THE NIGIRI PROJECT

MANAGED FLOODPLAINS FOR SALMON RESTORATION IN THE YOLO BYPASS

Title Page

Table of Contents

Executive Summary

THE PROJECT

Introduction and Purpose

Cal Marsh and Farm Ventures, LLC proposes to enhance of floodplain habitat for rearing juvenile Sacramento Valley salmon in the upper Yolo Bypass south of the Fremont Weir and north of the I-5 causeway (Figure 1). The total project area of 4000 (show exact acres) is based on the lands of two existing agricultural operations, the Knaggs Ranch with 2000 acres and the te Valde lands of 2000 acres. Proposed new infrastructure and water management operations on the project area would increase wetted acre-days in winter in the upper Yolo Bypass providing more rearing habitat for juvenile salmon entering the Bypass from the Sacramento River via the Fremont Weir. Access to the Bypass for young salmon spawned in the upper Sacramento River and tributaries is expected to increase in coming years with new weir notches to facilitate salmon upstream and downstream migrations to and from the Sacramento River near Knights Landing. More fry, fingerling, and pre-smolt salmon could benefit from access to floodplain rearing habitat in the Bypass, thus increasing their growth and survival potential.

The Project is proposed in partial fulfillment of the prescription in Action 1.6.1 of the National Marine Fisheries Service's OCAP Biological Opinion (BO). Action 1.6.1 of the OCAP BO specifically prescribes increasing available inundated habitat in the Yolo Bypass to enhance rearing and migratory habitat of Sacramento River salmon.

Location and Setting

The Nigiri Project is located in the upper Yolo Bypass, adjacent to the Sacramento River. Located in Yolo and Solano Counties approximately five miles west of the city of Sacramento and six miles east from the city of Woodland. The Yolo Bypass functions to prevent flooding by relieving pressure from the Sacramento River at high flows. The entire area is covered by floodway easements held by the State of California making all other land uses subservient to flood control. The Bypass is the Delta's largest contiguous floodplain at 59,000 acres and provides critical fish and wildlife habitat (Sommer et al. 2001a). Flooding in two thirds of years on average, typically during winter and spring, the Yolo Bypass represents one of most frequent large-scale connections of river and floodplain left in the Central Valley. When flooded, the Bypass is a critical link for waterfowl migrating through the Pacific Flyway and supports more than 45 fish species—15 of which are native—including the Sacramento splittail and Chinook salmon (Sommer et al. 2001b).

A major land use in the Yolo Bypass is agriculture and rice is the primary crop. Additionally, wild rice, processing tomatoes, corn, safflower, melons, are grown and substantial areas are in irrigated pasture or kept fallow. Extensive areas within the Bypass are also managed for waterfowl habitat and hunting.

Biological Components: Fish and Birds

The primary focus of the Nigiri Project is to integrate management of agricultural lands with recovery of Chinook salmon populations by optimizing floodplain habitat for fish. While the Sacramento River contains four distinct runs of salmon, the primary focus of the proposed project is the fall run, given timing of winter flooding and presence of fall run fish in the river. While Late Fall run, Winter run, Spring run fish will also be present in winter flood waters, the primary run represented will be Fall run fish because they would most benefit from winter floodplain inundation.

Sacramento splittail would be attracted to the wetted lands in late winter to spawn in flooded fields. Splittail eggs benefit from warm, shallow waters with abundant plankton food supply (Sommer et. al. 1997).

Migratory birds of the Central Valley flyway would also benefit from winter flooded rice fields.

Figure 1. Enhancements to floodplain rearing habitats are proposed on the 2000-acre Knaggs Ranch in the upper Yolo Bypass below the Fremont Weir

PROJECT ELEMENTS

Flooded Rice Fields and other Agricultural Lands

The primary project element consists of approximately 4000 acres of agricultural lands, mostly rice fields, that are flooded by flows from the Colusa Basin Drain (via Knights Landing Ridge Cut) or by Sacramento River via spill over the Fremont Weir. Research (Coreline et al. 2017) has shown that high concentrations of zooplankton biomass are rapidly established in flooded lands of the Yolo Bypass Flows are then significantly reduced, allowing water to warm, which triggers a zooplankton bloom. Zooplankton biomass primarily consists of cladocerans (water fleas), copepods and insects, all of which are readily available to feeding fish. This floodplain aquatic habitat with its

abundant aquatic invertebrate food supply promotes very high growth rates in young salmon (Sommer et al. 2001: Tanaka et al. 2016)

New infrastructure on the proposed project lands would increase the wetted acre-days of flooding by slowing draining and increasing residence time of water on the agricultural fields during the winter rearing season of juvenile Sacramento River salmon. A wetted-acre-day (WAD) is defined as an acre holding at least 6" of water depth over a 24 hr. period. Volitional entrance and exit features would be provided to ensure young salmon have ample opportunity to seek out the advantageous rearing habitat or leave as needed. Depth and other cover habitats would be included in the flooded habitats to minimize bird predation.

Studies have clearly documented that when water spreads out and slows down on floodplains, the water on the floodplains is generally warmer due to increased surface area and residence time compared to the relatively cool and swift river channel. This warmer water in conducive to much higher growth rates for the zooplankton that nourish young fish.

Water Supply

Water from the Colusa Basin Drain via the Knights Landing Ridge Cut canal and Sacramento River are available for initial field flood-up as well as during normal winter high water flooding. Local supplies and water retention infrastructure would make possible initial flood-up and food production prior to fish entering the Bypass via Fremont Weir spilling or notch diversion. Additionally, modification of the Fremont Weir Fish Ladder scheduled for 2018 will enhance the ability to supply water to maintain wetted acres as proposed by the Nigiri Project. Please see Section 5 below for details related to Fish ladder modification.

Water Control Infrastructure

New infrastructure (see diagram #xx) would replace the existing agricultural berms that currently control flooding and water surface elevation in the upper Bypass. New infrastructure would allow controlled flooding and draining (alleviating present stranding), including expansion of the existing seasonally flooded acreage from approximately 100 non-bermed acres to approximately 4000 (get exact acres) acres of flooded habitat. Flooded acreage would occur by establishing new berms up to approximately 5ft elevation (Figure 2). Outlets equipped with water control structures connected to the Tule Canal from the flooded area will allow draining and volitional downstream passage of rearing salmon. Adult salmon and sturgeon would be blocked from entering the flooded area except in full Bypass floods.

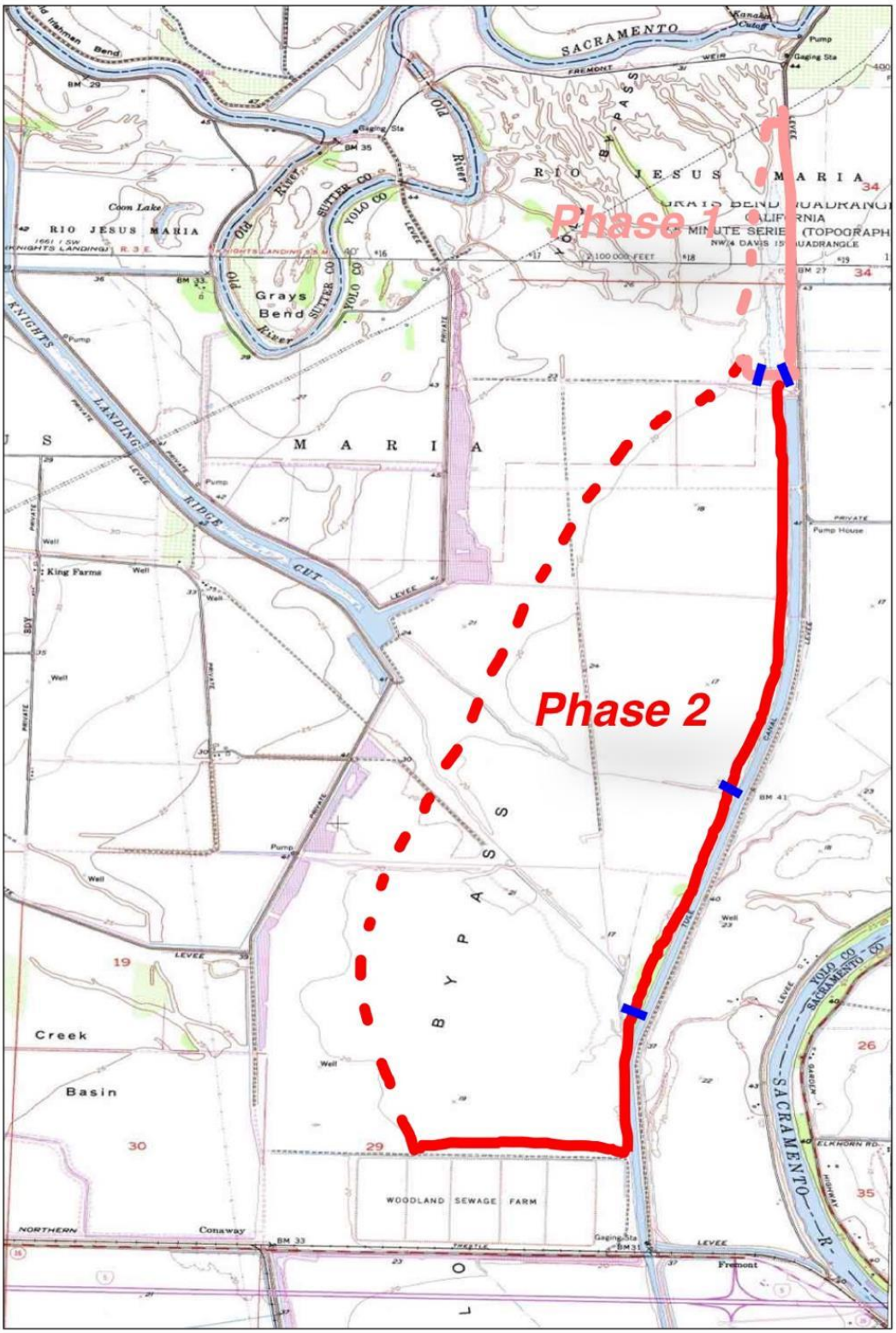

Figure 2. PLACEHOLDER

Habitat Enhancement

Water conveyance infrastructure associated with flooded rearing habitat would be deepened with new instream cover, and emergent and riparian planting along margins. Flooded rice fields would be modified to improve rearing conditions. Inside margins of rice fields will be deepened to provide cover for young salmon. Rice check berms will be lowered prior to the flooding season to allow free movement of young fish within the flooded areas. Passage channels that encourage fish movement onto and off the floodplain will have more cover in the form of lightly vegetated banks, in-stream cover, and deepened water. Flow onto and off the floodplain will be carefully distributed within the floodplain channels to facilitate targeted movement,

PROJECT BENEFITS

The benefits of the proposed Floodplain Project include improving growth and survival of juvenile salmon, Delta smelt, and other native Central Valley fishes. Benefits would be derived from direct and indirect effects of flow-related habitat improvements in the upper Yolo Bypass. Changes to land use and floodway infrastructure will increase the duration of flooded acreage in the Bypass from late fall to early spring providing optimal rearing habitat for juvenile salmon, spawning habitat for splittail, and enhanced food supply for north Delta Cache-Slough Delta smelt. The added habitat acres, warmer water temperatures, and increased zooplankton/insect food supplies would lead to higher growth, improved survival, and earlier ocean entry of young salmon.. These benefits would be derived from changes in the following ecological processes.

Enhancing Flooded Acreage

Capturing and restricting draining of water entering the upper Yolo Bypass would increase the total of wetted acre-days in the project area of the northern Bypass below the Fremont Weir, thus providing new rearing habitat for juvenile salmon entering the Bypass from the Sacramento River.

Increased Residence Time

The increased residence time in winter of water on the floodplain would facilitate warming of otherwise cold (<50°F) Sacramento River water. Young salmon grow faster in 50-60°F water.The warmer water and increased residence time greatly enhances biological primary (algae) and secondary (zooplankton, bacteria, and aquatic insect) productivity that provide an abundant food source for young salmon. Thus the combination of warmer water and greater food supply significantly increases the growth potential of young salmon.

Extended Flooding and Draining Season

Extending the flooding and draining season by creating and maintaining flooded area from December 1 and March 15 allows extended use by young salmon, spawning spring spawning splittail, and increases Delta productivity benefiting salmon, smelt, and other fishes

Enhanced Bypass and Delta Productivity

Water flowing from or drained/flushed from flooded area will increase nutrients, algal, organic detritus, and aquatic invertebrate inputs into the lower Bypass and the north Delta-Cache Slough tidal complex.

Improved Salmon Growth Rates

Enhanced growth of young salmon in prolonged flooded rice fields (Figure 3) has been well documented (Jeffres et al. 2008, Limm and Marchetti 2009, Tanaka et al. 2016, Corline et al. 2017). The growth rates documented in recent studies in the Yolo Bypass are among the most rapid ever recorded in the Central Valley (Katz et al, 2017). Warmer water and robust food resource contribute to high growth rates that are otherwise not possible in the cold, unproductive Sacramento River channel.

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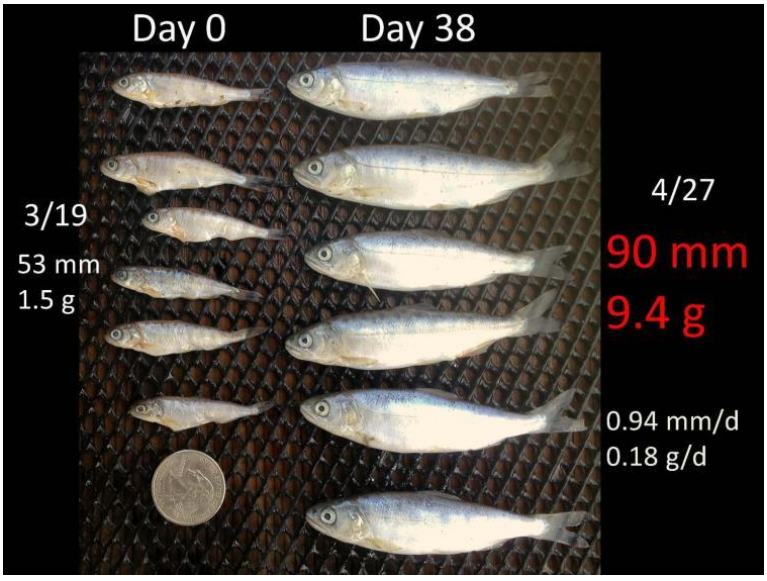
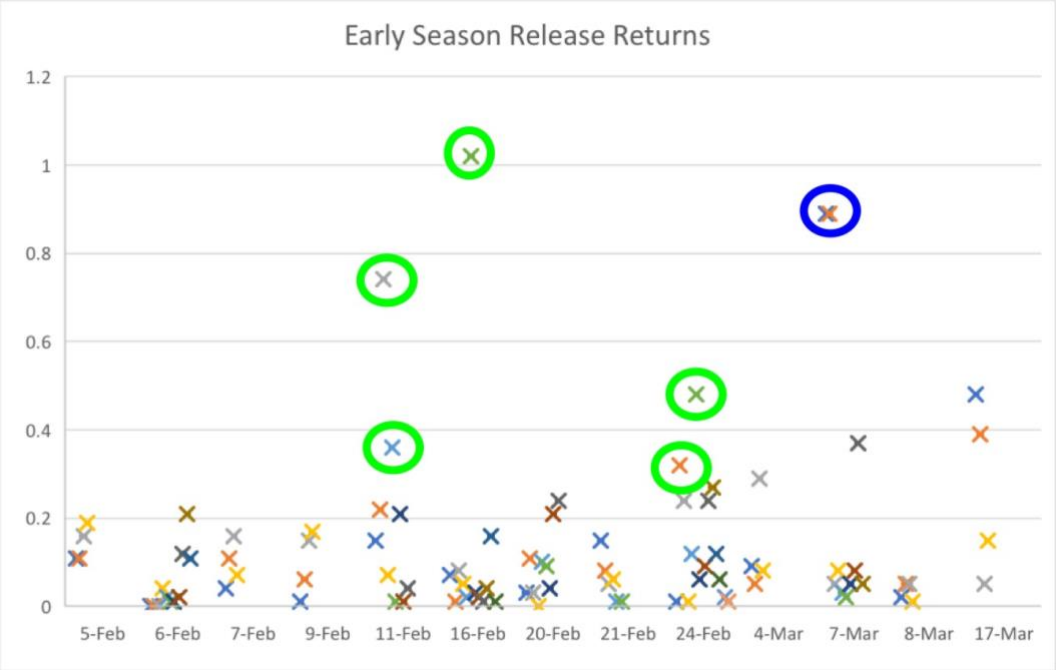


Figure 3. Example of high growth in rice field during five week rearing period in Knaggs Ranch rice fields.

Salmon Survival

The relatively large size and good body condition of floodplain-reared out-migrants is important because larger individuals are less vulnerable to predation and other causes of size-dependent mortality (e.g., starvation). Accumulated fat reserves resulting from floodplain rearing may increase survival by buffering effects of subsequent poor foraging conditions encountered during out migration..

Tagged hatchery fry salmon releases over the past two decades have shown relatively poor survival except for some Bypass releases. Some of the higher survival rates of these



releases were from the Yolo Bypass (Figure 4).

Figure 4. Survival/returns percentage from winter-released code-wire tagged hatchery fall run Chinook salmon in the Sacramento River and Delta from 1999 to 2011. Circled groups were from seven of the nearly 100 Delta and upper Yolo Bypass release groups. (Data source: http://www.rmis.org/, Oroville Hatchery fall-run winter releases

Reduced Predation

Existing Tule Canal rearing habitats in the Yolo Bypass have high densities of predatory fish and birds. Feeding habitat is near optimal for these predators in the Bypass Tule Canal system. Such habitat will be discouraged in the Project area and an active program of predatory fish removal will be prescribed Actions may include seining and trapping in project waterways and the adjacent Tule Canal.Predator fish will be hindered from moving into the rearing area during managed winter flooding periods by hindering/blocking pathways for mature predatory fish into the Project area from permanent aquatic habitats in the Bypass.

Improved Salmon Rearing Habitat

The Project rearing area will be actively managed to maintain optimal rearing conditions. The following habitat factors will be monitored, and refined as possible through active management.

1. Water Temperature
2. Depths and Velocities
3. Cover
4. Food supply
5. Emigration flows – timing and amount
6. Duration
7. Fish density

ALTERED BYPASS HYDROLOGY

As stated earlier, flow of water and young salmon from the Sacramento River are expected to increase in frequency with upgrade of the Fremont Weir ladder (2018) and constructions of notches in the weir (2020+). The frequency of young salmon entering the Bypass in winter will increase even in critically dry years like 2014 (Figure 5).

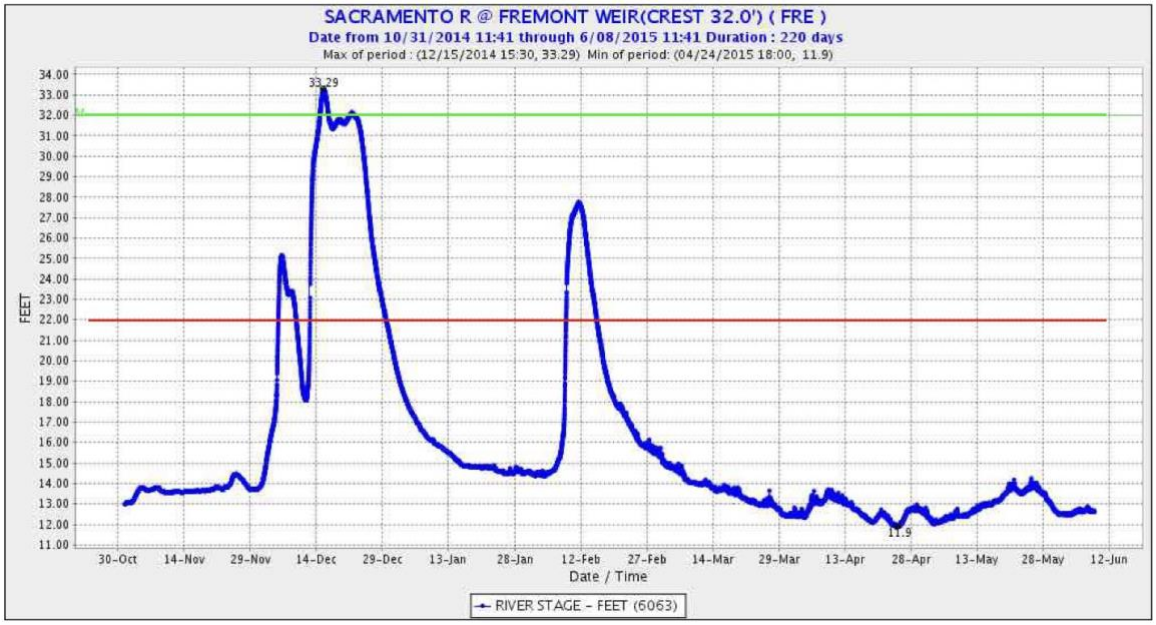


Figure 5. Sacramento River stage at Fremont Weir November to June in critically dry water year 2014. Green line is present level of fish ladder opening to Bypass. The red line is the planned (2018) entrance to the fish ladder. Note that there would have been two multi-day periods of influx of juvenile salmon into the Bypass via the ladder in winter 2014. The first in late December would have brought in juvenile winter run Chinook salmon during the first winter flow pulse. The second occurred during peak emigration of fry spring and fall run salmon.

DURATION OF FLOODING – WETTED ACRE DAYS

An anticipated fix of the Fremont Weir fish ladder in 2018 includes a lowering of ladder opening from a 30-ft elevation to 22-ft, therefore allowing a more frequent spill (diversion) of Sacramento River water and juvenile salmon into the Yolo Bypass at the Fremont Weir[1]. Overflow and juvenile salmon passage into and rearing events within the Bypass once restricted to infrequent flood events will now occur on a more frequent basis between and within years.

A benefit of the proposed project is to extend the period of floodplain inundation in the upper Bypass before, during, and after spill events. Prior to anticipated spill events, waters from the Colusa Basin Drain's Ridge Cut Outlet into the upper Yolo Bypass can be held within the new ponding areas to create habitat and food supplies for young wild salmon fry, fingerlings, and pre-smolts that may seek out such habitat upon entry into

[1] Note the main purpose of the ladder fix is to facilitate adult salmon passage from the Bypass to the Sacramento River.

the Bypass. The metric for this benefit would be additional acre-days of floodplain inundation created by the proposed project.

BYPASS FOOD SUPPLY AND HABITAT

The pre-flood, flooding, and draining of the project area will add to the food supply and improve rearing habitat conditions in the upper Bypass. With the flow-through feature of the ponded area there will continuous exit of inorganic nutrients, organic carbon, turbidity, and invertebrates into other Yolo Bypass habitats (e.g., Tule Canal) to benefit young salmon rearing in those habitats.

DRAINING

The new project infrastructure would allow draining of the ponds when it best suits young salmon survival. This may occur at the end of the winter rearing season when waters warm or at the end of a weir overflow event when flushing the Bypass of rearing fish is deemed advantageous to overall survival. The added flow from draining would add significantly to the flow of the Tule Canal as it flows to the north Delta.

OPERATION – MANAGEMENT

The proposed project design lends itself to intensive operations and management to best benefit juvenile passage and rearing in the Yolo Bypass. Habitat features such as depth, shade, and cover can be adjusted to best suit the fish. Inflow/outflow can be adjusted to provide best depths, velocities, residence time of water, food production, water quality, and attraction to and exit from the ponds.

Other improvements including water temperature, food, and predator protection: growth opportunity, opportunity for volitional movements could occur through active management. Proactive measures are planned such as predator removal or enhancing habitats that allow more protection from predators. Keeping fish off the floodplain late in the season when possible would help to lower potential natural late season mortality.

ENDANGERED SPECIES CONSERVATION

The proposed project would contribute directly to the conservation of the listed winter run and spring Chinook salmon populations of the Central Valley. Section 7(a)(1) of the Endangered Species Act directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a

proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

Federal National Marine Fishery Service Biological Opinions

2009 NMFS OCAP Biological Opinion (NMFS 2009)

Action 1.6.1 prescribes increases in floodplain rearing habitat for juvenile salmon including the Yolo Bypass: "(R)*estore floodplain rearing habitat for juvenile winter-run, spring-run, and CV steelhead in the lower Sacramento River basin, to compensate for unavoidable adverse effects of project operations. This objective may be achieved at the Yolo Bypass, and/or through actions in other suitable areas of the lower Sacramento River*".

"This plan should include an evaluation of options to: (1) restore juvenile rearing areas that provide seasonal inundation at appropriate intervals, (2) increase inundation of publicly and privately owned suitable acreage within the Yolo Bypass; (3) modify operations of the Sacramento Weir (which is owned and operated by the Department of Water Resources) or Fremont Weir to increase rearing habitat; and (4) achieve the restoration objective through other operational or engineering solutions".

"In high flow years (e.g., similar to 1998), this action can be achieved solely by inundation of the Yolo Bypass. In other years, this action may be accomplished by a combination of actions such as increasing the year-to-year inundation frequency of existing floodplains such as portions of the Yolo Bypass, by restoring rearing habitat attributes to suitable areas, through restoration or enhancement of intertidal areas such as Liberty Island, creation or re-establishment of side channels, and re-created floodplain terrace areas." The proposed Project helps to achieve the goal of the biological opinion by increasing the wetted-acre days of inundation through "operation and engineering" means. Design options have been discussed in detail and refined with upper Yolo Bypass stakeholders over the past several years.

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BDCP/WaterFix Biological Opinion (NMFS 2017)

The proposed Project fits within prescriptions for Terms and Conditions of the NMFS CWF BO:

"*Relevant components from Salmon Resiliency Strategy - Increase Juvenile Salmonid Access to Yolo Bypass, and Increase Duration and Frequency of Yolo Bypass Floodplain Inundation."*

Both of the above referenced biological opinions have general prescriptions to support actions outlined in the NMFS Recovery Plan for Central Valley Salmon and Steelhead

(NMFS 2010[2]). The proposed project fits within prescriptions for habitat restoration in the Yolo Bypass.

1. *In addition to recovery plan components included in the Terms and Conditions of this BO, Reclamation and DWR should use species recovery plans to help ensure that their mitigation measures will address the underlying processes that limit fish recovery by identifying high priority actions in the action area.*
2. *Reclamation should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid and sturgeon habitat restoration projects within the Sacramento River Basin, Delta, and San Joaquin River Basin.*

Federal National Marine Fisheries Service Recovery Plan for Central Valley Salmon and Steelhead (NMFS 2014[3]) calls for floodplain habitat restoration in the Yolo Bypass. In the Recovery Planning process, NMFS Five Year Plan (NMFS 2016)[4] prescribes improvements to Yolo Bypass floodplain habitat tor salmon. Specifically, the plan calls for:

"increased frequency, magnitude, duration, and access to seasonal floodplain habitat in the Bypass for juvenile salmon."

"provide floodplain connectivity, physical and biological habitat rearing conditions to promote food web productivity, and protection from predators that will in turn support juvenile winter-run development, growth, and survival."

NMFS also stated: "*We encourage sustained partnerships with DWR, CDFW, Bureau of Reclamation, Cal Trout, Cal Marsh and Farms, Metropolitan Water District, State and Federal Contractors Water Agency, Yolo Basin Foundation, Yolo County, Bureau of Reclamation District (RD) 108, RD 2068, Conaway Ranch, Sacramento Area Flood Control Agency, and seek additional partners to support restoration of the Yolo Bypass floodplain and improved fish passage*." The proposed Project is an example of partnership activities in the upper Yolo Bypass.

CDFW CESA

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[2] The final recovery plan for federally-listed Central Valley salmonids is available at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/california_central_valley/california_central_valley_salmon_recovery_domain.html

[3] http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/california_central_valley/california_central_valley_salmon_recovery_domain.html

[4] http://www.nmfs.noaa.gov/stories/2016/02/docs/sacramento_winter_run_chinook_salmon_spotlight_species_5_year_action_plan_final_web.pdf

SCIENCE BACKGROUND – FEASIBILITY OF PROJECT

The Project is based on sound science and a comprehensive planning effort over the past six years including early phases of the Nigiri project. Winter inundation of Bypass rice fields provides near optimal habitat for young salmon in terms of water temperature and aquatic invertebrate food supply (Katz et al. 2017; Corline et al. 2017).

The most likely occurrence of juvenile salmon of the four Sacramento River races in the Project inundated habitat is during the winter operating period (Figures 6 and 7). Winter run and late fall run would be first to show during December Sacramento River flow pulses. Fry and fingerling spring and fall run would be present from late December through the winter. Hatchery fall run smolts commonly released in April would likely be confined to the river channel as the Fremont Weir openings would be closed after March 15, except during floods.

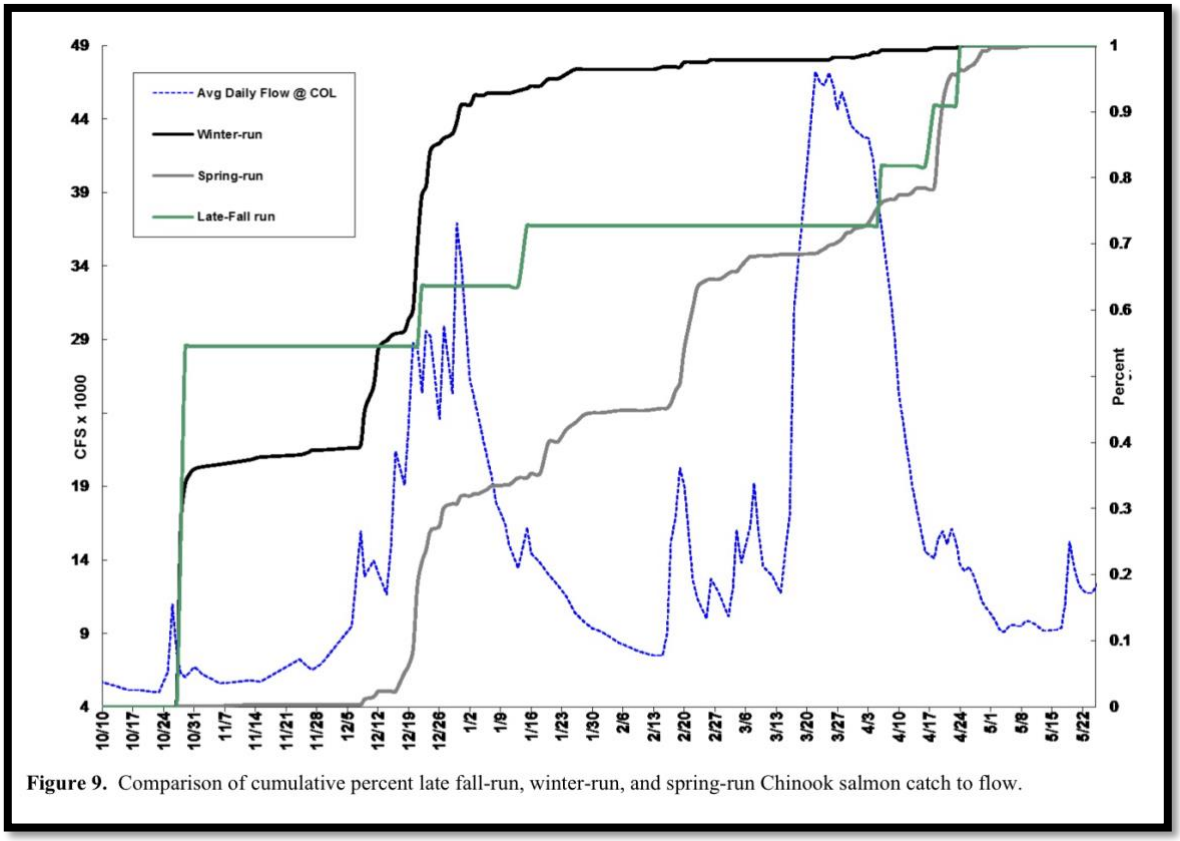

Figure 9. Comparison of cumulative percent late fall-run, winter-run, and spring-run Chinook salmon catch to flow.

Figure 6. Occurrence of juvenile salmon of three races at Tisdale Weir screw traps in water year 2011. Half of the late fall run salmon catch occurred with first pulse of flow in late October, with the remainder remainder coming in the late December and early April pulses. Most of the winter run came in the late December pulse. Spring run fry began showing in December and on through the winter with each flow pulse. (Source: http://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyJuvenileSalmonandSteelheadMonitoring.aspx)

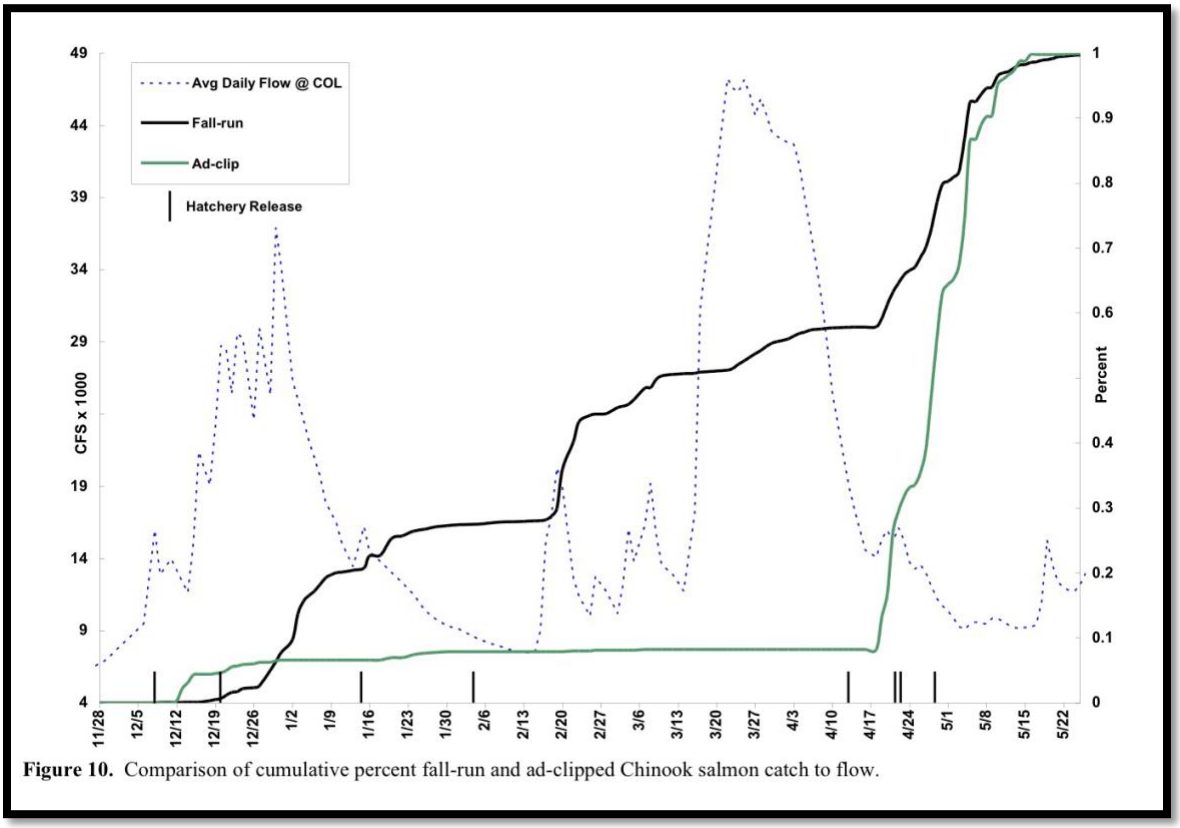

Figure 10. Comparison of cumulative percent fall-run and ad-clipped Chinook salmon catch to flow.

Figure 7. Occurrence of juvenile salmon of the fall run races at Tisdale Weir screw traps in water year 2011. Fall run salmon fry began showing in abundance in January at the peak of the late December flow pulse, and on through the winter. Most of the hatchery fall run smolts showed after the large April releases. (Source: http://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyJuvenileSalmonandSteelheadMonitoring.aspx)

Management and permitting of the project would occur through oversight of the **Regional Conservation Investment Strategy/Local Conservation Plan (RCI/LCD)** process outlined by CDFW at https://www.wildlife.ca.gov/Conservation/Planning/Regional-Conservation. Yolo County proposes to lead the Yolo Bypass RCI//LCD process through its Yolo Habitat Conservancy process (https://www.yolohabitatconservancy.org/landowners) under the general guidance of the federal biological opinions and recovery plans.

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APPENDICES

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Proposed Salmon Floodplain Credit criteria