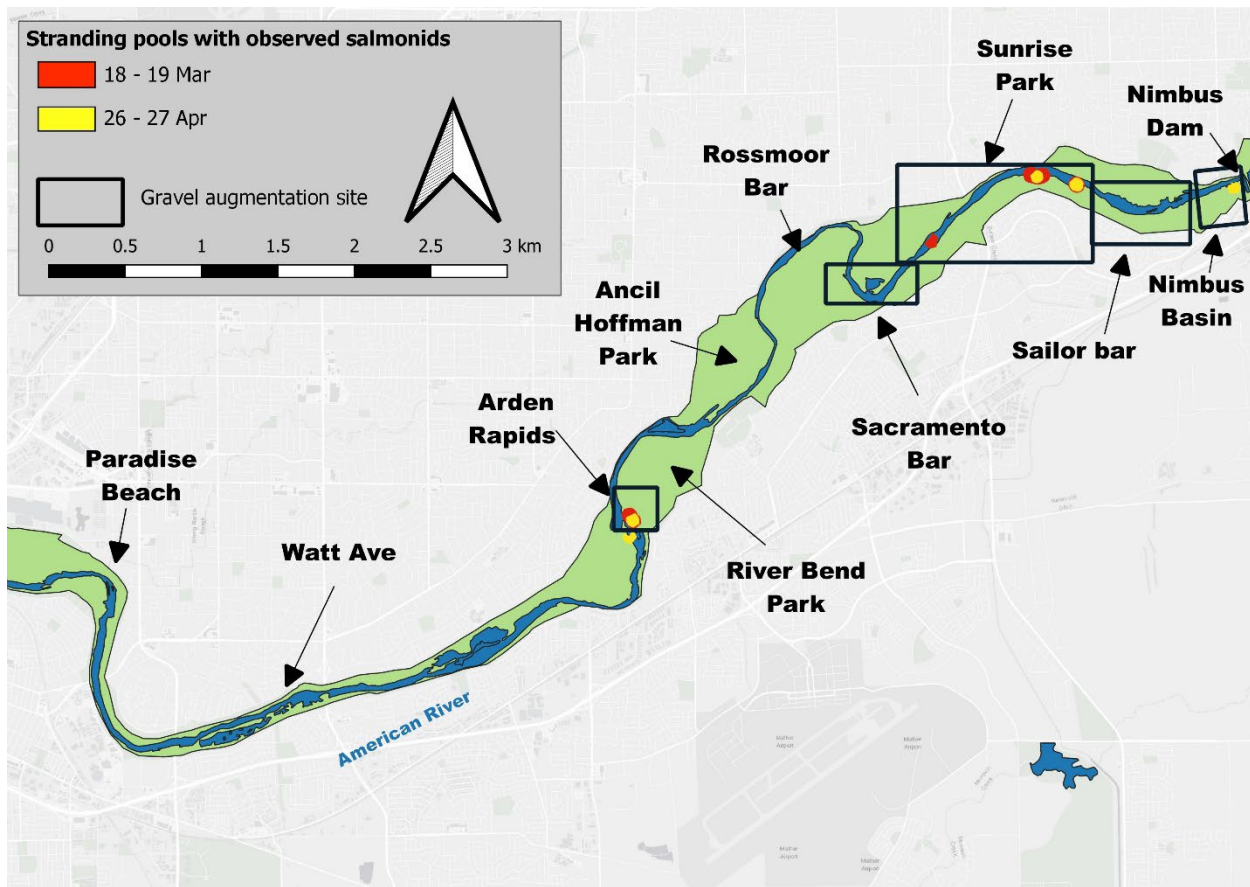


Figure 12. Locations of stranding areas on the Lower American identified March 18-19 and April 26-27, 2021. Stranded salmonids were not observed during the 20-22 January stranding surveys.

5.1.4 Steelhead Redd Dewatering

During stranding surveys, steelhead redds were monitored for dewatering. No steelhead redds were dewatered during 2021 flow reductions.

5.2 Other Monitoring Activities

5.2.1 Rotary Screw Trap

LAR rotary screw trap (RST) operations in 2021 were part of a collaborative effort by the USFWS' Comprehensive Assessment and Monitoring Program (CAMP), PSMFC, and CDFW, and results are reported annually. The primary objectives of the trapping operations are:

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;⁸ and
- To quantify raw catch of winter-, spring-, and fall-runs of Chinook salmon and steelhead/rainbow trout.

Sampling for the 2021 survey season began on January 12 and ended on June 4 with 124 days of successful sampling during the 144 day season. Two 8-foot diameter RSTs were deployed into the north channel of the Watt Avenue trapping site in a side-by-side configuration for the 2021 sampling season. Natural origin fall-run Chinook salmon encompassed the majority of all natural origin fish captured (88.62%) with a total of 35,433 determined to be fall-run based on the genetic analysis results. According to the CAMP platform “run_passage” report, which is used to expand catch into a passage estimate, 347,100 [95% CI: 324,000 – 372,800] natural origin fall-run Chinook salmon were estimated to have migrated past the Watt Ave rotary screw traps during the 2021 survey season (Figure 13). Daily catch peaked on February 28 when 3,292 natural origin fall-run Chinook salmon were captured. Daily passage estimate peak on February 26 when 27,131 natural origin fall-run Chinook Salmon were estimated to migrate past the rotary screw traps.

In total, 283 natural origin steelhead, 3 natural origin winter-run Chinook salmon and 4 natural origin spring-run Chinook salmon were captured during the 2021 survey season. No genetic analysis was performed on steelhead; however, spring-run Chinook salmon and winter-run Chinook salmon were identified through genetic analysis.

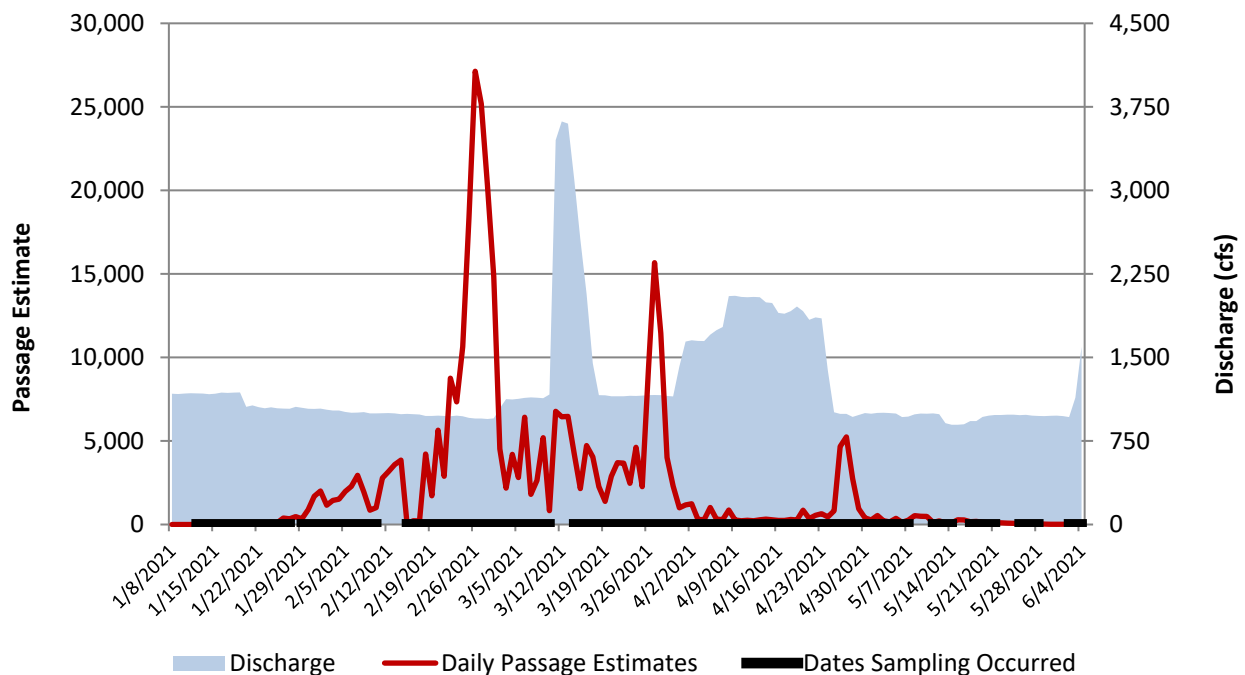


Figure 13: Daily passage estimate of natural origin fall-run Chinook salmon and daily average discharge at Fair Oaks during the 2021 lower American River rotary screw trap survey season.

⁸ Passage estimates were created using a mark-recapture spline model in the CAMP RST database platform.

5.2.2 Chinook Escapement Survey

CDFW conducted the Brood Year 2020 LAR fall-run Chinook salmon Escapement Survey over 15 survey periods from October 13, 2020, to January 22, 2021 (CDFW 2021).⁹ The 13.5-mile stretch of river from the Nimbus Dam, including Nimbus Weir downstream to Watt Avenue, was divided into six sections and surveyed once during each survey week for salmon carcasses. The objectives of the escapement survey are to:

1. Estimate the size of the fall-run Chinook salmon escapement in the LAR;
2. Determine the ratio of adults to grilse, as well as the sex ratios of adults and grilse;
3. Determine the degree of female pre-spawn mortality; and
4. Collect coded-wire tags (CWT) to investigate the number and origin of hatchery-reared fall-run Chinook salmon using spawning habitat in the LAR.

The 2020 LAR fall-run Chinook salmon in-river escapement estimate is 22,456. In addition to the in-river estimate, 6,264 salmon were trapped at the Nimbus Fish Hatchery for spawning purposes but were not included in the in-river escapement estimate. The carcass crew processed 4,532 carcasses in Nimbus Basin, 986 carcasses on the Nimbus Hatchery Weir, 6,927 carcasses in the area from below Nimbus Hatchery Weir to El Manto Dr access, 535 carcasses in the area extending from El Manto Dr access to River Bend Park, and finally, 52 carcasses in the area from River Bend Park to Watt Ave access.

Coded wire tagged carcasses (adipose fin clipped) comprised 25.5% of the total carcasses observed. Preliminary coded wire tag data revealed that approximately 52% originated from the Nimbus Fish Hatchery, 31% were from the Mokelumne River Fish Hatchery, 6% were from the Feather River Fish Hatchery, and 4% were from the Merced River Hatchery. Coded wire tags were either not recovered or unreadable for 239 (7%) of the adipose fin-clipped carcasses processed.

After carcasses were counted and processed by CDFW, Cramer collected genetic samples and otoliths from approximately 1,450 Chinook salmon carcasses to gather migratory information and to assess spawning success at gravel augmentation sites.

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, environmental DNA and video monitoring to assess presence and distribution of Chinook salmon and steelhead under 2021 late summer drought conditions, temperature monitoring, and comparisons of habitat availability before and after restoration implementation projects. A structured decision-making process is being used to determine future project types and identify monitoring needs.

⁹ Lower American River Fall-run Chinook Salmon Escapement Survey October 2020-January 2021 can be found here: https://www.calfish.org/portals/2/Programs/CentralValley/LAR/docs/2020_LARC_Report.pdf

References

- California Department of Fish and Wildlife (CDFW). 2021. 2020 Lower American River Fall-run Chinook salmon Escapement Survey, 2020-2021.
- California Department of Water Resources (DWR). 2021. California Department of Water Resources, Bulletin 120. <https://cdec.water.ca.gov/snow/bulletin120/>
- Cramer Fish Sciences (Cramer). 2021 Steelhead (*Oncorhynchus mykiss*) Spawning and Stranding Surveys, Central Valley Project, American River, California.
- Delta Stewardship Council (DSC). 2010. Report of the 2010 Independent Review Panel (IRP) on the Reasonable and Prudent Alternative (RPA) Actions Affecting the Operations Criteria And Plan (OCAP) for State/Federal Water Operations. https://www.noaa.gov/sites/default/files/atoms/files/2019-04-22_workshop_OCAP_2010_IRP_RPA_Final_Report_121310.pdf
- 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, Southwest Region. <https://www.fisheries.noaa.gov/resource/document/biological-opinion-and-conference-opinion-long-term-operations-central-valley>
- _____. 2011. 2011 Amendments to the National Marine Fisheries Service Long-Term Operations of the Central Valley Project and State Water Project Reasonable and Prudent Alternative. NMFS, Southwest Region. <https://www.fisheries.noaa.gov/resource/document/biological-opinion-and-conference-opinion-long-term-operations-central-valley>
- _____. 2019. Biological Opinion on Long-Term Operation of the Central Valley Project and State Water Project. NMFS, West Coast Region. <https://repository.library.noaa.gov/view/noaa/22046>
- _____. 2019. Final Biological Assessment: Reinitiation of Consultation on the Coordinated Long-Term Operation of the Central Valley Project and State Water Project. October 21, 2019.
- _____. 2020. Record of Decision (ROD). Reinitiation of Consultation on the Coordinated Long-Term Modified Operations of the Central Valley Project and State Water Project. https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=39181
- U.S. Fish & Wildlife Service (USFWS). 2019. Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project, October 2019. <https://www.fws.gov/sfbaydelta/cvp-swp/index.htm>
- Water Forum. 2006. Draft: Lower American River Flow Management Standard.
- _____. 2017. Lower American River Modified Flow Management Standard.