UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS No: WCR-2017-7245

May 16, 2018

Mr. William Guthrie
CA Delta Section Chief
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Fish and Wildlife Coordination Act Recommendations for the South Lathrop Regional Outfall Project (SPK-2017-00017)

Dear Mr. Guthrie:

Thank you for your letter of September 15, 2017, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the South Lathrop Regional Outfall Project (SPK-2017-00017).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action.

The enclosed biological opinion is based on our review of the proposed action as detailed in the provided biological assessment prepared by ECORP Consulting, Inc., and its effects on the federally listed threatened California Central Valley steelhead (*Oncorhynchus mykiss*) distinct population segment (DPS), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*) evolutionarily significant unit, and threatened North American green sturgeon (*Acipenser medirostris*) southern DPS, and their respective designated critical habitats, in accordance with section 7 of the ESA. Based on the best available scientific and commercial information, NMFS concludes that the project is not likely to jeopardize the continued existence of these federally listed species, nor adversely modify or destroy their critical habitats. NMFS has also included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor the incidental take of federally listed fish that will occur with project implementation.

This biological opinion also includes NMFS's review of the potential effects of the proposed action on EFH for Pacific Coast Salmon, as designated under the MSA. The document concludes that the project will adversely affect the EFH of Pacific Coast Salmon in the action area and has included conservation recommendations. As required by section 305(b)(4)(B) of the MSA, the action agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)). In your response to the EFH portion of this consultation, we ask that you clearly identify the number of conservation recommendations accepted.

Because the proposed action will modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources under the Fish and Wildlife Coordination Act (16 USC 662(a)) so these resources receive equal consideration.

Please contact Katherine Schmidt at the Central Valley Office in Sacramento at (916) 930-3685 or katherine.schmidt@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Barry A. Thom
Regional Administrator

Enclosure

cc: To the file: 151422-WCR2017-SA00344
Chandra Browne, U.S. Army Corps of Engineers, chandra.l.browne@usace.army.mil
Kathleen Ports, ECORP Consulting, Inc., kports@ecorpconsulting.com

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Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for South Lathrop Regional Outfall Project (SPK-2017-00017)

NOAA's National Marine Fisheries Service (NMFS) Consultation Number: **WCR-2017-7245**

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
California Central Valley steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No
Central Valley spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	N/A[1]	N/A
Southern DPS North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

_________________-___
Barry A. Thom
Regional Administrator

Date: May 16, 2018

[1] Central Valley spring-run Chinook salmon critical habitat does not occur within the action area.

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AAM	avoidance and minimization measure
ACID	Anderson-Cottonwood Irrigation District Diversion Dam
BA	biological assessment
BMP	best management practice
°C	degrees Celsius
CCV	California Central Valley
CDEC	California Data Exchange Center
CDFW/CDFG	California Department of Fish and Wildlife
cfs	cubic feet per second
CRs	Conservation Recommendations
CVP	Central Valley Project
dB	decibels
Delta	Sacramento-San Joaquin River Delta
DOC	dissolved organic carbon
DPS	distinct population segment
DQS	Data Quality Act
EFH	essential fish habitat
EPA	United Stated Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionary significant unit
°F	degrees Fahrenheit
FHWG	Fisheries Hydroacoustic Working Group
FWCA	Fish and Wildlife Coordination Act
HAPCs	Habitat Areas of Particular Concern
ITS	incidental take statement
LID	low impact development
mg/L	milligram per liter
MS4	Phase II MS4 General Permit
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSD	Mossdale Bridge station
NPDES	National Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service
NTU	nephelometric turbidity units
OHWM	ordinary high water mark
Opinion	biological opinion
PAHs	polyaromatic hydrocarbons
PBFs	physical or biological features
RBDD	Red Bluff Diversion Dam
RMS	root-mean-square
RPMs	reasonable and prudent measures
sDPS	southern distinct population segment
SFS	Stockton Fire Station precipitation station
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Program

SOC	Stockton Airport precipitation station
SRA	shaded riverine aquatic
SWE	snow water equivalent
SWRCB	State Water Resources Control Board
THMFP	total trihalomethane formation potential
TMDL	Total Maximum Daily Load
TOC	total organic carbon
UC Davis	University of California at Davis
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VSP	viable salmonid population
WOUS	Waters of the United States
YOY	young-of-the-year
µg/L	microgram per liter

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

Because the proposed action would modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources, and enabling the Federal agency to give equal consideration with other project purposes, as required under the Fish and Wildlife Coordination Act (FWCA, 16 U.S.C. 661 et seq.).

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System [*https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts*]. A complete record of this consultation is on file at the NMFS California Central Valley Area Office, titled: "Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for South Lathrop Regional Outfall (SPK-2017-00017)" [PCTS#: WCR-2017-7245].

1.2 Consultation History

On May 19, 2017, NMFS received a letter from United States Army Corps of Engineers (USACE), dated May 16, 2017, requesting informal consultation pursuant to Section 7 of the ESA and EFH consultation in accordance with section 305(b)(2) of the MSA, regarding a Department of the Army Permit application (SPK-2017-0017) from the City of Lathrop to place an outfall structure on the bank/levee of the San Joaquin River (SJR). In this letter, USACE requested that NMFS provide written concurrence with their determination that the action of permit approval and subsequent project implementation would not be likely to adversely affect:

- California Central Valley (CCV) steelhead (*Oncorhynchus mykiss*) distinct population segment (DPS) and its critical habitat

On June 1, 2017, NMFS requested via email additional information regarding the upland facilities to be serviced by the outfall, additional details on the construction best-management-practices (BMPs) that would be utilized, and if additional avoidance and minimization measures (AAM) could be incorporated into the project. Additionally, NMFS advised that the project would also impact Pacific Coast Salmon EFH.

On June 8, 2017, NMFS received a letter and a packet of supplement information dated June 6, 2017. The packet included email correspondence between project proponents, design engineers, the applicant, and their consultants regarding the conservation bank the City of Lathrop selected to purchase mitigation credits from (Fremont Landing Conservation Bank) and agreement to incorporate an AAM, the placement of smaller rocks to fill the voids created by placing riprap protection rock. The supplemental information also included additional details regarding project conservation measures. After reviewing the submitted material, NMFS replied via email and requested that the applicant request a variance from the USACE so that willow cuttings may be planted in the riprap after project completion to offset the scheduled tree removal within the project boundaries. NMFS also suggested incorporation of a July 1 – October 31 construction window for the greatest avoidance of species, and advised that the applicant consider impacts to southern DPS (sDPS) green sturgeon since the population and their critical habitat also occur within the direct project boundaries in their consultation packet.

On June 20, 2017, NMFS received a letter and more supplement information from applicant consultants dated June 19, 2017, answering questions about the project NMFS posed via email. The packet included 1) locations and identification of trees at the site proposed for removal, 2) agreement on the AAM in-water work window, 3) increased detail on the out-of-water project construction schedule and sequence of events, and 4) an analysis that concluded that project would also be unlikely to adversely affect:

- Southern distinct population segment sDPS North American green sturgeon (*Acipenser medirostris*) and its critical habitat

On June 21, 2017, NMFS received additional materials via email, an April 2017 supplementary packet that had been shared with USACE and other regulatory agencies but not included in prior exchanges with NMFS. This packet contained an update to the calculated extent of project impacts below the Ordinary High Water Mark (OHWM).

On July 6, 2017, NMFS determined that this project and the information provided for it did not support a “not likely to adversely affect” determination for CCV steelhead and their critical habitat, nor sDPS green sturgeon and their critical habitat, and issued a non-concurrence letter to the USACE regarding the Lathrop Regional Outfall Project (SPK-2017-0017).

On July 13, 2017, City of Lathrop sent an additional request via email for NMFS to concur with their not likely to adversely affect determinations regarding the South Lathrop Regional Outfall project (SPK-2017-00017). This letter contained project changes: 1) decision to remove only three small trees/willow bunches while retaining the larger trees in the project footprint, 2) reiteration that the AAM of smaller rock placed to fill voids created by larger riprap and avoid creating predator habitat would be incorporated, 3) reiteration that the AAM project work window would be July 1 through October 31 to avoid most impacts to listed fishes, and 4) some additional details regarding the water quality standards that would help control the stormwater quality that would be discharged from the outfall over the long-term.

On July 14, 2017, NMFS staff participated in a teleconference call with USACE and the City of Lathrop's consultants. The main points of the conference call were that, since the project was altering critical habitat from the status quo by placing artificial structure and riprap, NMFS could not concur with a not likely to adversely affect determination and that formal consultation would be necessary.

On July 17, 2017, USACE requested via email to amend their May 16, 2017, letter and requested formal consultation on the South Lathrop Regional Outfall Project (SPK-2017-00017) under the ESA and MSA.

On July 20, 2017, NMFS SJR Branch Chief Erin Strange requested via email that the Section 7 request be received by mail and that the request incorporate previous project changes (additions of AAMs) and include a full biological assessment with analyses supporting appropriate determinations regarding each species and their critical habitats.

On August 25, 2017, NMFS staff and SJR Branch Chief participated in a teleconference call with USACE, their applicant the City of Lathrop, and their consultants. USACE stated they have no discretion on the project outside of the construction zone, nor over the long-term operations of the outfall once construction is completed (i.e., the long-term indirect effects/interrelated and interdependent effects of discharging stormwater). NMFS stated that Section 7 consultations require staff to consider all interrelated and interdependent actions, and all direct and indirect effects both in the short-term and long-term, and these will be included in the effects analyses of the opinion. NMFS's main concern regarding long-term operation and discharge from the outfall was the amount and quality of the stormwater to be discharged. The applicant (City of Lathrop) was still in early planning phases of sub-shed (a sub-component of the drainage shed) development and was unable to provide additional details on the types of development that would generate the stormwater or the stormwater control-treatment system that would precede water being discharged into the SJR in perpetuity, other than that the stormwater would meet Clean Water Act/National Pollutant Discharge Elimination System (NPDES) discharge requirements.

On August 29, 2017, NMFS received the Clean Water Act section 401 certification for the project from USACE, as well as clarification on USACE's stance on the regulation of project components in the upland portions of the project (i.e., they have no jurisdiction outside of the scope of the 0.093 acres of outfall occupation in Waters of the United States (WOUS)). These statements were added to USACE's description of the project per their request.

On September 15, 2017, NMFS received a request for formal consultation from USACE dated September 7, 2017, requesting formal consultation under Section 7 of the ESA and EFH consultation in accordance with section 305(b)(2) of the MSA, regarding a Department of the Army Permit application (SPK-2017-0017) from the City of Lathrop to place an outfall structure on the bank/levee of the SJR. The initiation packet included the applicant's August 30, 2017, South Lathrop Regional Outfall Biological Assessment (BA) prepared by ECORP Consulting, Inc. (ECORP, 2017). In this request, USACE identified that this project may adversely affect:

- CCV steelhead and its critical habitat
- sDPS North American green sturgeon and its critical habitat
- Pacific Coast salmon EFH

In addition, USACE requested that the draft biological opinion be made available for their review so they may analyze the reasonable and prudent measures proposed by NMFS, with a comment turnaround of 10 days of receipt of the draft.

On September 27, 2107, NMFS responded to USACE acknowledging receipt of their request for formal ESA/MSA consultation, the project BA and attachments. In the letter, NMFS identified September 15, 2017, as the initiation date of formal consultation, the date the request and the BA were received. Using that initiation date, USACE was notified that they could expect to be provided a biological opinion January 28, 2018, given their request for 10 days for their internal review.

On December 12, 2017, NMFS staff requested via email additional detail regarding outfall pipe capacity to more accurately quantify the physical effects of the discharged water exiting the outfall. USACE did not provide the information.

On January 2, 2018, USACE requested an early draft of the opinion for review via email.

On January 17, 2018, NMFS Branch Chief provided USACE a partial draft of the project effects and ITS sections for their view via email.

On January 24, 2018, NMFS received comments on the draft sections and incorporated them into the opinion.

On February 6, 2018, NMFS Branch Chief received a letter via email attachment from the City of Lathrop expressing that they did not desire ESA take exemption coverage regarding stormwater discharge and associated effects since the proposed action and its effects are covered under a Nationwide #7 permit (construction phase) and a NPDES Program Phase II Small MS4 General Permit.

On February 13, 2018, USACE and NMFS regional leadership held a meeting to discuss the proposed action and developing opinion. USACE maintained that their agency would not have discretion over the project area after the action was complete but also that they would not include stormwater quality requirements or monitoring requirements with the permit that would be issued to their applicant, since USACE would ultimately be responsible if their applicant did not comply with permit stipulations.

On February 28, 2018, NMFS Branch Chief provided USACE a draft of the opinion for their review via email.

On March 6, 2018, NMFS received comments back from USACE.

On March 22, 2018, NMFS subsequently added analysis of the effects of the proposed action on the following listed species to the opinion:

- Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*) evolutionarily significant unit (ESU)

CV spring-run critical habitat has been designated but does not occur within the action area.

1.3 Proposed Federal Action

Under ESA implementing regulations, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Under MSA implementing regulations, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal agency (50 CFR 600.910). Under the FWCA, an agency is required to consult whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license (16 USC 662(a)).

The USACE proposes to approve a permit application submitted by the City of Lathrop to fill 0.093 acres of Waters of the United States (WOUS) during the installation of an outfall structure, riprap, and associated pipes that will extend over the existing flood-protection levee and connect with stormwater infrastructure within upland industrial development with the purpose of discharging treated stormwater (ECORP, 2017). The construction area and outfall structure placement is on the eastern bank of the SJR (approximately river mile 18), and approximately 0.30 miles south of the I-5/HWY-120 split, within the limits of the City of Lathrop, in San Joaquin County, California. The placement of the project falls within the Secondary Zone considered the Legal Delta, within the San Joaquin Delta Watershed (Hydrologic Unit Code # 18040003), also called the Sacramento-San Joaquin River Delta (Delta). The outfall structure will occupy approximately 64 linear feet of bank. Protective riprap rocks will be placed 100 feet upstream and 50 feet downstream of the outfall, and 50 feet from the bottom of the outfall structure to the top of the levee, for a total project occupation of 0.278 acres. Construction is proposed to begin in 2018 and take one construction season to complete outfall installation.

The riprap placed around the outfall structure will extend 50 feet downstream, 100 feet upstream, and 50 feet between the top and bottom of the levee slope, occupying a total river bank length of approximately 200 linear feet. Piping associated with the outfall structure will be installed over the existing levee and be connected with infrastructure placed upland within the adjacent industrial development area.

The construction site will be accessed via an existing levee maintenance road that is the top of the graded levee and connects to main roads in the City of Lathrop such as Madruga Road and Guthmiller Road. Originally the project proposed to remove all trees within the project footprint; however, the project proponents agreed to change the proposed action so that only three bunches of willows/small trees (tree numbers 5, 6, and 7, Figure 1 (ECORP, 2017)) would be removed because they overlap with the outfall structure footprint, while all other trees will remain and riprap will be placed around their bases. Trees number 4 and 8 may require trimming for construction access.

After the vegetation is removed/trimmed, an excavator stationed on top of the levee road will scrape surface soils and remove the remaining tree roots and stumps out from the outfall footprint, and grade the area to produce a stable slope. Next, a sheet pile cofferdam will be installed using a vibratory hammer around the length of the work area in the SJR with the purpose of isolating the work area and drying the soils below the OHWM. Dewatering will occur via pumping until the area enclosed within the cofferdam is dry and pumped water will be returned to the SJR, discharged within the floatable debris curtain.

The outfall area will be excavated to depth using an excavator. Before the casting of the concrete foundation, either a rock/gravel pad or an Armorflex® mat will be placed as a base to support the outfall foundation. The structure will be cast in concrete and cured in the dry. Once the outfall structure is set, pipes will be installed over the levee and connected to the outfall. Once connected, the pipes will be covered with soils excavated from the bank during the installation of the outfall, and the levee will be graded to retain the use of the levee top as an access road.

Riprap boulders will be placed via offloading from a small dump truck. The truck will dump the rock down the slope and the excavator will move the rock into place. As an AAM/project modification, riprap placed below the OHWM will also have smaller rocks placed to fill the voids between riprap boulders to avoid creating salmonid predator habitat.

After all in-the-dry construction work is complete, including riprap placement, the sheet pile cofferdam will be removed via vibratory hammer. After the sheet piles are removed and all other in-water work is completed, the floatable debris curtain will be removed.

The construction schedule estimates that the construction period would take six months of work to complete. The proposed in-water work window is the period of July 1st through October 31st, and all work will be limited to daylight hours between 8:00 am and 6:00 pm (project changes incorporated to limit impacts to listed fishes). Some activities may occur on the river bank above the OHWM outside of the in-water work window, such as: staging equipment of materials, out of water removal of vegetation as discussed above, the installation of exclusionary fencing and other best management practices (BMPs) intended for above OHWM use, pipe installation over the top of the levee, final levee top and landward side grading, the connection of the pipes to the concrete outfall structure, and removal of other BMPs once in-water work is completed.

To avoid degrading water quality during construction to the extent feasible, AMMs and BMPs have been included into the project design. All equipment and materials will be stored at least 200 feet away from the OHWM unless on established paved areas or existing roads. Any equipment or vehicles that will be operated or driven onto the levee will be checked and maintained daily to ensure they are in proper working order and free of leaks. This regular maintenance and all other fueling and cleaning will occur more than 200 feet from the OHWM unless in designated areas on existing paved surfaces or roads with secondary containment in use. Placement of construction debris, spoils, and trash will follow these requirements as well. A floatable debris curtain will be installed around the site in the SJR to capture construction debris and control sedimentation discharge.

To compensate for anticipated impacts to CCV steelhead and sDPS green sturgeon critical habitat resulting from the proposed project, the applicant (City of Lathrop) commits to purchase off-site mitigation credits that will benefit the CCV steelhead DPS and the sDPS of North American green sturgeon through the creation and maintenance of shaded riparian habitat, from a NMFS-approved conservation bank. The credit purchase will be at a 1:1 ratio for impacts above the OHWM and 3.3:1 for impacts below the OHWM, according to USACE guidelines. Since the outfall structure components and riprap will be placed above and below the OHWM in critical habitat, estimated to occupy 0.185 acres of riparian habitat above the OHWM and 0.093 acres below the OHWM, the City of Lathrop will purchase 0.185 acres of mitigation for above OHWM impacts and 0.3069 acres of mitigation for below OHWM impacts, for a total mitigation purchase of 0.4919 acres. NMFS-approved mitigation banks with service areas that include the proposed action area include: Bullock Bend Mitigation Bank, Cosumnes Floodplain Mitigation Bank, Fremont Landing Conservation Bank, and Liberty Island Conservation Bank. The City of Lathrop may choose to buy credits from these banks; otherwise, they may instead choose to participate in the in-lieu fee program to fulfill their obligations.

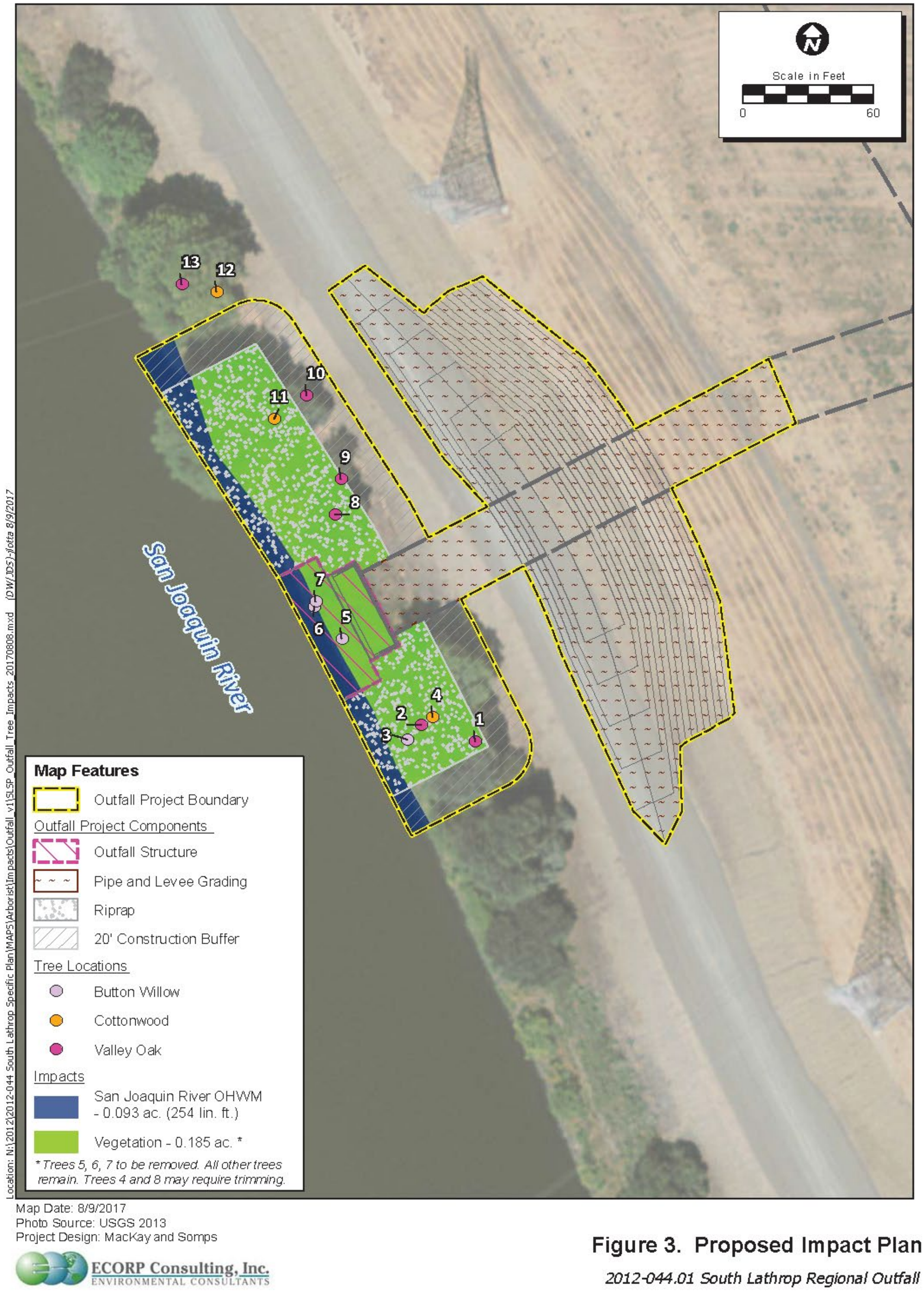


Figure 1. Proposed action construction area map (ECORP, 2017).

“Interrelated actions” are those that are part of a larger action and depend on the larger action for their justification. “Interdependent actions” are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

The purpose of the construction of the stormwater outfall, which requires approval from USACE to fill WOUS/wetland acreage to execute the construction, is to discharge stormwater from areas of the City of Lathrop that are planned for industrial development (City of Lathrop, 1991; ECORP, 2017). However, the operation of the stormwater outfall is not regulated by USACE, and the operation of the stormwater outfall is not part of USACE’s proposed action in this consultation. The operation of the regional stormwater outfall is authorized and regulated under the NPDES Program, Phase II MS4 General Permit Program (MS4 General Permit) administered by the U.S. Environmental Protection Agency (EPA) under Section 401 of the Clean Water Act.

NMFS must still analyze whether the operation of the stormwater outfall is interrelated to or interdependent with the USACE’s proposed action of issuing a permit related to the construction of the stormwater outfall. When directly applying the definition of “Interdependent actions,” the utility or use of both the construction and operation of the stormwater outfall is for discharge of stormwater, and the operation of the stormwater outfall does not have any independent utility apart from the action under consideration. Therefore, the operation of the stormwater outfall should at least be considered an interdependent action. In addition, NMFS and U.S Fish and Wildlife Service’s *Endangered Species Act Consultation Handbook* (Consultation Handbook, 1998); provides applicable guidance on how to analyze whether an activity is interrelated to or interdependent with the proposed action:

> As a practical matter, the analysis of whether other activities are interrelated to, or interdependent with, the proposed action under consultation should be conducted by applying a “but for” test. The biologist should ask whether another activity in question would occur “but for” the proposed action under consultation. If the answer is “no,” that the activity in question would not occur but for the proposed action, then the activity is interrelated or interdependent and should be analyzed with the effects of the action.

The operation of the stormwater outfall would not occur but for the proposed action under consideration; thus, it should be considered interrelated to or interdependent with the proposed action.

The South Lathrop Regional Outfall Project is a necessary component of the stormwater drainage system that will serve the region as part of the City of Lathrop’s Master Drainage Plan (City of Lathrop, 2016). In the 1992 Master Drainage Plan, the city designated ± 1,600 acres in the southeast part of the city limits as a drainage shed, referred to as “Trunkline C”. The limits of Trunkline C extend from Lathrop Road at the northern most extent to the San Joaquin River at the southernmost extent, and exists generally between the two Union Pacific railroad tracks to the east and west (Figure 2). Trunkline C is further divided up into three sub-sheds depending on the facilities/areas serviced by the drainage: the McKinley Corridor Shed, the Lathrop Gateway Shed, and the South Lathrop Shed. The outfall will serve proposed commercial and business development planned along McKinley Avenue, for the Lathrop Gateway Business Park Specific Plan, and for the South Lathrop Specific Plan.

The storm drains in South Lathrop and Lathrop Gateway Sheds will slope towards pump stations. The pump stations will initially pump water into the stormwater quality infiltration basin through either low-flow or high-flow water quality pumps. A level sensor in the stormwater infiltration basins will monitor water elevation and will shut down the water quality pumps when full. In the event the basins overtop, they would overflow into flood control detention basins. After the water quality basins are at capacity and the water quality pumps shut off, the lead flood control pumps would start pumping into the river, with a lag pump that will turn on if triggered. The flood control pumps will shut off once the systems have been drained.

The City of Lathrop is mandated to provide 200-year flood protection to incorporated areas, consistent with state standards, by 2025 (City of Lathrop, 2015; 2016). Therefore, each sub-shed is planned to have its own pump station that will eventually pump water to the SJR. The force mains in each sub-shed are not regional in that they only serve their own sub-shed. The only regional improvement common to all three sub-sheds is the stormwater outfall to the SJR. Each sub-shed is required to incorporate one or more detention basins (dependent on the runoff calculations) to reduce the peak pumping rate. Peak discharge rates to the SJR will be limited to no more than 30 percent of the developed condition peak 100-year flowrate. This limitation is intended to minimize the potential increase in the water elevation in the river when it reaches flood stage.

Each sub-shed is required to provide stormwater quality treatment prior to discharge pursuant to the City of Lathrop's MS4 permit. Proposed measures may include: infiltration basins (South Lathrop Shed), bioswales, or biofiltration, but additional details are not currently available. Though adjacent to the South Lathrop Shed, the McKinley Corridor Shed is not scheduled for development at this time. The Lathrop Gateway Shed may employ an infiltration basin similar to the one proposed for the South Lathrop Shed. Any stormwater quality infiltration basin will meet City requirements in accordance to the Multi-Agency Post-Construction Stormwater Manual (Multi-Agency, 2015). The stormwater system will be modeled with XP-Storm to ensure its efficiency. The basin will be designed to hold and infiltrate the volume of water generated by the first 0.36 inches of runoff (ECORP, 2017). Based on percolation rates suggested by the project's geotechnical report, the basin will empty within the specified 48-hour period. Based on the proposed project's described purpose and expected regular operations, the City of Lathrop is expected to use the outfall to discharge stormwater once constructed and functional in perpetuity for the foreseeable future.

SOUTHEAST LATHROP REGIONAL DRAINAGE EXHIBIT

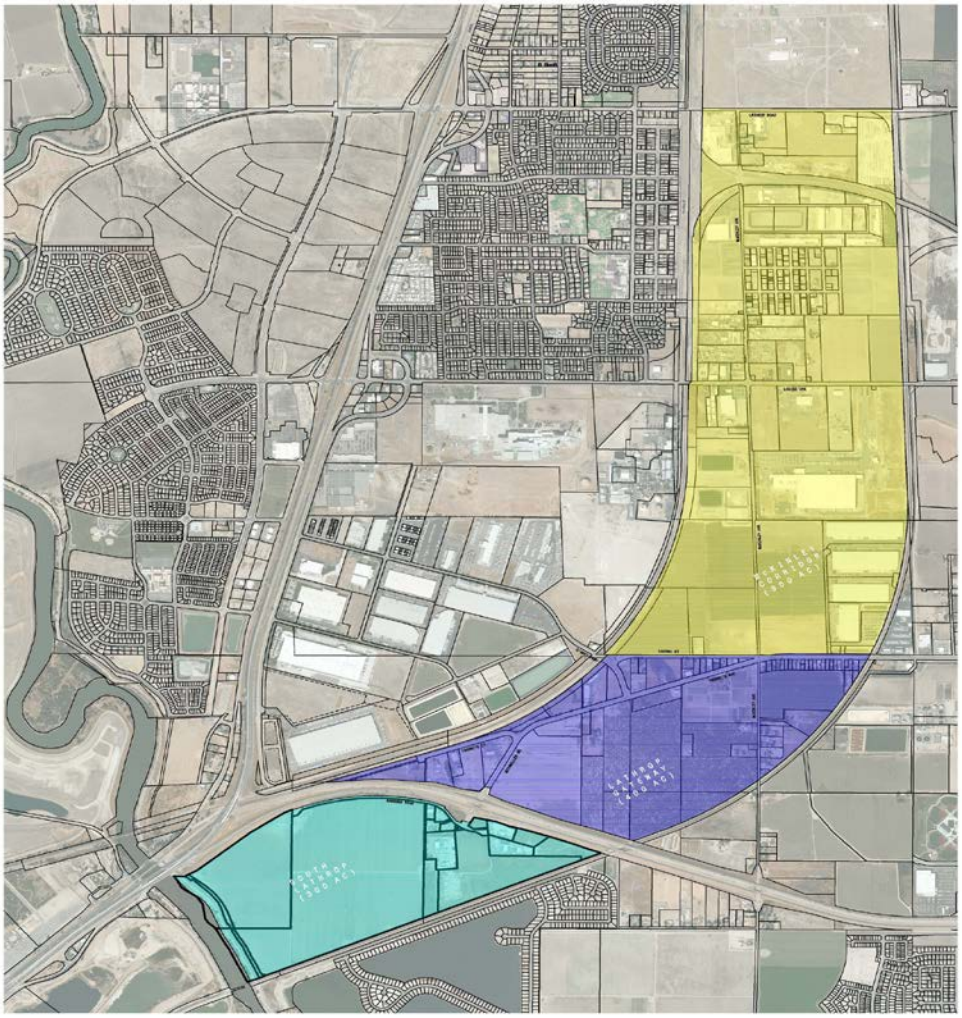


Figure 2. Southeast Lathrop drainage exhibit, highlighting “Trunkline C”, consisting as the McKinley Corridor Shed (yellow area), the Lathrop Gateway Shed (blue area), and the South Lathrop Shed (teal area).

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214; February 11, 2016).

The designations of critical habitat for CCV steelhead and sDPS green sturgeon use the term primary constituent element or essential features. The new critical habitat regulations (81 FR 7414; February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified primary constituent elements, PBFs, or essential features. In this biological opinion, we use the term PBF to mean primary constituent element or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.

- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a Reasonable and Prudent Alternative to the proposed action.

2.1.1 Conservation Banking in the Context of the ESA Environmental Baseline

Conservation (or mitigation) banks present a unique situation in terms of how they are used in the context of the *Effects Analysis* (section 2.5) and the *Environmental Baseline* (section 2.4) in ESA Section 7 consultations.

When NMFS is consulting on a proposed action that includes conservation bank credit purchases, it is likely that physical restoration work at the bank site has already occurred and/or that a Section 7 consultation occurred at the time of bank establishment. A traditional interpretation might suggest that the overall ecological benefits of the conservation bank actions belong in the *Environmental Baseline*. Under this interpretation, where proposed actions include credit purchases, it would not be possible to attribute their benefits to the proposed action, without double-counting. Such an interpretation does not reflect the unique circumstances that conservation banks serve. Specifically, conservation banks are established based on the expectation of future credit purchases. Conservation banks would not be created and their beneficial effects would not occur in the absence of this expectation.

For these reasons, it is appropriate to treat the beneficial effects of the bank as accruing in connection with and at the time of specific credit purchases, not at the time of bank establishment or at the time of bank restoration work. This means that, in formal consultations on projects within the service area of a conservation bank, the beneficial effects of a conservation bank should be accounted for in the *Environmental Baseline* after a credit transaction has occurred. More specifically, the *Environmental Baseline* section should mention the bank establishment (and any consultation thereon) but, in terms of describing beneficial effects, it should discuss only the benefits attributable to credits already sold. In addition, in consultations that include credit purchases as part of the proposed action, the proportional benefits attributable to those credit purchases should be treated as effects of the action. Conversely, where a proposed action does not include credit purchases, it will not receive any direct offset associated with the bank. This approach preserves the value of the bank for its intended purposes, both for the value of the credits to the bank proponent and the conservation value of the bank to listed species and their critical habitat.

This opinion will analyze the beneficial effects of the credit transaction associated with the proposed action. The beneficial effects associated with the remainder of the credits at the bank that have not been subject to a transaction (and their associated ecological benefits) will not be considered in the *Environmental Baseline* nor in the effects of the action.

2.1.2 Assumptions and Additional Information Sources Associated with the Analysis

In these analyses, NMFS assumes in good faith that discharge from the outfall will occur as stated in the BA and that supplemental documents submitted on behalf of this proposed action represent all future plans as accurately and precisely as possible, specifically: only stormwater will be discharged from this outfall under an appropriate NPDES permit, discharge will occur in response to rain/storm events experienced by upland sub-sheds served by this outfall, initial maximum discharge rate will be 100 cfs through two duck valves with a potential increase up to 400 cfs if all six duck valves are installed, and that adherence to EPA's NPDES requirements through State Water Resources Control Board (SWRCB) Clean Water Act section 401 certification will be maintained.

In writing this section, major information sources included:

- 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 (NMFS, 2014)
- 5-year review: Summary and evaluation of California Central Valley steelhead Distinct Population Segment (NMFS, 2016b)
- 5-year review: Summary and evaluation of Central Valley spring-run Chinook salmon evolutionarily significant unit (NMFS, 2016a)
- Draft Recovery Plan for the southern Distinct Population Segment of the North American green sturgeon (*Acipenser medirostris*) (NMFS, 2018a)
- 5-year review: Summary and evaluation of southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*) (NMFS, 2015)
- State of California Department of Water Resources Lathrop Urban Runoff Study Technical Report (Water Resources, 2015)
- Multi-Agency Post-Construction Stormwater Manual (Multi-Agency, 2015)

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

2.2.1 CCV steelhead DPS status

- Originally listed as threatened (63 FR 13347; March 19, 1998); reaffirmed (71 FR 834; January 5, 2006)
- Designated critical habitat (70 FR 52488; September 2, 2005)

The federally listed DPS of CCV steelhead and its designated critical habitat occur in the action area and may be affected by the proposed action. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, DPS life history, and viable salmonid population (VSP) parameters can be found in the 2015 5-year status review (NMFS, 2016b).

Historical CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan, 2001). By the early 1960s, the CCV steelhead run size had declined to about 40,000 adults (McEwan, 2001). Current abundance data for CCV steelhead are limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data are the most reliable because redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

CCV steelhead returns to Coleman National Fish Hatchery increased from 2011 to 2014 (see the 2015 5-year status review (NMFS, 2016b) for further information). After hitting a low of only 790 fish in 2010, 2013 and 2014 have averaged 2,895 fish. Wild adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically 200 to 300 fish each year. Numbers of wild adults returning each year ranged from 252 to 610 from 2010 to 2014.

The returns of CCV steelhead to the Feather River Fish Hatchery experienced a sharp decrease from 2003 to 2010, with only 679, 312, and 86 fish returning in 2008, 2009 and 2010, respectively. In recent years, however, returns have experienced an increase, with 830, 1,797, and 1,505 fish returning in 2012, 2013, and 2014, respectively. Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2015 that no clear trend is present.

An average of 143 redds have been counted on the American River from 2002 to 2015 (Chase, 2010; Hannon, 2005). An average of 178 redds have been counted in Clear Creek from 2001 to 2015 following the removal of Saeltzer Dam, which allowed steelhead access to additional spawning habitat. The Clear Creek redd count data ranges from 100 to 1,023 and indicates an upward trend in abundance since 2006 (U.S. Fish and Wildlife Service, 2015).

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good et al., 2005). Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) steelhead smolt catch ratios in the U.S. Fish and Wildlife Service (USFWS) Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 steelhead smolts are produced naturally each year in the Central Valley. Trawl data indicate that the level of natural production of steelhead has remained very low since the 2011 status review, suggesting a decline in natural production based on consistent hatchery releases. Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the production of wild steelhead relative to hatchery steelhead (CDFW, 2018). The overall catch of steelhead has declined dramatically since the early 2000s, with an overall average of 2,705 in the last 10 years. The percentage of wild (unclipped) fish in salvage has fluctuated, but has leveled off to an average of 36 percent since a high of 93 percent in 1999.

About 80 percent of the historical spawning and rearing habitat once used by CCV steelhead in the Central Valley is now upstream of impassible dams (Lindley et al., 2006). Many historical populations of CCV steelhead are entirely above impassable barriers and may persist as resident or adfluvial rainbow trout, although they are presently not considered part of the DPS. Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good et al., 2005; NMFS, 2016a). Most of the steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adults intercepted at the Coleman National Fish Hatchery weir), the American River, Feather River, and Mokelumne River.

The CCV steelhead abundance and population growth rates continue to decline, largely the result of a significant reduction in the amount and diversity of habitats available to these populations (Lindley et al., 2006). Recent reductions in population size are supported by genetic analysis (Nielsen et al., 2003). Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that unlike the situation in coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to O. mykiss above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers. The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, placing the natural population at a high risk of extinction (Lindley et al., 2007). Steelhead in the Central Valley historically consisted of both summer-run and winter-run Chinook salmon migratory forms. Only winter-run (ocean maturing) steelhead currently are found in California Central Valley rivers and streams as summer-run have been extirpated (McEwan & Jackson, 1996; Moyle, 2002).

Although CCV steelhead will experience similar effects of climate change to Chinook salmon in the Central Valley, as they are also blocked from the vast majority of their historical spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 57 degrees Fahrenheit (°F) to 66°F (14 degrees Celsius (°C) to 19°C). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough, 2001). In fact, McCullough (2001) recommended an optimal incubation temperature at or below 52°F to 55°F (11°C to 13°C). Successful smoltification in steelhead may be impaired by temperatures above 54°F (12°C), as reported by Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

In summary, the 2016 status of the CCV steelhead DPS appears to have remained unchanged since the 2011 status review, and the DPS is likely to become endangered within the near future throughout all or a significant portion of its range (NMFS, 2016b). All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good et al., 2005; NMFS, 2016b); the long-term trend remains negative. Hatchery production and returns are dominant. Most wild CCV populations are very small and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish.

2.2.2 Critical habitat and PBFs for CCV steelhead

The critical habitat designation for CCV steelhead lists the PBFs (70 FR 52488; September 2, 2005), which are described in their recovery plan (NMFS, 2014). In summary, the PBFs include freshwater spawning sites; freshwater rearing sites; freshwater migration corridors; and estuarine areas. The geographical extent of designated critical habitat includes the following: the Sacramento, Feather, and Yuba rivers and the Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries but excluding the mainstem San Joaquin River above the Merced River confluence; and the waterways of the Delta.

Many of the PBFs of CCV steelhead critical habitat are degraded and provide limited high quality habitat. Passage to historical spawning and juvenile rearing habitat has been largely reduced due to construction of dams throughout the Central Valley. Levee construction has also degraded the freshwater rearing and migration habitat and estuarine areas as riparian vegetation has been removed, reducing habitat complexity and food resources and resulting in many other ecological effects. Contaminant loading and poor water quality in central California waterways pose threats to lotic fish, their habitat, and food resources. Additionally, due to reduced access to historical habitats, genetic introgression is occurring because naturally produced fish are interacting with hatchery-produced fish, which has the potential to reduce the long-term fitness and survival of this species.

Although the current conditions of CCV steelhead critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in the Sacramento-San Joaquin River watersheds and the Delta are considered to have high intrinsic value for the conservation of the species as they are critical to ongoing recovery efforts.

2.2.3 CV spring-run Chinook salmon

- Originally listed as threatened (64 FR 50394; September 16, 1999); reaffirmed (70 FR 37160; June 28, 2005)

- Designated critical habitat* (70 FR 52488; September 2, 2005) *does not occur within the action area

The federally listed ESU of CV spring-run Chinook salmon may occur in the action area and may be affected by the proposed action. Its designated critical habitat does not occur within the action area and according to the most recent status review (NMFS, 2016a), this ESU would not be expected to be affected by this proposed action. However, since 2015, the San Joaquin River Restoration Program (SJRRP) has been reintroducing spring-run Chinook salmon incrementally back into the SJR mainstem far upstream of the construction area. These actions are to meet a settlement goal that also fulfills a NMFS's recovery requirement regarding this ESU. According to a final rule under ESA Section 10(j), these reintroduced CV spring-run Chinook salmon are designated as a non-essential experimental population inside of the experimental population area, which is generally in the San Joaquin River from its confluence with the Merced River upstream to Friant Dam. However, outside of the experimental population area, spring-run Chinook salmon are considered part of the non-experimental CV spring-run Chinook salmon ESU, which is listed as a threatened species. Since the action area for this proposed action occurs outside of the experimental population area but also includes the migration corridor the reintroduced fish must take to reach the ocean or return to the experimental population area, NMFS added the CV spring-run Chinook salmon ESU to this opinion. The number of spring-run Chinook salmon returning to the upper SJR in the experimental population area is expected to increase overtime, as experimental hatchery release numbers increase, adult spawning returns increase, and the number of juveniles produced naturally in the restoration area increases. Detailed information regarding the ESU's life history, and viable salmonid population (VSP) parameters pertaining to the natural populations that occur in tributaries of the Sacramento River basin can be found in the 2015 5-year status review (NMFS, 2016a).

Since the independent populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, NMFS can evaluate risk of extinction based on VSP parameters in these watersheds. Lindley et al. (2007) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon ESU failed to meet the "representation and redundancy rule" for the spatial structure parameter since these three populations are the only demonstrably viable populations from one diversity group (northern Sierra Nevada) out of the three diversity groups that historically supported the ESU, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS, 2014), which stated a recovery criteria of nine viable populations. Over the long term, these three remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

In the latest status review (NMFS 2016a), the authors found, with a few exceptions, CV spring-run Chinook salmon populations had increased through 2014 returns since the previous status review (2010/2011), which moved the Mill and Deer creek populations from the high extinction risk category to moderate, and Butte Creek remained in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations continued to show stable or increasing numbers the last five years, putting them at moderate risk of extinction based on abundance. Overall, the SWFSC concluded in their viability report (Williams et al., 2016) that the status of CV spring-run Chinook salmon (through 2014) has probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased; however, sharp declines were observed in 2015 and 2016 (CDFW, 2017). Therefore, the ESU is still facing significant extinction risk, and that risk is likely to increase over at least the next few years as the full effects of the recent drought are realized (NMFS, 2016a).

2.2.4 sDPS green sturgeon status

- Listed as threatened (71 FR 17757; April 7, 2006)
- Designated critical habitat (74 FR 52300; October 9, 2009)

The federally listed southern distinct population segment (sDPS) of North American green sturgeon and its designated critical habitat occur in the action area and may be affected by the proposed action. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, DPS life history, and viable population parameters can be found in the 2015 5-year status review (NMFS, 2015).

Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. During late summer and early fall, subadults and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Moser & Lindley, 2006). Using polyploid microsatellite data, Israel et al., (2009) found that green sturgeon within the Central Valley of California belong to the sDPS.

Additionally, acoustic tagging studies have found that green sturgeon found spawning within the Sacramento River are exclusively sDPS green sturgeon (Lindley et al., 2011). In waters inland from the Golden Gate Bridge in California, sDPS green sturgeon are known to range through the estuary and the Delta and up the Sacramento, Feather, and Yuba rivers (NMFS, 2018a). It is unlikely that green sturgeon utilize areas of the San Joaquin River upriver of the Delta with regularity, and spawning events are thought to be limited to the upper Sacramento River and its tributaries. There is no known modern usage of the upper San Joaquin River by green sturgeon for spawning (Jackson et al., 2016).

Recent research indicates that the sDPS is composed of a single, independent population, which principally spawns in the mainstem Sacramento River and also breeds opportunistically in the Feather River and possibly the Yuba River. Concentration of adults into a very few select spawning locations makes the species highly vulnerable to poaching and catastrophic events. The apparent, but unconfirmed, extirpation of spawning populations from the SJR narrows the available habitat within their range, offering fewer habitat alternatives. Whether sDPS green sturgeon display diverse phenotypic traits, such as ocean behavior, age at maturity, and fecundity, or if there is sufficient diversity to buffer against long-term extinction risk is not well understood. It is likely that the diversity of sDPS green sturgeon is low, given recent abundance estimates (NMFS, 2015).

Trends in abundance of sDPS green sturgeon have been estimated from two long-term data sources: (1) salvage numbers at the state and Federal pumping facilities (CDFW, 2018) and (2) by incidental catch of green sturgeon by the California Department of Fish and Wildlife (CDFW)'s white sturgeon sampling/tagging program (DuBois, 2016). Historical estimates from these sources are likely unreliable because the sDPS was likely not taken into account in incidental catch data, and salvage does not capture rangewide abundance in all water year types. A decrease in sDPS green sturgeon abundance has been inferred from the amount of take observed at the south Delta pumping facilities, the Skinner Delta Fish Protection Facility, and the Tracy Fish Collection Facility. This data should be interpreted with some caution. Operations and practices at the facilities have changed over the project lifetime, which may affect salvage data. These data likely indicate a high production year versus a low production year qualitatively, but cannot be used to rigorously quantify abundance.

Since 2010, more robust estimates of sDPS green sturgeon have been generated. As part of a doctoral thesis at the University of California at Davis (UC Davis), Ethan Mora has been using acoustic telemetry to locate green sturgeon in the Sacramento River and to derive an adult spawner abundance estimate (Mora et al., 2015). Preliminary results of these surveys estimate an average annual spawning run of 223 using dual-frequency identification sonar and 236 using telemetry fish. This estimate does not include the number of spawning adults in the lower Feather or Yuba rivers, where green sturgeon spawning was recently confirmed (Seesholtz et al., 2014).

The parameters of green sturgeon population growth rate and carrying capacity in the Sacramento Basin are poorly understood. Larval count data shows enormous variance among sampling years. In general, sDPS green sturgeon year class strength appears to be highly variable with overall abundance dependent upon a few successful spawning events (NMFS, 2010). Other indicators of productivity such as data for cohort replacement ratios and spawner abundance trends are not currently available for sDPS green sturgeon.

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate (NMFS, 2010). Although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS, 2010). Lindley et al. (2008), in discussing winter-run Chinook salmon, states that an ESU (or DPS) represented by a single population at moderate risk of extinction is at high risk of extinction over a large timescale; this would apply to the sDPS for green sturgeon. The most recent 5-year status review for sDPS green sturgeon found that some threats to the species have recently been eliminated such as take from commercial fisheries and removal of some passage barriers (NMFS, 2015). Since many of the threats cited in the original listing still exist, the threatened status of the DPS is still applicable (NMFS, 2015).

2.2.5 Critical habitat and PBFs for sDPS green sturgeon

The critical habitat designation for sDPS green sturgeon lists the PBFs (74 FR 52300; October 9, 2009), which are described in the sDPS green sturgeon recovery plan (NMFS, 2018a). In summary, the PBFs include the following for both freshwater riverine systems and estuarine habitats: food resources, water flow, water quality, migratory corridor, depth, and sediment quality. Additionally, substrate type or size is also a PBF for freshwater riverine systems. In addition, the PBFs include migratory corridor, water quality, and food resources in nearshore coastal marine areas.

In freshwater, the geographical range of designated critical habitat includes:

- The Sacramento River from the Sacramento I-Street bridge to Keswick Dam, including the Sutter and Yolo bypasses and the lower American River from the confluence with the mainstem Sacramento River upstream to the highway 160 bridge
- The Feather River from its confluence with the Sacramento River upstream to Fish Barrier Dam
- The Yuba River from its confluence with the Feather River upstream to Daguerre Point Dam
- The Delta (as defined by California Water Code section 12220, except for listed excluded areas).

Currently, many of the PBFs of sDPS green sturgeon are degraded and provide limited high quality habitat. Factors that lessen the quality of migratory corridors for juveniles include unscreened or inadequately screened diversions, altered flows in the Delta, and presence of contaminants in sediment. Although the current conditions of green sturgeon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in the Sacramento and San Joaquin River watersheds, the Delta, and nearshore coastal areas are considered to have high intrinsic value for the conservation of the species.

2.2.6 Climate change

One major factor affecting the rangewide status of all the listed anadromous fishes and their aquatic habitats in the Central Valley at large is climate change. Temperatures are projected to increase steadily during the century, with a general increase from about 1.6°F in the early 21st century up to almost 4.8°F in the Sierra Nevada Mountains by the late 21st century (Reclamation, 2015).

Increased temperatures influence the timing and magnitude patterns of the hydrograph. Central California has shown trends toward warmer winters since the 1940s (Dettinger & Cayan, 1995). Warmer temperatures associated with climate change reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen et al., 2000). These changes are partly due to more precipitation falling as rain rather than snow (Dettinger et al., 2004; Stewart et al., 2004). Runoff is expected to increase during the fall and winter months, and peak runoff may shift by more than a month earlier in some water sheds (Reclamation, 2015).

The magnitude of snowpack reductions is also subject to annual variability in total precipitation and air temperature. The large spring snow water equivalent (SWE) percentage changes, late in the snow season, are due to a variety of factors including reduction in winter precipitation and temperature increases that rapidly melt spring snowpack (VanRheenen et al., 2004). Factors modeled by VanRheenen et al. (2004) show that the melt season shifts to earlier in the year, leading to a large percent reduction of spring SWE (up to 100% in shallow snowpack areas). Additionally, an air temperature increase of 2.1°C (3.8°F) is expected to result in a loss of about half of the average April snowpack storage (VanRheenen et al., 2004). The decrease in spring SWE (as a percentage) would be greatest in the region of the Sacramento River watershed, at the north end of the Central Valley, where snowpack is shallower than in the San Joaquin River watersheds to the south.

An analysis on CCV steelhead's response to climate change is not available, but one has been conducted considering Chinook salmon environmental requirements. Projected warming is expected to affect all runs of CV Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if the climate warms by 5°C (9°F), it is questionable whether any CV Chinook salmon populations can persist (Williams, 2006). Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951 to 1980, the most plausible projection for warming over Northern California is 2.5°C (4.5°F) by 2050 and 5°C by 2100, with a modest decrease in precipitation (Dettinger, 2005).

Although the CCV steelhead DPS will likely experience detrimental effects of climate change similar to those projected for all runs of Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in freshwater streams for one to two summers prior to emigrating as smolts. In the CV, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than Chinook salmon (McCullough, 2001). McCullough (2001) recommended an optimal incubation temperature at or below 11°C to 13°C (52°F to 55°F), and successful smoltification in steelhead may be impaired by temperatures above 12°C (54°F) (Richter & Kolmes, 2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing are likely to become too warm to support wild steelhead populations, severely curtailing the range of suitable reproductive habitat for this DPS.

The Anderson-Cottonwood Irrigation District Diversion Dam (ACID) is considered the upriver extent of green sturgeon passage in the Sacramento River (71 FR 17757; April 7, 2006). The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer (Heublein et al., in review). Green sturgeon primarily spawning in the summer in the CV; therefore, if water temperatures increase with climate change, temperatures adjacent to the ACID may remain tolerable for the embryonic and larval life stages, but temperatures at spawning locations lower in the river may be more negatively affected. It is uncertain, however, if green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of green sturgeon in other accessible habitats in the Central Valley (i.e., the Feather River) is limited, in part, by late spring and summer water temperatures (NMFS, 2015). Similar to salmonids in the Central Valley, green sturgeon spawning in tributaries to the Sacramento River is likely to be further limited if water temperatures increase and higher elevation habitats remain inaccessible.

In summary, observed and predicted climate change effects are generally detrimental to all anadromous species as they rely on abundant cold water to successfully spawn and rear in freshwater habitats (McClure, 2011; Wade et al., 2013), so unless offset by improvements in other factors, the statuses of the CCV steelhead DPS and the sDPS of green sturgeon are likely to decline over time due to the decreases in the functionality of their critical habitats to support cold-water breeding and rearing. The climate change projections referenced above cover the time period between the present and approximately 2100. While there is uncertainty associated with projections, which increases over the amount of time of the projections, the direction of change is relatively certain (McClure et al., 2013) and is expected to exacerbate the extinction risk of the DPSs covered here.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The construction area for the proposed action is located on the eastern bank of the SJR at Latitude 37.78144908, Longitude -121.301645, south of the City of Lathrop in San Joaquin County, California. A total of 0.093 acres of direct construction impacts will occur to WOUS below the OHWM where the outfall structure will occupy 64 linear feet of river bank and an additional 0.185 acres of levee will be riprapped or be occupied by the outfall structure above the OHWM.

The City of Lathrop plans to purchase mitigation credits from a conservation bank or the in-lieu fee program for impacts to CCV steelhead and sDPS green sturgeon critical habitat. Therefore, the action area also includes the mitigation bank from which the City will purchase these credits. Mitigation banks that have service areas within the project area include: 1) the Cosumnes Floodplain Mitigation Bank, which is a 472-acre floodplain site at the confluence of the Cosumnes River and Mokelumne River, 2) Bullock Bend Mitigation Bank, a 119.65-acre floodplain site along the Sacramento River at the confluence of the Feather River, 3) Fremont Landing Conservation Bank, a 100-acre bank on the floodplain adjacent to the Sacramento River at its confluence with the Feather River, and 4) Liberty Island Conservation Bank, a 186-acre conservation bank located at the southern end of the Yolo Bypass in the Sacramento-San Joaquin River Delta.

From the outfall location, areas downstream will be indirectly affected by discharged stormwater following project construction completion. This outfall discharges directly into the San Joaquin River within boundaries considered the Legal Delta. As such the indirect action area includes the downstream extent to which stormwater contaminants or water temperature changes persist in the waters and sediments of the San Joaquin River mainstem into the Delta, and may extend until the confluence with Calaveras River, depending on the effectiveness of upland stormwater quality control. The action area also includes the upland areas that contribute to the stormwater discharged at this location, since future upland urban development will dictate how much stormwater will be directed to the discharge and the type and efficiency of stormwater treatment methods.

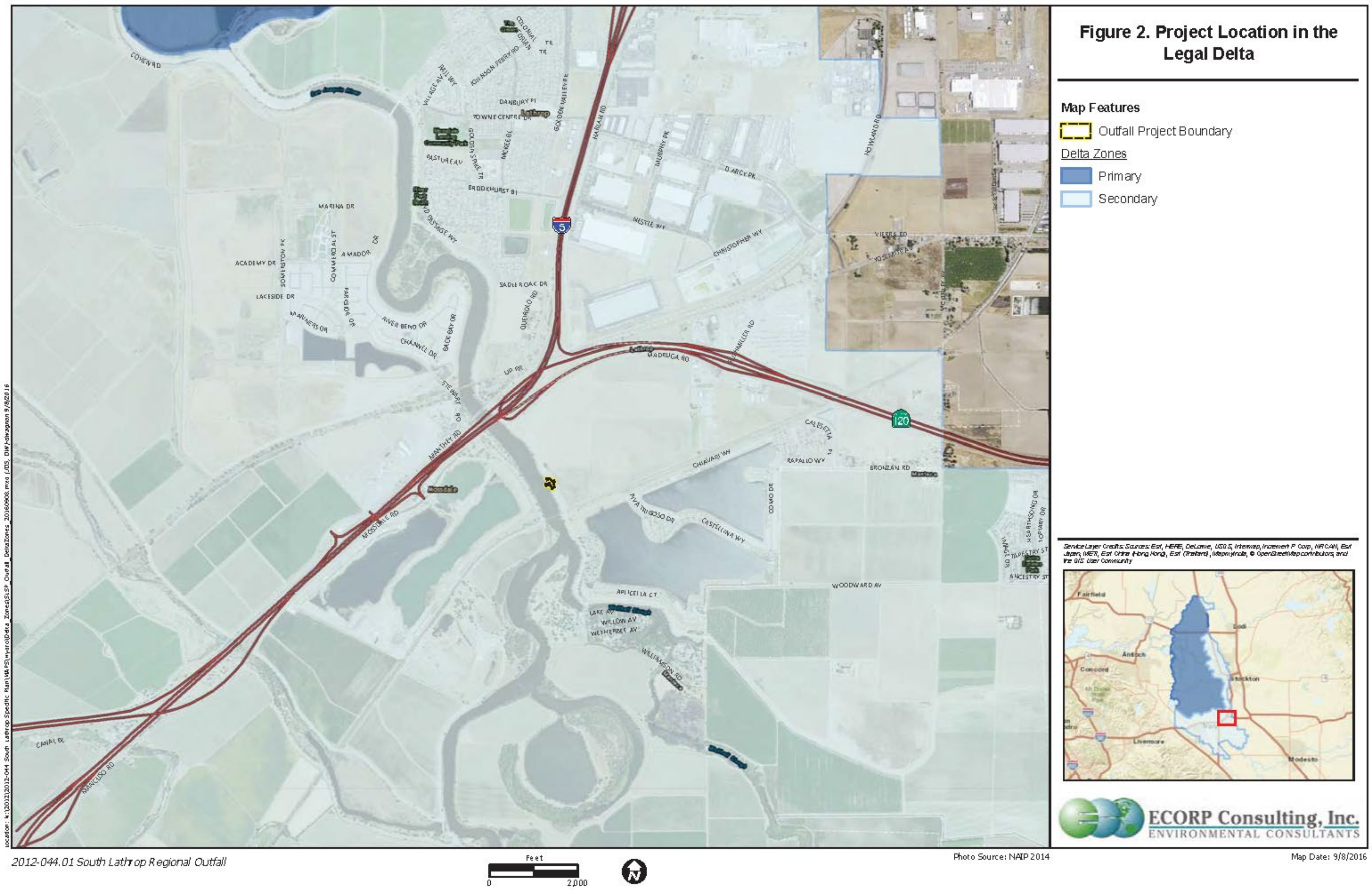


Figure 3. Project location map in the Legal Delta, from (ECORP, 2017).

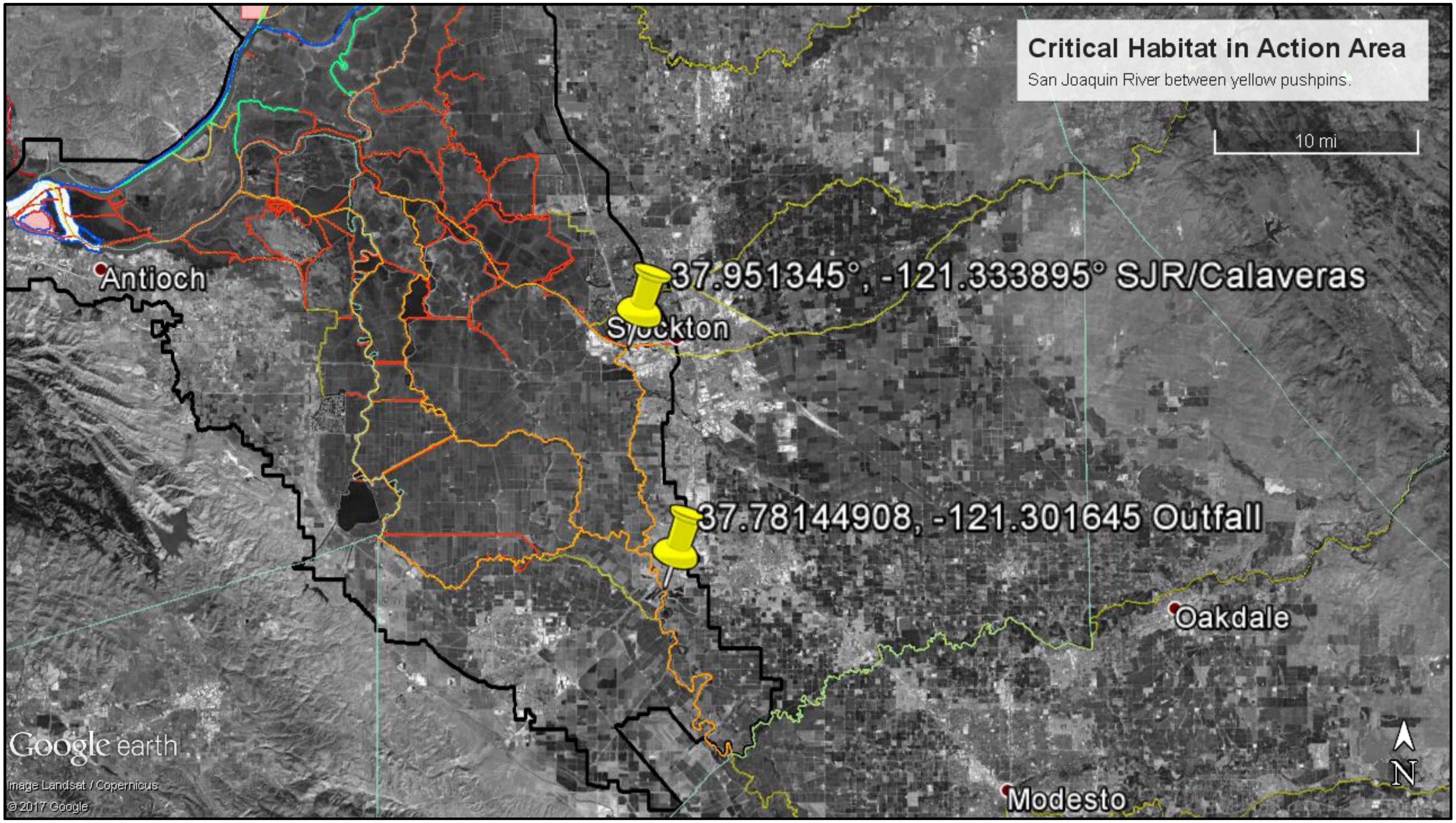


Figure 4. Critical habitat occurrence between the SJR mainstem from the outfall location downstream to the first confluence with the Calaveras River (between yellow push pins) in San Joaquin County, California. The thick black line denotes the boundary of the Legal Delta, red denotes designated sDPS North American green sturgeon critical habitat, yellow denotes designated CCV steelhead critical habitat (orange lines are where CCV steelhead and sDPS green sturgeon critical habitat overlap).

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

2.4.1 Occurrence of listed species and critical habitat

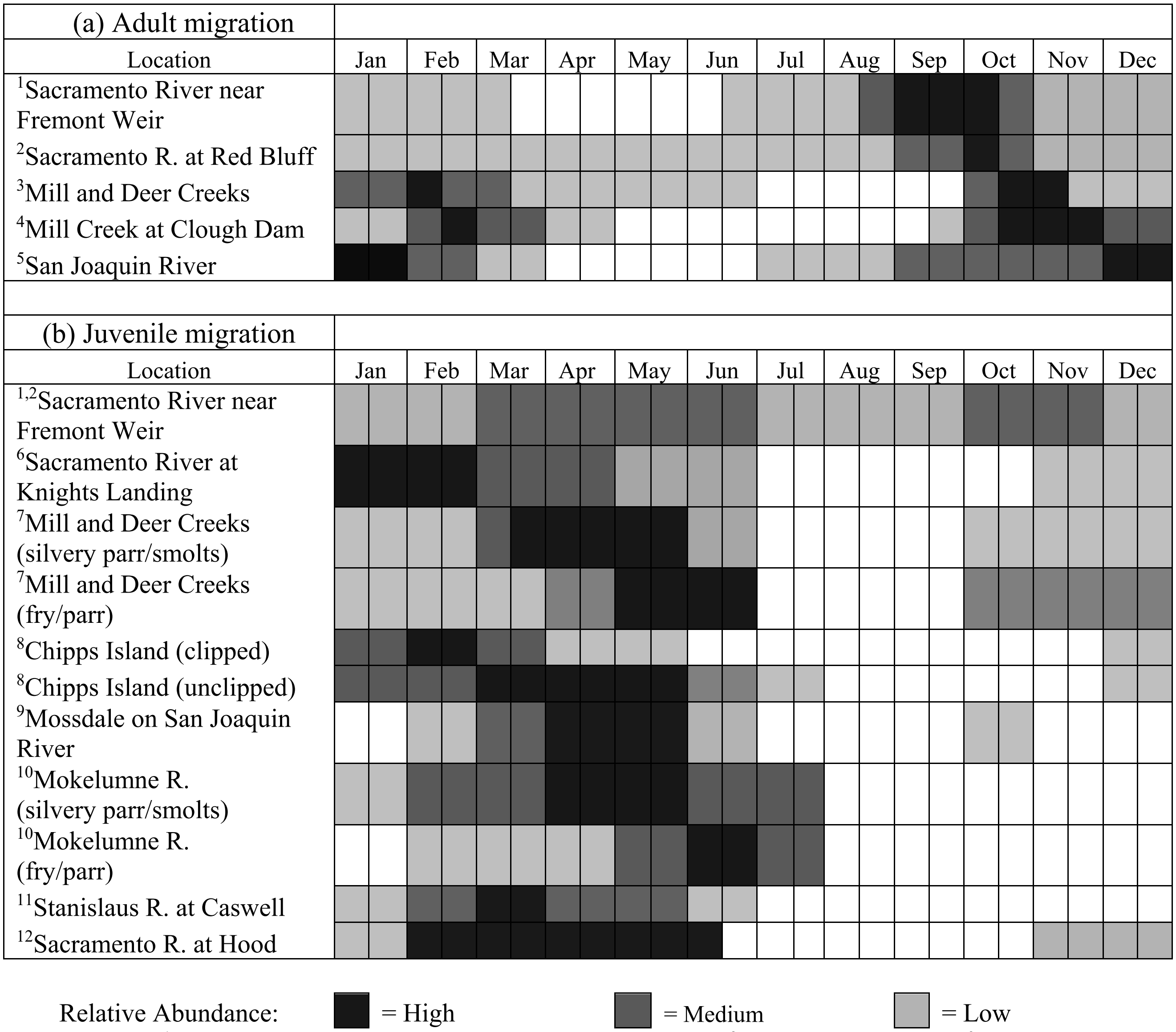
The federally listed anadromous species that use and occupy the action area are adult and juvenile CCV steelhead, CV spring-run Chinook salmon, and sDPS North American green sturgeon; and the action area contains the designated critical habitat of CCV steelhead and sDPS green sturgeon. The SJR mainstem in the action area is the primary migration corridor for both adult and juvenile life stages spawned in the SJR basin to the Delta, which contains important rearing habitat for juveniles. All anadromous fish that utilize the San Joaquin River Basin must also pass by this location at least twice to successfully complete their life histories.

2.4.1.1 CCV steelhead

It is believed that all current stocks of California Central Valley steelhead have a winter run timing, meaning they may migrate up rivers in the winter starting with the first pulse of notable rain run-off (Moyle et al., 1995). The life history strategies of steelhead are extremely variable between individuals, and it is important to take into account that steelhead are iteroparous (i.e., can spawn more than once in their lifetime (Busby et al., 1996)) and therefore may be expected to emigrate back down the system after spawning. As such, the determination of the presence or absence of steelhead in the Delta accounted for both upstream and downstream migrating adult steelhead (kelts).

Adult steelhead enter freshwater in August (Moyle, 2002) and peak migration of adults moving upriver occurs in August through September (Figure 5; Hallock, et al., 1957). Adult steelhead will hold until flows are high enough in the tributaries to migrate upstream where they will spawn from December to April (Hallock, et al., 1961). After spawning, most surviving steelhead kelts migrate back to the ocean and reach the Sacramento River during March and April, and have a high presence in the Delta in May. Adult steelhead are present in the Delta from August to May and juvenile steelhead from September to July (Figure 5).

Out-migrating juveniles have a large presence at Mossdale Bridge on the SJR, very near the immediate construction area, February through June, with the core of their migration occurring March through May. Larger juveniles in the process of smoltification (parr to smolt stage) have been captured until July on the Mokelumne River (Figure 5).



Sources: [1](R. J. Hallock, D.H. Fry Jr., and Don A. LaFaunce, 1957); [2](D. R. McEwan, 2001); [3](Harvey, 1995); [4]CDFW unpublished data; [5]CDFG Steelhead Report Card Data 2007; [6]NMFS analysis of 1998-2011 CDFW data; [7](Johnson & Merrick, 2012); [8]NMFS analysis of 1998-2011 USFWS data; [9]NMFS analysis of 2003-2011 USFWS data; [10]unpublished EBMUD RST data for 2008-2013; [11]Oakdale RST data (collected by Fishbio) summarized by John Hannon (Reclamation); [12](Schaffter, 1980).

Figure 5. The temporal occurrence of (a) adult and (b) juvenile California Central Valley steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

2.4.1.2 CCV steelhead critical habitat

The PBFs for CCV steelhead critical habitat in the action area include (1) freshwater migration corridors and (2) rearing habitat. The freshwater migration utility in the action area is of fair quality, since flows of the lower SJR are typically of adequate magnitude, quality, and temperatures to support adult and juvenile migration. Most importantly, this section of CCV steelhead critical habitat serves as a migration corridor for all of the adults and juveniles produced and supported by the SJR and its seven major tributaries.

The rearing habitat offered by this section of the SJR is of poor quality, however, due to the leveed and channelized nature of the SJR mainstem at this location. The floodplain habitat which would otherwise normally exist has been largely removed near the action area due to the high levees, which limits the value of the area for juvenile rearing.

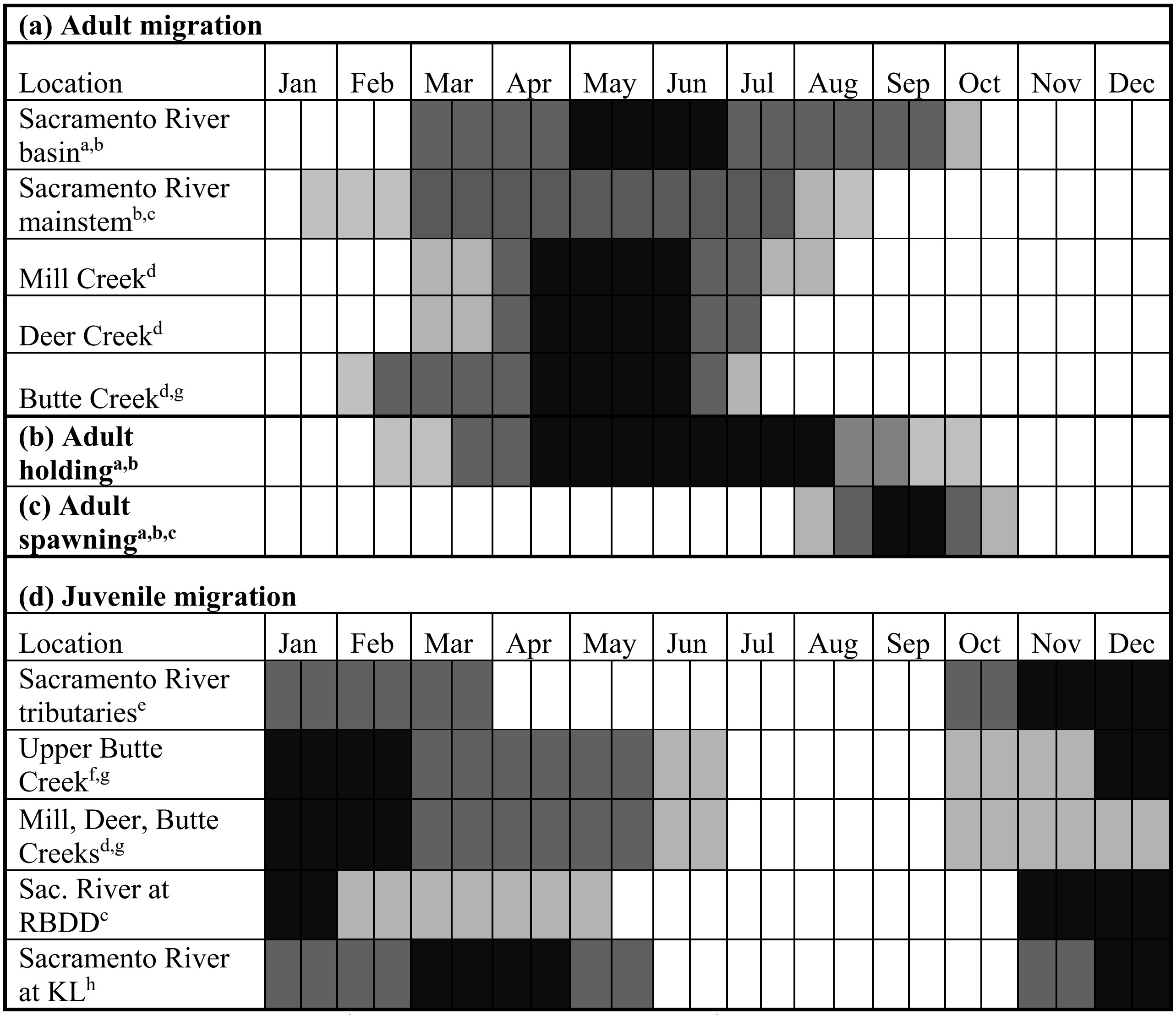
2.4.1.3 CV spring-run Chinook salmon

Typical CV spring-run life history patterns have adults returning to freshwater basins in March (Sacramento River basin, Figure 6a). Capitalizing on spring-time run off, adults travel to holding pools where available in preparation to over summer. Adults arrive in an immature state and hold over the summer months (Figure 6b) and develop gonads until ready to spawn in late summer through mid-autumn (Figure 6c).

CV spring run Chinook salmon are considered functionally extirpated from the Southern Sierra Nevada diversity group despite their historical abundance in the SJR basin (NMFS, 2016a). There have been observations of low numbers of spring time running fish returning to major SJR tributaries that exhibit some typical spring-run life history characteristics. While the genetic disposition of such fish remains inconclusive, the implementation of reintroduction of the spring-run Chinook salmon into the SJR has begun and has resulted in over 800 wild-spawned juvenile spring-run Chinook salmon (SJRRP preliminary data presented in weekly reports ending May 7, 2018, Don Portz, Bureau of Reclamation). These juveniles should be imprinted to the upper SJR mainstem below Friant Dam, and are expected to return as adults when volitional passage is achieved and river conditions are suitable (NMFS, 2016a).

Based on known spring-run life history timing and limited information of use of the SJR basin, juveniles may be expected in the action area November through May (Figure 6b) as they emigrate through the action area. Returning adults may be expected to travel through the action area most likely from March through September (Figure 6a). Again, exact timing of CV spring-run use of the action area would depend on in-river water being adequate in quality and temperature, and actual life history stage timelines are expected to differ slightly between the Sacramento River and SJR basins.

Again, designated CV spring-run Chinook salmon critical habitat does not occur within the action area.



Sources: [a]Yoshiyama et al. (1998); [b]Moyle (2002); [c]Myers et al. (1998); [d]S. T. Lindley et al. (2004); [e]CDFG (1998); [f]McReynolds, Garman, Ward, and Plemons (2007); [g]P. D. Ward, McReynolds, and Garman (2003); [h]Snider and Titus (2000)

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young-of-the-year spring-run Chinook salmon emigrate during the first spring after they hatch.

Relative Abundance: ■ = High ■ = Medium ■ = Low

Figure 6. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River (used for reference for the SJR). Darker shades indicate months of greater relative abundance.

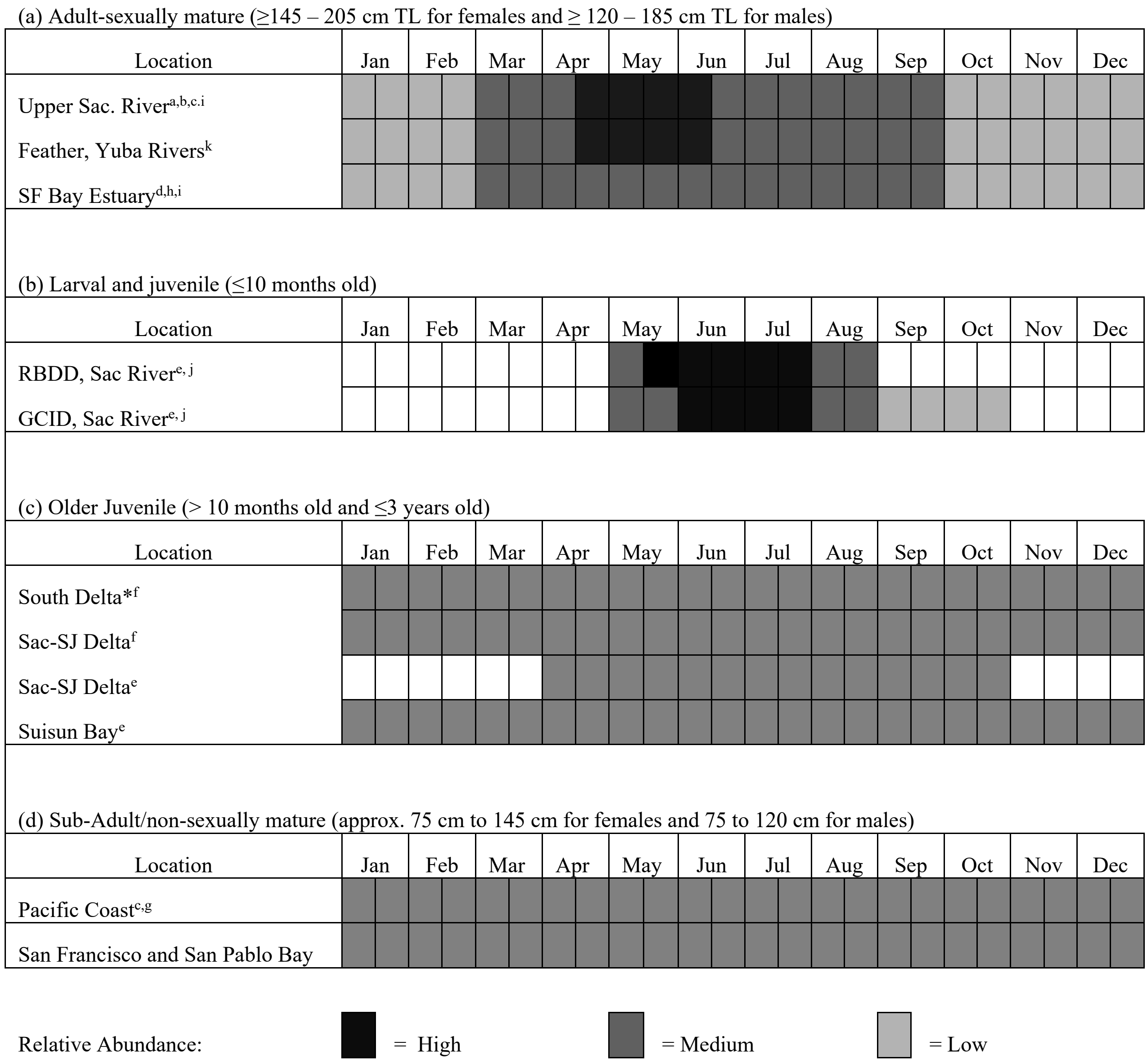
2.4.1.4 sDPS green sturgeon

Adult green sturgeon enter the San Francisco Bay starting in February, have been recorded in San Pablo Bay in March (Heublein et al., 2008), and in the Sacramento River system between late February and late July (Moyle et al., 1995). In general, green sturgeon enter the San

Francisco Bay estuary in winter and continue upstream to their spawning grounds from mid-winter to late-summer. Spawning occurs from March to July in the Feather River and mainstem Sacramento River (Moyle, 2002). Adults have been recorded out-migrating from the Sacramento River in the fall (November to December) and summer (June to August) (Heublein et al., 2008). It has been suggested that spawning may also occur in the San Joaquin River (Moyle et al., 1995); however, this was based on a 1-year study in the 1960's collecting a large number of young green sturgeon during the summer at a shallow shoal area in the lower San Joaquin River (Radtke, 1966). Data on green sturgeon distribution is extremely limited and out-migration appears to be variable occurring at different times of year. Seven years of CDFW catch data for adult green sturgeon show that they are present in the Delta during all months of the year. Adult and juvenile green sturgeon are therefore assumed to be present in the Delta year-round (Figure 7).

Prior to October 2017, all accounts of green sturgeon sightings in the SJR basin were anecdotal at best or misidentification of white sturgeon (Gruber et al., 2012; Jackson et al., 2016). Late October in 2017, an adult green sturgeon was sighted in the Stanislaus River near Knights Ferry by a fish biologist and its identity was genetically confirmed by genetic analysis of environmental DNA of green sturgeon in the surrounding water (Breitler, 2017). This is the first confirmed sighting of a green sturgeon in an SJR tributary, and indicates that adults are able to pass up stream past the location of the proposed action given river flows of suitable quality and amount. Since only one adult was located and spawning activities in the SJR basin have never been recorded, the production of juveniles from the Stanislaus is not considered likely in the near future but highlights that recovery for this sDPS may be forthcoming.

While the SJR basin may not produce juvenile green sturgeon, juveniles may use both estuarine and freshwater portions of the Delta to rear for 1 to 3 years prior to exiting the system and entering the Pacific Ocean. During this period they may range and stray up non-natal waterways searching for appropriate food resources, salinities, and shelter. Therefore, foraging juveniles, subadults, and adults may be found in the SJR mainstem at the location of the proposed action at nearly any time of year, depending on the local water depth, temperature, and quality.



* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al*. (1992); [c]Adams *et al*. (2002) and NMFS (2005); [d]Kelly *et al*. (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al*. (1995); [h]Heublein (2006); [i]CDFG Draft Sturgeon Report Card (2007), [j]Poytress *et al.* (2011, 2012), [k]Alicia Seesholtz, DWR, personal communication

Figure 7. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the Central Valley of California. Darker shades indicate months of greatest relative abundance.

2.4.1.5 sDPS green sturgeon critical habitat

The action area is close to the southernmost extent of sDPS green sturgeon designated critical habitat in freshwater, which ends just north of the confluence of the SJR and the Stanislaus River. There is little data regarding the exact services this portion of their critical habitat offers green sturgeon, except that the SJR is believed to have historically supported sDPS green sturgeon populations and therefore they must have used this area for migration and perhaps also perhaps for foraging and rearing to some degree, since this area is part of the Delta.

The PBFs of sDPS green sturgeon critical habitat believed to be included within the action area are (1) food resources, (2) adequate water flow regime for all life stages, (3) water quality, (4) adequate water depth for all life stages, and (5) sediment quality. The SJR mainstem in this section of sufficient depth to support even adult passage, though as stated before only one adult has been observed in the Stanislaus River to date. Spawning in the SJR basin may not be currently possible for green sturgeon given the extent of degradation prevalent throughout the SJR basin so juveniles are not expected to be produced in this system for some time; however, juveniles produced by the Sacramento River basin could range into this area during their long rearing period in the Delta, though none have been confirmed in this area.

In summary, NMFS has complied observed data of listed anadromous species that use the Delta by month into Figure 8, including the expected seasonality of both adult and juvenile CCV steelhead and CV spring-run Chinook salmon, and adult sDPS green sturgeon, in the action area.

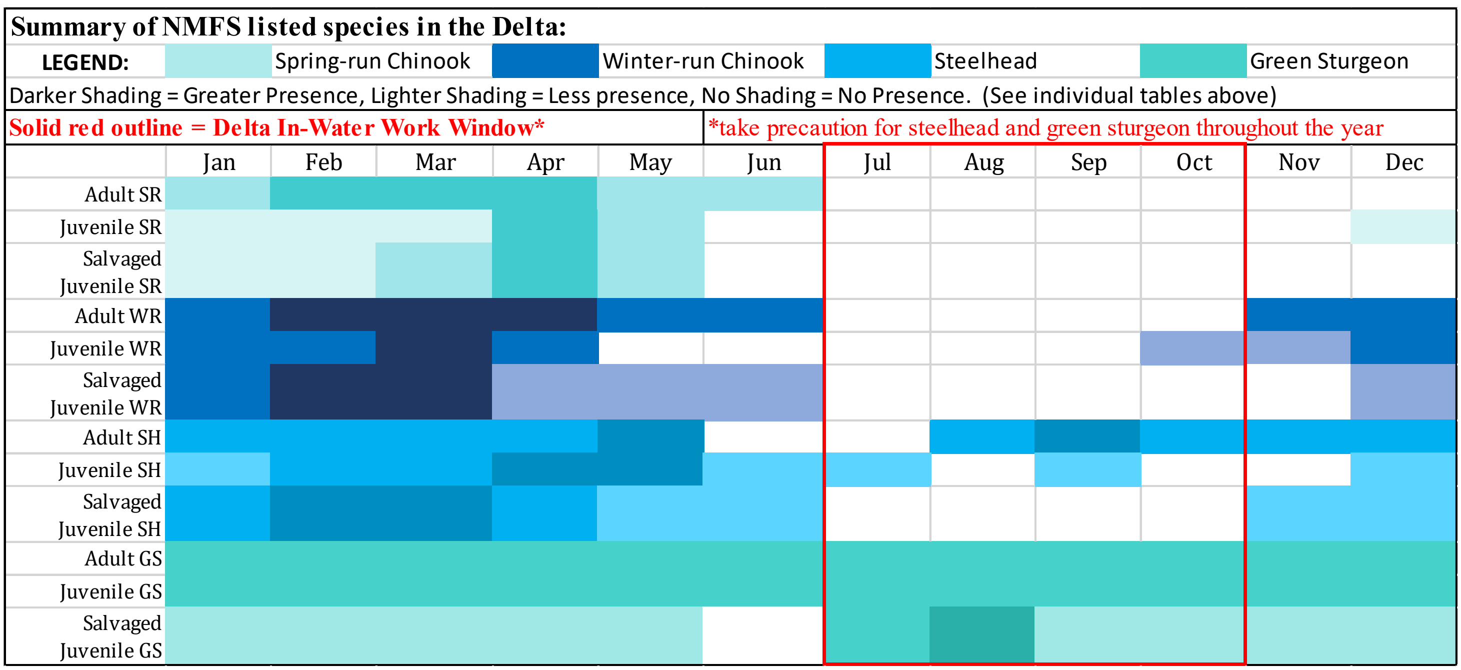


Figure 8. Summary of temporal presence or absence of the NMFS-listed species in the Delta. The solid red line indicates the in-water work window.

<u>2.4.2 Factors affecting listed species and critical habitats</u>

2.4.2.1 San Joaquin River Basin water resources
The SJR is the longest river in California, covering 366 miles, but is considered California's second largest river in California according to average total annual flow (the Sacramento River being the largest). The SJR has an average mean flow of 6 million acre feet per year compared to the Sacramento River's 18 million acre feet (Reclamation, 2016). It drains the central and southern portions of the CV and joins the Sacramento River near the center of California to form

the Delta, the largest estuary on the west coast of the United States. The SJR is primarily fed (receiving two thirds of its water) by the melting snowpack of the Sierra Nevada Mountains.

The primary storage reservoir on the SJR is the Friant Dam, which was completed in 1944. Friant Dam created Millerton Lake/Reservoir and can hold more than 500 thousand acre feet in water storage. Friant Dam diverts Sierra snowmelt water into two canals, the Friant-Kern Canal and the Madera Canal, both of which primarily support the irrigation needs of agriculture as part of the Central Valley Project (CVP). Except for releases to manage floods and to meet the requirements of riparian water rights holders, the entirety of SJR's flow is impounded by the Friant Dam and directed into the canals for distribution. See the existing Coordinated Long-term Operation of the CVP and SWP, and their effects on ESA-listed species and their critical habitats that have been analyzed in the 2009 NMFS CVP Operations opinion (NMFS, 2009) for more information on the effects of federal and state water management on listed species under NMFS jurisdiction. From the high degree of water management of the SJR, in a typical year, all of the SJR's flows were allocated to water users. Historically, the river ran dry annually for a 40 mile stretch, only connecting to the Delta during flood releases from Millerton. In recent years, mandated river restoration flows have reconnected the SJR to the Delta (see section 2.4.3, *Conservation and Restoration Efforts*).

At the Mossdale Bridge station (MSD), the SJR sits at 32 feet above sea level. Flood management starts monitoring the river when MSD has a river height over 19.5 feet, considers SJR in flood stage at 28.5 feet, and considers that the levees are in danger of being overtopped when at or over 29.5 feet (National Weather Service, 2018). According the California Data Exchange Center (CDEC), during typical to dry water years such as 2012 through 2016, SJR stage at MSD has read a maximum of 8 feet or less (Figure 9), with summer time lows below 3 feet. During the especially wet winter/spring of 2011 and 2017, river stages reached peaks of more than 17 feet and 21 feet, respectively (Figure 9).

During the two recent river stage peaks of 2011 and 2017, maximum SJR flow was recorded at over 22,500 and 32,800 cfs, respectively (Figure 10). Typically however, winter/spring maximum flows are regulated to remain between 5,000 and 2,500 cfs when possible, as SJR flows are typically regulated by either being kept as storage in Millerton Reservoir or the flows are directed for delivery.

According to data from 2016, typical summer and fall river velocities ranged from being negative (since the SJR is tidally influenced) to low positive velocities less than 1.5 feet per second (Figure 11). Furthermore, this part of the lower SJR is fairly wide without in-river obstacles and therefore is expected to typically support lower flow velocities especially at low flows. During the most recent maximum flow/river stage height in February of 2017, however, the velocity of SJR at MSD station was recorded at 3.75 feet per second (Figure 11) due to the large amount of water.

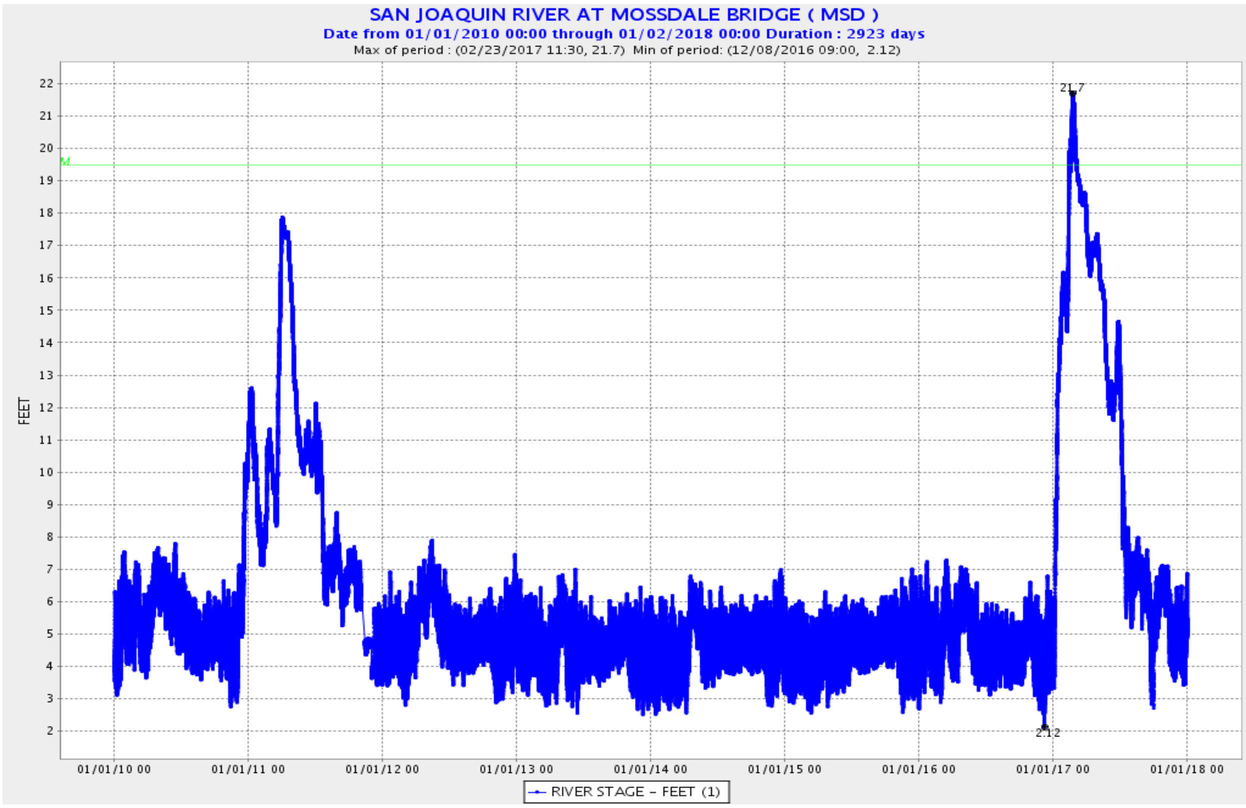


Figure 9. Recorded river stage of the SJR in feet measured at Mossdale Bridge (MSD) CDEC station July 2010 through January 2018 (CDEC, 2018).

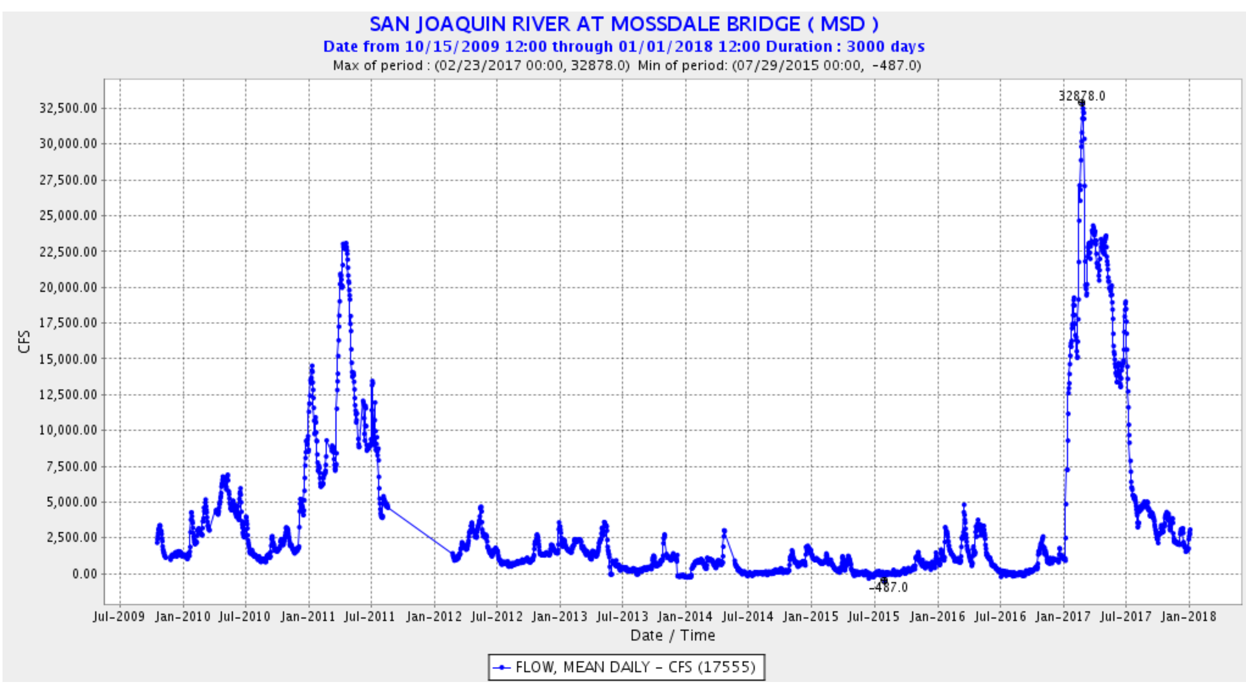


Figure 10. Recorded flow of the SJR in cubic-feet-per-second (cfs) measured at Mossdale Bridge (MSD) CDEC station July 2009 through January 2018 (CDEC, 2018).

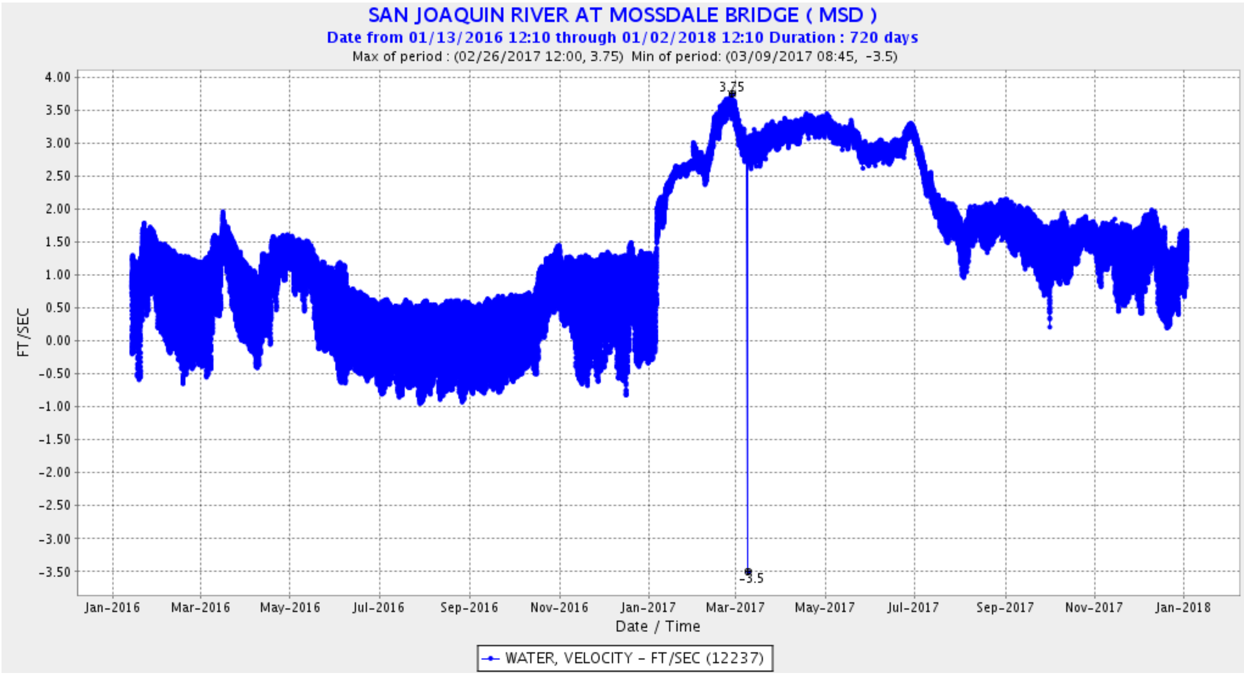


Figure 11. Recorded flow velocity of the SJR in feet-per-second (ft/sec) measured at Mossdale Bridge (MSD) CDEC station January 2016 through January 2018 (CDEC, 2018).

2.4.2.2 Local precipitation patterns

Typical rainfall patterns of this area are germane to these analyses, since the BA states stormwater discharge pumps will be activated after stormwater generated by a more than 0.36 inch rain event collects in the upland retention basins and triggers the automated pumps to turn on (the detention basins operating upland are described as being able to hold runoff from an event up to 0.36 inches and then pump all water out of the basins when such an event occurs). California is classified as having a "Mediterranean climate", with hot and dry summers and mild winters with little to a moderate amount of annual rainfall.

The two closest precipitation stations available near the City of Lathrop are approximately 7 to 10 linear miles away from the drainage area, at the Stockton Airport (SOC) and the Stockton Fire Station (SFS). Both stations offer historical data on daily (24 hour) incremental precipitation amounts observed, in inches, and were accessed through CDEC. The SOC station has been in operation since August 8, 2012, and is operated by NOAA's National Weather Service (CDEC, 2017a), and the SFS station has been in operation since October 1, 1996, and is operated by California's Department of Water Resources (CDEC, 2017b). Data from these two stations will be used to represent the rainfall patterns expected for the City of Lathrop. The end date of November 15, 2017, was chosen to close both data series (Figure 12).

According to the SOC station, which had approximately 5 years of data available, precipitation was typically recorded the months of October through April. Out of 1925 days of available data, there were 68 days when 0.36 inches of rain or more was observed. Therefore, according to this station, on average, 12.89 or 12-13 days per year had rainfall events within a 24-hour period that equal or exceeded 0.36 inches.

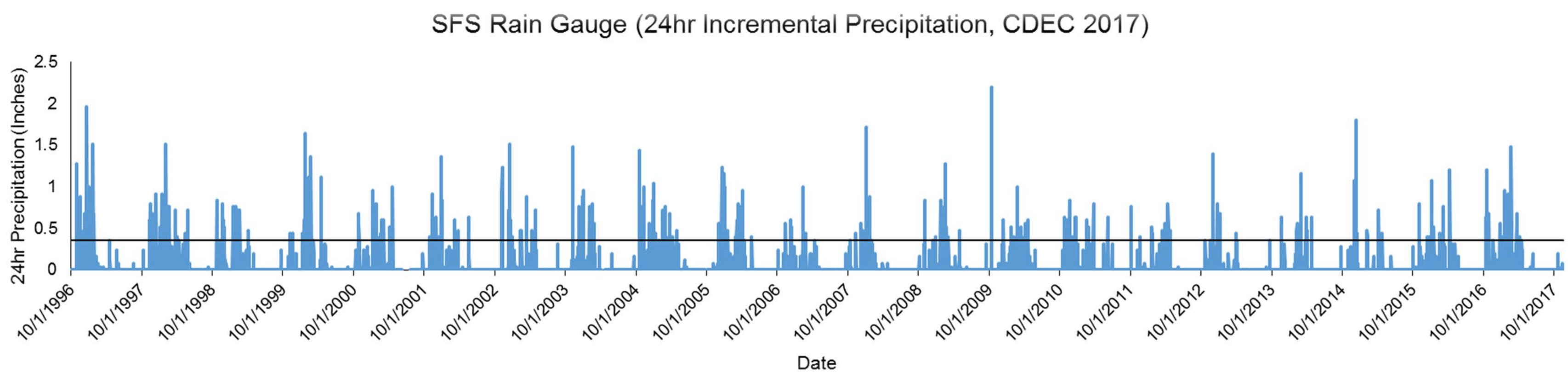
According to the SFS station, which offered approximately 21 years of data, precipitation was also typically observed October through April. Out of 7,716 days, 296 rainfall events of 0.36 inches or greater were observed within a 24 hour period. Therefore, according to this station, on average approximately 14 days per year are expected to have rainfall events equal or more than 0.36 inches within a 24 hour period.

Therefore, the total number of days in the local rainy season, the beginning of October through the end of April, amounts to 211 days. Within this time period, on average, 12 to 14 days of days of storm events that produce 0.36 inches or more of rain will be expected; thus, the outfall will be expected to be discharging stormwater 5.68 to 6.63 percent of the rainy season timeframe.

According to NOAA past weather records (NOAA, 2017), from October 1, 1996, to October 1, 2017 (21 years), it rained 0.36 inches or more in Stockton, California over a 24-hr period while the daily max air temperature was 65 °F or more, 54 times total. On average for this data, that equates to an averaged 2 to 3 days per year it may rain on a day that is also sufficiently warm so that impervious surfaces in urbanized watersheds may transfer atmospheric heat efficiently throughout the watershed and affect instream temperatures. These data support a trend of increasing number of days per year this situation may occur (Figure 13), with 2016 displaying the maximum at 9 days meeting these criteria.

Precipitation or snowmelt events normally drive in-river sediment loads in this system, increasing turbidity readings when precipitation/snowmelt increases river flow and decreasing turbidity when river flows are controlled by storing snowmelt behind Friant Dam or during controlled low-flow releases. According to CDEC data for the Mossdale Bridge station (MSD), with no flow contributions from seasonal precipitation or snow melt addition, SJR turbidity may normally range from 3 to 13 nephelometric turbidity units (NTU). During periods that correlate to storm events (Figure 12), turbidity regularly increases to 75 NTU or more (Figure 14).

a)



b)

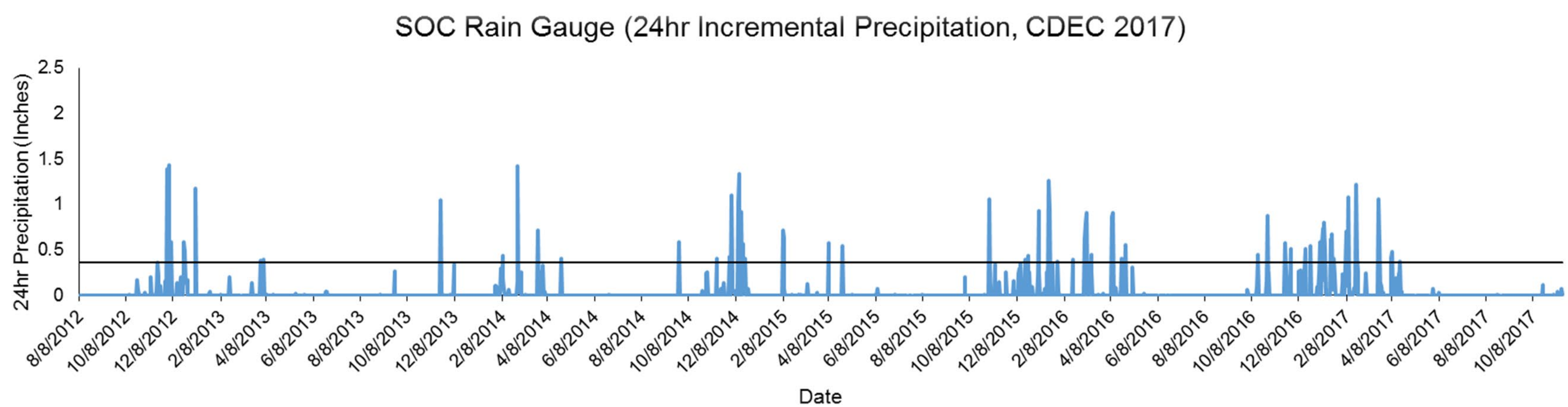


Figure 12. Incremental precipitation data from a) SFS and b) SOC rain gauge station in Stockton, California (graphed data from CDEC (CDEC, 2017a, 2017b)). Note different time series length, and threshold line at 0.36 inches.

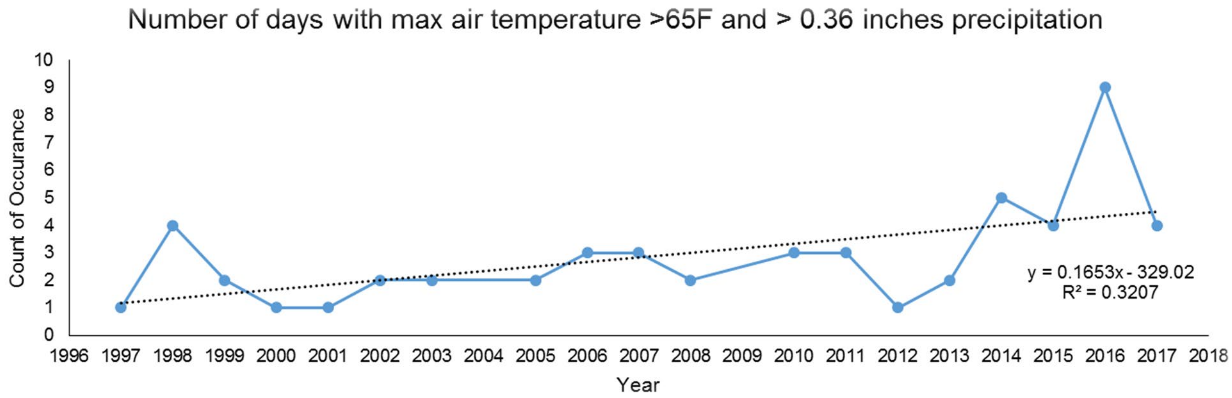


Figure 13. Number of days NOAA weather records indicate more than 0.36 inches of rain fell in Stockton, California within 24-hrs while daily maximum air temperature was 65°F or more (NOAA, 2017).

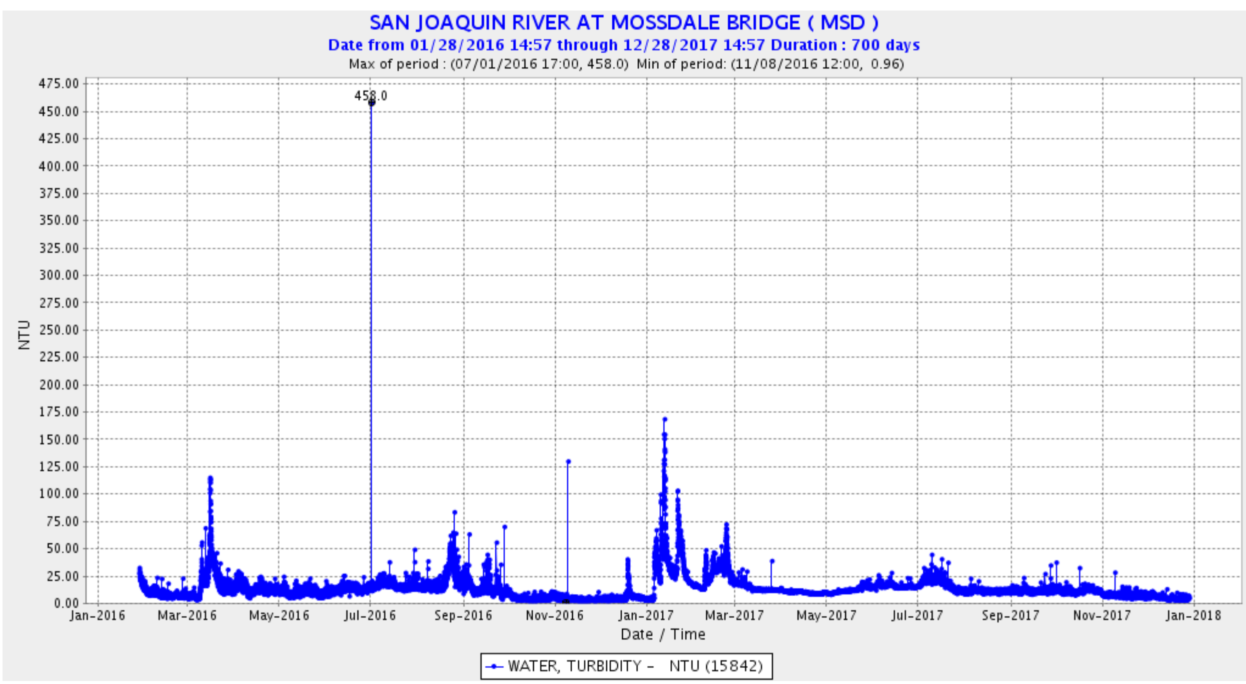


Figure 14. Recorded turbidity of the San Joaquin River in NTUs, from January 28, 2016 through December 28, 2017 (CDEC, 2018). The single maximum value of 458 NTU during the summer of 2016 may be an erroneous reading since there is no ramping up to or down from value on either side, though is not an impossible NTU value.

2.4.2.3 San Joaquin River water quality impairments

The southern portion of the Delta Waterways is listed under Clean Water Act section 303(d) as being impaired, including the portion of the SJR inside the action area of this proposed action (Table 1; EPA, 2010). These waterways were assessed in 2010 and listed as impaired for failing to meet water quality standards. The affected designated uses include agricultural supply, commercial and sport fishing, and warm freshwater habitat uses. The latest Waterbody Quality Assessment Report of 2012 indicates the causes of impairment have persisted since the 2010 report (EPA, 2012).

With the objective of controlling and eliminating the causes of contamination of surface water, a total maximum daily load (TMDL) is the calculation of the maximum amount of a pollutant allowed to enter a water body from known sources so that an impaired waterbody will eventually attain, and continue to meet, required water quality standards to enable various water uses. A pollutant reduction target is estimated and different sources will be allocated discharge loads so that any reductions necessary to achieve attainment of the water quality standards can be assigned. Four impairments are currently managed under a TMDL in the lower San Joaquin River/southern portion of the Delta Waterways. TMDLs have been established to address point and nonpoint sources of diazinon, chlorpyrifos, boron, and salinity. Currently, southern Delta waterways of the action area have not attained the water quality standards established by the EPA. The Sacramento-San Joaquin River Delta, the boundary of which overlaps the action area, is also managed by a TMDL to address methylmercury.

Table 1. The causes of southern Delta waterways being listed as impaired under Clean Water Act section 303(d), the designated waterbody negatively affected uses, and the status of the TMDL development (EPA, 2012; SWRCB, 2012).

Cause of Impairment	Cause of Impairment Group	Designated Use(s)	State TMDL Development Status
Chlorpyrifos	Pesticides	Warm Freshwater Habitat	TMDL completed
Conductivity	Salinity/Total Dissolved Solids/Chlorides/Sulfates	Agricultural Supply	TMDL needed
DDT	Pesticides	Commercial And Sport Fishing	TMDL needed
Diazinon	Pesticides	Warm Freshwater Habitat	TMDL completed
Group A Pesticides	Pesticides	Commercial And Sport Fishing	TMDL needed
Invasive Exotic Species	Nuisance Exotic Species	Warm Freshwater Habitat	TMDL needed
Mercury	Mercury	Commercial And Sport Fishing	TMDL needed
Unknown Toxicity	Total Toxics	Warm Freshwater Habitat	TMDL needed

The Clean Water Act gives the states the primary responsibility of protecting and restoring the quality of surface waters within state boundaries. Pursuant to Clean Water Act section 303(d), California is required to review and identify waterbodies within the state that do not meet water quality standards by identifying which parameter/standard not being met, the severity of the nonattainment, and the use of the waterbody curtailed because of its pollutants. Clean Water Act section 305(b) then requires California to report biennially the water quality conditions to the EPA. These duties are carried out by the State Water Resources Control Board (SWRCB). For the 2012 listing cycle, the Clean Water Act section 305(b) Report and the Clean Water Act section 303(d) List was integrated into a single report for the state of California (2012 California Integrated Report) which satisfied the requirements of both Clean Water Act sections (SWRCB, 2012). Beyond the requirements, the 2012 California Integrated Report also includes SWRCB staff recommendations for additions or removals of waterbodies from the list, and input from stakeholder meetings and public comments from regional divisions.

The 2012 California Integrated Report assigns waterbodies to tiered categories according to the number of core beneficial uses supported by the water quality, whether a TMDL or some other regulatory attainment framework has been implemented for the waterbody, and if enough data is available to evaluate the status of the water quality of a water body. Waterbodies assigned to categories 5, 4a, or 4b in the 2012 California Integrated Report either require the development of a TMDL, are being addressed by a TMDL, or are being addressed by a regulatory action other than a TMDL. In the action area, the southern portion of Delta Waterways/SJR is assigned to category 5 as a 3,125 acre estuary. Most pollutants listed for this area (Table 1) still require the development and approval of a TMDL, except for diazinon and chlorpyrifos which already have an approved TMDL in place. Considering the Sacramento-San Joaquin River Delta as an entire estuary of 41,736 acres of which this area is but one subsection, the EPA has also approved of a TMDL for methylmercury in 2011.

2.4.2.4 Lathrop stormwater quality

There are numerous other pollutants of concern that affect this area which have not quite risen to the level of federal jurisdiction but are causes of concern to local aquatic life. In response to concerns that increased urbanization in the Delta has demonstrated association with decreased water quality of the Delta, the Municipal Water Quality Investigations Program began the Lathrop Urban Runoff Study in 2009 (Water Resources, 2015). The purpose of the study was to assess the water quality impacts from urban runoff on the SJR specifically from the City of Lathrop. According to the 2010 census, Lathrop had an estimated population of 18,023 people (Water Resources, 2012) and is currently 65% open space or agriculture and 35% urban or industrial. The population was growing rapidly and open/agricultural lands were slated to be urbanized; however, following the late 2000s economic decline this growth rate slowed. A large housing development, the River Islands, is planned and consists of 11,000 homes and other features.

Water quality samples and data were collected over three wet seasons, with a focus on stormwater constituents of greatest concern to human needs/drinking water rather than aquatic species health (i.e., total and dissolved organic carbon (TOC and DOC), total trihalomethane formation potential (THMFP), haloacetic acid formation potential, ultraviolet absorbance, electrical conductance, total dissolved solids, bromide, ammonia, dissolved nitrate, dissolved nitrate plus nitrite, total nitrogen, dissolved orthophosphate, total phosphorus, total coliforms, fecal coliforms, *Escherichia coli* (*E.coli*), and pyrethroids).

In general, the study found that the concentrations of most constituents were significantly lower in the SJR than in the City's pumping stations, with some exceptions (Water Resources, 2015). Loads were calculated per storm event for TOC, bromides, ammonia, total nitrogen, and total phosphorus. Loads contributed by the City were generally low and sporadic, with most calculations indicating that the City of Lathrop contributed, on average, less than 3% of the total contaminate load of the SJR. However, during a first flush event, Lathrop contributed 6.8% of the organic carbon load, 7.3% to the total bromide load, and pathogens registered a high count. Ammonia contributions varied, though during approximately half of storm events, Lathrop contributed over 10% of the total ammonia load. During a summer storm event, Lathrop pumping stations produced elevated TOC, DOC, and THMFP in elevated concentrations when compared to concentrations in the SJR (Water Resources, 2015).

2.4.3 Conservation and restoration efforts

There are many efforts by federal and state agencies to restore aspects of the SJR back to its natural physical state and biological functionality. For example, the SWRCB is pursuing new narratives and revisions for the previously existing 2006 Bay-Delta plan that outline Lower SJR flow requirements that would be necessary to support natural populations of native fishes in this system and maintain southern Delta salinities that would protect surface water quality for agricultural beneficial uses (SWRCB, 2016). These recent proposed changes to the existing Bay-Delta plan are an attempt to address the "ecological crisis" occurring in the Delta and CV while also protecting the beneficial uses well-managed surface water provides to the communities of California. While ESA-listed salmonids needs are addressed in the Bay-Delta plan (SWRCB, 2016), these efforts focus more on restoring the functionality of the available existing habitat. Other agencies are implementing efforts that are more directed to restoring specific salmonid populations in the SJR basin.

2.4.3.1 NMFS recovery plans

Recovery is the process by which listed species and their ecosystems are restored to the point that the protections provided by the ESA are no longer necessary to ensure their continued existence. Recovering species in the California CV is challenging due to California's large and expanding human population, the associated amount and extent of water use and manipulation, and the continuous development of natural areas (NMFS, 2014).

In the 2014 Recovery Plan, NMFS established delisting/recovery criteria for the evolutionary significant unit (ESU) of spring-run Chinook salmon (*O. tshawytscha*) and the DPS of CCV steelhead, including that both have at least two robust populations in the Southern Sierra Diversity Group (i.e., the upper SJR tributaries) (NMFS, 2014). Though there are many recovery actions that are directed to the marine, estuarine, and other supporting freshwater systems that these species depend on, there are a series of actions/efforts that must be completed specific to the SJR basin for these populations to successfully establish and persist. These are identified in full in the 2014 Recovery Plan (NMFS, 2014), and include: implementation of restoration flows in the SJR, re-introduction of spring-run Chinook salmon, channel modifications and reconstructions for improved passage, minimization of fish entrainment and fish loss to diversions, improved management of predation risks, improved wastewater and stormwater treatment and management, spawning gravel augmentation, reestablishment of populations above dams, and development and execution of long-term population monitoring plans, to highlight an important subset. Many of the major actions required for recovery in the SJR are scheduled to be completed by the SJRRP, and habitat-improvement actions that are designed to benefit spring-run Chinook salmon are likely to also benefit CCV steelhead. SJRRP-moderated restoration flows that benefit fish passage through, and use of, the SJR basin have already begun, and spring-run Chinook salmon re-introduction efforts are ongoing. Fish passage and levee improvement components are scheduled to begin in 2018 through 2020, and the Department of Commerce is required to report to Congress on the progress made on reintroduction and plans for the future of the reintroduction by the end of 2024.

As previously mentioned, the SJR is not known to currently host sDPS green sturgeon spawning; therefore, the SJR basin is not a main focus of their recovery plan. Though the sDPS does utilize the lower SJR and the discovery of an individual adult in the Stanislaus River October 2017 highlights that passage for adults is possible during certain river conditions, the recovery plan and efforts are not likely to be modified unless adult spawning or juvenile reproduction occurs (NMFS, 2018a).

2.4.3.2 The San Joaquin River Restoration Program

The SJRRP is the result of a settlement that was reached in 2006 on an 18-year lawsuit between federal agencies, the Natural Resources Defense Council, and the Friant Water Users Authority (SJRRP, 2018). The settlement stipulates that sufficient fish habitat must be provided in the SJR below Friant Dam so that two primary goals are met: 1) Fish populations must be maintained and restored to "good conditions" in the mainstem of the SJR from Friant Dam to the confluence of the Merced River, including self-sustained populations of salmon; and 2) Water management must reduce or avoid adverse water supply impacts to all Friant Division long-term contractors that may result from interim and restoration flows provided for fish and wildlife restorations.

As previously identified, some critical recovery actions identified in the NMFS recovery plan are achieved through the implementation of the settlement goals. Though this settlement and the SJRRP actions are restricted to the recovery area, the SJR mainstem from Friant Dam to the Merced River, the achievement of volitional fish passage from the Delta to the base of Friant Dam would increase the use of the SJR mainstem within the action area of this project by both adult and juvenile salmonid migration.

2.4.3.3 Mitigation banks

There are several conservation or mitigation banks approved by NMFS with service areas that include the action area considered in this opinion. These banks may offer CCV steelhead credits or credits that would benefit CCV steelhead; however, mitigation bank credits are not available for sDPS green sturgeon.

Bullock Bend Mitigation Bank: Established in 2016, the Bullock Bend Mitigation Bank is a 116.15-acre floodplain site along the Sacramento River at the confluence of the Feather River (Sacramento River Mile 80) and is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead. There are salmonid floodplain restoration, salmonid floodplain enhancement and salmonid riparian forest credits available. To date, there have been 12.5 of 119.65 credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion, but not sDPS green sturgeon.

Cosumnes Floodplain Mitigation Bank: Established in 2008, the Cosumnes Floodplain Mitigation Bank is 472-acre floodplain site at the confluence of the Cosumnes and Mokelumne Rivers (Mokelumne River Mile 22) and is approved by NMFS to provide credits for impacts to CCV steelhead. There are shaded riverine aquatic, floodplain riparian, and floodplain mosaic wetlands credits available. To date, there have been 22.39 of 38.13 floodplain credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion, but not sDPS green sturgeon.

Fremont Landing Conservation Bank: Established in 2006, the Fremont Landing Conservation Bank is a 100 acre site near the confluence of the Feather River and the Sacramento River, at river mile 78 through 80, on the west bank of the Sacramento River. It is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. Out of 100 acres of potential credits, 28.283 acres have been sold/withdrawn and the ecological value (increased rearing habitat for juvenile salmonids) of these credits are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion, but not sDPS green sturgeon.

Liberty Island Conservation Bank: Established in 2010, the Liberty Island Conservation Bank is a 186 acre site located at the southern end of the Yolo Bypass on Liberty Island in the Delta. Out of the credits relating to salmonid restoration or preservation, 27.67 acre have been sold/withdrawn. It is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. There are riparian shaded aquatic, salmonid preservation, and salmonid restoration credits available, and the ecological value of the sold credits (increased rearing habitat for juvenile salmonids) are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion, but not sDPS green sturgeon.

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

2.5.1 Direct and indirect effects to species: Construction of the outfall

2.5.1.1 General construction impacts

Construction activities have the potential to introduce noise, vibration, artificial light, and other physical disturbances into the immediate environment around the construction zone that can result in the harassment of fish by disrupting or delaying their normal behaviors and use of areas, and in extreme cases, causing injury or mortality. The potential magnitude of effects depends on a number of factors, including type and intensity of disturbance, the proximity of disturbance-generating activities to the water body, the timing of the activities relative to the use and occurrence of the sensitive species in question, the life stages of the species affected, and the frequency and duration of disturbance periods.

Fish may exhibit avoidance movements near construction activities that displace them from locations they would normally occupy due to the noise generated by displaced rock and sediment or the general operation of construction machinery as the noise permeate the underwater environment. Depending on the innate behavior that is being disrupted, the direct and indirect adverse effects could be varied. An example of a significant, direct adverse effect would be cessation or alteration of migratory behavior. For juvenile fish, an additional effect may include alteration of behaviors that are essential to their maturation and survival, such as feeding or sheltering. In the absence of migration pattern alterations, general construction disturbance may increase fish physiological stress. Fish vacating protective habitat due to disturbance may experience increased predation rates and decreased survival rates compared to those left undisturbed. In the context of the proposed action area, the migratory and rearing behavior of juvenile salmonids and green sturgeon may be affected by various construction-related effects.

In extreme cases, general construction-related effects may also include debris and/or equipment falling into the channel. Such instances could cause physical injury or death, or acute avoidance of equipment would be an alteration of their normal behaviors and induce physiological stress. Adults and juveniles could potentially encounter equipment being used in-water or objects being placed in the water, or become trapped by piles as they are being installed or removed, however this effect will be discussed further as a potential dewatering effect.

For the South Lathrop Regional Outfall Project, construction activity will be limited to an in-water work window of July 1st through October 31st. This is concurrent with the in-water work window recommended by NMFS for work in the Delta, based on the information described and summarized in Figure 8. The NMFS in-water work window of July through October is most protective for spring-run Chinook salmon; it is less protective of steelhead and green sturgeon. This in-water work window decreases the probability that listed fish will occupy waters in the action area at the time of construction; however, due to the seasonality of their life history patterns, CCV steelhead or sDPS green sturgeon may still be present in the action area during this period.

All work would be limited to daylight hours between 0800 and 1800 hours, even outside of the in-water work window, per NMFS recommendations to minimize project effects on fish migration and passage through the area. Recent study suggests that adult steelhead show the greatest amount of upstream movement in river mainstems until from early dawn until approximately 0800 and somewhat more movement nocturnally compared to mid-morning and evening hours (Keefer et al., 2012). Steelhead juveniles are known to change diel movement tactics as they leave their natal streams; however, in this section of the SJR/Delta, they are expected to move most at night or have no preference between night or day movement (Chapman et al., 2012). Information on the diel movement patterns of green sturgeon is sparse, and that which is available suggest green sturgeon do not have preferred diel movement timing (Benson et al., 2006; Lindley et al., 2011; Moser & Lindley, 2006).

Though the impacts have been minimized to the extent practicable through the adoption of seasonal and daily work windows, there remains possibility that adult and juvenile CCV steelhead, CV spring-run salmon, and sDPS green sturgeon may occupy the SJR adjacent to the work area while construction is occurring, and their normal behavior and use of the immediate area would be altered due to harassment from equipment operation and construction noise, and general human presence. Specifically, adult CCV steelhead and sDPS green sturgeon may be deterred from using the area and delay their migration up or down stream during active construction periods, and construction may also deter juveniles CCV steelhead from using the area for migration or rearing purposes. Direct injury or mortality from general construction activity is not anticipated to be an adverse effect because a situation in which such an outcome would occur is expected to be an unlikely event (equipment failure/accident resulting in debris entering waterway). Nighttime work is not proposed and so artificial lighting from construction is not expected to adversely affect listed fishes.

2.5.1.2 Site preparation and vegetation removal
Site preparation may occur outside of the seasonal in-water work window (before July) and will include the installation of exclusionary fencing and other BMPs intended for above OHWM use, and levee top and slope grading. In addition, three willow bunches will be removed for outfall placement and other trees may be trimmed for construction access.

As examined above, human presence and general construction activities near waterways have the potential to disturb fishes and disrupt their normal behavior patterns when the timing of the activities and fish occurrence overlap. Given that site preparation and vegetation removal may occur before the NMFS recommended work window of July through October, adult CV spring-run Chinook salmon may still be migrating past this location to reach holding areas far upstream (Figure 6).

The decreases in riparian vegetation will create physical changes in the environment which cumulatively decrease the survivorship of juvenile salmonids (Bjornn & Reiser, 1991), in part because these changes in cover can influence the macroinvertebrate prey assemblage through alterations in shading and water temperatures (Meehan, 1991), to one less supportive of juveniles salmonid growth. Juvenile CCV steelhead and CV spring-run may still be in the valley floor ecosystem during late spring and summer months, but the adverse effects from removing a small amount of vegetation is difficult to quantify though juvenile fitness is likely to decrease to a small degree. Though the amount of vegetation removal in the project has been reduced to the least amount possible while still allowing construction access and structure placement, adverse effects to individual juvenile CCV steelhead and CV spring-run Chinook survival are still expected, as the project does not include replanting of the removed willows and the branches of the trimmed trees will take time to grow back to their previous cover extent.

Adult CCV steelhead and CV spring-run Chinook are not expected to forage and therefore are not expected to be adversely affected by site preparation and vegetation removal/trimming beyond the general construction effects already discussed. Green sturgeon are not known to associate with riparian vegetation, and therefore the effects of vegetation removal are not expected to be adverse; however, robust information on the relationship between riparian vegetation and green sturgeon is lacking.

2.5.1.3 Equipment staging and maintenance
Several BMPs will be implemented regarding equipment staging and maintenance, including: 1) storage at least 200 feet from the OHWM, preferably on paved roads or area; 2) equipment or vehicles to be driven/operated on the levee will be checked and maintained daily to ensure proper working conditions and prevention of leaks; and 3) fueling, cleaning, and equipment maintenance will be performed on vehicles and equipment in designated refueling/staging areas on existing paved surfaces with secondary placement at least 200 feet from the OHWM.

Adherence to these BMPs should minimize or avoid impacts to listed fishes that could potentially result from the staging and maintenance of equipment on-site, so much so that adverse effects resulting from these activities are not expected.

2.5.1.4 Cofferdam installation and dewatering

During the in-water work window, a floatable debris curtain will be installed in the SJR to capture construction debris and control sediment. Then sheet piling will be installed the length of the work area to form a cofferdam via vibratory hammer, so that soils below the OHWM may dry and allow for in-the-dry installation of the Armorflex® mat, construction of the outfall structure and headwall, and placement of riprap.

Ponded water in the sheet pile cofferdam will be pumped back into the SJR within the floatable debris curtain. Water pumped back into the SJR must meet Clean Water Act section 401 water quality standards prior to discharge (dependent on natural river turbidity, pg. 9 of Clean Water Act section 401 certification WDID#5B39CR00279). After construction and riprap placement is complete, the sheet piles and debris curtain will be removed, also via vibratory hammer.

As long as the quality of the dewatered water pumped back into the SJR does not exceed the acceptable turbidity units stipulated in the Clean Water Act section 401 certification (WDID#5B39CR00279) and a turbidity plume is not observed outside of the floatable debris curtain, dewatering activities as described are not likely to adversely affect CCV steelhead, spring-run Chinook salmon, or sDPS green sturgeon.

Underwater pressure waves generated from driving piles into river bed substrate propagate through the water and can damage a fish's swim bladder and other internal organs by causing sudden rapid oscillations in water pressure, which translates to rupturing or hemorrhaging tissue in the bladder when the air in swim bladders expand and contract in response to the pressure oscillations (Gisiner, 1998; Popper et al., 2006). Sensory cells and other internal organ tissue may also be damaged by noise generated during pile driving activities as sound reverberates through a fish's viscera (Gaspin, 1975). In addition, morphological changes to the form and structure of auditory organs (saccular and lagenar maculae) have been observed after intense noise exposure (Hastings, 1995). Smaller fish with lower mass are more susceptible to the impacts of elevated sound fields than larger fish, so acute injury resulting from acoustic impacts are expected to scale based on the mass of a given fish. Juveniles and fry have less inertial resistance to a passing sound wave and are therefore more at risk for non-auditory tissue damage (Popper & Hastings, 2009) than larger fish of the same species. Multiple studies have shown responses in the form of behavioral changes in fish due to human-produced noise (Popper & Hastings, 2009; Slotte et al.; Wardle et al., 2001).

Generally, NMFS uses a dual metric criteria to assess onset of injury for fish exposed to pile driving sounds (Caltrans, 2015). However, for this project, the pile driving is limited to use of a vibratory hammer, which is expected to produce pressure exposure levels below the interim thresholds for injury identified by the Fisheries Hydroacoustic Working Group (FHWG). When pressures generated are expected to be below injurious levels, as a conservative measure, NMFS uses 150 dB_{RMS} as the next threshold expected to illicit temporary behavioral effects on ESA-listed fish species (observed in salmon and trout, data is not available for sturgeon). Pressure levels in excess of 150 dB_{RMS} are expected to cause temporary behavioral changes (startle and stress) that could decrease a fish's ability to avoid predators. The background RMS sound pressure levels, or effective quiet, is assumed to be 150 dB_{RMS} and the acoustic impact area is the area where the predicted RMS sound pressure level generated by pile driving exceeds this threshold. Once the pressure waves attenuate below this level, fish are assumed to no longer be adversely affected by pile driving sounds. Under the concept of effective quiet being equal to 150 dB_{RMS}, the distance fish are expected to be adversely affected during pile driving is out to 100 meters from the location of the pile being driven, assuming a transmission loss constant of 15 (NMFS calculation sheet (Caltrans, 2015)).

Therefore, depending on the innate behavior that is being disrupted, the direct adverse effects could be varied and are expected to result in incidental take due to harassment, but are not expected to include injury to fish. Instantaneous behavioral responses may range from mild awareness to a startle response; such a response would not be considered incidental take due to harassment. Fish may also exhibit movements that displace them from a position normally occupied in their habitat for short or long durations. This is of particular concern for juvenile fish as there are innate behaviors that are essential to their maturation and survival such as feeding, sheltering, and migratory patterns. In the context of the proposed action area, the migratory behavior of steelhead and green sturgeon may be affected by various pile driving and acoustic impacts. Though pile driving may affect migratory behavior, it is not expected to completely prevent salmonids and sturgeon from passing upstream or downstream because pile driving will not be continuous through the day, will not occur at night, and the 100 meter affected distance does not stretch completely across the SJR mainstem at the location of the outfall. CV spring-run Chinook salmon are not expected to be adversely affected by pile driving because they are not anticipated to occupy the action area during the in-water work window during which pile driving is scheduled.

2.5.1.5 Construction of the outfall structure and associated infrastructure

After installation of the cofferdam and the drying and grading of previously wet areas is complete, the area will be excavated and an Armorflex® mat/gravel pad will be installed. Then the concrete structure/headwall will be cast and cured, and the pipes will be installed and connected from the outfall structure across the levee to the stormwater infrastructure on the other side of the levee.

The pouring and curing of new concrete may negatively affect water quality by increasing the pH of water in contact with the uncured curing surfaces and decreasing the pH as the concrete cures; either way can be highly toxic to fish through damage to gills, eyes, and skin, and interfere with fishes' ability to dispose of metabolic wastes (ammonia) through their gills (WADFW, 2009). In addition, alkali may leak from freshly cast concrete for some time after curing if in contact with water, up to several days to months depending on the water in the water-cement ratio of the mix (CTC & Associates, 2015).

Because the casting and curing of concrete will be done "in-the-dry", the potential that the curing concrete will adversely affect water quality and fish health is reduced. It is possible raised river heights caused by rain and snow melt in the months following project completion will cause SJR water to be in contact with the concrete. The large amount of river volume expected when the maturing concrete is in contact with raised river water is expected to dampen any changes in pH of river water from such contact down to immeasurable differences, even if listed fishes are present during this time. The new concrete is expected to mature and be practically inert within six months after casting. Therefore, adverse effects to listed fishes from chemical changes from new concrete are not expected to occur.

The installation of the Armorflex® mat/gravel pad is not expected to adversely affect fish through changes in water chemistry since these materials are created offsite before installation and are expected to be completely cured or consist of inert material. Neither is the connection of pipes between the outfall headwall and other stormwater infrastructure expected to adversely affect fishes through changes in water chemistry.

2.5.1.6 Placement of riprap

Riprap will be placed using a small dump truck via dumping the rock down the slope and the use of an excavator to move the rocks into place on the slope. Riprap placed below the OHWM will receive an additional treatment of smaller rock to fill gaps. Fugitive dust may be created during these activities; however, erosion control and dust control BMPs are expected to be employed and should prevent discharge of sediment/dust into the SJR to the extent feasible.

The areas to receive riprap placement should be isolated from the water via the sheet pile cofferdam, and therefore fish are not expected to be injured during riprap placement. The minimization measure of placing smaller rock to fill spaces created by the larger boulders reduces the probability that piscivorous predators will use the artificial spaces to ambush and more effectively prey on juvenile CCV steelhead and CV spring-run Chinook salmon passing through or rearing in the immediate area. Therefore, the placement of riprap in this area, when in combination with the placement of smaller rock fill, is not expected to directly adversely affect the instantaneous survival probability of individual juvenile salmonids. Adult CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon are not expected to be directly affected by the placement of riprap, and the disturbance of soils and dust is expected to be limited to periods of riprap placement and cease once placement is complete.

2.5.1.7 Mitigation credit purchase or in-lieu fee program participation

Artificial alterations to any available riparian habitat could hinder the recovery of the CCV steelhead DPS, CV spring-run Chinook salmon ESU, and sDPS green sturgeon, depending on the extent and severity of the artificial alterations, and how sparsely suitable habitat is otherwise locally available. Besides the three identified willow bunches, the other woody riparian vegetation may only be trimmed back to provide access and should continue to support the riparian function of the area once allowed to grow back. However, with outfall and riprap placement, reestablishment of removed overhanging riparian vegetation will be permanently controlled to ensure outfall function, so it is likely this action will prevent future naturalization of the area. Riprap is also likely to facilitate the channelization of the SJR and prevent natural river geological processes from occurring in an already highly modified system. The addition of the riprap and the placement of a new, artificial structure on a leveed bank is expected to result in adverse effects to CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon through increased changes to the SJR system, taking it further from its historical natural state.

Through the purchase of credits, however, some aspects of these unavoidable impacts are expected to be offset. Individuals of all of the populations that may experience adverse effects from this action should be able to access habitats created and maintained by the banks that serve the action area, and these individuals may potentially rest, shelter, and forage within these properties, which would increase the probability of their long-term survival. Although the conservation banks that cover the action area in their service area may not technically offer sDPS green sturgeon or CV spring-run Chinook salmon credits, we expect that individuals from both populations should benefit from the purchase of SRA credits since these fish should still be able to access the purchased riverine habitat areas created and maintained by the banks/programs by the purchase of such credits.

These benefits to individuals of each listed species are expected to be provided in perpetuity. The banks that serve the action area all have adequate mechanisms in place to track credits and debits to ensure that more debits are not sold than credits that are available. A non-wasting endowment fund to pay for long-term management of the bank sites also ensures credit values are maintained in perpetuity and therefore the properties are expected to be permanent habitat improvements that provide benefits to protected anadromous fishes. To document this, each bank must submit a Mitigation Banking Instrument with USACE when they are developed (USACE, 2018). A description of these tracking mechanisms can be found in the respective banking instruments for Bullock Bend (Westervelt Ecological Services, 2016), Fremont Landing (Wildlands Inc., 2006), Cosumnes (Westervelt Ecological Services, 2009), and Liberty Island (Wildlands Inc., 2010). The Mitigation Banking Instrument also specifically identifies that NMFS has jurisdiction over certain living marine resources that may occur within the property for the bank to be considered NMFS approved, such as the ones identified in this opinion.

2.5.2 Direct and indirect effects to critical habitat: Construction of the outfall

The action area in the SJR mainstem includes both CCV steelhead and sDPS green sturgeon designated critical habitat. In the action area, PBFs associated with CCV steelhead freshwater rearing sites and freshwater migration corridors exist. For sDPS green sturgeon, PBFs associated with freshwater riverine systems exist in the action area, such as food resources, water flow, water quality, migratory corridor, water depth, and sediment quality. There is no designated critical habitat for CV spring-run Chinook salmon within the action area, and the proposed action is not expected to cause direct or indirect effects to their critical habitat.

2.5.2.1 Vegetation removal

In preparation for construction, three small willow brunches will be removed from the leveed bank of the SJR. Originally, the project description called for removal of all woody riparian trees; however, through consultation the City of Lathrop agreed to keep all other woody trees in the construction area besides the willow bunches directly in the outfall structure footprint.

Removal of the willow bunches prior to construction will reduce some of the natural cover that was previously available on site and reduce habitat complexity that would otherwise be beneficial to CCV steelhead freshwater rearing and juvenile freshwater migration. These removals decrease habitat complexity in a stretch of the SJR mainstem that is relatively bare of riparian vegetation that overhangs the water line or occupies water habitat.

Due to the small amount of willows originally available at the area, their removal likely is a lesser degree of adverse effect to CCV steelhead critical habitat. The proposed action does not include in-kind replanting to replace these removals on site. Willow establishment will be prevented or delayed by this proposed action and so the expected small adverse effect to the PBF of natural cover may become permanent.

Natural cover has not been identified as a PBF for sDPS green sturgeon critical habitat, so it is unlikely that the removal of the willow bunches will adversely affect the sDPS green sturgeon critical habitat in the action area.

2.5.2.2 Placement of artificial structure

Adverse effects associated with general construction activities required to place these structures are not permanent forces, though they may temporarily degrade the condition of the critical habitat locally. For example, the green sturgeon PBF of water quality may be temporarily degraded via sediment disturbance during the construction and installation of the outfall and riprap, but once construction concludes and the site is regraded, the site is not expected to continuously discharge sediment into the river through erosion. Because the construction disturbance effect on critical habitat are ephemeral and conditions should revert back to baseline river conditions after construction activities cease, permanent adverse effects of critical habitat associated with construction activities are not expected.

The center piece of this project is the placement of the outfall and associated footing and pipes. The addition of this structure to the leveed bank of the SJR further changes the riverine habitat from its natural state, and permanently occupies a limited portion of both CCV steelhead and sDPS green sturgeon critical habitats, thus contributing to the degradation of these habitats in perpetuity.

2.5.2.3 Placement of riprap

The placement of riprap introduces further artificial alterations to the critical habitats in the action area. The river bank was previously leveed, which functionally removed floodplain, increased the bank slope, removed the natural riparian vegetation cover during levee creation, decreased habitat complexity, and channelized the SJR mainstem. While the purpose of the riprap is to ensure erosion will not compromise the integrity of the outfall structure, its placement further ensures that the earthen levee will remain in perpetuity and decreases any probability that this area may be restored to its previous functionality and become more aligned to the natural state of the critical habitats.

<u>CCV steelhead PBFs</u>

As addressed above, the floodplain connectivity PBF that supported freshwater rearing has been adversely affected to the point of removal on site. However, because the proposed action is located in historical floodplains, the riprapping associated with the proposed action is expected to have an additional indirect effect of the inhibition and prevention of habitat forming processes and floodplain connectivity that would otherwise naturally occur overtime without human intervention.

In regards to the functionality of CCV steelhead critical habitat PBF of freshwater rearing, increasing riprap cover is likely to reduce access to any available food resources over an extent that, at a minimum, includes the footprint of the structure and riprap placement. The introduction and benthic occupation of hard surfaces is likely to change the density and types of juvenile CCV steelhead prey items in the immediate area, therefore adversely affecting the already degraded state of their critical habitat.

The functionality of the freshwater migration corridor for adults is not expected to be completely precluded by the placement of riprap because these structures do not extend across the SJR or block access to the river bank on either side. However, navigation through the area for smaller juveniles may become more difficult as this area is likely to increase the speed of water flow as it flows around the artificially placed boulders, removing opportunities to rest.

Originally, NMFS had concerns that placement of riprap boulders would create shadows and crevices in which piscivorous predators could hide and more effectively ambush juvenile CCV steelhead passing by the riprapped area, which would further decrease the rearing value of the site. However, the City of Lathrop project proponents agreed to fill such voids around the riprap boulders below the waterline with smaller rocks/gravel to avoid creating such spaces, and therefore this aspect of the proposed action is not expected to result in adverse effects due to increased predation.

<u>sDPS green sturgeon PBFs</u>
Similar to the discussion above, the placement of riprap introduces alterations that are expected to further reduce green sturgeon food resources over an extent that, at a minimum, includes the footprint of the structure and riprap placement. The introduction and space occupation of hard surfaces is likely to decrease the density of sturgeon prey items in the immediate area and decrease the area of soft riverbed forage, therefore decreasing the value of their designated critical habitat.

There will be changes to sediment quality, as the proposed action now includes placement of smaller gravel/rock in between the spaces of the riprap to avoid the inadvertent creation of piscivorous predator ambush cover. However, green sturgeon are not known to spawn anywhere but in the upper Sacramento River basin. Therefore, this change is not expected to have an adverse effect on critical habitat supportive of green sturgeon spawning.

The placement of the structure and riprap is not expected to change green sturgeon migratory corridor use through the action area because the riprap will not extend across the river nor block access to the bank on either side of the structures. These structures are also not expected to change the water depth of the SJR at the time of installment, nor change the water flow in the SJR (until the outfall is utilized for stormwater discharge, see below, section 2.5.4 *Interrelated and interdependent action effects to critical habitat*).

2.5.2.4 Mitigation credit purchase or in-lieu fee program participation
As discussed in Section 2.5.1.7, the purchase of mitigation credit from a NMFS approved bank creates beneficial effects that will restore and protect riparian habitat and rearing habitat

elsewhere, which is expected to enhance the critical habitat available for CCV steelhead and, in most cases, sDPS green sturgeon, though located outside of the action area of the project.

2.5.3 Interrelated and interdependent action effects to species: Outfall operations and discharge

After the construction of the outfall structure and the associated site clean-up is complete, the applicant, the City of Lathrop, will be responsible for the outfall's management and operations. The purpose of this outfall is to discharge stormwater runoff after the infiltration limits of the three dry detention basins in the South Lathrop and Gateway business drainage sub-sheds designed to infiltrate the first 0.36 inch of storm events within 48 hours are exceeded. If more than 0.36 inches of rain falls and accumulates in the basins, automatic pumps are activated and stormwater is pumped through the system and eventually discharged into the SJR.

Effects associated with the City of Lathrop's operation of the outfall for stormwater discharge are considered effects of an interrelated/interdependent action, as described in section 1.3, *Proposed Federal Action*.

2.5.3.1 Addition of a new water discharge source: the physical effects
This step in the analysis only examines the physical hydrologic effects of a new water input source (i.e., changes in velocities, turbulence, and scour). The analyses of effects on CCV steelhead and CV spring-run Chinook salmon will occur together for the consideration of the effects of long-term operation of the stormwater outfall, due to the similarities in their life history patterns, timing and use of the action area, the limitations of their physiology, and reactions to environmental perturbations.

Adult CCV steelhead and CV spring-run Chinook salmon
Adult steelhead and spring-run Chinook salmon that spawn in SJR basin are expected to pass by the outfall location on the SJR mainstem anytime from July through March for steelhead pre-spawn adults and kelts (Figure 5), and January through September for pre-mature CV spring-run Chinook salmon, depending on flow and water temperature. The rainfall season (during which the outfall is projected to operate) normally starts in October and extends until April in the SJR basin (Figure 12, CDEC, 2017a; 2017b; 2018). Outfall discharge timing is therefore expected to overlap with a majority of the adult steelhead and part of the adult spring-run Chinook salmon migration schedules.

Some streams that host steelhead spawning only offer 25 to 90 cfs flows and still sufficiently support populations (Holmes & Cowan, 2014). Adult Chinook salmon generally require greater amounts of water to adequately pass compared to adult steelhead due to their larger body size and more modest swimming and jumping abilities. With a potential of 100 to 400 cfs of stormwater being discharged during rain events, it is possible adult salmonids could be attracted to the discharge from the outfall and the velocity gradients it creates, and try to climb, or jump at, the discharged stormwater outflow. Eliciting such behavior may delay their migration as fish attempt to climb the non-existent stream, or potentially injure fish if they impact the side of the concrete structure or land on the hard outfall pad structure if the river height is below the discharge pipe height.

All salmonids primarily use olfactory cues to home back to their natal streams once in the freshwater environment, though they may be temporarily attracted to other water inputs and turbulence (NMFS, 2011). Because the adults should be imprinted on olfactory cues of their natal streams, the probability of adults being attracted to this particular outflow is low despite its potential to create attractive flows and velocity gradients. Without an olfactory cue, it would be unlikely that adults would be attracted to this new water source for long. And due to the flexible material of the duck valves which close when not discharging, there is no possibility that adults would be able to enter the stormwater system and potentially injure themselves. Therefore the physical addition of this new water source is not expected to adversely affect adult CCV steelhead or adult CV spring-run Chinook salmon through alteration of their migration patterns.

Juvenile CCV steelhead and CV spring-run Chinook salmon

Juvenile CCV steelhead and CV spring-run Chinook salmon are expected to travel down the SJR mainstem to occupy and rear in the Delta after departing their natal tributaries from February through June for steelhead (Figure 5), and approximately November through May for CV spring-run Chinook salmon (Figure 6). This timing overlaps with the spring rainfall season and therefore the expected timing of outfall operation and discharges.

Outfall discharge is expected to occur during rainfall events on or near the City of Lathrop that are above the limits of the infiltration basins, estimated about 12 to 14 times per year (Figure 13). These discharge periods are more likely to occur when the SJR is also experiencing increased flows due to precipitation in the foothills, but most likely the greatest increase in river volume will be due to snowmelt: less than 2,500 cfs in drought years, to up to 5,000 cfs in average water years, to over 15,000 cfs during years when greater than average precipitation and snowmelt co-occurring (see maximum peak in spring flows in 2017 (Figure 9), with precipitation events also in spring 2017 (Figure 12)). It is also important to consider that the SJR is a managed river and the filling of the reservoirs and flood control measures dictate the amount of flow allowed downstream in the action area.

Young-of-the-year (YOY) juvenile CCV steelhead that migrate from their natal streams after less than one year of rearing in tributaries are small (50 to 100 mm total length (Moyle, 2002)) and are expected to largely drift passively with the current. To rest, YOY steelhead prefer the margins of streams (0-32 inches water depths) where currents are diminished (McEwan, 2001). During low flows, river velocities at MSD (Figure 11) measured in the main channel of the SJR range from less than 1 foot/second, to over 3 feet/second, during high flows of over 15,000 cfs. YOY steelhead and small juvenile salmonids would effectively act planktonic, or be swept along at such flows when over 60 centimeters or 2.2 feet per second (Swanson et al., 2004).

Direct impact of discharged stormwater from the outfall is estimated to have a velocity of 22.62 feet/second at peak discharge (Engineer Analysis: see APPENDIX 1) when it is pumped out of the pipe and drops to hit the crash pad, or the surface of the SJR, depending on river stage at time of discharge. River height is expected to be variable and dependent on a variety of upstream factors (Figure 9). When river height is above the Armorflex® pad (greater than 5.34 feet high), YOY CCV steelhead using SJR margin habitat are expected to be directly impacted by the force of the discharging water when using the marginal habitat or being swept in the discharge impact zone, since small YOY CCV steelhead are most often found in 0-32 inches water depth, with increasing depth utilization increasing with body length and smoltification stage (McEwan, 2001). The jet of water is estimated to engage the river with a zone of flow establishment approximately 18.6 feet out into the water (Appendix 1). The SJR would be expected to be maintained at elevated river stage/height during controlled release flows required to ensure the limits of dam reservoirs are not exceeded and in responses to CV precipitation events, and flows would likely be above 5,000 cfs. The severity of the impact of discharging water on CCV steelhead juveniles will be relational to the river stage and flow conditions in the SJR at the time of discharge. Small juvenile CCV steelhead become more susceptible to predation when they are disoriented. The expected exposure, response, and risk to small YOY CV spring-run Chinook juveniles is likely to be similar to that of juvenile steelhead.

Just upstream of the location of this outfall, the SJR mainstem performs an almost 90-degree left turn near Manteca, California, before flowing north into the Delta. Assuming that the SJR river bed depth at the outfall location is equal depth between its east and west banks in cross section, a current that is stronger on one side vs. the other is not expected. At current status quo, we would expect juveniles entrained in the river flow to have a split 50:50 probability in their distribution to the banks at the sharp turn. Therefore, at least half of YOY salmonids may route past the outfall location during their outmigration and become disoriented if the outfall is discharging stormwater when they cross its location.

At elevated flows (>5,000 cfs and >2.2 feet per second), small YOY salmonids are considered to be planktonic in regards to their ability to control their position in the river. The stormwater discharge may be pumped out at full capacity in this situation (400 cfs) and heightened river stage is likely to mean that discharged water directly contacts or flows into the SJR with little drop time from the duck values. All small juvenile salmonids swept downstream during such an elevated flow event have a probability of being directly impacted by the physical force of the discharged stormwater into the water column and being injured by the force of the discharged water or further disoriented, potentially succumbing to predation attempts further downstream.

At intermediate levels of flow (5,000 to 2,500 cfs), small YOY salmonids may be able to exert some control on their position in the SJR and are expected to occupy river bank/margin habitat as needed for resting. During these flow conditions, the SJR river height is expected to range up to and below the duck valves heights so that discharged water falls onto the river surface. At this point of contact, juveniles may be injured from the impact of the discharged water, or at least further disoriented. As the force of the discharge dissipates further downstream of the outfall, a widening plume of turbulence may disorient small YOY salmonids over a larger area, until the plume is sufficiently dissipated to vectors below 2 feet per second in velocity. There is expected to be a 3 foot diameter core jet of water that will jet out into the SJR about 6.2 times the diameter of the pipe (Appendix 1). This turbulent jet is expected to be worn down into smaller eddies as the plug of turbulent water is sheared down. A lesser percent of juveniles may be directly impacted and injured by the discharge jet when compared to the heavy flow/heavy rains scenario above. Juveniles not injured but disoriented are expected to succumb more easily to predation.

In low flow events (<2,500 cfs), the discharged water is expected to hit the crash pad since river stage is expected to be at or below the OHWM incorporated into outfall design. Direct injury to YOY juvenile salmonids is not expected because the crash pad will absorb the full impact of the falling water. A turbulence plume may still be created after the discharged stormwater flows from the crash pad down into the SJR but it is likely the turbulence plume will be greatly reduced since it will be dampened by contact with the river bank and quickly dissipate. Also since SJR flows would be reduced in such a situation, river velocities should be below YOY CCV steelhead critical swimming speed and allow them to avoid turbulent areas as needed. Such a situation should be extremely rare as well, since it could only be occurring when SJR flow is low but precipitation in Lathrop is so great that pumping out of the infiltration basins are triggered. In such situations, adverse effects due to the physical discharge of up to 400 cfs on small YOY salmonids are expected to be insignificant.

Over time, the thalweg of the SJR mainstem is expected to move closer to the outfall's discharge location caused by scour creating a depression in the river bed downstream of the discharge. The scoured deep pool will allow more water volume to move through this area, increasing the localized velocity of the eastern bank and drawing the thalweg ever closer to the outfall discharge. As this thalweg shift occurs, more drifting juveniles are expected to be directed by flow into the turbulence plume (Engineer Analysis: APPENDIX 1). Therefore, over time a greater percentage of small YOY salmonids may be drawn into the path of the discharge jet, be caught in outfall turbulence, and become injured or disoriented. Furthermore, the creation of a deep depression may attract more piscivorous ambush predators than would otherwise occupy a flat river bottom and these additional predators would prey more frequently on the juvenile salmonids out-migrating past this location, disoriented or not.

Some YOY and yearling salmonids will pass by the action area at a larger size (>150 mm TL). Juvenile CCV steelhead that have spent one year or more rearing in their natal streams (yearlings) and smolts close to exiting the Bay-Delta system for the Pacific Ocean are expected be strong enough swimmers that have muscles sufficiently developed so they could avoid the turbulent area and resist the pull of the realigned thalweg; such individuals are also more likely to have a reduced risk of predation in general, due to their larger body size. Initial data indicate some of the CV spring-run Chinook salmon leaving the SJRRP Restoration Area may have a total length greater than 150 mm TL, depending on collection month (SJRRP preliminary data presented in weekly reports ending May 7, 2018, Don Portz, Bureau of Reclamation). At larger sizes, juvenile salmonids can move more volitionally in currents and flows compared to YOY steelhead; however, they do have similar velocity limits and are expected to be swept along during large flow events as examined above (>5,000 cfs). Therefore, larger juvenile salmonids, are expected to experience similar adverse effects from the physical addition of the outfall discharge to the environment as described above, but only under the heavy flow scenario.

In summary, discharging stormwater from this location is expected to have an adverse effect on juvenile CCV steelhead and CV spring-run Chinook salmon as they exit the SJR basin into the Delta. These adverse effects have the potential to decrease the probability of individual survival in juveniles in the entire SJR basin due to the outfall's location near the connection of the SJR mainstem and the entry to the Delta. The adverse effects of the physical aspects of outfall discharge are expected to be more likely and be more severe as river stage and flow increase, since juveniles will be able to swim away from the turbulence plume at velocities below their critical swimming speeds. Overtime, it is expected that a larger percentage of juveniles will be affected as the discharge scours a deep pool in the river bed and aligns the natural thalweg closer to the outfall jet. Therefore, some percentage of CCV steelhead and CV spring-run Chinook YOY will pass by the outfall and be adversely affected by the physical forces of discharging stormwater and this effect will continue as long as the outfall is operated.

<u>sDPS green sturgeon</u>
Adult green sturgeon and juveniles older than 10 months may occupy the SJR mainstem and the Delta at any point of the year (Figure 7), including during outfall operations/discharge. Green sturgeon do not currently reproduce in the SJR basin tributaries and so larvae or juveniles are not expected to out-migrate past the outfall location (NMFS, 2018a).

Green sturgeon are benthic, slow-moving fish and are not known to be attracted to freshets or small, high velocity input sources at the margins of river mainstems like salmonids. It is unlikely green sturgeon will react or be attracted to the stormwater discharge during operations, or become disoriented if caught in the discharge flow due to their benthic natures and large adult body sizes. Over continued operations, if the discharge scours a deeper area in the SJR mainstem bottom, green sturgeon may congregate in the depression as they follow the re-aligned new thalweg in their search for prey items. This change is not expected to adversely affect green sturgeon.

2.5.3.2 Addition of a new water discharge source: the temperature effects
Water temperature in streams naturally fluctuate in response to changes in solar radiation and the ambient air temperature, though these natural temperature changes are typically limited to a 0.6-0.8°C temperature increase for every 1°C increase in air temperature (Morrill et al., 2005). On days when air temperatures are more than 65 degrees Fahrenheit (°F), or 18.3 degrees Celsius (°C), stream temperatures would reasonably measure below these values, especially if the stream was snowmelt fed. Discharge that occurs into urbanized streams during warm days has been shown to raise localized in-stream temperatures. The discharge of stormwater runoff into cold-water creeks can raise stream temperatures above normal levels, with runoff temperatures remaining elevated even during the night and early morning (Davis et al., 2010). During a relatively warm storm event, runoff collects this surface heat and distributes it throughout the watershed.

Infiltration basins can work to control output temperatures so long as the precipitation of a storm does not exceed their retention limits; otherwise, triggered pumping and direct discharge will still transport water warmed by pavement into natural, cooler waterways. The three detention basins are designed to hold the first 0.36 inches of rain, after which they will be pumped out and discharged. The larger the proportion of impervious surface in the watershed that contributes to the stormwater, the greater the amount of potential heat transfer to stormwater.

<u>CCV steelhead</u>
Adult steelhead are associated with optimal water temperatures of 46 to 52 °F or 7.8 to 11.11 °C (NMFS, 2014), and their critical water temperature is identified as 69.8°F or 21 °C. Juvenile steelhead can tolerate slightly higher temperatures, from 59 to 64.4 °F or 15 to 18 °C for optimal rearing and growth, and are considered to have a critical water temperature limit of 72 °F (22.2 °C).

The adult migration in the SJR is expected to be from July through May, which is potentially 334 days in length, extended into the summer because some adults may survive spawning and be traveling back down through the SJR system to again enter the ocean as kelts to breed again in following years. The CDEC station MSD shows higher optimal adult water temperature being exceeded most of the year, being 52 °F or less at Mossdale Bridge for only 54 days on average per year (Figure 15) from early December through late January, which coincides with peak winter migration. Increased water temperatures due to the outfall discharging warm stormwater (from storms on warm days that exceed 0.36 inches of precipitation) are most likely to occur during the typical rainy season and would be expected to decrease the number of days the lower SJR hosts optimal water temperatures at Mossdale Bridge, during the core of adult migration. This would adversely affect local water temperatures from current river conditions.

Adult steelhead are able to tolerate temperatures up to the critical value of 69.8 °F, which is exceeded 124 days on average per year, usually during early July through the end of September, which may prevent them from starting their migration into the tributaries. Adult critical water temperatures are typically seen outside of the adult migration period and the expected rainy season, and therefore outfall operations are not expected to adversely affect the start of steelhead migration because warm precipitation events are unlikely to occur during this period of the year by increasing the number of days that river temperatures at Mossdale are above critical.

The juvenile outmigration through the lower SJR may occur February through June, or potentially over 150 days. The average water temperatures at station MSD shows water temperatures exceed 64.4 °F (higher optimal) 162 days of the year, from about early May through late October (Figure 15), which potentially overlaps with the last couple months of juvenile outmigration. Increases in the water temperatures for additional days during the later rearing and migration period is likely to somewhat decrease juvenile fitness and survivorship over long term operations of the outfall by increasing the number of days water temperatures rise above optimal.

Juvenile steelhead are able to tolerate higher temperatures than adults, with a critical water temperature of 72 °F, which is exceeded 96 days on average per year. However, when juvenile steelhead are present in this area of the SJR, river temperatures exceed this threshold on average only 12% of the time between February through June. Because these extreme high temperatures occur during the end of the juvenile outmigration when even warm storms are not expected, the stormwater outfall is not expected to operate during this time and therefore would not increase the number of days water temperatures might rise above juvenile critical tolerances more than current conditions.

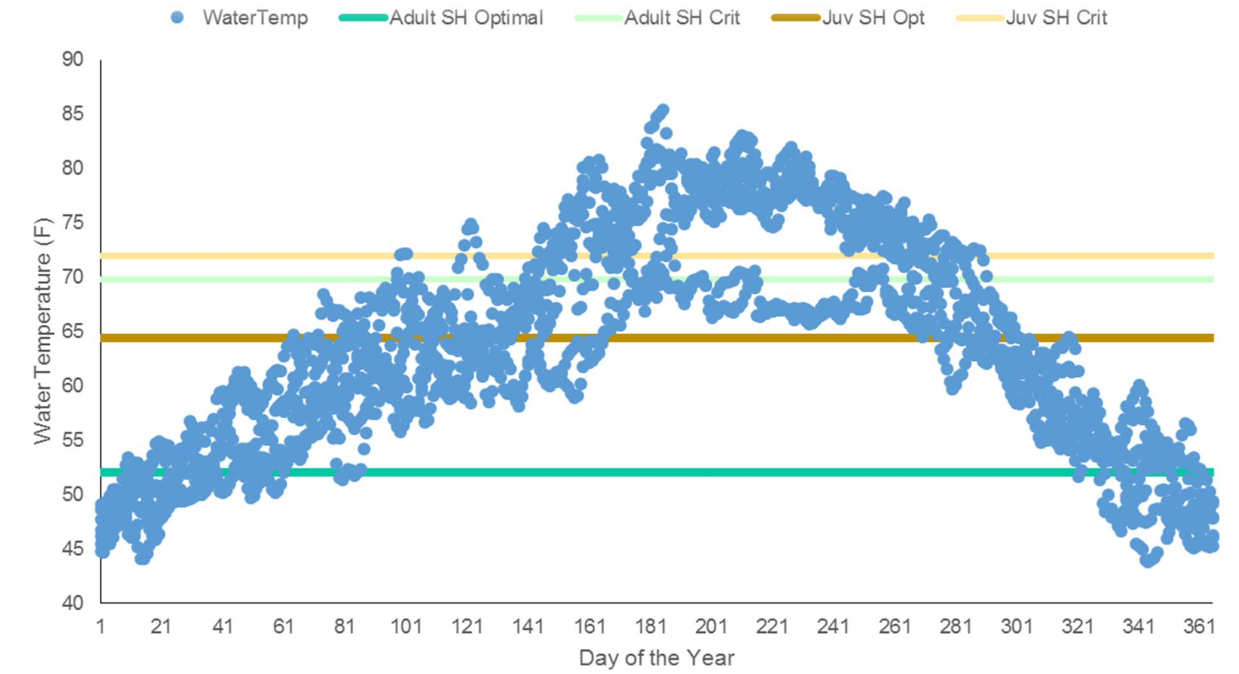


Figure 15. Observed water temperature (°F) at Mossdale Bridge from 2010 to October 1, 2017, arranged as day of the year (Day 1 through Day 365). Data obtained from CDEC, with threshold line indicating adult (green lines) and juvenile (brown lines) steelhead upper optimal to critical water temperatures.

CV spring-run Chinook salmon

The SJRRP has identified adult CV spring-run Chinook salmon migration temperature objectives of less than 59 °F as optimal, and a range of 62.6 through 68 °F as critical (SJRRP, 2010). Juveniles are expected to tolerate higher water temperatures during outmigration, from less than 60 °F for optimal and between 64.4 to 70 °F for critical. Lethal juvenile water temperature is identified as those over 75 °F.

The adult migration in the Sacramento basin occurs from mid-January through August (Figure 6), potentially 228 days in length, depending on how long water temperatures and flow conditions are suitable. The CDEC station MSD optimal adult migration water temperature criteria (59 °F or less) is met 122 days a year at Mossdale (*Figure 16*). Current exceedances coincide with the month of March through the summer, which overlaps a large portion of the spring-run migration timing. Increased water temperatures due to the outfall discharging warm stormwater (from storms on warm days that exceed 0.36 inches of precipitation) are most likely to occur during the typical rainy season and would be expected to decrease the number of days the lower SJR hosts optimal adult CV spring-run migration temperature conditions at Mossdale Bridge. This would adversely affect local water temperatures compared to current river conditions.

Adults are able to tolerate temperatures up to the upper critical threshold of 68 °F (SJRRP, 2010), which is exceeded 127 days on average per year, usually from the end of May through the beginning of October. Based on current conditions, adults are expected to be thermally blocked or unlikely to survive upstream migration after the end of May. Because the current temperature regime has limited adult migration to a couple months, outfall operations in the spring would be expected to adversely affect the length of the migration because any warm precipitation events may increase the number of days the water temperature would go above critical thresholds and make the area unsuitable for adults during their spring migration.

The juvenile CV spring-run salmon outmigration through the lower SJR may occur November through May (Figure 6), or potentially over 211 days. The average water temperatures at station MSD shows water temperatures exceed the optimal threshold of 60 °F on 235 days of the year, from about early March through early November (*Figure 16*), which potentially overlaps with the beginning and early spring months of juvenile outmigration. Increases in the water temperatures for additional days during the early emigration period is unlikely to decrease juvenile fitness or block their outmigration. However, increasing the number of spring month days that water temperatures would exceed optimal temperature is likely to decrease the fitness and movement rates of juveniles proportionally with the number of days optimal temperatures are exceeded,

Juvenile critical water temperature is 70°F, which is exceeded 119 days on average per year; however, these days do not coincide with expected the juvenile springtime occupation period (on average, water temperatures stay below 70°F until the end of May). Because these extreme high temperatures occur after the end of the juvenile outmigration when even warm storms are not expected, the stormwater outfall is not expected to operate during this time and therefore would not increase the number of days water temperatures might rise above juvenile critical tolerances more than current conditions.

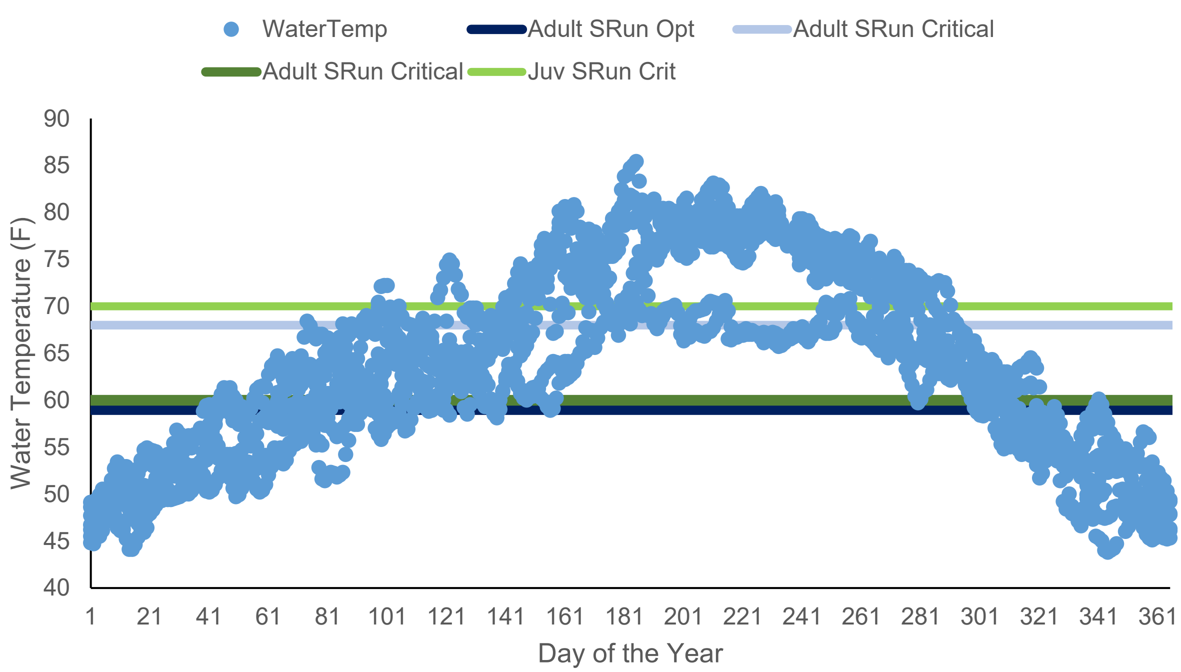


Figure 16. Observed water temperature (°F) at Mossdale Bridge from 2010 to October 1, 2017, arranged as day of the year (Day 1 through Day 365). Data obtained from CDEC, with threshold

line indicating adult (blue lines) and juvenile (green lines) CV spring-run Chinook salmon upper optimal to upper critical water temperatures objectives of the SJRRP.

<u>sDPS green sturgeon</u>
Exact optimal and critical water temperature criteria have not been established for sDPS green sturgeon. Green sturgeon have been observed foraging in coastal estuaries hosting water temperatures ranging from 11.9 to 21.9°C (53.42 to 71.42°F), and under laboratory conditions Mayfield and Cech (2004) reported optimal bio-energetic performance of age 0 and age 1 northern DPS green sturgeon from 15 to 19°C (59 to 66.2°F). These temperature ranges differ slightly from those that coincided with a large successful spawning event that resulted in a large number of juvenile green sturgeon being collected at the Red Bluff Diversion Dam (RBDD) following summer time water temperatures ranging from a low of 54.5°F to a high of 65.5°F (Figure 17).

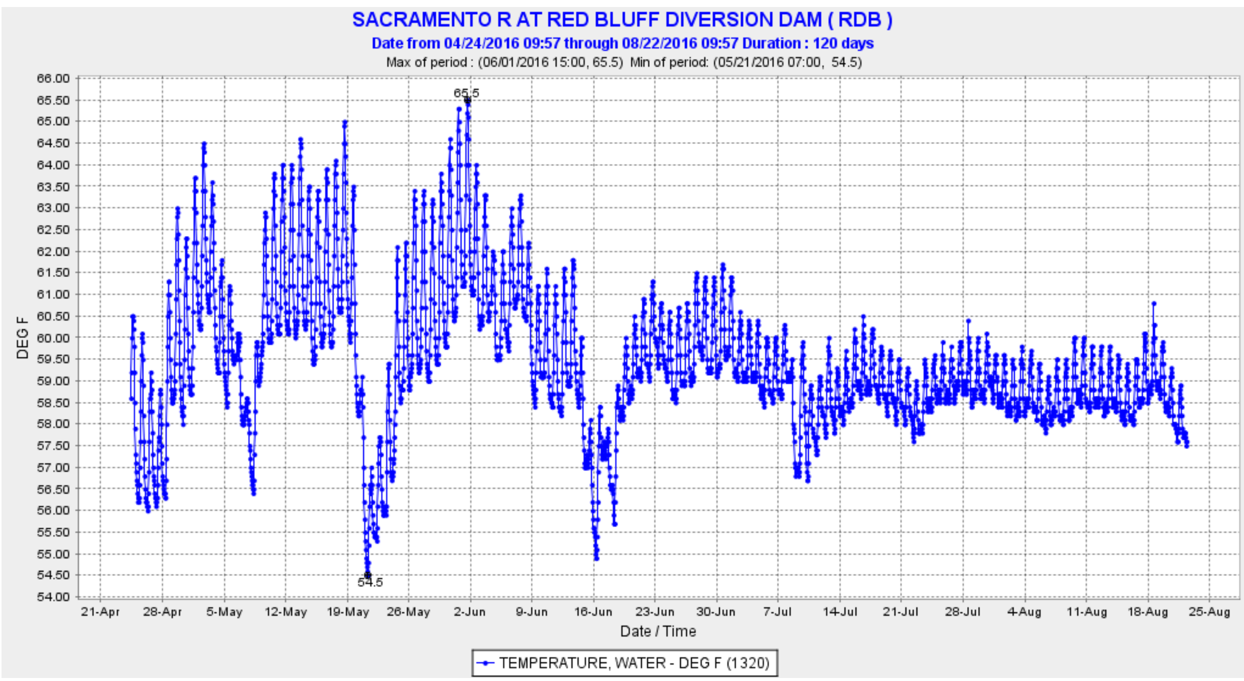


Figure 17. Range of river temperatures (°F) at Red Bluff Diversion Dam around the time period that supported a very successful spawning event (CDEC, 2017c).

Green sturgeon are not currently known to spawn in the SJR basin, though it is likely they did in the distant past. Using the juvenile steelhead optimal temperature as a facsimile threshold (64.4 °F) for optimal adult green sturgeon spawning water temperature, at station MSD, between May through October river temperatures are expected to exceed this value 162 days a year (Figure 15). An adult green sturgeon was recently confirmed in 2017 as being present in the SJR tributary in the Stanislaus River (Breitler, 2017), so adult presence is possible. While this was a singular confirmation, anecdotal records have recorded other adult green sturgeon capture and release in the SJR mainstem and tributaries (Gruber et al., 2012). More adults may recolonize the SJR basin as habitat conditions improve, eventually leading to spawning events somewhere upstream.

The unusual number of juveniles captured in 2016 at the Red Bluff Diversion Dam indicated that the adult green sturgeon spawned in the summer months while the Sacramento River ranged in temperature (Figure 17). The CDEC-MSD records for the SJR indicate river temperatures regularly exceed the 64.4°F threshold during the summer months. Additional days where this temperature threshold may be influenced by warmed stormwater discharge from a warm late spring/early summer heavy rain event could cause adult green sturgeon to avoid swimming further into the SJR basin to suitable spawning locations, which would not be supportive of sDPS green sturgeon recolonizing the SJR basin.

2.5.3.3 Addition of a new water discharge source: the dissolved oxygen effects
For the maintenance of aquatic health, dissolved oxygen concentrations should approach saturation –over 7.0 mg/L in concentration– which is in equilibrium with the partial pressure of atmospheric oxygen. If dissolved oxygen levels in water become too low, aquatic animals can become stressed or die. Salmon and trout are particularly at risk because they require high dissolved oxygen levels.

At sea level, freshwater is saturated with dissolved oxygen at about 14.6 mg/L at 0°C or 32°F and 8.2 mg/L at 25°C or 77°F. Generally, oxygen concentrations are below saturation due to the continuous presence and oxidation of decaying organic matter (suspended, benthic, or sediment). In addition to the organic, or carbonaceous oxygen demand, nitrogenous materials may exert a demand on available oxygen through bacterial oxidation of ammonia to nitrate (Krenkel & Novotny, 1980). Other materials may likewise produce an oxygen demand in aquatic systems. Thus, variations in dissolved oxygen can occur seasonally with primary production, as well as over 24-hour periods in response to temperature and bacterial activity. Concentrations below 5 mg/L may adversely affect function and survival of aquatic biological communities, and extended exposure to water with dissolved oxygen levels below 2 mg/L can lead to death in most fish species (Water Quality Assessments, 1996).

Theoretically, a critical oxygen level for each species exists (Colt et al, 1979); however, only limited data is available. Dissolved oxygen objectives to support salmonids are often set at 8 mg/L, or close to saturation to support maximum embryo survival (NMFS, 2014), though adults exhibit avoidance and delay migration when dissolved oxygen drops below 5 mg/L (Hallock et al., 1970). For green sturgeon, a preferred dissolved oxygen criteria is not stated in the recovery plan, only that sturgeon have been detected in waters down to 6.4 mg/L (NMFS, 2018a).

Fish can resist or tolerate short-term oxygen reductions without suffering permanent harm. It has been determined that certain species may acclimatize to reduced dissolved oxygen levels, as observed in trout species, if the declines in the dissolved oxygen levels are not abrupt (Vinson & Levesque, 1994; Davis 1975). However, low oxygen levels can also trigger an increase in the toxicity of water contaminants to anadromous fish, including ammonia, zinc, lead, and copper (Colt et al., 1979; Davis, 1975). Behaviorally, fish may avoid low dissolved oxygen conditions by physically moving out of an area, if possible.

The detention basins that precede the outfall discharge must fill up before pumping is activated. Ponded water has potential to become anaerobic as bacterial activity increases and breaks down organic materials in the stormwater; however, the project design states these basins should completely infiltrate within 48 hours of receiving stormwater. If the precipitation limits of the basins are reached (>0.36 inches), pumping is activated and the basins are pumped out entirely. The number of days pumping is expected to occur is between 12 to 14 days per year, and may co-occur with migration periods. When the water is discharged, at a rate of 100 to 400 cfs a minute, the velocity of the discharge is estimated at 22.62 ft/s (Appendix 1). This velocity should sufficiently aerate the stormwater discharge, even if limited ponding of the collected stormwater occurred prior to discharge and encouraged bacterial activity leading to decreased dissolved oxygen levels. Therefore, adverse effects to listed fishes originating from decreases to the dissolved oxygen content of the discharged stormwater are not expected.

2.5.3.4 Addition of a new water discharge source: the turbidity effects

While juvenile steelhead seem to prefer foraging in slightly turbid waters (Sigler et al., 1984; Gregory, 1988), juvenile steelhead display reduced growth rates in 25 NTU (Berg, 1982), and mobile juvenile steelhead tend to avoid areas with turbidities over 167 NTU (Sigler, 1980). CV spring-run Chinook juveniles are assumed to have similar reactions to turbidity.

White sturgeon (*Acipenser transmontanus*) eggs have been collected upstream of the action area from Sturgeon Bend to Laird Park during periods SJR mainstem water ranged from 16 to 28 NTU (Gruber et al., 2012). Green sturgeon spawning has never been confirmed in the SJR basin, and a lone adult was only just sighted in an upper SJR tributary in 2017 (Breitler, 2017), but overlap between the spawning of the two species exists in the Sacramento River basin. Gruber et al. (2012) speculate that this is because green sturgeon prefer to spawn in areas where turbidity is less than 10 NTU (Poytress et al., 2011), while white sturgeon spawn readily in turbid areas (on average, at 42 NTU). Besides their reproductive periods, adult green sturgeon are more tolerant of increased turbidity and regularly forage in San Francisco Bay and estuarine Delta waters where turbidity ranges up to 30 to 70 NTU. The green sturgeon recovery plan recommends more study on the effects of altered system turbidity on their health, movement and recovery (NMFS, 2018a).

The planned upland BMPs of infiltration basins are generally expected to perform well in preventing additional turbidity loads from a new urban source, provided the stormwater infiltrates for an initial period rather than being pumped directly through to discharge without being allowed to settle. If the storm event that creates the stormwater is large enough to trigger the automatic basin pumps (>0.36 inches of precipitation), infiltration basin turbidity control is effectively removed. However, since such storm events will likely produce natural spikes in turbidity (>75 NTUs) from erosion and sediment mobilization in upstream tributaries, the contributions to SJR mainstem turbidity from this source is expected to be relatively insignificant. Therefore, adverse effects to listed fishes originating from the expected turbidity levels of discharged stormwater are not expected.

2.5.3.5 Addition of a new water discharge source: water quality effects

Once the outfall is operational, a new stormwater discharge from the City of Lathrop is expected. The water quality of the stormwater discharge will be regulated by the NPDES permitting system, which is implemented through the SWRCB issuance of Clean Water Act 401 certification that stipulates limits on permissible TMDLs and some aquatic life criteria (EPA, 2018). While this aquatic life criteria has helped to improve water quality regarding specific toxins, often this system is not sufficiently protective for listed species that may be more sensitive than the sampled/experimental species used to establish the criteria. Also, stormwater runoff delivers a wide variety of pollutants to aquatic ecosystems, many of which are not listed by the EPA or SWRCB, so discharge of such pollutants often goes unregulated and uncontrolled. Increased urbanization of streams generally leads to decreases in the health and abundance of aquatic species (Closs et al., 2016; Feist et al., 2017; Scholz, 2011), including the abundance and health of salmonids and sturgeon. Post-construction stormwater runoff often picks up a variety of pollutants from both diffuse (nonpoint) and point sources before depositing them into receiving water bodies (EPA, 2017). Constituents may include, but are not limited to: fertilizers, herbicides, insecticides, and sediments (landscaping/agriculture); oil, grease, polyaromatic hydrocarbons (PAHs), and other toxic compounds from motor vehicle operations (roads and parking lots); pathogens, bacteria, and nutrients (pet/dairy wastes, faulty septic systems); toxic metals and metalloid like aluminum, arsenic, copper, chromium, lead, mercury, nickel, and zinc (from building decay, manufacturing or industry byproducts); and the atmospheric deposition onto impervious surfaces from other surrounding land uses (manufacturing industry, freight and trucking exhaust, agriculture field treatments).

Fish exposure to these ubiquitous pollutants in the freshwater and estuarine habitats is likely to cause multiple adverse effects to steelhead and sturgeon, even at pre-project, ambient levels (Hecht et al., 2007; Macneale et al., 2010; Sandahl et al., 2007; Spromberg & Meador, 2006), and are among the identified threats to sturgeon. Contaminants also accumulate in both the prey of and tissues of juvenile salmonids. Depending on the level of concentration, those contaminants can cause a variety of lethal and sub-lethal effects on salmon and steelhead, including disrupted behavior, reduced olfactory function, immune suppression, reduced growth, disrupted smoltification, hormone disruption, disrupted reproduction, cellular damage, and physical and developmental abnormalities (Hecht et al., 2007). Even at very low levels, chronic exposures to those contaminants have a wide range of adverse effects on the ESA-listed species considered in this opinion, including:

- Increases in early development issues in gastrulation, organogenesis (exposure of adults, sub-lethal effects passed to resulting offspring) which lowers hatching success
- Decreases in juvenile survival through reduction in foraging efficiency, reduced growth rates and condition index
- Increased delay in, or issues occurring during smoltification (only in salmonids) rooted in anion exchange, thyroxin blood hormone, and salinity tolerance
- Increases in mortality due to increased susceptibility to diseases and pathogens, and depressed immunocompetence
- Decreased survivorship due to increased predation, reduced predator detection, less shelter use, and less use of schooling behaviors
- Changes or delays to migration patterns, use of rearing habitats, ability of adults to home to natal streams, and spawning site selection
- Changes to reproductive behaviors that affect production, including altered courtship behavior, reduced number of eggs produced, and decreased fertilization success (NMFS, 2016b).

Stormwater infiltration treatment practices, such as infiltration/retention basins, bioretention, bioslopes, and porous pavements (Multi-Agency, 2015) can be highly effective to reduce or eliminate contaminants from runoff to a degree that sufficiently protects anadromous species (McIntyre et al., 2015), as well as providing flow control. Although the City of Lathrop proposes to implement some of these practices (infiltration basins) up to the design storm level stated in the project, this treatment will not eliminate all pollutants in the City's post-construction stormwater. Thus, adverse effects of post-construction upland development stormwater runoff discharge will persist for the design life of the discharge of stormwater runoff from the source sub-sheds when the proposed action is completed.

Stormwater runoff pollutant load and volume is likely to increase as the amount of impervious cover increases (NRC, 2009) with planned build out of the industrial sub-sheds from the City of Lathrop. Pollutants become more concentrated on impervious surfaces until either they degrade in place, or are transported via wind, precipitation, or active site management to another location. Though stormwater discharge from a single post-construction location may be small, especially in comparison to the total volume and pollutant loads in the receiving waterway, these contributions none the less have incremental impacts on total pollutant levels in downstream water bodies. Due to the additive and compound effects of persistent pollutants contributed by small, unrelated land developments with differing levels of stormwater treatment, such development may be more likely to have a greater impact on aquatic life in receiving waterbodies than the stormwater output of large, individual projects since larger actions are often more carefully planned and monitored.

Non-point source urban stormwater impacts to species can have drastic effect at times; adult coho salmon runs in Washington regularly experience acute mortality (fish kills) in otherwise 'healthy' streams that also receive stormwater drainage from urban areas with impervious surfaces supporting high amounts of automobile activity (Feist et al., 2017). This study highlights an extreme response of a salmonid to toxic nonpoint source urban stormwater; the species under consideration in this opinion have not displayed the same response to similar condition even when co-occurring in the same watershed (Scholz, 2011). Data that quantify the exact effects of urban stormwater on steelhead, Chinook salmon, and green sturgeon are severely lacking, which makes analyzing the effects of a new source of non-point stormwater discharge on a subset of these populations difficult.

It is reasonable, however, to conclude that stormwater that is not sufficiently treated will cause adverse effects that are realized at a watershed level due to the expected persistent low-level addition of pollutants and the synergistic effects that occur when different chemicals co-occur. Stormwater constituents that are benign or that are not toxic enough alone to elicit a negative response through interactions with other chemicals may cause significant effects in individual fishes using affected habitat as these new compounds pervade their habitat and bioaccumulate in their prey and tissues (Presser & Louma, 2010, 2013; Closs et al., 2016). ESA-listed species will absorb or ingest some of those contaminants in quantities sufficient to cause injury or death due to modified behavior, disrupted endocrine functions, or immunotoxin disease effects, either by themselves or through additive, interactive, and synergistic interactions with other contaminants in the river. These adverse effects are likely to be greater for sDPS green sturgeon, because of their benthic feeding habits, and for Pacific salmon with sub-yearling, or mixed sub-yearling/yearling life histories. Juveniles of those species are more closely associated with low velocity habitats where contaminants are likely to be more concentrated in fine, suspended sediments and in their prey organisms.

Because sub-lethal responses in individual fishes are difficult to isolate and attribute back to single constituents or nonpoint sources, it is more useful to consider the effects of urban stormwater runoff on fish through changes to their aquatic habitats, because environmental water quality measurements are more quantifiable. Therefore, the adverse effects resultant from the expected increase of urban stormwater pollutant load to the SJR will be discussed further in the effects to critical habitat section below.

2.5.4 Interrelated and interdependent action effects to critical habitat: Outfall operations and discharge

Designated critical habitat within the action area for CCV steelhead and sDPS green sturgeon considered in this opinion consists primarily of freshwater rearing sites and freshwater migration corridors, and their essential PBFs that supports their functionality. These effects will occur during and after each discharge of runoff that will occur throughout the design life of the outfall, although the duration and severity of each effect will vary depending on the storm event characteristics, such as the precipitation volume and discharge of stream flow in the receiving stream according to the water year type.

2.5.4.1 CCV steelhead: Freshwater rearing
Juvenile (YOY, parr, and smolts) and adults (including kelts) CCV steelhead will be subject to these effects, although juvenile life stages will be most affected due to their habitat preference for shallow areas for resting and foraging, where pollutants from stormwater runoff are pervasive and the discharge plume is more concentrated. Yearling or older steelhead may experience fewer effects due to their preference for deeper water conditions, where suspended sediments and contaminants are less abundant, and adults may experience even less effects because they are not expected to feed as much as rearing juveniles.

Forage PBF
Direct pollutants in stormwater runoff from the outfall will add to, and compound with, other pollutants already present in the SJR in ways that adversely affect the amount of food available for juvenile steelhead by injuring or killing their prey, thus reducing the amount of energy available to meet the physiological demands of rearing and migration. Similarly, the differential impact of the discharge of stormwater runoff on prey species is likely to change their relative abundance and their community composition, thus further altering the foraging efficiency of juvenile fishes. Consumption of contaminants ingested inside the bodies of prey, or with plankton, detritus or sediment that is also ingested while feeding, provides a major pathway into the body of steelhead where they are likely to adversely affect juvenile growth and development, suppress their immune systems, and impair sensory functions thereby reducing their survival.

Water quality PBF
Pollutants in the discharge of stormwater runoff interrelated/interdependent with the project will add to, and compound with, other pollutants already present in rearing habitats, in ways that

reduce water quality. The water column is an important connection between many of the biogeochemical processes that move stormwater pollutants through the action area in suspension, solution, or the bodies of aquatic organisms, and is a medium that brings those pollutants into contact with freshwater rearing sites where young steelhead are rearing and developing. There is also the possibility of impaired predator avoidance due to pollutant-diminished sensory abilities.

Water quantity PBF
Where stormwater flow control is used, altered timing and location of water sourcing to streams is likely to occur, particularly in smaller tributaries. Hydromodification resulting from stormwater inputs can increase erosion, scour, and habitat forming processes to the detriment of rearing habitat quality at the point of discharge and areas downstream of a discharge. Scour can remove habitat complexity, resulting in less refugia from high stream velocity; increase turbidity in the water column, which can directly injure fish and impair forage success; and remove habitat elements from rearing areas, decreasing the abundance of epibenthic nutrient sources and prey species. These effects are expected to occur every time stormwater is discharged from the outfall, and will scale with the amount of water discharged by the outfall. Habitat changes linked to scour effects are expected to increase and worsen over time, and redirect more of the river flow closer to the eastern bank where the outfall and discharge is located.

2.5.4.2 CCV steelhead: Freshwater migration corridors
In addition to the effects discussed above for CCV steelhead freshwater rearing, the operation and discharge of stormwater from the outfall is expected to have small adverse effect on the functionally of freshwater migration corridors.

Free of obstruction PBF
Migration can be impaired due to pollutant-diminished sensory abilities, which is a form of obstruction. Trace amounts of copper in stormwater have been shown to diminish the ability of salmonids to navigate (Hecht et al., 2007; McIntyre et al., 2012). This effect is likely to persist in the environment only as long as the outfall is actively discharging. The extent to which stormwater pollutants may chemically alter the homing ability of returning adults is dependent on the composition of the pollutants in the stormwater at discharge and the efficacy of the upland stormwater treatment.

Water quality PBF
Pollutants in the discharge of stormwater runoff interrelated/interdependent with the project will add to, and compound with, other pollutants already present in migratory habitats in ways that reduce water quality. The water column is an important connection between many of the biogeochemical processes that move stormwater pollutants through the action area in suspension, solution, or the bodies of aquatic organisms, and is a medium that brings those pollutants into contact with freshwater migratory sites where they contact salmon that are undergoing growth, development, and smoltification.

If stormwater quality control BMPs were fully implemented in upland development, including extensive incorporation of stormwater control and treatment, outfall discharge and operation would be expected to have a small adverse impact on the condition of PBFs for CCV steelhead freshwater rearing and freshwater migration critical habitat. However, since shed-specific upland development designs, stormwater treatment and water quality monitoring plans are unavailable, the extent to which these PBFs will be adversely altered cannot be estimated accurately. Therefore, NMFS concludes that the proposed project will adversely affect the identified steelhead PBFs.

2.5.4.3 sDPS green sturgeon: Freshwater riverine systems
As long-lived, benthic fish that spend an appreciable amount of their life history cycle in bays, estuaries, and lower elevation mainstem of large rivers, green sturgeon are vulnerable to the effects of stormwater pollution, particularly in suspended sediments and bioaccumulation of contaminants in their prey species, though otherwise exposure to pollutants has not be identified as a limiting factor in their recovery (NMFS, 2018a).

Food resources PBF
Pollutants in the discharge of stormwater runoff interrelated/interdependent with the outfall construction will add to, and compound with, other pollutants already present there in ways that adversely affect the amount of food available to sDPS green sturgeon by injuring or killing their prey. This will reduce the amount of energy available for young/subadult green sturgeon foraging downstream and they may become unable to meet the physiological demands of growth needed prior to migration to the Pacific Ocean. Similarly, the differential impact of the discharge of stormwater runoff on prey species is likely to change their relative abundance and their community composition, thus further altering the foraging efficiency of mature and sub-adult fishes. Consumption of contaminants ingested inside the bodies of prey, or with plankton, detritus or sediment that is also ingested during feeding, provides a major pathway into the body of sDPS green sturgeon where they are likely to adversely affect mature and sub-adult fish growth and development, suppress their immune systems, and impair sensory functions thereby reducing their survival.

Sediment quality PBF
The discharge of stormwater runoff interrelated/interdependent with the outfall construction will add pollutants to, and compound with, other pollutants already present in rivers in ways that adversely affect the chemical composition of the sediment in freshwater riverine systems used by sDPS green sturgeon in the action area. Most pollutants in stormwater runoff adsorb to organic particulates and settle out in sediments. There the pollutants undergo a complex process of biogeochemical cycling driven by physical forces related to water flow and circulation, sediment re-suspension, deposition, and bed dynamics, chemical fate and transport, and biotic processes including food web relationships and bioaccumulation that transport the pollutants to the estuary and ocean. The particulate forms of those pollutants are either immediately bioavailable at discharge through re-suspension, are a delayed source of toxicity through bioaccumulation in prey and tissues, or are available when water quality conditions favor dissolution at a later date. Specifically, contaminated sediments will influence food sources and individual fish through direct ingestion of prey, plankton, and detritus or sediment while feeding, or by deposition of particulate forms of pollutants on the gill surfaces or sensory organs.

Water depth and water flow PBFs
Because the use of the outfall over time is likely to scour additional depth into the SJR below and downstream of the outfall discharge, an increase in water depth is expected. However, this

change is not expected to adversely affect the water depth PBF of sDPS green sturgeon critical habitat since green sturgeon require greater water depths compared to CCV steelhead. Given the highly variable volume of the flow in the SJR at this location (Figure 9), it is difficult to assign value to positive or negative effects on water flow from the detention and eventual discharge of stormwater from this location.

Water quality PBF

Pollutants in the discharge of stormwater runoff interrelated/interdependent with the construction of the outfall will add to, and compound with, other pollutants already present in ways that adversely affect water quality in freshwater riverine systems used by sDPS green sturgeon. The water column is an important connection between many of the biogeochemical processes that move stormwater pollutants through the action area in suspension, solution, or the bodies of aquatic organisms, and it is a medium that brings those pollutants into contact with sDPS green sturgeon.

Similar to the conclusion made for CCV steelhead critical habitat, the effects of the proposed outfall operation are likely to have an adverse impact on the condition of PBFs that support sDPS green sturgeon critical habitat, through impacting the food resources, sediment quality and water quality of downstream freshwater riverine sites. If stormwater quality control BMPs were fully implemented in upland development, including extensive incorporation of stormwater control and treatment, outfall discharge and operation would be expected to have a small adverse impact on the condition of the PBFs. However, since shed-specific upland development designs, stormwater treatment and water quality monitoring plans are unavailable, the extent to which these PBFs will be adversely altered cannot be estimated accurately. Therefore, NMFS concludes that the proposed project will adversely affect the identified green sturgeon PBFs.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

2.6.1 City of Lathrop planned development

The City of Lathrop has a General Plan that was last amended in 2004. The City is planning to develop 21,000 new residences, 5,243,942 square feet of commercial and office property, and 788,363 square feet of new industrial developments within city limits (City of Lathrop, 1991; 2015; 2016). The River Islands at Lathrop is a project that consists of a 4,905 acre masterplan community located on Stewart Tract and Paradise Cut, which border the action area. The proposed alteration of riparian habitat associated with the River Islands project is under separate consultation with NMFS and USFWS.

The City of Lathrop also operates a wastewater treatment plant to manage sewage from existing and planned growth. The current wastewater treatment plan is not permitted to discharge to the

San Joaquin River and instead requires a series of recycled water basins and irrigated land application.

A similar stormwater outfall is planned upstream 4.5 miles to the north in central Lathrop. It is proposed to have a similar footprint and loss of understory vegetation, with an additional 215 feet of riprap. The second outfall will also require a USACE permit and will undergo consultation with NMFS regarding effects to listed fishes and their critical habitat, if USACE determines the project may affect listed anadromous species or their designated critical habitats.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the *Environmental Baseline* (section 2.4).

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (section 2.5) to the environmental baseline (section 2.4) and the cumulative effects (section 2.6), taking into account the status of the species and critical habitat (section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species.

Both CCV steelhead and sDPS green sturgeon are listed as threatened under the ESA, and the most recent 5-year status reviews for these DPSs conclude that the threatened status is still applicable (NMFS, 2015; 2016b). Despite recovery efforts, both CCV steelhead and sDPS green sturgeon remain threatened in large part because of widespread degradation, destruction, and blockage of their natural freshwater habitats. The CV spring-run Chinook salmon ESU is also listed as threatened under the ESA but is considered extirpated from the SJR basin (NMFS, 2016a). Through recovery and SJRRP reintroduction efforts (SJRRP, 2018), CV spring-run Chinook salmon are expected to use the action area. One of the primary reasons these fish species are listed under the ESA is the ubiquitous artificial modifications to, and destruction of, crucial freshwater habitat and the services it provides in the CV. This threat currently persists and is expected to grow as human populations, land development and freshwater demands increase in California. Such trends are likely to suppress the recovery potential of these populations, despite recovery efforts, based on the effective scale of adverse habitat changes compared to recovery actions.

The placement of an additional artificial structure (the outfall) and riprap on a pre-existing levee is expected to further degrade the remaining functionality of the freshwater habitat available on the SJR mainstem in the action area. This project is also likely to prevent this area from being returned to a natural state through restoration efforts, due to armoring that will maintain the stability of the structure and the outfall's intended purpose of discharging stormwater. As with most communities in the CV, the City of Lathrop's masterplan is to continue developing almost all available plots within the city limits as soon as possible, leaving very little space for natural ecosystems. Because of the location of the outfall, on the lower SJR mainstem/entry to the Delta, the proposed action has potential to affect the success of all anadromous fish that use the SJR basin and its tributaries since they must pass by this location at least twice to successfully complete their life cycles. The effects to species through structure construction and riprap placement are expected to cause some short-term disturbance, decreased survivorship probabilities, and disruption the normal behaviors/habitat use of individual fish in the immediate area.

The placement and occupation of the outfall structure and riprap in the designated critical habitats of CCV steelhead and sDPS green sturgeon effectively removes functional acreage from their critical habitats in perpetuity, though the total amount removed is small. Because the project must occupy some amount of critical habitat to proceed as proposed, a purchase of compensatory mitigation credits is included as part of the action to offset this unavoidable impact to some degree. The purchase of compensatory mitigation credits will restore and preserve, in perpetuity, 0.4919 acres of SRA or similar types of riverine habitat that will be beneficial to CCV steelhead. The shallow, river margin habitat used by juvenile salmonids in particular will be impacted by the project. In offset, most of the mitigation banks that serve the action area offer floodplain or other habitat that can support rearing salmonids in the same way the river margin habitat otherwise would have, had the project not occurred. At least, SRA types of conservation credits can benefit both adult and juvenile listed fishes, even if such banks are located far from the action area and individuals affected by the project would be unlikely to benefit from the compensation purchase. And although the banks that cover the action area in their service area may not technically offer sDPS green sturgeon credits, we expect that some sDPS green sturgeon individuals should benefit from the purchase of SRA credits since individuals should be able to access the purchased riverine habitat areas created and maintained by the banks/programs. The credit purchase amount is a greater amount of restoration and preservation than the spatial footprint of the outfall and riprap placement footprint in an attempt to address the fact that suitable habitat away from the action area will likely not benefit individuals adversely affected in the action area. In addition, the compensatory mitigation serves as a form of advance mitigation because the habitat at the bank may have been restored between one year (Bullock Bend Mitigation Bank) to 8 years (Cosumnes Floodplain Mitigation Bank) before the construction of the outfall and project completion.

The effects of the interrelated/interdependent operation of the outfall will not be offset by conservation credit purchase. The intended purpose of the outfall structure is to provide stormwater discharge service to the newly developed areas, and the negative impacts anticipated from long term operations are dependent on the treatment of the stormwater prior to discharge. Stormwater control guidelines were accepted in 2015 (City of Lathrop, 2015; Multi-Agency, 2015) for the City of Lathrop and the surrounding municipalities, and some of new development. The current Lathrop city service plan (City of Lathrop, 2016) and Stormwater Master plan (City of Lathrop, 1991) does not incorporate stormwater recommendations and regulations of the SWRCB, the EPA, or the new Multiagency stormwater quality control manual. In addition, plans to retrofit old stormwater infrastructure, such as city streets and public properties, to allow control and treatment of stormwater that these services generate to meet current stormwater standards, are not in place. The treatment and control of industrial- and urban-sourced stormwater associated by land development and impervious cover seems to be at the discretion of developers of new plots rather than a consistent adherence to a comprehensive stormwater quality plan. In addition, the NPDES certificates that regulate small discharges such as this municipality generally only address the EPA approved TMDLs that apply to the local waterbodies and not the wide variety of constituents of concern, so non-point urban pollution is anticipated to increase with this new discharge location. As such, CV spring-run Chinook salmon, sDPS green sturgeon, and CCV steelhead are expected to be exposed to an increase of pollutants that 1) are permitted by the NPDES program and meet NPDES permit requirements and 2) stormwater pollutants that have not been addressed by a TMDL and therefore are not regulated by the NPDES program. Even stormwater sufficiently treated/controlled to meet NPDES compound standards may be expected to contain pollutants in sufficient quantities that would elicit sub-lethal effects in fishes. These effects will affect fishes in perpetuity after the outfall structure is constructed, over an indeterminate distance downstream. As the city grows in population, transportation use, and impervious cover percentage, impacts to aquatic systems and fishes are expected to increase further as pollution concentration increases.. There is the potential for this outfall to affect the success of rearing juveniles using the estuarine waters of the SJR and the Delta, depending on the stormwater contaminant types and concentrations, which is expected to decrease the number of surviving juveniles that would otherwise be produced by this system by further compounding already existing issues.

NMFS considers it more likely that the stormwater discharge is expected to cause adverse effects in critical habitat functionality by introducing contaminants into their prey, which will also adversely affect individual fish. Prey base effects can occur through the introduction of pesticides, heavy metals, or various petroleum-based compounds, which will either kill the prey, reduce prey abundance, alter prey species compositions, or introduce these constituents into the tissues of the prey and eventually bioaccumulate to toxic levels in the fish as they continue to ingest contaminated prey. The outcome for individual fish in bioaccumulation situations may entail reduction in individual fitness through a variety of pathways, including suppressed autoimmune functions, decreased growth, abnormal behavioral phenomena, reduced predator avoidance performance, decreased reproductive potential, and increased progeny birth defects.

As the human population in the CV are projected to increase in the future, associated freshwater water demands are also expected to increase. Coupled with the expectations of climate change to produce extreme swings in California precipitation patterns, low water year types may become more frequent and more severe. The SJR is historically a snowmelt-fed system; however, if snow pack become unavailable, surface water in the SJR will become limited. Thus, dependence on other sources of water to dilute stormwater pollutants is expected to become limited, especially as new sources of discharge are planned for installation in the near future. Better water quality control of new sources of urban discharges is a very important step needed to ensure that the water quality of aquatic habitats will be maintained at a sufficient quality that can support threatened aquatic species and the functionality of the prey base they depend on, even during low precipitation/snowpack years and droughts.

Over and above the current listing statuses of the species under examination, the degraded condition of their critical habitats within the action area, and the expected adverse influence of climate change, the construction of the proposed project is expected to cause fishes to temporarily change their behavior patterns, inflict a variety of sub-lethal physiological effects, temporarily delay their migrations and reduce their natural movements during work activities, and slightly increase the predation risk to juveniles. These adverse effects are likely to occur despite the employment of several conservation BMPs and AAMs designed to lessen the adverse impacts to listed fishes and their habitats. However, many of the adverse effects expected to occur during construction are temporary in nature and are expected to affect a small number of individuals. The applicant is purchasing mitigation credits in an effort to offset unavoidable adverse effects associated with the placement of artificial structure and riprap in critical habitat. The adverse effects associated with the construction of the structure and the beneficial effects of the purchase of credits are expected to act in perpetuity. The interrelated/interdependent action of using the outfall to discharge treated stormwater is associated with a host of adverse impacts to fishes and their critical habitats that are also expected to re-occur every year in perpetuity, as long as the City operates the outfall. Long-term discharge effects are anticipated to include physical injury and disorientation to a limited number of juvenile salmonids during discharge, increased predation risk in juveniles associated with disorientation events, an increase in the number of days water temperatures near MSD station exceed optimal and critical thresholds, and most importantly, an increase in the amount of pollutants in the SJR and downstream waterways.

Adding together all of the adverse and beneficial effects associated with this proposed action, effects of the interrelated/interdependent action, the environmental baseline and the cumulative effects, and taking into account the status of the species and critical habitat, this action is not expected to appreciably reduce the likelihood of survival or recovery of the listed species examined in the opinion because it is anticipated only a few individuals of each population will experience severe effects from this project. Though these impacts will re-occur each year, the potential reduction in numbers is anticipated to be small compared to the total population. In addition, although the proposed action is expected to degrade and reduce the functionality of critical habitat PBFs in the action area, the proposed action is not expected to appreciably diminish the value of the designated critical habitat due to the combination of the small footprint of the structure and riprap relative to the amount of critical habitat that is similar in function and locally available, the offset of some adverse impacts to critical habitat through the purchase of credits at a compensatory mitigation bank, and the expected efforts to control stormwater quality through upland treatment, as required by the NPDES program and City of Lathrop stormwater manual (Multi-Agency, 2015).

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCV steelhead, CV spring-run Chinook salmon, or sDPS green sturgeon, or adversely modify or destroy designated critical habitat for CCV steelhead or sDPS green sturgeon.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “Incidental take” is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

Although our jeopardy and adverse modification analysis indicates that adverse impacts to habitat are likely to occur in the future from the interrelated/interdependent action of stormwater discharge, NMFS is not including incidental take for this activity in this incidental take statement for the following reasons: 1) as the lead federal agency for this consultation, USACE has determined that they do not have discretion over post-construction activities, such as stormwater discharge; and 2) NMFS cannot predict the level of impact resulting in take to listed species and their habitats with the current limited information on frequency and content of the future stormwater discharge. The applicant, the City of Lathrop, can pursue take coverage for the stormwater discharge if it becomes warranted in the future through Section 10 of the ESA.

2.9.1 Amount or extent of take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

Adult and juvenile CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon are expected to be incidentally harassed, harmed, or killed as a result of the proposed action. The construction of the outfall and placement of riprap includes vibratory pile driving to install a cofferdam, which will be dewatered to allow construction in-the-dry below the OHWM. General construction and cofferdam installation is expected to potentially alter their normal behaviors, even during the proposed in-water work window, since both CCV steelhead and green sturgeon are present year round (Figure 8) in the mainstem of the SJR at this location. These actions will produce underwater noise and have the potential to increase water turbidity from the disturbance. Fish are expected to avoid the immediate area or experience increased stress levels. Take is also anticipated in association with the placement of artificial structure and riprap because it will reduce the amount of habitat available locally and will reduce available feeding and resting habitat for rearing and migrating CV spring-run Chinook salmon and CCV steelhead juveniles and, potential foraging areas for adult sDPS green sturgeon. A reduction in the amount of feeding and resting areas is expected to reduce the fitness of fishes that would have otherwise used this area.

NMFS cannot, using the best available information, quantify and track the amount or number of individuals that are expected to be incidentally taken per species because of the variability and uncertainty associated with the population sizes of the species, annual variation in the timing of migration, and variability regarding individual habitat use of the action area. However, it is possible to express the extent of incidental take in terms of ecological surrogates for those elements of the proposed action that are expected to result in incidental take.

These ecological surrogates are measureable, and USACE can monitor the ecological surrogates to determine whether the level of anticipated incidental take described in this incidental take statement is exceeded.

2.9.1.1 Incidental take associated with elevated underwater noise and disturbance

The most appropriate threshold for incidental take consisting of fish displacement or behavior modification associated with elevated underwater noise is an ecological surrogate of the amount of habitat disturbance due to elevated underwater noise and vibration within a certain distance from the construction site. Vibratory pile driving is expected to produce underwater pressure levels over 150 dB_{RMS} out to 100 meters from the location of the pile driving sites. Though these elevated levels are not expected to injure or kill fish directly, they are expected to cause disruption of normal habitat utilization and elicit temporary behavioral effects in CCV steelhead and sDPS green sturgeon juveniles and adults leading to harm as described below. Any behavioral alterations in juvenile fish are expected to decrease their fitness and ultimate survival by decreasing feeding opportunities which will decrease their growth, and by causing area avoidance which will delay their downstream migration and increase their predation risk. Adult fitness is expected to decrease slightly when area avoidance delays their upstream migration, and in the case of adult sDPS green sturgeon, will also cause decreased feeding opportunities.

Elevated noise disturbance is also expected to elevate fish stress levels. Beyond 100 meters, underwater sound is expected to attenuate down to effective quiet underwater sound levels, or 150 dB_{RMS} or less, and therefore 100 meters from the pile being driven is considered the limit of this ecological surrogate. For simplicity, this surrogate will be limited in general to 100 meters from the boundary of the construction footprint and cofferdam placement. All other temporary disturbance effects related to noise created by equipment operation, construction noise, and human presence is expected to also be contained within the 100 meter boundary of anticipated incidental take. Exceeding 150 dB_{RMS} beyond 100 meters from the construction site boundary will be considered exceeding expected incidental take levels for this surrogate.

2.9.1.2 Incidental take associated with elevated in-river turbidity plumes and disturbance

The most appropriate threshold for incidental take consisting of fish disturbance and sub-lethal effects associated with elevated in-river turbidity plumes is an ecological surrogate of the amount of increase in downstream in-river turbidity generated by dewatering or cofferdam pile driving activities. In-river pile driving, cofferdam dewatering, and in-river pile removal are expected to mobilize sediment and increase water turbidity beyond natural levels. Increased turbidity is expected to cause harm to adult and juvenile CCV steelhead through elevated stress levels and disruption of normal habitat use. These temporary responses are linked to decreased growth, survivorship, and overall reduced fitness as described for underwater noise avoidance.

The surrogate for turbidity increase will be based on CCV steelhead sensitivity to raised turbidity levels. According to the data in Figure 14 (CDEC, 2017), typical turbidity in the SJR during the in-water work season is usually less than 50 NTU. 50 NTUs is already above the range at which steelhead experience reduced growth rates (25 NTU) but below the range steelhead would be expected to actively avoid the area. Therefore, the turbidity (in NTU) immediately downstream of the boundary already established for the construction noise/pile driving disturbance surrogate (100 meters in the SJR waterway from the northernmost boundary of the construction footprint and cofferdam placement) cannot measure more than 25 NTU above the turbidity level in SJR water measured immediately upstream of project activities. Within the already established 100 meter disturbance surrogate, SJR river water cannot be more than 50 NTU above the turbidity level in upstream measurements. Of note, CDEC's MSD station turbidity readings cannot be used to represent the baseline turbidity of the SJR since project activities are expected to influence this value because the project location is upstream of the MSD station location. Since in-river values change daily, the upstream comparison value must therefore be taken daily, in association with the downstream readings. Exceeding these tiered turbidity thresholds will be considered as exceeding the expected incidental take levels.

2.9.1.3 Incidental take associated with placement of permanent artificial structure and habitat occupation by artificial material

The most appropriate measurement of harm to CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon associated with placement of permanent artificial structure and habitat occupation is a surrogate of the amount of degradation of critical habitat function in the immediate area associated with artificial structure placement and material occupation. The artificial hard structure and materials would occupy benthic substrates that support benthic prey of juvenile CCV steelhead, CV spring-run Chinook salmon and sDPS green sturgeon, reducing feeding opportunities and negatively affecting their potential growth rates. The hard structures and the new water velocities created around them also reduce the possibility of natural processes from otherwise occurring in the area, like aquatic vegetation or large woody material establishment, preventing juveniles from resting or sheltering in the immediate project area. Adult green sturgeon are also expected to experience reduced feeding opportunity and reduced fitness following project completion. While habitat functionality will not be lost completely, the outfall will be used and maintained in perpetuity; therefore, the adverse effects associated with these structures will also remain as long as the artificial structure and riprap remain.

On the bank, USACE estimates that the structure and riprap will occupy 0.185 acres of riparian habitat above the OHWM on the leveed bank. Riparian trees are being retained to the extent feasible without changing the project placement. Below the OHWM, in aquatic habitat, the pad and the riprap are estimated to occupy a 0.093 acre footprint. Therefore, permanent degradation of critical habitat will be limited to 0.185 acres above the OHWM and 0.093 acres below the OHWM, for a degradation surrogate of 0.278 acres of total affected habitat. Exceeding this total acreage surrogate amount for structure placement will be considered as exceeding the expected incidental take level.

2.9.2 Effect of the take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitats.

2.9.3 Reasonable and prudent measures

"Reasonable and prudent measures" (RPM) are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken by USACE, or its applicant, to minimize the extent of disturbance to listed species created by construction activities and equipment operation in the action area, related to both direct and indirect effects, as discussed in this opinion.

2. Measures shall be taken by USACE, or its applicant, to reduce the extent of degradation and alteration to the critical habitats in the action area, related to both direct and indirect effects of this project, as discussed in this opinion.

3. USACE, or its applicant, shall prepare and provide NMFS with a monitoring plan that includes: a) monitoring and evaluation of the implementation and performance of construction/site AAMs and BMPs chosen to conserve and protect CCV steelhead and sDPS green sturgeon individuals, and their critical habitats in the action area; b) monitoring and evaluation so that the ecological surrogates for incidental take of listed species associated with this project will be monitored and documented, to ensure incidental take does not exceed expected levels. In addition, USACE or its applicant shall submit to NMFS a monitoring report on the results of the monitoring and evaluation described in the monitoring plan.

2.9.4 Terms and conditions

The terms and conditions described below are non-discretionary, and the USACE or its applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The USACE or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in the ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement RPM 1:

    a. The City of Lathrop, USACE, and any other local, State, and Federal agencies associated with this project shall include in bid packages to contractors a specific requirement that addresses the implementation of the identified AAMs necessary to reduce and limit the amount of take, the required environmental monitoring to ensure AAM/BMP performance, and a clause that includes the schedule of the construction activities to limit the impacts of construction on CCV steelhead and sDPS green sturgeon by use of the seasonal in-water work window of July 1st through October

31st, and the daily work schedule of 0800 to 1800, in order to limit the extent of harm or harassment that fish experience.

b. Underwater sound shall be monitored to ensure that the limit of incidental take does not exceed effective quiet, or 150 dB RMS, beyond 100 meters from the point of construction activity (section 2.5, Effects of the Action), in order to limit the extent of harm or harassment.

c. If pumps are required to dewater area, the pumps shall be checked periodically to ensure they are working properly and fish are not being entrained and taken up by the pumps.

d. A qualified biologist shall use a held-hand turbidity monitor to conduct water quality monitoring during all in-water and dewatering pumping activities to insure the turbidity control measures are functioning as intended. If an in-river turbidity plume is created and conditions within the plume exceed take limits for CCV steelhead described in section 2.9.1.1 under the heading "Take associated with elevated in-river turbidity plumes and disturbance," the applicant and/or contractors will cease construction and adaptively manage the turbidity control AAMs/BMPS until increases to turbidity downstream cease.

2. The following terms and conditions implement RPM 2:

a. Only the three willow bunches shall be fully removed from the project footprint, as previously identified in the BA. All other vegetation removal shall be limited to trimming activities only, and trimming shall be limited to the absolute minimum amount required for construction access. Clearly mark or flag with construction tape which trees/vegetation are to be removed, which are to be trimmed to allow access, and which are to be protected, in order to ensure the preservation of those which are not planned for removal.

b. Remaining trees shall be protected from damage during construction activities and riprap placement to ensure their continuing survival as part of the riverine habitat. Protective measures may include wrapping their trunks with burlap and/or creating a scaffold buffer of scrap timber around the trunks, in both cases to buffer against damage. A qualified biologist will ensure proper application of these protective measures.

c. The construction and placement of structures on the river bank shall be limited to the amount described in the project BA, no more than 0.093 acres of habitat occupied below the OHWM in the SJR and no more than 0.185 acres above the OHWM.

d. The placement of riprap on the river bank shall be limited to the extent described in the project BA. Voids created by the riprap boulders shall be filled by smaller diameter rocks/gravel when below the OHWM to avoid supporting piscivorous predator ambush habitat. After the first storm and snowmelt season following placement of this smaller gravel, the area shall be examined to ensure the smaller gravel was not scoured out and effectively removed. If it is found to be removed, USACE or its applicant must develop a plan for maintenance of this BMP over time so that this adverse effect can be reduced and controlled, provide NMFS with a draft of the plan for review, and implement the plan after receiving NMFS' concurrence.

e. Disturbed areas that were graded to minimize surface erosion and siltation will be re-contoured and stabilized at the end of the construction year to ensure erosion and sediment mobilization into the SJR will be avoided.
f. To compensate for unavoidable permanent impacts caused by outfall and riprap placement to the riverine habitat used by CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon, USACE's applicant shall purchase mitigation bank credits or participate in an in-lieu fee program that includes the action area in its "service area" at a minimum 3.3:1 ratio (credits to net acreage of permanent impact) for impacts below the OHWM and 1:1 ratio for impacts above the OHWM. The applicant shall only purchase credits that will benefit steelhead/salmonids from a conservation bank that is NMFS-approved. Green sturgeon mitigation bank credits do not currently exist, though green sturgeon may benefit from the purchase of credits from banks that offer riverine credits containing access to large river mainstems and deeper channels (>2 meters). Although the applicant will purchase the credits, USACE must ensure that the purchase is finalized prior to completion of the installation phase of the project, in order to meet this term and condition.

3. The following terms and conditions implement RPM 3:
    a. In the course of monitoring and evaluating the construction portion of the project, USACE or its applicant shall contact and coordinate with NMFS within 24 hrs after an incidental take surrogate is observed or suspected of being exceeded, so that USACE or its applicant in coordination with NMFS can work to reduce take back down below applicable levels. If individual CCV steelhead or sDPS green sturgeon are observed by a qualified field biologist as being harassed, injured, or killed during construction, USACE or its applicant shall cease construction activities on site and contact NMFS to coordinate on how to proceed with the project in a manner to avoid recurrence of individuals being taken.
    b. The monitoring report related to RPM 3 shall include record of adherence to project schedules, project milestone completion dates, and details regarding AAM/BMP implementation and performance.
    c. The monitoring report related to RPM 3 regarding construction activities shall be submitted to NMFS by December 31st following completion of outfall construction, regardless of whether the outfall has begun discharge operations.

Updates and reports required by these terms and conditions shall be sent to:

San Joaquin River Branch Chief – Erin Strange
California Central Valley Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814

2.10 Conservation recommendations

Section 7(a)(1) of the ESA 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).

- The City of Lathrop and USACE 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 Delta and lower SJR. Doing so would aid restoration of the functionality of existing critical habitats in general, and improve the recovery probability of both CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon.
- Prioritize and continue to support flood management actions that set levees back from rivers and, in instances where this is not technically feasible, land-side levee repairs should be pursued instead of waterside repairs. Setting back levees, or allowing rivers to naturally widen by only performing landside repairs, would increase the availability of floodplain habitat, which is currently limited but an important component of CCV steelhead critical habitat. Doing so would increase the recovery probability of the CCV steelhead DPS and CV spring-run Chinook salmon ESU through improved juvenile rearing conditions.
- Use biodegradable oil in equipment and onsite vehicles. Doing so will reduce the amount of construction equipment contamination resultant from the project, and available critical habitat quality will be better maintained, in support of CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon recovery.
- The City of Lathrop should update applicable stormwater treatment management plans to include specific attainment standards pertaining to new constituents of emerging concerns as they are added to the EPA's aquatic life criteria list, the TMDL/Clean Water Act section 303(d) list for the SJR, or to the Sacramento River Basin and San Joaquin River Basin Water Quality Control Plan, so that aquatic life degradation associated with specific pollutants can be controlled and minimized by upland treatment and control before discharge, in perpetuity.
- Prepare and utilize a long-term stormwater end-of-pipe quality monitoring and control evaluation plan to assess low impact development (LID)/green stormwater treatment performance, including flexibility and planning for adaptive management.

2.11 Reinitiation of consultation

This concludes formal consultation for the South Lathrop Regional Outfall Project.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the USACE and descriptions of EFH for Pacific Coast salmon (PFMC, 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat affected by the project

The geographic extent of salmon freshwater EFH is described as all water bodies currently or historically occupied by PFMC managed salmon within the USGS 4th field hydrologic units identified by the fishery management plan (PFMC, 2014). This designation includes the Lower San Joaquin River (HUC 18040002) and the San Joaquin Delta (HUC 18040003) for all runs of Chinook salmon that historically and currently use these watersheds (spring-run, fall-run, and late fall-run). The Pacific Coast salmon fishery management plan also identifies Habitat Areas of Particular Concern (HAPCs): complex channel and floodplain habitat, spawning habitat, thermal refugia, estuaries, and submerged aquatic vegetation. Because of the extensive urbanization that has occurred in the CCV over the last 100 years, the SJR in the action area has been leveed and channelized and is no longer considered complex channel and floodplain HAPCs. Downstream of the outfall, the stormwater discharge may adversely affect estuarine HAPCs in the Delta, as the stormwater constituents or its physical properties may negatively alter water quality or contribute to sediment contamination in the southern Delta, depending on the quality of the discharged stormwater.

3.2 Adverse effects on Essential Fish Habitat

Projects in or along waterways can be of sufficient scope to cause significant long-term or permanent adverse effects on aquatic habitat. However, most waterway projects and other projects associated with population growth, urbanization, and construction within the region are small-scale projects that individually cause minor losses or temporary disruptions and often receive minimal or no environmental review, but cumulatively greatly decrease the functionality of aquatic ecosystems when considered over larger landscapes. Therefore, the significance of small-scale projects lies in the cumulative and synergistic effects resulting from a large number of these activities occurring throughout a single watershed.

3.2.1 Urbanization (Pacific Coast salmon EFH, Estuary HAPC, Complex Channel & Floodplain HAPC)

Activities associated with urbanization (e.g., building construction, utility installation, road and bridge building, storm water discharge) significantly alter the land surface, soil, vegetation, and hydrology and adversely impact salmon EFH through habitat loss or modification. Effects of urbanization on stream ecology are second only to agriculture, even though urban areas occupy significantly less land surface than farmlands (Paul & Meyer, 2008). Construction in and adjacent to waterways can involve dredging and/or filling activities, bank stabilization (see other sections), removal of shoreline vegetation, waterway crossings for pipelines and conduits, removal of riparian vegetation, channel re-alignment, and the construction of docks and piers. These alterations can destroy salmon habitat directly or indirectly (Phillips, 1984).

Construction activities can also have detrimental effects on salmon habitat through the run-off of large quantities of sediment, as well as nutrients, heavy metals, and pesticides. Due to the intermittent nature of rainfall and runoff, the large variety of pollutant source types, and the variable nature of source loadings, urban runoff is difficult to control (Safavi, 1996). The National Water Quality Inventory (EPA, 2009) reports that runoff from urban areas is the leading source of impairment to surveyed estuaries and the third largest source of impairment to surveyed lakes. Oxygen deficits associated with high biological oxygen demand during and after storms are common (Faulkner et al., 2000; Ometo et al., 2000). Run-off of petroleum products and oils from roads and parking lots and sediment, nutrients, and chemicals from yards as well as discharges from municipal sewage treatment plants and industrial facilities are also associated with urbanization. Urbanized areas also alter the rate and intensity of stormwater run-off into streams and waterways. Inorganic and organic contaminants in urban runoff can cause acute, chronic and sub-lethal effects in aquatic species.

Similarly, effects on run-off rates can be much greater than in any other type of land use, because of the amount of impervious surfaces associated with urbanization. Buildings, rooftops, sidewalks, parking lots, roads, gutters, storm drains, and drainage ditches, in combination, quickly divert rainwater and snow melt to receiving streams, resulting in an increased volume of runoff from each storm, increased peak discharges, decreased discharge time for runoff to reach the stream, and increased frequency and severity of flooding. Flooding reduces refuge space for fish, especially where accompanied by loss of instream structure, off-channel areas, and habitat complexity. Flooding can also scour eggs and young from the gravel. Increases in streamflow disturbance frequencies and peak flows also compromises the ability of aquatic insects and fish life to recover (May et al., 1997).

The amount of impervious surfaces also can influence stream temperatures. Summer time air and ground temperatures in impervious areas can be 10-12°C warmer than in agricultural and forested areas (Metro, 1997). In addition, the trees that could be providing shade to offset the effects of solar radiation are often missing in urban areas. The alteration in quantity and timing of surface run-off also accelerates bank erosion and the scouring of the streambed, as well as the downstream transport of wood. This results in simplified stream channels and greater instability, all factors harmful to salmon (Spence et al., 1996). The lack of infiltration also results in lower stream flows during the summer by reducing the interception, storage, and release of groundwater into streams. This affects habitat availability and salmonid production, particularly for those species that have extended freshwater rearing requirements (e.g., spring-run Chinook salmon/Coho salmon). Generally, it has been found that instream functions and value seriously deteriorate if the levels of impervious surfaces reach 10 percent of the total land surface cover in a sub-basin.

The USACE proposes to approve a permit to fill 0.093 acres of WOUS, in the process of placing the outfall, associated pipes, and stabilizing riprap, to provide stormwater discharge service to a land development project upland of the project location. The proposed action will increase the degree of urbanization in the action area, and therefore increase the urbanization of Pacific Coast salmon EFH. As discussed in the ESA effects analyses (section 2.5 of the biological opinion), this action will have direct impacts to local habitat from artificial structure placement. In addition, discharging stormwater will affect habitats far downstream (the Delta estuary), depending how the stormwater is treated prior to discharge.

3.2.2 Floodplain alteration (Pacific Coast salmon EFH, Estuary HAPC, Complex Channel & Floodplain HAPC)

Many river valleys in the west were once marshy and well vegetated, filled with mazes of floodplain sloughs, beaver ponds, and wetlands. Salmon evolved within these systems. Juvenile salmon can spend large portions of their fresh water residence rearing and over-wintering in floodplain environments and riverine wetlands. Spring-run Chinook salmon also will spend up to a year rearing in freshwater and will rely on floodplains for refuge during flood conditions, and access to such floodplain refuge improves their overall growth and fitness (Sommer et al., 2001). Salmon survival and growth are often better in floodplain channels, oxbow lakes, and other river-adjacent waters than in mainstream systems (NRC, 1996). Additionally floodplains and wetlands provide other ecosystem functions important to salmonids such as regulation of stream flow, stormwater storage and filtration, and often provide key habitat for beavers (that in turn may provide instream habitat benefits to salmon from their active and continual placement of wood in streams). The action area for this project no longer offers floodplain habitat HAPCs since the San Joaquin River has been leveed for flood protection prior to this proposed project.

3.2.3 Bank stabilization and protection actions (Pacific Coast salmon EFH, Estuary HAPC, Complex Channel & Floodplain HAPC)

The alteration of riverine and estuarine habitat from bank and shoreline stabilization, and protection from flooding events, can result in varying degrees of change in the physical, chemical, and biological characteristics of the existing shoreline and riparian habitats that support Pacific salmon. Armoring of shorelines to prevent erosion and maintain or create shoreline real estate simplifies habitats, reduces the amount of complex freshwater and intertidal habitats by design, and affects nearshore processes and the ecology of a myriad of species (Williams & Thom, 2001). The physical, chemical and biological processes driving the riverine ecosystem are often not correctly considered in bank stabilization and shoreline protection project designs (Beechie et al., 2010) and frequently result in alterations of stream flows and temperatures and reduction of the heterogeneity of rearing habitat. These physical changes can also decrease the effectiveness of salmon habitat restoration efforts (Beechie et. al, 2005).

The approval of the WOUS fill permit will enable project implementation and part of the described action is placement of riprap on the leveed bank around the outfall structure and piping. Associated effects to habitat functionality and individual salmon are discussed in Section 2.5 of the biological opinion. Though the SJR mainstem bank to be riprapped under this proposed action is already leveed, the addition of hard stabilization methods make it unlikely that this area will ever be set-back or restored to be more beneficial to Chinook salmon rearing.

3.2.4 Stormwater discharge (Pacific Coast salmon EFH, Estuary HAPC)

Water quality is essential to salmon, and the quality of their habitat can be altered when pollutants are introduced through surface runoff or through direct discharges of pollutants into the water. Direct input of pollutants include the wastewater discharges of municipal sewage or stormwater treatment plants, power generating stations, and industrial facilities (e.g., pulp mills, desalination plants, fish processing facilities). Indirect sources of water pollution in salmon habitat results from run-off from streets, yards, construction sites, gravel or rock crushing operations, or agricultural and forestry lands. Stormwater run-off from streets is the main indirect concern in this instance, and it may carry oil and other hydrocarbons, lead and other heavy metals, pesticides, herbicides, sediment, nutrients, bacteria, and pathogens into salmon habitat. The introduction of pollutants into EFH can create both lethal and sublethal habitat conditions to salmon and their prey.

Pollutant and water quality impacts to EFH can also have more chronic effects detrimental to fish survival. Contaminants can be assimilated into fish tissues by absorption across the gills or through bio-accumulation as a result of consuming contaminated prey. Pollutants either suspended in the water column (e.g., nitrogen, contaminants, and fine sediments) or settled on the bottom (through food chain effects) can affect salmon. Many heavy metals and persistent organic compounds such as pesticides and polychlorinated biphenyls tend to adhere to solid particles. As the particles are deposited these compounds or their degradation products (which may be equally or more toxic than the parent compounds) can bioaccumulate in benthic organisms at much higher concentrations than in the surrounding waters (Presser & Luoma, 2010; 2013; Stein et al., 1995).

Numerous Federal and state programs have been established to improve and protect water quality. One of the most important programs relating to salmon EFH is the Clean Water Act's Section 319 program administered by the EPA. Under this section, states are required to submit to EPA for approval of an assessment of waters within the state that, without additional action to control nonpoint sources of pollution, cannot be expected to attain or maintain applicable water quality standards. In addition, states are to submit to EPA their management programs that identify measures to reduce pollutant loadings, including BMPs and monitoring programs. It is, therefore, critical that actions aimed at improving EFH water quality, especially in streams and rivers, are taken in concert with state agencies (e.g., California Water Resources Control Board) responsible for water quality management.

The approval of the WOUS fill permit will enable project implementation and the intended project purpose is to provide stormwater discharge services to new, large-scale, upland development. The expected effects of non-point stormwater pollution is discussed in Section 2.5 of the biological opinion; however, the severity of the effects in the immediate area and downstream are dependent on the scale and efficacy of upland stormwater treatment. It is unlikely that the degree of treatment will be sufficient to remove all stormwater pollutants to insignificant levels, so negative impacts are expected. These impacts are expected to persist and increase over time as the City increases stormwater discharge volumes with increases in impervious surfaces according to development plans. The discharge of pollutants into waterways often compounds downstream, especially in estuary areas like the Delta, and is a persistent problem in Estuary HAPCs.

See section 2.5 of the ESA portion of the opinion for more details on the potential adverse effects of this project.

3.3 Essential Fish Habitat Conservation Recommendations

The species managed under the Pacific Coast salmon that may be affected by this project are: Chinook salmon, *O. tshawytscha,* both the fall-run and spring-run, since fall-run Chinook are known to migrate and spawn in SJR tributaries, and juveniles from both runs are known to grow and rear in the Delta. The EFH of Chinook salmon is adversely effected by the proposed project through the pathways identified above: urbanization, floodplain alteration, bank stabilization/protection, and stormwater discharge.

<u>Urbanization effects:</u> Existing urban and industrial sites, highways, and other permanent structures prevent restoration of riparian zones in heavily developed areas. In these areas, generally along major river systems, buffers will not be continuous, and riparian areas will remain fragmented. Habitat improvement plans will need to identify locations of healthy riparian zones requiring special protection and also opportunities for re-establishing corridors of riparian vegetation between them, so that nodes of good quality habitat can be maintained and managed in ways that protect salmon habitat functionality (Sedell et al., 1997). Some of these concerns are addressed through ESA consultation RPM's 1-3. In addition, the following EFH Conservation Recommendations (CRs) are intended to address the adverse effects of urbanization:

1. Protect existing riparian vegetation, and wherever practicable, establish new vegetated zones of appropriate width on all permanent and ephemeral streams that include or influence EFH. To address the impacts of this project in particular, plant new trees of appropriate species like willows in the riprap and disturbed areas to increase bank cover and shade. Establish the buffers wide enough to support shading, leaf litter inputs, sediment and nutrient control, and bank stabilization functions. (Complex Channel HAPC).
2. During construction, temporarily fence setback areas to avoid disturbance of natural riparian vegetation and mark retained trees with high visibility items to ensure their protection during construction (Complex Channel/Floodplain HAPC).
3. Where feasible, remove impervious surfaces in upland areas not in use in the watershed, such as abandoned parking lots and buildings, and re-establish wetlands, floodplains, and

continuous riparian habitats where feasible, starting with their inclusion in long-term city development plans (Complex Channel/Floodplain HAPC).

4. Implement Low Impact Development (LID) construction practices to the maximum extent possible in upland areas and make plans for the long-term maintenance and monitoring of stormwater treatment devices overtime to ensure their continued efficacy.

Full implementation of these CRs will help avoid or offset the expected impacts associated with the increased urbanization caused by the approval of the WOUS fill permit.

Floodplain Alteration effects: As previously stated, much of the floodplain rearing habitat in the CCV has already been highly altered and its functionality has been greatly reduced. As such, the preservation and enhancement of any remaining floodplain is important to maintain the ability of Pacific Coast salmon to naturally rear in the CCV. Within the action area, floodplain alterations have already occurred in this area prior to the implementation of the proposed action; therefore, only the purchase of credits in conservation banks where floodplain habitat is actively created and maintained could be considered a practical measure to address this issue, and are addressed through ESA consultation RPM's 1-3. The floodplains and wetlands supported by such a purchase should meet specific performance objectives to account for function and value, and be monitored to assure achievement of these objectives. In general, to support floodplain HAPCs, USACE should promote the restoration of degraded floodplains and wetlands, including in part reconnecting rivers with their associated floodplains and wetlands. Regarding EFH CRs, there are no additional practical measures to further address this issue.

Bank Stabilization effects: Similar to the general effects of urbanization, the placement of riprap associated with this project is likely to interrupt the remaining contagious suitable rearing areas for Pacific Coast salmon by introducing artificial elements while simultaneously preventing future restoration of the immediate area. Some of these concerns are addressed through ESA consultation RPM's 1-3. In addition, the following EFH CRs are intended to address the adverse effects of bank stabilization:

5. Use vegetative or "soft' bank erosion control methods such as beach nourishment, vegetative plantings, and placement of large woody debris to help anchor the levee rather than the currently proposed shoreline modifications, as feasible. Hard bank protection should be a last resort and the following options should be explored (tree revetments, stream flow deflectors, and vegetative riprap). Develop design criteria based on site-specific geomorphological, hydrological and sediment transport processes appropriate for the stream channel for any stabilization, protection and restoration projects (Complex Channel HAPC).
6. Minimize the loss of riparian habitats as much as possible (Complex Channel HAPC).
7. Replace in-stream fish habitat by providing root wads and deflector logs below the stabilized bank, and by planting shaded riverine aquatic cover vegetation, as part of bank revitalization during the stabilization actions in a way that reduces the likelihood of scour caused by long-term stormwater discharge (Complex Channel HAPC).

Full implementation of these CRs will help avoid or offset the expected impacts associated with the increased bank stabilization caused by the approval of the WOUS fill permit.

Stormwater Discharge effects: Suitable clean water is an important quality of Pacific Coast salmon EFH. The proposed project should incorporate short-term and long-term measures that can be implemented to address the potential effects of both point and nonpoint sources of pollution from this outfall. The EPA (1993) publication "Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters" extensively describes BMPs for control of runoff from developing areas, construction sites, roads, highways and bridges in watersheds hosting Pacific Coast salmon EFH. Some of these concerns are addressed through ESA consultation RPM's 1-3, and some treatment stormwater treatment measures are expected to be included in upland stormwater management before discharge. In addition, however, the following EFH CRs are intended to address the adverse effects of stormwater discharge to the extent practical:

8. Install and monitor vegetated buffers along drains to streams in a large percentage of upland areas to trap sediment, remove nutrients and metals, moderate water temperatures, and increase stream and channel stability as feasible. Remove/replace sediment in traps regularly. (Estuary HAPC).
9. Monitor water quality discharges following NPDES and SWRCB requirements from all stormwater discharge points, and before and after pollution control BMPs to establish their performance over time, and adapt/replace/maintain stormwater quality BMPs as necessary (Estuary HAPC).
10. Allocate more resources to monitor and improve SJR water quality in general, meet existing TMDLs that affect salmon EFH locally, and make steps to address emerging stormwater constituents of concern according to the SWRCB monitoring reports (Estuary HAPC).

Full implementation of these CRs will help avoid or offset the expected impacts associated with the discharge of pollutants in stormwater caused by the approval of the WOUS fill permit.

In total, fully implementing these EFH CRs would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, at least 7 acres (approximately) of designated EFH for Pacific Coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, USACE must provide a detailed response in writing to NMFS within 30 days after receiving an EFH CR. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH CRs unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the CRs, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many CRs are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of CRs accepted.

3.5 Supplemental Consultation

The USACE must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH CRs (50 CFR 600.920(l)).

4. FISH AND WILDLIFE COORDINATION ACT

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 USC 661). The FWCA establishes a consultation requirement for Federal agencies that undertake any action to modify any stream or other body of water for any purpose, including navigation and drainage (16 USC 662(a)), regarding the impacts of their actions on fish and wildlife, and measures to mitigate those impacts. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources, and providing equal consideration for these resources. NMFS's recommendations are provided to conserve wildlife resources by preventing loss of and damage to such resources. The FWCA allows the opportunity to provide recommendations for the conservation of all species and habitats within NMFS's authority, not just those currently managed under the ESA and MSA.

The following recommendations apply to the proposed action:

- Utilize an alternative to traditional riprap, such as designing compacted fill lifts and vegetation to stabilize banks. This could involve placing granular soil under compost socks above the OHWM. The compacted fill lifts would consist of compost socks, would have a minimum durability of one year and would be composed of biodegradable jute, sisal, burlap, or coir fiber fabric. A 12-inch diameter compost sock would be installed on the face of each lift and then the compost sock and soil at each lift would be wrapped with biodegradable material. The process would be repeated until the top of the erosion site is reached. Once the compost socks and soil wraps have been placed, two 6-foot live willow branch cuttings would be placed per linear foot in each of the lifts and a 2-inch layer of topsoil would be placed over the cuttings. Exchanging riprap placement for these recommendations would help restore the disturbed ground, decrease the chance of erosion (see Appendix 1, page 8), and move the riverbank back to a more natural state so that all species may utilize this riverine habitat while still providing the stabilization needed for the continuous operations of the levee and stormwater outfall.

- Apply for, and obtain, an USACE approved vegetation variance allowing the City of Lathrop or its contractors to re-plant the area with native species, such as riparian willows, in the lower one-third of the waterside of the levee prior to project wrap up.

- Develop the immediate area, current access roads, and infiltration basins as public open space that allows access and enjoyment, with interpretive signage that explains SJR water use history, and how river restoration and functional LID benefits aquatic ecosystems and human society. This would be consistent with current City plans to develop this stretch of riverbank into a green public space and also increase biological function and habitat condition in the area for all riverine and wildlife species.

The action agency must give these recommendations equal consideration with the other aspects of the proposed action so as to meet the purpose of the FWCA. This concludes the FWCA portion of this consultation.

5. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

5.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful serviceable, and beneficial to the intended users. The intended users of this opinion are the USACE. Other interested users could include the City of Lathrop. Individual copies of this opinion were provided to the USACE. This opinion will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

5.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, ‘Security of Automated Information Resources,’ Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

5.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.
Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

6. REFERENCES

Beechie, T.J., C.N. Veldhuisen, E.M. Beamer, D.E. Schuett-Hames, R.H. Conrad, and P. DeVries. 2005. Monitoring treatments to reduce sediment and hydrologic effects from roads. P. 35-66 in: P. Roni (ed.). Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, MD.

Beechie, T.J., D.A. Sear, J.D. Olden, G.R. Pess, J.M. Buffington, H. Moir, P. Roni and M.M. Pollock. 2010. Process-based principles for restoring river ecosystems. BioScience 60: 209-222.

Benson, R. L., Turo, S., & McCovery, B. W. (2006). Migration and Movement Patterns of Green Sturgeon (Acipenser medirostris) in the Klamath and Trinity rivers, California, USA. Environmental Biology of Fishes, 79(3-4), 269-279. doi:10.1007/s10641-006-9023-6

Berg, L. 1982. The effect of exposure to short-term pulses of suspended sediment on the behavior of juvenile salmonids. P. 177-196 in G.F. Hartman et al. [eds.] Proceedings of the Carnation Creek workshop: a ten-year review. Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, Canada.

Bjornn, T. C., and D. W. Reiser. (1991). Habitat requirements of salmonids in streams. American Fisheries Society Special Publication. 19:83-138.

Breitler, A. (2017, 10/30/17). Fish out of (normal) water: Rare sturgeon seen in Stanislaus River. Recordnet.com. Retrieved from http://www.recordnet.com/news/20171030/fish-out-of-normal-water-rare-sturgeon-seen-in-stanislaus-river

Busby, P. J., Wainwright, T. C., Bryant, G. J., Lierheimer, L. J., Waples, R. S., Waknitz, W., & Lagomarsino, I. (1996). Status Review of West Coast Steelhead from Washington, Idaho, Oregon and California. (NOAA Technical Memorandum NMFS-NWFSC-27).

California Department of Fish and Wildlife. (2014). Salvage FTP Site Report.

California Department of Transportation (Caltrans). (2015). Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Appendix I: Compendium of Pile Driving Sound Data, October 2012. Retreived from:

Caltrans. (2015). Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. (Vol. CTHWANP-RT-15-306.01.01.). Sacramento, California: Division of Environmental Analysis, California Department of Transportation.

CDEC. (2017a). Precipitation Gauge Data for Stockton Airport (SOC). State of California, Department of Water Resources, California Data Exchange Center. Retrieved from https://cdec.water.ca.gov/cgi-progs/selectQuery?station_id=soc&sensor_num=&dur_code=D&start_date=&end_date=

CDEC. (2017b). Precipitation Gauge Data for Stockton Fire Station (SFS). State of California, Department of Water Resources, California Data Exchange Center. Retrieved from https://cdec.water.ca.gov/cgi-progs/selectQuery?station_id=sfs&sensor_num=&dur_code=D&start_date=&end_date=

CDEC. (2017c). Sacramento River at Red Bluff Diversion Dam (RBD). State of California, Department of Water Resources, California Data Exchange Center. Retrieved from http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=RDB

CDEC. (2018). River Sensor Data for San Joaquin River at Mossdale Bridge (MSD). State of California, Department of Water Resources, California Data Exchange Center. Retrieved from https://cdec.water.ca.gov/cgi-progs/selectQuery?station_id=msd&sensor_num=&dur_code=D&start_date=&end_date=

CDFW. (2017). Grandtab 2017.04.07, California Central Valley Chinook Population Database Report. Retrieved from: http://www.dfg.ca.gov/fish/Resources/Chinook/CValleyAssessment.asp.

CDFW. (2018). Salvage Monitoring. Retrieved from http://www.dfg.ca.gov/delta/apps/salvage/SalvageExportCalendar.aspx

Chapman, E. D., A. R. Hearn, C. J. Michel, A. J. Ammann, S. T. Lindley, & Thomas, M. J. (2012). Diel movements of out-migrating Chinook salmon (Oncorhynchus tshwaytscha) and steelhead trout (Oncorhynchus mykiss) smolts in the Sacramento/San Joaquin watershed. Environmental Biology of Fishes, 96(2-3), 273-286.

Chase, R. (2010). Lower American River Steelhead (Oncorhyncus mykiss) spawning surveys - 2010. US Department of the Interior, Bureau of Reclamation: Central Valley Project, American River, California Mid-Pacific Region.

City of Lathrop. (1991). Comprehensive general plan for the City of Lathrop, California. As amended November 9, 2004. SCH. NO. 91022059.

City of Lathrop. (2015). Draft General Plan Amendment of 2015 SB 5 200-Year Flood Protection to the City of Lathrop Comprehensive General Plan. Community Development Department.

City of Lathrop. (2016). Final Municipal Service Review and Sphere of Influence Plan. Approved by San Joaquin LAFCo April 14, 2016.

Closs, P., M. Krkosek, & J. D. Olden. (2016). Conservation of Freshwater Fishes: Cambridge University Press.

Cohen, S. J., Miller, K. A., Hamlet, A. F., & Avis, W. (2000). Climate Change and Resource Management in the Columbia River Basin. Water International, 25(2), 253-272. doi:10.1080/02508060008686827

Colt, J., S. Mitchell, G. Tchobanoglous, and A. Knight. (1979). The use and potential for aquatic species for wastewater treatment: Appendix B, The environmental requirements of fish. Publication No. 65. California State Water Resources Control Board, Sacramento, CA.

Consultation Handbook. (1998). Endangered Species Consultation Handbook. Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act, Final. U.S. Fish & Wildlife Service and National Marine Fisheries Service.

CTC & Associates. (2015). Preliminary investigation: Determining the appropriate amount of time to isolate Portland Cement Concrete from receiving waters. Retrieved from Caltrans Division of Research, Innovation, and System Information: www.dot.ca.gov/drisi.

Davis, A. P., Traver, R. G., & Hunt, W. F. (2010). Improving Urban Stormwater Quality: Applying Fundamental Principles. Journal of Contemporary Water Research & Education, 146(1), 3-10. doi:10.1111/j.1936-704X.2010.00387.x

Davis, J.C. 1975. Minimal dissolved oxygen requirements of aquatic life with emphasis on Canadian species: a review. Journal of Fisheries Research Board Canada. 32(12), 2295-2332.

Dettinger, M. D. (2005). From climate-change spaghetti to climate-change distributions for 21st Century California. San Francisco Estuary and Watershed Science, 3(1), Article 4.

Dettinger, M. D., & Cayan, D. R. (1995). Large-Scale Atmospheric Forcing of Recent Trends toward Early Snowmelt Runoff in California. Journal of Climate, 8(3), 606-623. doi:10.1175/1520-0442(1995)008<0606:lsafor>2.0.co;2

Dettinger, M. D., Cayan, D. R., Meyer, M. K., & Jeton, A. E. (2004). Simulated Hydrologic Responses to Climate Variations and Change in the Merced, Carson, and American River Basins, Sierra Nevada, California, 1900–2099. Climatic Change, 62(1-3), 283-317. doi:10.1023/B:CLIM.0000013683.13346.4f

DuBois, J., Harris, M. D. (2016). 2016 Field Season Summary for the Sturgeon Population Study. California Department of Fish and Wildlife, Bay Delta Region (Wildlife).

ECORP. (2017). Biological Assessment: South Lathrop Regional Outfall. ECORP Consulting, Inc.

EPA. (1993). Guidance specifying management measures for sources of nonpoint pollution in coastal waters. United States Environmental Protection Agency, Office of Water, 840-B-92-002. Retrieved from https://www.epa.gov/sites/production/files/2015-09/documents/czara_-frontmatter.pdf.

EPA. (2009). National Water Quality Inventory: Report to Congress 2004 Reporting Cycle. United States Environmental Protection Agency (January 2009).

EPA. (2010). Waterbody Quality Assessment Report: 2010 Waterbody Report for Delta Waterways (southern portion). United States Environmental Protection Agency. Retrieved from https://ofmpub.epa.gov/waters10/attains_waterbody.control?p_au_id=CAE5440000020041005161347&p_list_id=CAE5440000020041005161347&p_cycle=2010

EPA. (2018). National Recommended Water Quality Criteria: Aquatic Life Criteria Table. United States Environmental Protection Agency. Retrieved from https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

Faulkner, H., V. Edmonds-Brown, and A. Green. 2000. Problems of quality designation in diffusely populated urban streams- the case of Pymme's Brook, North London. Environmental Pollution 109: 91–107.

Feist, B. E., Buhle, E. R., Baldwin, D. H., Spromberg, J. A., Damm, S. E., Davis, J. W., & Scholz, N. L. (2017). Roads to ruin: conservation threats to a sentinel species across an urban gradient. Ecol Appl, 27(8), 2382-2396. doi:10.1002/eap.1615

Garza, J. C., & Pearse, D. E. (2008). Population Genetic Structure of Oncorhynchus mykiss in the California Central Valley: Final Report for California Department of Fish and Game. Retrieved from Santa Cruz, California.

Gaspin, J. B. (1975). Experimental investigations of the effects of underwater explosions on swimbladder fish. I. 1973 Chesapeake Bay tests.

Gisiner, R. C. (1998). Proceedings: workshop on the effects of anthropogenic noise in the marine environment, 10-12 February 1998: United States, Office of Naval Research.

Good, T. P., Waples, R. S., & Adams, P. (2005). Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead (NOAA Technical Memorandum NMFS-NWFSC-66).

Gregory, R.S. 1988. Effects of turbidity on benthic foraging and predation risk in juvenile Chinook salmon, p. 65-73. In C.A. Simenstad [ed.] Effects of dredging on anadromous Pacific coast fishes. Workshop Proceedings, September 8-9, 1988. Washington Sea Grant Program, University of Washington, Seattle, USA.

Gruber, J. J., Jackson, Z. J., & Van Eenennaam, J. P. (2012). 2011 San Joaquin River sturgeon spawning survey. Lodi Fish and Wildlife Office. Anadromous Fish Restoration Program: Stockton, CA.

Hallock, R. J., D.H. Fry Jr., and Don A. LaFaunce. (1957). The Use of Wire Fyke Traps to Estimate the Runs of Adult Salmon and Steelhead in the Sacramento River. California Fish and Game, 43(4), 271-298.

Hallock, R. J., Woert, W. F. V., & Shapolalov, L. (1961). An evaluation of stocking hatchery-reared steelhead rainbow trout (Salmo gairdnerii gairdnerii) in the Sacramento River system. State of California Department of Fish and Game Fish. Bulletin No.114.

Hallock, R. J., R. F. Elwell, and D. H. Fry, Jr. (1970). Migrations of adult King Salmon *Oncorhynchus tshawytsca* in the San Joaquin Delta as demonstrated by the use of sonic tags. State of California Department of Fish and Game. Fish Bulletin No. 151, 92pp.

Hannon, J., Deason, B. (2005). American River Steelhead (Oncorhynchus mykiss) spawning 2001 - 2006. US Department of the Interior, Bureau of Reclamation, Mid-Pacific Region: Central Valley Project, American River, California.

Harvey, C. (1995). Adult steelhead counts in Mill and Deer Creeks, Tehama County, October 1993-June 1994. (Inland Fisheries Administrative Report Number 95-3).

Hastings, M. C. (1995). Physical effects of noise on fishes. INTER-NOISE and NOISE-CON Congress and Conference Proceedings, 1995(2), 979-984.

Hecht, S.A., D.H. Baldwin, C.A. Mebane, T. Hawkes, S.J. Gross, and N.L. Scholz. (2007). An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity. U.S. Department of Commerce, NOAA Fisheries, NOAA Technical Memorandum NMFSNWFSC-83, 39 pp.

Heublein, J. C., Kelly, J. T., Crocker, C. E., Klimley, A. P., & Lindley, S. T. (2008). Migration of green sturgeon, Acipenser medirostris, in the Sacramento River. Environmental Biology of Fishes, 84(3), 245-258. doi:10.1007/s10641-008-9432-9

Holmes, R. W. & W. Cowan. (2014). Instream Flow Evaluation Steelhead Spawning and Rearing, Big Sur River, Monterey County. California Department of Fish and Game, Stream Evaluation Report 14-2.

Israel, J. A., Bando, K. J., Anderson, E. C., & May, B. (2009). Polyploid Microsatellite Data Reveal Stock Complexity Among Estuarine North American Green Sturgeon (Acipenser medirostris). Canadian Journal of Fisheries and Aquatic Sciences, 66(9), 1491-1504. doi:10.1139/F09-091

Jackson, Z. J., Gruber, J. J., & Van Eenennaam, J. P. (2016). White Sturgeon Spawning in the San Joaquin River, California, and Effects of Water Management. Journal of Fish and Wildlife Management, 7(1), 171-180. doi:10.3996/092015-JFWM-092

Johnson, M. R., & Merrick, K. (2012). Juvenile Salmonid Monitoring Using Rotary Screw Traps in Deer Creek and Mill Creek, Tehama County, California. Summary Report: 1994-2010. Retrieved from Red Bluff Fisheries Office - Red Bluff, California.

Keefer, M. L., Caudill, C. C., Peery, C. A., & Moser, M. L. (2012). Context-dependent diel behavior of upstream-migrating anadromous fishes. Environmental Biology of Fishes, 96(6), 691-700. doi:10.1007/s10641-012-0059-5

Krenkel, P. A., & Novotny, V. (1980). Water Quality Management: Academic Press, New York.

Lindley, S. T., Erickson, D. L., Moser, M. L., Williams, G., Langness, O. P., McCovey, B. W., . . . Klimley, A. P. (2011). Electronic Tagging of Green Sturgeon Reveals Population Structure and Movement among Estuaries. Transactions of the American Fisheries Society, 140(1), 108-122. doi:Pii 93406997510.1080/00028487.2011.557017

Lindley, S. T., Moser, M. L., Erickson, D. L., Belchik, M., Welch, D. W., Rechisky, E. L., . . . Klimley, A. P. (2008). Marine Migration of North American Green Sturgeon. Transactions of the American Fisheries Society, 137(1), 182-194. doi:10.1577/T07-055.1

Lindley, S. T., Schick, R. S., Agrawal, A., Goslin, M., Pearson, T. E., Mora, E., . . . Williams, J. G. (2006). Historical Population Structure of Central Valley Steelhead and its Alteration by Dams. San Francisco Estuary and Watershed Science, 4(1), 19.

Lindley, S. T., Schick, R. S., Mora, E., Adams, P. B., Anderson, J. J., Greene, S., . . . Williams, J. G. (2007). Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science, 5(1), 26.

Macneale, K.H., P.M. Kiffney, and N.L. Scholz. 2010. Pesticides, aquatic food webs, and the conservation of Pacific salmon. Frontiers in Ecology and the Environment 8(9):475-482.

May, C., E. Welch, R. Horner, J. Karr, and B. Mar. 1997. Quality indices for urbanization effects in Puget Sound lowland streams. Department of Ecology, Olympia, Washington. Publication number 98-04.

Mayfield, R.B., and J.J. Cech. 2004. Temperature effects on green sturgeon bioenergetics. Trans. Am. Fish. Soc. 133:961-970.

McClure, M. (2011). Status review update for Pacific salmon and steelhead listed under the ESA: Pacific Northwest. . (Climate Change. In M.J. Ford (Ed.)). NMFS-NWFCS-113.

McClure, M. M., Alexander, M., Borggaard, D., Boughton, D., Crozier, L., Griffis, R., . . . K, V. A. N. H. (2013). Incorporating climate science in applications of the US endangered species act for aquatic species. Conserv Biol, 27(6), 1222-1233. doi:10.1111/cobi.12166

McCullough, D. A., Spalding, S., Sturdevant, D., Hicks, M. (2001). Summary of technical literature examining the physiological effects of temperature on salmonids - Issue Paper 5. United States Environmental Protection Agency. Report No. EPA-910-D-01-005.

McEwan, D. (2001). Central Valley steelhead. In R. L. Brown (Ed.), Contributions to the biology of Central Valley salmonids (Vol. 179, pp. 1-44). Fish Bulletin: CDFW Sacramento, CA

McEwan, D. R. (2001). Central Valley Steelhead. Fish Bulletin, 179(1), 1-44.

McEwan, D., & Jackson, T. A. (1996). Steelhead restoration and management plan for California. California Department of Fish and Wildlife, Inland Fisheries Division, 1416 Ninth Street, Sacramento, CA 95814.

McIntyre, J. K., Baldwin, D. H., Beauchamp, D. A., & Scholz, N. L. (2012). Low-level copper exposures increase visibility and vulnerability of juvenile coho salmon to cutthroat trout predators. Ecological Applications, 22(5), 1460-1471. doi:10.1890/11-2001.1

McIntyre, J. K., Davis, J. W., Hinman, C., Macneale, K. H., Anulacion, B. F., Scholz, N. L., & Stark, J. D. (2015). Soil bioretention protects juvenile salmon and their prey from the toxic impacts of urban stormwater runoff. Chemosphere, 132, 213-219. doi:10.1016/j.chemosphere.2014.12.052

Meehan, W. R. (Ed.) (1991). Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society. Special Publication Number 19. Bethesda, Maryland.

Metro. 1997. Policy analysis and scientific literature review for Title 3 of the urban growth management functional plan: Water quality and floodplain management conservation. Metro. Growth Management Services Department. Portland, Oregon.

Mora, E. A., Lindley, S. T., Erickson, D. L., & Klimley, A. P. (2015). Estimating the Riverine Abundance of Green Sturgeon Using a Dual-Frequency Identification Sonar. North American Journal of Fisheries Management, 35(3), 557-566. doi:10.1080/02755947.2015.1017119

Morrill, J. C., Bales, R. C., & Conklin, M. H. (2005). Estimating Stream Temperature from Air Temperature: Implications for Future Water Quality. Journal of Environmental Engineering, 131(1), 139-146. doi:10.1061/(asce)0733-9372(2005)131:1(139)

Moser, M. L., & Lindley, S. T. (2006). Use of Washington Estuaries by Subadult and Adult Green Sturgeon. Environmental Biology of Fishes, 79(3-4), 243-253. doi:10.1007/s10641-006-9028-1

Moyle, P. B. (2002). Inland fishes of California. University of California Press: Berkeley, CA.

Moyle, P. B., Yoshiyama, R. M., Williams, J. E., & Wikramanayake, E. D. (1995). Fish Species of Special Concern in California, Second Edition. Retrieved from http://www.dfg.ca.gov/habcon/info/fish_ssc.pdf

Multi-Agency. (2015). Multi-Agency Post-Construction Stormwater Standards Manual June 2015. Prepared by Larry Walker Associates.

National Weather Service. (2018). California Nevada River Forecast Center: San Joaquin River - Mossdale (MOSC1). NOAA's National Weather Service. Retrieved from http://www.cnrfc.noaa.gov/graphicalRVF.php?id=MOSC1

Nielsen, J. L., Pavey, S., Wiacek, T., Sage, G. K., & Williams, I. (2003). Genetic Analyses of Central Valley Trout Populations 1999-2003. U.S.G.S. Alaska Science Center - Final Technical Report submitted December 8, 2003.

NMFS. (2009). Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project (2008/09022). (2008-09022). Central Valley Office: Sacramento, CA.

NMFS. (2010). Federal Recovery Outline North American Green Sturgeon Southern Distinct Population Segment.

NMFS. (2010). Biennial Report to Congress on the Recovery Program for Threatened and Endangered Species.

NMFS. (2011). Anadromous Salmonid Passage Facility Design. National Marine Fisheries Service, Northwest Region, Portland, Oregon.

NMFS. (2014). 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. Central Valley Office: Sacramento, CA.

NMFS. (2015). 5-year Review: Summary and Evaluation of the Southern Distinct Population Segement of the North American Green Sturgeon (Acipenser medirostris). Long Beach Office: Long Beach, CA.

NMFS. (2016a). 5-Year Review: Summary and Evaluation of Central Valley Spring-run Chinook Salmon Evolutionary Significant Unit. Central Valley Office: Sacramento, CA.

NMFS. (2016b). 5-year Review: Summary and Evaluation of California Central Valley steelhead Distinct Population Segment. Central Valley Office: Sacramento, CA.

NMFS. (2016c). Endangered Species Act Section 7 Formal Programmatic Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the U.S. Department of Housing and Urban Development Housing Programs in Oregon WCR-2016-4853. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.NMFS. (2018a). Draft Recovery Plan for the Southern Distinct Population Segment of the North American Green Sturgeon (Acipenser medirostris). Central Valley Office: Sacramento, CA Retrieved from http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/other_species/draft_sdps_green_sturgeon_recovery_plan_1_4_18_final.pdf.

NOAA. (2017). Past Weather by Zip Code - Data Table. National Oceanic and Atmospheric Administration's Climate.gov. Retrieved from https://www.climate.gov/maps-data/dataset/past-weather-zip-code-data-table

Nobriga, M., & Cadrett, P. (2001). Differences Among Hatchery and Wild Steelhead: Evidence from Delta Fish Monitoring Programs. IEP Newsletter, 14(3), 30-38.

NRC. 1996. Upstream: salmon and society in the Pacific Northwest. Report of the committee on protection and management of Pacific northwest anadromous salmonids, Board on Environmental Studies and Toxicology, and Commission on Life Sciences. National Academy Press. Washington, D.C.

NRC. 2009. Urban Stormwater Management in the United States. National Research Council. The National Academies Press. Washington, D.C.

Ometo, J.P.; L.A. Martinelli, M.V. Ballester, A. Gessner, and A. Krusche. 2000. Effects of land use on water chemistry and macroinvertebrates in two streams of the Piracicaba River Basin, southeast Brazil. Freshwater Biology 44: 327–37.

Paul, M. J., & Meyer, J. L. (2008). Streams in the urban landscape Urban ecology (pp. 207-231): Springer.

PFMC. 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

Phillips, R. 1984. The ecology of eelgrass meadows in the Pacific Northwest: A community profile. U.S. Fish and Wildlife Service. FWS/OBS-84/24.

Popper, A. N., & Hastings, M. C. (2009). The effects of human-generated sound on fish. Integrative Zoology, 4(1), 43-52.

Popper, A. N., Carlson, T. J., Hawkins, A. D., Southall, B. L., & Gentry, R. L. (2006). Interim criteria for injury of fish exposed to pile driving operations: A white paper. Report to the Fisheries Hydroacoustic Working Group, California Department of Transportation, USA, 15pp.

Poytress, W. R., Gruber, J. J., & Van Eenennaam, J. P. (2011). Annual Report: 2010 Upper Sacramento River Green Sturgeon Spawning Habitat and Larval Migration Surveys. Red Bluff, CA.

Presser, & Luoma. (2010). Ecosystem-scale selenium modeling in support of fish and wildlife criteria development for the San Francisco Bay-Delta Estuary, California. US Department of the Interior: US Geological Survey.

Presser, T. S., & Luoma, S. N. (2013). Ecosystem-scale selenium model for the San Francisco Bay-Delta regional ecosystem restoration implementation plan (DRERIP). San Francisco Estuary and Watershed Science, 11(1), 1-39.

Radtke, L. D. (1966). Distribution of Smelt, Juvenile Sturgeon, and Starry Flounder in the Sacramento-San Joaquin Delta with Observations on Food of Sturgeon. Fish Bulletin - Ecological Studies of the Sacramento-San Joaquin Delta. Part II: Fishes of the Delta(136).

Reclamation. (2015). Sacramento and San Joaquin Basins Study, Report to Congress 2015. US Department of the Interior, Bureau of Reclamation, Mid-Pacific Region.: Prepared by CH2M Hill, Contract No.R12PD80946.

Reclamation. (2016). Sacramento and San Joaquin Rivers Basin Study: Basin Study Report and Executive Summary. US Department of the Interior, Bureau of Reclamation, Mid-Pacific Region. Retrieved from - https://cwc.ca.gov/Documents/2016/2016_Correspondence/49_WSIP_Quant_45Day_USBR_031616.pdf.

Richter, A., & Kolmes, S. A. (2005). Maximum Temperature Limits for Chinook, Coho, and Chum Salmon, and Steelhead Trout in the Pacific Northwest. Reviews in Fisheries Science, 13(1), 23-49. doi:10.1080/10641260590885861

Safavi, H.R. 1996. Quality control of urban runoff and sound management. Hydrobiologia., 320(1-3):131-141.

Sandahl, J.F., D.H. Baldwin, J.J. Jenkins, and N.L. Scholz. 2007. A sensory system at the interface between urban stormwater runoff and salmon survival. Environmental Science & Technology 41(8):2998-3004.

Schaffter, R. (1980). Fish Occurrence, Size, and Distribution in the Sacramento River Near Hood, California During 1973 and 1974. (Administrative Report No. 80-3).

Scholz, N. L., Myers, M. S., McCarthy, S. G., Labenia, J. S., McIntyre, J. K., Ylitalo, G. M., Rhodes, L. D., Laetz, C. A., Stehr, C. M., French, B. L., McMillan, B., Wilson, D., Reed, L., Lynch, K. D., Damm, S., Davis, J. W., Collier, T. K. (2011). Recurrent die-offs of adult coho salmon returning to spawn in Puget Sound lowland urban streams. PLoS One, 6(12), e28013. doi:10.1371/journal.pone.0028013

Sedell, J., G. Reeves, and P. Bisson. 1997. Habitat policy for salmon in the Pacific Northwest, In: Pacific salmon and their ecosystems: Status and future options, D. Stouder, P. Bisson, and R. Naiman, ed. Chapman and Hall, New York.

Seesholtz, A. M., Manuel, M. J., & Van Eenennaam, J. P. (2014). First Documented Spawning and Associated Habitat Conditions for Green Sturgeon in the Feather River, California. Environmental Biology of Fishes, 98(3), 905-912. doi:10.1007/s10641-014-0325-9

Sigler, J. W., Bjornn, T. C., & Everest, F. H. (1984). Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society, 113, 142-150.

SJRRP. (2010). Fisheries Management Plan: A Framework for Adaptative Management in the San Joaquin River Restoration Program. Exhibit A. Conceptual Models of Stressors and

Limiting Factors for San Joaquin River Chinook Salmon. Retrieved from http://www.restoresjr.net/?wpfb_dl=865

SJRRP. (2018). Background and History: San Joaquin River Restoration Settlement. San Joaquin River Restoration Program. Retrieved from http://www.restoresjr.net/about/background-and-history/

Slotte, A., Hansen, K., Dalen, J., & Ona, E. (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research, 67(2), 143-150.

Sommer, T.R., M.L. Nogriba, W.C. Harrell, W. Batham, W. J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence for enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58: 325-333.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. Prepared by Management Technology for the National Marine Fisheries Service. TR-4501-96-6057. 356p. (Available from the NMFS Habitat Branch, Portland, Oregon).

Spromberg, J.A., and J.P. Meador. 2006. Relating chronic toxicity responses to population-level effects: A comparison of population-level parameters for three salmon species as a function of low-level toxicity. Ecological Modeling 199:240-252.

Stein, J., T. Hom, T. Collier, D. Brown, and U. Varanasi. 1995. Contaminant exposure and biochemical effects in outmigrant juvenile Chinook salmon from urban and nonurban estuaries of Puget Sound, Washington. Environmental Toxicology and Chemistry, 14:1019-1029.

Stewart, I. T., Cayan, D. R., & Dettinger, M. D. (2004). Changes in snowmelt runoff timing in western North America under a 'business as usual' climate change scenario. Climatic Change, 62, 217-232.

Swanson, C., Young, P. S., & Cech, J. J. (2004). Swimming in Two-Vector Flows: Performance and Behavior of Juvenile Chinook Salmon near a Simulated Screened Water Diversion. Transactions of the American Fisheries Society, 133(2), 265-278. doi:10.1577/03-068

SWRCB. (2012). Impaired Water Bodies: Final 2012 California Integrated Report (Clean Water Act Section 303(d) List/305(b) Report. State of California, California Environmentla Protection Agency, State Water Resources Control Board. Retrieved from https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml

SWRCB. (2016). Draft revised substitute environmental document in support of potential changes to the water quality control plan for the Bay-Delta: San Joaquin River flows and southern Delta water quality. State Water Resources Control Boards, San Francisco/Sacramento-San Joaquin Delta Estuary (Bay-Delta) Program. Retrieved from https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/2016_sed/

USACE. (2018). Mitigation Bank Enableing Instrument Template. Posted September 28, 2017. Retrieved from http://www.spd.usace.army.mil/Missions/Regulatory/Public-Notices-and-References/Article/1328706/mitigation-bank-enabling-instrument-bei-template/

U.S. Fish and Wildlife Service. (2015). Clear Creek Habitat Synthesis Report Sacramento, CA USFWS Anadromous Fish Restoration Program.

VanRheenen, N. T., Wood, A. W., Palmer, R. N., & Lettenmaier, D. P. (2004). Potential Implications of PCM Climate Change Scenarios for Sacramento–San Joaquin River Basin Hydrology and Water Resources. Climatic Change, 62(1-3), 257-281. doi:10.1023/b:clim.0000013686.97342.55

Vinson, M., and S. Levesque 1994. Redband trout response to hypoxia in a natural environment. Great Basin naturalist 54(2): 150-155.

Wade, A. A., Beechie, T. J., Fleishman, E., Mantua, N. J., Wu, H., Kimball, J. S., . . . Punt, A. (2013). Steelhead vulnerability to climate change in the Pacific Northwest. Journal of Applied Ecology, n/a-n/a. doi:10.1111/1365-2664.12137

WADFW. (2009). Section 7.6 Direct and Indirect Effects: Water Quality Modifications. Washington Department of Fish and Wildlife, Compiled White Papers for Hydraulic Project Approval HCP: Washington Department of Fish and Wildlife, Compiled White Papers for Hydraulic Project Approval HCP.

Wardle, C., Carter, T., Urquhart, G., Johnstone, A., Ziolkowski, A., Hampson, G., & Mackie, D. (2001). Effects of seismic air guns on marine fish. Continental Shelf Research, 21(8), 1005-1027.

Water Quality Assessments. (1996). Water Quality assessments: A guide to the use of biota, sediments and water in environmental modeling. Ed. D. Chapman. Published on behalf of UNESCO United Nations Education, Scientific, and Cultural Organization; WHO World Health Organization; UNEP United Nations Environmental Program. Chapman & Hall, London.

Water Resources. (2015). Lathrop Urban Runoff Study Final Technical Report. State of California The Resources Agency: Department of Water Resources.

Westervelt Ecological Services. (2009). Cosumnes Floodplain Mitigation Bank, Bank Enabling Instrument.

Westervelt Ecological Services. (2016). Bullock Bend Mitigation Bank, Final Bank Enabling Instrument (BEI).

Wildlands Inc. (2006). Central Valley Anadromous Salmonids Umbrella Conservation Bank Agreement.

Wildlands Inc. (2010). Conservation Bank Agreement, Liberty Island Conservation Bank.

Williams, G.D. and R.M. Thom. 2001. Marine and estuarine shoreline modification issues: White paper submitted to the Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation.

Williams, J. G. (2006). Central Valley Salmon: A perspective on Chinook and steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science, 4(3), Article 2.

Williams, T. H., Spence, B. C., Boughton, D. A., Johnson, R. C., Crozier, L., Mantua, N. J Lindley, S. T. (2016). *Viability Assessment for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Southwest*. Memorandum from Steve Lindley to Will Stelle.

Project: South Lathrop Regional Outfall
Prepared by: Jean Castillo
Date: February 5, 2018

OVERVIEW:

The City of Lathrop is proposing the installation of an outfall structure on the eastern bank of the San Joaquin River, south of the I-5 crossing of the San Joaquin River and north of the Union Pacific Railroad line, within the City limits of Lathrop, located in San Joaquin County, California (BA 2017).

FLOW EFFECTS

The outfall consists of six (6) 36-inch stormwater pipes that have a "duckbill valve"[A] at the end of each pipe. They are designed primarily for backflow prevention. A video of a duckbill valve operating can be found at:
http://www.martinchilds.com/duckbill-check-valves/

Because there is a valve on the end of the pipe, typical jet flow theory can't be directly applied but it still can be referenced with the understanding the jet will be hindered by the friction losses in the valve along with the altered shape of the jet.

[A] **Duckbill valves** are unique, one-piece, elastomeric components that act as backflow prevention devices or one-way valves or check valves. They have elastomeric lips in the shape of a duckbill which prevent backflow and allow forward flow.

The design calls for 36-inch Proflex Check Valve Series. Using the spreadsheet from the manufacturer, it shows for a standard weight valve size of 36-inches, the jet velocity would be 22.62 ft/sec our of the valve. The 60,000 gpm equates to 133.7 cfs. Without knowing all of the headloss in the design this might be the worst case scenario.

To determine how far the jet may go into the river, horizontal and vertical Kinematic equations were used.

PROCO

PROCO PRODUCTS, INC.

ProFlex™ Series 710/730 Check Valve

Flow Sizing Program

Input Flow Rate 60,000 U.S. gpm

Valve Size (in)	Pipe Velocity (ft/s)	Standard Weight Headloss (ft)	Standard Weight Jet Velocity (ft/s)	Light Weight Headloss (ft)	Light Weight Jet Velocity (ft/s)	Heavy Weight Headloss (ft)	Heavy Weight Jet Velocity (ft/s)
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-
28	-	2.66	21.33	2.02	19.77	3.22	21.91
30	-	-	-	-	-	-	-
36	18.91	2.39	22.62	1.90	21.91	2.87	23.30
42	13.89	1.68	17.36	1.37	16.78	1.99	17.92
48	10.64	1.22	13.86	1.02	13.38	1.43	14.32
54	8.41	0.92	11.39	0.78	11.00	1.06	11.78
60	6.81	0.71	9.59	0.61	9.26	0.80	9.90
66	5.63	0.56	8.22	0.49	7.95	0.62	8.48
72	4.73	0.45	7.15	0.40	6.93	0.50	7.37

Kinematic equations were used to determine how far out the jet of water could go perpendicular to the river.

1) USE EQUATION TO SOLVE FOR TIME (VERTICALLY)
2) USE EQUATION TO SOLVE FOR DISTANCE (HORIZONTALLY)

1) $$y = \frac{1}{2} g t^2$$

$$t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{2(2\,ft)}{32.174\,ft/\sec^2}} = 0.3526\sec$$

2) $$velocity = \frac{(L)}{(t)}$$ L = distance traveled, t = time

Solve for length: L = VELOCITY x TIME

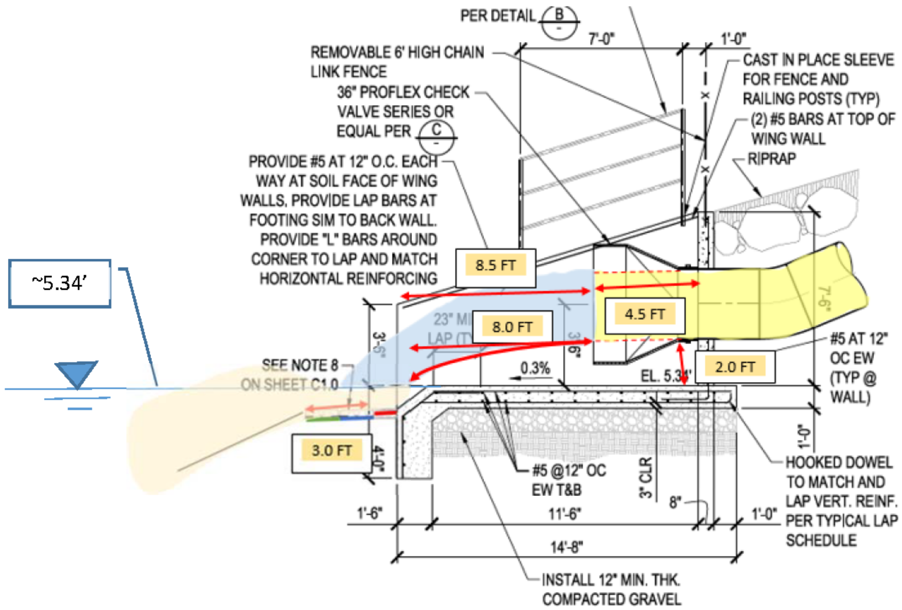
Q = 60,000 gpm

V=22.62 ft/sec from PROCOR Check Valve Manufacturer flow sizing program

$$length = 22.62 \frac{ft}{\sec} x 0.3526 \sec = 7.97\,feet$$

Say 8.0 feet into the river

So the jet of water out of the pipe could potential extend 8.0 feet out into the river.

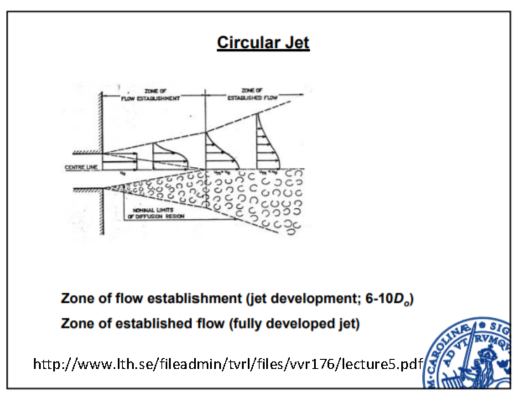


SECTION Y

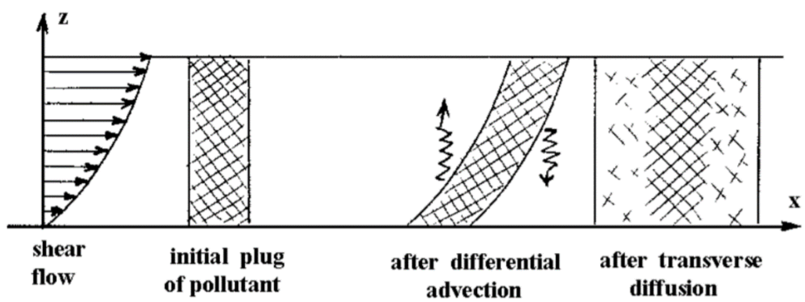
When the river stage is below the estimated average maximum water elevation of 5.34 feet, there will be a zone of turbulence due to the energy being dissipated onto the concrete apron and the Armorflex mat.

When the river stage is above the average maximum water elevation, the jet of water will engage the river flow.

When the flow out jets into the river, there is typically a ***zone of flow establishment*** out of the pipe where there will be a mixing of the water with the river water which will cause eddies and turbulence as shown in the photo. The initial 3-foot diameter core jet of water will be worn down by water little eddies being sheared off from the plug on the fringes.

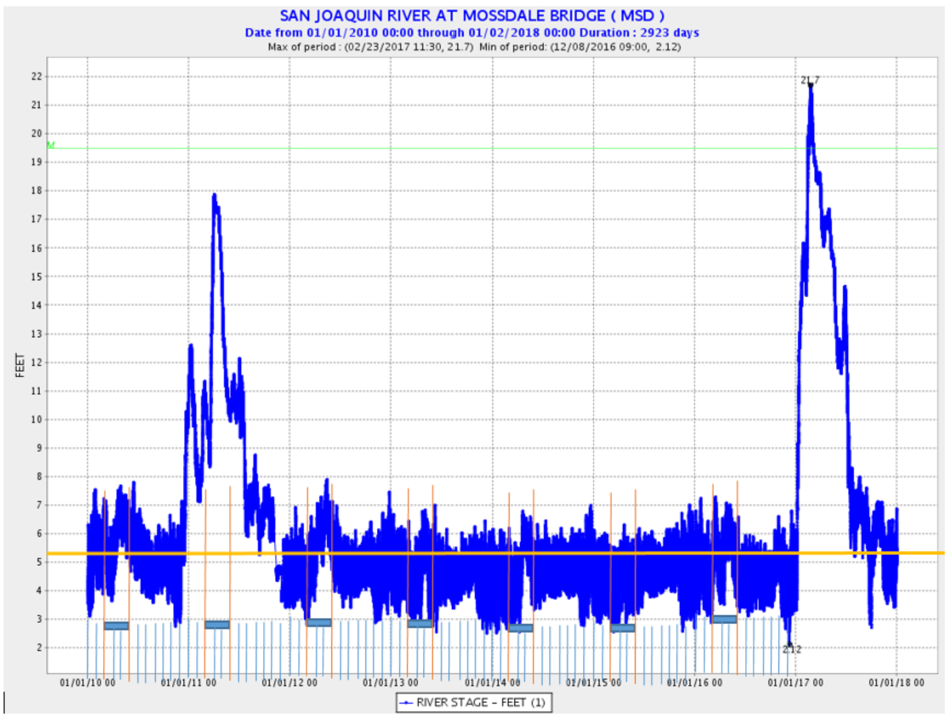


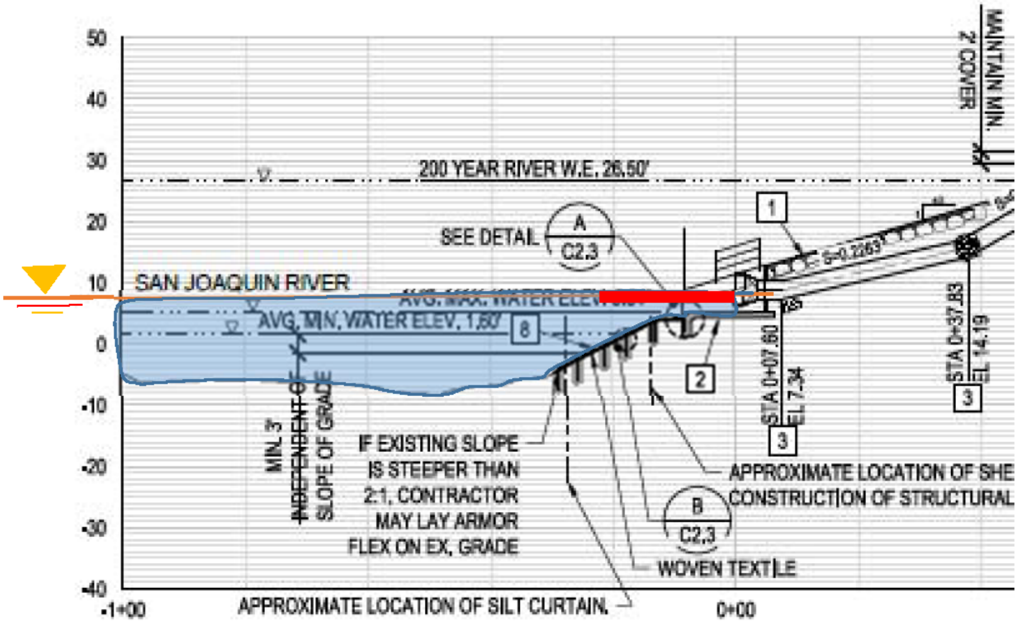
As the jet of water engages the river the zone of flow establishment which is generally accepted as 6.2 times the diameter of the pipe in length, will begin to develop. Keep in mind, on the Lathrop outfall pipes, there will be a valve that obscures the shape of the plug of water out of the pipe so this rule of thumb could be somewhat skewed by the valve shape. The pipe diameter is three feet so 6.2 x 3 ft = 18.6 feet out into the water. The diagram below shows how the plug of water out of the pipe will be moved downstream (in our case hopefully there is no pollutant).



http://thayer.dartmouth.edu/~d30345d/courses/engs43/Chapter3.pdf

The water surface does go above the estimated average maximum during the core months of juvenile migration from March to May. As the graph shows, the river stage can get as high as 7 or more feet.





Taking the higher river stage into account, the core plug of water will be split with part of the flow submerged and part skimming the top of the water. The part of the jet that is in the water was estimated above to be about 6.2 times the pipe diameter = 18.6 feet as represented by the red line coming out of the pipe.

Also, the jet of the water's centerline will be curved somewhat downstream by the ambient flow.[3] But again, straight jet calculations are not easily applied to the duckbill valve but it is known that the river flow will push the outflow jet downstream. When all six pipes are active this effect might be cumulative lengthening the dissipation time of the outfall flows.

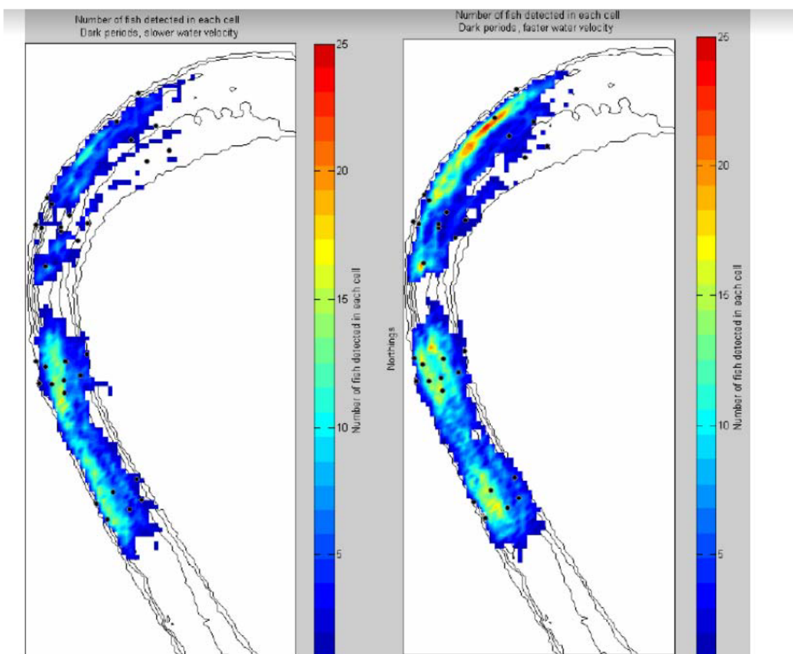
The annotations on the images are for presentation only and are not scaled or precisely accurate. They are only to give you an idea of what is happening. For exact calculations and drawings I would request the applicant to provide documentation the exact length of the zone of flow establishment and the jet projection into the river.

BANK PROTECTION

Riprap, or hard armoring, is the traditional response to controlling and minimizing erosion along shorelines or riverbanks. As demonstrated by past multiple disasters in Washington State, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) has provided funding assistance for the repair to these riprap facilities. The very nature of having to repair these facilities counters the popular engineering belief that riprap is the best solution for mitigating stream bank erosion.[2] Because of this, FEMA has come out with documentation on Engineering With Nature Alternative Techniques to Riprap Bank Stabilization. With FEMA on board with alternatives to riprap, perhaps the applicant would be open for future discussions to eliminate or reduce the riprap on this project.

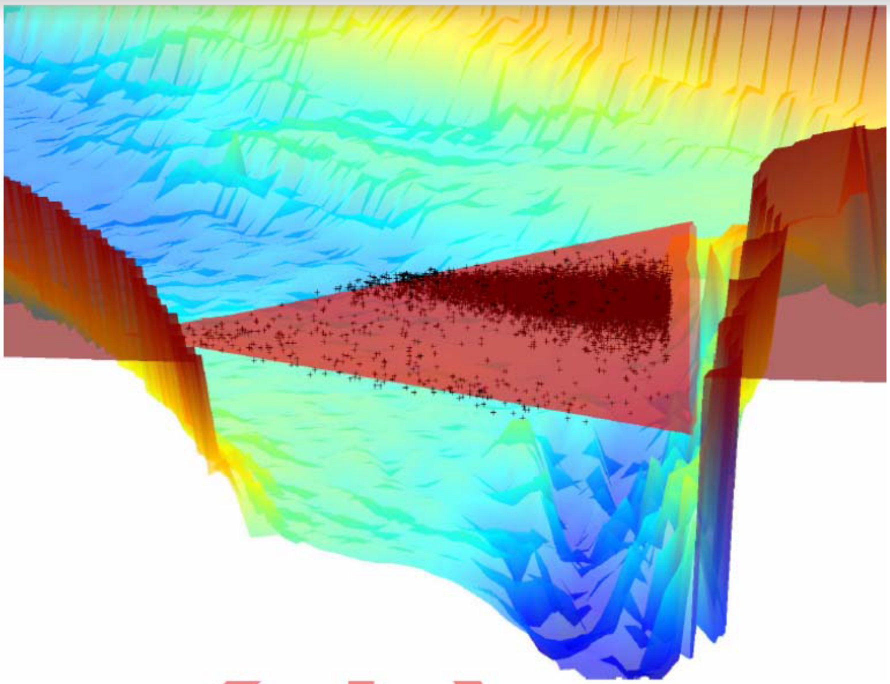
JUVENILE DISTRIBUTION IN THE RIVER

As I previously mentioned and we have discussed, just upstream of the project there is a bend in the river which forces the flow to the east bank where the stormwater outfall is located. In studies done by ICF on the proposed CWF intakes, they hypothesized that this type of flow condition could lead to a greater proportion of juveniles to pass by their project intakes than if they were occurring evenly distributed across the channel cross-section. They support their analysis by studies at Clarksburg Bend (Figure 5) and near the Delta Cross Channel (Figure 6). (ICF Draft 2016 Memorandum)



Source: Burau et al. (2007: Figure C.17)

Figure 5. Clarksburg Bend Acoustic Tracking Study: Juvenile Chinook Salmon Distributions for Dark Periods, Separated into Fast (Greater than or Equal to Mean) and Slow (Less than Mean) Water Velocity Periods.



Source: Burau et al. (2007: Figure 2.5)

Figure 6. Delta Cross Channel Vicinity Hydroacoustic Study: Detections of Juvenile Salmon (+) on the Outside of a Bend in the Sacramento River Immediately Downstream of its Junction with Georgiana Slough (Upper Right)

These observations agree with the general pattern of downstream-migrating juvenile salmonids in the Pacific northwest often being distributed near the thalweg, or near the shoreline (Smith et al. 2009). Therefore, it is possible that a relatively large proportion of downstream-migrating juvenile salmonids could pass close to the NDD, particularly during nighttime periods when most migration occurs (Chapman et al. 2013; Zajanc et al. 2013; Plumb et al. 2016). The general pattern of downstream-migrating juvenile salmonids in the Pacific Northwest often being distributed near the thalweg, or near the shoreline (Smith et al. 2009).

Therefore, it is possible that a relatively large proportion of downstream-migrating juvenile salmonids could pass close to the proposed outfall location particularly during nighttime periods when most migration occurs (Chapman et al. 2013; Zajanc et al. 2013; Plumb et al. 2016).(2015 ICF Draft Memorandum)

REFERENCES:

[1] **Biological Assessment, South Lathrop Regional outfall** prepared for: **City of Lathrop,** Prepared By: ECORP Consulting, **August 30, 2017**

[2]https://www.fema.gov/pdf/about/regions/regionx/Engineering_With_Nature_Web.pdf

[3] Email correspondence with Stephen Schlenker, USACE and author of Jet Velocity Dissipation and Modeling with Aeration.

END OF APPENDIX 1