USBR NOFO Funding Opportunity No. R23AS00106

NIGIRI MANAGED FLOODPLAIN HABITAT PROJECT

Technical Proposal

State of California, Department of Water Resources
715 P Street
Sacramento, CA 95814

Project Manager: Josh Martinez
715 P Street, 6th Floor
Sacramento, CA 95814
Joshua.Martinez@water.ca.gov
(916) 281-6477

TABLE OF CONTENTS

Technical Proposal

Page

Executive Summary **1**

Project Location **2**

Project Description **3**
- Project Design Goals 6
- Project Design Elements 6
- Project Design Development, Regulatory Approvals, and Implementation 7
- Conceptual Operations and Management 7

Evaluation Criteria **10**
- Evaluation Criterion A: Project Benefits 10
- Evaluation Criterion B: Prior Restoration Planning and Stakeholder Involvement and Support 20
- Evaluation Criterion C: Project Implementation and Readiness to Proceed 21
- Evaluation Criterion D: Presidential and Department of the Interior Priorities 22
- Evaluation Criterion E: Performance Measures 24

References **30**

List of Figures

Figure 1 Nigiri Project Location Map 2
Figure 2 Nigiri Project Conceptual Design 4
Figure 3 Conceptual Primary (Managed) Water Control Structure 5
Figure 4 Conceptual Passive Water Control Structure 5
Figure 5 Conceptual Nigiri Project Tule Canal Corridor 6
Figure 6 Conceptual Operations Calendar for Nigiri Project and Compatible Uses 10
Figure 7 Fremont Weir Notch Flood Up/Drawdown Operation Conceptual Model 16
Figure 8 Yolo Bypass Inundation (Nigiri Project) Conceptual Model 17
Figure 9 Modeled Managed Floodplain Salmon Habitat Volumes in Yolo Bypass (1997 – 2012) 18
Figure 10 Modeled Distribution of Water Year Types 23
Figure 11 Accumulated Suitable Acre-Day Statistics 24

List of Tables

Table 1 Monitoring and Forecasting Data Sources and Parameters 9
Table 2 Species of Management Interest and Occurrence In the Project Area 11

Executive Summary

January 18, 2024

California Department of Water Resources (DWR), Sacramento County, California

DWR is a Category A applicant (State Agency with water delivery authority)

DWR is applying for funding under Task A: Study and Design

The Nigiri Managed Floodplain Habitat Project (Nigiri Project, Project), located in the northern portion of the Yolo Bypass between the Fremont Weir and the Interstate 5, is being planned to provide 4,200 acres of high-value seasonal managed floodplain habitat consistent with *Managed Agricultural Floodplain Design Criteria* (September 2020) and National Marine Fisheries Service (NMFS) White Paper on *Central Valley Floodplain Management for Salmon: Considerations for Balancing Food Web Productivity and Fish Viability*.[1] The Project will include perimeter berms and water-control structures, allowing the area to be inundated by flows from the Colusa Basin Drain (via Knights Landing Ridge Cut Canal) or the Sacramento River via the Fremont Weir, the Fremont Weir Fish Ladder, or the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Fremont Weir Notch Project, Notch Project). This will allow early season flood-up and activation of the food web, management of the timing and duration of shallow, slow-moving waters, and volitional passage of adult and juvenile native fishes on and off the floodplain. The Project will also include approximately four miles of riparian corridor enhancements along the Tule Canal to increase ecological function without compromising critical floodwater conveyance in the Yolo Bypass. The Project improves critical floodplain rearing habitat for native salmonids as well as producing annual export of food. The Project is a key component of the California's Agreements to Support Healthy Rivers and Landscapes Program (Voluntary Agreements), which is a watershed-wide approach to increase river flows and restore ecosystems and habitats to benefit special status aquatic fishes. This project will contribute roughly 20% of the Program's 20,000-acre floodplain restoration target.

This funding request is to advance design to 60% in preparation of a future Task B application. Planning, design, regulatory approvals, and construction is anticipated to take approximately five years to complete with a completion date of Fall, 2028.

The Project enhances the performance and benefits of U.S. Bureau of Reclamation (Reclamation) and DWR Fremont Weir Notch Project, which is being implemented under the Yolo Bypass Salmon Habitat Restoration and Fish Passage actions, required under the 2009 and 2019 NMFS biological opinions on the Long-Term Operations of the Central Valley Project and State Water Project.

[1] Managed Agricultural Floodplain Design Criteria (September 2020) has been developed collaboratively between California Department of Fish and Wildlife (CDFW) and DWR to identify key attributes for optimizing juvenile salmonid rearing habitat in managed agricultural floodplains, while providing for adult passage.
NMFS' White Paper on Central Valley Floodplain Management for Salmon was developed to advance the dialogue with scientists, restoration practitioners, other agencies, and stakeholders by summarizing current science, outlining areas of agreement and disagreement, and recommending considerations to help make choices about active versus passive floodplain restoration design.
The Interagency Design Evaluation Team (DET) consists of members from CDFW and NMFS and was formed to evaluate and provide recommendations for managed floodplain projects consistent with the design criteria and White Paper.

Project Location

The Nigiri Project is located in the Sacramento Valley, in Yolo County, California, approximately 6 miles east of the City of Woodland, approximately 11.5 miles northeast of the City of Davis, in the Yolo Bypass. The approximate Project location latitude is 38°42'N and longitude is 121°39'W. A map of the project is depicted in **Figure 1**.

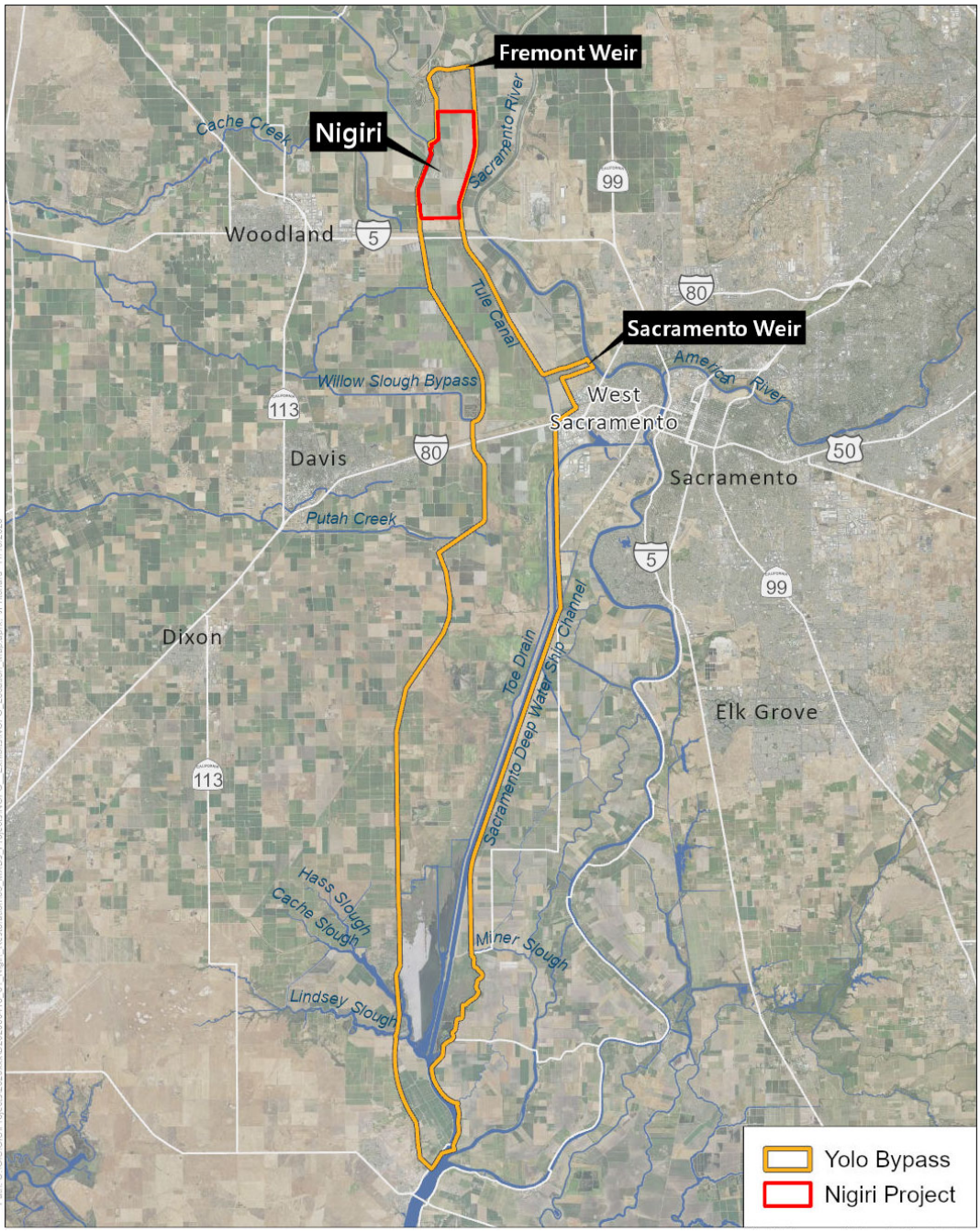


Figure 1
Nigiri Project Location Map

Project Description

This application seeks funding to advance Project design to 60% in anticipation of a future Task B: Construction application. The Nigiri Project would activate and improve approximately 3,200 acres of managed seasonal floodplain habitat on agricultural lands. The Project site will be designed and operated within a monitoring and adaptive management framework (see *Evaluation Criterion E: Performance Measures* below) to retain water to enhance the frequency and duration of floodplain inundation during the fall and winter months, after rice has been harvested and when water temperatures are suitable for creating productive habitat for juvenile salmon. The Nigiri Project will accomplish this by constructing a berm with several passive and one active water control structures (WCSs) around the southern and eastern perimeters of the site to allow for management of a large, shallow floodplain, and use a roughened (enhanced) channel (depicted as the "Flow Split" location) to bifurcate flows and juvenile salmonids that are conveyed the Sacramento River via the Fremont Weir, the Fremont Weir Fish Ladder, or the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Fremont Weir Notch Project, Notch Project) (**Figure 2**). The roughened channel and passive and managed (operational) WCSs (**Figures 3** and **4**) would be designed and operated to provide continuous volitional fish passage whenever fish are present. Approximately four miles of riparian corridor enhancements will also be created between the eastern perimeter berm and the Tule Canal (roughened channel), increasing the ecological function of the Tule Canal (**Figure 5**).

The Project improves conditions in the upper Bypass by providing high-quality managed floodplain habitat, rich in food resources that supports the development, growth, and survival of all runs of Chinook salmon and steelhead by extending inundation area and duration, increasing the number of continuous wetted acre-days, and prolonging the residence time for production and access of food, even in critically dry years. High densities of phytoplankton, zooplankton, and invertebrates are produced in shallow, inundated floodplains, becoming a vital food source for many freshwater fish. Managed floodplain draining events will allow for the natural export of aquatic forage production to the Delta via the Tule Canal, benefiting the Delta and longfin smelt populations in the Sacramento River and Delta ecosystems. The Nigiri Project will provide volitional passage both on and off the floodplain for juvenile salmon and be operated in conjunction with Wallace Weir fish capture facility and the new enhanced fish passage facility in Fremont Weir to optimize adult fish passage through the northern Yolo Bypass.

The Project is designed to be compatible with other beneficial uses, including providing varied depths of floodplain habitat for multiple species of water birds; continuing to employ seasonal agricultural as a viable means of cost-effective vegetation control to maintain flood flow conveyance and benefit the regional economy; and enhance infiltration (recharge) potential into the underlying groundwater basin.

The Nigiri Project substantially enhances the performance and benefits of the Fremont Weir Notch Project, which is being implemented under the Yolo Bypass Salmon Habitat Restoration and Fish Passage actions under the 2009 and 2019 NMFS biological opinions on the Long-Term Operations of the Central Valley Project and State Water Project.

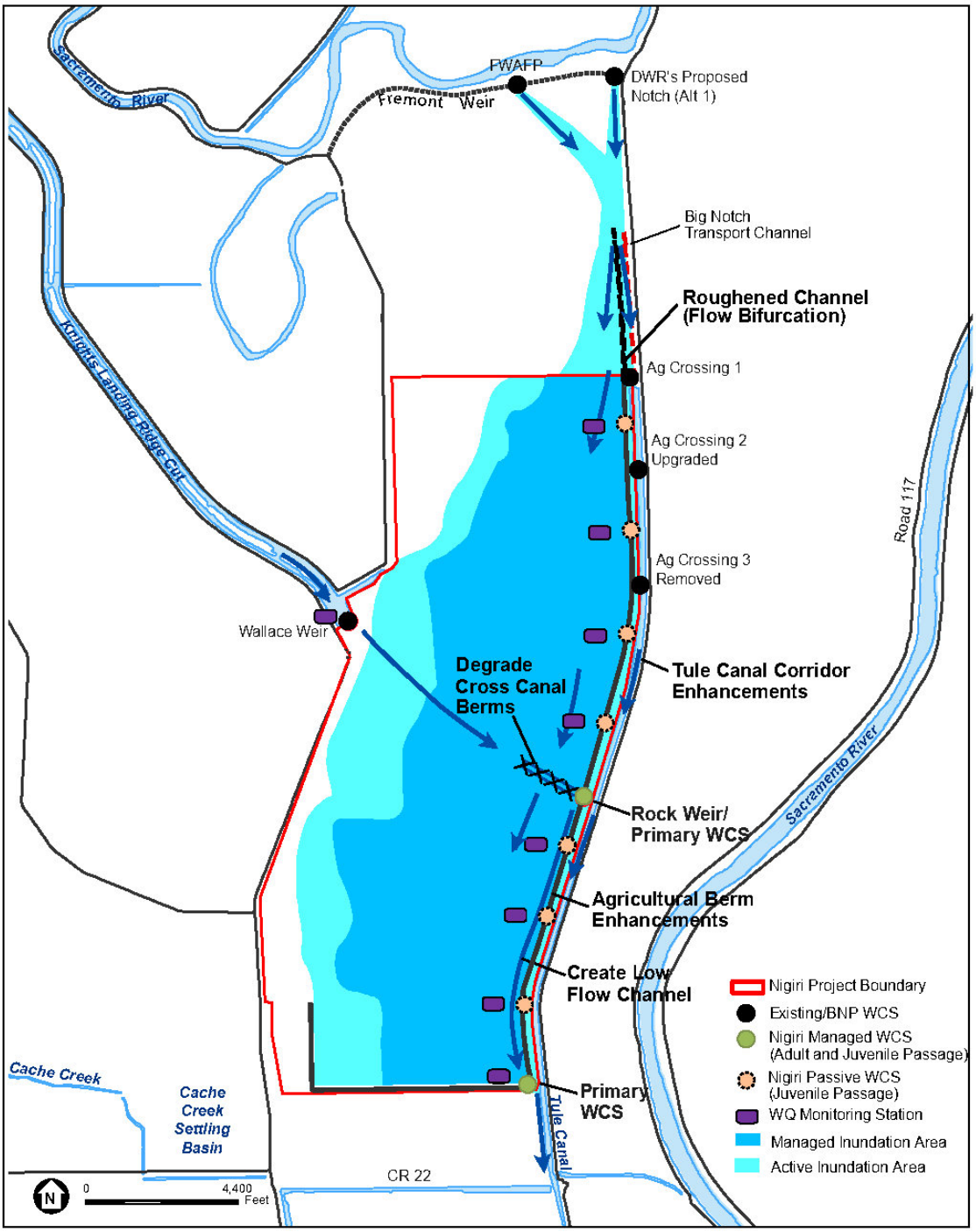


Figure 2
Nigiri Project Conceptual Design

Figure 3
Conceptual Primary (Managed) Water Control Structure
The Primary (Managed) Water Control Structure will be designed to be operable and allow for controlled water release, and volitional adult and juvenile fish passage.

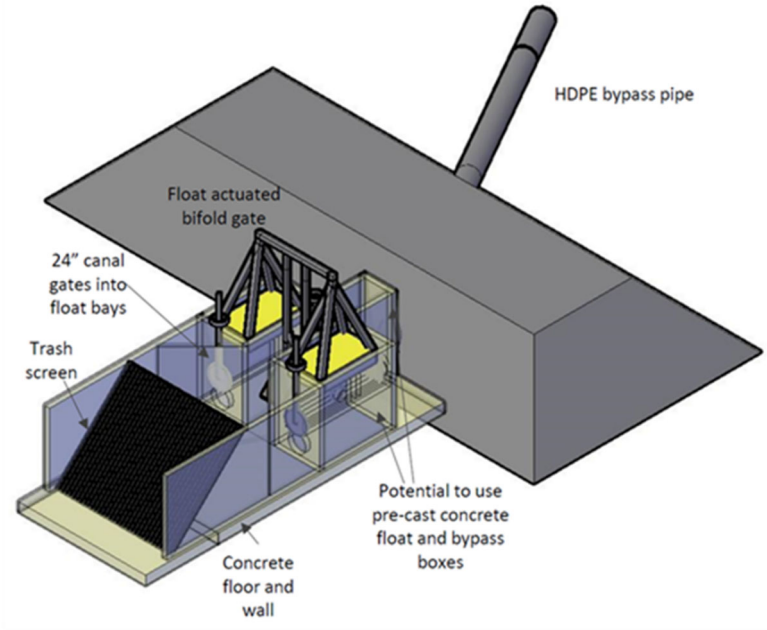


Figure 4
Conceptual Passive Water Control Structure
The Passive Water Control Structures will be designed with a float actuated gate with fish bypass (HDPE bypass pipe) to provide volitional juvenile passage.

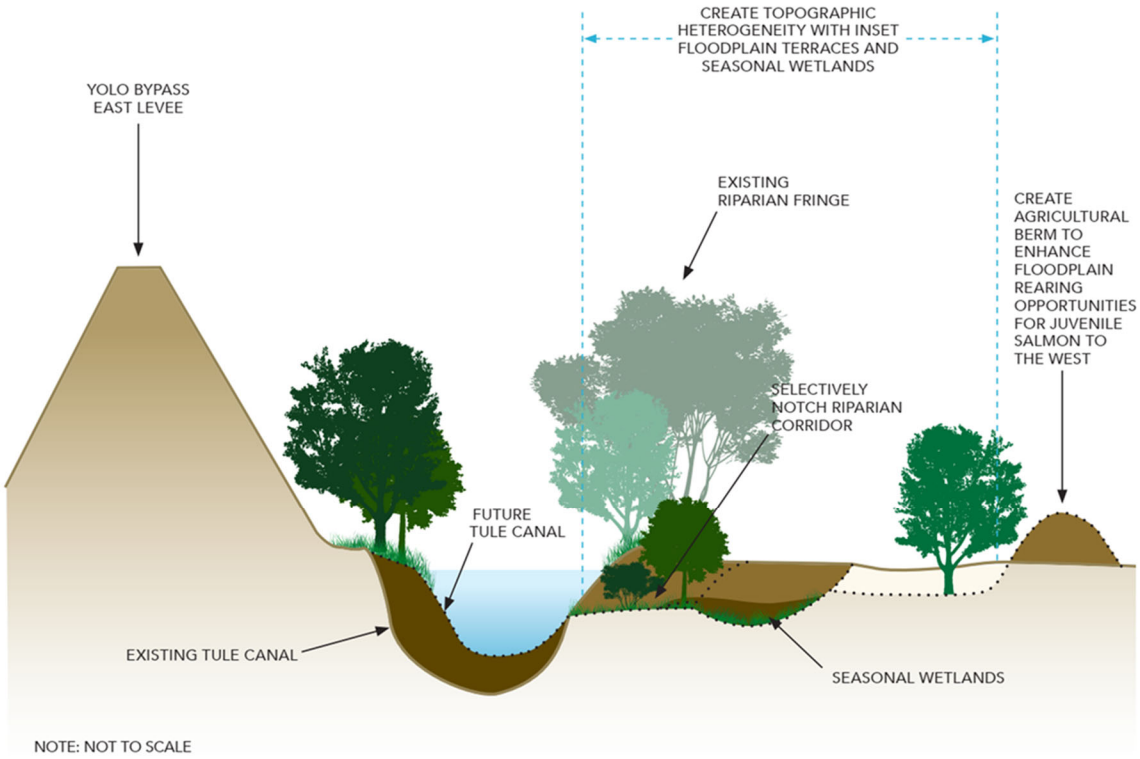


Figure 5
Conceptual Nigiri Project Tule Canal Corridor

Project Design Goals

The Nigiri Project will incorporate best available science and collaborate with regulatory agency stakeholders while advancing the project design. This will require that DWR work with State and federal fisheries agencies to:

1. Refine the design and operation of the Nigiri Project accordingly to improve baseline conditions for native fishes using informed design considerations put forth by the NMFS whitepaper on managed floodplains, as well as other potential published literature on improving managed floodplains to benefit native fishes; and
2. Develop monitoring protocols and performance criteria to support adaptive management.

Project Design Elements

- Any existing stranding risks associated with infrastructure or topography within project boundaries will be reduced to the maximum extent feasible.
- Flood control, irrigation, and drainage infrastructure and site topography will be upgraded to allow for adaptive management of project site hydrology.
- Project areas will be graded for positive drainage.
- Project managed floodplains will be maintained to minimum agreed-upon depth.

- The floodplain is a dynamic and sometimes destructive place. All project infrastructure will be designed and built to withstand prolonged flooding without failure or deterioration.
- Design and operations will consider and work to minimize avian and fish predation risk.

Project Design Development, Regulatory Approvals, and Implementation

The Project will be further developed and implemented over the following three phases:

Phase 1

- Preliminary Design
  - Design Evaluation, Preliminary Design Review Approval
- Design Development, Environmental Review, and Permitting
  - 65% Design Documentation and Reporting, Draft CEQA, Draft Permits, Revised Draft Operations and Maintenance Manual
  - Design Evaluation Team Design Development Review

Phase 2

- Final Design, Environmental Review, and Regulatory Approvals
  - 100% Design Documentation and Reporting, Final CEQA, Final Permits, Final Operations and Maintenance Manual

Phase 3

- Easements Placement
- Project Construction
- Project Operations, Maintenance, and Adaptive Management Actions

Conceptual Operations and Management

Following rice harvest in the late fall, the WCSs on the Nigiri Project site could be closed to capture residual runoff from the Colusa Basin Drain, delivered through Knights Landing Ridge Cut, to initiate early season activation of the floodplain in advance of the arrival of juvenile salmonids. Early inundation would prime the site for natural floodplain food productivity, thereby creating a beneficial setting for arriving juvenile salmonids.

Starting in early November, as the Sacramento River begins to swell, the Fremont Weir Notch would be opened, conveying up to 6,000 cubic feet per second (cfs) and entraining juvenile out-migrating salmonids into the Tule Canal. The Nigiri Project roughened channel would be designed to bifurcate flows, routing a fraction of flow and fish onto the managed floodplain. Preliminary modeling has been performed to evaluate the flow split ratio for a roughened low flow fish passage channel, which demonstrates that an approximate 35%/ 65% flow split between the Canal and the floodplain can be achieved for lower notch flows. At this condition, the geometry and configuration of the roughened channel would be designed to not cause fish passage delays. At higher notch flows, the flow split ratio is less meaningful because the flows exceed the capacity of the canal and generally activates the floodplain. Further, the roughened

Tule Canal within the enhancement corridor would provide more meaningful ecosystem functions and water level control while still providing necessary drainage functions.

The Nigiri Project would be operated to accommodate early out-migrating winter-run Chinook salmon, because the first flows through the Fremont Weir Notch will allow fish to access high-quality rearing habitat already containing a pre-activated food web and abundant forage.

The Project site modifications will capitalize on these winter flows, as well as any additional overtopping flows from the Fremont Weir, creating multiple volitional pathways for fish to and from the site's high-value seasonal floodplain habitat. Beginning in mid-March, the Fremont Weir Notch would be closed and water control operations at the Nigiri Project site would transition to begin fully draining the site in anticipation of the coming farming season.

Enhanced actions to increase food web support, such as initiating an early flood-up in advance of arrival of fish on the floodplain, or regular draining of floodplain waters after approximately three weeks of residence time, will require additional active management of the WCSs and drainage facilities.

The new roughened channel and WCSs at the Nigiri Project site will require regular maintenance (e.g., inspection, debris removal) and all structures that are designed for active management will require both regular maintenance and intervention during the operational season (e.g., removal of flashboards, raising of gates). Berms will require regular inspection and as-needed repair following the flood season. Vegetation management to maintain flood conveyance and maintenance of approximately four miles of the Tule Canal (e.g., dredging, erosion repair) may also be needed.

Monitoring and Forecast-Informed Managed Floodplain Operations

The Nigiri Project proposes to utilize active, monitoring and forecast-informed management by a coordinating body – a person or persons known as a 'Bypass Keeper' – to manage site response to varying flows from the Notch and westside tributaries and associated water quality conditions in coordination with existing Yolo Bypass interagency teams (i.e., Interagency Ecological Program Yolo Bypass Project Work Team, Fisheries Engineering Technical Team). The Yolo Bypass Drainage and Infrastructure Study Update envisions such a 'Bypass Keeper' entity to serve as a forum for the many stakeholders in the Bypass, make recommendations on management actions, share data and information, and coordinate ongoing research.

Monitoring and forecast-informed managed floodplain operations is intended to provide a flexible managed floodplain management approach that uses data from Sacramento River monitoring and weather forecasting, in combination with site monitoring, to inform floodplain management activities to selectively retain or release water on managed floodplains to maximize benefits, especially during seasonal shoulder periods. This approach is modeled after Forecast-Informed Reservoir Operations (FIRO), which is being successfully developed and tested as a collaborative effort in several river basins that engages experts and stakeholders in civil engineering, hydrology, meteorology, biology, economics, and climate from several federal, state, and local agencies, universities, and others.

Monitoring and forecast-informed managed floodplain operations for the Nigiri Project involves continuous monitoring and forecasting to inform water management activities within the site such that conditions are managed to provide suitable habitat for fish species. The framework for this approach includes identification of monitoring and forecasting parameters (e.g., site water quality parameters, Notch flows, forecasting data) with associated trigger values or intervention thresholds, that if met or exceeded require action, including potential management response (includes forecasting, retaining water, or draining site, where appropriate). Implementation of monitoring and forecast-informed operations would require various levels of coordination between the designated floodplain manager (Bypass Keeper) and an interagency technical team. A summary of monitoring and forecasting data sources and parameters that would be used to inform monitoring and forecast-informed operations is provided in **Table 1**.

TABLE 1
MONITORING AND FORECASTING DATA SOURCES AND PARAMETERS THAT WOULD BE USED TO INFORM ADAPTIVE OPERATIONS

Monitoring/ Forecasting	Parameter
Monitoring	
Site (multiple stations)	Water temperature (degrees C) (5-day average daily maximum; all stations)
Site (multiple stations)	Dissolved oxygen (mg/L) (5-day average daily minimum; all stations)
Site (multiple stations)	pH (standard pH unit) (5-day average daily value; all stations)
Notch activation flows	Notch activation flows (cfs)
Fremont Weir overtopping events	Overtopping flows (cfs)
Knights Landing Ridge Cut (KLRC) flows	Knights Landing Ridge Cut flows (cfs)
Site (multiple stations)	Water levels (feet)
Forecasting	
Weather station	Barometric pressure (indicator), temperature, wind
Sacramento River stage	Relative to Notch activation

Compatible Management with Existing Uses

Flood Flow Conveyance

All Project modifications to the Nigiri Project site to enhance fish and wildlife habitat will either improve flood conveyance or be flood neutral. The Yolo Bypass is the backbone of California's flood control system. Bypass lands must be managed to ensure the safe conveyance of major floods away from the State Capitol. Agriculture and managed wetlands sustain the flood conveyance of the Bypass by controlling vegetation and maintaining low "roughness" on the floodplain surface. To maintain long-term flood safety, the Bypass benefits from widespread farming, as agriculture is a viable means of cost-effective vegetation control within the Bypass. The Project will work with private agricultural operations and landowners to ensure the long-term viability of the both the agriculture economy and Bypass flood conveyance.

Agriculture

Agriculture serves as a compatible use in conjunction with the flood function of the Bypass by managing vegetation and thereby maintaining flood conveyance. The Nigiri Project proposes to add another layer of interaction between uses in the Bypass by integrating the purposeful management of water to enhance the ecological capacity of working agricultural lands, especially outside of the growing season (**Figure 6**). Because agriculture is a dominant land use within the Bypass, the integration of these two compatible uses is important in terms of increasing ecological function within the Bypass landscape while maintaining agricultural production.

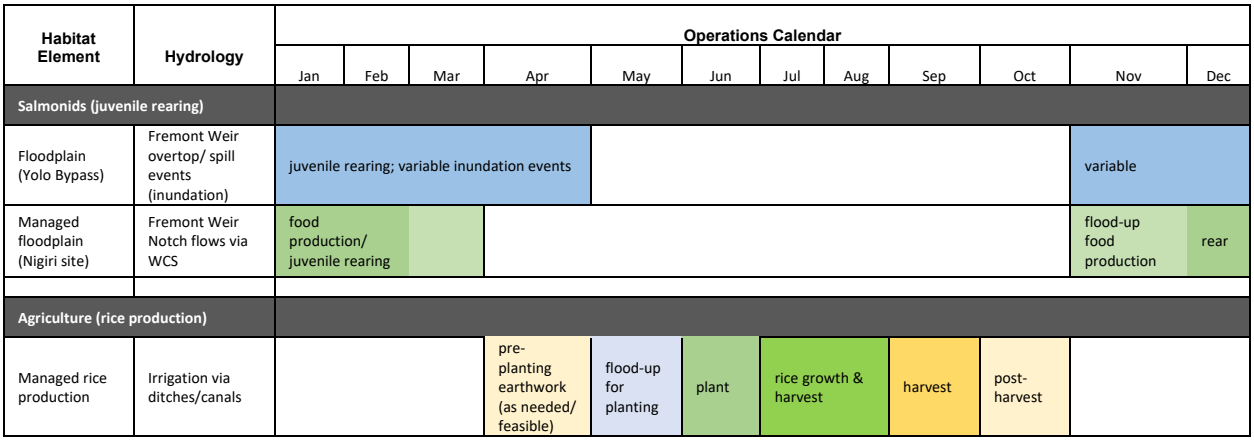


Figure 6
Conceptual Operations Calendar for Nigiri Project and Compatible Agricultural Uses

Evaluation Criteria

Evaluation Criterion A: Project Benefits

Sub Criterion A.1. General Project Benefits (Task A: Study and Design)

Species of Primary Management Interest

A total of six fish species protected under California and/or federal Endangered Species Acts (CESA and/or FESA) are known to occur seasonally in the Yolo Bypass: Sacramento River Winter-Run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), Central Valley Spring-Run Chinook salmon ESU, Central Valley steelhead distinct populations segment (DPS) (*Onchorhynchus mykiss*), southern DPS of the North American green sturgeon (*Acipenser medirostris*), Delta smelt (*Hypomesus transpacificus*), longfin smelt (*Spirinchus thaleichthys*) (**Table 2**). Additionally, Central Valley fall- and late fall-run Chinook salmon also occur in the Yolo Bypass. These species are not listed under

CESA or FESA; however, they are species of concern, and their habitat (Essential Fish Habitat [EFH]) is protected under the Magnuson-Stevens Fisheries Conservation Act, as amended.

TABLE 2
SPECIES OF MANAGEMENT INTEREST AND OCCURRENCE IN THE PROJECT AREA

Species	Status	Distribution in Nigiri Project Area
Central Valley spring-run Chinook salmon	ST, FT, CH, EFH	Rears in the Yolo Bypass during juvenile outmigration periods; adults may enter the Yolo Bypass during spawning migrations Designated critical habitat includes the Yolo Bypass
Sacramento River winter-run Chinook salmon	SE, FE, CH, EFH	Rears in the Yolo Bypass during juvenile outmigration periods; adults may enter the Yolo Bypass during spawning migrations Designated critical habitat includes the Yolo Bypass
Central Valley fall-/ late fall-run Chinook salmon	SC, EFH	Rears in the Yolo Bypass during juvenile outmigration; adults may enter the Yolo Bypass during spawning migrations
Central Valley steelhead	FT, CH	May rear in the Yolo Bypass during juvenile outmigration; adults may enter the Yolo Bypass during spawning migrations Designated critical habitat includes the Yolo Bypass
North American green sturgeon	FT, CH	Present in the Yolo Bypass during migrations Designated critical habitat includes the Yolo Bypass
Delta smelt	SE, FT	Spawns and rears in tidally influenced portions of the lower Yolo Bypass and Cache Slough complex (south of the Project area)
Longfin smelt	ST	Spawns and rears in Cache Slough complex (south of the Project area)

Key:
ST = State threatened species
SE = State endangered species
FT = Federal threatened species
FE = Federal endangered species
CH = critical habitat
SC = Species of concern
EFH = Essential Fish Habitat

The Nigiri Project would substantially increase high value floodplain rearing habitat, primarily benefiting all four runs (ESUs) of Chinook salmon and steelhead, while providing volitional passage for these species and green sturgeon throughout the Project area. Delta and longfin smelt would also benefit from the production of lower trophic level food resources, which would be produced on the Project site and conveyed into the Cache Slough Complex.

General Benefits

Research over the past two decades has shown that the seasonally flooded Bypass lands support a suite of native fishes and provide important food web resources to aquatic ecosystems in the Sacramento-San Joaquin Delta and San Francisco Estuary (Sommer et al. 2020; NMFS 2021; Sommer et al. 1997, 2001a, 2001b; Jeffres et al. 2008; Jeffres et al. 2020). These same studies show that when the Yolo Bypass floods, the inundated floodplain is not optimal because the landscape has been highly modified to drain rapidly, as compared to historic wetlands under natural, pre-development flood patterns (Sommer et al. 2020; NMFS 2021). Natural hydrology would have seen the Yolo Basin flood multiple times annually and stay wet for months; the Bypass currently connects to the river in about two out of three years, but most inundation events are of short duration. Adding a large-scale managed floodplain to the operation of the Fremont Weir Notch will provide salmonids with prolonged access to high-value inundated habitat during

drier years - approximately 600% more than the baseline condition (approximately six times the number of 'suitable wetted acre-days').

The Nigiri Project proposes to capitalize on the releases at the Notch by controlling how the Nigiri Project site fills and drains, and then pulsing water with juvenile fish and food from it through the Tule Canal at sufficient flow to overcome tidal energy at the Lisbon Weir, located to the south (downstream) of the Nigiri Project site.

Alterations to the landscape and water management structures are proposed as part of the Nigiri Project to improve the ability to support the creation of managed seasonal floodplain across a broader area (at least river basins defined as HUC-10 level: 1802016303, 1802016205, 1802016306) for longer time periods, with improved connectivity and accessibility for juvenile salmonids. In summary, the Nigiri Project will Provide the following benefits:

Improved Rearing Habitat: Provide high-quality floodplain habitat, rich in food resources that support the development, growth, and survival of salmon by extending inundation duration, increasing the number of continuous wetted acre-days, and prolonging the residence time for production of more food. Extended access to more food enhances fish growth and increases survival to adulthood.

Enhanced Export of Aquatic Food Production: High densities of phytoplankton, zooplankton, and invertebrates are produced in shallow, inundated floodplains, becoming a vital food source for many freshwater fish, including all runs of Chinook salmon, Sacramento splittail, longfin smelt, Delta smelt, green and white sturgeon.

Migratory Waterbird Habitat: Migratory birds along the Pacific Flyway will benefit from winter water practices that generate varied depths of floodplain habitat at key times for multiple species of waterfowl, shorebirds, and wading birds.

Retain Farming for Flood Control: Agriculture is the only viable means of cost-effective vegetation control on the bypass. The Nigiri Project works with private agricultural businesses and landowners to ensure long-term viability of the Yolo Bypass flood control system.

Groundwater Recharge: Increased duration of water inundation in the Bypass has potential to enhance infiltration into the underlying groundwater basin.

Sub Criterion A.2. Quantification of Specific Project Benefits (Task A: Study and Design)

Species, Habitats, and Watershed Benefits

Current Status of the Species of Primary Management Interests and their Habitats

The state of decline of special-status anadromous salmonids, including Chinook salmon, and other native species in the Central Valley has been well documented in scientific literature and biological opinions for many decades. NMFS' White Paper on Central Valley Floodplain Management for Salmon: *Considerations for Balancing Food Web Productivity and Fish Viability* (NMFS 2021), summarizes these declines, especially how they are attributed to the loss of floodplain habitats in the Central Valley, and the review below relies on information presented in the White Paper.

Wild Chinook salmon and steelhead were once abundant throughout the rivers and creeks in the Central Valley. Prior to Euro-American settlement, an estimated 1-2 million Chinook salmon would return to Central Valley rivers each year (Yoshiyama et al. 1998). Such high abundance was achieved in large part because of unimpeded access to vast and diverse natural freshwater habitats, from which an unsurpassed diversity of Chinook salmon life history strategies emerged.

Central Valley rivers once carried runoff from large winter storms and spring snowmelt onto floodplains, slowing and spreading water into complex mosaics of riparian forest and wetlands, depositing sediment, and recharging groundwater (Whipple et al. 2019). Large flood basins, floodplains, and tidal wetlands were often inundated for long periods in most years providing food-rich rearing habitat essential to support large salmonid populations. Inundation occurred for weeks to months at a time and the slow, highly productive floodplain waters provided ideal conditions for juvenile salmon to feed and grow before migrating to the ocean.

Over the last 1.5 centuries, however, floodplain habitats have been reduced to about 5% of their historical extent. Valued for their rich soils, most of the Central Valley's floodplains have been converted to agriculture and disconnected from their rivers by levees and dykes (Sommer et al. 2001a). In addition, most of these formerly activated floodplains that now support agriculture have been modified to alter drainage via some combination of berms, ditches, drains, canals, and tile.

Flow alteration from large upstream dams, especially the reduction of high flow events, has also limited the inundation duration and extent of remnant floodplain habitats. Prior to construction of Shasta Dam, the Sacramento River spilled onto flood bypasses for 1+ weeks each spring in nearly 8 of 10 years, whereas after Shasta Dam operations commenced, such overflow events occurred in roughly 2 of 10 years (Opperman et al. 2010; Whipple et al. 2019). The total wetted-acre-days per year and the "average" inundation event have also been reduced.

Overall, the loss of floodplain habitat, along with other limiting factors (e.g., loss of spawning habitat, degradation of remaining accessible habitat), have resulted in declines of Central Valley Chinook salmon such that each distinct run is now at risk of extinction by the end of the century if present trends continue (Moyle et al. 2012).

Floodplain Management for Salmon Recovery

It is widely accepted that recovering viable salmon populations in the Central Valley will require large-scale floodplain and wetland ecosystem restoration (NMFS 2014). Restoring functional floodplain ecosystems requires addressing four primary elements: hydrological connectivity between the river and floodplain, a variable flow regime incorporating a range of flow levels, sufficient spatial scale for key natural processes to occur, and floodplain habitat quality (NMFS 2014). The natural processes occurring on functional floodplains that provide ecological benefits for salmon include decreased water velocity, sediment deposition, nutrient cycling, including routing carbon from basal algal and detrital sources into invertebrate food webs, increased water clarity, increased photosynthesis, and increased zooplankton and invertebrate production (NMFS 2014). Due to decreased water velocity and sediment deposition, floodplain water is often less turbid than river water and can thus support greater rates of photosynthesis from algae and

phytoplankton (Aherns et al. 2006). In turn, this primary productivity supports high zooplankton productivity and aquatic invertebrates (NMFS 2014), which then provides food for rearing salmonids and other fish (Sommer et al. 2001a; NMFS 2014).

Early Yolo Bypass studies by Sommer et al. (1997), demonstrated that the Yolo Bypass provides some of the most important habitat for floodplain spawning fish species, like the Sacramento splittail. Shortly thereafter, Sommer et al. (2001a), indicated that this seasonal floodplain habitat also provides better rearing conditions for Chinook salmon than the adjacent Sacramento River channel.

Sommer et al. (2001a), also found another important attribute: an enhanced food web where drift insects (primarily chironomids) were 1,000% to 10,000% more abundant in the floodplain than the adjacent Sacramento River channel during flood events. Subsequent studies on winter-flooded Bypass agricultural rearing habitat supported zooplankton food webs up to 15,000% more abundant than in the adjacent Sacramento River and juvenile Chinook salmon that reared on these managed floodplains grew at rates among the highest ever documented in California. (Katz et al. 2017, Corline et al. 2017).

Rearing salmonids' food production quality is influenced by inundation duration. Floods greater than one week can provide feeding fish access to terrestrial invertebrates from soil and vegetation, but longer inundation and extended solar exposure of at least two weeks are key to maximize aquatic productivity and fish growth (Sommer et al. 2001b; Grosholz and Gallo 2006).

Cosumnes River floodplain research showed that secondary productivity reached peak levels at approximately 21 days (Grosholz and Gallo 2006), after which it stabilizes or declines. Grosholz and Gallo (2006) recommend a 2- to 3-week post-flood interval duration and repeated flood pulses to best support native fish (Whipple et al. 2019). A significant portion of the trophic energy transfer in floodplains and similar off-channel habitats may also move through heterotrophic food webs driven by breakdown of plant detritus (Murase and Frenzel 2007). Studies on the Yolo Bypass have found that detritivores, such as chironomid larvae, can be very abundant in floodplain habitats during flood events (Benigno and Sommer 2008). After six weeks of inundation, zooplankton densities in rice fields in Yolo Bypass were documented at greater than 150,000 individuals per cubic meter of water, compared to approximately 50 per cubic meter of water in the adjacent Sacramento River (Corline et al. 2017). The abundant floodplain food resources contribute significantly to the diets of juvenile salmonids accessing these off-channel habitats during flood events (Benigno and Sommer 2008; Sommer et al. 2001a), where they grow much more quickly (up to five times faster) than fish confined to adjacent leveed river channels (Sommer et al. 2001b; Jeffres et al. 2008; Jeffres et al. 2020; Sommer et al. 2020).

More recent advancements in stable isotope analysis (SIA) in eye lenses have emerged as a promising tool in fishes to develop long-term interpretive records of dietary histories using a single archival tissue (Bell-Tilcock et al. 2020). This new technique, developed as part of managed floodplain experiments in the Yolo Bypass, provides the opportunity to further

document the benefits of salmon rearing in a managed floodplain by analyzing their diet, the locations where they have thrived, and subsequent outcomes (adult returns).

The whole of these studies demonstrate how seasonally managed floodplains reconciles the needs of native fish and waterfowl species, as well as rice production and flood control, and sets the stage for a new multi-benefit floodway land use paradigm for the Bypass (Katz et al. 2017, Jeffres et al. 2020; Sommer et al. 2020). In plain terms, the science clearly says that fish benefits come from not simply getting the floodplain wet but from keeping it wet long enough to activate the food web, building up the invertebrate food supply, and allowing the fish enough time to consume it. The Nigiri Project is being designed to achieve these necessary requirements and provide substantial benefits to rearing Chinook salmon.

Conceptual Models of Salmonids, Floodplains, and the Nigiri Project

Two conceptual models were identified in the *Fremont Weir Notch Project Adaptive Management Plan* (DWR 2020) as being useful for considering design and adaptive management of floodplains are the *Salmon and Sturgeon Assessment of Indicators by Life Stage* conceptual model (**Figure 7**) (Windell et al 2017) and a *Conceptual Model Regarding Floodplain Function* (**Figure 8**) (Opperman 2012). Similarities of these models include ecological outcomes for Chinook salmon and food web contribution but differ in the structure of linkages between hydrology and environmental attributes and habitat conditions. These models and their application to the Fremont Weir Notch Project (DWR 2020) were further adapted to describe the processes affected by the Nigiri Project and the ecological responses expected to be observed.

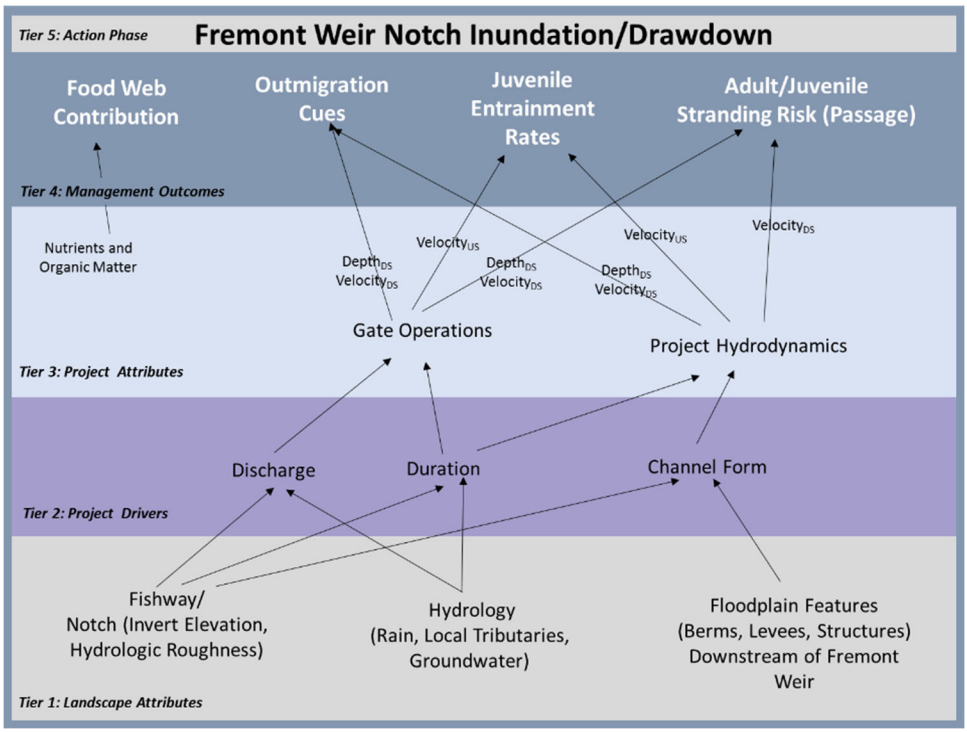
The Fremont Weir Notch Project increases connectivity between the Sacramento River and Yolo Bypass to improve adult fish passage and juvenile salmon entrainment. Also, the Fremont Weir Notch Project operation during the drawdown phase of the project's operations primarily focuses on passage benefits related to reducing adult and juvenile stranding risks while creating fish outmigration cues. As the Fremont Weir Notch opens and closes, it connects the Sacramento River and Yolo Bypass landscape leading to nutrient exchange throughout the floodplain and subsequently the Delta food webs (DWR 2020). The Nigiri Project roughened channel bifurcates and routes a fraction of this flow (and fish) onto a larger area in the Bypass where it can be managed via passive and operable WCSs, optimizing residence times and associated productivity while maintaining continuous volitional fish passage whenever fish are present.

Inundation of a Notch and fishways in Fremont Weir are directly affected by the elevation of these facilities relative to the Sacramento River. The Notch's design and hydrology (e.g., Sacramento River, local inputs, and groundwater) are key landscape attributes leading to the discharge rate and duration of inundation. The channel form of the Notch and fishway facilities are also critical to flow-related project attributes and biological outcomes, that can be measured biological and physically and are representative of the effectiveness of a Notch and fishway's design to contribute to the success of the project (DWR 2020).

The Notch gate, and Nigiri Project roughened channel and WCSs operations and resulting hydrodynamics are attributes that are affected by the two (Fremont Weir and Nigiri) project drivers, and directly affect the benefits of the projects to juvenile and adult listed species.

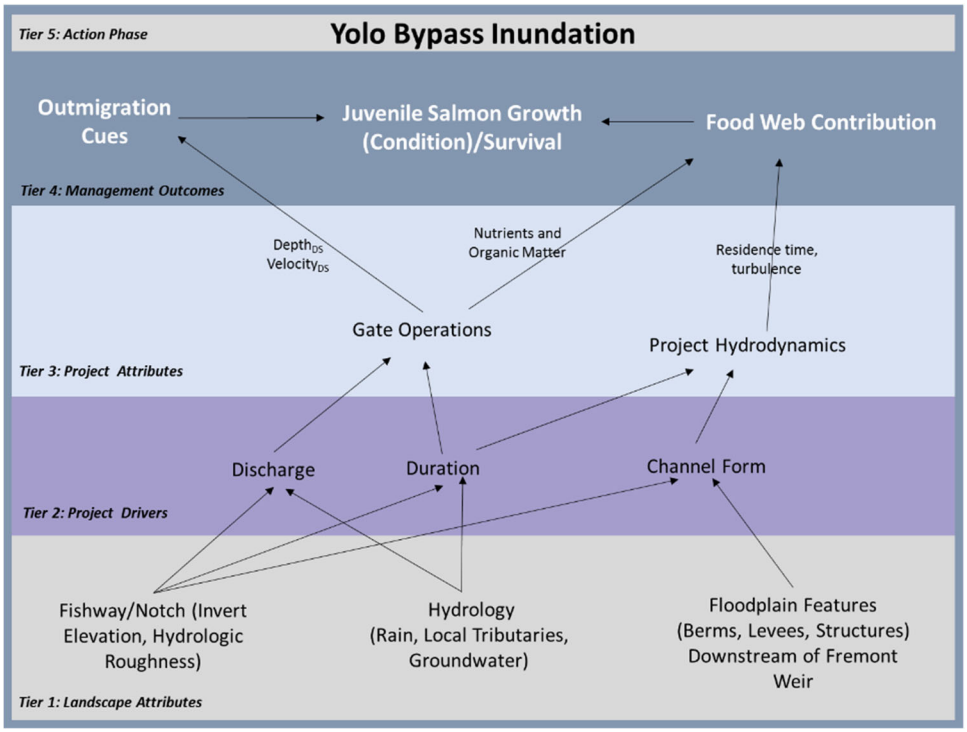
Salmonids and sturgeon are affected by the projects through the key processes of being entrained onto the Yolo Bypass through the Notch, routed onto the expanded managed floodplain (Nigiri) for enhanced rearing, and cued to out-migrate south into Cache Slough's tidal wetlands. Entrainment rates through a Notch and routing at the roughened channel are dependent on the upstream (Sacramento River) stage, velocities, accelerations, turbulence, and bulk flow split characteristics created through gate and roughened channel design and operations.

Juvenile outmigration or increased juvenile stranding are controlled by discharge and duration of Notch control gate and Nigiri WCSs. These attributes influence water depths and velocities on the inundated floodplain and downstream channels. Localized hydrodynamics (i.e., velocities, depths, residence times) and associated environmental variables (e.g., water temperatures, dissolved oxygen [DO]) are project attributes that may be monitored and managed to maintain suitable conditions and reduce stranding of juvenile fish trying to migrate off a floodplain (see *Evaluation Criterion E: Performance Measures*, below). The risk of adult stranding in the Fremont Weir fishways or on the Nigiri managed floodplain is dependent on the water velocities and depths created by gate, roughened channel, and WCSs operations.



Source DWR 2020; adapted from Windell et al 2017

Figure 7
Fremont Weir Notch Flood Up/Drawdown Operation Conceptual Model



Source DWR 2020; adapted from Opperman 2012

Figure 8
Yolo Bypass Inundation (Nigiri Project) Conceptual Model

Depending on the daily discharge and duration of potential Notch flows, Fremont Weir Notch Project gate and Nigiri WCSs operations may be modified following the adaptive management process to affect juvenile and adult migration on the Yolo Bypass (DWR 2020 and below). To improve outmigration and reduce stranding, modification of channel forms may also be considered through the adaptive management process. Ultimately, drawdown has an important impact on juvenile salmon migration timing and survival, as well as adult salmon passage condition, passage rate, and passage survival.

The connection between the Sacramento River and Yolo Bypass, including the Nigiri managed floodplain, via a Fremont Weir Notch and Nigiri roughened channel and WCSs is important to nutrient availability and exchange. This connection imports allochthonous riverine nutrients and organic matter to the floodplain. Primary productivity is stimulated by temperatures and influences DO concentrations, which can be actively monitored and controlled (by managing residence times) by the WCSs associated with the Nigiri Project.

Increasing the frequency, duration, and magnitude of Yolo Bypass inundation area is the Fremont Weir Notch and Nigiri Project's operational actions focused on improving juvenile salmonid growth, survival, and increased life history diversity in the lower Sacramento River. Also, inundation of the Yolo Bypass is a major contributor of secondary production to the Delta food web. As the Yolo Bypass floodplain is inundated via the Fremont Weir Notch, additional flows from Knights Landing Ridge Cut play a pivotal role in the extent and duration of inundation and promoting continuous volitional passage via continuous inflow.

The Notch in combination with the Nigiri Project managed floodplain features expand managed floodplain area while maintaining habitat connectivity. The volume and duration of flows through a Fremont Weir Notch and the flow split at the Nigiri roughened channel are directly affected by the elevation of these facilities. The Notch and Nigiri roughened channel and WCSs design and hydrology, and key landscape attributes affect operations and hydrodynamics for both projects. These attributes influence outmigration cues and residence times that result in biological outcomes that can be measured biologically and physically and are representative of the effectiveness of a Notch and roughened channel design to contribute to the success of the Fremont Weir Notch Project in combination with the Nigiri Project.

As noted above, adding a large-scale managed floodplain to the operation of the Fremont Weir Notch will enable salmon prolonged access to high-value inundated habitat during drier years approximately 600% more than the baseline condition (approximately six times the number of 'suitable wetted acre-days') (**Figure 9**).

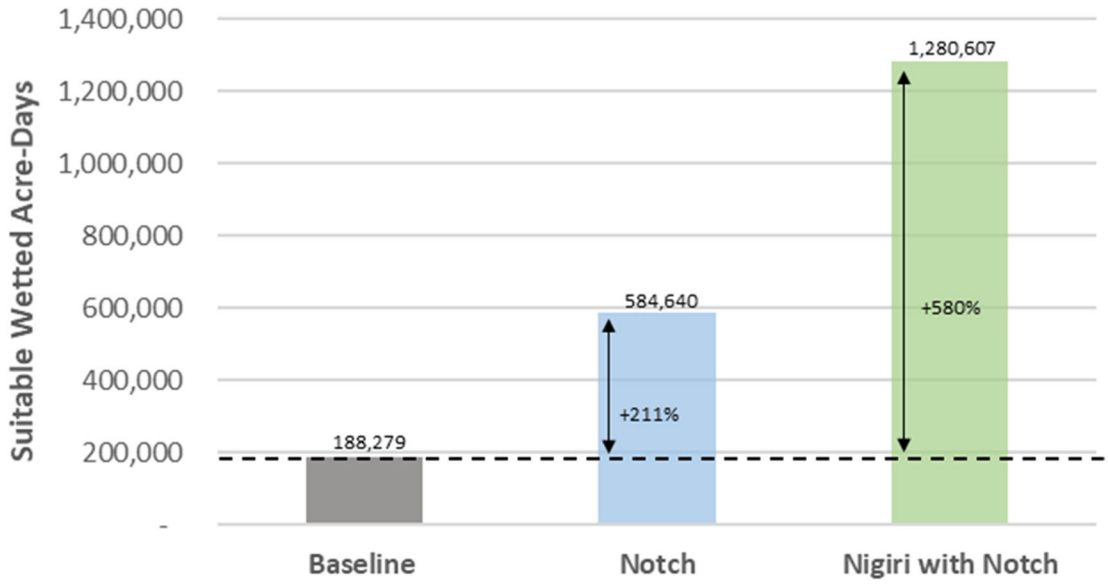


Figure 9
Modeled Managed Floodplain Salmon Habitat Volumes in Yolo Bypass (1997 – 2012)
Suitable wetted habitat acre days equals number of acres inundated to a depth of 0.3 ft. to 6.6 ft. between November 1 and March 15 (suitable habitat parameters based on CDFW Managed Agricultural Floodplain Design Criteria (September 2020)

Water Supply Benefits

As described above, the primary function of the Nigiri Project is to leverage water from the Sacramento River that is already being conveyed through the Yolo Bypass via the Fremont Wier Notch Project and does not require new water supplies. The Nigiri Project will provide high-quality floodplain habitat, rich in food resources that support the development, growth, and survival of salmon by extending inundation duration, increasing the number of continuous wetted acre-days, and prolonging the residence time for production of more food, effectively getting substantially more functional habitat out of existing water that is already being conveyed

down the Bypass. Further, increased duration of water ponding in the Bypass because of the Nigiri Project will enhance infiltration into the groundwater basin, which could, in turn, increase water supplies for both groundwater users in the region and groundwater-dependent ecosystems.

Other Quantifiable Benefits

In addition to serving as key habitat and a critical migratory corridor for several native fishes, the Yolo Bypass provides critical flood conveyance, a rich tapestry of agricultural production, and provision of seasonal habitat for migratory waterbirds.

A critical function of the Yolo Bypass is associated with its ability to convey flood waters from the Sacramento River and west side tributaries (e.g., Cache and Putah creeks). The Nigiri Project is being designed to be flood neutral and not impact the flood flow conveyance capacity of the Bypass. All Project modifications to enhance fish and wildlife habitat will either improve flood conveyance or be flood neutral. The Yolo Bypass is the backbone of California's flood control system. Bypass lands must be managed to ensure the safe conveyance of major floods away from the State Capitol.

The Project will collaborate with bird experts and will work through any habitat conflicts that come from changes to Bypass flow regime. Migratory birds along the Pacific Flyway will benefit from winter water management practices that expand the seasonal window of availability for wetland habitats of varying depths. The Project will restore a diverse array of wetland, riparian, and grassland communities that provide habitat for multiple species of waterfowl, shorebirds, and wading birds as well as a variety of native plant, wildlife, and fish species. Further, the traditions of agriculture will also be maintained, employing innovative wildlife-friendly management strategies to achieve multiple resource objectives.

Agriculture and managed wetlands sustain the flood conveyance of the Bypass by controlling vegetation and maintaining low "roughness" on the floodplain surface. To maintain long-term flood safety, the Bypass benefits from widespread farming, as agriculture is a viable means of cost-effective vegetation control within the Bypass. The Project will work with private agricultural operations and landowners to ensure the long-term viability of both the agriculture economy and Yolo Bypass flood conveyance.

Waterbird management is a prominent use within the Bypass, occurring on lands dedicated to that purpose, on agricultural fields, or within the Yolo Bypass Wildlife Area. Migratory birds along the Pacific Flyway will benefit from Nigiri Project winter water practices that generate varied depths of floodplain habitat at key times for multiple species of waterfowl, shorebirds, and wading birds.

Evaluation Criterion B: Prior Restoration Planning and Stakeholder Involvement and Support

Sub-Criterion B1: Task A: Study and Design

Prior Planning and Design

The current proposal for the Nigiri Project builds on over two decades of research in the Yolo Bypass (see discussion under *Sub Criterion A.2. Quantification of Specific Project Benefits*, above). In addition to the studies cited above, many Nigiri Project-specific studies have been conducted since 2011. These specific efforts started with the formation of the Nigiri Pilot Project Team (in 2011) and subsequent implementation of the Knaggs Ranch Experimental Agricultural Floodplain Habitat Investigations. The investigations examined whether seasonally flooded rice fields could be modified to provide off-channel rearing habitat for juvenile Chinook salmon (Sommer et al. 2020). Overall, the group found that seasonally flooded fields are highly productive, resulting in significantly higher levels of zooplankton and high Chinook salmon growth rates as compared to the adjacent Sacramento River. The investigations also faced numerous logistic and environmental challenges to complete the research. Specifically, the investigation found that recent and future infrastructure improvements in Yolo Bypass could substantially improve options for experimental work and broaden efforts to enhance salmon habitat (Sommer et al. 2020). The key findings and recommendations identified as part of the investigations have been incorporated into the current proposal for the Nigiri Project.

Additional planning and design associated with the Nigiri Project has been occurring since 2021 with the Managed Floodplains Design Evaluation Team (DET) (CDFW, NMFS), Reclamation, local agricultural interests, CalTrout, and UC Davis Center for Watershed Sciences. To date, there have been dozens of meetings with the DET to review the Managed Floodplain Criteria and Considerations documents, develop, review, and iterate on conceptual designs, and develop and review the Draft Operations, Monitoring, and Adaptive Management Framework for the Project. Additionally, approximately 50 on-site meetings and tours have been conducted with representatives from Reclamation, DWR, CDFW, NMFS, USFWS, CalTrout, UC Davis, Yocha Dehe Wintun, Santa Clara Valley Water, Metropolitan Water District of Southern California, Floodplain Forward partnership members, and agricultural interests. The primary objective for the early stakeholder outreach and coordination was intended to set the stage for further design and operational detail development, ultimately leading to a Project that can get through permitting and can be implemented to benefit salmon while also being compatible with existing land uses.

Stakeholder Involvement and Support

The Knaggs Ranch Experimental Agricultural Floodplain Habitat Investigations (described above) represents a private-public partnership with landowners, government agencies, non-governmental organizations (NGOs), and university researchers, all dedicated to finding solutions that work for both agriculture and the environment. Participants (past, current, and future) and funders (of past work efforts) include:

- California Department of Water Resources
- California Department of Fish and Wildlife

- UC Davis Center for Watershed Sciences
- Cal Marsh and Farm Ventures, LLC
- Knaggs Ranch, LLC
- California Trout
- The U.S. Bureau of Reclamation
- The National Oceanic and Atmospheric Administration – Southwest Fisheries Science Center
- Floodplain Forward Partnership

Stakeholder outreach activities will continue through planning, design, environmental review, and regulatory permitting phases of the Project. Anticipated audiences for outreach include, but are not limited to, the federal, State, and local governments; non-governmental organizations, tribal, agricultural, and other local stakeholders listed below.

- Interagency Managed Floodplain Design Evaluation Team (CDFW, NMFS)
- Adjacent landowners, adjacent Reclamation Districts (RDs)
- City of Woodland
- Yolo County
- Sacramento Area Flood Control Agency (SAFCA), United States Army Corps of Engineers (USACE), Central Valley Flood Protection Board (CVFBP)
- Non-governmental organizations (e.g., CalTrout, Ducks Unlimited)
- CDFW (regulatory and Yolo Bypass Wildlife Area management), USFWS, NMFS
- Lower Sacramento/North Delta Regional Flood Management Plan
- Sacramento International Airport
- UC Davis Center for Watershed Sciences
- Yolo County Farm Bureau/other agricultural interests
- Yocha Dehe Wintun and other tribal stakeholders

Stakeholder outreach will be implemented across many forms including workshops, site tours, public meetings, consultations, and other outreach tools such as using local media, targeted outreach to known stakeholder groups, and web-based outreach.

Evaluation Criterion C: Project Implementation and Readiness to Proceed

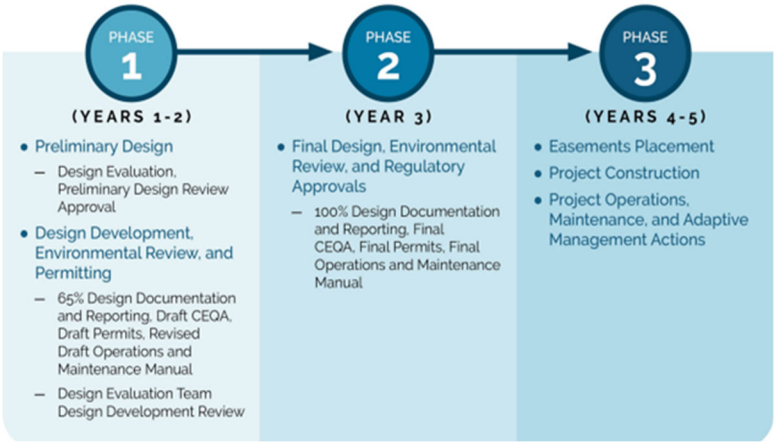
Sub-Criterion C1: Task A: Study and Design Project Implementation

Work on the Nigiri Project will be performed in three phases. **Phase 1** will include work through 65% design (to allow a development of a construction cost estimate and development of the Rivers and Harbors Act Section 408 Permission [408 Permission] application). In addition, **Phase 1** will include the completion of the California Environmental Quality Act (CEQA) compliance document through the Public Draft version of the EIR and development of all permit applications. **Phase 2** will include work from 65% through final design, Final EIR, and submittal

of permit applications and permit processing by the agencies. **Phase 3** will include placement of easements on the property, construction, operations and maintenance, and monitoring.

A comprehensive scope of work has been developed for each phase of the Project and is ready for implementation. Further, property is in private ownership with a willing seller and DWR has exclusive rights for acquisition.

A graphic that provides a brief summary of the scope of work, with a general schedule is provided at the right inset. The full scope of work with detailed schedule for implementation is available upon request.

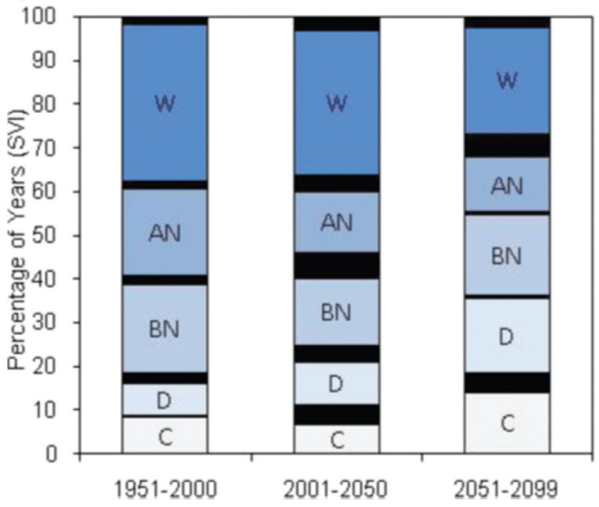


Evaluation Criterion D: Presidential and Department of the Interior Priorities

Climate Change

Under climate change scenarios, hydrologic models predict substantially more dry and critically dry years are anticipated to occur into the future (Null and Viers 2013) (**Figure 10**). This would disproportionately impact environmental uses (i.e., Bay Delta outflows are reduced by approximately 36% between wet and dry years, whereas exports and out-of-stream agricultural uses have relatively constant deliveries among year types) (Null and Viers 2013). With more frequent, persistent dry conditions under these scenarios, California risks failing to provide adequate baseflow and hydrologic variability to support various ecosystems, including floodplains, and failing to protect species and habitat.

California's Sacramento Valley and San Joaquin Valley Indices are used as case studies to examine how climate change affects these indices. Modeled streamflow for 1951–2099 from the climate-forced Variable Infiltration Capacity hydrologic model estimate potential changes in runoff and water year type frequency (Null and Viers 2013). The analysis shows that the frequency of water year types changes significantly with climate change and different strategies to adapt water year classification indices to climate change affect water allocations as much as the impacts from changing hydroclimatic conditions (Figure 10) (Null and Viers 2013).



Source: Null and Viers 2013

Figure 10
Modeled distribution of water year types trending towards fewer wet and above normal years for Sacramento Valley Index (SVI) (black bands show uncertainty in projections)
Note: C is critically dry, D is dry, BN is below normal, AN is above normal, and W is wet

A model-based analysis of the Nigiri Project for 1997 – 2012 shows that it has the ability to provide climate change resiliency and substantially mimic above normal and wet hydrologic conditions, in terms of inundation and suitable habitat acre-days, during dry and critical conditions by bifurcating flows onto the Project site and providing high-quality floodplain habitat, rich in food resources that support the development, growth, and survival of salmon by extending inundation duration, increasing the number of continuous wetted acre-days and prolonging the residence time for production of more food (**Figure 11**).

The water year analysis of Nigiri Project accumulated suitable habitat acre-days between November 1 and March 15 (period when juvenile salmon are outmigrating and may access the Yolo Bypass) (1997 – 2012).

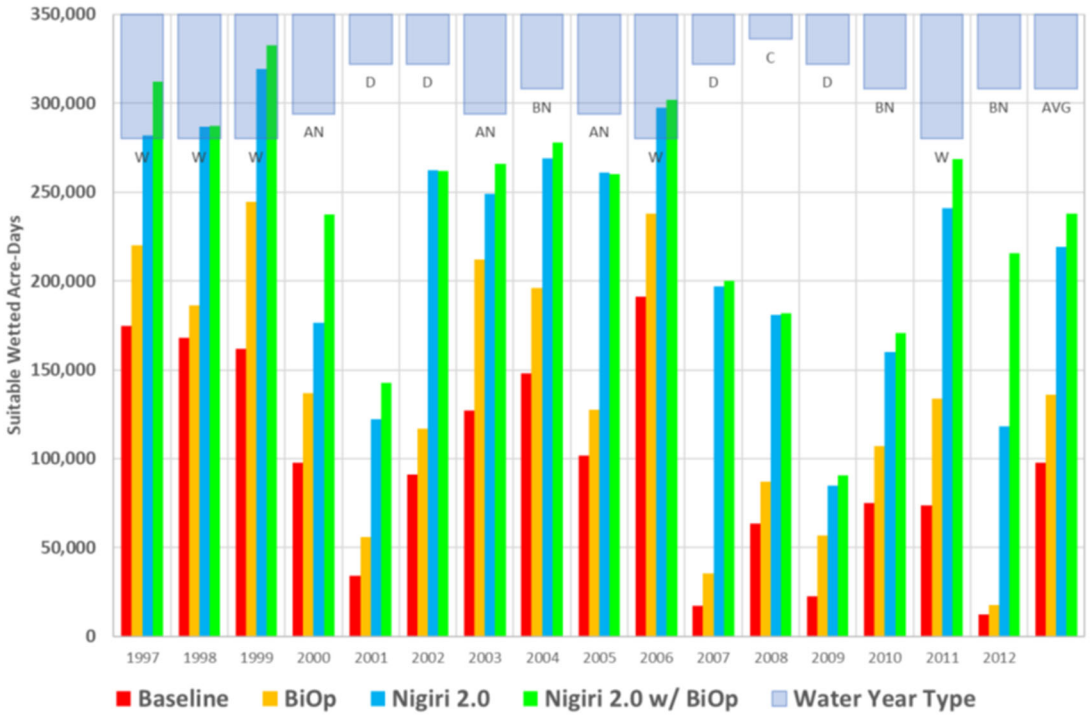


Figure 11
Accumulated suitable acre-day statistics between November 1 and March 15 (period when juvenile salmon are outmigrating and may access the Yolo Bypass) (1997 – 2012) by water year type for Baseline (includes Fremont Weir Adult Passage Project), BiOp (Notch Project), Nigiri 2.0 (Nigiri + Baseline), and Nigiri 2.0 w/ BiOp (Nigiri + Big Notch)
Note: C is critically dry, D is dry, BN is below normal, AN is above normal, and W is wet

Disadvantaged or Underserved Communities

The Project site is located in a portion (tract) of Yolo County that has been identified as disadvantaged and underserved because it meets more than one burden threshold and the associated socioeconomic threshold. As stated above, the Project will continue to employ seasonal agricultural, which will provide jobs and benefit the regional economy.

Tribal Benefits

The Nigiri Project is being implemented to benefit Chinook salmon with the ultimate goal of improving survival of the species and contributing towards recovery. Recovery of Chinook salmon in the Central Valley is a common interest with many tribal communities, including the Yocha Dehe Wintun, whose members have been stakeholders on the early phases of the Project and have attended tours of the Project sites to provide input on the project development.

Evaluation Criterion E: Performance Measures

A draft operations, monitoring, and adaptive management plan has been developed in coordination with the DET to guide monitoring and to identify the thresholds that may comprise the Nigiri Project's objectives. The draft plan describes the Nigiri Project's objectives and expected outcomes, goals and metrics by which progress towards meeting the objective will be

measured, and thresholds for undertaking a management response if objectives are not being met. Because of the interrelated nature of the Nigiri Project with the Fremont Weir Notch Project, the Nigiri Project plan is intended to be coordinated with the Fremont Weir Notch Project Adaptive Management Plan (DWR 2020).

Food Web Contribution

Objective: Enhance food web productivity and export into the Yolo Bypass and Cache Slough in support of native listed fish recovery.

Expected Outcome: The increased magnitude, duration, and frequency of managed floodplain inundation will increase aquatic-terrestrial exchange on the Nigiri Project site. This productivity exchange will increase the export of primary and secondary productivity within the Yolo Bypass and downstream.

Monitoring Category: Physical Process and Hydrology

- **Goal:** A Notched Fremont Weir in combination with the Nigiri Project roughened channel will supply flows to increase terrestrial-aquatic exchange within the Nigiri Project area and to downstream areas.
- **Metric:** Elevation and topography. Hydrology measured with flow sensors and water level-loggers in various locations along managed floodplain (Nigiri Project area) cross sections.
- **Intervention Threshold**: If managed floodplain inundation area changes (decreases) for 2 or more years in a row from excessive sedimentation on the managed floodplain area. Also, an obstruction such as a large tree blocks the roughened channel flow bifurcation site.
- **Potential Management Response:** Review appropriate actions to take, including but not limited to, removal of obstruction or grading. A log of action location, and cause will be reported as part of an Annual Report. Equipment may include a long-reach excavator or backhoe.

Monitoring Category: Food Web

- **Goal:** Food web contributions within or from the Nigiri Project area are higher than other areas within the Yolo Bypass or the Sacramento River entering the North Delta. Food web contributions from the various habitat components within the Nigiri Project area are maximized to the extent possible.
- **Metrics:** Chlorophyll a, phytoplankton, zooplankton, drift invertebrates.
- **Intervention Threshold:** Food web components within or coming off the Nigiri Project into the Tule Canal and Toe Drain are lower in concentration than those found in the Tule Canal upstream of the Nigiri WCSs and lower Sacramento River entering the Delta.
- **Potential Management Response:** Increase water quality monitoring to determine conditions that may be leading to lower productivity. Modify the WCSs or the draw-down operations to increase residence times or other water quality characteristics favorable to increased productivity. Prior to any modifications to Nigiri Project features, information describing the proposed work and expected response will be reported to the interagency technical team.

Juvenile Salmonid Entrainment and Routing

As part of the Fremont Weir Notch Project, Reclamation and DWR will release marked (either PIT- or acoustically-tagged), hatchery-origin juvenile Chinook salmon into the Sacramento River upstream of the Fremont Weir to monitor the entrainment rate of fish as they pass the Fremont Weir. The Nigiri Project designated floodplain manager (Bypass Keeper or other) will subsequently monitor these tagged fish as they move/travel from the Fremont Weir Notch into Tule Canal and onto the Nigiri Project site. This monitoring action will occur each year for five years following the construction of the Nigiri Project.

Objective: Provide juvenile entrainment and routing rates of at least 90% the proportion of flow entrained through the Fremont Weir and subsequently routed via the Nigiri roughened channel.

Expected Outcome: The Nigiri Project area will provide approximately a 0.9:1.0 ratio between juvenile entrainment and routing rates, and flow split rates. It is anticipated that entrainment and routing rates may vary by hydrologic condition.

Monitoring Category: Fish

- **Goal:** Measure the entrainment and routing of tagged, hatchery-raised juvenile Chinook salmon.
- **Metric:** Juvenile Chinook salmon entrainment and routing
- **Intervention Threshold**: Additional consideration if results from five-year special study of juvenile entrainment do not support expected outcome being met.
- **Potential Management Response:** Additional monitoring and study of obstacles to entrainment and routing. Develop model for behavioral guidance structures to improve entrainment and routing and implement if likely to provide desired objective. Modify roughened channel and/or areas downstream in Tule Canal.

Salmonid Rearing

The Nigiri Project designated floodplain manager will coordinate with the Fremont Weir Notch Project and Yolo Bypass Fish Monitoring Program, which includes monitoring an existing rotary screw trap located in the lower Yolo Bypass. All juvenile Chinook salmon, including tagged fish (detection histories; routed onto the Nigiri Project versus continuing down the Tule Canal), will be recorded.

Objective: Provide rearing habitats for a diverse range of life histories of juvenile salmonids.

Expected Outcome: The Nigiri Project area will provide an increase occupied habitat area for rearing and out-migrating salmonids compared to baseline conditions during similar water period conditions.

Monitoring Category: Fish presence

- **Goal:** Observe Chinook salmon at Nigiri Project downstream WCSs (tag detection) and southern Yolo Bypass rotary screw trap site.
- **Metric:** Juvenile Chinook salmon presence (tag detection mark-recapture and screw trap).

- **Intervention Threshold:** Duration of juvenile Chinook salmon presence (during times when juvenile salmon are typically present at the south Yolo Bypass screw trap site) is shorter than during years with operation of the Fremont Weir Notch and Nigiri Project operations than without operation.
- **Potential Management Response:** Change period of Nigiri Project WCSs operation associated with first and last operational dates during the Fremont Weir Notch operation period.

Monitoring Category: Fish growth

- **Goal:** Measure Chinook salmon growth rates (with and without Nigiri Project detection histories) at southern Yolo Bypass rotary screw trap site.
- **Metric:** Enhanced growth rate of juvenile Chinook salmon during Fremont Weir Notch operations and Nigiri Project operations.
- **Intervention Threshold:** Range of sizes of juvenile Chinook salmon (with and without Nigiri Project detection histories) at the southern Yolo Bypass rotary screw trap site is narrower during years with operation of the Fremont Weir Notch and Nigiri Project than without Nigiri Project.
- **Potential Management Response:** Evaluate WCSs at select locations to extend the duration of floodplain inundation and increase growth.

Monitoring Category: Managed Floodplain Water Quality

As discussed above, monitoring and forecast-informed managed floodplain operations for the Nigiri Project involves continuous monitoring and forecasting to inform water management activities within the site to ensure that conditions are managed to provide suitable habitat for fish species. The framework for this approach includes identification of monitoring and forecasting parameters (e.g., site water quality parameters, Notch flows, forecasting data) with associated trigger values or intervention thresholds, that if met or exceeded require action, including potential management response (includes forecasting, retaining water, or draining site, where appropriate). Implementation of monitoring and forecast-informed operations would require various levels of coordination between the designated floodplain manager (Bypass Keeper) and an interagency technical team. Monitoring and forecasting data sources and parameters that would be used to inform monitoring and forecast-informed operations has been developed.

- **Goal:** Maintain suitable water quality conditions for rearing salmonids.
- **Metrics:** DO, temperature.
- **Intervention Threshold:** If juvenile Chinook salmon are present within the Nigiri Project area and water quality conditions are unsuitable (see discussion on triggers above), consider potential management response (e.g., draining the site). No threshold for intervention is appropriate if juvenile Chinook salmon are not present on the site. Note, an operations trigger decision tree has been developed as part of the draft monitoring and adaptive management framework.

- **Potential Management Response:** Operate the Nigiri Project based on monitoring and adaptive management framework consistent with decision tree and in coordination with interagency technical team. This includes informed retaining flow or draining the Nigiri site to move (volitionally) juvenile Chinook salmon off the managed floodplain habitat and maintain migration flows in Tule Canal to move fish into Cache Slough.

Adult Fish Passage

The Nigiri Project designed floodplain manager, in coordination with Reclamation, DWR, and CDFW staff, will monitor fish movements, flows (velocity, depth and bulk flow splits) at Nigiri Project roughened channel and WCSs.

Objective: Provide volitional passage to adult salmon and sturgeon so that they remain in good condition passing through the Yolo Bypass to upstream spawning grounds.

Expected Outcome: The Nigiri Project will maintain passage of adult salmon and sturgeon by reducing delays and minimizing straying at Nigiri Project WCSs.

Monitoring Category: Fish

- **Goal:** Measure number of adult salmon and sturgeon straying to Wallace Weir during fish rescue operations (with and without Nigiri Project operations).
- **Metric:** Percent of salmon escapement captured at Wallace Weir.
- **Intervention Threshold:** More than 1% of Chinook salmon or green sturgeon annual escapement stray to Wallace Weir during Nigiri Project operations.
- **Potential Management Response:** Maintain the Nigiri roughened channel and operate WCSs to maintain volitional passage during Notch flow activation and following end of Fremont Weir overtopping. Consider rerouting Knights Landing Ridge Cut flows and re-operating Nigiri WCSs to reduce Wallace Weir and/or Nigiri Project (WCSs) attractions flows.

Monitoring Category: Physical processes and hydrology

- **Goal:** Measure velocity and depth at Nigiri Project roughened channel during fish passage period.
- **Metric:** Length of time Nigiri Project roughened channel (flow bifurcation) is passable by adult salmon and sturgeon.
- **Intervention Threshold:** Volitional passage conditions at the roughened channel are unsuitable during Notch activation flows or within 36 hours following cessation of natural Fremont Weir overtopping.
- **Potential Management Response:** Modify roughened channel and/or downstream areas in Tule Canal.

Monitoring Category: Yolo Bypass Adult Salmon and Sturgeon Acoustic Telemetry Study

Nigiri Project designated manager will coordinate with Reclamation and DWR, who propose to maintain an acoustic telemetry array in the Yolo Bypass and in the Sacramento River along the

Fremont Weir to monitor the movement of adult fall-run Chinook salmon and white sturgeon during the project's first five years (as part of Fremont Weir Notch Project Adaptive Management Plan). Upward-migrating adult fall-run Chinook salmon and white sturgeon will be captured in the lower Yolo Bypass and affixed with acoustic transmitters. Receivers will be located downstream of the fish passage structure and upstream of the structure in the Sacramento River to provide information on fish passage success.

- **Goal:** Acoustically tagged fish will be tracked above and below the Nigiri WCSs and roughened channel as part of broader Fremont Weir Notch Project monitoring.
- **Metric:** The percentage of acoustically tagged adult fall-run Chinook salmon and white sturgeon that successfully pass the Nigiri WCSs and roughened channel (flow bifurcation).
- **Intervention Threshold:** More than 10% of tagged fish that are detected at the WCSs and/or roughened channel are not subsequently detected at the receiver upstream of the WCSs and/or roughened channel.
- **Potential Management Response:** Telemetry results will be analyzed in conjunction with depth and velocity measurements (see "Flow Monitoring" below) to determine if shallow depth, excessive velocity, or turbulence at the WCSs or roughened channel negatively affect passage efficiency. Once a source of passage inefficiency has been identified, evaluate options for modifying WCSs and/or roughened channel to provide more favorable flow conditions as described previously.

Monitoring Category: Flow Monitoring

- **Goal #1:** Combine velocity and depth measurements to identify sources of fish avoidance or failure to pass the fish passage structure.
- **Metric #1:** Length of time adult fish passage criteria are exceeded at the Nigiri Project roughened channel.
- **Intervention Threshold:** Adult fish passage criteria at the roughened channel are exceeded for 36 hours or more following cessation of natural overtopping events and Fremont Weir Notch Project operation.
- **Potential Management Response:** Compare depth and velocity measurements to telemetry results and direct observations to determine if shallow depth, excessive velocity, or turbulence are negatively affecting adult fish passage. Once a source of passage inefficiency has been identified, examine modifying roughened channel to provide more favorable flow conditions beginning with additional roughening or otherwise modifying the roughened channel or downstream areas. If target species can pass under conditions deemed outside of the prescribed fish passage criteria, consider adjusting criteria to include observed conditions.
- **Goal #2:** Maintain dominant migratory cue in the Tule Canal at and downstream of Nigiri Project roughened channel and WCSs.
- **Metric #2:** Percent flow split at Nigiri Project roughened channel and subsequent WCSs relative to Tule Canal.
- **Intervention Threshold:** Migratory cue in the Tule Canal at and downstream of Nigiri Project WCSs is not dominant and resulting in migratory delays due to false attraction.

- **Potential Management Response:** Modify the roughened channel and/or operation of WCSs to maintain dominant migratory cues in the Tule Canal.

Predatory Fish and Predation

The Nigiri Project designated floodplain manager will coordinate with the Fremont Weir Notch Project and Yolo Bypass Fish Monitoring Program, which includes monitoring at several locations throughout the Yolo Bypass. Near-field sampling targeting areas in the immediate vicinity of the Nigiri Project features (e.g., berms, roughened channel, and WCSs) focused on predatory fish and predation is also proposed. Juvenile Chinook salmon, including fish tagged as part of Reclamation and DWR efforts (DWR 2020) will also be recorded (detection histories; routed onto the Nigiri Project versus continuing down the Tule Canal; see above),

Monitoring Category: Predatory fish and predation

- **Goal:** Evaluate Nigiri roughened channel and WCSs and associated features to determine if these features result in increased predatory fish aggregations and/or predation rates on juvenile salmonids or other species of management concern.
- **Metric:** Predatory fish aggregations and predation rate.
- **Intervention Threshold:** Measurable increase in predatory fish aggregations documented through sampling and/or measurable increase in predation rates documented through predation event recorders in the immediate vicinity of the project features during active managed floodplain periods. Data on predatory fish from regional Yolo Bypass Monitoring Program may also be considered in analyses.
- **Potential Management Response:** Evaluate roughened channel and WCSs features to determine potential design or operational modifications to address potential increases in predatory fish aggregations or predations rates.

References

Ahearn, DS, Viers JH, Mount JF and Dahlgren RA. 2006. Priming the productivity pump: flood pulse driven trends in suspended algal biomass distribution across a restored floodplain. *Freshwater Biology*, 51: 1417-1433.

Bell-Tilcock M, Jeffres CA, Rypel AL, Willmes M, Armstrong RA, Holden P, et al. 2021. Biogeochemical processes create distinct isotopic fingerprints to track floodplain rearing of juvenile salmon. *PLoS ONE* 16(10): e0257444.

Benigno GM and TR Sommer. 2008. Just add water: sources of chironomid drift in a large river floodplain. *Hydrobiologia*, 600(1):297-305.

California Department of Water Resources (DWR). 2020. *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project, Adaptive Management Plan*. Sacramento, CA.

Corline NJ, TR Sommer, CA Jeffres, and J Katz. 2017. Zooplankton ecology and trophic resources for rearing native fish on an agricultural floodplain in the Yolo Bypass California, USA. *Wetlands Ecology and Management*, 25:533-545.

Grosholz, E, and E Gallo. 2006. The influence of flood cycle and fish predation on invertebrate production on a restored California floodplain. *Hydrobiologia*, 568: 91–109.

Jeffres, C. A., Holmes, E. J., Sommer, T. R., & Katz, J. V. E. 2020. Detrital Food Web Drives Aquatic Ecosystem Productivity in a Managed Floodplain. *PLoS ONE* 15(9):e0216019.

Jeffres, C. A., Opperman, J. J., & Moyle, P. B. 2008. Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California river. *Environmental Biology of Fishes*, 83(4), 449–458.

Katz, JVE, C Jeffres, JL Conrad, TR Sommer, J Martinez, S Brumbaugh, N Corline, and PB Moyle. 2017. Floodplain farm fields provide novel rearing habitat for Chinook salmon. *PLoS ONE*, 12(6):e0177409.

Moyle, PB, W Bennett, J. Durand, W Fleenor, B Gray, E Hanak, J Lund, and J Mount. 2012. *Where the Wild Things Aren't: Making the Delta a Better Place for Native Species*. San Francisco: Public Policy Institute of California.

Murase, J and P Frenzel. 2007. A methane-driven microbial food web in a wetland rice soil. *Environmental microbiology*, 9(12):3025-34.

National Marine Fisheries Service (NMFS). 2014. *Final Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead*. 427 pp. Sacramento, California.

National Marine Fisheries Service (NMFS). 2021. *White Paper on Central Valley Floodplain Management for Salmon: Considerations for Balancing Food Web Productivity and Fish Viability*.

Null, S. E., and J. H. Viers. 2013. In bad waters: Water year classification in nonstationary climates, *Water Resources. Res*.,49.

Opperman, Jeffrey J. 2012. A Conceptual Model for Floodplains in the Sacramento-San Joaquin Delta. *San Francisco Estuary and Watershed Science*, 10(3). jmie_sfews_11155. Retrieved from: http://escholarship.org/uc/item/2kj52593.

Sommer, T., and Mejia, F. 2013. A place to call home: a synthesis of Delta Smelt habitat in the upper San Francisco Estuary. *San Francisco Estuary and Watershed Science*, 11(2).

Sommer, T., Schreier, B., and Conrad, J. L. 2020. Farm to Fish: Lessons from a Multi-Year Study on Agricultural Floodplain Habitat. *San Francisco Estuary and Watershed Science*, 18, 3.

Sommer, T. R., Nobriga, M. L., Harrell, W. C., Batham, W., and Kimmerer, W. J. 2001a. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. *Canadian Journal of Fisheries and Aquatic Sciences*, 58(2), 325–333.

Sommer, T., Harrell, B., Nobriga, M., Brown, R., Moyle, P., Kimmerer, W., and Schemel, L. 2001b. California's Yolo Bypass: Evidence that flood control can be compatible with fisheries, wetlands, wildlife, and agriculture. *Fisheries* 26(8), 6–16.

Sommer, T., R. Baxter, and B. Herbold. 1997. The resilience of splittail in the Sacramento-San Joaquin Estuary. *Transactions of the American Fisheries Society*, 126:961-976.

Whipple A, T Grantham, G Desanker, L Hunt, A Merrill, B Hackenjos, and R Askevold. 2019. *Chinook Salmon Habitat Quantification Tool: User Guide (Version 1.0).* Prepared for American Rivers. Funded by the Natural Resources Conservation Service Conservation Innovation Grant (#69- 3A75-17-40), Water Foundation and Environmental Defense Fund. A report of SFEI-ASC's Resilient Landscapes Program, Publication #953. San Francisco Estuary Institute, Richmond, CA.

Windell, S., P.L. Brandes, J.L. Conrad, J.W. Ferguson, P.L. Goertler, B.N. Harvey, J. Heublein, J.A. Israel, D.W. Kratville, J.E. Kirsch, R.W. Perry, J. Pisciotto, W.R. Poytress, K. Reece, B.G. Swart, and R.C. Johnson). 2017. *Scientific Framework for Assessing Factors Influencing Endangered Sacramento River Winter-run Chinook Salmon (*Onchorhynchus tshawytscha*) Across the Life Cycle*. National Oceanic and Atmospheric Administration Technical Memorandum National Marine Fisheries Service. https://doi.org/10.7289/V5/TM-SWFSC-586.

Yoshiyama, RM, FW Fisher, and PB Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley region of California. *North American Journal of Fisheries Management*, 18:487-521

January 24, 2024

Bureau of Reclamation
Financial Assistance Operations Section
Attn: NOFO Team
P.O. Box 25007, MS 84-27133
Denver, CO 80225

Subject: Reclamation 2023 WaterSMART Aquatic Ecosystem Restoration Projects Grant – California Department of Water Resources Application for the Nigiri Project

Dear Grant Application Review Team,

The California Natural Resources Agency (CNRA) and the California Department of Fish and Wildlife support the Aquatic Ecosystem Restoration Grant Program application being submitted by the California Department of Water Resources (DWR) for the Nigiri Project. The Nigiri Project would work in conjunction with Reclamation and DWR's Yolo Bypass Big Notch Project, a fish passage and juvenile salmon floodplain rearing project along the Sacramento River. The Nigiri Project is a 4,000-acre system of berms and water control structures that would allow for a broader range of operational flexibility of Big Notch. The Project would allow managers to retain floodwaters longer to increase production of food for rearing fish, and to export that food through the Yolo Bypass/ Sacramento-San Joaquin Delta.

New and exciting research shows that although very few juvenile Chinook salmon have access to floodplain rearing habitat as they migrate to the ocean, those that do make up a large proportion of the adult fish that return to spawn. Simply put, increasing access to off-channel rearing habitat may be a key step towards recovering depleted salmonid populations. As such, floodplain habitat is a major component of California's Agreements to Support Healthy Rivers and Landscapes (Voluntary Agreements). The Voluntary Agreements have committed to producing 20,000 acres of floodplain habitat in the Central Valley, and the Nigiri Project would provide 20% of that commitment.

This project is broadly supported by a diverse group of local, regional, state, and federal interests, including the Department of the Interior.

We look forward to continued collaboration with DWR on project design and implementation to ensure maximum benefits for all involved. We encourage Reclamation to provide grant funding for this first of its kind project.

Sincerely,

Wade Crowfoot
Secretary
CA Natural Resources Agency

Charlton H. Bonham
Director
CA Department of Fish and Wildlife