DRERIP Evaluations of BDCP Draft Conservation Measures

Summary Report

DRAFT

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1. INTRODUCTION

This report describes the application of the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) Scientific Evaluation Process to evaluate draft conservation measures being considered for inclusion in the Bay Delta Conservation Plan (BDCP). The report summarizes the DRERIP process, how it was applied, who was involved, and the key findings. This application of the DRERIP process to proposed BDCP conservation measures is intended to provide technical input to the BDCP planning process and to provide insights into potential refinement of draft conservation measures.

The DRERIP evaluation process, as described in more detail below, involved evaluating each proposed BDCP conservation measure independently to identify the effectiveness of each on its own merits. Some measures related to water operations such as the Hood Bypass Criteria were provided to the evaluation team as a single measure with a given set of assumptions regarding Delta Cross Channel operations and south Delta diversions, because they are integral components of the dual conveyance strategy being pursued by the BDCP. Ultimately, the BDCP will include an overall Conservation Strategy comprised of a suite of conservation measures, many of which bear on each other (see *An Overview of the Draft Conservation Strategy for the Bay Delta Conservation Plan* dated January 12, 2009). Such a suite of measures may provide benefits greater than the sum of the individual measures. To begin to address this issue, a Synthesis Team was convened following the initial DRERIP evaluations to consider potential synergies and conflicts between various measures and to develop recommendations for possible modifications to the draft conservation measures. Due to time limitations, however, the Synthesis Team did not utilize the DRERIP evaluation procedure to evaluate the outcomes of modified conservation measures or the potential impact of combinations of conservation measures.

All evaluation results presented herein are relative to existing, baseline conditions in the Delta (i.e. will the measure result in a change, either positive or negative, making conditions better or worse than they currently are). The existing regulatory baseline was assumed to be D-1641.

Following this introduction, Section 2 provides general background information on the DRERIP evaluation process. Section 3 provides a summary of how the process was specifically applied to proposed BDCP conservation measures and Section 4 provides a summary of findings from the evaluations of individual conservation measures. Section 5 presents results and recommendations from the Synthesis Team.

2. DRERIP EVALUATION PROCESS

The following sections provide a brief summary of how the DRERIP evaluation process is structured including information on scoring procedures and scoring criteria.

2.1 Background and Purpose

The DRERIP Scientific Evaluation Process was developed to aid planning and decision making for ecosystem restoration projects in the Delta. The process entails engaging teams of experts to work through a structured, step-by-step scientific examination of the potential positive and negative outcomes resulting from proposed restoration actions. Detailed instructions describing each of the steps used in the evaluation process, as well as definitions for key terms, is provided in Appendix A.

The process relies on a series of ecosystem and species' life history conceptual models developed specifically for the Delta. These conceptual models describe the current scientific understanding of how the Delta ecosystem works and are designed to serve as a foundation for the evaluation process. The conceptual models are useful because they summarize existing scientific knowledge in a comprehensive manner for a given species or aspect of the ecosystem. Additional sources of information, for example recent published literature not embraced by the models can also be utilized, resulting in evaluations based on up-to-date information. In a few limited cases, the evaluation team conducted new analyses to assess potential outcomes. In these cases, the analysis is provided as an appendix to the evaluation worksheet. These additional analyses have not been peer reviewed.

The DRERIP process focuses strictly on ecological issues. It is not designed, or intended to address other factors that may ultimately influence decisions, such as cost or socio-economic considerations. The process also does not address issues of feasibility or priority setting. Most of the BDCP conservation measures evaluated were previously screened relative to basic feasibility factors.

The DRERIP process is designed to evaluate restoration actions at any level provided, with the evaluations results being more specific as the action itself is described in more specific terms. It can look at single actions and groups of actions; the more complex the restoration action, the more effort required to conduct the evaluation and potentially less certainty in the findings. DRERIP was not designed to conduct new technical analyses of restoration actions (e.g., numerical hydrodynamic modeling) but instead to draw upon the existing knowledge base as contained in peer-reviewed conceptual models and other information where needed and available.

The scope of evaluations for BDCP were focused on individual BDCP conservation measures (which in many cases are very large in nature) and not on considering multiple conservation measures together. The Synthesis Team examined these possible synergies and provided recommendations to further refine the conservation measures, where appropriate, to improve their overall benefits to covered fish species. Readers should be cautious in attempting to estimate cumulative or synergistic impacts of different actions; the scores are not necessarily additive or multiplicative. Several low magnitude actions may or may not correspond to a "medium" overall outcome. Also, some conservation measures may interact negatively with other conservation measures (e.g. if habitat restoration produces changes in tidal prism or hydrodynamics that are counter to those required for positive outcomes of another conservation measure).

2.2 Magnitude and Certainty Scores

After identifying likely outcomes for each conservation measure, the evaluation team assigned scores to each outcome reflecting the expected magnitude of the outcome (positive and negative) and the level of certainty regarding that magnitude. Magnitude and certainty scores were assigned to both positive and negative outcomes based on current scientific information. Definitions and the criteria used for assigning magnitude and certainty scores are shown in Table 1 and 2 below.

Table 1 - Criteria for Scoring the Magnitude of Ecological Outcomes

Magnitude *–the size or level of the outcome, either positive or negative, in terms of population or habitat effects on a given species. Magnitude is not the same as the scale of the action; however, higher magnitude scores require consideration of scale.*
4 - High: expected sustained major population level effect, e.g., the outcome addresses a key limiting factor, or contributes substantially to a species population's natural productivity, abundance, spatial distribution and/or diversity (both genetic and life history diversity) or has a landscape scale habitat effect, including habitat quality, spatial configuration and/or dynamics. Requires a large-scale Action.
3 - Medium: expected sustained minor population effect or effect on large area (regional) or multiple patches of habitat. Requires at least a medium-scale Action.
2 - Low: expected sustained effect limited to small fraction of population, addresses productivity and diversity in a minor way, or limited spatial (local) or temporal habitat effects.
1 - Minimal: Conceptual model indicates little effect.

Table 2 - Criteria for Scoring Certainty of Ecological Outcomes

Certainty *-– the likelihood that a given Restoration Action will achieve a certain Outcome. Certainty considers both the predictability and understanding of linkages in the pathway from the action to the outcome. Generally, high importance-low predictability linkages drive the scoring; it is important to ensure that certainty is not unduly weighted by a comparatively low-importance, albeit low-predictability linkage.*
4 - High: Understanding is high (based on peer-reviewed studies from within system and scientific reasoning supported by most experts within system) and nature of outcome is largely unconstrained by variability (i.e., predictable) in ecosystem dynamics, other external factors, or is expected to confer benefits under conditions or times when model indicates greatest importance.
3 - Medium: Understanding is high but nature of outcome is dependent on other highly variable ecosystem processes or uncertain external factors or understanding is medium (based on peer-reviewed studies from outside the system and corroborated by non peer-reviewed studies within the system) and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors
2 - Low: Understanding is medium and nature of outcome is greatly dependent on highly variable ecosystem processes or other external factors or understanding is low (based on non peer-reviewed research within system or elsewhere) and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors
1 - Minimal: Understanding is lacking (scientific basis unknown or not widely accepted), or understanding is low and nature of outcome is greatly dependent on highly variable ecosystem processes or other external factors

These definitions indicate how challenging it is for an individual action to achieve a magnitude score of 4 (population level effect) in a complex ecosystem with many stressors. Similarly, because many of the outcomes are influenced by highly variable (and thus unpredictable) ecosystem dynamics, only rarely will an individual action achieve high or even medium certainty scores. A measure with a "low" magnitude score can still be implemented – and the cumulative effects of many such actions may result in a greater level of effect at the population level scale.

For some species, particularly salmonids and sturgeon that spend a relatively short portion of their life history in the Delta, it is rare for Delta-specific actions to have population level effects. The benefits of measures in the Delta can easily be overwhelmed by conditions upstream and/or downstream (i.e., ocean), which may be driving the population in more significant ways. Given this fact, magnitude scores of "3" or "4" are not common for salmonids with Delta restoration alone.

Beyond individual magnitude and certainty scores, it is important to review combinations of magnitude and certainty (i.e., different combinations suggest different things). For example, a medium benefit with low certainty (combined score of "3, 2") means that the team concluded that the outcome would have a minor population level effect and that the certainty that this magnitude would be achieved (as opposed to a lower magnitude) was low.

Both positive and negative outcomes are scored, and it's important to look at the positive scores in combination with the negative scores to provide an overall evaluation of the action. Together, these outcomes could result in a theoretical no-net-gain, or even a net negative effect. Many of these trade-offs are potentially quite complex and very difficult to predict in terms of likely net biological response, the mechanisms underlying those responses, and our ability to mitigate risk factors in design and implementation.

3. EVALUATION OF BDCP CONSERVATION MEASURES

The following sections describe how the DRERIP Scientific Evaluation Process was applied to proposed BDCP measures.

A total of 32 draft BDCP conservation measures were identified for evaluation. These measures were selected by the BDCP planning team from the draft conservation measures described in Handouts #3, 4, and 5 from the October 31, 2008 BDCP Steering Committee meeting. These measures were reviewed and refined in December 2008 for the purposes of conducting the DRERIP evaluations. Refinements included stipulating details such as target restoration acreages and bypass flows. A listing of the measures evaluated as well as descriptions of those measures as provided to the evaluation team are contained in Appendix C. This refinement for the purposes of evaluation occurred prior to the release of the BDCP Overview document entitled *An Overview of the Draft Conservation Strategy for the Bay Delta Conservation Plan* dated January 12, 2009. As a result, there are some minor differences in the descriptions and assumptions between the measures evaluated and those described in the Overview document.

A team of 50 experts was convened to evaluate several draft proposed BDCP conservation measures. Team members were selected based on their expertise relative to the specific ecological issues associated with the draft conservation measures, as well as their familiarity with the Delta, the DRERIP conceptual models, and the DRERIP evaluation process. Team members were trained on how to conduct the evaluations and were tasked with reviewing particular conceptual models prior to the evaluations. The team was further divided into five subteams with each team assigned specific conservation measures on related topics. Each subteam was headed by a Chair familiar with the topic and was assigned a 'coach; familiar with the DRERIP process. A listing of evaluation team members is provided in Appendix D.

A series of workshops were held where team members discussed the draft measures and worked through the pre-established evaluation steps for each action. Workshops were followed by team conference calls and email deliberations over a three-month period from January to April 2009, including review and refinement of findings. The results of each team's evaluations were recorded in standardized worksheets which were reviewed and edited by the teams. Due to the intensity and volume of work, not all evaluations were completed to the same level of detail and not all worksheets were reviewed by all team members.

4. SUMMARY OF FINDINGS

The following presents a brief summary of findings from the evaluation of individual draft proposed BDCP conservation measures. Summary findings are presented for each subteam. All findings are for the specific conservation measures as given to the teams in January 2009 (see Appendix C). Findings regarding interrelationships between conservation measures are discussed in Section 5 of this report.

Completed evaluation worksheets for each measure, including the rationales behind the findings, can be viewed at _______________. The detailed worksheets include the specifics regarding individual measures and expected species outcomes. The numerous and complex ecological interactions and trade-offs between the various measures do not lend themselves well to simple summary results. For example, there can be a temptation to gauge a measure's merits by simply reviewing the magnitude scores for positive outcomes. Readers should note that: (1) magnitude scores for positive outcomes represent the highest possible outcome; (2) certainty scores indicate the degree of certainty experts have about attaining an outcome as high as that indicated by the magnitude score; and (3) negative outcomes associated with the conservation measures deserve attention as well. The worksheets prepared by each evaluation subteam describe in detail the potential benefits and pitfalls associated with each conservation measure.

Not all evaluations were completed with equal degrees of analysis due to time and budget constraints. In several instances, general conclusions from one evaluation were applied to other evaluations, with varying levels of measure-specific refinements. Details of measure-specific differences were not always explored fully due to limited information and uncertainties about the population level effects of these differences. Evaluations that fall into this category are noted in their worksheets.

Each evaluation worksheet contains a list of data gaps and future research needs. These lists warrant further consideration by BDCP.

Appendix D provides a series of tables listing the magnitude and certainty scores for each measure and the expected outcomes (positive and negative) by species.

4.1 Floodplain and Riparian Habitat Restoration Measures

Nine specific floodplain and riparian habitat restoration measures were evaluated including restoring former floodplains along the San Joaquin River (HRCM1, 2) and in the South Delta (HRCM3), creating channel margin habitat along Steamboat and Sutter sloughs (HRCM12) and the San Joaquin River (HRCM13), and creating riparian habitat in association with other actions (HRCM11, 14). The Floodplain and Riparian Habitat team also evaluated measures to modify and reoperate the Fremont Weir and Yolo Bypass (Core Element No.1, WOCM2) and to create a new bypass adjacent to the Sacramento River Deep Water Ship Channel (WOCM3). Multiple scenarios were considered for several of the actions involving different restoration acreages and different inundation regimes.

Fremont Weir and Yolo Bypass (Core Element No.1; WOCM2)

- Modifications to the Fremont Weir and reoperation of the Yolo bypass to provide higher frequency and duration of inundation is expected to have high magnitude benefits for several covered species with a high degree of certainty.
- Benefits are attributable to increased spawning and rearing habitat as well as expected reductions in stranding and associated illegal harvest.
- Results suggest that Option 1 (spill discharge of 4,000 cfs for 45 days) would provide greater benefits for covered species than Option 2 (spill discharge of 2,000 cfs for 30 days) due to the greater extent and duration of flooding.
- Potential negative outcomes to covered species were few, and appear to be manageable through more detailed design and effective monitoring. The potential for mercury methylation and associated environmental toxicity is expected to be of low magnitude for covered fish species, but the certainty of that outcome is low because there is very limited data on mercury toxicity to fish in the Delta.
- Results for creation of a new floodplain bypass adjacent to the Sacramento Deep Water Ship channel (WOCM3) were similar to those for reoperation of the Yolo bypass.

San Joaquin River and South Delta (HRCM1, 2, and 3)

- Floodplain restoration measures along the San Joaquin River would be expected to provide minimal to low benefits (with a medium to high degree of certainty) due to infrequent floodplain inundation associated with the current San Joaquin River flow regime, which is a limiting factor.
- Expected benefits of floodplain restoration in the south Delta (along Old River at Fabian Tract) are also minimal to low due to the relatively small scale of the action (800 to 1600 acres). However, there could be minor population level benefits for splittail associated with this measure if the Old River were isolated such that it did not experience the effects of south Delta pumping.

Channel Margin and Riparian Habitat (HRCM 11, 12, 13 and 14)

- Proposed improvements to "channel margin habitat" would be expected to have largely minimal to low benefits for covered species due to the relatively small scale of the actions, the lack of any change in the currently impaired flood hydrology, and the fact that channels would not be allowed to evolve and erode providing limited instream structure such as woody debris.
- The team recommended providing a clearer definition of "channel margin" habitat.

4.2 Tidal Restoration Measures

The effects of reintroducing tidal flows into six Restoration Opportunity Areas (ROA) in the Delta were evaluated, including the Yolo/Cache Slough Complex ROA (Core Element No. 6; HRCM4), the Cosumnes/Mokelumne ROA (HRCM5), the West Delta ROA (Core Element No. 7; HRCM6), the South Delta ROA (HRCM7), the East Delta ROA (HRCM8), and the Suisun Marsh ROA (Core Element No. 8; HRCM9). Restoration of these areas would involve varying degrees of tidal marsh and shallow subtidal restoration as described in more detail in Appendix C. Multiple scenarios were considered for several of the ROAs reflecting different amounts of restored habitat. The evaluation team focused its greatest efforts on HRCM4 (Yolo/Cache) and

HRCM9 (Suisun); HRCM6 (West Delta) received the next level of effort; and the remaining measures were evaluated with far less detail.

In general, evaluation results vary considerably depending on the species in question and the geographic location of the restoration. The magnitude of the benefits tend to be greater for delta smelt (which spends its entire life history in the delta preferring cooler, turbid waters) than they are for migratory fish, such as salmon and sturgeon which spend a relatively small portion of their life cycle in the Delta. The likelihood that restored tidal areas would export zooplankton and insects to provide food for covered species in other areas of the Delta is a function of the size of the restoration area, its relative mix of marsh and open water, its connectivity to the estuary, the amount of riverine influence on the area, and the degree to which production is consumed within the ROA. The evaluation team had difficulty evaluating this outcome and in the end presented alternate conclusions. These different viewpoints reflect a core need to gain better understanding, which can be accomplished most effectively through implementing restoration efforts and evaluating their outcomes on this issue.

Negative outcomes of concern include the potential for restored areas to be colonized by *Egeria* providing habitat that increases predation risk, and the potential for methylation of mercury.

<u>Yolo/Cache Slough ROA (Core Element No. 6; HRCM4)</u>

- Many of the benefits of this restoration depend upon relocation of major urban and agricultural water supply diversions within the Cache Slough area, especially the North Bay Aqueduct intake and a handful of the large agricultural intakes.
- Expected medium magnitude benefits (minor population level effect) for delta smelt, splittail, and Sacramento fall-run Chinook salmon, but with low certainty. While the measure would increase the amount of habitat area for delta smelt in the north Delta, it would not expand the range of the species in the Delta, a critical concern for delta smelt conservation.
- Expected minimal to low population benefits for longfin smelt, sturgeon, winter and spring-run Chinook salmon, and steelhead with low certainty. The evaluation recognized that the near total absence of tidal marshes in the Delta and thus the near total absence of local data to understand how these species may use or be affected by restored tidal habitats contribute to the low certainty score.
- The measure has the potential to produce a considerable quantity of organic carbon to support the aquatic food web; uncertainty exists regarding the extent to which the primary production component might be reduced if invasive clams colonize restored areas. Uncertainty also exists about the magnitude of secondary production being transported to locations where covered fish species could gain the most benefit.
- The establishment of *Corbicula* could limit or eliminate the benefits of the action by consuming increases in primary productivity created by the restored marsh and subtidal areas. Uncertainty is high regarding whether this loss of primary production could affect secondary production – zooplankton and insects – that serve as the primary prey items for covered fish species.
- Other invasives, namely *Egeria* and centrarchids, could have a medium magnitude negative effect on covered species, but the certainty of this effect is low.
- The potential for mercury methylation is expected to be of low magnitude with medium certainty; the associated environmental toxicity for covered fish species is expected to be of

low magnitude, but the certainty of this toxicity outcome is low because there is very limited data on mercury toxicity to fish.

- The negative outcomes for human health and piscivorous wildlife associated with the potential for habitat restoration to increase MeHg concentrations in fish received low magnitude and medium certainty scores and need to be seriously considered.
- Increased mercury methylation could potentially be a significant issue for birds and humans.
- Linkage to Yolo Bypass improvements identified as raising the benefits of this measure though the magnitudes were not assessed.

<u>Cosumnes/Mokelumne ROA (HRCM5)</u>

- This evaluation was not subject to the full development and review by the evaluation team so its findings are preliminary and subject to revision were further analysis to be conducted.
- Expected medium magnitude benefits (minor population level effect) for splittail with medium certainty.
- Expected minimal to low benefits for delta smelt, longfin smelt, sturgeon, steelhead, and salmonids (all runs) with minimal to low certainty.
- The measure would likely provide low magnitude local increases in productivity, but may not provide a significant net increase in zooplankton or insects to other areas of the Delta. See productivity discussion for HRCM4 above.
- Potential for negative outcomes, including establishment of *Egeria* and centrarchids are similar to that described above for the Yolo/Cache ROA.

<u>West Delta ROA (Core Element No. 7; HRCM6)</u>

- This evaluation was not subject to the full development and review by the evaluation team so its findings are preliminary and subject to revision were further analysis to be conducted.
- Results indicate that the effects of *Egeria* establishment and associated predation are potential medium to high magnitude negative outcomes, but certainty is low. This measure has a greater likelihood for this negative outcome due to its composition of many, relatively small restorations alongside large water bodies vs. the larger restorations of other ROAs.
- The West Delta ROA is particularly limited by the fact that it consists of numerous, small, disconnected parcels.

<u>South Delta ROA (HRCM7)</u>

- This evaluation was not subject to the full development and review by the evaluation team so its findings are preliminary and subject to revision were further analysis to be conducted.
- Expected minimal to low benefits for all covered species with minimal to low certainty.
- Similar to the West Delta ROA, results indicate that the effects of *Egeria* establishment and associated predation are potential medium to high magnitude negative outcomes, but certainty is low.
- The potential for this measure to adversely contribute to low dissolved oxygen (DO) conditions in the Delta was also identified as a concern with a medium magnitude, but low certainty. Increased residence times associated with limited circulation combined with greater biological productivity contributing to increased water column Biological Oxygen Demand (BOD) could lead to low DO conditions.
- Benefits considered minimal at best under current conveyance and export configuration.
- Potential for negative outcomes is similar to that described above for the Yolo/Cache ROA.

East Delta ROA (HRCM8)

- This evaluation was not subject to the full development and review by the evaluation team so its findings are preliminary and subject to revision were further analysis to be conducted.
- Benefits for covered fish species are expected to be low with minimal to low certainty.
- Potential for negative outcomes is similar to that described above for the Yolo/Cache ROA.
- Evaluation noted potential for greater magnitude of negative outcomes due to the relative isolation of this ROA and the poor quality habitats linking it to other suitable habitat areas.

Suisun Marsh ROA (Core Element No. 8; HRCM9)

- Expected medium magnitude benefits (minor population level effect) of providing habitats for splittail, delta smelt, and fall and spring-run Chinook salmon, but certainty is minimal to low.
- Expected medium magnitude benefits for contributing desired productivity contributions, with low to medium certainty; benefits highly dependent on where within Suisun Marsh the restoration efforts are located.
- Expected to reduce periodic low dissolved oxygen conditions that originate with the existing managed wetlands.
- May reduce overall methyl mercury production and exposure that originate with the existing managed wetlands (medium magnitude, low to medium certainty).
- Potential for establishment of *Egeria* is zero, but potential for establishment of *Corbula*, which could constrain the desired productivity benefits, is high with a low certainty. Predator establishment potential is minimal to low, with low certainty.

4.3 Water Operations Measures

The team evaluated two potential water operations conservation measures, a new diversion point in the north Delta with Hood Bypass Criteria and other Measures (Core Elements No. 2, 3, 4, and 5; WOCM1) and new Interim Tidal Gates in the south Delta (Core Element No. 9; WOCM8) - commonly referred to as 2-Gates. Evaluation of the new north Delta diversion and associated other measures included reductions in south Delta pumping (dual conveyance), changes to Delta Cross-channel gate operations, and two alternative Hood bypass flow criteria. Modifications and operational changes to the Yolo Bypass (WOCM2) were evaluated as part of the floodplains evaluation. The Interim Tidal Gates measure included installing operable tidal gates in Old River on the eastern side of Bacon Island, and in Connection Slough on the western side of Bacon Island. The implications of the Interim Tidal Gates measure were only evaluated for delta smelt and longfin smelt.

The evaluation of WOCM1 did not include any assessment of entrainment or impingement related to fish screens on the new North Delta Diversion(s). The team assumed that the fish screens would be 100% efficient.

Results of the evaluation point to complex trade-offs between potential positive outcomes in the south Delta associated with reduced export pumping resulting in modified Old and Middle River (OMR) flows and potential negative outcomes in the north Delta associated with the new diversion. Negative outcomes are also expected in the south Delta related to exacerbation of existing low dissolved oxygen conditions and other water quality impacts, including the potential for greater residence times (i.e., less flushing) and less dilution of San Joaquin River inflows.

<u>New North Delta Diversion with Hood Bypass Criteria and other Measures (Core Elements No. 2, 3, 4, and 5; WOCM1)</u>

- Reduced diversions at the South Delta facilities, and associated reductions in entrainment are expected to result in:
  - medium magnitude benefits with medium certainty for delta smelt adults and juveniles by reducing entrainment at the facilities.
  - medium magnitude benefits for longfin smelt adults with low magnitude benefits for longfin smelt larvae and juveniles by reducing entrainment at the facilities.
  - low magnitude benefits with medium certainty for splittail, Sacramento River salmon runs, and steelhead.
- The potential benefits of reduced diversions at the South Delta facilities are expected to be minimal for San Joaquin fall-run Chinook salmon (*Stanislaus, Merced, and Tuolumne rivers)* because exports remain high during the period SJR fall run Chinook are migrating through the south Delta and the action does not address SJR flows which are needed to facilitate escapement.
- New diversions on the Sacramento River would have negative effects due to increased predation, both at the diversion facilities themselves and downstream due to modified hydrodynamics and fish travel time. The magnitude of the negative impact due to increased predation ranged from low to high depending of species, and will depend on the design of the diversion structures and associated screens (particularly their location and orientation to the river bank), and the change in flow conditions downstream.
- Potential impacts of large diversions of Sacramento River water on foodweb dynamics are highly uncertain. Removal of organic carbon and organisms from the system could adversely impact productivity downstream. However, increased residence time associated with reduced flows could increase primary productivity (additional conservation measures could also potentially influence productivity downstream, namely Yolo Bypass inundation and tidal marsh restoration). Increased primary productivity may not yield suitable secondary productivity utilized by covered fish species because the primary productivity may be intercepted by other organisms, including invasive clams, or it may be of an undesirable form (e.g., Microcystis).
- Evaluation results indicate that operation of a new North Delta Diversion would have a medium magnitude negative impact on covered species (sustained minor population level effect) due to declines in water quality in the South Delta. Some of this would be due to reduced dilution of loadings from the San Joaquin River.
- Potential impacts to *Mokelumne and Cosumnes fall run Chinook were not evaluated.*

<u>Interim Tidal Gates (Core Element No. 9; WOCM8)</u>

- The construction of operable tidal gates in Old River and Connection Slough along the east and west sides of Bacon Island is expected to provide medium to high magnitude benefits for adult delta smelt and low to medium benefits for juvenile delta smelt, with low to medium certainty for both outcomes.

- The potential for negative outcomes for delta and longfin smelt associated with increased predation at the new gate structures and increased entrainment at the pumps are expected to be low, with a low certainty.
- Potential implications of the 2-Gates measure on other covered species, including salmonids were not evaluated.

4.4 Hatcheries and Harvest Measures

Six "Other Stressor" conservation measures related to hatcheries and harvest regulations were evaluated including increased sport harvest of non-native predatory fishes (OSCM14), enhanced enforcement in the Delta (OSCM16), modified splittail harvest regulations (OSCM17), implementing a Mark-Select program to reduce the harvest of wild Chinook salmon (OSCM19), establishing artificial propagation programs for delta smelt and longfin smelt (OSCM20), and modifying or eliminating non-project diversions in the Delta (OSCM21).

<u>Increased Sport Harvest of Non-Native Predatory Fishes (OSCM14)</u>
- Expected medium benefits for delta and longfin smelt, but low certainty. Potential benefits for other covered species are minimal to low with low certainty.
- The likelihood and magnitude of positive effects on covered species are not well-understood due to uncertainty regarding (1) the magnitude and frequency of competition between juvenile striped bass and delta and longfin smelt, (2) how fishermen will respond to changes in sport fishing regulations, and (3) the magnitude of the impact of bass predation on any one species. Research in these areas will increase our understanding of the benefits provided to covered species by this measure.
- Negative outcomes identified for this conservation measure are: (1) increased by-catch of non-target species (minimal magnitude, low certainty), (2) release of other predator populations from predation pressure (low magnitude, low certainty), (3) release of other competitor populations from predation pressure (medium magnitude, medium certainty), and (4) unintended changes to the bass populations (i.e., may shift average size of bass populations) (low magnitude, low certainty).

<u>Enhanced Enforcement in the Delta (OSCM16)</u>
- Expected medium benefits for green and white sturgeon, low to medium benefits for Chinook salmon, and low benefits for steelhead – all with low certainty.
- Uncertainty regarding the impact of poaching on population sizes of covered fishes, relative to other threats, makes it difficult to determine the potential benefits of implementing this measure.
- There is a possibility that lack of information regarding where poaching is most important may result in greater effort to enforce fishing regulations in less important areas and a shift of poaching to areas of greater importance to the population.

<u>Modified Splittail Harvest Regulations (OSCM17)</u>
- Two positive outcomes were identified by the evaluation team: (1) increased population abundance of splittail, and (2) improved foodweb energy transfer in wet years. Both are expected to result in medium benefit with low certainty.

- It is difficult to evaluate the potential benefits of this measure due to uncertainty regarding the size of the current splittail fishery, and magnitude of foodweb energy transfer caused by movement of splittail into and out of inundated floodplains.
- The primary negative outcome identified was the potential for redirection of fishing effort toward other sensitive species as splittail harvest regulations are put in place (low magnitude, medium certainty).

<u>Mark-Select Program for Chinook salmon (OSCM19)</u>

- Based on experiences in other states with mark-select fisheries, the evaluation team stated that the effectiveness of such a program largely depends on implementation and monitoring, and that it would be difficult, if not impossible, to limit all commercial and recreational harvest to marked fish.
- Expected medium magnitude benefits for integrated (natural and hatchery produced) Chinook salmon population with medium certainty. The evaluations found that natural Chinook populations may not necessarily increase abundance as other stressors may exert a greater influence on the population.
- Potential negative outcomes include: (1) complication of management and data for conservation hatcheries and agency sampling programs; and (2) increased bycatch and non-harvest mortality of covered salmonids. These outcomes are based largely on uncertainty regarding the magnitude of non-catch mortality and approaches for managing conservation stocks.

<u>Artificial Propagation of Delta and Longfin Smelt (OSCM20)</u>

- Expected medium magnitude benefits for delta smelt and longfin smelt with minimal to low certainty.
- Negative outcomes include: (1) potential genetic consequences for hatchery and wild populations; (2) negative ecological interactions with wild fish (e.g., competition, displacement); (3) genetic bottlenecks resulting from mining of wild population to support broodstock needs leading to reduced capacity of species to adapt to changing environmental conditions; and (4) mortality associated with catching broodstock.
- The potential for mortality associated with collection of broodstock is considered to be low (with medium certainty) because effective collection techniques have been established for delta smelt. Longfin smelt are expected to be less sensitive to handling stress and physical injury than delta smelt (magnitude low, certainty low).
- It will be difficult to determine how many hatchery fish are needed to boost spawning in the wild. Adaptively managing the numbers of hatchery fish introduced will be necessary. Numbers should be adjusted if reproductive rates do not increase.
- The negative outcome results are based largely on uncertainty regarding the genetic implications of hatchery propagation for wild and hatchery delta and longfin smelt. The genetic diversity of hatchery fish is of concern because these fish are to be introduced into the wild, are expected to interbreed with wild fish, and will undergo domestication without integrating new wild broodstock into the propagation activity. Information is particularly limited for longfin smelt, for which hatchery propagation has not been conducted to date.

<u>Reducing Non-project Diversions (OSCM21)</u>

- The positive outcomes identified include: (1) reduced entrainment mortality by non-project diversions; and (2) increased food availability. Benefits are expected to be of minimal magnitude, with minimal certainty for both outcomes due to uncertainty regarding the entrainment mortality caused by non-project diversions and how these diversions affect planktonic food availability.
- No negative outcomes for covered species were identified for this measure.

4.5 Water Quality and Invasive Species Measures

Six "Other Stressor" conservation measures related to water quality and invasive species were evaluated including, measures to: reduce the concentrations of ammonia discharged into the Sacramento River (OSCM1); reduce the loads of endocrine disrupting compounds (EDCs) (OSCM2); reduce the load of methylmercury (OSCM3); reduce loads of pesticides and herbicides (OSCM4); reduce loads of toxic contaminants in stormwater and urban runoff (OSCM5); and remove water hyacinth (*Eichornia crassipes*) and Brazilian waterweed (*Egeria densa*) from select areas of the Delta (OSCM13).

Results of the evaluation indicate that the majority of the water quality and invasive species measures would be expected to deliver positive benefits to covered species, with the exception of OSMC13 (SAV and FAV), for which significant negative outcomes were identified that could potentially deliver net losses for covered species. Negative outcomes were also identified for OSCM1 (Ammonia), OSCM4 (Pesticides) and OSCM5 (Urban runoff). In general, reducing the amounts of chemicals in Delta waterways are expected to be a good thing for covered fish species, even if the specific benefits are difficult to quantify.

<u>Ammonia Loadings Reductions (OSCM1)</u>

- Expected to have medium magnitude benefits for delta smelt and longfin smelt, but the certainty of these benefits is minimal. Benefits for other species are minimal to low magnitude with a range of certainty depending on the species and the specific outcome (see Appendix D).
- Negative outcomes identified include: (1) possible removal of important nutrients from the system by tertiary treatment of WWTP effluent (magnitude minimal, certainty high); (2) microcystis blooms could result from increased nitrate (from nitrification of ammonium) (magnitude low, certainty low); and (3) enhanced phytoplankton production from reduction of ammonium (by nitrification) could increase clam biomass and uptake of selenium, impairing reproduction in benthic-foraging fishes (magnitude medium, certainty high).
- The negative outcomes anticipated in the evaluation are based largely on uncertainty regarding the need to identify more sources of ammonia and the unsettled state of the science regarding food web relationships of phytoplankton, diatoms, microcystis, zooplankton, and clams, and how they and their relationships are affected by excess ammonium in the system, water residence time, salinity, temperature, and flow.
- Integrated research should be undertaken to develop a numerical model of ammonia/ammonium affects on the Delta food web and covered species so that the multiple factors influencing production can be manipulated/isolated from other factors, and the respective roles of each factor can be determined for the different portions of the estuary.

Endocrine Disrupting Compounds (EDCs) Loadings Reductions (OSCM2)

- Reducing EDCs is expected to result in benefits for all covered fish species. The magnitude of these benefits range from low to medium, while certainty is minimal to medium, depending on the outcome.
- There were no negative outcomes identified by the evaluation team for this conservation measure. However, to effectively target reductions in EDCs, the main sources need to be identified and quantified.
- WWTPs contribute to the EDC problem. However, EDCs can also come from pyrethroids and other agricultural runoff, particularly dairies, which represent potentially large, untreated loadings. Therefore, the relative contributions of wastewater treatment plants to those of other potential EDC sources such as hatcheries, pesticide sources (which include both agricultural and urban use), and dairies need to be determined.
- Secondarily, EDC monitoring based on biological responses is needed to identify hotspots and sources as well as temporal and special distribution of EDCs within the system.

Methyl Mercury Loadings Reductions (OSCM3)

- The expected benefits for covered fish species of reducing methyl mercury loadings and resulting bioavailability are minimal to low, with low certainty. The benefits to wildlife and humans, however, are expected to be of medium magnitude with medium certainty.
- There were no negative outcomes for covered species identified by the evaluation team for this conservation measure.
- As more seasonal wetlands are created in the Delta and as the Delta's hydrology changes due to the dual conveyance system or climate change, monitoring of MeHg concentrations in water and fish becomes more important. Species-specific studies on sub-lethal population-level effects (e.g. feeding efficiency, growth, or spawning success) of MeHg in covered fish species are also necessary.
- Monitoring studies would contribute to the development of a numerical MeHg transport and fate model, with a food web component, that combines source information, water transport and residence times, photodemethylation and particle settling to predict methyl mercury concentrations in water, sediment, and biota at various locations in the Delta under different hydrologic conditions.
- From a sociological perspective, better estimates of the number of people at risk for MeHg toxicity due to recreational or subsistence fishing should be made to refine or expand fish consumption advisories and to develop educational strategies for teaching the affected public how to reduce the risk.

Pesticide and Herbicide Loadings (OSCM4)

- Reducing pesticide and herbicide loadings in Delta waterways would be expected to have benefits (medium to high magnitude, medium certainty) for several covered fish species, including delta smelt, green and white sturgeon, spring-run Chinook salmon, and winter-run Chinook salmon.
- The negative outcome identified for this conservation measure was loss of freshwater input to the system and loss of habitat for freshwater phytoplankton and zooplankton if tailwater recovery systems are used as a BMP to reduce pesticide-contaminated runoff (medium magnitude, minimal certainty). This outcome, if confirmed, could be managed by specifying appropriate BMPs to avoid loss of freshwater input.

- There are currently no data on the use of small creeks by covered species or their phytoplankton and zooplankton prey. Such data could be developed to evaluate: 1) the relative importance of the freshwater input of small creeks to the system; 2) the use of small creeks as nursery areas by ecologically important phytoplankton and zooplankton species; and 3) where to avoid freshwater reductions.

Urban Runoff (OSCM5)

- Reducing urban runoff is expected to have benefits (medium magnitude, low to medium certainty) for several covered fish species, including steelhead, spring-run Chinook salmon, winter-run Chinook salmon, fall-run Chinook salmon, delta smelt, longfin smelt, and green and white sturgeon,.
- Negative outcomes identified include: (1) human health impacts from use of ponded stormwater by breeding mosquitoes; and (2) contamination of groundwater by infiltration of impounded surface water. Both of these outcomes could be managed to reduce the likelihood of occurrence.
- Urban runoff containment and treatment methods (both existing and potential future methods) should be assessed with respect to mosquito control and groundwater infiltration. Monitoring should include collection of data to determine how and when small subgroups of the covered species and their zooplankton prey use urban creeks, and how individual sources of runoff affect receiving waters.

Submerged and Floating Aquatic Vegetation (SAV and FAV) (OSCM13)

- Reducing non-native SAV and FAV in specific areas of the Delta is expected to have positive benefits for Chinook salmon and steelhead rearing in the Delta (magnitude medium, certainty medium).
- Negative outcomes identified include: (1) reduction in zooplankton from herbicide toxicity (magnitude low, certainty low); (2) reduction in phytoplankton from herbicide toxicity (magnitude medium, certainty minimal); (3) increased detritus including particulate organic carbon (POC) (magnitude low, certainty low); (4) increased microcystis blooms due to reduced competition for nutrients from phytoplankton and microcystis resistance to herbicides (magnitude low, certainty medium); (5) toxic effects on juvenile sturgeon from fluridone and 2,4-D used at approved application rates (magnitude low, certainty medium); and (6) endocrine disrupting effects of 2,4-D on fish (magnitude low, certainty low).
- A large part of the uncertainty regarding this conservation measure is due to unknown factors in the relationship between phytoplankton and microcystis and how they are affected by herbicides. In addition, more information is needed on the interactive effects of flow and temperature on microcystis blooms.
- The potential toxic effects on sturgeon are based on studies from outside the system that looked specifically at aquatic herbicides. Sturgeon were more sensitive than salmon to these chemicals in controlled laboratory tests. However, the use of proposed weed control areas in the Delta and actual water concentrations resulting from the CDBW program are unknown.
- Most of the uncertainties could be addressed by controlled, small-scale pilot studies with detailed before-and-after monitoring.

5. SYNTHESIS TEAM RECOMMENDATIONS

Following the individual evaluations, a Synthesis Team was formed to examine potential synergies and conflicts between the various draft conservation measures. The team was comprised of the five DRERIP evaluation subteam chairs and select members of the evaluation subteams. Members of the Synthesis Team (see Table 5.1) were assigned to review the evaluation worksheets and identify potential refinements to the draft conservation measures, including additional information or analyses that would be useful in reducing uncertainties. The Team also looked at areas where measures could work with or against each other and tried to identify refinements that would enhance potential synergies and reduce potential conflicts among actions. The Team did not attempt a comprehensive assessment of cumulative impacts or a scoring of the ultimate net effect of the all the measures combined. Synthesis Team findings, as presented below, were based on a series of meetings and discussions among team members culminating in a two-day workshop where the team developed final recommendations.

Table 5.1 – Synthesis Team

Name	Affiliation	Evaluation Team(s) Role
Dave Harlow	SWC	Tidal reintroduction, chair
Stuart Siegel	Wetland and Water Resources	Tidal reintroduction, coach
Chuck Hanson	Hanson Environmental	Tidal reintroduction
Amy Richey	Mosaic/SLDMWA	Tidal reintroduction
Campbell Ingram	TNC	Floodplains, chair
Denise Reed	UNO	Floodplains, coach
Jim Haas	USFWS	Water quality and invasives, chair
David Fullerton	MWD	Water quality and invasives, member
Brad Cavallo	CFS/SWC	Hatcheries and harvest, chair
John Cain	NHI	Water operations, chair
Joshua Israel	EDF	Water operations, Hatcheries and harvest
Rosalie del Rosario	NMFS	Water operations, Floodplains
Matt Norbriga	DFG	Water operations
Armin Munevar	CH2M Hill	Hydrodynamic modeling results
Carl Wilcox	DFG	NA
Michael Hoover	USFWS	NA

5.1 General Synthesis Team Conclusions

Collectively, the synthesis team concluded that a number of the conservation measures have the potential for additional synergistic effects that can raise or lower the worth of some individual conservation measures when implemented concurrently with other actions. The complexity of various trade-offs between expected positive and negative effects make it difficult to predict the biological responses to multiple measures in combination. The Synthesis Team recommended that refinements could be made to the proposed modification of the Fremont Weir and Yolo Bypass inundation, North Delta diversions with bypass criteria, and Cache slough restoration to optimize ecological benefits and water supply goals. They also identified the need for better information and modeling of the survival and growth of covered species and predators to establish baseline conditions against which benefits can be assessed as these BDCP conservation measures are further developed and implemented. The Synthesis Team further recommends that BDCP proceed with large scale implementation of tidal reintroductions in Cache Slough, Suisun Marsh and Dutch Slough based on the existence of favorable landscape characteristics for restoration in the areas and expected benefits to multiple covered fish species.

The Synthesis Team identified seven general conclusions that apply broadly to the evaluations and that form the foundation for the Team's recommendations.

1. Refinements should be made to add specificity to the proposed modifications to the Fremont Weir and Yolo Bypass inundation (WOCM2), North Delta Diversions with Hood bypass criteria and other measures (WOCM1), and Cache Slough restoration (HRCM4) to reduce potential conflicts between ecosystem and water supply goals, and better optimize ecological benefits.

2. Better information on the survival and growth of covered species and predators using the Yolo Bypass, Cache Slough and Sacramento River (above, within, and below the section where new diversions are proposed) is needed to establish baseline conditions against which covered species benefits resulting from implementing the conservation measures can be determined and documented.

3. Potential benefits to San Joaquin River fish are limited by San Joaquin River flows and source water quality. The potential benefits of proposed BDCP measures, including reduced south Delta pumping and habitat restoration for San Joaquin River fishes, is minimal without concurrently addressing other limiting factors.

4. Tidal restoration measures could be more clearly defined, to clarify the desired future conditions, including the intent to provide tidal marsh <u>and</u> tidally influenced open water habitats with hydrodynamic and water quality characteristics suitable to native fishes and not suitable for extensive growth of *Egeria densa* and with conditions that promote desirable secondary production and its availability to target covered fish species within and beyond the restoration areas. Unpublished research data (Wilcox, pers. comm.) on the ecological characteristics and fish use in the Cache Slough/Liberty Island area suggest it could serve as a model for future tidal restoration.

5. The potential benefits of habitat restoration measures (tidal reintroduction and floodplain restoration) are highly dependent on location, scale, landscape setting, and design that considers site specific characteristics (e.g., elevations, tidal exchange, substrate, sediment supply, turbidity, quality and frequency of available habitat, geomorphology, wind-wave regime, and connectivity to adjacent aquatic and upland environments).

6. The uncertainties surrounding benefits of tidal restoration for habitat and productivity can be reduced primarily through two main strategies: (1) implementation of large-scale pilot projects designed to address these questions and with associated science-based monitoring, and (2) collection of further data from existing restorations to maximize their "lessons learned" value for subsequent project designs.

7. Other stressor measures should be refined and strategically paired with habitat restoration and conveyance conservation measures to enhance benefits for covered species; some also have value as stand-alone measures.

5.2 Specific Observations and Recommendations

Results from the DRERIP evaluations point to complex ecological trade-offs between implementation of multiple conservation measures, particularly measures that influence hydrodynamic conditions in the Delta such as modifying the Fremont Weir, operating new diversions in the north Delta, reintroducing tidal flows to large areas, and reducing pumping in the south Delta. There are likely opportunities to optimize benefits and manage risks for covered species better through more refined modeling analyses and a closer examination of the interrelationships between measures.

The following sections describe specific observations regarding trade-offs, synergies between various draft conservation measures, and recommendations regarding potential adjustments to the draft conservation measures. It should be noted that the DRERIP evaluations were defined by dual conveyance Scenarios 1 and 2, which assumed 2-10% greater export levels over the Reference Scenario (D1641 with existing infrastructure). Neither the Synthesis Team nor the evaluation team were tasked with considering lowered export levels to improve biological outcomes; no such Conservation Measure was provided for evaluation.

<u>Floodplain Inundation Benefits and Predation Losses</u> - Results of the DRERIP evaluations indicate that increased flooding of the Yolo bypass would enhance conditions for splittail and salmon. However, operation of a New North Delta Diversion could have negative population level effects on splittail and salmon due to increased predation (see WOCM1, Outcome N2). Predation losses could off-set the positive benefits of increased Yolo inundation. This may be particularly true in dry years when both the predation effects associated with the new diversion could be higher (as all salmon must pass the new diversion point) and the Yolo Bypass may not be available, or may not flood for a sufficient duration to allow adequate splittail spawning or salmon access to off-set predation losses. Under certain flow conditions, Particle Tracking Model(PTM) results indicate that fewer particles (i.e., representing salmon smolts) exit the Delta.

High uncertainty about salmon survival necessitates better hydrodynamic modeling capabilities (with salmon models of the diversion structures and important junctions). DSM2 modeling to date of reintroducing large tidal flows into the Yolo/Cache Slough area shows a big impact on phase shift, tidal range, net flow, and flow magnitudes of tides which in turn affect conditions at the North Delta Diversions and thus operating scenarios for Fremont Weir. These changes will affect residence times, salmon migration, availability of streambank habitat, and predation losses in the Sacramento River and its distributaries, particularly Georgiana, Steamboat and Sutter sloughs.

Recommendations:

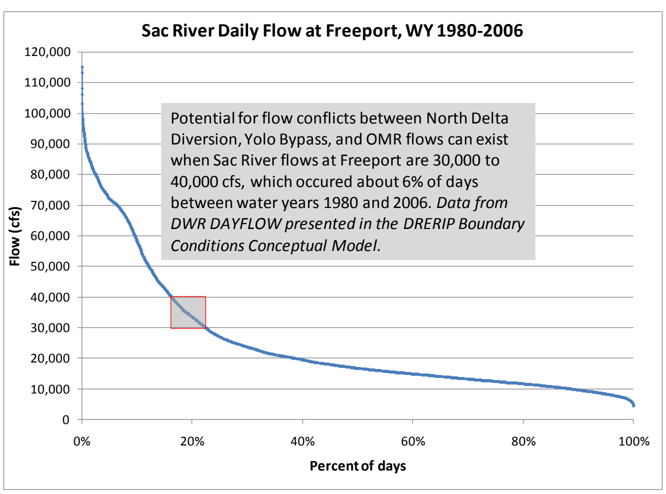
1. Institute pre-implementation acoustic studies to establish baseline survival data and growth for covered species and predators using the Yolo Bypass, Cache Slough, and Sacramento River. Use the Delta Passage Model as a working hypothesis to look at how fish respond to various dual conveyance and habitat restoration scenarios.

- Couple with CALSIM to develop relationships for baseline alternative.
- Review CWT/acoustic study design from past study to inform study design for evaluating alternative combinations of conservation measures. Past study designs are not sufficient to develop a necessary pre-project baseline for BDCP.
- Test sensitive model outputs with refined study design to field validate survival estimates.
- Consider similar studies for San Joaquin River and Cosumnes/Mokelumne.
- Develop explicit Hood Bypass survival data.

2. Develop modeling capability to assess salmon survival, using a diversity of potential diversion designs as necessary with:
   - 3D hydrodynamic model in the diversion reach, including fish behavior;
   - 2D hydrodynamic model at the tributaries influenced by the diversion;
   - Field validations;
   - Comparisons of with and without diversions, and with and without diversion structures;
   - Fish screen effectiveness (i.e., what happens if a screen does not meet its expected efficiencies).

3. Conduct more sophisticated 2D modeling in order to better understand the potential implications of changing hydrodynamics, on factors such as tidal phase, tidal amplitude, net tidal flow, and tidal flow magnitudes, under different scenarios of flooded island inundation on covered species (including the influence of Cache Slough restoration on hydrodynamics in Steamboat and Sutter sloughs). DSM2 was not designed to do this type of modeling.

Yolo Bypass Inundation, Hood bypass criteria, and South Delta Entrainment -Modeling results indicate that when flows at Freeport are between 30,000 to 40,000 cfs (see figure below) there is a potential conflict between inundating Yolo Bypass and Hood bypass flow and OMR flow. This potential conflict was not evaluated by either the DRERIP Water Operations subteam or the DRERIP Floodplains subteam.



Recommendations:

4. Conduct sensitivity analyses using finer scale modeling tools (e.g., daily time step modeling) and refined operational criteria to examine the effects different combinations of Hood bypass flow, Yolo inundation, and south Delta export pumping on OMR flows, residence time, and the fate of SJR waters. Scenarios should include examining the potential benefits of higher Hood bypass flows, as well as modified Yolo inundation regimes (including modified timing and inflow volumes).

5. Better optimize potential ecological benefits of WOCM1 and 2 through modified Hood bypass flow criteria and more refined Yolo Bypass operations (see recommendation below) to reduce negative OMR flows and associated entrainment, particularly for periods when Sacramento River flows are between 30k and 40k cfs. Consider incorporating OMR flow criteria as an explicit element of WOCM1.

6. Develop more specific operational criteria for Yolo inundation based on daily time-step modeling to optimize potential benefits. Take advantage of additional information being developed by DWR (e.g., improved bathymetry data) and utilize BDCP hydrologic modeling of Yolo Bypass to estimate increased production of adult splittail in the Yolo bypass and weigh that against increased predation in dry years.

7. Consider more naturalistic floodplain pulse flows into the Yolo Bypass that could involve an early pulse to achieve inundation and more fish onto the floodplain, followed by occasional inputs of smaller volumes of water to retain depths, and subsequent higher volume pulse flows that would move fish and material downstream. The CM presents the Yolo Bypass more as a higher-flow side channel to the Sacramento River than a pulse-flow floodplain system.

8. Consider flooding the Yolo Bypass only when sufficient flows exist to support a sustained level of inundation (i.e., avoid risk of stranding from attraction flows that cannot be followed by sufficient inundation flows).

<u>North Delta Diversions and South Delta Water Quality</u> - Changes in Delta hydrodynamics resulting from operational modifications (new diversions in the north Delta coupled with modified diversions in the south Delta), particularly in the summer and potentially in combination with proposed south Delta restoration measures, are expected to result in increased South Delta residence times, which, when combined with the influence of greater levels of nitrate- and phytoplankton-rich San Joaquin River water in the south and central Delta, could exacerbate the frequency and severity of low dissolved oxygen conditions. Reduced estuary flows and turbidity combined with the existing high nutrient levels, warming temperatures, greater relative contributions from the San Joaquin River, and constricted tidal flows could produce many “classic” eutrophication symptoms in the Delta. Reduced exports in the south Delta could also result in increased concentrations of Selenium (Se) and other chemical stressors in the Delta.

Recommendations:

9. Develop a comprehensive water quality – biological response modeling capability to inform decisions about flow needs given particular water temperature and nutrient load scenarios. Modeling should include examining nutrient uptake potential for marsh and floodplain vegetation which could increase bioavailability or provide alternate exposure pathways affecting different receptors.

10. Consider in-Delta and upstream source control measures to reduce nutrient and contaminant loading, including the effects of ongoing efforts to reduce Se loading into the San Joaquin River.

11. Refine and articulate Other Stressor conservation measures to target specific issues in the southern and central Delta, so they are coupled strategically with proposed habitat restoration measures. .

<u>Limitations for San Joaquin River Fishes</u> - Results of the DRERIP evaluations indicate that the benefits of reduced south Delta pumping and floodplains habitat restoration along the San Joaquin River (SJR) and in the south Delta are limited by SJR flows through the Delta (i.e., not just inflow but through-flow as well), source water quality, and limited tidal exchange capacity of existing waterways, particularly for San Joaquin fishes. Under current operations, little San Joaquin River water makes it to Chipps Island when juvenile salmon and steelhead are out-migrating, except under rare flood flow conditions. Proposed BDCP conservation measures do not appear to improve these conditions measurably.

12. Run fingerprinting analyses for San Joaquin River water without south Delta exports to determine if conditions for out-migrating juvenile San Joaquin River fishes could be improved by getting more San Joaquin water into the west Delta.

13. Consider the use of a Vernalis to south Delta export ratio as an additional operational criterion.

<u>Adjustments to San Joaquin River Floodplain Restoration, Levee Setbacks, and Channel Margin Habitat Measures</u> - Similar to the limitations for San Joaquin River fishes noted above, the benefits of floodplain restoration measures in the south Delta are limited by San Joaquin River flows and the expected low frequency of inundation. The DRERIP evaluations were based on simplified assumptions regarding levee setbacks (i.e., 500 feet on each side of the river). More specific designs that work with the existing flow regime and seek to incorporate important site specific features such as backwater areas, more habitat diversity, greater channel migration capacity, and more overbank flooding could increase the potential benefits of these measures. The current configuration of largely rip-raped, trapezoidal channels in the Delta provides little habitat for covered species and contributes to a high degree of predation.

Recommendations:

14. Evaluate the likely outcomes of San Joaquin River Floodplain Restoration, Levee Setbacks, and Channel Margin Habitat measures under several scenarios of future increased SJR flows

to identify the benefits such restoration could provide if flows were increased under other authorities.

15. Where there are currently narrow corridors, consider levee setbacks for wider floodplain with natural meanders, backwaters, and channel margin habitat.

16. Revise the existing BDCP definition of channel margin habitat (see evaluation worksheets for HRCM 12 and13).

17. Integrate ecological design into future flood control projects. Incorporate modified channel geometry to provide habitat for splittail and other covered species, including allowing for channels to meander providing more microhabitats with emergent vegetation, woody debris, and more structural heterogeneity.

<u>Yolo Bypass Inundation and Cache Slough Productivity</u>
The potential benefits of coupled Yolo Bypass improvements and tidal restoration in Cache Slough, especially desired productivity benefits, are influenced greatly by flows (inputs) and urban and agricultural diversions (losses), or the net flows. First and foremost, relocation of the major diversions (North Bay Aqueduct and the major agricultural intakes) is essential to realize many of these benefits and in particular to allow the advective transport capacity of Yolo Bypass outflows to increase transport and mixing. Second, there is potential to improve the hydrologic connectivity of the southern end of the Yolo Bypass and the Cache Slough area in a manner that takes better advantage of the base flows from Putah and Cache creeks, reported to be on the order of 100-200 cfs, in providing contributions to advective transport. The magnitude of these contributions to advective transport has not been evaluated quantitatively. Through physical modifications at the southern end of the bypass it may be possible to enhance the benefits of increased seasonal flooding of the Yolo Bypass. These adaptations to the conservation measure should be articulated as part of a possible adaptive management program including Cache Slough.

Recommendations:

18. Develop plans for relocating the major water supply intakes away from the Cache Slough area.

19. Identify and articulate specific physical landscape modifications (focused on tributaries at the bottom end of the Yolo Bypass and Cache Slough restoration) to improve distribution of Yolo Bypass base outflow into the Cache Slough area to enhance the movement of insects and zooplankton to the northwest Delta. Descriptions regarding the type, location, and nature of the modifications should be developed based on more specific operational criteria and analysis for Yolo Bypass flooding (see Recommendation #6 above).

<u>Tidal Reintroductions and Restoration Design</u>
While restoration of tidal marsh and open water habitat in the Cache Slough and Suisun Marsh areas are expected to benefit covered species, particularly delta smelt, there is uncertainty and disagreement on the potential population level effects of the proposed measures for rearing

juvenile salmonids. Unpublished data (Wilcox, pers. comm.) regarding salmon use of the Cache Slough/Liberty Island area are available, but need to be compiled and summarized.

The value of tidal reintroductions for covered fish species will be strongly influenced by location, landscape setting, and site specific design considerations such as elevation, tidal exchange, substrate, sediment supply, turbidity, geomorphology, wind-wave regime, and connectivity to aquatic and upland environments. Careful siting and design can influence the likelihood of species benefits as well as the potential adverse effects of non-native invasives such as *Egeria* and associated predation risk.

The relationships between geomorphic elements of a tidal reintroduction (vegetated tidal marsh, channels, and open water), tidal flow regimes and connectivity to pelagic environments, and the potential for adverse effects from invasive species establishment affect the benefits that may be achieved for covered fish species. Key uncertainties include relative benefits of vegetated tidal marsh vs. open water (and thus how to address subsided properties), importance of productivity contributions from vegetated tidal marsh directly or indirectly to covered species, conditions that promote vs. discourage *Egeria* establishment (see page 25), extent to which invasive clams may divert considerable quantities of new primary production, magnitude of suitable productivity (zooplankton and insects) exported from restoration areas, and density of channels in Delta historical tidal marshes and ability of natural processes to establish channels in restored marshes.

Recommendations:

20. Compile, analyze, and summarize existing fish utilization data from existing restored and reference sites in the Delta and Suisun Marsh to identify "lessons learned" applicable to proposed restorations.

21. Proceed with large scale tidal reintroduction in Cache Slough, Suisun Marsh and Dutch Slough based on existing information and maximize adaptive management in the design and monitoring in recognition that proto-habitat types and additional research are both needed to address uncertainties and make future decisions.

22. Describe baseline survival and growth of salmon runs so that post-restoration monitoring and analysis can demonstrate to what extent tidal marsh contributes to salmonid survival.

23. Develop a focused suite of restoration design principles for the Delta and Suisun, building on existing work where available, that reflects the variability in landscape context, unique setting of each restoration site, and lessons learned from successful and unsuccessful projects. These principles should not be overly prescriptive nor contain any single "template" so as to avoid over-engineering or over-simplification. They should also direct incorporation of adaptive management design features to address the uncertainties identified here to the extent possible at each site. Principles should specifically address approaches for areas below the elevation of potential colonization by emergent vegetation: e.g. whether to incorporate as open water, grading/sculpting, reverse subsidence by planting before tidal reintroduction, or retain as leveed.

24. Pursue tidal restoration of small parcels in the West Delta ROA only if they are expected to result in net benefits for covered species. Focus on aggregation of smaller parcels so as to create larger, contiguous restoration areas wherever possible.

Egeria Control - *Egeria* changes habitat toward conditions more suitable for largemouth bass and other centrarchids fishes than for native fishes and increases predation success on covered fish species. However, the presence of some Egeria may not eliminate covered fish species benefits, as evidenced at Sherman Lake which has extensive *Egeria* within small tidal channel networks, but does not extend into Delta smelt's pelagic habitat in the open-water like it does in Franks Tract. There are three categories of *Egeria* control methods each with varying efficacy and undesirable consequences:

1) Through various design considerations including tidal flushing, wind fetch and turbidity, competitive exclusion via establishment of other vegetation such as tules in the area of tidal reintroduction. Promoting higher energy open water should reduce *Egeria* but also limits tidal marsh formation.
2) Mechanical removal after establishment. Has practicality limitations given *Egeria*'s ability to reestablish quickly and to reestablish from cut pieces.
3) Chemical treatment after establishment. Though has had reasonable effectiveness where used (e.g., Frank's Tract, Big Break), the chemicals used pose direct and indirect risks to covered species that limit desirability.

Recommendations:

25. Explicitly design tidal, floodplain, and channel margin restoration measures to control the establishment of *Egeria* and to reduce predator success. Existing areas in the Delta should be used as models both successful and unsuccessful: Liberty Island, Little Holland Tract, Frank's Tract, Mildred Island, Big Break, Sherman Lake, and Donlon Island.

26. Focus post-establishment *Egeria* control measures on locations and habitats that are known to be, or could become important for covered fish and where physical design approaches are insufficient.

27. Prioritize tidal reintroduction locations where control through design has the best chances for success.

Managing MeHg Release from Restored Tidal Areas and Floodplains - DRERIP evaluations indicate that there is a potential for Mercury methylation in high marsh and floodplain areas due to ongoing input of mercury and patterns of wetting and drying. While not a direct threat to covered fish species, elevated mercury levels in fish could adversely affect wildlife that prey on fish, as well as humans that harvest them.

28. Monitor MeHg concentrations in water, fish and wildlife as more seasonal wetlands are created in the Yolo Bypass and elsewhere and the hydrology of the Delta is changed with construction of a dual conveyance system

29. Conduct species-specific studies on sub-lethal population-level effects (e.g. feeding efficiency, growth, or spawning success) of MeHg in birds and wildlife species.

30. Develop a numerical MeHg transport and fate model, with a food web component, that combines source information, water transport and residence times, photodemethylation and particle settling to predict methyl mercury concentrations in water, sediment, and biota at various locations in the Delta under different hydrologic conditions.

31. Establish better estimates of the number of people at risk for MeHg toxicity due to hunting and recreational or subsistence fishing to refine or expand fish and wildlife consumption advisories and develop educational strategies for teaching the affected public how to reduce the risk.

32. Focus efforts on controlling ongoing mercury loading into the Delta and Suisun Marsh so as to reduce mercury supply over the long term available for methylation. Plan tidal and floodplain inundations to minimize frequent wetting and drying of areas containing mercury.

Appendix A:
DRERIP Scientific Evaluation Process Instructions

Appendix A
DRERIP Scientific Evaluation Process Instructions

The following instructions were developed for the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP). For the purpose of evaluating draft Bay Delta Conservation Plan (BDCP) conservation measures, evaluation teams were asked to stop after Step 9. Overall worth and risk scores were not developed, and the DRERIP Decision Tree was not applied.

Step 1: Is the action written in such a way that it can be evaluated?

The action should be clearly written and contain basic components (action, approach, and outcome) as outlined in the Guidelines for Writing and Parsing Actions (*7/16/07*). An action can include multiple outcomes, but should list only one approach.

Step 2: Is the cause and effect relationship between the action, approach, and outcome supported by the conceptual models, or other source material?

Review General Outcomes table to identify conceptual models that include the general type of outcome identified in the action. Use these models and any other relevant source materials to assess if the relationship inferred by the action has been documented. If it is determined that the cause and effect relationship is not supported, document why and provide suggestions for how the actions might be re-cast to better achieve the desired outcome based on information in the conceptual models and other available scientific information. These suggestions can be used by action developers to improve the action for the next round of screening.

Step 3: Identify Scale of Action

Identify the scale of the Action 'scope' based on the following criteria. The purpose of establishing Action scale is to assist with determining the magnitude of effect on the ecosystem. Large, medium and small should be considered relative to the Delta and the temporal dynamics of processes being manipulated.

Large: Broad spatial extent, significant duration and/or frequency, and/or major reversal compared to existing conditions. Landscape scale.

Medium: Moderate spatial extent, moderate duration and/or frequency, and/or moderate change compared to existing conditions. Regional scale.

Small: Small acreage, short duration or only occasionally, and/or small change compared to existing conditions. Local scale.

Step 4: Describe Relation to Existing Conditions

Review the Boundary Conditions paper to assess whether or not the action has the potential to change system dynamics (either within the Delta or as inputs to the Delta) beyond the existing range conditions (i.e. change in inflows to the Delta, modified hydrodynamic conditions, or salinity regimes) such that the current understanding of how the system works may no longer hold? Consider how the changes may affect the ability to evaluate the action using existing models and information.

Step 5: Identify Positive and Negative Outcome(s) to be Evaluated

Using the standardized lists of outcomes and stressors from the Outcomes Table, identify as many positive and negative outcomes as possible (including the intended outcome). Outcomes should not be evaluated at this step, just simply listed. Outcomes not captured in models but identified based on other available information should be included, with notes describing the information used to identify the outcomes.

Identify positive and negative outcomes focusing only on covered species, but ensuring that all covered species anticipated to be affected are addressed, i.e., if the action is intended to benefit salmon, still look at effects on smelt.

Step 6: Score Magnitude and Certainty of Potential Positive Ecological Outcome(s)

Using the conceptual models and other relevant source materials, identify and score the expected magnitude and certainty of the identified positive ecological outcomes. Record the magnitude and certainty for each positive outcome. ***Use one table per positive outcome.*** Add additional tables as needed to reflect additional outcomes.

Step 7: Score Magnitude and Certainty of Potential Negative Ecological Outcome(s)

Using the conceptual models and other relevant source materials identify and score the expected magnitude and certainty of each negative ecological outcome. Record the magnitude and certainty in the tables below. ***Use one table per outcome***. Add additional tables as needed to reflect additional outcomes.

Step 8: Identify any Important Gaps in Information and/or Understanding

Using the levels of understanding described in the conceptual models, and/or other additional information sources used, identify important data or research needs, that could enhance future evaluation of this or similar actions.

Step 9: Assess Reversibility and Opportunity for Learning

Assess reversibility and opportunity to learn using the criteria below.

Reversibility

Yes/Easy Outcome could likely be reversed as, or more quickly and cheaply than implementing the action.

No/Hard Reversing outcomes would require more time or more money than implementing the action; outcomes may not be completely reversible.

Opportunity for Learning

High Expect to advance our understanding of critical uncertainties as identified in Conceptual Models in a quantifiable manner

Low Impractical or excessive time or resources likely required to achieve such understanding.

Definitions and Scoring Criteria

The following definitions and criteria are provided to aid the Scientific Evaluation process. Some of the definitions pertain to terms used in the conceptual models, such as understanding and predictability. Other definitions relate directly to completion of the Scientific Evaluation worksheet.

Scientific Evaluation Terms

The terms ***scale, magnitude, and certainty*** are Scientific Evaluation terms used to characterize the cumulate "path" or "chain" found between a Restoration Action being evaluated and each Outcome being considered within Scientific Evaluation. Such a path or chain is not the same as the linkages in the conceptual models that describe the cause-effect relationships between a single driver and a single outcome (see conceptual model terms below).

The terms ***reversibility, and opportunity for learning*** are Scientific Evaluation terms designed to aid in making decisions regarding implementation of proposed actions.

> ***Scale*** - Scale addresses temporal and spatial considerations, quantity and/or degree of change contained within the Action.
>
> ***Magnitude*** – Magnitude assesses the size or level of the outcome, either positive or negative, in terms of population or habitat effects on a given species. Magnitude is not the same as the scale of the action, however, higher magnitude scores require consideration of scale.
>
> ***Certainty*** - Certainty describes the likelihood that a given Restoration Action will achieve a certain Outcome. Certainty considers both the predictability and understanding of linkages in the DLO pathway from the action to the outcome. Generally, high importance-low predictability linkages drive the scoring; it is important to ensure that certainty is not unduly weighted by a comparatively low-importance, albeit low-predictability linkage.
>
> ***Reversibility*** - The ease and predictability with which the outcome(s) of a Restoration Action or a group of Restoration Actions can be undone and/or reversed. For example, if the Action changes the ecosystem structure, can the original form be re-established? Have such outcomes been un-done in the past? A change to a flow regime is relatively easy to reverse; successful introduction of a new species is relatively difficult to reverse.
>
> ***Opportunity for learning*** - Opportunity for learning is the likelihood that a Restoration Action or a group of Restoration Actions will increase the level of understanding with regard to the species, process, condition, region or system that is in question or of concern, assuming that appropriate monitoring and evaluation is conducted.

Conceptual Model Terms

The terms ***importance, predictability, and understanding*** are used in the conceptual models to characterize individual linkages (depicted as arrows in the models) between a driver and an outcome. The terms pertain to specific processes or mechanisms within a given model (e.g. how important is the supply of organic matter to mercury methylation?). The graphical forms of the conceptual models apply line color, thickness, and style to represent these three terms.

> ***Importance*** - The degree to which a linkage controls the outcome *relative to* other drivers and linkages affecting that same outcome. Models are designed to encompass all identifiable drivers, linkages and outcomes but this concept recognizes that some are more important than others in determining how the system works. If a driver is potentially more important under particular environmental conditions, the graphic should display the maximum level of importance of this driver with the narrative describing the range of spatial and temporal conditions associated with this driver.
>
> ***Predictability*** - The degree to which the performance or the nature of the outcome can be predicted from the driver. Predictability seeks to capture the variability in the driver-outcome relationship. Predictability can encompass temporal or spatial variability in conditions of a driver (e.g., suspended sediment concentration or grain size), variability in the processes that link the driver to the outcome (e.g., sediment deposition or erosion rate as influenced by flow velocity), or our level of understanding about the cause-effect relationship (e.g., magnitude of sediment accretion inside vs. outside beds of submerged aquatic vegetation). Any of these forms of variability can lead to difficulty in predicting change in an outcome based on changes in a driver.
>
> ***Understanding* –** A description of the known, established, and/or generally agreed upon scientific understanding of the cause-effect relationship between a single driver and a single outcome. Understanding may be limited due to lack of knowledge and information or due to disagreements in the interpretation of existing data and information; or because the basis for assessing the understanding of a linkage or outcome is based on studies done elsewhere and/or on different organisms, or conflicting results have been reported. Understanding should reflect the degree to which the model that is used to represent the system does, in fact, represent the system.

Scientific Evaluation Scoring Criteria

The following tables should be used to inform ***magnitude and certainty*** scores for Scientific Evaluation. These entail looking holistically at the cumulative value (positive or negative) of an action.

Table 1 - Criteria for Scoring Magnitude of Ecological Outcomes (positive or negative)

4 - High: expected sustained major population level effect, e.g., the outcome addresses a key limiting factor, or contributes substantially to a species population's natural productivity, abundance, spatial distribution and/or diversity (both genetic and life history diversity) or has a landscape scale habitat effect, including habitat quality, spatial configuration and/or dynamics. Requires a large-scale Action.
3 - Medium: expected sustained minor population effect or effect on large area (regional) or multiple patches of habitat. Requires at least a medium-scale Action.
2 - Low: expected sustained effect limited to small fraction of population, addresses productivity and diversity in a minor way, or limited spatial (local) or temporal habitat effects.
1 - Minimal: Conceptual model indicates little effect.

Table 2 - Criteria for Scoring Certainty of Ecological Outcomes (positive or negative)

4 - High: Understanding is high (based on peer-reviewed studies from within system and scientific reasoning supported by most experts within system) and nature of outcome is largely unconstrained by variability (i.e., predictable) in ecosystem dynamics, other external factors, or is expected to confer benefits under conditions or times when model indicates greatest importance.
3 - Medium: Understanding is high but nature of outcome is dependent on other highly variable ecosystem processes or uncertain external factors or understanding is medium (based on peer-reviewed studies from outside the system and corroborated by non peer-reviewed studies within the system) and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors
2 - Low: Understanding is medium and nature of outcome is greatly dependent on highly variable ecosystem processes or other external factors or understanding is low (based on non peer-reviewed research within system or elsewhere) and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors
1 - Minimual: Understanding is lacking (scientific basis unknown or not widely accepted), or understanding is low and nature of outcome is greatly dependent on highly variable ecosystem processes or other external factors

Appendix B:
List of Evaluation Team Members

Appendix B: List of Evaluation Team Members

Tidal Restoration Subteam

Name	Affiliation
Dave Harlow	SWC
Stuart Siegel	Wetland and Water Resources
Dan Kratville	CDFG
Jon Rosenfield	The Bay Institute
Chris Enright	DWR
Wim Kimmerer	SFSU
Charlie Alpers	USGS
Chuck Hanson	Hanson Env.
Amy Richey	Mosaic/SLDMWA
Kateri Harrison	SWALE Inc.

Floodplains and Riparian Habitat Subteam

Name	Affiliation
Campbell Ingram	TNC
Denise Reed	UNO
Eric Ginney	PWA
Ted Sommer	DWR
Rosalie del Rosario	NMFS
Dennis McEwan	DWR
Bill Harrell	DWR
Dan Welsh	USFWS
Vance Russell	Audubon Society
Yvette Redler	NMFS
Carrie Battistone	DFG

Water Quality and Invasives Subteam

Name	Affiliation
Jim Haas	USFWS
Bruce Herbold	US EPA
Frances Brewster	SCVWD
Chris Foe	CVRWQCB
Inge Werner	UCD
Ron Smith	USFWS
Jan Thompson	USGS
Karen Larsen	CVRWQCB
Holly Gellerman	CDFG
Chrisinte Joab	CVRWQCB
David Fullerton	MWD
Lori Clammurro	DFG

Appendix B: List of Evaluation Team Members

Harvest and Hatcheries Subteam

Name	Affiliation
Brad Cavallo	CFS/SWC
Dave Zezulak	CDFG
Alison Willy	USFWS
Shirley Witalis	NMFS
Jim Smith	USFWS
Kevin Shaffer	CDFG
Jason Kindopp	DWR
Joshua Israel	UCD
Larry Wise	Entrix

Water Operations Subteam

Name	Affiliation
John Cain	NHI
Denise Reed	UNO
Joshua Israel	UCD
Rosalie del Rosario	NMFS
Chuck Hanson	Hanson Env.
Matt Norbriga	DFG
Rick Sitts	MWD
Chris Enright	DWR
Wim Kimmerer	SFSU
Bruce Herbold	US EPA
David Fullerton	MWD
Armin Munevar	CH2M Hill
Steven Detwiler	USFWS
John Burke	USBR
Tracy Hinojosa	DWR
Neil Clipperton	DFG

Appendix C:
Conservation Measures Evaluated

Tidal Restoration Conservation Measures

HRCM4: Yolo/Cache Slough Complex ROA Tidal Marsh & Shallow Subtidal Restoration - Restore between 5,000 and 11,000 acres to tidal action and vegetated tidal marsh and shallow sub tidal habitat in the Yolo Bypass/Cache Slough Complex ROA (in addition to Liberty Island and Little Holland Tract). *(Evaluate both 5,000 and 11,000 acres).*

HRCM5: Cosumnes/Mokelumne ROA Tidal Marsh & Shallow Subtidal Restoration
Restore 1,150 acres of vegetated tidal marsh and 300 acres of shallow subtidal habitat within the Cosumnes/Mokelumne ROA.

HRCM6: West Delta ROA Tidal Marsh & Shallow Subtidal Restoration
Restore 3,900 acres of vegetated tidal marsh and 900 acres of shallow subtidal habitat in the West Delta ROA.

HRCM7: South Delta ROA Tidal Marsh & Shallow Subtidal Restoration
Restore 3,650 acres of vegetated tidal marsh and 950 acres of shallow subtidal habitats on portions of Union, Upper Roberts, and Middle Roberts Islands in the South Delta ROA.

HRCM8: East Delta ROA Tidal Marsh & Shallow Subtidal Restoration
Restore 1,300 acres to tidal action and vegetated tidal marsh and 300 acres of shallow subtidal habitats on portions of Canal Tract, Terminus Tract, and Bract Tract in the East Delta ROA.

HRCM9: Suisun Marsh ROA Tidal Marsh & Shallow Subtidal Restoration
Re-establish 9,000 acres of brackish intertidal marsh and shallow subtidal aquatic within the Suisun Marsh.

Floodplains and Riparian Habitat Restoration Measures

HRCM1: San Joaquin ROA Floodplain Restoration (upstream of Mossdale)
Restore floodplain habitat along 7 to 14 miles of the San Joaquin River from Vernalis to Mossdale.

HRCM2: San Joaquin ROA Floodplain Restoration (downstream of Mossdale)
Restore floodplain habitat along 6 to 12 miles of the San Joaquin River from Mossdale to French Camp Slough.

HRCM3: South Delta ROA Floodplain
Restore between 800 and 1,600 acres of floodplain habitat (including aquatic, intertidal marsh, floodplain and riparian features) along Old River at Fabian Tract. (Evaluate both 800 and 1,600 acres).

HRCM11: BDCP-Constructed Levees
Establish native riparian woody vegetation and emergent vegetation along a 5 mile segment of levee constructed along the Sacramento River in the West Delta (somewhere between Isleton and Ryde), and along a 5 mile segment of levee along Old River near Bacon Island.

HRCM12: Channel Margin Habitat in Sutter and Steamboat Sloughs
Enhance channel margin habitats along between 12 and 36 miles of Steamboat and Sutter Sloughs to improve habitat conditions for covered fish species. *(Evaluate both 12 and 36 miles of habitat enhancement).*

HRCM13: Channel Margin Habitat in the San Joaquin River ROA
Enhance channel margin habitats along between 14 and 28 miles of the San Joaquin River in the San Joaquin River ROA to improve habitat conditions for covered fish species.

HRCM14: Riparian/scrub Habitat Restoration as a Component of Other Restoration Actions –

Water Operation Conservation Measures

WOCM1: New North Delta Diversions with Hood Bypass Criteria and other Measures
Construct new diversion facilities in the North Delta along the Sacramento River between Walnut Grove and Freeport with a capacity to divert up to 15,000 cfs. The new diversions would be operated to divert large amounts of water during wet periods and less in dry periods. No diversion would be allowed unless flows downstream of the diversion points exceed minimum flow requirements known as the Hood Bypass Flow Criteria.

WOCM2: Modify And Reoperate The Yolo Bypass And Fremont Weir
Option #1 Period of Potential Operation: December 1-May 15
Desired Duration of Inundation: 45 days
Target Spill Discharge into Bypass: 4000 cfs
Predicted area of inundation: 22,982 acres
Predicted mean depth of inundated area: 2.2 feet
Predicted travel time: 6.5 days
Spill Frequency of Fremont Weir (assuming 4000 cfs and 45 day duration with a spill intermission of no more than 7 days): 48% of years (38 of 79), compared to 6% of years (5 out of 79) at existing weir height.

Option #2 Period of Potential Operation: January 1-April 15
Desired Duration of Inundation: 30 days
Target Spill Discharge into Bypass: 2000 cfs
Predicted area of inundation: 17,421 acres
Predicted mean depth of inundated area: 2.3 feet
Predicted travel time: 9.3 days

Spill Frequency of Fremont Weir (assuming 2000 cfs and 30 day duration with a spill intermission of no more than 7 days): 54% of years (43 of 79), compared to 6% of years (5 out of 79) at existing weir height.

WOCM3: Deep Water Ship Channel Bypass Floodplain
Create a new flood bypass that provides up to 3800 acres (at 3000 cfs) of inundated floodplain habitat adjacent to and east of the Sacramento Deep Water Ship Channel (DWSC) and that inundates in ~50% of years from December 1 to May 15 for 45 consecutive days with a spill intermission of no more than 7 days.

WOCM8: Interim Tidal Gates (2-Gates)
Construct and operate two tidal gates:

1. one installed in Old River on the eastern side of Bacon Island,
2. the second gate would be installed in Connection Slough on the western side of Bacon Island.

Water Quality and Invasives Other Stressor Measures

OSCM1: Reduction Of Ammonia Discharges
Implement advanced treatment processes at Sac Regional County Sanitation District (SRCSD) Wastewater Treatment Plant to reduce the concentrations and load of ammonia in effluent discharged into the Sacramento River to levels that do not directly or indirectly harm covered fish species.

OSCM2: Reduction Of The Load Of Endocrine Disrupting Compounds
Implement advanced treatment processes at wastewater treatment plants in the Delta to reduce the loads of endocrine disrupting compounds (EDCs) discharged into the Delta to levels that do not harm covered fish species.

OSCM3: Reduce The Load Of Methylmercury
Implement measures to reduce the load of methylmercury entering the Delta from upstream and in-Delta sources by 50 percent.

OSCM4: Reduce The Load Of Pesticides And Herbicides
Implement measures to reduce loads of pesticides and herbicides entering Delta waterways to levels that are not toxic to covered fish species.

OSCM5: Reduce The Loads Of Toxic Contaminants In Stormwater And Urban Runoff
Develop and implement stormwater management plans and additional measures to reduce loads of toxic contaminants in stormwater and urban runoff entering Delta waterways to levels below which they are toxic to covered fish species.

OSCM7: Improve Dissolved Oxygen Levels In The Stockton Deep Water Ship Channel

OSCM8: Improve Managed Seasonal Wetlands Discharge

OSCM 12: Reduce The Risk For Establishment Of Zebra Mussel And Quagga Mussel In Delta Waterways –

OSCM 13: Remove Non-Native Sav And Fav
Remove water hyacinth (*Eichornia crassipes*) and Brazilian waterweed (*Egeria densa*) from 1,000 water acres of ecologically important Delta waterways each year.

Harvest and Hatcheries Other Stressor Measures

OSCM 14: Increase Harvest Of Non-Native Predatory Fish
Modify sport fishing regulations to reduce the abundance, size, and, therefore, reproductive capacity of black bass (largemouth, smallmouth, and spotted bass) and striped bass in the Sacramento-San Joaquin Delta (the Delta).

OSCM16: Enhanced Delta Enforcement
Increase enforcement of existing fishing regulations to reduce illegal harvest of catchable covered salmonids and sturgeon in the Delta and tributary rivers, including summer holding habitat for spring-run and sturgeon.

OSCM17: Splittail Harvest Regulations
Modify fishing regulations to reduce the effects of harvest on Sacramento splittail.

OSCM19: Mark-Select Chinook Salmon Fishery
Mark all Central Valley Chinook salmon produced in hatcheries with a visible mark (e.g., adipose fin clip), and limit all commercial and recreational harvest of Chinook salmon to those with visible marks.

OSCM20: Artificial Propagation Of Smelt
Establish artificial propagation programs for delta smelt and longfin smelt.

OSCM21: Non-Project Diversions
Modify or eliminate non-project diversions in the Delta to reduce the entrainment of covered fish species.

Appendix D:
Summary of Evaluation Scores and Tables

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P6	All	Increased establishment of woody riparian vegetation to export LWD	2	3
P7a/b	Chinook salmon-San Joaquin	Increase establishment of woody riparian vegetation to provide shaded channel habitat	2	3
P8a	Delta smelt	Increased downstream turbidity improves habitat quality for delta smelt and longfin smelt	2	3-4
P5g	Delta smelt	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	2	3
P5a	Fall-run Chinook Salmon	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	2	3-4
P4a	Fall-run Chinook Salmon	Increase production of food for rearing Chinook salmon, steelhead, green/white sturgeon, splittail from inundation and riparian vegetation (local)	2	3-4
P3a	Fall-run Chinook Salmon	Create rearing habitat for Chinook salmon, green/white sturgeon, splittail and steelhead. Consider loss to entrainment.	2	3-4
P1a	Fall-run Chinook Salmon	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (Splittail, G/W sturgeon, Chinook salmon and steelhead)	2	3-4
P5e	Green Sturgeon	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	1	2
P4e	Green Sturgeon	Increase production of food for rearing Chinook salmon, steelhead, green/white sturgeon, splittail from inundation and riparian vegetation (local)	1	2
P3e	Green Sturgeon	Create rearing habitat for Chinook salmon, green/white sturgeon, splittail and steelhead. Consider loss to entrainment.	1	2
P1e	Green Sturgeon	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (Splittail, G/W sturgeon, Chinook salmon and steelhead)	1	2
P8b	Longfin smelt	Increased downstream turbidity improves habitat quality for delta smelt and longfin smelt	2	3
P5f	Longfin smelt	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	2	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes (contd.)				
P5c	Splittail	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	3	3-4
P4c	Splittail	Increase production of food for rearing Chinook salmon, steelhead, green/white sturgeon, splittail from inundation and riparian vegetation (local)	3	3-4
P3c	Splittail	Create rearing habitat for Chinook salmon, green/white sturgeon, splittail and steelhead. Consider loss to entrainment.	3	3-4
P2a	Splittail	Create additional splittail spawning habitat on floodplain	3	3-4
P1c	Splittail	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (Splittail, G/W sturgeon, Chinook salmon and steelhead)	3	3-4
P5b	Steelhead	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	2	2
P4b	Steelhead	Increase production of food for rearing Chinook salmon, steelhead, green/white sturgeon, splittail from inundation and riparian vegetation (local)	2	2
P3b	Steelhead	Create rearing habitat for Chinook salmon, green/white sturgeon, splittail and steelhead. Consider loss to entrainment.	2	2
P1b	Steelhead	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (Splittail, G/W sturgeon, Chinook salmon and steelhead)	2	2-3
P5d	White Sturgeon	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	1	1
P4d	White Sturgeon	Increase production of food for rearing Chinook salmon, steelhead, green/white sturgeon, splittail from inundation and riparian vegetation (local)	1	1
P3d	White Sturgeon	Create rearing habitat for Chinook salmon, green/white sturgeon, splittail and steelhead. Consider loss to entrainment.	1-2	1
P1d	White Sturgeon	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (Splittail, G/W sturgeon, Chinook salmon and steelhead)	1-2	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N6a	All	Increased exposure risk to contaminants (including Selinium) due to longer residence time in this area	2	3
N3a	All	Increased frequency and magnitude of low DO in SDWSC due to an increase in algae/POM and impact on Chinook salmon, steelhead, and green and white sturgeon passage.	1	4
N2a	All	Increased resuspension/mobilization and export of toxic compounds with impact on covered species (consider time course of effect)	1	2
N1a	All	Increased MeHg and impact on covered species (direct or indirect)	1	3
N5a	Chinook salmon	Increased habitat for non-native predators/competitors to native fishes (Chinook salmon, steelhead, green and white sturgeon, and splittail)	2	4
N4	Delta smelt & Longfin smelt	Decreased downstream turbidity decreases habitat quality for longfin smelt and delta smelt	1	4
N5c	Green & White Sturgeon	Increased habitat for non-native predators/competitors to native fishes (Chinook salmon, steelhead, green and white sturgeon, and splittail)	1	2
N5d	Splittail	Increased habitat for non-native predators/competitors to native fishes (Chinook salmon, steelhead, green and white sturgeon, and splittail)	2	4
N5b	Steelhead	Increased habitat for non-native predators/competitors to native fishes (Chinook salmon, steelhead, green and white sturgeon, and splittail)	2	4

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Positive Outcomes						
P7	All	Increased establishment of woody riparian vegetation to provide shaded channel habitat	3	2	3	2
P6	All	Increased establishment of woody riparian vegetation to export LWD	2	3		
P8a	Delta smelt	Increased downstream turbidity to improve habitat quality for longfin smelt and delta smelt	2	3-4		
P5g	Delta smelt	Increased availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for splittail, green and white sturgeon, Chinook salmon, steelhead (off site), longfin smelt, and delta smelt	2	3		
P5a	Fall-run Chinook Salmon	Increased availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for splittail, green and white sturgeon, Chinook salmon, steelhead (off site), longfin smelt, and delta smelt	2	3-4		
P4a	Fall-run Chinook Salmon	Increased production of food for rearing splittail, green and white sturgeon, Chinook salmon and steelhead from inundation and riparian vegetation (local)	2	3-4		
P3a	Fall-run Chinook Salmon	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	2	3-4		
P1a	Fall-run Chinook Salmon	Improved connectivity of seasonally inundated floodplain habitat for juvenile splittail, green and white sturgeon, Chinook salmon and steelhead	2	3-4		
P5e	Green Sturgeon	Increased availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for splittail, green and white sturgeon, Chinook salmon, steelhead (off site), longfin smelt, and delta smelt	1	2		
P4e	Green Sturgeon	Increased production of food for rearing splittail, green and white sturgeon, Chinook salmon and steelhead from inundation and riparian vegetation (local)	1	2		
P3e	Green Sturgeon	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	1	2		
P1e	Green Sturgeon	Improved connectivity of seasonally inundated floodplain habitat for juvenile splittail, green and white sturgeon, Chinook salmon and steelhead	1	2		

			Scenario 1		Scenario 2	
Outcome Code	**Covered Spp.**	**Description**	**Magnitude**	**Certainty**	**Magnitude**	**Certainty**
Positive Outcomes (contd.)						
P8b	Longfin smelt	Increased downstream turbidity to improve habitat quality for longfin smelt and delta smelt	2	3		
P5f	Longfin smelt	Increased availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for splittail, green and white sturgeon, Chinook salmon, steelhead (off site), longfin smelt, and delta smelt	2	3		
P5c	Splittail	Increased availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for splittail, green and white sturgeon, Chinook salmon, steelhead (off site), longfin smelt, and delta smelt	3	3-4		
P4c	Splittail	Increased production of food for rearing splittail, green and white sturgeon, Chinook salmon and steelhead from inundation and riparian vegetation (local)	3	3-4		
P3c	Splittail	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	3	3-4		
P2	Splittail	Additional splittail spawning habitat on floodplain	3	3-4		
P1c	Splittail	Improved connectivity of seasonally inundated floodplain habitat for juvenile splittail, green and white sturgeon, Chinook salmon and steelhead	3	3-4		
P5b	Steelhead	Increased availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for splittail, green and white sturgeon, Chinook salmon, steelhead (off site), longfin smelt, and delta smelt	2	2		
P4b	Steelhead	Increased production of food for rearing splittail, green and white sturgeon, Chinook salmon and steelhead from inundation and riparian vegetation (local)	2	2		
P3b	Steelhead	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	2	2-3		
P1b	Steelhead	Improved connectivity of seasonally inundated floodplain habitat for juvenile splittail, green and white sturgeon, Chinook salmon and steelhead	2	2		

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Positive Outcomes (contd.)						
P5d	White Sturgeon	Increased availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for splittail, green and white sturgeon, Chinook salmon, steelhead (off site), longfin smelt, and delta smelt	1	1		
P4d	White Sturgeon	Increased production of food for rearing splittail, green and white sturgeon, Chinook salmon and steelhead from inundation and riparian vegetation (local)	1	1		
P3d	White Sturgeon	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	1-2	1		
P1d	White Sturgeon	Improved connectivity of seasonally inundated floodplain habitat for juvenile splittail, green and white sturgeon, Chinook salmon and steelhead	1-2	1		

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Negative Outcomes						
N6	All	Increased exposure risk to contaminants (including Selinium) due to longer residence time in this area	2	3		
N2	All	Increased resuspension/mobilization and export of toxic compounds with impact on covered species (consider time course of effect)	1	2		
N1	All	Increased MeHg and impact on covered species (direct or indirect)	1	3		
N5a	Chinook salmon	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail	2	4		
N4	Delta smelt & Longfin smelt	Decreased downstream turbidity decreases habitat quality for longfin smelt and delta smelt	1	4		
N5c	Green & White Sturgeon	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail	1	2		
N3	green and white sturgeon, Chinook salmon and steelhead	Increased frequency and magnitude of low DO in SDWSC due to an increase in algae/POM and impact on Chinook salmon, steelhead, and green and white sturgeon passage.	1	4		
N5d	Splittail	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail	2	4		
N5b	Steelhead	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail	2	4		

Scenario 1 Restore floodplain habitat along 6 miles (363 acres) of the San Joaquin River from Mossdale to French Camp Slough.

Scenario 2 Restore floodplain habitat along 12 miles (725 acres) of the San Joaquin River from Mossdale to French Camp Slough.

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Positive Outcomes						
P7	All	Increase establishment of woody riparian vegetation to provide shaded channel habitat	2	3	2	3
P6	All	Increase establishment of woody riparian vegetation to export LWD	2	3	3	3
P8a	Delta smelt	Increased downstream turbidity improves habitat quality for delta smelt and longfin smelt	2	3-4		
P5g	Delta smelt	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	2	3		
P5a	Fall-run Chinook Salmon	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	2	3-4		
P4a	Fall-run Chinook Salmon	Increase production of food for rearing Chinook salmon, steelhead, green and white sturgeon, and splittail from inundation and riparian vegetation (local)	2	3-4		
P3a	Fall-run Chinook Salmon	Create rearing habitat for Chinook salmon, green and white sturgeon, splittail and steelhead (consider loss to entrainment)	2	3-4		
P1a	Fall-run Chinook Salmon	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (splittail, green and white sturgeon, Chinook salmon and steelhead).	2	3-4		

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Positive Outcomes (contd.)						
P5e	Green Sturgeon	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	1	2		
P4e	Green Sturgeon	Increase production of food for rearing Chinook salmon, steelhead, green and white sturgeon, and splittail from inundation and riparian vegetation (local)	1	2		
P3e	Green Sturgeon	Create rearing habitat for Chinook salmon, green and white sturgeon, splittail and steelhead (consider loss to entrainment)	1	2		
P1e	Green Sturgeon	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (splittail, green and white sturgeon, Chinook salmon and steelhead).	1	2		
P8b	Longfin smelt	Increased downstream turbidity improves habitat quality for delta smelt and longfin smelt	2	3		
P5f	Longfin smelt	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	2	3		
P5c	Splittail	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	3	3-4		
P4c	Splittail	Increase production of food for rearing Chinook salmon, steelhead, green and white sturgeon, and splittail from inundation and riparian vegetation (local)	3	3-4		
P3c	Splittail	Create rearing habitat for Chinook salmon, green and white sturgeon, splittail and steelhead (consider loss to entrainment)	3	3-4		
P2	Splittail	Create additional spawning habitat for splittail on floodplain	3	3-4		
P1c	Splittail	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (splittail, green and white sturgeon, Chinook salmon and steelhead).	3	3-4		

			Scenario 1		Scenario 2	
Outcome Code	**Covered Spp.**	**Description**	**Magnitude**	**Certainty**	**Magnitude**	**Certainty**
		Positive Outcomes (contd.)				
P5b	Steelhead	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	2	2		
P4b	Steelhead	Increase production of food for rearing Chinook salmon, steelhead, green and white sturgeon, and splittail from inundation and riparian vegetation (local)	2	2		
P3b	Steelhead	Create rearing habitat for Chinook salmon, green and white sturgeon, splittail and steelhead (consider loss to entrainment)	2	2-3		
P1b	Steelhead	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (splittail, green and white sturgeon, Chinook salmon and steelhead).	2	2-3		
P5d	White Sturgeon	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (off site), longfin smelt, and delta smelt	1	1		
P4d	White Sturgeon	Increase production of food for rearing Chinook salmon, steelhead, green and white sturgeon, and splittail from inundation and riparian vegetation (local)	1	1		
P3d	White Sturgeon	Create rearing habitat for Chinook salmon, green and white sturgeon, splittail and steelhead (consider loss to entrainment)	1-2	1		
P1d	White Sturgeon	Improve connectivity of seasonally inundated floodplain habitat for juvenile fish (splittail, green and white sturgeon, Chinook salmon and steelhead).	1-2	1		

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Negative Outcomes						
N5	All	Increased exposure risk to contaminants (inc. Se) due to longer residence time in this area	1	3		
N2a	All	Increased resuspension/mobilization and export of toxic compounds with impact on covered species (consider time course of effect)	1	4		
N1	All	Increased MeHg and impact on covered species (direct or indirect)	1	3		
N4a	Chinook salmon	Increased habitat for non-native predators/competitors to native fishes (Chinook salmon, steelhead, green and white sturgeon, and splittail)	2	4		
N3a	Delta smelt & Longfin smelt	Decreased downstream turbidity decreases habitat quality for delta smelt and longfin smelt	1	4		
N4c	Green & White Sturgeon	Increased habitat for non-native predators/competitors to native fishes (Chinook salmon, steelhead, green and white sturgeon, and splittail)	1	2		
N4d	Splittail	Increased habitat for non-native predators/competitors to native fishes (Chinook salmon, steelhead, green and white sturgeon, and splittail)	2	4		
N4b	Steelhead	Increased habitat for non-native predators/competitors to native fishes (Chinook salmon, steelhead, green and white sturgeon, and splittail)	2	4		

Scenario 1 Restore 800 acres of floodplain habitat (including aquatic, intertidal marsh, floodplain and riparian features) along Old River at Fabian Tract (see map).

Scenario 2 Restore 1600 acres of floodplain habitat (including aquatic, intertidal marsh, floodplain and riparian features) along Old River at Fabian Tract (see map).

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P3	All	Food resources produced on the restored marsh will be exported and contribute to foood availability downstream of Rio Vista	1-2	1
P4b	chinook salmon	Provide local cool water refugia for delta smelt and rearing salmonids	2	1
P4a	delta smelt	Provide local cool water refugia for delta smelt and rearing salmonids	2	1
P1a	delta smelt	Increase rearing habitat and local food production	3	2
P1c3	Fall-run Chinook salmon, Sac.	Increase rearing habitat and local food production	3	2
P2	Green & White Sturgeon	Increase food production for local consumption by green and white sturgeon (added by evaluation team).	2	1
P1c4	Late Fall-run Chinook Salmon, Sac.	Increase rearing habitat and local food production	1	1
P1b	Longfin smelt	Increase rearing habitat and local food production	1	2
P1d	splittail	Increase rearing habitat and local food production	3	2
P1c2	Spring-run Chinook Salmon	Increase rearing habitat and local food production	2	2
P1c5	steelhead	Increase rearing habitat and local food production	1	1
P1c1	Winter-run Chinook Salmon	Increase rearing habitat and local food production	2	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N3a	All	Contaminate Resuspension Hg	1	2
N2b1	All	Local toxicity from residual pesticides and herbicides: e.g. pyrethroids:	1-2	1
N2a1	All	Potential for mercury methylation and local bioaccumulation	1	2
N1d	All	Establishment of Inland silversides that will prey or compete or alter habitat conditions for covered fish.	2	2
N1c	All	Establishment of centrarchids that will prey or compete or alter habitat conditions for covered fish.	3	2
N1b	All	Establishment of undesirable clams species that will compete with or alter habitat conditions for covered fish.	1	2
N1a	All	Establishment of undesirable SAV will alter habitat conditions for covered fish.	3	2
N4a	delta smelt	Increased velocities in larger channels could scour spawning habitat for Delta smelt and/or habitat for other covered species.	4	1
N2a3	Human health	Potential for mercury methylation and local bioaccumulation	2	3
N4b	Longfin smelt	Increased velocities in larger channels could scour spawning habitat for Delta smelt and/or habitat for other covered species.	2-3	1
N2b2	Wildlife	Local toxicity from residual pesticides and herbicides: e.g. pyrethroids:	1-2	1
N2a2	Wildlife	Potential for mercury methylation and local bioaccumulation	2	2-3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P2a	All	INCREASE THE AVAILABILITY AND PRODUCTION OF FOOD IN THE EAST AND CENTRAL DELTA BY EXPORTING ORGANIC MATERIAL FROM THE MARSH PLAIN AND PHYTOPLANKTON, ZOOPLANKTON, AND OTHER ORGANISMS PRODUCED IN INTERTIDAL CHANNELS INTO THE DELTA.	2	1
P3b	Chinook Salmon	LOCALLY PROVIDE AREAS OF COOL WATER REFUGIA (FEB-JUN) FOR DELTA SMELT AND SALMON.	2	1
P3a	Delta smelt	LOCALLY PROVIDE AREAS OF COOL WATER REFUGIA (FEB-JUN) FOR DELTA SMELT AND SALMON.	2	1
P1a	Delta smelt	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	1	1
P1c	Fall-run Chinook salmon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	1	2
P1e	Green sturgeon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	?	?
P1d	Splittail	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	3	3
P1b	steelhead	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	1	2
P1f	White Sturgeon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	?	?

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N4a	All	Resuspension and export of mercury and methylmercury to downstream areas	1	2
N3b	All	Local effects of contaminants including toxicity from residual pesticides and herbicides: e.g. pyrethroids	1-2	1
N3b	All	Contaminate Resuspension - Residual pesticides and herbicides	1	1
N3a	All	Local effects of contaminants including toxicity from residual pesticides and herbicides: e.g. pyrethroids	1-2	1
N2a	All	POTENTIAL FOR MERCURY METHYLATION AND LOCAL BIOACCUMULATION TO AFFECT WILDLIFE: N2-A - TARGET SPECIES, N2-B, NON-TARGET WILDLIFE SPECIES, N2-C, HUMAN HEALTH.	1	2
N1b	All	Establishment of undesirable species (such as Centrachids) that will prey or compete or alter habitat conditions for covered fish.	4	2
N1a	All	Establishment of undesirable species (such as egeria,) that will prey or compete or alter habitat conditions for covered fish.	3	2
N1c	All	Establishment of undesirable species (such as Corbicula) that will prey or compete or alter habitat conditions for covered fish.	1	2
N1d	Delta smelt	Establishment of undesirable species (such as Inland Silversides) that will prey or compete or alter habitat conditions for covered fish.	2	2
N2c	Human health	POTENTIAL FOR MERCURY METHYLATION AND LOCAL BIOACCUMULATION TO AFFECT WILDLIFE: N2-A - TARGET SPECIES, N2-B, NON-TARGET WILDLIFE SPECIES, N2-C, HUMAN HEALTH.	2	3
N2b	Wildlife	Potential for mercury methylation and local bioaccumulation to affect wildlife: N2-A - Target species, N2-B, Non-target wildlife species, N2-C, Human health.	3	2-3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P3a	All	INCREASE THE AVAILABILITY AND PRODUCTION OF FOOD IN THE WESTERN DELTA AND SUISUN BAY BY EXPORTING, VIA TIDAL FLOW, ORGANIC MATERIAL FROM THE MARSH PLAIN AND ORGANIC CARBON, PHYTOPLANKTON, ZOOPLANKTON, AND OTHER ORGANISMS FROM INTERTIDAL CHANNELS INTO THE DELTA	2	1
P4b	Chinook Salmon	LOCALLY PROVIDE AREAS OF COOL WATER REFUGIA FOR DELTA SMELT AND SALMONIDS.	2	1
P4a	Delta smelt	LOCALLY PROVIDE AREAS OF COOL WATER REFUGIA FOR DELTA SMELT AND SALMONIDS.	2	1
P1b	Fall-run Chinook Salmon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	2
P2b	Green Sturgeon	Provide a continuous corridor of habitat & food productivity linking current & future restored habitat in the Cache Slough Complex with habitat in Suisun Marsh & Bay	2	1
P2a	Splittail	Provide a continuous corridor of habitat & food productivity linking current & future restored habitat in the Cache Slough Complex with habitat in Suisun Marsh & Bay	3	3
P1a	Spring-run Chinook Salmon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	2
P2c	White Sturgeon	Provide a continuous corridor of habitat & food productivity linking current & future restored habitat in the Cache Slough Complex with habitat in Suisun Marsh & Bay	2	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N4a	All	Resuspension and export of mercury and methylmercury to downstream areas	1	2
N3a	All	Local effects of contaminants including toxicity from residual pesticides and herbicides: e.g. pyrethroids	1-2	1
N2a	All	POTENTIAL FOR MERCURY METHYLATION AND LOCAL BIOACCUMULATION TO AFFECT WILDLIFE: N2-A - TARGET SPECIES, N2-B, NON-TARGET WILDLIFE SPECIES, N2-C, HUMAN HEALTH.	1	2
N1c	All	ESTABLISHMENT OF UNDESIRABLE SPECIES (SUCH AS Corbicula) THAT WILL PREY OR COMPETE OR ALTER HABITAT CONDITIONS FOR COVERED FISH	4	2
N1b	All	ESTABLISHMENT OF UNDESIRABLE SPECIES (SUCH AS Centrachids) THAT WILL PREY OR COMPETE OR ALTER HABITAT CONDITIONS FOR COVERED FISH	4	2
N5a	All	Movement of fish and food resources to areas in central Delta with high predation	2-3	1
N1a	All	ESTABLISHMENT OF UNDESIRABLE SPECIES (SUCH AS EGERIA,) THAT WILL PREY OR COMPETE OR ALTER HABITAT CONDITIONS FOR COVERED FISH	3	2
N1d	Delta smelt	ESTABLISHMENT OF UNDESIRABLE SPECIES (SUCH AS Inland Silversides) THAT WILL PREY OR COMPETE OR ALTER HABITAT CONDITIONS FOR COVERED FISH	2	2
N2c	Humans	POTENTIAL FOR MERCURY METHYLATION AND LOCAL BIOACCUMULATION TO AFFECT WILDLIFE: N2-A - TARGET SPECIES, N2-B, NON-TARGET WILDLIFE SPECIES, N2-C, HUMAN HEALTH.	2	3
N3b	Others	Local effects of contaminants including toxicity from residual pesticides and herbicides: e.g. pyrethroids	1-2	1
N2b	Wildlife	Potential for mercury methylation and local bioaccumulation to affect wildlife: N2-A - Target species, N2-B, Non-target wildlife species, N2-C, Human health.	3	2-3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P2a	All	INCREASE THE AVAILABILITY AND PRODUCTION OF FOOD IN THE DELTA AND SUISUN BAY BY EXPORT FROM THE SOUTH DELTA OF ORGANIC MATERIAL VIA TIDAL FLOW FROM THE NEW MARSH PLAIN AND ORGANIC CARBON, PHYTOPLANKTON, ZOOPLANKTON, AND OTHER ORGANISMS PRODUCED IN NEW INTERTIDAL CHANNELS.	1	3
P3a	Delta smelt	Locally provide areas of cool water refugia for Delta smelt and Salmonids	2	1
P1a	Delta smelt	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	1	2
P1b	Fall-run Chinook Salmon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	2
P1d	Green sturgeon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	2
P1c	Splittail	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	3
P1e	White sturgeon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N4a	All	Resuspension and export of mercury and methylmercury to downstream areas	1	2
N3a	All	Local effects of contaminants including toxicity from residual pesticides and herbicides: e.g. pyrethroids	1-2	1
N2a	All	POTENTIAL FOR MERCURY METHYLATION AND LOCAL BIOACCUMULATION TO AFFECT TARGET SPECIES	1	2
N1b	All	Establishment of undesirable species (such as Centrachids,) that will prey or compete or alter habitat conditions for covered fish	4	2
N1a	All	Establishment of undesirable species (such as egeria,) that will prey or compete or alter habitat conditions for covered fish	3	2
N6a	All	Production of organic matter that will contribute to low dissolved oxygen (DO) conditions	3	2
N5a	All	Creation of a population sink due to longer residence times with associated increased exposure to predators and entrainment.	2	4
N1c	All	Establishment of undesirable species (such as Corbicula,) that will prey or compete or alter habitat conditions for covered fish	1	2
N1d	Delta smelt	Establishment of undesirable species (such as Inland Silversides,) that will prey or compete or alter habitat conditions for covered fish	2	2
N2c	Human health	POTENTIAL FOR MERCURY METHYLATION AND LOCAL BIOACCUMULATION TO AFFECT WILDLIFE: N2-A - TARGET SPECIES, N2-B, NON-TARGET WILDLIFE SPECIES, N2-C, HUMAN HEALTH.	2	3
N3b	Others	Local effects of contaminants including toxicity from residual pesticides and herbicides: e.g. pyrethroids	1-2	1
N2b	Wildlife	Potential for mercury methylation and local bioaccumulation to affect wildlife: N2-A - Target species, N2-B, Non-target wildlife species, N2-C, Human health.	3	2-3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P2a	All	Increase the availability and production of food in the east and central Delta by exporting organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in intertidal channels into the Delta.	2	1
P3a	Delta Smelt	Locally provide areas of cool water refugia for delta smelt	2	1
P1a	Fall-run Chinook salmon- San Joaquin River or eastside	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	2
P1c	Green Sturgeon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	2
P1b	Splittail	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	3
P1d	White Sturgeon	Increase rearing habitat area (including physical and biotic attributes) for covered fish species	2	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N4a	All	Resuspension and export of mercury and methylmercury to downstream areas	1	2
N3a	All	Local effects of contaminants including toxicity from residual pesticides and herbicides: e.g. pyrethroids	1-2	1
N2a	All	Potential for mercury methylation and local bioaccumulation to affect wildlife: N2-A - Target species, N2-B, Non-target wildlife species, N2-C, Human health.	1	2
N1b	All	Establishment of undesirable species (such as Centrachids) that will prey or compete or alter habitat conditions for covered fish.	4	3
N1a	All	Establishment of undesirable species (such as egeria,) that will prey or compete or alter habitat conditions for covered fish.	3	2
N7a	Chinook salmon-San Joaquin	Restoration site creates a population sink for covered fish species (Provides rearing habitat that becomes a one-way trip	1	3
N1c	All	Establishment of undesirable species (such as Corbicula) that will prey or compete or alter habitat conditions for covered fish.	4	2
N7c	Delta smelt	Restoration site creates a population sink for covered fish species (Provides rearing habitat that becomes a one-way trip	2	3
N1d	Delta smelt	Establishment of undesirable species (such as Inland Silversides) that will prey or compete or alter habitat conditions for covered fish.	2	2
N2c	Human health	Potential for mercury methylation and local bioaccumulation to affect wildlife: N2-A - Target species, N2-B, Non-target wildlife species, N2-C, Human health.	2	3
N3b	Others	Local effects of contaminants including toxicity from residual pesticides and herbicides: e.g. pyrethroids	1-2	1
N7b	Steelhead	Restoration site creates a population sink for covered fish species (Provides rearing habitat that becomes a one-way trip	1	3
N2b	Wildlife	Potential for mercury methylation and local bioaccumulation to affect wildlife: N2-A - Target species, N2-B, Non-target wildlife species, N2-C, Human health.	3	2-3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P4a	All	Reduce periodic low dissolved oxygen events and associated Mercury Methylation events associated with the discharge of waters from lands managed as seasonal freshwater wetlands that would be restored as brackish intertidal marsh.	4	3
P2a	All	Increase the availability & production of food in Suisun Bay by exporting organic material via tidal flow from the marsh plain & phytoplankton, zooplankton, & other organisms produced in intertidal channels into the Bay.	1-2	1
P3a	Delta Smelt	Locally provide areas of cool water refugia for Delta smelt and Salmonids	2	1
P1a	Delta Smelt	Increase rearing habitat area for covered fish species.	3	1
P3b2	Fall-run Chinook Salmon	Locally provide areas of cool water refugia for Delta smelt and Salmonids	2	1
P1c3	Fall-run Chinook Salmon	Increase rearing habitat area for covered fish species.	3	1
P1e	Green Sturgeon	Increase rearing habitat area for covered fish species.	2	2
P1c4	Late Fall-run Chinook Salmon	Increase rearing habitat area for covered fish species.	1	1
OP2	Late Fall-run Chinook Salmon	Locally provide areas of cool water refugia for late fall-run Salmonids	0	
P1b	Longfin smelt	Increase rearing habitat area for covered fish species.	1	1
P1d	Splittail	Increase rearing habitat area for covered fish species.	3	2
P3b1	Spring-run Chinook salmon	Locally provide areas of cool water refugia for Delta smelt and Salmonids	2	1
P1c2	Spring-run Chinook Salmon	Increase rearing habitat area for covered fish species.	3	1
P3b3	Steelhead	Locally provide areas of cool water refugia for Delta smelt and Salmonids	2	1
P1f	White Sturgeon	Increase rearing habitat area for covered fish species.	2	2
P1c1	Winter-run Chinook Salmon	Increase rearing habitat area for covered fish species.	1	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N2a	All	Potential for mercury methylation and local bioaccumulation: N2-A-Covered species, N2-B, Non-covered wildlife species, N2-C, human health.	1	2
N1b	All	Establishment of undesirable species (such as Centrachids) that will prey or compete or alter habitat conditions for covered fish.	1	4
N1a	All	Establishment of undesirable species (such as Egeria) that will prey or compete or alter habitat conditions for covered fish.	1	4
N1c	All	Establishment of undesirable species (such as Corbicula) that will prey or compete or alter habitat conditions for covered fish.	4	2
N1d	Delta smelt	Establishment of undesirable species (such as Inland Silversides) that will prey or compete or alter habitat conditions for covered fish.	2	2
N2c	Human health	Potential for mercury methylation and local bioaccumulation: N2-A-Covered species, N2-B, Non-covered wildlife species, N2-C, human health.	2	3
N2b	Wildlife	Potential for mercury methylation and local bioaccumulation to affect wildlife: N2-A - Target species, N2-B, Non-target wildlife species, N2-C, Human health.	3	2-3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P6	All	Increase availability and production of food (POM, phytoplankton, zooplankton, small fish, etc) for Chinook salmon, steelhead, green and white sturgeon, splittail (offsite), longfin smelt, and delta smelt (consider loss to entrainment on Bacon Island option)	1	3
P2	All	Increased establishment of instream structure through export of LWD to benefit covered species	1	1
P5d	Chinook salmon	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	2	3-4
P4e	Chinook salmon	Increase rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment for Old River)	2-3	2-3
P5b	Green & White Sturgeon	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	1	2
P4b	Green Sturgeon	Increase rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment for Old River)	2	1
P5a	Splittail	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	3	3
P4a	Splittail	Increase rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment for Old River)	2	3-4
P3	splittail	Increase splittail spawning habitat on narrow floodplain margin	2	3-4
P5c	Steelhead	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	2	3
P4d	Steelhead	Increase rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment for Old River)	3	2
P4c	White Sturgeon	Increase rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment for Old River)	2	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N2	All	Increased exposure risk to contaminants (including Selinium) due to longer residence time in this area (for Bacon Island option only)	1	3
N1a	Delta smelt	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives	2	3
N1d	Green & White Sturgeon	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives	1	2
N1b	Longfin smelt	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives	3	2
N1c	Splittail	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives	2	3
N1e	Steelhead & Chinook salmon	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives	2-3	2

			Scenario 1		Scenario 2	
Outcome Code	**Covered Spp.**	**Description**	**Magnitude**	**Certainty**	**Magnitude**	**Certainty**
		Positive Outcomes				
P2	All	Increased establishment of instream structure through export of LWD to benefit covered species.	3	2		
P5e1	Chinook salmon	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	2	3-4	3	3-4
P4e	Chinook Salmon	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	3	3	3	3
P5b	Green Sturgeon	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	1	2	1	2
P4b	Green Sturgeon	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	2	1	2	1
P5a1	Splittail	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	2	3	3	3
P4a1	Splittail	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	2	3	3	3
P3a1	Splittail	Additional splittail spawning habitat on narrow floodplain margin (12 mi)	2	3	3	3
P5d	Steelhead	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	2	2		
P4d	Steelhead	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	2	2	2	2
P5c	White Sturgeon	Increased production and export of terrestrial invertebrates into the aquatic ecosystem for rearing splittail, green and white sturgeon, Chinook salmon and steelhead	1	2	1	2
P4c	White Sturgeon	Additional rearing habitat for splittail, green and white sturgeon, Chinook salmon and steelhead (consider loss to entrainment)	2	1	2	1

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Negative Outcomes						
N2	All	Increased mortality of covered species due to increased exposure risk to contaminants due to longer residence time in this area	1	3		
N1c	Green & White Sturgeon	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives (by creating more predator habitat)	1	2		
N1a	Longfin smelt	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives (by creating more predator habitat)	2	2		
N1b	Splittail	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives (by creating more predator habitat)	2	3		
N1d	Steelhead & Chinook salmon	Increased habitat for non-native predators/competitors to Chinook salmon, steelhead, green and white sturgeon, and splittail, if flows through sloughs are not sufficient to prevent colonization by non natives (by creating more predator habitat)	2-3	2		

Scenario 1 Enhance channel margin habitats along 12 miles (6 miles/side) of Steamboat and Sutter Sloughs to improve habitat conditions for covered fish species.

Scenario 2 Enhance channel margin habitats along 36 miles (18 miles/side) of Steamboat and Sutter Sloughs to improve habitat conditions for covered fish species.

			Scenario 1		Scenario 2	
Outcome Code	**Covered Spp.**	**Description**	**Magnitude**	**Certainty**	**Magnitude**	**Certainty**
		Positive Outcomes				
P3	All	Improved resting habitat for migrating adults (Chinook Salmon upstream, steelhead up and downstream, Green/White sturgeon)	1-3	1-2		
P4e	Chinook salmon	Increased food production and availability (fall of OM, terrestrial invertebrates) for Chinook salmon, steelhead, splittail and green and white sturgeon (consider loss to entrainment)	1	3	1	3
P1e	Chinook salmon	Increased establishment of woody riparian and emergent vegetation to provide high quality rearing habitat for covered species	2-3	2-3	2-3	2-3
P4b	Green Sturgeon	Increased food production and availability (fall of OM, terrestrial invertebrates) for Chinook salmon, steelhead, splittail and green and white sturgeon (consider loss to entrainment)	1	3	1	3
P1b	Green Sturgeon	Increased establishment of woody riparian and emergent vegetation to provide high quality rearing habitat for covered species	2	1	2	1
P2	Splittail	Increase availability of spawning habitat for splittail	3	3-4	3	3-4
P4a	Splittail	Increased food production and availability (fall of OM, terrestrial invertebrates) for Chinook salmon, steelhead, splittail and green and white sturgeon (consider loss to entrainment)	1	3	1	3
P1a1	Splittail	Increased establishment of woody riparian and emergent vegetation to provide high quality rearing habitat for covered species	1	3-4	2	3-4
P4d	Steelhead	Increased food production and availability (fall of OM, terrestrial invertebrates) for Chinook salmon, steelhead, splittail and green and white sturgeon (consider loss to entrainment)	1	2	1	2
P1d	Steelhead	Increased establishment of woody riparian and emergent vegetation to provide high quality rearing habitat for covered species	3	2	3	2
P4c	White Sturgeon	Increased food production and availability (fall of OM, terrestrial invertebrates) for Chinook salmon, steelhead, splittail and green and white sturgeon (consider loss to entrainment)	1	1	1	1
P1c	White Sturgeon	Increased establishment of woody riparian and emergent vegetation to provide high quality rearing habitat for covered species	2	1	2	1

			Scenario 1		Scenario 2	
Outcome Code	**Covered Spp.**	**Description**	**Magnitude**	**Certainty**	**Magnitude**	**Certainty**
		Negative Outcomes				
N2	All	Increased exposure risk to contaminants (including Selenium) to longer residence time in this area	1	4		
N1	All (note salmonids more sensitive to Selenium)	Increased exposure risk to contaminants (including Selenium) to longer residence time in this area	2	3		
N3c	Green & White Sturgeon	Increased habitat for non-native predators/competitors to native fishes (longfin smelt, splittail, green/white sturgeon, steelhead, Chinook salmon)	1	2		
N3a	Longfin smelt	Increased habitat for non-native predators/competitors to native fishes (longfin smelt, splittail, green/white sturgeon, steelhead, Chinook salmon)	2	2		
N3b	Splittail	Increased habitat for non-native predators/competitors to native fishes (longfin smelt, splittail, green/white sturgeon, steelhead, Chinook salmon)	3	2		
N3d	Steelhead & Chinook salmon	Increased habitat for non-native predators/competitors to native fishes (longfin smelt, splittail, green/white sturgeon, steelhead, Chinook salmon)	2-3	2		

Scenario 1 Enhance channel margin habitats along 14 miles of the San Joaquin River in the San Joaquin River ROA to improve habitat conditions for covered fish species.

Scenario 2 Enhance channel margin habitats along 28 miles of the San Joaquin River in the San Joaquin River ROA to improve habitat conditions for covered fish species.

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P4b	All	Reduction in ammonia would decrease blooms of nuisance species such as microcystis* or non-native zooplankton**	2	1
P4a	All	Reduction in ammonia would decrease blooms of nuisance species such as microcystis* or non-native zooplankton**	2	3
P3b	All	Effect of increasing diatom production on zooplankton abundance	2	2
P2b	All	Effect of increasing diatom production on zooplankton abundance	2	2
P6c	Chinook Salmon	Reduction in direct toxic effects on fish species	2	3
P3c	Chinook salmon	Effect of increasing zooplankton abundance on fish abundance	2	1
P2c	Chinook salmon	Effect of increasing zooplankton abundance on fish abundance	2	1
P1c	Chinook Salmon	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the freshwater portion of the estuary (Lower Sacramento River)	2	1
P6a	Delta smelt	Reduction in direct toxic effects on fish species	3	2
P3c	Delta smelt	Effect of increasing zooplankton abundance on fish abundance	2	2
P2c	Delta smelt	Effect of increasing zooplankton abundance on fish abundance	3	1
P1c	Delta smelt	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the freshwater portion of the estuary (Lower Sacramento River)	3	1
P1b	Delta smelt	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the freshwater portion of the estuary (Lower Sacramento River)	2	2
P3a	Delta smelt & Longfin smelt	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the brackish portion of the estuary (Suisun and Grizzly Bays)	2	2
P2a	Delta smelt & Longfin smelt	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in low-salinity portion of the estuary (confluence).	3	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes (contd.)				
P1c	Delta smelt & Longfin smelt	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the freshwater portion of the estuary (Lower Sacramento River)	3	1
P1a	Delta smelt & Longfin smelt	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the freshwater portion of the estuary (Lower Sacramento River)	3	1
P5a	Delta smelt, Longfin smelt, & Chinook salmon	Reduction in direct toxic effects on zooplankton species	2	3
P6d	Green & White Sturgeon	Reduction in direct toxic effects on fish species	1	3
P6b	Longfin smelt	Reduction in direct toxic effects on fish species	1	3
P3c	Longfin smelt	Effect of increasing zooplankton abundance on fish abundance	3	1
P2c	Longfin smelt	Effect of increasing zooplankton abundance on fish abundance	2	1
P1c	Longfin smelt	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the freshwater portion of the estuary (Lower Sacramento River)	2	2
P6e	Splittail	Reduction in direct toxic effects on fish species	1	3
P2c	Splittail & Sturgeon	Effect of increasing zooplankton abundance on fish abundance	1	4
P2	Splittail & Sturgeon	Effect of increasing zooplankton abundance on fish abundance	1	4
P1c	Splittail & Sturgeon	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the freshwater portion of the estuary (Lower Sacramento River)	1	4
P3c	Steelhead	Effect of increasing zooplankton abundance on fish abundance	2	1
P2c	Steelhead	Effect of increasing zooplankton abundance on fish abundance	2	1
P1c	Steelhead	Reductions in total ammonia in the Sacramento River will increase Delta smelt and longfin smelt abundance by increasing diatom production and abundance in the freshwater portion of the estuary (Lower Sacramento River)	2	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N1	All	Removal of valuable nutrients as a function of WWTP outputs	1	4
N2	All	Nitrification will reduce ammonia, but increased nitrate could result in growth of undesirable algal blooms and macrophytes	2	2
N3	All	Increased phytoplankton productivity will increase clam biomass and uptake of selenium, impairing reproduction in benthic foraging fish species	3	4

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P4	All	Ancillary benefits – if you're removing EDCs you're also removing other harmful chemicals (e.g. methylmercury, personal care products, ammonia, antibacterial, pharmaceuticals, pesticides)	NA	NA
P3	All	Reduce effects of endocrine disrupting compounds to food web organisms/invertebrates	2	1
P2	All	Reduced endocrine issues (transgender, reproductive, etc.) caused by endocrine disruptors in delta and longfin smelt, white and green sturgeon, salmonids (all races), and splittail.	2-3	3
P1	All	Increased reproductive success of covered fish species	2	2

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P1	All	Reduced direct mortality due to consumption of mercury by splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon.	1	2
P2	All	Reduced sublethal effects (genetic, tissue/organ damage, development, reproductive, growth, and immune) of mercury on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon.	2	2
P3	Humans & birds	(Added) Reduce toxic concentrations of methyl mercury in forage and sportfish to protect wildlife and humans from chronic sublethal toxicity.	3	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P3a	All	Increased food abundance and quality for splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from reduced food web disruption	3	2
P2a	Delta smelt	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	4	3
P1a	delta smelt	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	3	3
P2i	Fall, late Fall-run Chinook salmon	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	3	3
P1i	Fall, late Fall-run Chinook salmon	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	2	3
P2d	Green Sturgeon	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	2	2
P1d	Green Sturgeon	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	2	2
P2b	Longfin smelt	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	2	2
P1b	Longfin smelt	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	2	2

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes (contd.)				
P2c	Splittail	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	3	2
P1c	Splittail	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	3	2
P2h	Spring-run Chinook salmon, Sac.	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	3	3
P1h	Spring-run Chinook salmon, Sac.	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	2	3
P2f	Steelhead	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	3	3
P1f	Steelhead	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	2	3
P2e	White Sturgeon	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	3	3
P1e	White Sturgeon	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	3	3
P2g	Winter-run Chinook salmon, Sac.	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of pesticides on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races).	3	3
P1g	Winter-run Chinook salmon, Sac.	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from pesticides.	2	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N1	All	Possible drying up of some smaller creeks	3	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P3a	All	Increased food abundance for splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from reduced food web disruption and increased food quality and abundance for important invertebrate species.	2-3	2-3
P1	All	Reduced direct mortality of splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races) from contaminants.	3	2
P2a	Delta smelt	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	2	2
P2i	Fall-run Chinook salmon	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	3	3
P2d	Green Sturgeon	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	2	2
P2b	Longfin smelt	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	2	2
P2c	Splittail	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	2	2

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes (contd.)				
P2h	Spring-run Chinook salmon, Sac.	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	3	3
P2f	Steelhead	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	3	3
P2e	White Sturgeon	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	2	2
P2g	Winter-run Chinook salmon, Sac.	Reduced sublethal effects (behavior, tissue/organ damage, reproduction, growth, and immune) of contaminants on splittail, delta and longfin smelt, green and white sturgeon, steelhead, and Chinook salmon (all races)	3	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N1	Human health	Ponded or contained stormwater could exacerbate mosquito control problems and associated human health issues.	1	3
N2	Human health	Ponded or contained stormwater could transfer of contaminants to groundwater by infiltration	1	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P4	Chinook salmon, steelhead, and splittail- juvenile	Reduce predation on juvenile salmon, steelhead, and splittail by reducing habitat for non-native predatory fish.	2	2
P5a	Chinook salmon	Increase rearing habitat for juvenile salmon (all races), steelhead, and splittail.	3	3
P6a	Delta smelt	Increased extent of spawning habitat for delta smelt and longfin smelt.	2	2
P3a	Delta smelt	Improve the extent of delta and longfin smelt rearing habitat by reducing local water temperatures.	1	2
P2	delta smelt	Reduce predation of delta smelt as a result of reduced turbidity	3	2
P1a	Delta smelt	Increase food consumption by delta and longfin smelt due to higher turbidity	1	4
P6b	Longfin smelt	Increased extent of spawning habitat for delta smelt and longfin smelt.	1	2
P3b	Longfin smelt	Improve the extent of delta and longfin smelt rearing habitat by reducing local water temperatures.	1	2
P1b	Longfin smelt	Increase food consumption by delta and longfin smelt due to higher turbidity	1	3
P5c	Splittail	Increase rearing habitat for juvenile salmon (all races), steelhead, and splittail.	2	3
P5b	Steelhead	Increase rearing habitat for juvenile salmon (all races), steelhead, and splittail.	3	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N6	All	Possible endocrine disruption in fish by 2,4-D	2	2
N4	All	Increased blooms of microcystis due to a reduction in competition for nutrients	2	3
N3	All	Increase in detritus POC – temporally and spatially limited	2	2
N2	All	Reduction in phytoplankton quantity or quality from effects of herbicide	3	1
N1	All	Reduction in zooplankton from effects of herbicide	2	2
N5	Green & White Sturgeon	Possible toxic effects to juvenile white and green sturgeon from Fluridone and 2,4-D used at approved application rates	2	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P3a	Chinook salmon	Reduced predation mortality by black bass	2	3
P1a	Chinook salmon	Reduced predation mortality by striped bass	2	3
P3c	Delta smelt	Reduced predation mortality by black bass	2	2
P1c	Delta smelt	Reduced predation mortality by striped bass	2	2
P4	Delta smelt & Longfin smelt	Increased knowledge about the efficacy of using fishing regulations to modify bass population size	2	2
P2	Delta smelt & Longfin smelt	Reduced competition for food with delta and longfin smelt by juvenile striped bass	3	2
P3f	Green Sturgeon	Reduced predation mortality by black bass	1	2
P1f	Green Sturgeon	Reduced predation mortality by striped bass	1	2

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes (contd.)				
P3d	Longfin smelt	Reduced predation mortality by black bass	2	2
P1d	Longfin smelt	Reduced predation mortality by striped bass	2	2
P3e	Splittail	Reduced predation mortality by black bass	1	2
P1e	Splittail	Reduced predation mortality by striped bass	2	2
P3b	Steelhead	Reduced predation mortality by black bass	2	2
P1b	Steelhead	Reduced predation mortality by striped bass	2	2
P3g	White Sturgeon	Reduced predation mortality by black bass	1	2
P1g	White Sturgeon	Reduced predation mortality by striped bass	1	2

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N4	All	Unintended changes to the striped and black bass populations (e.g., decrease abundance but increase average size)	2	2
N3	All	Release of other competitor populations from predation pressure	3	3
N2	All	Release of other predator populations from predation pressure	2	2
N1	All	Increased bycatch of non-target species	1	2

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P3	Chinook Salmon	Increased population sizes of Chinook salmon	2-3	2
P1	Green Sturgeon	Increased population sizes of green sturgeon	3	2
P4	Steelhead	Increased population sizes of steelhead	2	2
P2	White Sturgeon	Increased population sizes of white sturgeon	3	2
Negative Outcomes				
N1	Chinook salmon & Green & White Sturgeon	Information gap about where poaching is most important may result in effort being directed at less important areas and may shift poaching to areas with greater importance to the population	1	2

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P3	All	Would improve ability to gather information about species	2	3
P4	Splittail	Increased predation on Corbula	2	2
P2	Splittail	Improved foodweb energy transfer in wet years	3	2
P1	splittail	Increase population abundance of splittail	3	2
Negative Outcomes				
N1	Splittail	Potential for redirection of fishing effort to other sensitive species	2	2

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P1	Chinook Salmon	Increased population size of Central Valley Chinook salmon (all races)	4	3
P2	Chinook Salmon	Increased knowledge base regarding Central Valley Chinook salmon (population sizes, harvest rates, success of restoration programs, and other key biological parameters) for improved management	3	3
P3	Chinook Salmon	Reduce competition and introgression from hatchery fish with natural fish on spawning grounds	4	3
P4	Chinook Salmon	Can improve broodstock management at hatcheries (with tagging, much improved)	4	4
Negative Outcomes				
N1	Chinook Salmon	Complicates management and data acquisition for conservation hatcheries (e.g., Livingston-Stone) and associated agency sampling programs	4	4
N2	Chinook Salmon	Action may lead to increased harvest of hatchery fish, which may result in higher bycatch of covered salmonids	2	2
N3	Chinook Salmon	Action may lead to sociological pressure for increased hatchery production	?	?

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P2a	Delta smelt	Preserve genetic diversity	3	2
P1a	Delta smelt	Increased population sizes to self-sustaining levels in the wild	3	2
P3	Delta smelt & Longfin smelt	Improved knowledge base about threats to and management of the species stemming from ability to study the effects of various stressors on these species using hatchery reared specimens	4	4
P2b	Longfin smelt	Preserve genetic diversity	3	1
P1b	Longfin smelt	Increased population sizes to self-sustaining levels in the wild	3	1
Negative Outcomes				
N4a	Delta smelt	Mortality associated with catching broodstock (genetic material lost)	2	3
N1a	Delta smelt	Genetic consequences for hatchery and wild populations	3	2
N3	Delta smelt & Longfin smelt	Mining of wild population to support broodstock needs	3	3
N2	Delta smelt & Longfin smelt	Negative ecological interactions with wild fish (competition, displacement)	3	2
N4b	Longfin smelt	Mortality associated with catching broodstock (genetic material lost)	2	2
N1b	Longfin smelt	Genetic consequences for hatchery and wild populations	3	1

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P2f	Chinook Salmon	Increased Food Availability	1	1
P1f	Chinook salmon-Fry and juvenile	Reduce entrainment mortality by non-project diversions	1	1
P2a	Delta smelt	Increased Food Availability	1	1
P2c	Green Sturgeon	Increased Food Availability	1	1
P1c	Green Sturgeon-juvenile	Reduce entrainment mortality by non-project diversions	1	1
P1a	Larval and juvenile delta smelt	Reduce entrainment mortality by non-project diversions	2	2
P2b	Longfin smelt	Increased Food Availability	1	1
P1b	longfin smelt- Larval and juvenile	Reduce entrainment mortality by non-project diversions	1	1
P2e	Splittail	Increased Food Availability	1	1
P1e	Splittail- Juvenile	Reduce entrainment mortality by non-project diversions	1	1
P2g	Steelhead	Increased Food Availability	1	1
P1g	steelhead-Fry and juvenile	Reduce entrainment mortality by non-project diversions	1	1
P2d	White Sturgeon	Increased Food Availability	1	1
P1d	White Sturgeon-Juvenile	Reduce entrainment mortality by non-project diversions	1	1

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Positive Outcomes						
P1a	Fall-run Chinook salmon- San Joaquin River	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	1	2	?	?
P1b	Spring-run Chinook salmon, Sac	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	1	3	3	3
P1c	Fall-run Chinook salmon, Sac.	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	2	3	3	3
P1d	Late Fall-run Chinook Salmon	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	2	2	2	2
P1e	Winter-run Chinook salmon	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	2	3	3	3
P1f	White Sturgeon	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	1	2	1	2
P1g	Green Sturgeon	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	1	2	1	2
P1h	Steelhead, Sacramento	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	2	3	3	3
P1i	Steelhead, San Joaquin	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	1	1	2	2

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Positive Outcomes (contd.)						
P1j	Delta smelt-adult	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	3	3	3	3
P1k	Delta Smelt – Larval and Juvenile	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	3	3	3	3
P1L	Longfin Smelt - Adult	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	2	3	2	3
P1m	Longfin Smelt – Larval-Juvenile	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	3	3	3	3
P1n	Splittail	Reduced entrainment and predation mortality of covered species directly associated with South Delta project facilities and operations.	2	3	2	3
P2	All	Increased food availability for covered species due to higher productivity at lower trophic levels in the Delta associated with increased residence time	2	3		

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Negative Outcomes						
N1a2	Winter-run Chinook salmon	Increased predation on juvenile Sacramento salmon, steelhead, and sturgeon associated with local hydraulics at new North Delta water diversion structures or with repeated impingement at screens that leads to long recovery times	2	2	4	2
N1b2	Fall-run Chinook, Spring-run Chinook, & Steelhead	Increased predation on juvenile Sacramento salmon, steelhead, and sturgeon associated with local hydraulics at new North Delta water diversion structures or with repeated impingement at screens that leads to long recovery times	2	2	4	2
N1c2	White sturgeon	Increased predation on juvenile Sacramento salmon, steelhead, and sturgeon associated with local hydraulics at new North Delta water diversion structures or with repeated impingement at screens that leads to long recovery times	2	2	2	2
N2a	Splittail- Juvenile	Increased predation on outmigrating juvenile fish in the mainstem Sacramento River and in Sutter, Steamboat, and Georgiana Sloughs due to lower flow conditions allowing aggregation of exotic predators and increased residence and travel time of juveniles in region of predators.	4	3		
N3	Delta smelt	Increased mortality of juvenile delta smelt associated with new North Delta facilities and operations	2	3	2	1
N4a,b	Green & White Sturgeon	Increased mortality of covered species due to degradation of water quality which increases a stressor (on fish species of concern)	2	2		
N4c	Chinook salmon- San Joaquin	Increased mortality of covered species due to degradation of water quality which increases a stressor (on fish species of concern)	4	1		
N4d	Steelhead- San Joaquin	Increased mortality of covered species due to degradation of water quality which increases a stressor (on fish species of concern)	4	1		
N4e	Splittail, Sac.	Increased mortality of covered species due to degradation of water quality which increases a stressor (on fish species of concern)	2	1		

Outcome Code	Covered Spp.	Description	Scenario 1 Magnitude	Scenario 1 Certainty	Scenario 2 Magnitude	Scenario 2 Certainty
Negative Outcomes (contd.)						
N5	Delta smelt	Lower quality Delta smelt habitat due to reduced turbidity (i.e. loss of sediment due to fewer pulse flows on the Sacramento River).	2-3	1		
N6a,b	Chinook Salmon & steelhead- San Joaquin	Increased frequency, duration and extent of low DO at Stockton and blockage of salmon/steelhead migration on the San Joaquin River.	4	4		
N6c,d,e	Green & White Sturgeon, & Sacramento splittail	Increased frequency, duration and extent of low DO at Stockton and blockage of salmon/steelhead migration on the San Joaquin River.	4	4		
N7	All	Loss of Sacramento River food material for covered species into the Delta due to diversions of water and reduction in flow to the Delta.	2	1		
N8	All	Increased Microcystis biomass which will affect aquatic food webs and covered fish species due to the new North Delta Diversion.	3	2		

Scenario 1

Mid-Range Hood Bypass Criteria.

- December 1 through June 30 maintain a Sacramento River bypass flow of not less than 11,000 cfs;
- July 1 through August 30 maintain a Sacramento River bypass flow of not less than 5,000 cfs;
- September 1 through November 30 maintain a Sacramento River bypass flow of not less than 7,000 cfs for fall salmon attraction and migration;
- Require at least 55% of river flows above minimum bypass flows during February-April, 45% during January and May, and 35% during December and June

Scenario 2

Low (5,000 cfs) Hood Bypass Criteria

- Set minimum bypass flow of 5,000 cfs year round except as provided in the bullet below;
- Require at least 55% of river flows above 5,000 cfs during February-April, 45% during January and May, and 35% during December and June (see figure 3) to maintain the shape of the hydrograph.

			Scenario 2a		Scenario 2b	
Outcome Code	**Covered Spp.**	**Description**	**Magnitude**	**Certainty**	**Magnitude**	**Certainty**
Positive Outcomes						
P8a	Chinook salmon	Increase survival of out migrating juveniles (steelhead and Chinook salmon) by providing migration route with lower predation and entrainment (at North and South Delta diversions) risk	3-4	3	3-4	3
P6c	Chinook salmon	Reduce losses due to stranding, illegal harvest and blocked/delayed passage for Chinook salmon, steelhead, green/white sturgeon	4	3-4	4	3-4
P5f	Chinook Salmon	Increase frequency and magnitude of transport of OC and organisms from Cache Slough/Bypass tidal marshes to support Delta foodweb for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2	2	2	2
P4f1	Chinook Salmon	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2-3	2	2-3	2
P3d1 & 2	Chinook salmon	Increase production of food for rearing of Chinook salmon, green and white sturgeon, splittail, and steelhead, on the seasonal floodplain	4	3	3-4	3
P2d	Chinook salmon	Create additional juvenile rearing habitat for splittail, green and white sturgeon, steelhead and Chinook salmon	4	4	4	4
P7	delta smelt	Increase delivery of readily suspendable sediments to north Delta and improved delta smelt habitats	3	3	3	3
P5a	Delta Smelt	Increase frequency and magnitude of transport of OC and organisms from Cache Slough/Bypass tidal marshes to support Delta foodweb for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	3	2	3	2
P4a	Delta Smelt	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	3	3	3	3

Outcome Code	Covered Spp.	Description	Scenario 2a Magnitude	Scenario 2a Certainty	Scenario 2b Magnitude	Scenario 2b Certainty
Positive Outcomes (contd.)						
P2b	Green & White Sturgeon	Create additional juvenile rearing habitat for splittail, green and white sturgeon, steelhead and Chinook salmon	1	2	1	2
P6a	Green & White Sturgeon Scenarios 1 & 2	Reduce losses due to stranding, illegal harvest and blocked/delayed passage for Chinook salmon, steelhead, green/white sturgeon	4	4	4	4
P5d	Green & White Sturgeon Scenarios 1 & 2	Increase frequency and magnitude of transport of OC and organisms from Cache Slough/Bypass tidal marshes to support Delta foodweb for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2	2	2	2
P4d	Green & White Sturgeon Scenarios 1 & 2	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2	2	2	2
P3b	Green & White Sturgeon Scenarios 1 & 2	Increase production of food for rearing of Chinook salmon, green and white sturgeon, splittail, and steelhead, on the seasonal floodplain	1	2	1	2
P5b	Longfin Smelt	Increase frequency and magnitude of transport of OC and organisms from Cache Slough/Bypass tidal marshes to support Delta foodweb for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	3	2	3	2
P4b	Longfin Smelt	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2-3	2	2-3	2

Outcome Code	Covered Spp.	Description	Scenario 2a Magnitude	Scenario 2a Certainty	Scenario 2b Magnitude	Scenario 2b Certainty
Positive Outcomes (contd.)						
P5c	Splittail	Increase frequency and magnitude of transport of OC and organisms from Cache Slough/Bypass tidal marshes to support Delta foodweb for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2	2	2	2
P4c	Splittail	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	3	2	3	2
P3a	Splittail	Increase production of food for rearing of Chinook salmon, green and white sturgeon, splittail, and steelhead, on the seasonal floodplain	4	4	4	4
P2a1 & 2	Splittail	Create additional juvenile rearing habitat for splittail, green and white sturgeon, steelhead and Chinook salmon	4	4	3	4
P1a1 & 2	Splittail	Create additional spawning habitat for splittail	4	4	3	4
P8b	Steelhead	Increase survival of out migrating juveniles (steelhead and Chinook salmon) by providing migration route with lower predation and entrainment (at North and South Delta diversions) risk	3-4	2	3-4	2
P6b	Steelhead	Reduce losses due to stranding, illegal harvest and blocked/delayed passage for Chinook salmon, steelhead, green/white sturgeon	4	3	4	3
P5e	Steelhead	Increase frequency and magnitude of transport of OC and organisms from Cache Slough/Bypass tidal marshes to support Delta foodweb for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2	2	2	2
P4e1	Steelhead	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2-3	2	2-3	2
P3c1 & 2	Steelhead	Increase production of food for rearing of Chinook salmon, green and white sturgeon, splittail, and steelhead, on the seasonal floodplain	3	3	2	3
P2c	Steelhead	Create additional juvenile rearing habitat for splittail, green and white sturgeon, steelhead and Chinook salmon	4	2	4	2

			Scenario 2a		Scenario 2b	
Outcome Code	**Covered Spp.**	**Description**	**Magnitude**	**Certainty**	**Magnitude**	**Certainty**
		Negative Outcomes				
N4	All	Reduced flows in Sacramento River and distributaries to support successful outmigration (scenarios 1 & 2).	2	3	2	3
N2	All	Increased resuspension/mobilization and export of toxic compounds w/impact on covered species (consider sensitivity to changes in land use - none stated in assumptions)	1-2	2		
N1	All	Increased MeHg and impact on covered species (on floodplain and downstream)	1-2	2		
N3d2	Chinook salmon-juvenile	Increased stranding of covered species (consider grading proposed in the approach)	2	4	2	4
N3d1	Chinook Salmon-Adults	Increased stranding of covered species (consider grading proposed in the approach)	1	4	1	4
N5a	Delta smelt	Increased habitat for predators/competitors to covered species	2	3		
N5d	Green & White Sturgeon	Increased habitat for predators/competitors to covered species	1	3		
N3b	Green & white Sturgeon-adult & juvenile	Increased stranding of covered species (consider grading proposed in the approach)	1	4	1	4
N5b	Longfin smelt	Increased habitat for predators/competitors to covered species	2	3		
N5c	Splittail	Increased habitat for predators/competitors to covered species	2	4		
N3a	Splittail- adult and juvenile	Increased stranding of covered species (consider grading proposed in the approach)	1	4	1	4

Outcome Code	Covered Spp.	Description	Scenario 2a Magnitude	Scenario 2a Certainty	Scenario 2b Magnitude	Scenario 2b Certainty
Negative Outcomes (contd.)						
N5e	Steelhead & Chinook salmon	Increased habitat for predators/competitors to covered species	2	4		
N3c1	Steelhead- Adults	Increased stranding of covered species (consider grading proposed in the approach)	1	4	1	4
N3c2	Steelhead- Juvenile	Increased stranding of covered species (consider grading proposed in the approach)	2	4	2	4

Scenario 2a

Period of Potential Operation: December 1-May 15
Desired Duration of Inundation: 45 days
Target Spill Discharge into Bypass: 4000 cfs
Predicted area of inundation: 22,982 acres
Predicted mean depth of inundated area: 2.2 feet
Predicted travel time: 6.5 days
Spill Frequency of Fremont Weir (assuming 4000 cfs and 45 day duration with a spill intermission of no more than 7 days): 48% of years (38 of 79), compared to 6% of years (5 out of 79) at existing weir height.

Scenario 2b

Period of Potential Operation: January 1-April 15
Desired Duration of Inundation: 30 days
Target Spill Discharge into Bypass: 2000 cfs
Predicted area of inundation: 17,421 acres
Predicted mean depth of inundated area: 2.3 feet
Predicted travel time: 9.3 days
Spill Frequency of Fremont Weir (assuming 2000 cfs and 30 day duration with a spill intermission of no more than 7 days): 54% of years (43 of 79), compared to 6% of years (5 out of 79) at existing weir height.

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P4f	Chinook salmon	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2	2
P2d	Chinook salmon	Create additional juvenile rearing habitat for splittail, green and white sturgeon, steelhead and Chinook salmon	3-4	3-4
P8a	Chinook salmon	Increase survival of out migrating juveniles by providing mitigation route with lower predation and entrainment (at North and South Delta diversions) risk.	3-4	3
P7a	Delta smelt	Increase delivery of readily suspendable sediments to Prospect Is and improved DS habitats	3	2
P5a	Delta smelt	Increase transport of OC and organisms from Prospect/Miner Sl tidal marshes to support Delta foodweb for DS, LS, CS, splittail, steelhead, G/W sturgeon	3	2
P4a	Delta smelt	Increase export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for DS, LS, CS, splittail, steelhead, G/W sturgeon	3	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes (contd.)				
P4d	Green & White Sturgeon	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	1	2
P2b	Green & White Sturgeon	Create additional juvenile rearing habitat for splittail, green and white sturgeon, steelhead and Chinook salmon	1	2
P4b	Longfin smelt	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	2	2
P4c	Splittail	Increase frequency and magnitude of export of DOM, POM and organisms from seasonal floodplain to provide food in Delta for delta smelt, longfin smelt, Chinook salmon, splittail, steelhead, and green and white sturgeon	4	4
P3a	Splittail	Increase production of food for rearing of CS, splittail, steelhead, (onsite = seasonal floodplain only)	4	4
P2a	Splittail	Create new juvenile rearing habitat for CS, splittail, steelhead, G/W sturgeon (esp. for American River CS and steelhead)	4	4

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes (contd.)				
P1a	Splittail	Create new spawning habitat for Splittail	4	4
P6a	Steelhead	Increase in upstream migration opportunity for CS and steelhead	2	2
P4e	Steelhead	Increase production of food for rearing Chinook salmon, steelhead, green and white sturgeon, and splittail from inundation and riparian vegetation (local)	2	2
P2c	Steelhead	Create additional juvenile rearing habitat for splittail, green and white sturgeon, steelhead and Chinook salmon	3	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes				
N4a	All	Reduced flows in Sacramento River and distributaries to support successful outmigration.	2	3
N2a	All	Increased resuspension/mobilization and export of toxic compounds w/impact on covered species (consider sensitivity to changes in land use - none stated in assumptions)	2	2
N1a	All	Increased MeHg and impact on covered species (on floodplain and downstream)	2	3
N3d1	Chinook salmon-adults	Increased stranding of covered species	1	4
N3d2	Chinook salmon-juvenile	Increased stranding of covered species	2	4

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes (contd.)				
N5a	Delta smelt	Increased habitat for non-native predators/competitors to covered species	1	3
N6a	Delta smelt & Longfin smelt	Decrease in turbidity downstream of Yolo and reduction in habitat for delta smelt and longfin smelt	1	3
N5d	Green & White Sturgeon	Increased habitat for predators/competitors to covered species	1	2
N3b	Green & White Sturgeon	Increased stranding of covered species	1	4
N5b	Longfin smelt	Increased habitat for predators/competitors to covered species	1	3

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Negative Outcomes (contd.)				
N3a1	Spilttail- Adults	Increased stranding of covered species	1	4
N3a2	Spilttail- Juvenile	Increased stranding of covered species	2	4
N5c	Splittail	Increased habitat for predators/competitors to covered species	1	3
N5e	Steelhead & Chinook salmon	Increased habitat for predators/competitors to covered species	1	3
N3c1	Steelhead- Adults	Increased stranding of covered species	1	4
N3c2	Steelhead- Juvenile	Increased stranding of covered species	2	4

Outcome Code	Covered Spp.	Description	Scenario 1		Scenario 2	
			Magnitude	Certainty	Magnitude	Certainty
Positive Outcomes						
P1a	Delta smelt – adult	Reduce entrainment induced mortality of covered fish species from the western Delta.	2	3	3-4	2-3
P1b	Delta smelt - Larval	Reduce entrainment induced mortality of covered fish species from the western Delta.	2	1	2-3	2
P1c	Longfin smelt – Adult	Reduce entrainment induced mortality of covered fish species from the western Delta.	1	3	2-3	2
P1d	Longfin smelt – Larval	Reduce entrainment induced mortality of covered fish species from the western Delta.	1-3	2	1-3	2
Negative Outcomes						
N3a	Delta smelt	The gate structure may be conducive to higher predator presence and therefore the risk of predation on covered fish species may increase	2	2		
N2a	Delta smelt	When closed, the gates could increase entrainment and mortality of Delta smelt in the central and southern Delta.	2	2		
N3c	Longfin smelt	The gate structure may be conducive to higher predator presence and therefore the risk of predation on covered fish species may increase	1	2		
N2b	Longfin smelt	When closed, the gates could increase entrainment and mortality of Delta smelt in the central and southern Delta.	2	2		

Scenario 1 D-1640 Baseline

Scenario 2 OCAP delta smelt BO